THE SOCIAL ECONOMIC COST OF LION DEPREDATION ON LIVESTOCK IN THE AMBOSELI ECOSYSTEM, KENYA

BY

MURIUKI W. MARGARET
(BSc HONS WILDLIFE MANAGEMENT, MOI UNIVERSITY)

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DECLARATION

DECLARATION BY THE CANDIDATE

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MURIUKI W. MARGARET **Signature:** ---------- **Date:** ----------
(NRM/PGM/05/07)

DECLARATION BY SUPERVISORS

This thesis has been submitted for examination with our approval as University supervisors.

PROF. HELLEN IPARA **Signature:** ---------- **Date:** ----------
Department of Wildlife Management
Eldoret University

DR. JOHN W. KIRINGE Signature: ---------- Date: ----------
School of Field Studies
Center for Wildlife Management Studies
Kenya

DEDICATION

I dedicate this work to my husband Grey Mausi and other family members, who tolerated my long absence during data collection and gave me moral support as I wrote this thesis.

ABSTRACT

The African lion population in the Amboseli ecosystem of Kenya has been on the decline in recent years, a trend largely attributed to retaliatory killing by the Maasai due to livestock predation. The local people incur a lot of financial costs due to predation of livestock by lions, but little is known about the extent of this loss. This study was carried out in the Olgulului Group Ranch (OGR) located adjacent to Amboseli National Park in June 2009. The main objective of the study was to assess the economic cost of livestock predation by lions in Amboseli ecosystem. Specific objectives of the study were: to determine the cost of livestock predation by lions in the Amboseli ecosystem, to compare the cost of livestock predation by lions relative to other large predators, to assess whether killing of livestock by lions and other wildlife results in the highest loss of livestock compared to diseases, drought and theft, and to investigate the husbandry practices used in the study area to minimize livestock attacks and determine their effectiveness against the attacks. Questionnaires, focus group discussions, key informants interviews with officials from OGR, KWS and compensation scheme organizations were the methods used to collect information. Cluster and systematic sampling techniques were used to select a sample of 200 respondents from OGR. Lions were blamed for 40.2% (US$ 374,603) of the total cost of livestock lost to wildlife between 2008 and June 2009, and represent an economic concern for livestock owners. The differences between the mean costs incurred due to losses attributed to lion US$374,603, hyena US$276,321, and leopard US$117115 were significant ($F=34.297$, $df=2, 1782$, $p=0.00$). The costs of livestock lost to hyena and the lion were not significantly different ($q=0.24$, $p=0.968$), while the economic losses of livestock to drought US$1,334,718, wildlife US$946673 and diseases US$370813 were significantly different ($F=61.484$, $df=2, 1782$, $p=0.00$). Lions caused greater economic damage compared to hyenas because they attacked cattle which had high economic value. Although the mitigation measures including well built livestock enclosures and use of dogs, used against livestock attack were successful in deterring other wildlife species, none of them deterred attacks of livestock by lions. Addressing human-lion conflict adequately calls for an improvement in livestock husbandry practices in order to minimize problems facing livestock production systems in the study area.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF ACRONYMS

ANOVA	Analysis of Variance
ANP	Amboseli National Park
ASAL	Arid and Semi Arid Lands
BWP	Botswana Currency, Pula
GR	Group Ranches
HA	Hectare
Ksh	Kenya Shillings
KWS	Kenya Wildlife Service
MGR	Mbirikani Group Ranch
OGR	Olgulului Group Ranch
NP	National Park
OGR	Olgulului Group Ranch
SHOATS	Sheep and Goats
US	United States of America
US$	United States of America Dollar
WS	Wildlife Service
GR	Group Ranch

LIST OF FIGURES

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CHAPTER ONE

INTRODUCTION

1.0 Background to the study

The African lion (*Panthera leo*) population in Africa has been undergoing serious decline over time. Although there is no reliable data, it is estimated that the lion population in the continent before colonization could have been at least one million (Hazzah, 2006). With European settlement in Africa, large carnivores including lions were considered vermin because they preyed on livestock. Consequently settlers made great efforts to exterminate them in farming and ranching areas (Herne, 1999).

The population declined steadily to 500,000 by 1950, 200,000 by 1975 (Myers, 1975) and less than 100,000 by the early 1990's (Nowell and Jackson, 1996). The current estimate for the entire continent ranges from 23,000 (Bauer and Merwe, 2004) to 39,000 (Chardonnet, 2002). The most recent population assessment by Riggio (2011) has shown that over 30,000 lions remain in approximately 3,000,000 km2 of sub-Saharan Africa, distributed across a total of 78 lion habitat patches in 27 countries. Its current range includes all African habitats except deep desert and deep rainforest making the lion an important component in most African ecosystems (Nowell and Bauer, 2006).

The IUCN Red List classification speculatively proposes a suspected continental decline of 30-50% over two decades (IUCN, 2004). Estimates further show that although more than half of Africa's surviving lions are in Tanzania which has a large

wilderness area without livestock, a robust trophy hunting industry places such a high value on lions that if left unchecked may pose a great threat in future (Hazzah, 2006). The Kenyan situation on the contrary portrays a declining population of lions over time.

Lion killing in the Maasai group ranches between the Tsavo NPs and Amboseli NP is remarkably high, and lions were extirpated from Amboseli NP and the surrounding lands in the early 1990s (Frank *et al*. 2006). Conservation programs such as the Lion Guardians have however significantly reduced lion killing in the region and a recent estimate of the lion population in and around Amboseli NP put the total at approximately 60 individuals (Frank *et al*. 2010). In earlier times, a vast lion population was resilient to regular killing by a small human population in response to both livestock predation and traditional ritual killing (*Olamayio)* (Hazzah, 2006). To counter this, conservation initiatives and benefit sharing schemes are slowly becoming more prevalent in Maasai land and other pastoralist areas with high number of warriors linked to *Olamayio.* Lion killing may continue as a traditional Masaai practice and as retaliation for lost livestock and sometimes as a result of political statements associated with unresolved human- lion conflicts (Hazzah, 2006).

The retaliatory killing of 87 lions between 1998 and 2003 adjacent to Nairobi National Park was documented and reported in the international press (BBC, 2003). However, little was done to document and publicize similar killings in the region between Amboseli NP and Tsavo West National Parks in 2001. A significant increase in hunting and poisoning of lions has been noted in Mbirikani and other group ranches adjacent to Amboseli since 2001. Since then, the Amboseli-Tsavo Game Scouts

Association has recorded at least 108 confirmed killings of lions from 2001 to 2006 **(**Frank *et al*. 2006)**.** These figures represent only known killings and with the exception of Mbirikani Group Ranch where monitoring of lion killings has been consistent, many others are likely to have gone undocumented.

The latest estimate of Kenya's lion population is a total of 1970 is documented by KWS (Table 1.1) with the Maasai land having 825 lions (Kenya Wildlife Service, 2009).

