ASSESSMENT OF PREDATOR-PROOF BOMAS AS AN EVIDENCE-BASED CONSERVATION TOOL IN LOITOKITOK SUB-COUNTY, KENYA

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DECLARATION

This project report is my original work and has not been presented for examination in any other university.

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DEDICATION

Dedicated to my family Lilian, Rispah and Jeremy for being patient and the generous support you have offered me during my studies. Without you, I would not have come this far.

‘*’After climbing a great hill, one only finds that there are many more hills to climb’’*

(Nelson Mandela)

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ABSTRACT

Human-wildlife conflict (HWC) occurs when wildlife requirements encroach on those of the human population. The conflict has been in existence for many years, both in developing and developed countries. HWC in Africa, particularly livestock predation can results in great economic losses to communities as well as decline in carnivore's species. The human-carnivore conflict has been intensified by loss of wildlife habitats, negative community attitudes, and the reduction in wild prey base due to the rapid demographic developments. In Kenya, various strategies such as compensation for livestock losses and injuries, guarding livestock while grazing in the field, translocation of the problematic predator, and use of barrier such as the predator-proof bomas (PPB) have been used to mitigate conflicts between human and carnivores.

This study examined the use of the predator-proof bomas in mitigating human-predator conflict in the Amboseli ecosystem in Loitokitok sub-county. The researcher sought to find out the performance of predator-proof boma, the most problematic predator, community perception on the most problematic predator, effects of predator-proof bomas on community livelihood, and to compare the characteristics of predator-proof bomas and traditional bomas. Forty five respondents with predator-proof bomas from three group ranches, OGR, MGR and Kimana/Tikondo were first selected using a multistage technique. Additional 45 traditional bomas within the range of 1 kilometre were sampled using a paired experimental design. This was done to facilitate a comparisons of the traditional bomas and the predator-proof bomas characteristics, and the respondent's perceptions and attitudes. Data was analyzed using frequencies tables, percentages, correlation and regressions.

The results revealed that majority of the respondents were 42-49 years (31.1%), an indication that they had a relative long experiences with human-predator conflicts. On average, the bomas consisted of 20.41±1.654 people, 242.54±25.633 livestock, 5.03±0.390 traditional huts and 2.11±0.120 livestock gates. The respondents, had more Shoats (160.8±16.355) than cattle (81.99 ±11.870) and donkey (1.96±0.337). The mean circumference of the boma was 138.9±5.4681m. The size of the boma correlated with the total number of livestock in the boma (r= 0.386, n=90, p=0.000) but not the number of people. Livestock losses to predator were more in field than in traditional bomas. Hyena and lion accounted for the highest loss of shoats and cattle; with hyena

mostly (37%) killing shoats and lions preying largely on cattle (34%). Hyena was cited as the most problematic predator (68%). There was a positive relationship between the most problematic predator and total number of livestock ($r = 0.319$, $n=90$, $p = 0.002$), boma circumference ($r = 0.295$, $n=90$, $p = 0.005$), number of traditional huts ($r = 0.015$, $n = 90$, $p=0.892$), numbers of gates around the boma ($r = 0.173$, $n =90$, $p=0.103$); and number of people in the boma ($r=0.140$, $n=90$, $p = 0.188$). Livestock predation was high both in the boma and in the grazing field during the wet seasons (April, September, October and December). This was attributed to availability of water in the entire ecosystem that trigger both herbivore and predator to migrate from the park into group ranches, where livestock becomes an easy prey compared to the wild herbivores. The fortification of bomas to predator-proof status resulted in the reduction in livestock predation at night in bomas by 91.11% (n=45). Majority of the respondents (62%, n=45) rated the performance of the predator-proof boma as 'Excellent". The predator-proof bomas resulted to reduced depredation on livestock and time spend guarding at night thereby positively enhancing the livelihood of the respondents. However, the effectiveness of the boma is largely depend on it's the size, livestock numbers, number of entrances to the boma and the type of predator that challenges the boma. Majority of the respondents were conversant of the role of predator in the ecosystem (66%) and 73% were of the opinion that predators should be protected because they bring more benefits than harm and indication of the community's level of awareness.

The researcher recommends that an awareness should be carried out to encourage the community to keep vigilance of livestock grazing in the field to avoid predation during the day. The livestock should also be returned home early enough and counted, so that any lost livestock in the bush can immediately be searched before dark; construction and maintenance of the predator-proof boma should be encouraged as a long term solution to livestock loss at night and an additional research on distribution of prey densities effects on livestock predation problem should be carried out. The project implementing organization should focus on enhancing boma maintenance which will help to increase community ownership of the project and deter livestock attacks in the predator-proof bomas.

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LIST OF ACRONYMS

AWF	African Wildlife Foundation
BFF	Born Free Foundation
CBD	Community Based Conservation
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GOK	Government of Kenya
ha	hectares
HWC	Human Wildlife Conflict
IUCN	International Union for Conservation of nature
KWS	Kenya Wildlife Service
MEA	Millennium Ecosystem Assessment
MGR	Imbirikani Group Ranch
OGR	Olgulului Group Ranch
PPB	Predator-Proof Boma
UNEP	United Nation Environmental Programme
USDA	United Stated Department of Agriculture

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

Human-wildlife conflict (HWC) arises when wildlife such as elephants, hyena, bear, and crocodiles among others share the same physical space with humans. According to Mayaka (2002), HWC is a "contentious issue" that negatively impacts on the local resident's socio-economic dimensions, while at the same time wildlife species are legally protected both nationally and internationally. Historically, HWC has been in existence since the dawn of man, for example Berger and Clarke (1995) affirmed that first hominids fell prey to the animals with which they shared their habitats and shelters. The HWC can be ''real or perceived, economic or aesthetic, social or political'' (Messmer, 2000). Dickman (2010); Hoffman and O'Rian (2012) asserts that HWC is a global problem occurring both in developed and developing world. The conflict is rapidly becoming a key issue to the wildlife conservationist and managers as society is diversified with varied opinions, with more people wanting to actively participate in wildlife management decisions (Marchini, 2014).

Barlow (2009) points out that HWC involves a huge diversity of situations and species, from a grain eating rodents to a man eating tigers (*Panthera tigris*). For instance, in the Sanjiangyuan region of China, brown bear are reported to raid villages and damage foods stores and kill sheep. It is estimated that the cost of repairing damages ranges from $700 to $2800, which is exceeds most family's annual income (Worthy & Foggin, 2008). In the United States of America (USA), Storm et al (2007) found out that the white-tailed deer (*Odocoileus virginianus*) collision with motorist was injuring 29,000 people and damaging properties worthy more than $ 1 billion annually in rural counties. In Manitoba Canada, conflict between elk (*Cervus elaphus*) and the farmers had been documented since 1880. However, the creation of the Riding Mountain National Park in 1930 and a ban in hunting increased the elk population and intensified elk-farmers conflicts. Elks damage fences and crops estimated to be over $ 24,000 annually and they are also associated with the spread of bovine tuberculosis to dairy cattle (Brook, 2009).

Africa is one of the continents which still hold a considerable number of wildlife, and HWC is very high. This has been attributed to the poverty, defective institutions, and over-reliance of people on

natural resources, which happens to be the home of wildlife. As illustrated by Lamarque *et al.* (2009) that communities in Africa loses up to 10-15% of their agricultural produce to elephants, a figure which might seem low nationally, but very significant to individual families. For example, in Cabo Delgado province of Mozambique, 70 people were killed by elephants in 2001-2002 while protecting their crops at night, while in Tanzania, 28 people were killed and 57 other injured by crocodiles between 1999-2004; and in Kenya more than 200 people were reported to have been killed by elephants between the years 2000 and 2007(FAO, 2009).

1.1.1 Human-wildlife conflict in Kenya

Changes in land use patterns, sedentary lifestyle of the pastoralist, inadequate wildlife control, expansive farming and a ban on hunting of some wild animals have been cited by Prins and Grootenhuis (2000) as some of the factor that have escalated the HWC. Kenya is classified by the Convention on Biological Diversity (CBD) along with Indonesia, Brazil, Congo, Madagascar and Tanzania as a mega-diverse country because of its species' richness, endemism and ecosystem diversity. Wildlife resources play a key role in generating revenue and wealth creation thus contributing directly and indirectly to the local and national economy. For example, in the year ending 30th June 2006, wildlife accounted for 70% of the gross tourism earnings, 25% of the Gross Domestic Product (GDP) and more than 10% of total formal sector employment. Furthermore, productive sector such as agriculture, fishing, livestock, water, energy, forestry and trade and industry, which are a source of livelihood for people, gain vital environmental goods and services from wildlife resources(Ministry of Tourism & Wildlife, 2007).

Conversation of land for agriculture and population pressure have reduced land and other resources available for wildlife, resulting in an increase in HWCs, which is a significant threat to ecosystem variability in general and large mammal populations in particular. The Ministry of Tourism & Wildlife (2007) affirms that:

> "HWCs are also manifested through encroachment on protected areas and poaching and killing of animals, some of which are endangered or threatened, in retaliation or to prevent future conflicts. Thus, HWCs are occurring more and more and affecting many different species. Increasing human-wildlife conflict is a major problem in wildlife areas. Acute water shortage and inadequate dry season pasture has severely affected

wildlife, livestock and humans. As competition for the available resources continues, there have been rising levels of human wildlife conflicts. In addition to climate variability, increased HWCs have been attributed to extending human activities in areas originally preserved for wildlife"

Kenya Wildlife Service (KWS), the state corporation mandated to protect and conserve wildlife. KWS together with other wildlife stakeholders have a number of mitigations measures that are being implemented to reduce HWC. For example, live animal translocations have been carried out to ease pressure from some areas to other ecosystems and mitigate HWC. In 2012, forty three (43) elephant were trans-located from Siyiapei to the Maasai Mara National Reserve, and another 35 elephants were moved from Tana River County to Meru and the Aberdares National Park (KWS, 2012).

Kenya has a total area of 582,646 km^2 , of which 44,562 Km^2 is national parks and reserves – approximately 8% of the country national parks account for 5% and national reserves and sanctuaries for about 3% (Ministry of Tourism & Wildlife, 2007); It is estimated that 65-80% of the wildlife are outside the government protected areas in community land (Matiko, 2000). One such area where wildlife is sustained by the diverse communal areas is Amboseli National park. Amboseli National park and its surrounding communal land has been documented to have human-wildlife conflict that has adverse impacts on wildlife and humans. It is reported that between 1974 and 1990, one hundred and forty one (141) elephants were killed through spearing (Kangwana, 1993). Muruthi (2005) identified the main problems in the Amboseli region as competition for water and grazing, killing of livestock, disease transmission and human fatalities. Muruthi adds that where local livelihoods depends on livestock production, high levels of human-carnivore occurs.

There is a range of approaches that are being implemented in Amboseli region to mitigate the human-carnivore conflicts. The most common are compensation scheme for livestock killed by carnivores, lion monitoring to alert the herds and evade lion areas, land zoning for wildlife and grazing, lion lights installation and predator-proof bomas. This study will focus on the predator-

proof bomas project which is being implemented in three community group ranches: Olgulului, Imbirikani and Kimana/Tikondo.

1.1.2 The predator-proof boma project in Kenya

Predator-proof bomas is one of the measures prescribed by the KWS in the *Conservation & Management Strategy for Lions & Spotted hyenas in Kenya*-2009-2014 for addressing human-predator conflicts. Since 2010, The Born Free Foundation, African Wildlife Foundation (AWF) and KWS have been partnering to implement the predator-proof bomas. The project seeks addresses three key objectives:

a) To limit or eliminate human-lion/hyena conflicts and related issues;
b) To change community negative perceptions of carnivores especially hyena;
c) To enhance community awareness and promote coexistence.

The project entails upgrading the traditional Maasai manyatta by adding posts, chain-links and flattened oil drum doors. In March 2015, a total of 175 traditional Maasai bomas had been upgraded to Predator-Proof Bomas status both in Amboseli-Tsavo ecosystem in Kenya and West Kilimanjaro in Tanzania. The project is implemented on a cost sharing basis, with community members contributing 25% of the material and operation costs (BFF, 2014).

The project focuses on livestock predation at night and intend to change the perception of the beneficiaries of the project and encourage others to adopt the PPB. However, livestock predation in the field while grazing is likely to negatively influence the community attitudes to the project and the predators. There is also the question of whether the PPB are 'diverting' predators to the traditional bomas (unfenced) or not. This study, was designed to fill up the identified gaps in the project so as to help inform future replications and designs by implementing organizations. In addition, there is an increasing pressure from the donors for "evidence" and hence the need for evidence-based conservation. The evidence is essential in measuring the effects of such projects and therefore providing a basis upon which donors, beneficiaries, researchers and the implementing organizations can replicate the project in other areas experiencing similar problems.

1.2 STATEMENT OF THE PROBLEM

Human-wildlife conflict (HWC) occurs when wildlife requirements overlap those of human populations, creating costs to residents and wild animals (Ogada, 2011). The HWC is fast becoming a critical threat to the survival of both large and rare globally endangered species (MEA, 2005). According to Woodroffe *et al.* (2005), conflicts increases as human encroach on wildlife areas and, potentially, as wildlife repopulate human-dominated landscapes. Conflicts caused by livestock predation lead to retaliatory killing of large carnivores. This is perhaps the most serious threat facing large carnivores amidst the ever-expanding human population (Kissui, 2008). In Kenya, more than 50% of wildlife habitat is outside protected area in communal grazing lands and group ranches, where wildlife, people, and livestock all interact and compete for the same natural resources increasing the rate of conflicts. Livestock predation can cause significant economic losses among pastoralists. Patterson *et al.* (2004) estimated livestock predation to represent 2.6% of the herd's economic value in Galana ranch in Kenyan, which incurred a loss of $8749 per annum, a similar study Butler (2000) recorded economic loss averaging $13 or 12% of each household's net annual income in Zimbabwe.

Against this background, effective conservation of large carnivores – both inside and outside reserves – demands the resolution of conflicts between people and predators. The extent to which this is achievable depends upon whether predators' impact on human lives and livelihoods can be reduced to a level that local people will tolerate, without reducing the predators population (Woodroffe & Frank, 2005). Different mitigation methods have been tried to reduce livestock predations, including separating livestock and carnivores (e.g. predator-proof fencing, confining livestock at night or during bad weather), discouraging predators (e.g. electric fences, proper carcass disposal, adjusting lambing/calving seasons), and guarding livestock (Treves & Karanth, 2003). The effectiveness of these interventions in reducing conflicts has not always been adequately assessed (Rigg, *et al*, 2011; Sapkota *et al*, 2014).

In Amboseli, it is not well known if the predator-proof bomas have actually reduced the livestock predation compared to traditional bomas. Therefore, the purpose of this study was to assess the efficacy of the predator-proof methods in group ranches around Amboseli national park. The study also assessed the perceived socio-economic benefits of the intervention, losses associated with

depredations, and the most problematic predator in livestock depredation. The researcher hypothesised that the community's perception on the effectiveness of predator-proof boma, human-carnivore conflicts, and attitude toward problematic carnivore will generally vary across the study community due to the contextual differences among the communities.