Table 1.1: Status of Lion Population in Kenya

Region	Estimated number of lions
Masailand	825
Tsavo	675
Laikipia	230
Meru	40
Samburu/Isiolo	100
Northern Kenya	100
Total	1970

(**Source: Kenya Wildlife Service, 2009)**

Although protected areas and in particular parks offer refuge for lions, and also a potential solution to lion conservation, they may fall short if they are too few or are surrounded by burgeoning human populations (Woodroffe and Ginsberg, 1998). As the pressure on land due to occupation becomes more intense, there is considerable potential for conflict between wildlife and people over grazing land and predation of domestic stock may increase. This calls for innovative ways to promote lion conservation. One way that wildlife and in particular lions can be conserved in shrinking pastoral areas like the Amboseli ecosystem is to ensure that socio-economic benefits from wildlife are realized by pastoral communities and negative wildlife

related impacts such as diseases and predation minimized. Past researchers (Nuding, 1996; Homewood *et al*. 2001; Ashley and Elliott 2003; Barnes *et al.* 2003) have documented that economic returns from integrated wildlife and livestock production can be higher than those from either enterprise on its own.

To solve the ever contentious and increasingly complex issue of human-wildlife conflicts, economically attractive solutions to human wildlife conflicts must be developed and implemented. This is possible if communities that bear the costs of living with lions and other wildlife are sensitized on how to coexist with them and accrue benefits. From the foregoing observations it can be argued that ultimately, the degree to which communities support and participate in predator conservation will depend on the value that people place on predators (Sillero-Zubiri and Laurenson, 2001). This value is likely to be a function of costs (livestock losses or threats to peoples' lives) and benefits (tourism revenue or cultural values) resulting from the presence of predators. Livestock predation in particular has been a serious challenge to conservation of threatened predators outside protected areas (Treves and Karanth, 2003), with predators potentially adversely affecting the profitability of livestock production and people's livelihoods.

Accordingly, landscapes outside the boundaries of protected areas often represent anthropogenic sinks for predator populations (Woodroffe and Ginsberg, 1998). As a consequence many studies suggest that retaliation on carnivores as reported earlier is driven by the proportion of livestock lost, not necessarily the frequency of conflict (Mishra 1997). Hence, when translated in economic costs, it can be argued that lions

like other carnivores (predators) can cause much loss to households living adjacent to protected areas like ANP.

This study aimed at quantifying lion -related costs to communities living in Olgulului Group Ranch adjacent to Amboseli National Park where livestock are raised within the same landscape with wildlife. Although many studies have documented the cost of livestock depredation by lions, many have failed to portray the same relative to other causes of loss including other wildlife species, drought, diseases and theft. For instance animal diseases impose a significant cost to both livestock ranching and pastoralism (Maddox, 2003). In a study spanning 23 years among ranches in Kenya, livestock losses to diseases were found to be twice as high as the total annual losses due to carnivores (Mizutani, 1993).

1.1 Statement of the Problem

Retaliatory Killing of predators by humans in response to livestock predation has been one of the major factors contributing to the disappearance or decline of carnivores from large areas of their former ranges. This is exemplified by the dramatic changes in the distribution of lions as illustrated by Schaller (1972) and Bauer and de longh (2001). Lion population in the Amboseli area has reduced significantly through killings due to their tendency to cause high economic losses when they prey on livestock (Chardonnet, 2002; Frank *et al*. 2006). These losses greatly affect the economic development of communities living in buffer zones of protected areas like the Olgulului community in the Amboseli region. Understanding strategies that can encourage the coexistence of both lions (see plate 1) and humans is important for successful conservation of these large predators.

Plate 1. Photograph of African Lion (Source : Author, 2013)

Amboseli's expansive swamps create a perennial source of water and food resources for diverse wildlife species in an otherwise semi-arid savanna environment at the northern base of the snowcapped base of Mt Kilimanjaro (Wayumba and Mwenda, 2006). The 600km^2 Amboseli basin is thus heavily used in the dry season by wildlife especially water dependent species like the African elephant *(Loxodonta africana),* zebra (*Equus burchelli*) and wildebeest (*Connochaetes taurinus*) and livestock which aggregate there from a wet season grazing area of about 5000Km$^{2.}$ (Western, 1975; Talbot and Olindo, 1990).

Prior to 1930 there was no attempt by the colonial government to end the traditional use of the current Amboseli National Park area by Masaai pastoralists. However when the colonial government in 1945 began establishing national parks and protected areas such as Amboseli National Park, the local Maasai populations were excluded and denied access to such areas and traditional hunting of wildlife was prohibited

(Halderman, 1987)**.** The Maasai pastoral community of the Amboseli area was however too large to be ignored and therefore it was designated as a National Reserve in 1974 (Western, 1975; Talbot and Olindo, 1990). Some access and use of resources found up in the reserve by local population was permitted (Halderman, 1987). Despite this, the designation marked the beginning of alienation of the Maasai people from land and resources they considered theirs thus setting a stage for confrontations between the Maasai and protected area managers which continues to date. The designation of Amboseli National Reserve also brought many problems for the Maasai; most notably wildlife competition for water and fertile pasture (Campbell *et al*. 2003b), disease transmission (i.e., Malignant Catarrhal Fever), and depredation of livestock (Lindsay, 1987; Lovatt Smith, 1997).

In 1961, the government handed over the administration of Amboseli Reserve to the Kajiado County Council (Lindsay, 1987). Unfortunately the council had little expertise in reserve management and this led to a series of incidents of fraudulent mismanagement of the reserve and revenue (Lindsay, 1987). Almost from the beginning there were constant conflicts among the Maasai of Kajiado District about the disposition and use of revenue collected from the reserve. This was partly because of the nomadic lifestyle of the local inhabitants of Kajiado District so that any social welfare facilities constructed were scattered and it was hard for people to appreciate them as part of the benefits accruing from conservation. Communities living adjacent to wildlife areas were distant both physically and politically from the council which controlled the revenue and they complained that they received no benefits from it at all (Talbot and Olindo, 1990).

In spite of the foregoing revelations, the Maasai continued to graze and water their livestock in the Amboseli basin during dry periods (Talbot and Olindo, 1990). To show their frustrations and resentments they killed lions, rhinos (*Diceros bicornis*) and other wildlife like elephants (Talbot and Olindo, 1990). This spurred conservationists into pushing for a National Park status for Amboseli, while the Maasai people responded by mounting political pressure to gain title to the entire region to themselves. Finally, the government decided that Amboseli becomes a national park under government jurisdiction in 1974 (Lindsay, 1987). In a nationwide program of land adjudication (a concept introduced in 1968 with the aim of addressing the issues of land degradation and overgrazing by encouraging pastoral Maasai to graze only within the group ranch boundaries) Maasai were to move into predetermined group ranches (Kimani and Pickard, 1998).

From the background information given, conflicts between humans and wildlife in the Amboseli region are inevitable, given the circumstances in land use changes, ownership and access as well as accelerated wildlife conflicts which have resulted in heavy losses due to livestock predation. To develop the necessary mitigation strategies it is necessary to consider other causes of loss besides the lions and other wildlife species that could possibly result from land use changes, changes in land ownership and access. Lions and other large predators like the leopard (*Panthera pandus)* and hyena raid livestock herds and occasionally attack herders both inside and outside the park. Besides the human tragedies through death and or injury, the predators make livestock keeping grossly unprofitable. In retaliation, herders in Amboseli area, who are mostly Maasai, resort to spearing, snaring and poisoning

predators, a situation which has led to en mass predator deaths in recent years (Frank *et al*. 2006).

This latest development has alarmed the Kenya Wildlife Service (KWS) and conservationists. For example, each lion costs ranchers US$290 in depredation each year in ranches neighboring Tsavo National Park (Patterson *et al*. 2004). To resolve the existing conflict between the local Maasai and large predators in the Amboseli region, more detailed information on the cost and intensity of lion predation on livestock is key in developing strategies for conserving both large carnivores and wild lands. This will also help alleviate incidences of retaliatory killings and increase tolerance towards problem wildlife thereby promoting co-existence between the community and predators especially lions. Besides, this to avoid the establishment of population ‘‘sinks’’ surrounding the park, in which human-caused mortality limits survival of predators dispersing from the park, strategies to reconcile livestock keeping, sustenance of local livelihoods and wildlife conservation are necessary. If the conflict between large predators and the local Maasai is not resolved, then the future of lions in the Amboseli ecosystem remains uncertain.

1.2. Objectives of the study

The overall goal of this study was to assess the economic loss from livestock predation by lions and the implications of the loss on pastoralists and the conservation of lions.

1.2.2. Specific objectives

1. To determine the loss of livestock due to predation by lions in the Amboseli ecosystem.

2. To compare the loss of livestock due predation by lions versus other large predators in the Amboseli ecosystem.
3. To assess whether killing of livestock by lions and other wildlife results in higher losses of livestock compared to diseases, drought and theft
4. To establish the husbandry practices used to minimize livestock attacks by predators in the Amboseli ecosystem and determine their effectiveness.

1.2.3 Research questions

1. Is the loss of livestock due to predation by lions high enough to cause retaliatory killings?
2. Do other large predators cause high livestock losses comparable to lions?
3. Do other causes of livestock mortality (diseases, drought, theft and other wildlife species) contribute to livestock losses comparable to lions?
4. What is the role of husbandly practices in reducing livestock exposure to depredation?

1.3. Justification and significance of the study

The lion is one of the flagship species of Africa for research, tourism and trophy hunting, and as such solutions for their conservation problems should be developed. Nearly all parks and reserves in Kenya including Amboseli National Park depends on dispersal areas for the survival of the wildlife they hold (Western 1975; Wishitemi and Okello, 2003). The issue of land use conflicts has come to the fore in the country because of a rapidly growing, essentially rural population (Campbell *et al*. 2000). Increasing at a rate of about 3.5 percent a year, human population pressures have built up in the ecologically better endowed highland areas.

To release this pressure, people have spontaneously moved to the rangelands and established dense settlements thereby destabilizing traditional pastoral ecosystems (Campbell *et al*. 2000). This has led to human-wildlife resource use conflicts, ecological degradation and poverty. Wide spread poverty has in turn resulted in unsustainable resource exploitation and conflict between biodiversity preservation and economic opportunities for local residents (Ntiati, 2002).

Lack of effective human-wildlife conflict resolution mechanisms and measures has led to negative attitudes towards conservation of wildlife particularly endangered species that range outside protected areas (Okello, 2005). If wildlife continues to cause losses to households and fails significantly to benefit the Maasai directly, it will continue to remain a discredited form of land use by the local community. According to Holmern *et al*., (2006), retaliatory killing of lions is associated with the number of livestock lost as a result of depredation.

Wildlife forms an important economic activity in the study area and entire Amboseli ecosystem and wildlife related activities such as tourism should bring adequate benefits to offset the losses incurred from wildlife attacks on livestock. It is estimated that the lion's annual contribution to Amboseli is Ksh 19,500,000 or approximately US $260,000 and remains an important aspect to the success of the Amboseli National Park (Thresher, 1981). Although lions pose serious challenges for African communities bordering conservation areas, it is a powerful and omnipresent symbol, and its disappearance would represent a great loss for the traditional culture of Africa since it is used in coats of arms, heroic names of former kings, frescos, names of football teams, tales, proverbs and sayings among others (Skuja, 2002). In many areas

where lions still occur, livestock owners suffer substantial losses from stock-raiding lions (Stander, 1990; Bauer et al., 2001; Loveridge *et al*. 2002).

To enhance conservation of lions and other carnivores all the factors that motivate the persecution of lions and other predators must be looked into. Some of these could be the high losses incurred by locals particularly from lions which mostly prey on cattle which are more valued in monetary terms and other traditional values like paying bride price and as a measure of wealth. Detailed information on the intensity and cost of predation is necessary in developing suitable strategies towards the conservation of lions and other wildlife species. Compensation programs which compensate individuals fully or in part in accordance with the market value of lost livestock have been implemented in various parts of Maasai land (Amboseli Trust for Elephant and Predators Fund in the Amboseli ecosystem) and other pastoral areas in Kenya (Nyhus *et al*. 2005). Most of these programs have failed due to lack of funds and locals are left even more bitter resulting in more and intensified persecution of lions.

This study can therefore be used as a model to assess the economic cost of livestock predation per year which can in turn be used to determine the cost of compensation in the long term. It is envisaged that compensation for livestock killed by carnivores can lead to reduced vigilance and increased stocking rates of livestock. Increased predation can be reduced if appropriate husbandry practices like proper fencing of livestock bomas are put in place. It is necessary to examine different traditional methods of livestock husbandry among them fencing and use of dogs to determine the most effective one against livestock predation by lions. This would also reduce the

costs incurred in compensation of lost livestock and at the same time reduce the amount of loss to the pastoralists.

Compensation schemes are more reactive than proactive in addressing the root causes of human lion conflict. However if implemented efficiently, they still hold promise to manage one of the basic challenges of wildlife (and biodiversity) conservation, that is, the economic burden of carnivores moves away from the locals and onto conservationists (Naughton-Treves *et al*. 2003; Nyhus *et al*. 2003).

Although different challenges facing livestock keeping for example drought, diseases and theft are well documented, few studies have documented their economic impact on livestock keepers and the development of Arid and Semi Arid Lands (Karani *et al*. 1995, Maddox, 2003). While predation and particularly by lions could be high, losses incurred due to drought and diseases could even be higher relative predation in terms of economic cost to the local communities.

Drought also contributes to human lion conflict directly when pastoralists move livestock into the park seeking pasture and water where they interact with lions and indirectly by reducing herbivore numbers which form the natural prey for lions making them turn to livestock as the alternative prey. If challenges such as the impacts of droughts, diseases and theft are also addressed by different stakeholders including KWS, NGOs and private investors, the magnitude of predation as a cause of livestock loss can be felt less. By so doing locals will feel less alienated by the park management and other stakeholders since they currently feel that wildlife conservation is given priority at the expense of their livestock and even human life.

Alhough lions may have suffered the greatest persecution due to livestock predation, other carnivores also kill livestock causing high losses. Kissui's (2008) research in the Maasai steppe landscape in Northern Tanzania shows that lions, leopards and spotted hyenas are the three major predators on livestock, but the lion is most vulnerable to retaliatory killing. From this perspective, this study evaluated the role of other wildlife species among them the spotted hyena (*Crocuta crocuta*), cheetah (*Acynonyx jubatus)*, leopard (*Panthera pardus*), olive baboons (*Papio cynocephalus*), black-backed jackal (*Canis mesomelas*) and the African elephant (*Loxodonta africana*), in causing livestock losses. It is worth noting that although many studies have studied predation of livestock by large carnivores including the lion, cheetah, leopard and the hyena, research has not been undertaken to determine the losses caused by other wildlife species besides these listed. From the findings of this work different methods of livestock husbandly practices aimed at reducing livestocks attacks by lions in the study area will be recommended.