The study is essential for Born Free Foundation, African Wildlife Foundation, Kenya Wildlife Service, and group ranches management which are implementing the project in Amboseli ecosystem. Minimizing human-carnivore conflict by using the predator-proof boma is one of the methods outlined in the 'Conservation and Management Strategy for lions and spotted hyenas in Kenya 2009-2014. The strategy is expired in 2014, and knowing the performance of predator-proof bomas is vital in formulating sections the next conservation strategy (2015-2020).

The study expected to answer the following research questions:

i. What are the community opinions on the predator-proof fences performance?
ii. Which is the most problematic predator in predation of livestock?
iii. What are the community's attitude and perception on the most problematic carnivore?
iv. What are the effects of predator-proof barrier on household's livelihood?
v. Is there a significant difference between predator-proof bomas and the traditional bomas?

1.3 OBJECTIVES

i. To describe the community opinions on the effectiveness of the predator-proof barrier in mitigating livestock predation;
ii. To establish the most problematic predator on livestock attacks in the community;
iii. To assess the local community's attitude towards the main problematic carnivore;
iv. To assess the perceived social-economic benefits of predator-proof barriers to the beneficiary households;
v. To compare traditional bomas and predator-proof bomas characteristics.

1.4 RESEARCH HYPOTHESES

i. A higher perceived effectiveness of the predator-proof boma would be associated with decline in human-carnivore conflicts;

ii. Communities with higher perceived effectiveness of predator-proof bomas would have more favourable attitude toward carnivores than those without;
iii. There is a significant difference in the characteristics of fenced and unfenced boma

1.5 JUSTIFICATION AND SIGNIFICANCE OF THE STUDY

This study is important to the following stakeholders:

1.5.1 Case study (BFF, AWF, KWS & group ranches)

The predator-proof boma projects funding organizations will use the data obtained to determine what progress has been made toward achieving project aims. This will assist in making decisions on whether to or not to replicate the project in other areas that are facing human-carnivore conflict. There is potential for leverage of further funding; particularly important considering conservation projects sole reliance upon receipt of grants and donations.

1.5.2 The government of Kenya

The KWS is the state corporation with the mandate to wildlife conservation and management in Kenya. The KWS will use the data in gauging the progress made in minimizing human-lion/hyena conflict by 50% as outlined in its 'Conservation and Management strategy for lions and spotted hyena in Kenya (2009-2014).

1.5.3 Researchers

The predator-proof boma project is a new concept in Amboseli-Tsavo ecosystem and there are no studies that have been carried in Amboseli to document the performance of the predator-proof bomas as tool to mitigate human-carnivore conflict. It is against this background that this study was undertaken to contribute to further knowledge and act as a basis for further research for future researchers on other related topics; it will help other academicians who undertake the same topic in their study and shall recommend areas for further studies.

1.6 RESEARCH ASSUMPTIONS

The study assumed that all target respondents' (community) would generally cooperate and provide all the relevant information that would be used in arriving at valid conclusions and

recommendations of the study. The researchers also expected that the translation of the questions from English to Maasai did not distort the message. It was presumed that a period of six (6) months was sufficient enough for the performance of the predator-proof boma to be based on.

1.7 OPERATIONAL DEFINITIONS

Attitude: the tendency to respond positively or negatively towards a certain idea, object, person, or situation.

Boma: a traditional Maasai night-time enclosures made of a ring of cut thorns bushes, approximately surround the homesteads and livestock sheds and has no chain-links.

Community participation: active involvement by the public in decision making processes through use of the national media, relevant consultative mechanisms and public hearings

Effectiveness of the boma: the capability of a boma to prevent predators from entering it and preying on livestock.

Human-wildlife conflict: interaction between people and wildlife that results in negative effects on any human social, economic or cultural life and affects the conservation of wildlife and their environment.

Community perception: the act of the people knowing, analyzing things and taking a position.

Predator-proof boma: a reinforced traditional Maasai homestead with thorn bush, posts, chain-links and flattened drum oil gates.

Problematic predator: a lion, hyena, cheetah, leopard or jackal which injures or kills livestock frequently.

CHAPTER TWO
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses the literature reviewed related to research problems. It looks at the human-wildlife conflict from the general global perspective, type of human-wildlife conflicts, and then narrow down to the human-predator conflicts, its impacts and the various mitigation measures that have been used. The last part of the chapter focuses on the use of the barrier methods and their application in the Amboseli ecosystem.

2.2 GLOBAL HUMAN-WILDLIFE CONFLICTS

Human-wildlife conflict (HWC) has been defined by IUCN (2005) as 'when wildlife requirements encroach on those of human populations, with both cost to both residents and wild animals''. HWC has been in existence for as long as humans and wild animals share the same landscapes and resources, for example Berger and Clarke (2005) asserts that first hominids fell prey to the animals with which they shared their habitats and shelters. All continents and countries, whether developed or not, are affected by HWC. In the United States (US), deer collusions with automobiles cause injuries to an average of 29,000 people annually and cause more than US$ 1 billion in damage (USDA, 2006). In United Kingdom, badgers spread bovine tuberculosis to dairy cattle (Wilkinson, *et al*, 2004), while Australian farmers have always regarded kangaroos as pest, because they damage crops and compete with sheep for forage (Treves, 1999). In China, the rural community around Xishuang Banna Nature Reserve losses their crops to elephants, totalling to US$ 314 600 between 1996 and 1999 (Zang & Wang, 2003).Crocodiles have attacked and eaten humans and their predecessors in Africa over the last four million years. Egyptian historical recorded reveal that in 200BC hippopotamuses in the Nile delta fed on cultivated crops while crocodile ate livestock and occasionally humans (FAO, 2009).

According to Nelson and Sillero-Zubiri (2003) and MEA (2005), HWC is fast becoming a critical threat to the survival of many globally endangered species, including the large and rare mammals. The conflict is considered to be even more problematic as it affects poorest human populations vulnerable in terms of food security, health, education, infrastructure, social institutions and violent conflict over natural resources (USIP, 2001).

2.3 HUMAN-CARNIVORE CONFLICTS

Human-carnivore conflict is one of the main limitations to biodiversity conservation efforts outside many protected area (Mwakatobe *et al*, 2013). Baldus (2004), Sillero-Zubiri and Laurenson (2001) argues that despite the large taxonomic diversity in species conflicting with humans, a variety of factors mean that large carnivores tend to generate particularly intense conflict. Their obligate carnivory results in competition with humans for both domestic and game species, and such predation can have significant economic impacts. Moreover, they are large-bodied, potentially aggressive and can sometimes kill human themselves, which understandably generates powerful antagonism toward their presence around area of human habitation. According to Ogutu *et al.* (2003), conflict with local people, particularly over depredation of livestock, is a major cause of population decline in carnivore, affecting both protected carnivore populations as well as those living outside of protected areas.

Perceived economic losses due to livestock depredation often lead to retaliatory responses by agro-pastoralists. These include carnivore persecution, opposition to wildlife sanctuaries close to farms, or resistance to reintroduction of extirpated predators to protected areas. In many cases these responses hinder the conservation of threatened species, and increasingly, contravene the public and political aims of large carnivore management (Graham *et al*, 2004). As result, natural resource managers and researchers are seeking methods to prevent some or all carnivore predation on domestic animals at the outset (Treves *et al*, 2004).

2.4 THE CAUSES OF HUMAN-CARNIVORE CONFLICTS

Human-carnivore is as result of various factors: habitat loss, community attitude and perceptions and reduction in wild prey.

2.4.1 Habitat loss and anthropogenic activity

The broad patterns of changes in land use and cover have occurred since the advent of modern industrial times are reasonably well characterized. Global-scale changes in land use and cover are dominated by increase in cultivated land (UNEP, 1993). According to Richards (1990), since 1700s, some 12 billion ha of land have been brought into cultivation. This expansion has not occurred evenly throughout the world; Americas, South-east Asia and former USSR have

experienced greater rates of conversion to agricultural land than the world as whole. The expansion of cropland is at the expense of forestland and wildlife habitats (Meyer & Turner, 1992).

Land degradation is rapidly leading to loss or reduction of land productivity as result of human activities. Land degradation may be caused by a variety of anthropogenic pressures including deforestation, overgrazing, unsustainable agriculture practices and industrial activities. In practice, land degradation typically occurs as a result of a combination of these physical, chemical, biological and socio-economic factors, rather than as result of any one single factor (UNEP, 1993). If degradation of cultivated land continues, the predictions are that harvest yields will be reduced by half in 40 years resulting to food insecurity (UNEP, 2002).Food shortages encourages poor populations to resort to wild resources, which often become over-exploited to the extent that the capacity to regenerate is endangered. Conservation of carnivores must occur in the context influenced by the failure to satisfy the protein needs of the human population. The increasing livestock numbers in Africa, particularly in the sub-Saharan Africa exerts pressure on natural habitats that supports the prey base for carnivores. If prey habitats are converted to agricultural or pastoral land, human-carnivore conflicts are sound to increase. (FAO, 2010).

2.4.2 Community attitude and perceptions

During the colonial period in African, European introduced the unsustainable hunting of wildlife. The colonial approach lead, not only, to the failure in conservation, but also to a drastic change in the way the local people viewed wildlife (Kiss, 2003). What was once viewed as irreplaceable assets and highly guarded, local communities began to view wildlife as worthless. Locals also began to believe the only ones who benefited from wildlife were the state, wildlife departments, tourists and poachers. They began to despise the wildlife departments, and the relationships between the two quickly fell apart (Nsanjara, 1993). Even with the introduction of Community Based Conservation (CBC), rural communities do not see the link between themselves, tourism and CBC programs because they do not have access to money generated by tourism (Kirby, 2003).

According to Linnel *et al.* (2005), community interaction with large carnivores, primarily overlap of predator range and human distribution directly reduces people's perceived quality of life. Lions are considered by many rural communities as pests to be eliminated. For example, the Maasai

pastoralists who traditionally were perceived to be tolerant to wildlife have become less willing to suffer losses by predations without compensation. Kiss (2003) argues that biodiversity loss is linked to economic forces and thus communities will not stop to convert land to agriculture or performing retaliatory killings of predators until benefits reach then directly.

Cultural believes also influence people's attitude toward wildlife, for instance in Maasai societies, spotted hyenas are often reputed with hostility disproportionate to their impact on stock, as they have many negative associations with gluttony, stupidity and witchcraft (Frank, 1998). Hazzah (2006) study in Amboseli showed that religious beliefs have significant in explaining variation in attitudes towards wildlife: that people who adhered to the evangelical teachings of the Kenyan Assemblies of God (KAG) church were more hostile towards carnivores and were seemingly less likely to employ good livestock husbandry techniques as they trusted that God would take care of their stock for them.

2.4.3 Reduction in wild prey base

Due to human population growth, people have encroached into wildlife areas thus reducing the area where wild herbivores range. This coupled with competition for pasture with domestic and illegal hunting by the communities has led to reduction in wild prey numbers (KWS, 2009). Commercial poaching is becoming a significant threat with the growing urban demand for bushmeat, and modern weapons are widely available; in contrast there is less and less traditional hunting in spite of its low impact on wildlife resources and its significant socio-cultural importance (Galhano Avles & Harouna, 2005). According to Nowell and Jackson (1996), the fatal attack by lions in southern Tanzania in 1980s was a result of widespread poaching that reduced the population of wild ungulates forcing the lions to turn to livestock. However, TRAFFIC report (1997), attributes the increased illegal wildlife killing to the non-consumptive policies particularly in many African countries and rural poverty. As such, people are compelled to use what naturally occurs around them; in this context wild animals become an economic resource of major importance, mostly as food. The report asserts that wildlife is critically important as source of cheap protein for malnourished people and, when traded as cash income where few alternative sources of income exist, although this is regarded illegal in many countries.

2.5 TYPES OF HUMAN-CARNIVORE CONFLICTS

Thirgood *et al.* (2005) listed predation upon livestock, predation upon game species, attacks on humans, crop raiding, and diseases transmission as most common direct causes of conflicts.

2.5.1 Livestock predation

Kruuk (2002) claims that since humans domesticated the first animals several thousand years ago, there have been conflicts with larger carnivores attacking livestock. Kruuk assertions are exemplified by the following cases, in Western United State of America(USA), coyote kill between 1% and 5% of adult sheep and between 4% and 9% of lambs(Andelt,1992); and in Europe, most livestock problems are supposedly caused by wolves, Eurasian lynx, brown bears and wolverines. According to Breitenmoser *et al.* (2000), lynx killed about 19000 sheep in Norway between 1990 and 1995.In Asia, Asiatic lions, leopards, wolves and tigers feed extensively on domestic animals due to an acute depletion of their wild preys in their ranges (Miller & Jackson 1994).

According to Nowell and Jackson (1996), livestock predation in Africa is a problem both along the border of protected areas and outside the reserves. In their study in Namibia in 1996, they found out that leopards and cheetah each killed an average of 320 cattle and 375 sheep between 1986 and 1991 while Kissui (2008) study in Northern Tanzania indicates that Maasai pastoralist lost 58% of livestock to hyenas, 25% to lions and 17% to leopards. Patterson *et al.* (2004) reported annual losses of 2.4% for all livestock ranches in South-eastern Kenya while Kolowski and Holecamp (2006) reported an annual loss of 0.6% for cattle and 0.2% for goats and sheep in the Maasai Mara.

2.5.2 Predation upon games

Prey population of interest to the hunters, can be reduced by predator such as Wolves, bears and lynx (see e.g. Gasaway *et al.,* 1992; Thirgood, 2000; Peterson, 2004) resulting to tension between hunter and carnivores. Sillero-Zubiri and Laurenson (2001) found out that predation upon game was the second common reason for human-carnivore conflicts. Although predation on endangered species is part of natural process, rare species caught in a ‘’predator pit’’ need to be freed by wildlife managers to escape extinction (FAO, 2010). For instance, in Kruger National Park in South Africa,

lion predation has been suspected as major cause of the decline of roan antelope(*Hippotragus equinus*), although Harrington *et al*. (1999) cites mismanagement as possible reason. In Kenya;

> ''…the KWS has, over several months, culled some 30 lions from the Aberdare National park which is fenced, (where) the total number of lions is estimated to be 145-180. The principal reason for culling is their having been the main predators of the rare Bongo(*Boocerus euryceros*) as well as inflicting serious depredation on the bush pig and giant forest hog within this particular habitat…''(Nehemiah Rotich, in Anon,2000).

2.5.3 Human deaths and injuries

Human deaths and injuries, although less common than crop damage, are most severe manifestations of human-wildlife conflicts (FAO, 2005). For example the Sundarbans region of eastern India has long been a; 'hotspot' for man-eating tigers, with about 100 human deaths reported annually (Sanyal, 1987). In South Africa, between 1996 and 1997, at least 11 illegal immigrants making their way on foot from Mozambique across the Kruger National Park were killed by lions. (Frump, 2006), and in Mozambique, lions killed 70 people in Cabo Delgado province over a period of 18 months between 2001 and 2002 most of these people were out at night protecting their crops from elephants (FAO, 2005).In southern part of Tanzania, lions killed at least 563 people and injured more than 308 between 1990 and 2004 ((Packer *et al.*, 2005), while Treves and Naught on-Treves (1999) reported that leopards and lions have preyed on hundreds of humans in Uganda over the past several decades with lion attacks being more dangerous than leopard attacks. The case of the Tsavo man-eating lions, which killed 28 people in 1898-1899, is well-known worldwide, but for many people man-eating lions and other carnivores still represent a real, daily threat rather than an interesting historical tale (Baldus, 2004).