Land use change to agriculture in parts of the Amboseli ecosystem including the Namelok swamp and Kimana has had negative implications for both livestock and wildlife (Worden *et al*. 2003). Although various studies have attributed this land use change to increase in population and security of land tenure (Worden *et al*., 2003) high cost of livestock predation by lions and other carnivores are likely to motivate land use change by making livestock keeping unreliable as a source of livelihood. Land use change to agriculture in particular is likely to alter the whole ecosystem by affecting herbivore populations thus increasing human wildlife conflict. As a result, the combination of strategies to offset the economic loss from livestock predation by

lions recommended by this study are likely to solve the bigger problem of land use change and the consequent land degradation.

1.4. Scope and limitations of the study

This study was conducted in Olgulului Group Ranch adjacent to Amboseli National Park and the data collected covered the whole of year 2008 up to June 2009. It focused on the economic cost of livestock predation by lions as well as other wildlife species which kill livestock even if not necessarily for food. Costs incurred from other causes of livestock loss including disease, theft and drought were also quantified for comparison with the cost of livestock lost to wildlife and to the lion in particular. The diseases considered are not necessarily transmitted by wildlife to livestock but all diseases that affect livestock. Losses were only quantified on numbers of livestock killed. Other costs associated with livestock production like predator management or use of husbandry practices to deter predation, costs incurred from livestock treatment (in cases where wildlife injured livestock or are suffering from diseases), as well as benefits lost when livestock is killed for example milk, meat, leather and cultural value, were not considered.

Although questionnaires were the main data collection tool, there are some potential disadvantages of relying solely on questionnaires that might have influenced livestock loss data. As Rasmussen (1999) has documented, livestock holders may wrongly attribute stock that has died of natural causes to being caused by carnivores – through sheer neglect or prejudices towards specific carnivore species. Secondly, livestock keepers might also have had an interest in overestimating the rate of loss, because they might believe that they may get compensated by compensation schemes

particularly because a predator compensation scheme began operating in Olgulului in the year 2008.

To avoid this misconception, respondents were informed that the research was purely academic and that no benefits were to be expected. Fourthly, respondents often bias their recollection of past events in favor of larger species, especially when sampling from multiple years (Kruuk, 1980). This was reduced by collecting data for 2008 up to June 2009, instead of using a longer time period. Despite these limitations, several studies show that livestock keeper's perception of livestock depredation gives a relatively reliable index of livestock depredation (Kruuk, 1980; Woodroffe *et al*. 2005).

1.5. Conceptual Framework

This study looked at cost of livestock depredation by the lion and the consequent retaliatory killings by the local community. The major question that comes to mind is this, is the lion the only cause of livestock loss among the pastoralists in the study area? There are other factors that contribute to loss of livestock including drought, theft, diseases and attacks from other wildlife species. Underlying constraints including group ranch subdivision and loss of land to other land uses including agriculture and other developments considered more economical than pastoralism contribute directly and indirectly to losses of livestock (Figure 1.1). Ecologists suggest that traditional patterns, including livestock diversity, mobility, low energy efficiency, and biomass maintenance are cornerstones of environmental sustainability (McCabe, 1990).

Mobility of pastoralists and their livestock has been an important strategic response to ecological variability and risk associated with dry areas (Niamir-Fuller, 1999; Mehta *et al*, 1999). The Maasai have also lost most of their traditional livestock husbandry strategies or practices including optimizing livestock forage intake by selecting the best grazing pastures in any season and minimizing stock losses to drought, disease and predation, including raiding which are strongly linked with mobility (Scoones, 1996; Hendrickson et al., 1998) This has led to increased attack on livestock by wildlife species including lions which are seen as causing the highest economic impact.

Reduced mobility leads to range degradation as livestock is concentrated within smaller, individual land units leading to increased vulnerability to drought and diseases. Attempts to solve the problem of livestock predation by lions will have to unravel the underlying problems and if these are solved we will not only have a healthy lion population in the Amboseli ecosystem, but also a healthy habitat for other wildlife species to live in.