According to Thirgood *et al*.(2005), although in a global context, the number of human fatalities due to wildlife including carnivores is negligible when compared to famine, war and disease, the intensity of conflict that it generate can have very significant impacts in terms of hostility toward conserving potentially dangerous species.

2.5.4 Diseases transmissions

Carnivore species such as racoons, skunks and bat-eared foxes act as reservoirs for rabies, which is responsible for around 50,000 human deaths worldwide each year (Charlton *et al.,* 1998; Thirgood *et al.,* 2005 & WHO, 1998). In the UK, Hudson *et al.* (2002) reported that farmers were concerned about badgers that are linked to spread of tuberculosis to cattle. Nyahongo and Røskaft (2011) reported that livestock diseases were the most important factor responsible for livestock losses in the western Serengeti Tanzania. According to Hugh-Jones and de Vos (2002) 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. For example, predators ingest anthrax spores together with carcass tissue; the spores are then widely disseminated in the predators' faeces in areas where livestock and wildlife share habitats, raising the infection rates.

2.6 IMPACTS OF HUMAN-CARNIVORE CONFLICT

2.6.1 Impacts on communities

Maintaining carnivore in human-dominated landscape can incur significant direct economic costs, both to individuals and to the wider community as well. The economic impacts of human-carnivore conflict in particular are frequently borne by those very communities least able to manage such costs (Swenson & Andren, 2005). Depredation can have a significant economic impact on the owners concerned, for instance a level of 2% stock loss to depredation cost households in Bhutan 18% of their capita cash income (Wang & Macdonald(2006) while depredation by wolves and snow leopards cost Nepalese villagers around 50% of their average annual per capita income(Mishra,1997). According to Swenson and Andren (2005), the Norwegian government paid out more than US$ 3 million in compensation for stock losses to carnivore in year 2000 alone. Butler (2000) recorded economic loss averaging $13 or 12% of each household's net annual income in Zimbabwe. Kissui (2008) reported an annual loss to predation of 1% for cattle and 4% loss for goats and sheep in the Maasai steppe in Tanzania.

There are also indirect costs associated with human-carnivore conflicts, as people have to invest more heavily in strategies such as livestock herding, guarding and predator control (Thirgod *et al.,* 2005). Barua *et al.(*2012) argues that there still other hidden human-wildlife conflicts cost such as

diminished states of psycho-social well-being resulting from injury or fatality, disruption of family, livelihoods and food security through livestock loss. It also includes opportunity costs, poor health and nutritional status, and transaction costs incurred when pursuing compensation. Barua *et al.* adds that such impacts are generally temporally delayed, their effects on individuals or communities becoming pronounced well after the occurrence of conflict event.

2.6.2 Impacts on carnivores

Sometimes the affected community may retaliate by killing the carnivore to reduce the economic losses, for instance Ogada *et al.* (2003) reported that the number of lions, hyenas and leopards killed by farmers in northern Kenya was equal to the number of livestock killed by the carnivores, while Packer *et al.* (2006) reported that pastoralist speared 27 out of 40 lions in Nairobi National park in 2003. Such retaliatory killings lead to decline in carnivore populations, for instance it is estimated that the African lions population has declined by 30-50%, with the current population estimated to range from 23,000 to 39,000; in Kenya there are only 2000 lions, down from about 10,000 in 2-3 decades ago (KWS, 2009).Removing top predators from habitat patches often results in significant changes in community structure, which can have marked negative impacts in terms of local ecology (Terborgh *et al.,* 2002).

2.7 HUMAN-CARNIVORE MITIGATION MEASURES

2.7.1 Compensation

Compensation schemes are intended to prevent people who bear the cost of living with wildlife from becoming enemies of conservation. The scheme should balance the costs of damage incurred by victims with the benefits provided by income-generating activities or the state agencies or non-governmental organizations (NGOs). The mechanism might be (i) preventive in that it allows potential victims to benefit from wildlife activities through employment or income, sharing, or (ii) compensatory in that it grants victims monetary or in-kind subsidies (FAO, 2009). According to Cozza *et al.* (1996) and De Klemm, (1996), compensation programs typically target single species or small groups of species. Payment for damage by large or predatory protected species is common. What or who is eligible for compensation may be narrowly defined. For example, compensation for damage by specific large predators may be limited to livestock owners following specified animal husbandry guidelines.

Kruuk (2002) argues that determining loss and compensation values can be a challenge because the value of livestock (or crops) may vary with age, size, or reproductive status. For example, farmers may receive compensation for a young animal killed by a carnivore, but resent not receiving compensation for the value the animal could have provided if sold for meat or for breeding when mature. Even when compensated monetarily, some farmers may perceive they are not receiving fair compensation for the trauma, time, or hardships they face protecting their assets, or the emotional loss of losing their livestock while Zhang and Wang (2003) reasons that putting a value on a human life is both difficult and immoral. Paying too little for a human death or injury may have no effect on reducing negative attitudes toward wildlife. Despite these obstacles, several nations compensate for the loss of human life.

Bulte and Rondeau (2005) describe compensation as a ‘‘moral hazard”, where the incentive scheme encourages behaviour detrimental to its objectives, such as lax livestock husbandry or poor defence of livestock. Financial sustainability of any direct incentive scheme is of utmost importance especially if the motivation to conserve wildlife becomes purely financial, and withdrawal of the financial incentives can be detrimental to long-term conservation (Nyhus *et al.,* 2005).

In the Amboseli ecosystem KWS (2008) indicated that an approximately 108 lions were killed in the region between 2001 and 2006 in spite of a generous compensation program for livestock lost to predators on Mbirikani Group Ranch. KWS asserts that the killings were through poisoning and spearing both in retaliation for livestock killed by lions and for traditional Olamayio (young men proving their manhood).

2.7.2 Livestock guarding using dogs and donkeys

Dogs and donkeys are used to detect approaching predators and interrupt attacks by acting in self-defence, or carnivores that are potential competitors (Breitenmoser *et al.,* 2005). For example in Namibia, Anatolian sheep dogs have been used to guard livestock against as they reduced livestock losses in a cost-effective manner for an extended period of time against Cheetahs. With respect to conservation, the dogs were deemed a species-selective and biologically efficient form of predator control with a relatively minor impact on non-target species (Potgieter,2011).Another study by

Ocholla *et al.*(2013) in Samburu Kenya, indicated that dogs were effective in protecting homesteads and livestock from predators, and that their effectiveness depended on the training given to them. According to Breitenmoser *et al*. (2005) donkeys can be used to protect livestock as they have more developed instinct for defence than cattle, are aware of predators and are not afraid of them, they can chase them away, biting and kicking. Ocholla *et al* (2013) found that the use of animals to guard livestock provided an alternative to monitoring a flock, which is a labour-intensive, time consuming and costly.

2.7.3 Translocation of carnivores

Translocation is the deliberate movement of carnivores from its source site to a recipient site that may either be within its extant or historic range or a novel but suitable environment. The objectives of translocations differ but commonly include population augmentation, introduction and re-introduction, or transfers into permanent captivity and population control (Wolf *et al.,* 1996).

The use of translocation in the mitigation of human-carnivore conflicts and carnivore conservation in general has been viewed with skepticism. Different concerns have been examined extensively and include large post-release movements reduced survivorship, possible creation of conflict at the recipient site and quickly recurring conflict at the source site. Some translocations have in fact exacerbated human-carnivore conflicts, resulting in increased human mortality (Fontúrbel & Simonetti, 2011). The translocation of carnivores, although technically feasible, is generally unsuccessful. For example in Namibia 16 leopards and 22 lions were relocated, marked with radio collars and then followed, in a study to test the success of relocations. All the leopards, and many of the lions, returned to the area where they were captured (WWF SARPO, 2005). In South Africa and Botswana, the Kgalagadi Trans frontier Park study from 1997 to 2001 showed a similar trend: in 38 translocations of male lion, 14 were moved more than once; territorial males were translocated to areas about 50 km from their territory, but always returned. Linnell *et al.* (1997) and Woodroffe and Frank (2005) add that translocation is rarely a suitable strategy, except in the case of some highly endangered species or in special situations. It is more a public-relation exercise than an effective management tool

2.7.4 Use of barriers

The use of barrier fences to protect humans, domestic animals and some wildlife species from depredation began long before written history, perhaps with primitive man blocking the entrances of his caves for security from large carnivores. In various forms, barrier fences were developed and persist worldwide (Wade, 1982). Barriers developed for protection from human predators include, among others, The Great Wall of China, moats surrounding medieval European castles, and the stockades which surrounded early forts in North America (Wade, 1982). Fencing can be used to protect livestock in small night-time pens, provide predators-proof grazing areas, and to exclude carnivores from entire regions.

Fence type varies depending on the goals and material available, for example the African thorn bush corrals (Breitenmoser *et al,* 2005). According to Ogada *et al* (2003) the design of the boma varies, in terms of the number of gates and the height and thickness of wall; some particularly those constructed with Acacia bush consist area separating herds and making it less likely that panicked livestock will escape. Conventional wire-netting fences are used worldwide, and as Linnell *et al.* (1996) found out in USA and Canada, their assessments have been limited. Experience from a case study by Ogada *et al.* (2003) demonstrated that wire fences are less effective than brush fences at excluding lions and hyenas. This was attributed to the jumping and climbing nature of the carnivores.

In Amboseli, an improved traditional bomas with chain-links dubbed "Predator-proof bomas" have become a growing mitigation strategy against human-carnivore conflicts in Kenya. KWS together with several organisations have been implemented predator-proof bomas in wildlife conflict stricken area. The project was initiated by the Born Free Foundation in 2010, and for the last four years 175 predator-proof bomas have been constructed across six different community-managed group ranches adjacent to Amboseli National Park. The project is based on a cost-sharing approach, whereby communities contribute 25% the cost needed and also provide labour for construction. The priority is given to individuals in the areas of highest predator conflict (BFF, 2014).

2.8 RESEARCH GAPS

There are several studies conducted in Amboseli on human-wildlife conflict by scholars on different issues; Gichohi *et al.* (2014) examined the 'Long-Term Monitoring of Livestock Depredation '; Okello *et al.* (2014) assessed the pattern and cost of carnivore predation on livestock in Maasai homestead focusing on compensation scheme; and Tuqa *et al.* (2014) evaluated the Impact of severe climate variability on lion home range and movement patterns.

While considerable effort has been made to mitigation of human-wildlife conflict, when it comes to assessing the success of its interventions, the field of ecosystem protection and biodiversity conservation lags behind most other policy fields (Ferraro & Pattanayak, 2006). The lack of rigorous assessment of the conservation efficacy is problematic for achieving conservation goals. Ferraro and Pattanayak (2006) furthers asserts that:

> "It is disappointing that so little evaluation occurs of nature conservation activities. The failure to apply evaluation tools in nature conservation decision-making can result in errors in project selection, wasted use of scarce resources, and lower levels of conservation than may be achievable from the limited resources available''

Similarly, little has been done regarding the assessment of the predator-proof boma in mitigating conflict in Amboseli. The literature review indicates that the last study on bomas in Amboseli was conducted in March-June 2013 by Okello *et al.* (2014). The study generally dwelled on the human-carnivore conflict in Elerai and Olitiyiani conservancies. No studies have been done to assess the predator-proof bomas as a tool for mitigating conflict with carnivores in the human-dominated landscape (larger group ranches) around Amboseli National Park and therefore this study seeks to fill up these gaps. As argued by Ferraro and Pattanayak (2006), conservation must be geared to answer the question 'what would have happened if there had been no intervention?' James *et al.* (1999) also emphasized that judging the effectiveness of conservation interventions in different contexts is absolutely essential to ensuring that overstretched and scarce conservation funds go as far as possible in achieving conservation outcomes.

2.9 THEORETICAL AND CONCEPTUAL FRAMEWORK

This study is based on four theories: protectionist approach, community conservation, evidence based conservation, and vulnerability.

2.9.1 Protectionist Approach

The protection approach entails creation of protected areas, use of fences and fines, excluding people and livestock, prevention of consumptive use, and minimizing any human impacts for the purpose of retaining a pristine environment (Terborgh, 1999). There has been an exponential increase in the number of protected areas in recent years with the global network of protected area now covering 11.5% of the world surface area. Majority of these protected areas are within the categories of I-IV of the International Union for Conservation of nature (IUCN) classification (Schmidt, *et al*. 2009). Rabinowitz (1999) asserts that:

> ….biodiversity conservation is doomed to failure when it is based on bottom-up process that depend on voluntary approach to nature conservation, contrary to much contemporary political and conservation rhetoric because in most countries it is the government and not the people around protected area that ultimately decides the fate forest and wildlife…..

While Terborgh (1999), argued that protected areas have been and will continue to be essential elements of global biodiversity conservation strategies, and more significant time and energy should be dedicated to protected areas management, ensure many species and undisturbed tracts of habitats with more emphasis on the ecological role of protected area. However, Sanderson and Redford (2003), claims that protected areas approach ignores the political side of the conservation which is essential in explaining why conflicts and resistance often occurs. Yet, this helps the protected area managers to deal with political realities that occurs more often. Lele *et al.* (2010) found out that protectionist approach has been successful in several places but at a high social cost and conflicts, especially in developing countries. In addition to social cost, Andrade and Rhodes (2012) study also showed that protectionist approach failed to address the cultural and political factors, hence difficulties to enforce the conservation policies.

2.9.2 Community Involvement Approach

More often, protected areas have been established on water or land that traditionally belong to communities, making it illegal and impossible to limit human activities in these areas. As a result, such protected areas become difficult to operate even with the substantial backing of donors funding. These protectionist limitations prompted conservationist to find complementary conservation strategies that entail working with local communities to make economic development feasible around parks and protected areas. Conservationist relied on indirect ways of meeting livelihoods of the community. Biosphere reserves such as Amboseli national parks were established to provide communities chances of make use of the biological resources as per the defined spatial zoning with the core zones restricted for biodiversity conservation with no consumptive use by people (Salafsky & Wollenberg, 2000). The buffer zones have limited human activities, with the intention of meeting the community's livelihoods and protecting the key species and habitats by decreasing overreliance on natural resources. The approach relies on providing communities with an economic activities that deter people from livelihood that harms biodiversity, with little focus on the bio-physical environment. This approach, again has been found to be ineffective in preventing people from over-exploiting the resources at the core zones as well as preventing external threats to biodiversity (Wells & Brandon, 1992).

In 1990s the direct approaches were adopted to address the shorting-comings of indirect methods and meet economic well-being of people. The economic benefits were directly linked to the biodiversity. The approach offers the community on opportunities to benefit directly as an incentives to stop external threats to the biodiversity (Wells & Brandon, 1992). Salafsky and Wollenberg (2000) asserts that livelihoods drive conservation, rather than simply being compatible with it; recognizing the local people's role in maintaining biodiversity. The community based conservation takes a variety of forms, from community outreach to Integrating Conservation and Development Projects (ICDPs), taking into account the development and conservation goals of community living in and around. ICDPs are meant to mitigate the focal conflicts between biological conservation of national resource use in remote areas that are economically poor, thus improving the welfare of the people and reducing pressure on biodiversity. According to Garnett *et al*. (2007), such approaches are not effective in protecting biodiversity as result of difficulties of getting meaningful economic benefits from protected areas and benefits of conservation that fails to

capture the diversity and complexity of the local communities' geo-politics. ICDPs have advanced with over the years to incorporate sustainability in biodiversity conservation.

2.9.3 Evidence based conservation approach

Conservation agencies and organizations operate at larger spatial scales in attempt to achieve outcomes at the scale of large natural resource systems. One of the biggest challenges for conservation activities conducted is that of measuring progress in improving the conservation performance and providing an evidence base on what works and what does not (Sunderland *et al*, 2013). Evidence based conservation provides the impacts of interventions in sustaining the environmental values that underpin rural development. The approach integrate the measurement of livelihood outcomes with the achievement of conservation outcomes and provide a clear and explicit linkages between the two. Evidence based conservation gives an opportunity to identify, articulate and negotiate possible trade-offs that may exist between these two, often differing, objectives. This is important as there is a clear need to be able to assess the performance of conservation and development interventions that attempt to improve the outcomes at the scale of complex mosaic landscapes in which biodiversity of global concern often coexists with people living in extreme poverty(Sunderland *et al*, 2013). The effectiveness of the project may positively determine the community perceptions and social-economic benefits attained (**Figure 2.1**)

2.9.4 Vulnerability theory

Vulnerability is an international factor of the subject or system that is exposed to hazards and corresponds to its intrinsic predisposition to be affected, or to be susceptible to damage. It represents the physical, economic, political or social susceptibility or predisposition of a community to damage in the case a destabilising phenomenon of natural or anthropogenic origin. Certain community's (such as pastoralist) livelihoods may be extremely fragile depending on the level of development success (Cardona, 2003). This research project focuses on the pastoralist community in semi-arid land with various species of wildlife that makes their main source of livelihood-livestock to be fragile, as result of predations.

Over the years, pastoralist have survived in erratic and risky environment making use of traditional risk-management strategies such as livestock accumulation, regular and opportunistic herd

movements tracking rainfall, breed and species diversification, and herd dispersion between community members. However, these traditional risk management strategies have become increasingly ineffective over the past decades and poverty levels among pastoral populations have risen (FAO, 2015).

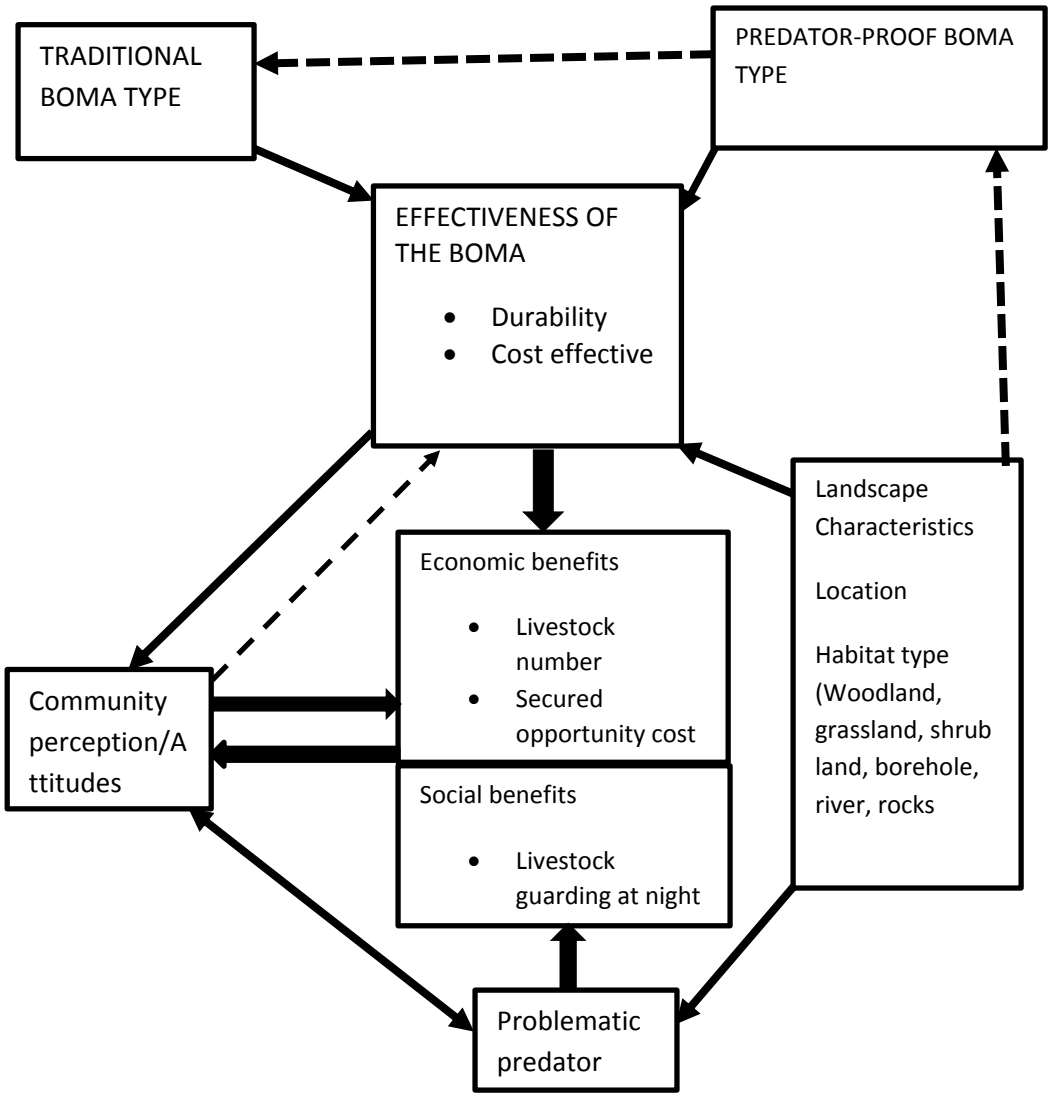

Figure 2.1 Conceptual Framework - **Source: Researcher: (2015)**

CHAPTER THREE
STUDY AREA

3.1 INTRODUCTION

This chapter covers the location, demographic, climate, land use patterns, geology, hydrology, livelihoods and fauna and flora of the study. It specifically focused on the following: location, climate, fauna and flora, livelihood and demographic characteristics of the study area.The focus of this study is the section of the Amboseli Ecosystem that lies between Amboseli, Tsavo West and Chyulu National Parks in Kenya.

3.2 LOCATION

Amboseli ecosystem is located in the Loitokitok sub-county on the boarder of Kenya and Tanzania. The sub-county is located at the southern end of the Kajiado County. The Republic of Tanzania borders it to the southwest, Taita-Taveta district to the southeast, Machakos district to the east, Nairobi and Kiambu to the north, and Narok to the west. The Kajiado County is situated between longitudes 36º, 5' and 37º, 55' East and between latitude 1º, 10' and 3º 10' South (Esikuri, 1998).

The Amboseli ecosystem comprises of six group ranches: Olgulului, Kimana/Tikondo, Kuku, Rombo and Eselenkei (Figure 3.1). The six group ranches covers an area of about 506,329 hectares in Loitokitok Sub-county (Kissui & Kenana, 2013).

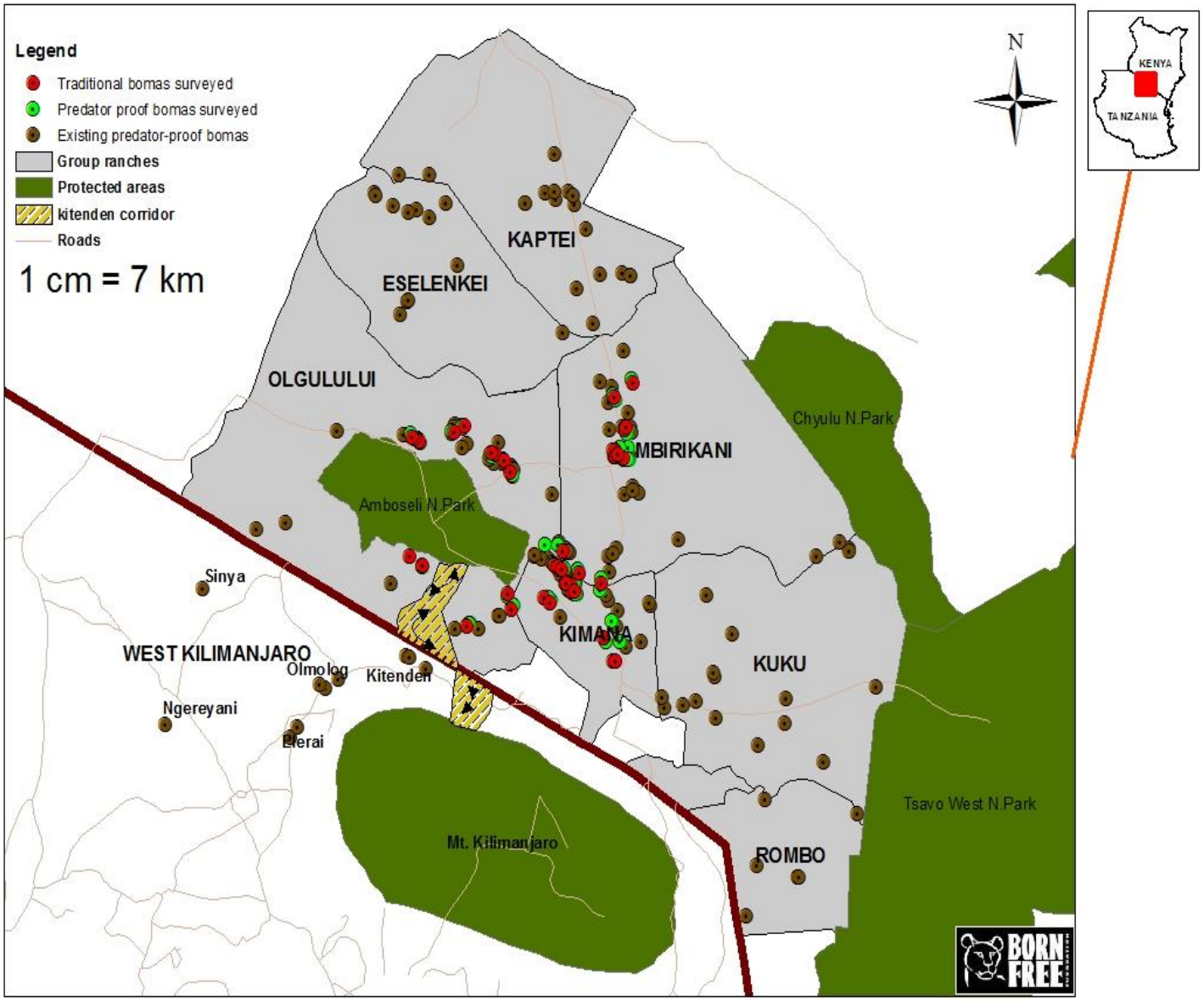

Figure 3.1 Map of the study area **Source: BFF (2015)**

3.3 CLIMATE

The Amboseli ecosystem is semi-arid characterized by a warm and dry climate (Pratt and Gwynne, 1977).The area receives a bimodal rainfall pattern, with short rains between October and December, and the long rains between March and May. The annual mean rainfall ranges from 500-600mm while the annual average temperature is 18.9^{o} C (GOK, 2009). Topography of the area consist of plains, occasional hills and valleys. Several valleys dissects the plain and its

physiography is influenced by geology. The area is characterized by erosional and depositional features, resulting to deep reddish brown clay loams and poorly drained cotton soil (GOK, 2009).

3.4 FAUNA AND FLORA

3.4.1 Flora

The vegetation type is greatly determined by altitude, soil type and rainfall patterns, with the ground cover varying from 1% on the densely populated area to 30% on steep slopes. The main vegetation type species are *Acacia*, *Commiphora* and *Balanites gabra* species, while the dominant grass is *Pennisetum* and *Chloris guyana* species (GOK, 2009).

3.4.2 Fauna

The sub-county is rich in natural endowment with range of wildlife species such as elephants, buffalo, Zebra, cheetah, hyena, lions, wildebeests, giraffes, elands among others (GOK, 2009). Most of the carnivore species, including leopard, lion, cheetah, and caracal, hyena, and serval cat can be seen easily in the Amboseli ecosystem. These carnivores rank high as a tourist attraction in the Park and adjacent areas. They also play a significant role in controlling the herbivore populations (KWS, 2008). The Amboseli ecosystem is estimated to have 64±20.96 lions, 272±59.31 hyena and 25.56±3.53 jackals (Kissui & Kenana, 2013).

Wildlife migrate during the dry season to higher areas and swamps where forage is still available. The areas designated for game reserves include Amboseli 392Km^2 and Chyulu conservation area 445Km^2 (GOK, 2009). Amboseli is one of the 60 Important Bird Areas (IBA's) in Kenya and thus it is recognized as globally significant for bird conservation. The ecosystem has a rich birdlife, with over 400 species recorded, of which 40 are birds of prey. It has globally threatened bird species (e.g. Lesser Kestrel), restricted-range birds that are found only in a very small area such as the Taveta golden weaver, bird species that live only in a particular vegetation type such as the Grosbeak weaver, and regionally threatened bird species such as Martial eagles. The bird life in Amboseli is diverse due to the varying habitats (KWS, 2008).

3.5 DEMOGRAPHIC PROFILE AND LIVELIHOOD SYSTEMS

The Sub-county has a population of about 137,496 people, with a population density of 21 persons per square kilometre. There are approximately 29,703 households with 68,837 males and 68,659 females (KNBS, 2013). Approximately 27,000 Maasai residents and roughly 100,000 heads of livestock live in the study area (KNBS, 2013).The MGR has about 4600 members, OGR has 3400 members and Kimana/Tikondo has 840 members (Ntiati, 2009).

Pastoralism is the main economic activity with over 75% of the population deriving their livelihood from livestock which accounts for 60% of the total labour force (Okello & Kioko, 2010; GOK, 2009). About 31% practice both livestock keeping and crop cultivation, 22% practice crop farming only, 2% are employed and 1% rely on small scale business. In Loitokitok sub-county agriculture provides an alternative livelihood strategy to most livestock keeper. Agriculture in the irrigated areas is mostly undertaken by newcomers from other parts of the country and Tanzania with only about 23% being local (Okello & Kioko, 2010).

3.6 LANDSCAPES

Amboseli ecosystem group ranches such as MGR still have land available to wildlife, estimated to be over 75% of the group ranch. However, others like Kimana/Tikondo Group Ranch, have settlement clusters poorly oriented within wildlife movement corridors with 50% of the land still available for wildlife. Several human settlement clusters are growing towards each other as is the case of OGR. The growing threat is the settlement patterns that tend to be clustered along critical resources such as transport (along roads), near fertile areas for cultivation, and along rivers and swamps (Okello & Kioko, 2010).

Land and land use change over the years in the county, has been marked by turbulence as a result of both man-made and nature; events. As a result land has and traditional mobility and flexibility characteristic of pastoralism has been lost. The relationship between pastoralism, agriculture and hunting has been dynamic according to the environmental circumstances at any given time (GOK, 2009).