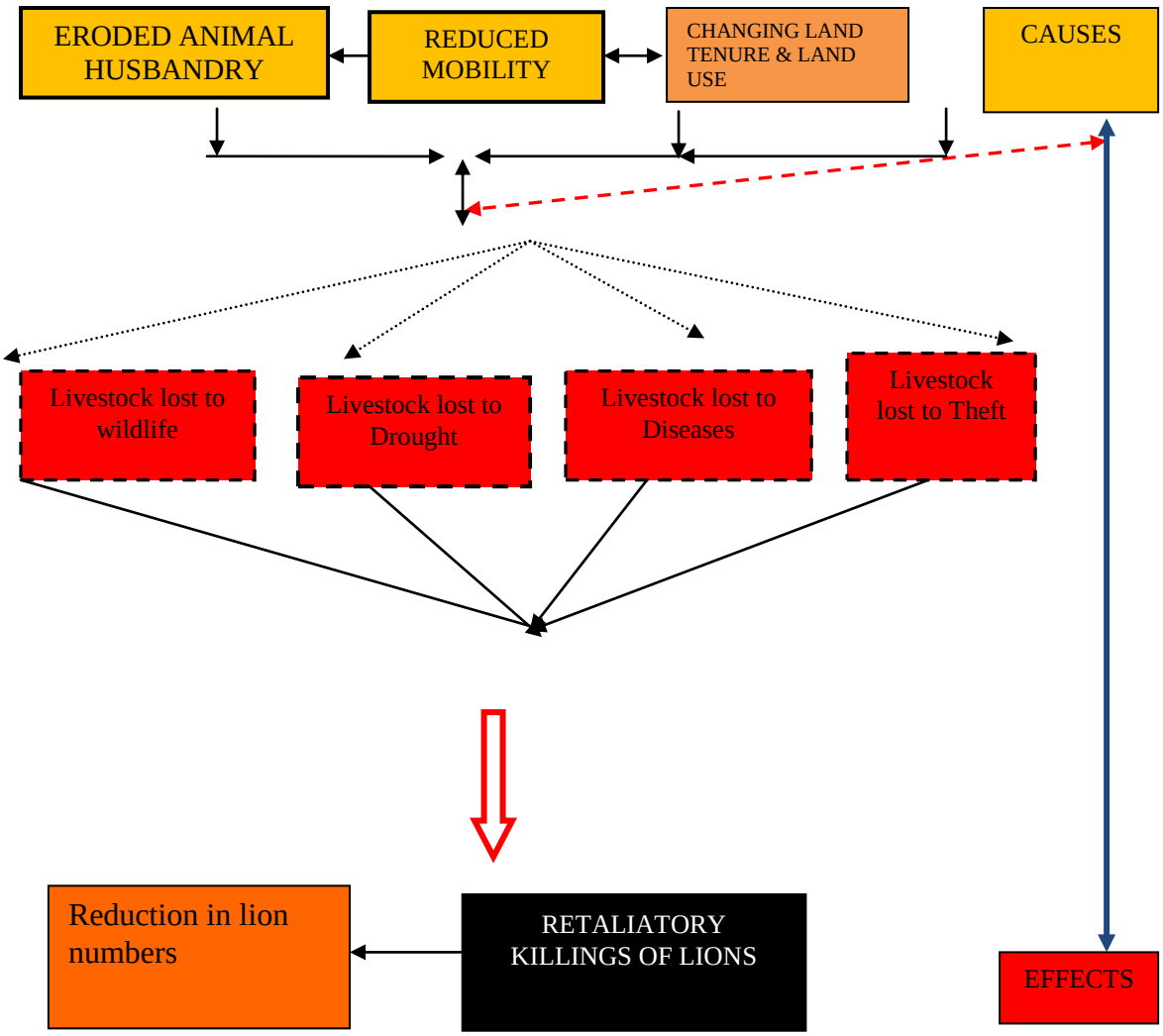

Figure 1.1: Conceptual Model for the Study

1.6. Operational definition of terms

Retaliatory killing – this is the killing of lions by human beings because of the negative economic loss they cause, either through loss of life and livestock or through loss of income-generating opportunities (Kissui, 2008). This study specifically looks at retaliatory killing of lions because of negative economic loss they cause as a result of livestock predation. This definition includes three methods used in killing predators in the study area namely spearing, poisoning and trapping.

Predation-ecologically predation is defined as a form of symbiotic relationship between two organisms of unlike species in which one of them acts as predator that captures and feeds on the other organism that serves as the prey (Andrew, 1985). The predator in the current study is defined as carnivores including lions, leopard, cheetah and jackal while the prey is defined as livestock including cattle, shoats and donkeys.

Economic losses- economic losses according to the study are direct losses that result when livestock die from different causes of death including wildlife, diseases, and drought. The loss of livestock to theft is also included in this definition but the definition excludes indirect losses like reduced breeding that result when animals are stressed after an attack, costs of treatment when livestock are injured during an attack and when they are sick.

Livestock – this term refers to different types of domestic animals raised for home use or to generate profit (Koocheki and Gliessman, 2005). Four types of livestock are included in this study that is cattle, shoats and donkeys.

Pastoralists - Pastoralists are people who derive more than 50 per cent of their incomes from livestock and livestock products (Koocheki and Gliessman, 2005).

Shoats – the term shoats was used to refer to a collection of goats and sheep .

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The reasons that make lions prey on livestock vary but they are not fully understood. Although the sex of the lion may be influential to predation, a study on lion predation in Gir Forest, India, showed a disproportionate number of attacks due to sub-adult lions (Saberwal *et al*. 1994). According to Frank *et al* (2008), although sub-adult males may be more likely to kill livestock, all lions are potential livestock killers. Culprits might also be mature lions forced out of prides that are no longer capable of killing wild animals as a result of old age, damage to the paws or teeth (La Grange, 2005).

While most lions feed exclusively on wild prey, few become chronic livestock killers (Frank, 2006). For example in Waza National Park in Cameroon, some lions are problem animals, one collared male lion was a habitual problem animal who spent most of his time outside the park feeding primarily on livestock (de Iongh *et al*. 2008). What emerged from this study is that lions may acquire the behavior of killing livestock if the wild prey are unavailable and livestock became an easy prey to find and subdue. Wild prey may get depleted due to drought, from extreme competition with livestock for forage and displacement from their range by land uses like agriculture.

Fundamental ecological and behavioral characteristics of carnivores such as density,

grouping, range size and prey selection are influenced by habitat and by prey density, dispersion and richness (Stander, 1997). Lions need more space than many other predators, and their predatory behavior and reproductive strategies show extensive regional variation reflecting their adaptability.

Ecological data shows that lions are still found in areas with human settlements, because of favorable habitat and an adequate prey base in the form of domestic animals and wildlife with high tolerance of humans (Saberwal *et al*. 1994). Lions' preference for dense habitat, for example, may increase the likelihood of encounters with humans thus increasing the opportunity for lions to ambush humans and livestock (Saberwal *et al*. 1994). Consequently where people are living in largely unaltered wilderness areas like Olugulului where this study was done, encounters of lions with people and their livestock are likely to cause conflict. One aspect of lion behavior is "surplus killing". A lion breaking into a fenced enclosure may kill more – sometimes many more – domestic animals than it can eat (Nowell and Jackson, 1996). This trait certainly increases human hostility towards lions and exacerbates conflict.

This study investigates the economic cost of this loss and compares it to the cost of livestock losses reported from other causes including disease, drought and theft. To acquire a deeper understanding of these losses literature was reviewed on the biology of the lions and on various studies that have documented information on human conflicts with lions and the cost of the resulting livestock losses. The cost resulting from other causes of loss including other wildlife species and the factors mentioned above was also reviewed.

2.1. Morphology, Distribution, Social Organization and Behavior of lions

Although today most people associate lions with the open plains of the African continent south of the Sahara, during the Pleistocene period lions were the most widespread large terrestrial mammal found all over the Holartic region including North America, they were present on every continent except Australia and Antarctica (Nagel *et al*., 2003, Barnett *et al.*, 2006). The lion range included most of Europe, Asia, Africa, and North and South America (Barnett *et al*., 2006).

It was eliminated from the New World at the end of the Pleistocene and from Europe and nearly all of Asia. In Africa, it has been eliminated from 83% of its historic range since European colonization (Figure 2.1). Traditionally twelve and later eight sub species of *Panthera leo* have been classified based on location, mane appearance, size and distribution (Burger *et al*., 2004, Barnett *et al*., 2006). Two distinct lineages are recognized to have existed at the end of Pleistocene, namely, the Holarctic cave lion (*Panthera leo spelaea*) and the modern lion (*Panthera leo spp*). The free ranging lions today exist as two disjunct populations: *Panthera leo leo* and *Panthera leo persica* in India. The former are presently found in savannah habitats across sub-Saharan Africa while the only living representatives of the latter occur in the Gir Forest, in western India (Nowell and Jackson 1996).

African lions exist as fragmented populations in west and central Africa, and as a continuous large population in east and southern Africa (Figure 2.1). All sub-Saharan Africa lions are classified into a single subspecies (Dubach *et al*., 2005, O' Brien *et al*., 1987b). However, they may be divided into two main clades: to the west and east of the Great Rift Valley indicated by the fact that lions from Tsavo in Eastern Kenya

are much closer genetically to lions in Transvaal (South Africa), than to those in the Aberdare Range in Western Kenya (Barnett *et al*., 2006).

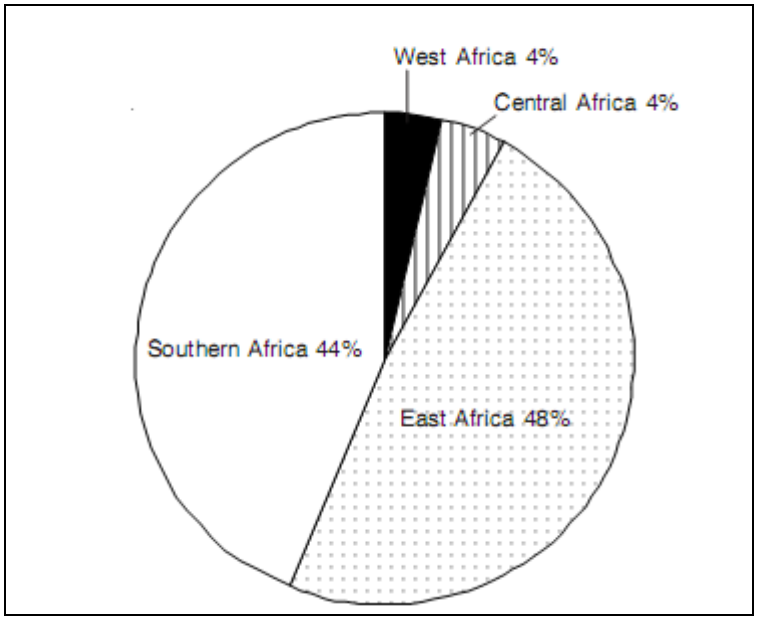

Figure 2.1: Lion distribution in Africa

(Source: Bauer and van der Merwe, 2004)

Most African lions live in prides and group formation in lions has been described as fission-fusion interactions (Schaller, 1972). The size of a pride varies dependent upon the available prey, in open habitats, female pride consist of 2–18 females and a coalition of males that has entered the pride from elsewhere and associate with the pride during their tenure with the pride (Schaller 1972, Bertram 1975, Bygott *et al*., 1979, Packer and Pusey 1982). Female companions of a pride are always closely related, male companions are either closely related or unrelated and mating partners

are usually unrelated (Packer *et al*., 1991). Interestingly lion do not form dominance hierarchies within prides (Schaller 1972, Bertram 1975, Bygott *et al*., 1979, Packer and Pusey 1983)**.**

Group territoriality, group hunting and communal cub-rearing form the basis of this cooperation (Grinnell *et al*., 1995, Heinsohn and Packer 1995). In the open savannah, where it is difficult to ambush prey, better hunting success and fewer injuries are obtained through adaptation for sociality. Hunting success has been shown to increase with increase in group size, especially in hunting down large prey (Stander 1992, Funston *et al*., 2001). Hunting success of males is reduced in open areas because they are much slower and more conspicuous to the prey and they therefore optimize their feeding requirement by associating with pride females throughout their tenure and appropriating prey from them (Bertram *et al*., 1979). However, in closed areas males hunt successfully alone and rarely scavenge from females (Funston *et al*., 1998). Another advantage of group living is to scare off scavengers like hyenas and also other male lions, so the kill don't go to strangers (Alderton, 1999). A third advantage is the communal rising of offspring and, therefore, better reproductive success.

Coalitions (groups of male lions) may live in association with one or more prides (Schaller, 1973; Bertram 1975a, b, 1978, 1991) but still the individuals compete with each other for prey and mating partners. Female African lions select their favorite males from the features of the mane; the longer the mane and the darker the hair (black), the more often a male is chosen by the females. The mane will help the males defend their territory against invaders, as the mane provides good protection during fighting (Estes, 1991). The mane is not well developed until the lion is three to four

years old, when they have a spurt of growth in body size and mane length (Rudnai, 1973).

The social system of lions is very dynamic and varies with respect to habitat, anthropogenic pressures and dependency on livestock, prey availability and competition (Funston, 2007; Hemson 2003; Hanby *et al*., 1995; Cooper 1991; Schaller 1972). They can survive on a broad range of prey species that vary between habitats (Hayward and Kerley, 2005). However, the dietary preferences of lions are medium sized and large ungulates, weighing between 50-300kg (Schaller, 1972).

An adult female lion needs a minimum of 5 Kgs of meat per day to maintain basic metabolic requirements (Schaller, 1972). Their most common prey in the wild are wildebeest (*Connochaetes taurinus*), zebra (*Equus burchelli and E.grevyi*), buffalo (*Syncerus caffer*) (Schaller 1972; Kissui and Packer, 2004) and warthog (*Phacochoerus aethiops)* (Scheel and Packer, 1991). Lions do hunt actively at night and also during the day (Schaller, 1972). Humans have expanded into the last corners of the lion's range, leaving few refuges, and the Amboseli ecosystem is not an exeption. Lions are large predators that constitute real threats to both rural people and livestock (Packer *et al*., 2005b). Conservation of lions entails coexistence that will depend on mitigation measures based on local ecological and social economic situations.

2.2. Concept of wildlife damage

Livestock predation by mammalian carnivores is one of the most frequent sources of conflict between humans and wildlife throughout the world (Mazzoli *et al*., 2002). What constitutes wildlife damage, like what constitutes wildlife and wilderness in

general is inherently subjective (Nash, 1967). Moreover, what constitutes acceptable loss to a rancher is very different from what constitutes acceptable loss to other members of the public (Mech, 1995: Reiter *et al*., 1999). A study carried out in central Kenya revealed that commercial ranchers own an average 1,536 head of cattle, whereas community members own an average of 8 heads of cattle (Romanach *et al*., 2007). As negative attitudes towards predators are often related to economic loss (Lindsey *et al*., 2005), stock lost to predation even when very few can be significant to small scale farmers (Butler, 2000; Swarner, 2004).

Results of a study conducted in Zimbabwe showed the average loss to a household due to predation of livestock by carnivores amounted to $13 per year; which amounted to 12% of each household's net annual income (Butler, 2000). Lethal control seemed like an effective and convenient way of dealing with the problem (Swarner, 2004). Therefore, one possible definition of loss would be to confine economic loss to cases of confirmed predation (dead livestock found and predation confirmed by forensic examination). This definition severely underestimates economic loss as confirming predation is extremely difficult and defining or estimating its cost is equally difficult (Bodenchuk *et al*, 2000).

Definitions of loss ignore costs incurred by producers to reduce predation risks such as the purchase, training, and maintenance of guard animals, fencing, herders, repellent devices and contributions to private or public predation management programs (Littauer *et al*. 1986). These additional costs, though beyond the scope of this study, are significant and can be equivalent to or exceed the cost of predation. For example, in 1981 the indirect cost of predation management in Wyoming, United

States of America (USA) was estimated to be US$ 2,639,900 while reported losses to Wyoming producers that year totaled US$ 2,979,970 (Jahnke *et al.,* 1987). Some studies have also shown that predation management reduces predation significantly. Livestock depredation is effectively reduced by improving static defenses such as reinforced stock enclosures, guard dogs and increased vigilance by human guards, especially during certain periods (Hemson, 2003; Lindsey *et al*., 2005). Consequently those with good livestock husbandry systems rarely lose stock and therefore rarely kill predators (Frank *et al*., 2006).

In this study it was hypothesized that fewer and probably cheaper methods are used for predation management by the Maasai of the Amboseli region. As a consequence although the present study focuses on the direct cost of livestock predation, practices used for predation management were also examined. Literature reviewed revealed that in the USA, predators killed about 22,600 heads of cattle, 144,000 sheep and 35,000 goats in 1998, and the estimated market value of these losses was more than US$17.4 million (Bodenchuk *et al.,* 2000). Although opponents of predation management frequently claim that self-reported losses are overestimated (Bodenchuk, *et al.,* 2000), the available evidence suggests otherwise. Connolly (1992) reported that surveys of livestock producers tend to under-report losses because reports given emphasize on confirmed kills only.