The wildlife dispersal areas in the county include dry dispersal grazing zones habited in the dry season, wet season grazing and is extensive due to park boundaries, arable potential areas and have

been encroached by cultivation. Migratory routes are Kaputei plains to Nairobi National Park through Kitengela area, Amboseli National Park to Tsavo West National Park through either Kuku Group Ranch or Chyulu Game Conservation area, and Amboseli National Park to Kilimanjaro area in Tanzania (GOK, 2009).

CHAPTER FOUR
RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter also describes the approach and methods used in the research project in terms of the following attributes: study design, sampling and sample size, sources of data and data analysis.

4.2 STUDY DESIGN

According to Williams (1978), sampling design is a set of rules that specify how sample (subset of the population) is to be selected .The researcher used a descriptive study design. Descriptive study design is the precise measurement and reporting of the characteristics of the phenomena under investigation. The study design gives answers to who, how, when, where and not why questions (Rossi et al, 1983).

4.2 SAMPLE SIZE AND SAMPLING PROCEDURES

The study area had six clusters: Imbirikani group ranch (MGR), Olgulului group ranch (OGR), Eselenkei group ranch (EGR), Kuku/Rombo group ranch (K/RGR), Enduimet and Kimana/Tikondo (KGR/Tikondo) with 175 predator-proof bomas which formed the target population (**Table 3.1**).

Table 3.1 Target population

Group ranch	**No. of predator-proof boma**
OGR	36
MGR	39
KGR/Tikondo	54
Kuku/Rombo	26
Eselenkei	10
Enduimet	10
Total	**175**

Source: BFF (2015)

4.3 SAMPLING HOMESTEADS

The latest map of predator-proof bomas location and a list of their respective GPS were obtained from the Born Free Foundation. Although, the entire Amboseli-West Kilimanjaro region had a total of 175 predator-proof bomas, the researcher concentrated on MGR, OGR and KGR/Tikondo which had the highest number of chain-link fenced bomas that had been in existence for at least six months since fortification. This study dwelled on Maasai pastoralist who own bomas only.

Random sampling method was used in selecting respondents from each cluster. The purpose of choosing this method was to avoid bias and ensuring a representative sample is selected. The sampling procedures used were as follows:

a) **Sampling stage one:** From the six clusters, elimination method was used to select three cluster-MGR, KGR/Tikondo and OGR. The selected clusters had at least 50% of the PPBs having been in existence for more than six months.

b) **Sampling stage two**: All the homesteads in the three clusters that were picked were then awarded numerical 1-3 separately to form a sampling frame. Numbers were then assigned to households in three selected clusters. The numbers for each cluster were then written onto separate pieces of papers and folded. All the folded papers were thereafter put in a basket and thoroughly shaken to mix them up. Numbers were then drawn from the basket, one after another, until the sample size of 15 per cluster was reached. Using the paired experimental design, for every predator-proof boma sampled, a traditional boma (control) within a range of a kilometre (to avoid overlapping with the next PPB) was selected at random using the North, South, East and West directions. Using this procedure, a sample size of 90 was randomly obtained for the study.

c) **Sampling stage three:** The areas to be survey were first visited by the researcher and a permission to carry out the survey granted by the respective local leaders. Six locally trained enumerators were trained by the researcher on the objectives of the survey and the approach to be employed. The questionnaires was pre-tested in group ranches (Eselenkei and

Rombo), outside the three selected study area to ensure that all questions are clear, and a final version prepared before sampling took place.

4.4 SOURCES OF DATA

4.4.1 Primary data

Primary data was gathered through a face-to-face interview using questionnaires, photographs and field measurements.

a) Questionnaire

Data from the respondents was collected using questionnaires (Appendix 1) which had precise and closed questions with a list of possible answers to each question, and a board and open questions giving respondents an opportunity to freely express their opinions. The questionnaire had four parts, the first designed to provide respondent's background and boma characteristics such as area of resident, gender and age categories, livestock numbers, size of households, location and type of boma. The second part sought information on the performance of the traditional bomas on livestock losses, and the third part had questions to determine the performance of the predator-proof bomas. The second and third sections examined the livestock losses both in the boma and in the field grazing, predators involved in the attacks, respondents rating of the boma types and frequency of livestock guarding at night. The fourth part had information on community's perception on human-predator conflicts. This section had questions pertaining mainly to the most problematic predators and seasonality of predations both in the boma and in the filed while livestock are grazing.

The questionnaires were administered to the 90 respondents. Before beginning the interview, the general purpose of the study was explained to each willing respondent and the confidentially of their information assured. The homestead heads were targeted as the respondents but in case where they were absence, their wives or another permanent resident adult (above 18 years) were interviewed. Each enumerator, administered 5 questionnaires per day for a period of 3 days.

b) Field measurements and observations

The circumferences of the boma, thickness and height of the boma wall were measured using a 100metre length tape measure. The distance between the observed nearest habitats type that can

conceal a predator was determined by pacing. The damaged parts of the boma was determined by observation and counting.

4.4.2 Secondary data

Secondary data was obtained from existing map of the area, predator-proof boma unpublished project reports, articles and magazines.

4.5 DATA ANALYSIS

Data processing, tallying and analysis was done at Microsoft Excel-Pivot Tables software 2013 and SPSS statistical package version 20.0. Data on sample households characteristics were treated according to clusters: OGR, MGR and KGR. Correlation tests were used to determine relationships between characteristics among the three area and paired-students t-test used to test significance difference in traditional boma and predator-proof bomas characteristics. Other data on boma characteristics, performance of the boma on livestock losses and community perceptions on human-predator conflicts were analyzed by calculating means, percentages and frequencies. Where questions had alternative answers on a Likert scale (such as Agree, Disagree, Strongly Agree, Strongly Disagree and Don't Know) were tested using modes to evaluate the opinion of the community

CHAPTER FIVE
RESULTS AND DISCUSSION

5.1 INTRODUCTION

This chapter presents the analysis and interpretation of the findings from the 90 respondents who participated in the study. I analysed the data, using statistical package for social sciences (SPSS) version 20.0. Percentages and correlation tests were used in the data analysis and summaries to determine the relationships between keys variables.

5.2 RESPONDENT CHARACTERISTICS

Out of a total of 90 respondents in the study area, 56.7% were men and 43.3% women. This was a fair representation of gender in the survey and indicates that both men and women were willing to participate in the survey (**Table 5.1**).

5.2.1 Gender

Table 5.1 Gender

Gender	Frequency	Percent
Male	39	43.3%
Female	51	56.7%
Total	90	100.0%

5.2.2 Age

Most of the respondents were 42-49 years (31.1%) and 34-41years (28.9%) with the least representation (5.6%) being those above 50 years (**Table 5.2**).

Table 5. 2 Age

Age category	Frequency	Percent
18-25yrs	12	13.3%
26-33yrs	19	21.1%
34-41yrs	26	28.9%
42-49yrs	28	31.1%
Above 50yrs	5	5.6%
Total	90	100.0%

5.3 BOMAS

5.3.1 Boma Characteristics

On average, the bomas consisted of 20.41±1.654 people, 242.54±25.633 livestock, 5.03±0.390 traditional huts and 2.11±0.120 livestock gates. The respondents, had more Shoats (160.8±16.355) than cattle (81.99 ±11.870) and donkey (1.96±0.337). The mean circumference of the boma was 138.9±5.4681m (**Table 5.3**).

Table 5.3 Boma characteristics

Characteristics	**Mean ± S.E**
No. of household traditional huts	5.03±0.93
No. of livestock gates in boma	2.11±0.20
No. of males in the boma	3.52±0.358
No of females in boma	4.33±0.424
No. of children in boma	12.56±0.945
Total No. of people in boma	20.41±1.654
No. of cattle in boma	81.99±11.870
No. of shoats in boma	160.80±16.355
No. of donkeys in boma	1.96±0.337
Total No. of livestock in boma	242.54±25.633

Source: Researcher (2015)

5.3.2 Characteristics of Livestock Predation Problem

The respondents relatively had lost their livestock to predators while grazing in the field than in the traditional bomas within the period of January 2014 to April 2015 (**Table 5.4**). When asked if they had lost their livestock in the in traditional bomas within the same period, majority of the respondents (84.88%, n=45) said Yes, while 15.56% answered No. A large proportion of the respondents (71.11%, n=45) had also lost their livestock in the field grazing compared to 28.89% who had not. Sixty even (67.42%, n=90) of the respondents were of the opinion that hyena was the most problematic predator in livestock killings both in field and in the boma.

Table 5.4 Livestock lost in the traditional bomas and in the field grazing

	N	Maximum	Mean ±S.E
No. of shoat killed in traditional boma	39	86	7.56±2.311
No. of shoat killed in the field grazing	32	106	8.75±3.440
No. of shoat injured in traditional boma	38	70	4.24±1.893
No. of shoat injured in the field grazing	32	79	5.72±2.564
No. of cattle killed in Traditional boma	38	14	1.71±0.445
No. of cattle killed in field grazing	32	21	2.03±0.772
No. of cattle injured in Traditional boma	38	9	1.08±0.332
No. of cattle Injured in the field grazing	31	15	1.45±0.641
No of donkeys killed in Traditional boma	38	1	0.05±0.037
No. of donkeys killed in the field grazing	31	2	0.10±0.71
No. of donkeys injured in the Traditional boma	38	1	0.03±0.026
No. of donkey Injured in the field grazing	31	2	0.06±0.65

Source: Researcher (2015)

5.3.2.1 Species involved in livestock predation

Hyena accounted for the largest loss of shoats in traditional boma (37%, n=68), while lion was majorly responsible for the loss of cattle (34%, n=44). Cheetah killed more (89%, n=9) shoats in the field, followed by leopard (60%, n=5). Livestock killings in the predator-proof boma was comparatively low, with the highest killing being that of cattle by lions (5%, n=44). Out of the total 126 reported incidents, shoats killing proportion was the highest at 57% followed by cattle at 37% (**Table 5.5**).

Table 5.5 Predators and livestock loss incidences

	Traditional boma incidences			**Field Incidences**			**Predator-proof boma incidences**			**Total**
	Shoat	Cattle	Donkey	Shoat	Cattle	Donkey	Shoat	Cattle	Donkey	
Predator										
Lion	25%	34%	2%	7%	25%	0%	2%	5%	0%	**100%**
Hyena	37%	16%	1%	24%	13%	3%	4%	1%	0%	**100%**
Cheetah	11%	0%	0%	89%	0%	0%	0%	0%	0%	**100%**
Leopard	20%	20%	0%	60%	0%	0%	0%	0%	0%	**100%**
Jackal	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Total	**30%**	**21%**	**2%**	**24%**	**16%**	**2%**	**3%**	**2%**	**0%**	**100%**

Source: Researcher (2015)

5.3.2.2 Community's attitudes toward the most problematic predator

The hyena is considered to be the most problematic predator (68%), followed by the lion at 26%. Jackal (4%), cheetahs (2%) and leopards (0%) were the least mentioned as problematic predators by the respondents (**Figure 5.1**). The community had varied opinions on why the identified species

were problematic. The hyena and lion were considered most problematic because of community settlement near the park and conservancies (26%), their population is also perceived to be more (16%), and their ability to attacks and kill more livestock at a go (12%). Jackals were cited to be problematic because they attack the young ones of the sheep and goats.

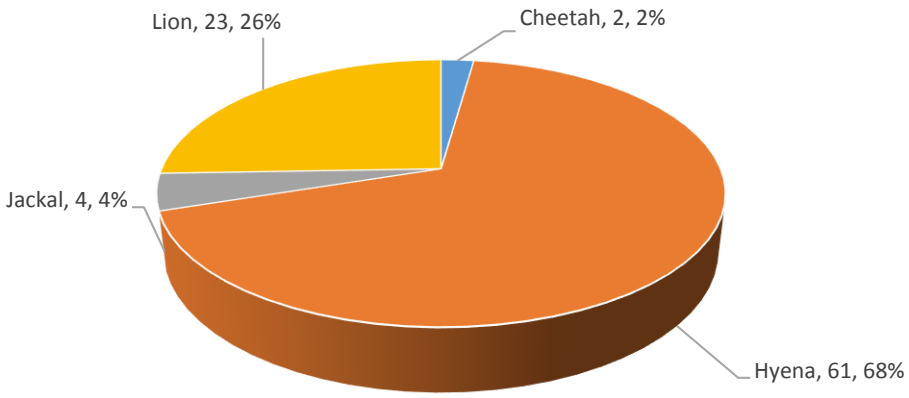

Figure 5.1 Most problematic predators **Source: Researcher (2015)**

Majority of the respondents (73%) agreed that predators need protection because they bring more benefits than problems (**Table 5.6**). However, 26% were of the opinion that predator should be killed if they kill family's livestock to avoid any further predations. On average a large proportion of the respondents(56%) disagreed with the statement that 'Conserving predator is a waste of resources as it leads to more conflict with the community and that today, time and money would be better spent on more urgent issues such as education, health, development and security. Only 23% agreed with the statement. On the duty to conserve predator, 52% think that is not the KWS and conservationists role, but all stakeholders. Many of the respondents (66%) are aware of the role of predators in maintaining a healthy environment and so the need to ensure their number do not decrease further.

Table 5.6 Community opinions on predators

	Percentages					
Characteristics	**Agree**	**Disagree**	**Strongly Agree**	**Strongly Disagree**	**Don't Know**	**Total**
Predator should be protected because they bring more benefits to this community than do problems	73%	7%	12%	8%	0%	100%
If the predator kills a few of my family's livestock it is acceptable for me or family member to kill that predator so that it does take any more livestock from us and other people	26%	53%	12%	9%	0%	100%
Conserving predator is a waste of resources as it leads to more conflict with the community**.** Today, time and money would be better spent on more urgent issues such as education, health, development and security	23%	56%	11%	10%	0%	100%
Tourist are attracted here by predators, sometimes losing a livestock to a predator is a fact of life we must accept if we want tourism to continue	67%	8%	20%	3%	2%	100%
Only KWS and conservationist have a duty to conserve predators, not other people like us	20%	52%	12%	12%	3%	100%
Predator are important to maintaining a healthy environment so we must make sure their number do not decrease further	66%	12%	18%	4%	0%	100%

Source: Researcher (2015)

5.3.2.3 Relationship between Problematic predator and boma characteristics

There was a positive relationship between the most problematic predator and total number of livestock ($r = 0.319$, $n=90$, $p = 0.002$), boma circumference ($r = 0.295$, $n=90$, $p = 0.005$), number of traditional huts($r = 0.015$, $n = 90$, $p=0.892$), numbers of gates around the boma($r = 0.173$, $n =90$, $p=0.103$); and number of people in the boma($r=0.140$, $n=90$, $p = 0.188$). However, there was a negative correlation between the most problematic predator and height of the boma wall($r = -0.074$, $n=90$, $p=0.491$) and thickness of the boma wall ($r=-0.004$, $n=90$, $p=0.970$). (**Table 5.7**). These results suggest that the boma characteristics influences the types of the problematic predator that attacks the boma.