In USA, predation is the leading cause of sheep and lamb mortality (National Agricultural Statistics Service, 1999) with average annual rate of predation being 5.7% for adult sheep and 17.5% for lambs. These rates were found to be considerably high compared to predation rates when predation management programs are used

(National Agricultural Statistics Service, 1999). In eight studies by the National Agricultural Statistics Service where management was practiced, average loss of sheep and lambs was within a range of 3.6% to 6.5%. Based on the National Agricultural Statistics Service (1999) report, predation losses averaged 1.6% of adult sheep and 6.0% of the calculated lamb crop when predation management programs were in place.

Elsewhere, Mishra (1997) reported an economic loss of US$ 15,418 due to predation among the Indian-trans Himalayan communities, which was equivalent to $128 loss per family per year. In Hemis National Park in Ladakh, India, the rate of predation on cattle was high, with a survey in the area showing that over a 14 month period, the average household lost six animals, valued at almost US$ 300. Predation was so high that a livestock compensation scheme in Hemis National Park in the area, sponsored by the Ladakh Wildlife Department, failed due to high costs involved. Butler (2000) recorded economic loss averaging $13 or 12% of each household's net annual income in Zimbabwe. Human-carnivore conflicts in northern Botswana resulted to a total of 938 predator attacks, causing an estimated financial loss of BWP 350,000 (US$ 57,000) (Gusse *et al.*, 2009).

In Northern Ethiopia depredation due to spotted hyenas (*Crocuta crocuta)* caused an estimated financial loss of US$ 6,116 in 2009 (Gidey and Hans, 2010). While the costs due to livestock loss in the Western Serengeti, Tanzania averaged US$ 97.7 per household constituting two thirds of the average annual income per household (Holmern *et al*. 2006). In Northern Kenya, attacks on livestock by wild dogs (*Lycaon pictus*) cost the local community about KSh 2.2 million (US$2870) during a period of

three months in 2003 (Woodroffe and lidsey, 2004). In villages surrounding Maasai Mara National reserve livestock depredation resulted in a loss of US$ 6049 (Kshs 460,000) over a 14-month period from 2003 to 2004 (Kolowski and Holekamp 2006). A predator compensation fund introduced in Mbirikani group not very far from Olgulului group ranch in 2003 paid over $30,000 as compensation for killed livestock (Rodriguez, 2006). The figures cited in the foregoing studies are enormous and cost farmers huge costs in terms of livestock losses.

2.3. Cost of livestock predation by lions and other carnivores

In some countries, lions remain a serious predator of cattle in *bomas* at night and on grazing grounds during the day. On average around Waza National Park in Cameroon the number of domestic animals killed by all carnivores (mainly lions and hyenas) together equaled the mortality caused by diseases (Bauer, 2003). Lions caused more economic damage than any other carnivore, as they preferably attacked cattle, which are relatively expensive compared to other livestock species (Bauer *et al.* 2001; Bauer, 2003). Some studies have shown that a single lion may kill more than one domestic animal in a single attack (Butler, 2000; Schiess-Meier *et al*., 2007; Woodroffe *et al*., 2007). Consequently a few lions may cause great economic losses to individual owners compared to other carnivores that attack single animals.

In Taita and Rukinga ranches in Kenya, lions killed an average of 1.36 animals per attack and at least twice killed as many as six individuals (Patterson *et al*., 2004). On the contrary attacks by spotted hyena and cheetah typically claimed a single victim (Patterson *et al*., 2004). On average, wildlife attacks claimed 2.4% of range stock annually and livestock represented 5.8% of the diet to lions in the ranch. This predation represented 2.6% of the herd's estimated economic value and cost the

ranches US$ 8,749 per annum with lions costing the ranchers about US$ 290 per year in depredations (Patterson *et al*. 2004). In Waza National Park slightly a less number of cattle than shoats were lost to lion predation in 2002 (335 cows, compared with 373 shoats) but the economic impact of cattle predation that stood at US$ 797 per livestock owner per year was almost eight times higher (Van Bommel and de longh, 2007).

In Uganda, near Northern Queen Elizabeth National Park, losses from lion predation on livestock between 1990 and 2000 were estimated at US$ 6,400 (Bauer and De Iongh, 2001). In Namibia, around Kaudom Game Reserve 40 percent of villages suffered from livestock losses due to lion predation valued at US$ 18.75 for each village involved (Stander, 1997). Farmers in the buffer zone of Western Transfrontier Park in Niger lost US$ 149,530 to lion predation on livestock between 2000 and 2006, while the annual average cost per person was US$ 138 (Hamissou and Di Silvestre, 2006).

In many parts of Africa, the lion is the principal predator of livestock leading to conflicts with livestock keepers. This has caused a recent increase in lion killing and the consequent drop in lion population from most of it range in African countries. In Kenya, recent evidence has shown an increase in lion killing as discussed in chapter one particularly in Kajiado district where the study area is located. Lions can have serious economic implications on livestock production and people's livelihoods in general as is often manifested through increased predation leading to high livestock losses.

Many carnivore species like cheetah (*Acynonyx jubatus)* (Marker-Kraus, 1997), leopard (*Panthera pardus*) (Mizutani, 1993); (Sekhar, 1998), tigers (*Panthera tigris*) (Sekhar, 1998) and wild dogs (*Lycaon pictus*) (Rasmussen, 1999)) have been reported to prey on domestic animals. Hyenas followed by leopards, cheetahs, jackals and wild dogs preyed mainly on shoats (Mizutani, 1993). Despite this, results of various studies (Kerbis and Gnoske, 2002; Patterson *et al*., 2004) allude that lions cause the greatest economic damage compared to other large predators.

For instance in Taita and Rukinga Ranches of Kenya while lions in the ecosystem accounted for 277 attacks amounting to 83.5–95.7% of livestock preyed on annually, the spotted hyena was responsible for 0–9.1%, cheetah 0– 4.9%, and Elephants 0–3.6% of the attacks (Patterson *et al*. 2004). In a three-year study in Zimbabwe, baboons were responsible for more than half of the 241 livestock kills (Butler, 2000). Between 1994 –1998, the Kenya Wildlife Service recorded 121 incidents near Voi, Kenya involving carnivore attacks, including a fraction of the Galana Cattle Company incidents (Kerbis and Gnoske, 2002). Of these, 93% (n=112) were caused by lion, 3% (n=4) by leopard, 2% (n=2) by hyena, and 2% (n=3) by cheetah (Kerbis and Gnoske, 2002).

Elsewhere in Kenya, rankings of depredations by these species differs substantially. In Maasai Mara, leopards, hyenas and lions accounted for 50.1%, 31.1% and 18.9%, of kills and injuries to livestock respectively in 1992 (Karani, 1994). Outside Maasai Mara in 2003 and 2004, hyenas were responsible for 45% of monetary loss, lions for 36% and leopards for 19% in a period of 14 months (Kolowski and Holekamp 2006).

In Tanzania the hyena ranked first with 58% of total livestock kills while the lions and leopards accounted for 25%and 17%, respectively (Kissui, 2008).