Table 5.7 Problematic predator and boma characteristics relationship

Boma characteristics		**Correlation**
Boma circumference (m)	Pearson Correlation	0.295
	Sig. (2-tailed)	0.005
	N	90
Height of the boma wall (m)	Pearson Correlation	-0.074
	Sig. (2-tailed)	0.491
	N	90
Thickness of boma wall (m)	Pearson Correlation	-0.004
	Sig. (2-tailed)	0.970
	N	90
Number of traditional huts	Pearson Correlation	0.015
	Sig. (2-tailed)	0.892
	N	90
No. of livestock gates in boma	Pearson Correlation	0.173
	Sig. (2-tailed)	0.103
	N	90
Total No. of people in boma	Pearson Correlation	0.140
	Sig. (2-tailed)	0.188
	N	90
Total No. of livestock in boma	Pearson Correlation	0.319
	Sig. (2-tailed)	0.002
	N	**90**

Source: Researcher (2015)

5.3.2.4 Seasonality of livestock attacks

Livestock attacks by predators in the boma were averagely high in the months of April (33%) and December (30%), while predation in the field were high in September and October, each with 17 % (**Figure 5.2**). In general, more livestock are attacked in boma (137 incidents) than in field grazing (120 incidents).

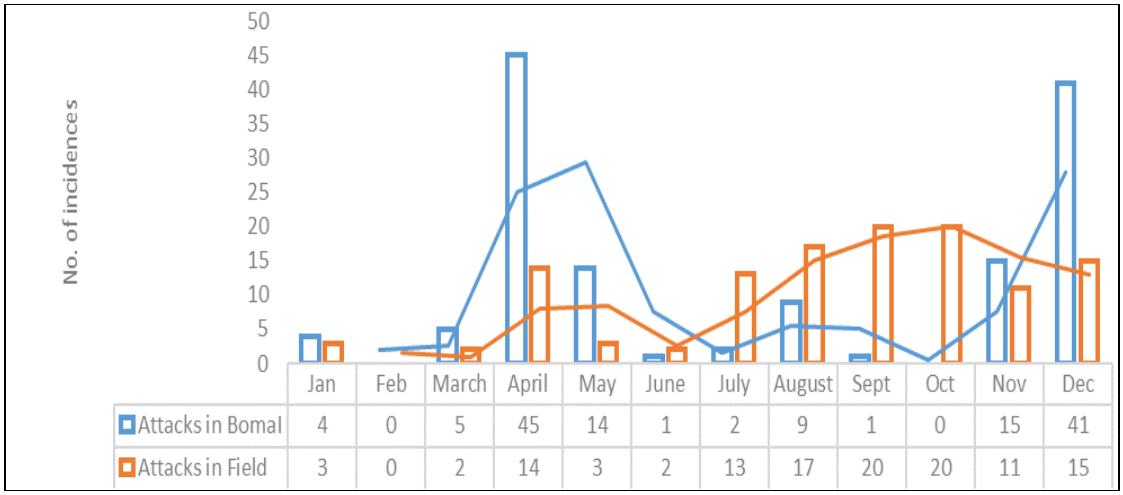

Figure 5.2 Seasonality of livestock attack in bomas and in the field

Source: Researcher (2015)

A regression analysis indicates that there was a positive significant relationship between frequencies of livestock attacks in the field and the time of the year (R^2=0.5407, n=90). However, there no relationship between the livestock attacks in the boma and the time of the year.

5.3.2.5 Effects Habitat type on livestock attacks

Table 5.8 show the distances of various habitat types from the centre of the sampled boma that can conceal predators. On average, the closest habitat types around households are shrubs (215.28m) while the furthest sited was woodland (1008.78m). A Pearson correlation indicates positive relationships between shrub distance and the predator that killed the shoat (r = 0.277, n=38, p = 0.093); rock distance and the predator that killed the cattle (r = 0.450, n=27, p = 0.191); swamp distance and the predator that killed shoat (r = 0.138, p = 0.653, n =13); and rock distance and predator that killed the shoat (r = 0.176, p = 0. 546, n= 14).

Table 5. 8 Habitat type and distances from the boma

Habitat type	Average distance from middle of the boma (in metres)
Shrub	215
Rock	865
River	699
Woodland	1009
Swamp	733
Grassland	749
Water spring	941

Source: Researcher (2015)

5.3.3 Effectiveness of Predator-Proof Boma on Livestock Loss

5.3.3.1 Predator-proof boma and livestock predation

The effectiveness of the predator-proof boma was determined by assessing the community opinion on the livestock loss and time spend guarding livestock at night before and after fortification of the bomas. From **Table 5.9**, we can see that the majority of the predator-proof boma were constructed 2012 (44.4%, n=45). Ninety one (91.1%, n=45) of the sampled PPB had been in existence for more than one year, which is fairly sufficient time to use to determine the performance of the PPB on livestock loss. The number of livestock killed in PPB reduced over the year with the increase in the numbers of constructed the PPB.

Table 5.9 Year when PPBs were fortified

Year	Frequency	Percent	No. of livestock killed		
			Shoat	Cattle	Donkey
2010	7	15.6 %	1	-	-
2011	8	17.8%	22	4	-
2012	20	44.4%	-	-	-
2013	6	13.3%	-	-	-
2014	4	8.9%	-	-	-
Total	45	100.0%	23	4	-

Source: Researcher (2015)

Livestock predation incidences greatly reduced after the predator-proofing the bomas. Shoat's incidents subsided from 219 to 23 cases, cattle from 109 to 4 cases (n=45). There were no donkey killings after fortification of the bomas (**Figure 5.3**).

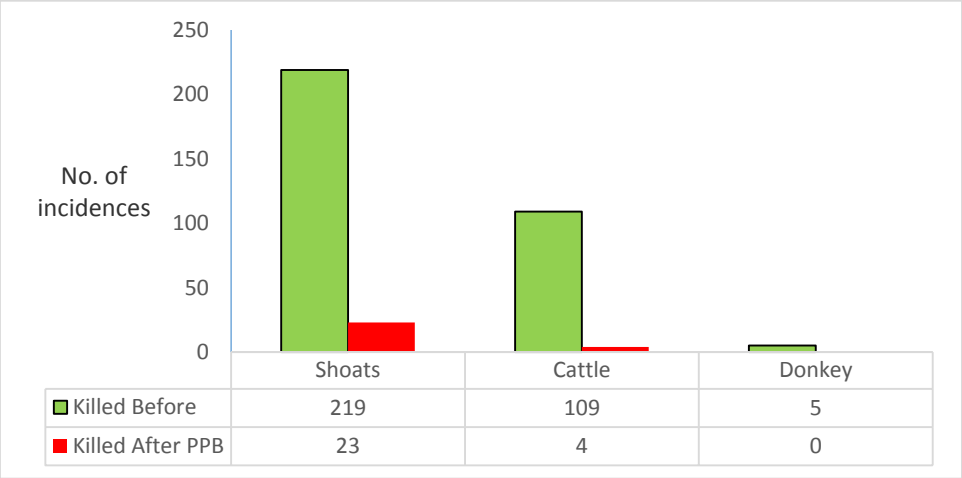

Figure 5.3 Livestock killings before and after boma fortification.

Source: Researcher (2015)

Most of the respondents (82.22%, n=45) were losing their livestock both in the field and in boma at night in the proportion of 66% Shoats, 33% cattle and 1 % donkeys (**Figure 5.5** and **Plate 5.1**). Out of the 113 livestock attacks incidents recorded, 76.12% (n=45) occurred in the boma compared to 23.88% in the field. However, after the boma fortification, majority of the respondent (91.11%, n=45) said they had not lost their livestock to predators in the bomas at night.

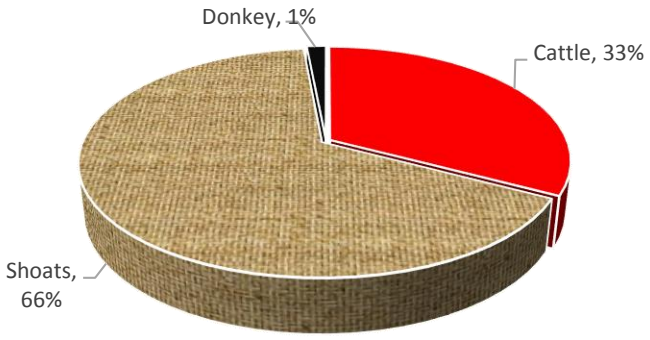

Figure 5.4 Livestock killings incidences by predator

Source: Researcher (2015)

5.3.3.2. Livestock guarding and predation at night

Figure 5.6 illustrates that the rate of daily guarding of livestock at night reduced from 36 times before PPB fortification to 2 times after PBB fortification(n=45)

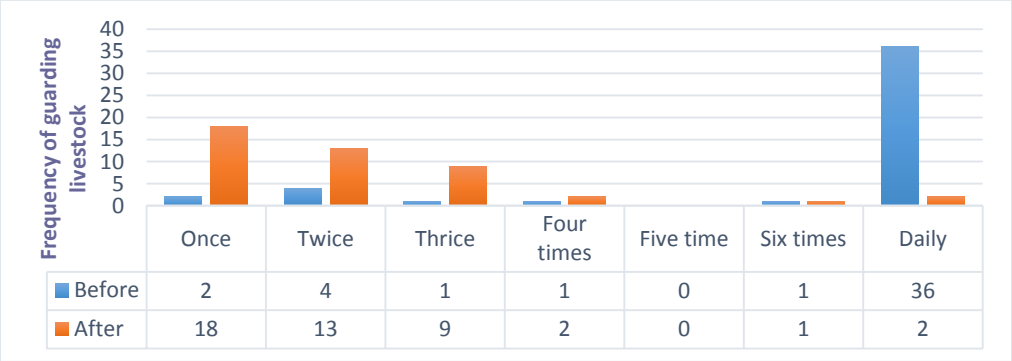

Figure 5.5 Livestock guarding at night in PPB

Source: Researcher (2015)

Plate 5.1 An injured donkey by hyena in OGR

Source: Researcher (2015)

5.3.3.3 Community rating of predator-proof bomas performance

Table 5.10 show the community varied opinions on the performance of predator-proof bomas on livestock loss. 62%(n=45) of the respondents rated predator-proof bomas as 'Excellent' in reducing livestock killings at night, 56% said the project was 'Good' in reducing retaliatory killings of predators especially lions, and 47% of think the predators-proof bomas are also 'Good' in minimising night vigilance of livestock at night and offering alternative time for engaging in other livelihood activities (Plate 5.2). Cost effectiveness of the predator-proof boma was largely rated as 'Good' (44%, n=45) and 'Average'(40%, n=45); while majority said that the durability of the predator-proof bomas is 'Average', with only 4% saying it is 'Excellent'(**Plate 5.2**).

Table 5.10 Rating of predator-proof boma by households

Characteristics	**Percentages Ratings**						**Total**
	Excellent	Good	Average	Poor	Very poor	Don't know	
Reducing livestock predations	62%	31%	7%	0%	0%	0%	100%
Reducing retaliatory killings of predators especially lions	38%	56%	7%	0%	0%	0%	100%
Minimising night vigilance of livestock and offering alternative time for engaging in other social and economic activities	13%	47%	40%	0%	0%	0%	100%
Cost effectiveness	2%	44%	40%	13%	0%	0%	100%
Durability of the structure	4%	29%	38%	24%	4%	0%	100%

Source: Researcher (2015)

Plate 5.2 Livestock entering into a predator-proof boma
Source: Researcher (2015)

On contrast, the traditional boma were largely rated as poor in reducing livestock predations by predators at night in the bomas (**Figure 5.7**). Only 5% of the respondents said it was 'Excellent'.

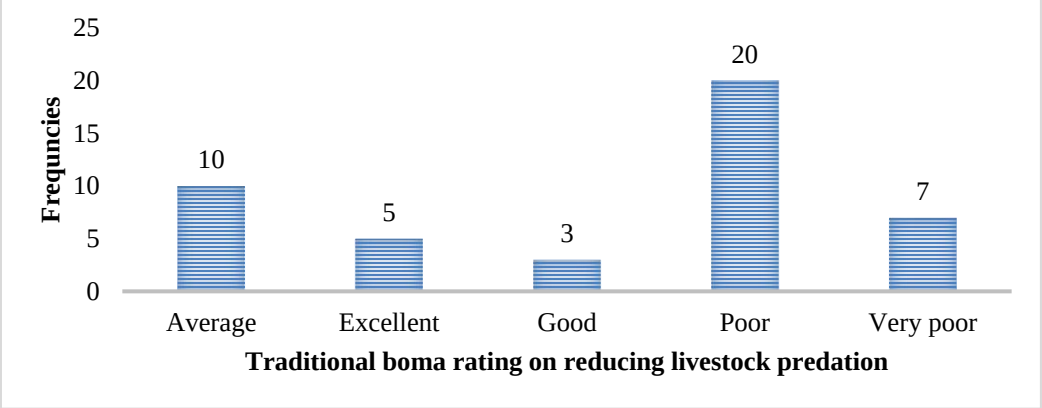

Figure 5.6 Rating of the traditional boma on livestock loss
Source: Researcher (2015)

5.3.3.4 Comparison of predator-proof bomas and traditional bomas characteristics

In terms of size, the predator-proof bomas were larger (149.5m) than traditional bomas (128.3m) and had more livestock numbers (293.2). There were no much differences between the heights,

thickness of fence, number of traditional huts, numbers of entrances around the boma and the total number of people in predator-proof and traditional bomas (**Table 5.11**).

Table 5.11 Comparison of predator-proof boma and traditional boma

Boma Type	Circumference (m)	Height of wall(m)	Thickness of fence (m)	No. of traditional huts	No. of entrances around boma	No. of people	No. livestock
Predator-proof boma	149.5	2.16	1.34	4.98	2.18	20.5	293.2
Traditional boma	128.3	1.93	1.31	5.08	2.04	20.3	191.9

Source: Researcher (2015)

Hypothesis Testing

H_O : There is no significant difference in the characteristics of traditional boma and predator-proof boma

H_A : There is a significant different in the characteristics of the traditional boma and predator-proof bomas.

Tabulated t= 2.015, d.f=44, p=0.05. Since the absolute values of size (t=2.504, d.f=44, p=0.016), height of fence (t=-2.379, d.f=44, p=0.022), and total number of livestock (t= -2.253, d.f=44, p=0.029) are all greater than the critical value (t= 2.015), the null hypothesis is rejected (**Table 5.12**).The size, height and total number of livestock had significant differences. However, numbers of gates, people and traditional huts in PPB and traditional bomas were all similar (p>0.05).

Table 5.12 Hypothesis testing

Boma Characteristics	t-test value	d.f	Sig. (2-tailed)	Remarks
Size (Circumference)	-2.504	44	P=0.016	Significant
Height of the fence	-2.379	44	P=0.022	Significant
No. of gate around the boma	-0.643	44	P=0.524	similar
Total no. of people in boma	-0.053	44	P=0.958	similar
Total no. of livestock in boma	-2.253	44	P=0.029	significant
No. of traditional huts in the boma	0.180	44	P=0.858	similar

Source: Researcher (2015)

5.3.3.5 Relationships between traditional boma characteristics and livestock predation

A Pearson product-moment correlation coefficient was computed to assess the relationship between boma characteristics (**Table 5.13**) and the predation incidents and fatalities in traditional bomas. There were positive correlation between boma circumference and number of livestock in traditional bomas (r = 0.386, n=90, p=0.00). A strong positive correlation was revealed between the number of males and the donkeys injured(r =0.802, n=38, p =0.00) and cattle killed(r =0.774, n=38, p = 0.00); number of gates and shoat killed (r= 0.625, n=39, p=0.00) and cattle killed(r =0.55, n=38, p=0.00). Overall, there was a positive correlation between boma characteristics and livestock loss. Increases in number of number of boma elements were correlated with increases in livestock killings and injuries. However, there was no correlation between the circumference of the boma and the livestock loss and injuries.

Table 5.13 Correlation of boma characteristic and livestock attacks

Correlations						
Boma characteristics		Livestock killed/ injured in traditional bomas				
		No. of shoat killed	No. of shoat injured	No. of cattle killed	No. of cattle injured	No. of donkeys injured
No. of traditional huts	Pearson Correlation	.515**	.509**	.583**	.560**	.520**
	Sig. (2-tailed)	.001	.001	.000	.000	.001
	N	39	38	38	38	38
No. of livestock gates in boma	Pearson Correlation	.625**	.513**	.555**	.443**	.305
	Sig. (2-tailed)	.000	.001	.000	.005	.062
	N	39	38	38	38	38
No. of males in the boma	Pearson Correlation	.548**	.483**	.774**	.682**	.802**
	Sig. (2-tailed)	.000	.002	.000	.000	.000
	N	39	38	38	38	38
No of females in boma	Pearson Correlation	.541**	.478**	.640**	.547**	.487**
	Sig. (2-tailed)	.000	.002	.000	.000	.002
	N	39	38	38	38	38
No. of children in boma	Pearson Correlation	.489**	.444**	.571**	.469**	.440**
	Sig. (2-tailed)	.002	.005	.000	.003	.006
	N	39	38	38	38	38
Total No. of people in boma	Pearson Correlation	.548**	.492**	.674**	.569**	.567**
	Sig. (2-tailed)	.000	.002	.000	.000	.000
	N	39	38	38	38	38
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Source: Researcher 2015

a) Effects of predator-proof bomas on household's livelihoods Change in vigilance time

Before the fortification of bomas, 80% (n=45) of the community members were daily spending their night time guarding their livestock. However, with the construction of PPBs, 4 %(n=45) of the community does not need to guard their livestock at night (**Table 5.14**).

Table 5.14 Guarding frequency before and after PPB

	Before	**After**
Once	4%	40%
Twice	9%	29%
Thrice	2%	20%
Four times	2%	4%
Five time	0%	0%
Six times	2%	2%
Daily	80%	4%

Source: Researcher (2015

b) Reduction in livestock killings

The respondents who own the predator-proof bomas lost a total 333 livestock at night in the boma at least one year before their boma was fortified, and only 27 after the construction of the PPBs (**Table 5.15**).

Table 5.15 Livestock killed before and after boma fortification

Livestock	**Killed Before**	**Killed After PPB**
Shoats	219	23
Cattle	109	4
Donkey	5	0
Total	**333**	**27**

Source: Researcher (2015)

5.4 DISCUSSION

5.4.1 Respondents characteristics

There was a fair representation of both the male and female in the study. This ensured that there was balanced opinions from both sexes. Majority of the respondents (31.1%) were 42-49 years, an indication that they had a relative long experiences with human-predator conflicts. Nonetheless, the opinions of all age groups was captured giving varied experiences on different variables under study. The size of the boma correlated with the total number of livestock in the boma (r= 0.386, n=90, p=0.000) but not the number of people. This could be as result of smaller families (on average 20 people per boma) possessing a large livestock numbers (average of 240 livestock). As the study area is in a dryland, pastoralism represent the majority of the population with livestock being a form of wealth among the Maasai. According to GOK (2009), over 75% of the Kajiado County's population derives its livelihood from livestock production which account for about 60% of the total labour force. The lifestyle of the majority of the population depends on livestock and livestock products for subsistence. Bruun (2006), asserts that being a pastoralist is closely tied to specific notions of identity and culture, which commonly are centred on livestock and in nomadic contexts often is tied to mobility. Mobility too thus cannot solely be conceived as necessity but is also preference and culturally conditioned. Iona (2011) study on Boran pastoralist in Isiolo showed that most (75%) relied on livestock for milk, meat and liquid cash - and multiplies by nature.

5.4.2 Characteristics of livestock predation problem

5.4.2.1 Livestock predation patterns

Livestock predation occurred both in the field and in traditional boma. However, on a comparative basis there were high livestock attacks occurred in the field when livestock were grazing than in the traditional boma. These findings are similar to Ikanda & Packer (2008) study in Ngorongoro conservation area which revealed that most (76.4%) of livestock attacks occurred during the day when livestock were grazing away from the boma, compared to 23.6% of night time attacks at the boma. This study has shown that hyena accounted for the largest loss of shoats in traditional boma (37%, n=68), while lion was majorly responsible for the loss of cattle in boma (34%, n=44). Cheetah killed more (89%, n=9) shoats in the field, followed by leopard (60%, n=5). Similarly,

Ikanda & Packer (2008) found out that 23.2% of the livestock attacks were on cattle, 67.4% shoats, and 9.3% donkeys.

The hyena was the most problematic predator (68%), taking mostly sheep and goats. In Magadi area, Mwathe (2007) also found out that hyena was a significant species largely associated with shoats killings at 44.4% among the Maasai. A review of the predator compensation scheme in Imbirikani group ranch by Okello *et al*. (2014) also showed that hyena was most involved in most predation incidences and associated with higher compensation costs, followed by jackal, cheetah, lion and leopard, with some deaths by buffalo attacks. This study findings also resembles Kissui (2008) study in Maasai Steppe in Tanzania, where lions mostly preyed upon adult cattle and donkeys, while hyenas and leopards primary killed small stock (goat, sheep and calves) and dogs. In another survey carried out by Holmern *et al* (2007) around Serengeti National park in Tanzania, livestock depredation was reported to be caused most often by spotted hyena (97.7%), leopard (1.6%), baboon (0.4%), lion (0.1%) and lastly black-backed jackal (0.1%).

The high depredation on shoats can be attributed to their high numbers per boma compared to cattle and donkeys. The high killings of shoats by hyena, cheetah and leopards could be as result of their smaller size and can be quickly be picked perhaps without the predators using more energy compared to cattle and donkeys. In addition, their smaller body size could mean they are more vulnerable and likely to succumb to injuries from the predators.

Rock, shrub and swamp habitats distances from the traditional boma had positive relationships with the predators that killed livestock. Rock habitat distance had an effect on both cattle killed ($r= 0.450$, $n=27$, $p =0.191$) and shoat killed ($r = 0.176$, $n=14$, $p = 0.546$) while shrub and swamp had positive relationship with predators that killed shoats. These finding related to Kissui and Kenana (2013) finding in the Amboseli-West Kilimanjaro landscape, where distances from abandoned bomas and distance to water sources greatly influenced the distribution of spotted hyena, lion and black jackal. Kissui and Kenana study further revealed that vegetation cover contributed 40.1% of the influence on spotted hyena distribution, 48.1% of black-backed jackals' distribution, and 18.1% of lion's distribution. Open grasslands with sparse shrubs, open grasslands and sparse grasslands had the greatest contribution indicating that all three carnivore species were more likely to be found

in these types of vegetation. The study found that the optimum distance that hyena and jackal would be found from human settlement was 5 kilometres. Therefore, human settlements and habitat type influence the distributions of predators, and the distribution determines the predation on livestock

5.4.2.2 Seasonality of attacks

Seasonality of livestock attacks in the field and in the boma varied. The months of April and December on average had high predation incidents in bomas, while September and October registered high field predation incidents. A regression analysis indicates that there was a positive significant relationship between frequencies of livestock attacks in the field and the time of the year (R^2=0.5407, n=90). The Loitokitok sub-county, where the Amboseli rangeland is located experiences a bimodal rainfall pattern. The short rains falls between October and December while the long rains fall between March and May (GOK, 2009). According to Tuqa *et al.* (2014), stochastic weather patterns can force wide-ranging species beyond current reserve boundaries, into areas where there will be greater conflicts with humans. Kissui (2008) studies in Maasai Steppe in Tanzania revealed that livestock predation by lions and hyenas were more prevalent in the wet season while leopard attacks did not differ between seasons.

The high livestock predation during the rain seasons can be attributed to the wet-season migration of wild prey from protected areas onto communal village land. The predator are then expected to follow the herbivore, and since there is enough pasture and water, it may require the predators to use more energy to capture the prey. In this case, livestock becomes an alternative 'easy' prey for the predators. This study findings were different from those of Mwathe (2007), whose results revealed that general human-wildlife were more in dry season than wet season in Magadi. The difference could be as result of this study having specifically focused on livestock predation rather than crop raiding, destructive of facilities and livestock predation combined in relation to seasons.

5.4.2 Bomas

5.4.2.1 Comparison of traditional and predator-proof Boma characteristics

Predator-proof bomas had either wooden or recycled plastic posts (2.4m long), flattened oil drums gates and rolls of chain-links (1.84m). On average the predator-proof bomas were larger in

circumferences (149.5m) than the traditional bomas (128.3) and had more livestock (293.2). However, in terms wall thickness, numbers of traditional huts, gates and height of walls were almost the same. The presence of more livestock in the predator-proof boma could be as result of the additional strong posts, rolls of chain-links and metal doors that provided an additional protection to livestock at night than the traditional bomas, encouraging community to stock more livestock in the predator-proof bomas. This study found a positive relationship between the boma characteristics and livestock predations. The boma that were larger, had more people, livestock, and gates had high livestock attacks. These findings supports Okello *et al.*(2014) study in Elerai and Oltiyiani conservancies in Amboseli, in which homestead size, number of livestock (cattle, shoats and donkeys) and human demographics all had a positive correlation with livestock killed. Dickman study in 2008 around Ruaha National park in Tanzania also showed that boma characteristics were important in reducing the predator attacks, with larger bomas that had more livestock and external entrances having high attacks. Several external entrances were seen as being a risk factor as they could be weak points of entry into the bomas. However, this study findings are contrarily to Ikanda & Packer (2008) results in Ngorongoro which indicated that the only factor consistently related to livestock attack rate was the number of people living at the homestead ($r = –0.62$, $n= 15$, $p = 0.015$) with the smaller bomas being more vulnerable to livestock loss. Also Ogada *et al.* (2003) studies in Laikipia on commercial and community ranches detected no effect of the thickness, height or complexity of boma walls on the rate of livestock loss. Ogada *et al* (2003) compared livestock loss in different bomas and found that wire enclosures provided the least protection from predators, with up to five times the depredation rate in traditional bomas.

5.4.2.2 Performance of predator-proof bomas on livestock predation

The predator-proof bomas resulted to the reduction in livestock predation incidences in the boma at night. The findings showed that 91.11% n=45) had not lost their livestock to predators at night in the boma since their bomas were fortified. 62%(n=45) and 31%(n=45) of the respondents rated the predator-proof boma to be ‘Excellent’ and ‘Good’ in reducing livestock attacks at night respectively. These findings supports those of Lichtenfeld *et al.* (2015) study in Maasai Steppe in the eastern side of Tarangire National park in Tanzania, where fortification of bomas resulted in the reduction of livestock predation by 90%, only two incidences of livestock depredation being reported. In both attacks, leopard entered through a faulty gate and killed two Shoats.

The time spent guarding livestock on daily basis also reduced significantly with only two people still guarding their boma daily per week. The reduction in vigilance time at night have several positive implications: the community members can now be active during the day and participate in other social and economic activities, reduced chances of individuals being bitten by insects such as mosquitoes and scorpions, which can have a detrimental effect on one's health, families can also have an opportunity to sit together and bond in the evening and couples have a chance to share their matrimonial bed together and enhance their relationship.

The community considered the predator-proof boma to be cost effective (Good= 44% and Average=40%). However, the rating on the durability of the structure on aggregate (Average, Poor and very poor) was on average low. This can be explained by the fact that some of the sampled bomas were built using wooden posts that had been chewed by termites reducing the durability of the boma structure. On the other hand, cost effectiveness high ratings can be attributed to the cost sharing nature of the project, where the community makes a one-time contribution of 25% of the overall cost of construction.

5.4.2.3 Effects of predator-proof bomas on community livelihood

The predator-proof bomas resulted to the reduction in livestock loss and time spend guarding livestock at night. Based on the average livestock market prices at Kimana (4th May, 2015) of sheep & goat (Ksh 5000 each), donkey (Ksh10, 000) and cattle (Ksh20, 000), it implies that households had lost Ksh3, 225,000 compared to Ksh195, 000 lost after boma fortification. MacLennan *et al.* (2009) study on the Mbirikani Group Ranch Amboseli showed that predators took 2.28% of the livestock herd annually. Okello *et al.* (2014) found out that Big Life Foundation spent more than Kenya shillings 28 million on compensation for over 9000 livestock killed in bomas only. Livestock remains the main asset that pastoralist can own/ control and can be sold to meet emergency and family health and education needs. In times of food shortages, households sell livestock to purchase other food such as cereals and legumes. Livestock and livestock products are consumed and provide protein diet for households. It is for these reasons, that a single loss of stock can elicit a much stronger emotional response from owners.

McManus *et al.* (2014) asserts that an ideal tools for reducing depredation should benefit both farmers and wildlife conservation and outlines its desirable features as, persistent efficacy, minimal unintended environmental consequences, selectivity towards problematic individuals, lower cost than that of the depredation prevented, and social acceptability. This study results suggest that predator-proof boma can efficiently and cost-effectively reduce depredation on domestic stock by reducing the economic cost of livestock depredation by carnivores.

5.4.2.4 Community attitudes and perceptions on the most problematic predator

Hyena was cited as the most problematic predator (68%). Community living near the park and conservancies (26%), their growing population (16%) and their predation on livestock (12%) were the major reasons for predator being problematic. Okello *et al*. (2014) reviewed the data of compensation scheme of the Big Life Foundation, and found out that hyena were the major predators targeting all livestock types, while lions primary targeted cattle. When asked about their opinions on the most problematic predator, majority showed a positive tolerance to the protection of predator (73%), predator's role in revenue generation through tourism (67%) and their importance in maintaining a healthy environment (66%). However, on aggregate (Agree and Strongly Agree) a considerable proportion of 38% were against sparing a predator that kill livestock. In Shari (2007) study in Imbirikani group ranch in Amboseli, 4.0% of respondents indicated nothing would stop them from killing a carnivore which had attacked/killed their livestock regardless of knowing there is a law in Kenya against killing carnivores. In other study conducted in Ewaso ecosystem in Samburu in 2010, Stephanie found out that community members were less enthused about the presence of predators, with only about 20% wanted to have spotted hyenas on their land, and about 40% wanted to have other predator species. Stephanie *et al.* (2010), argued that community members were more likely to want predators on their land if benefits from having predators reached the individual, not if benefits were only given to the community as a whole. These results suggest that strategies aimed to reduce livestock predation should be increased in addition to conservation efforts that focuses on increasing the spread of wildlife benefits revenue generated and community awareness on the importance of predators.

CHAPTER SIX
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

In this chapter, I summarizes the findings and present the conclusions of the research. At the end of the chapter, I have proposed some recommendations to the government and the organizations implementing the project to help minimize the human-carnivore problems. The recommendations are based on the findings from the study. Human-carnivore conflict has increased in Loitokitok sub-county, majorly in the community ranches surrounding Amboseli national park. The increase in the cases of conflict has been so rife that it has called for the need to find mitigation measures to the problem. The resulting consequences from the human-carnivore conflicts are equally devastating. In many cases, either side of the antagonizing group have borne the brunt in one way or another. This research study was conducted in group ranches around the Amboseli national park to assess the effectiveness of the predator-proof boma as a tool for mitigating human-carnivore conflicts. The research reveals that indeed, the conflict can be mitigated by using predator-proof bomas.

6.2 SUMMARY OF FINDINGS

6.2.1 Respondents Characteristics

This study gathered opinion from all gender and age groups. However age set of 42-49 years had the highest representation (31.1%) which was good for study because they were presumed to have had enough experience with predation thus giving relatively reliable information to the researcher. The high representation by women indicates that there is less gender disparities in households, and women are allowed to give information on behalf of the family. The boma circumference correlated to the livestock numbers in the boma, and the respondents kept more shoats (160.8±16.335) than cattle (81.99±11.870). Most household averaged 20 individuals, the household size implies that the area has a low population density.

6.2.2 Characteristics of livestock predation problem

Livestock losses to predator were more in field than in traditional bomas. Hyena and lion accounted for the highest loss of shoats and cattle; with hyena mostly (37%) killing shoats and lions preying

largely on cattle (34%). Cheetah and leopards killed more shoats in the field that rest of the predators. Generally, the hyena was identified as the most problematic predator (68%), killing more shoats. The high predation on shoats can be attributed to their relative high number per boma and their smaller size that makes them 'easy' to be preyed and even succumb to injuries compared to donkeys and cattle. Livestock predation was high both in the boma and in the grazing field during the wet seasons (April, September, October and December). This was attributed to availability of water in the entire ecosystem that trigger both herbivore and predator to migrate from the park into group ranches, where livestock becomes an easy prey compared to the wild herbivores.

6.2.3 Comparison of traditional and predator-proof bomas characteristics

The predator-proof bomas were larger in size (149.5m) compared to the traditional boma (128.3m), and had more livestock (293.2). All other physical characteristics, height, thickness of wall, number of traditional huts and number of gates had no meaningful differences. However, the researcher found a positive relationship between the boma characteristics and the livestock predation incidences. The bomas that were larger, had high number of people and livestock, and several entrance had the highest livestock attacks.

6.2.4 Performance of predator-proof bomas on livestock predations

The fortification of bomas to predator-proof status resulted in the reduction in livestock predation at night in bomas by 91.11% (n=45). Majority of the respondents (62%, n=45) rated the performance of the predator-proof boma as 'Excellent" and additional 31% rated it "Good'. The predator-proof boma also largely reduced the time the respondent spend guarding their livestock at night against predators. The rate of daily guarding of livestock at night reduced from 80% Before PPB fortification to 4% After PBB fortification(n=45).

6.2.5 Effects of predator-proof bomas on community livelihoods

The reduction in time spend guarding livestock and livestock predation case is positive changes to the respondents. The respondents has lost a total of Ksh 3,225,000 worth of livestock a year before their bomas were fortified compared to only Ksh 195,000 several years after. The predator-proof bomas have therefore cost-effectively helped the respondents to reduce depredation on livestock by reducing the economic cost of livestock depredation by predators.

6.2.6 Community attitudes and perceptions on the most problematic predator

The hyena was the most problematic predator (68%), followed by the lion at 26%. Jackal (4%), cheetahs (2%) and leopards (0%) were the least mentioned as problematic predators by the respondents. A correlation test revealed a positive relationship between the most problematic predator and total number of livestock ($r = 0.319$, $n=90$, $p = 0.002$), boma circumference ($r = 0.295$, $n=90$, $p = 0.005$), number of traditional huts($r = 0.015$, $n = 90$, $p=0.892$), numbers of gates around the boma($r = 0.173$, $n =90$, $p=0.103$); and number of people in the boma($r=0.140$, $n=90$, $p = 0.188$). The respondents had varied opinions on why the identified species were problematic. 26% of the respondents were of the opinion that hyena and lion most problematic because closeness of human settlements to the park and conservancies, 16% thought their population was high (16%), and 12% pointed out the two species ability to attacks and kill more livestock at a go. Jackals were cited to be problematic because they attack the young ones of the sheep and goats.

Despite the community having suffered livestock loss due predation, majority were conversant of the role of predator in the ecosystem (66%) and 73% were of the opinion that predators should be protected because they bring more benefits than harm. However, 26% thought that predators should be killed if they prey on livestock. This indicate a lower individual tolerance towards carnivores.

6.3 CONCLUSIONS

6.3.1 Performance of predator-proof bomas on livestock predation

The findings of this study suggest that predator-proof bomas are effective in reducing livestock predation at night. However, the effectiveness of the boma is largely depend on it's the size, livestock numbers, number of entrances to the boma and the type of predator that challenges the boma. The predator-proof bomas have also proved to be a highly valued mitigation measure by the respondents. Of importance is the maintenance aspects to avoid creating avenue for predator entry into fortified bomas. A change in herding practices can reduce livestock loss in fields and hence supplement the predator-proof boma project effects.

6.3.2 Most problematic predator on livestock attacks

Human-carnivore conflicts is a regular occurrence in Amboseli homesteads, with predation problem on livestock being more pronounced in the field than in the traditional bomas. Although

several species of predators are involved in the livestock loss, hyenas is singled out as the most problematic predator, disliked by the respondents. This can be attributed to its nature of attacks and the number of livestock losses it cause at a go.

6.3.4 Community attitudes and perceptions on the most problematic predator

The respondents are averagely tolerant to the predators. The small proportion that thought otherwise should be given more attention to deter any possible retaliatory killings of the predators. Promoting positive attitudes to predators and helping individuals to understand the value of predator in the landscape could still be necessary to reduce human-predator conflict in Amboseli, particularly as predators not only attack households at night, but also livestock grazing in the field. Depredation can result to considerable losses for individuals, and some pastoralist may continue to harbor negative attitudes towards carnivores despite the existence of fortified bomas

6.3.5 Effects of predator-proof bomas on community livelihoods

The livestock predation results to both social and economic losses to the community. The findings of this study suggest that conflicts could be significantly be reduced by improving husbandry practices. Therefore, human-wildlife conflict mitigation project should not only minimize conflicts, but also enhance the livelihood of the beneficiaries.

6.3.6 Comparison of traditional and predator-proof bomas characteristics

The predator-proof boma are larger than the traditional bomas. This is as result of PPBs providing safety for livestock at night and reducing livestock predations at night. The study also demonstrates that the larger the boma, the more attacks it is likely to have. Larger bomas had more entrances, more livestock and people. More gates are expected to be easy entry points for predators and high number of livestock reduces the durability of the bomas structure. However, the presence of more people was contrarily to the expectations, that more people would be an additional security. Therefore, it is the structure of the boma that determine the predation incidences and not the attentiveness and number of people in it.

6.4 RECOMMENDATIONS

6.4.1 Recommendations to management

a) An awareness should be carried out to encourage the community to keep vigilance of livestock during grazing in the field to avoid predation during the day. The livestock should also be returned home early enough and counted, so that any lost livestock in the bush can immediately be searched before dark;
b) The construction and maintenance of the predator-proof boma should be encouraged as a long term solution to livestock loss at night and regular maintenance be done for durability of the structure.

6.4.2 Recommendations for further research

a) A further research on distribution of prey densities effects on livestock predation problem should be carried out.
b) An examination of the changes in human settlements patterns in major migratory corridor effects on the dynamics of human-carnivore conflicts
c) Before the inauguration of the new constitution and the subsequent enactment of the new Wildlife Act 2014, the laws used to address HWC were cited as contributing to the occurrence and therefore I suggests a study on the effectiveness of new wildlife laws and policies in addressing human-wildlife conflict.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

INTRODUCTORY STATEMENTS

1. FOR THE RESEARCHER

Good morning/afternoon/evening, my name is David Manoa Master's student from the University of Nairobi pursuing Environmental planning and Management. I am conducting a survey to find out how people, livestock and predators interact in your group ranch, and I will appreciate to hear your views on this and on the predator-proof boma project that is attempting to address the issues. If you do not understand any specific question tell me to repeat and clarify. I want to assure you that your views will be treated confidential and reported mixed-in with others. The interview will last approximately 25-30 minutes.

2. FOR LOCAL RESEARCH ASSISTANTS

Good morning/afternoon/evening, my name is _____ and I am conducting a survey on behalf of David Manoa- Master's student from the University of Nairobi pursuing Environmental planning and Management. We are interested to find out how people, livestock and predators interact in your group ranch, and we would appreciate to hear your views on this and on the predator-proof boma project that is attempting to address the issues. If you do not understand any specific question tell me to repeat and clarify. I want to assure you that your views will be treated confidential and reported mixed-in with others. The interview will last approximately 25-30 minutes.

Respondent no._____

Group Ranch □ MGR □ OGR □ KGR

Gender: □ Male □ Female

Age category □ 18-25 yr. □ 26-33 yr. □ 34-41 yr. □42-49yrs □>50 yr.

Boma type: □ Predator-proof boma **(WITH CHAIN-LINKS**)

□Traditional boma (**NO CHAIN-LINKS**)

PART 1: BOMA CHARACTERISTICS

1.1.How long ago was this boma constructed?

□<1 year □ 1-2 years □ 2-3years □ 3-4 years □ 4-5 years □>5 years

1.2.GPS location: X-coordinates_____Y-coordinates_____

1.3.Circumference of boma in metres_____

1.4.Height of wall (m)_____Thickness of wall(thorns plus chain) (m)_____

1.5.Number of traditional huts in the boma_____

1.6.Number of traditional gates/entries for livestock around the boma_____

1.7.Number of people and livestock in the boma:

People	No.	Livestock	No.
Men		Cattle	
Women		Shoat	
Children		Donkey	
Total			

1.8.Landscape characteristics around the BOMA which can conceal or attract a predator.

	Habitat type	Distance from the centre of the boma(Metres)
□	Shrub	
□	Rock	
□	River	
□	Woodland	
□	Swamp	
□	Grassland	
□	Water spring	
□	Grassland	

PART 2: PERFORMANCE OF TRADITIONAL BOMAS ON LIVESTOCK LOSSES

2.1.Have any of your livestock been injured or killed in the **BOMA** by a predator between January 2014 and April 2015? □Yes □ No.

2.2.If yes above, which livestock of yours was injured or killed:

Livestock	Number killed	Predator involved	Number Injured	Predator involved
□ **Shoat**				
□ **Cattle**				
□ **Donkey**				
Total				

2.3.Have any of your livestock been injured or killed in the **FIELD** grazing between January 2014 and April 2015? □Yes □ No.

2.4.If yes above, which Livestock was injured or killed?

Livestock	Number killed	Predator involved	Number Injured	Predator involved
□ **Shoat**				
□ **Cattle**				
□ **Donkey**				
Total				

2.5. Please rate the traditional boma in terms of:

Aim	Excellent	Good	Average	Poor	Very poor	Don't
1. Reducing livestock predations						
2. Reducing retaliatory killings of predators especially lions						
3. Minimising night vigilance of livestock and offering alternative time for engaging in other social and economic activities						
4. Cost effectiveness						
5. Durability of the structure						

5.1.How frequent do you guard your livestock against predators at night in the Boma per week.

□ None □ Once □ Twice □ Thrice □ Four times □ Five times □ Six times □ Daily

PART 3: PERFORMANCE OF PREDATOR-PROOF BOMA

3.1.Which year was this boma fenced? _____

3.2.Did you lose livestock before this boma was fenced?□Yes □ No

If yes, what is the **total** numbers of livestock killed_____Injured_____? Please provide details of the predation occurrences below:

			No. of Livestock KILLED				Predator involved	No of Livestock INJURED				Predator involved
Incidents	Where?		Cattle		Shoats	Donkey		cattle		Shoats	Donkey	
	Field	In boma										
First incident												
Second incident												
Third incident												
Fourth incident												
Fifth incident												
Sixth incident												
Seventh incident												
Eighth incident												
Ninth incident												
Total												

3.3.Have any of your livestock been injured or killed in this **fenced boma**? □Yes □ No

If yes, please provide the details:

Livestock	Number killed	Predator involved	Number Injured	Predator involved
□ **Shoat**				
□ **Cattle**				
□ **Donkey**				
Total				

3.4. Have any of your livestock been injured or killed in the **FIELD** grazing between January 2014 and April 2015? □Yes □ No. If yes above, which Livestock was injured or killed?

Livestock	Number killed	Predator involved	Number Injured	Predator involved
□ **Shoat**				
□ **Cattle**				
□ **Donkey**				
Total				

3.5.How frequent were you guarding your livestock at night and how often do you guard livestock after your boma was fenced?

Before		**After**	
Once		Once	
Twice		Twice	
Thrice		Thrice	
Four time		Four time	
Five times		Five times	
Six times		Six times	
Daily		Daily	

3.6. Is your predator-proof boma been damaged? □Yes □ No

If Yes, which part is damaged? (The enumerator to go around the boma with respondents and provide the details below):

Boma part	Number/ size/length damage	Chances of predators gaining entry into the boma as a result of the damage			
		Very low	Low	High	Very high
1. Posts					
2. Chain-links					
3. Gates					

3.7.Overally, how would you rate predator-proof bomas in terms of:

Aim	Excellent	Good	Average	Poor	Very poor	Don't k
3. Reducing livestock predations						
4. Reducing retaliatory killings of predators especially lions						
6. Minimising night vigilance of livestock and offering alternative time for engaging in other social and economic activities						
7. Cost effectiveness						
8. Durability of the structure						

PART 4: COMMUNITY PERCEPTIONS ON HUMAN-PREDATOR CONFLICTS.

4.1.Which predators do you consider to the **MOST** problematic to you? □ Cheetah □ Hyena □ Leopard □ Jackal □Lion □

Why is the predator most problematic? _____

4.2.To what extend do you agree/disagree with the following statements on your attitude toward the most problematic predator named above:

	Statement	**Rates**				
		Agree	**Disagree**	**Strongly**	**Strongly**	**Don't**
1.	Predators should be protected because they bring more benefits to this community than they do problems					
2.	If the predators kills a few of my family's livestock it is acceptable for me or a family member to kill that predator so that it does not take any more livestock from us and other people					
3.	Conserving predators is a waste of resources as it leads to more conflict within the community. Today, time and money would be better spent on more urgent issues e.g. education/healthcare/development/security					
4.	Tourist are attracted here by predators, sometimes losing a livestock to a predator is a fact of life we must accept if we want tourism to continue					
5.	Only KWS and conservationist have a duty to conserve predators, not other people like us.					
6.	Predator are important to maintaining a healthy environment so we must make sure their numbers do not decrease further.					

4.3.What time(s) of the year are attacks likely to be **very high** in the **Bomas**?

□Jan□Feb□March□April□May□June□July□Aug□Sep□Oct□Nov□Dec

4.4.What time(s) of the year are attacks likely to be **very high** in the **FIELD** when livestock are grazing?

□Jan□Feb□March□April□May□June□July□Aug□Sep□Oct□Nov□Dec

Thank you for your time.