In most areas where lions are found close to livestock, lions are the major killers of livestock when compared to other wildlife species that attack livestock. Exceptions do however occur probably because of the different circumstances surrounding livestock loss and different lion densities.

2.4. Livestock losses to diseases, drought and theft.

Endangered wildlife species sometimes take more than its share to the blame for causing livestock mortality (Gidey and Hans, 2010). However, a critical analysis revealed that predation may not be the largest source of mortality among livestock (Kruuk, 2002). In Brazil's Panatanal floodplain, losses of cattle due to non predation causes were 4 times higher (Fernando *et al*., 2007) thus indicating that non predation factors constitute a more important factor in cattle death (Mizutani, 1993; Cozza *et al*., 1996; Patterson *et al*., 2004; Graham *et al*., 2005). Cattle likely constitute an alternative prey and are killed opportunistically by predators (Oakleaf *et al*., 2003; Polisar *et al*., 2003; Patterson *et al*., 2004). Therefore, if the loss of livestock to other causes of loss can be reduced, then livestock mortality in general would be negligible.

Where overall mortality estimates for livestock are available, depredation rates on African livestock can be dwarfed by losses to disease and parasites. In the Maasai Steppe in Northern Tanzania, diseases claimed far more livestock than predation (Kissui, 2008). Similarly, in the Maasai Mara area of Kenya, losses of livestock to disease were higher than those to predators (Karani, 1994), while in Laikipia losses of livestock to large predators represented 20–25% of total livestock losses (Frank, 1998;

Mizutani, 1993). Disease imposes a significant cost to both livestock ranching and pastoralism (Homewood and Rodgers 1991; Mizutani, 1995; Karani *et al*. 1994; Maddox, 2003). In the western Serengeti (US$ 140, (Borge, 2003), losses of livestock because of diseases were responsible for 59.6 % of the average annual household income. Livestock disease remains a strong limitation to household livelihoods in pastoral areas (FAO, 2002).

Finding a solution to the problem of livestock mortality and the consequent economic loss would mean addressing all the causes of livestock mortality including diseases, drought, theft and wildlife. Evidence exists that livestock may actually tolerate pathogens in the presence of wildlife (Barre *et al*. 2001), and by adopting certain improved husbandry practices, it may be possible to limit disease outbreaks while managing the coexistence of livestock and wildlife. Kenyan traditional herders like the Maasai appear to have evolved husbandry practices that can accommodate the limitations of having wildlife including disease transmitted by wildlife, resource competition and livestock attacks. Traditional subsistence pastoralism revolved around optimizing livestock forage intake by selecting the best grazing pastures in any season and minimizing stock losses to drought, disease and predation, including raiding (Ole Lengisugi and Mziray, 1996; Scoones, 1996; Hendrickson *et al*. 1998).

A primary strategy has been to move the animals across landscapes and to alternate grazing areas so as to avoid disease outbreaks and predation. Such use of pastures implies that there is sufficient available land to provide isolation of infected herds and to protect the remaining animals from outbreak. However, land tenure has changed and with the subdivision of group ranches and fencing of private lands, this strategy

will no longer be viable in the future. Diseases will continue to cause even bigger losses if other disease prevention strategies are not implemented to suit the current situation.

In a study done in Southern Machakos District of Kenya on constraints affecting agropastrol systems, drought was ranked as the most severe cause of livestock mortality, while diseases and wildlife followed in that order (Mukhebi, 1985). Drought and predation are linked in several ways. To begin with, pastoralists graze in protected areas during drought seasons where livestock interact with predators, for example the Maasai access national parks like Amboseli during drought seasons in southern Kenya (Ngethe *et al*. 1994; Okello, 2005; Hazzah, 2006). Butler (2000) noted that rates of livestock loss to predators in agro-pastoral communities in Zimbabwe were highly seasonal with 80% occurring in the dry season and 20% in the wet season months. Rudnai (1979) and Ikanda *et al* (2005) found similar results in Kenya and Tanzania respectively where they documented lions attacked livestock more often during the dry season.

Some studies have documented a pattern of rise and fall of livestock numbers with drought and rains (Grunblatt, *et al.* 1996; Little *et al*. 2001). A more negative perception of predators is created when a pastoralist loses to predators the few livestock surviving drought which are supposed to rebuild the herd. Reducing the severe impacts of drought to a minimum would also mean that pastoralists are less vulnerable to predation and that fewer carnivores like lions are killed in retaliation.

Yodzis (2001) suggests that other factors lead to livestock losses but attention

invariably falls to predators because they are highly visible, and are frequently perceived as a nuisance. Additionally they may turn to the lion simply because they have the ability to kill the lion compared to responding to other causes of livestock loss like drought and diseases which are more complicated. The level of livestock depredation may also be exaggerated intentionally to attract public attention and/or to mask effects of poor livestock management (Infield, 1996; Nabane, 1996).

Livestock keepers often claim wild carnivores to be major causes for losses of livestock despite the severe impact of diseases due to the negative attitudes they have towards wild carnivores (Rasmussen, 1999). Several other factors such as theft, drought and poor livestock husbandry may equally cause significant livestock loss (Ogada *et al.* 2003). Negative attitudes towards carnivores due to perceived levels of predation have been cited as a challenging issue in both wildlife conservation and rural development (Woodroffe, 2001). The perceived high levels of predation may lead to neglect of more important causes of livestock loss. Therefore livestock losses to wildlife attacks can be understood better when related to other causes of loss mentioned above.

2.5. Measures to minimize livestock predation

Implementation of any practices that reduce the vulnerability of livestock to predation is critically important for reducing retaliatory killing of predators. Ogada *et al.* (2003) found that ranchers killed significantly more predators on ranches where predators kill more livestock. Ogada *et al*. (2003) assessed the efficacy of traditional African methods of livestock husbandry in protecting livestock from predators on commercial ranches. These practices evolved in response to the twin threats of both predators and livestock-stealing humans and are thought to have remained relatively unchanged for

thousands of years (Marshall, 1990). Oganda *et al.* (2003) noted that 75% of predations on the ranches take place at night and lions were responsible for over 75% of the predation. As such well-built *bomas* can effectively constrain cattle and keep predators out.

Bomas in Laikipia area of Kenya are made from native thorn bush, stone walls, wooden posts or wire mesh. Of these, thick strong thorn bush was most effective at keeping lions out. Stone is an excellent building material if there is a fence on top to prevent lions from leaping onto the wall and into the *boma*. Although expensive to build stone *bomas,* they last essentially forever and need little or no maintenance. On the other hand wire mesh is a very poor barrier if not well-supported, but as Woodroffe *et al* (2007) report, one Laikipia ranch has developed a modular, moveable fence made of 8 x 4 x 4 foot panels of mesh welded into interconnecting angle iron frames that is highly resistant to predators and easily transported. Thorn bush *bomas* are most effective if divided into inner 'rooms' that make it harder for cattle to reach the main gate and the gate must be very strong preferably made from lumber (Frank, 2010).

The normal practice of using a tree or bush as a gate is ineffective as it does not contain cattle and allows hyenas to enter. Lions are reluctant to approach *bomas* that are located in close proximity to large numbers of people. However, for security and environmental reasons, some ranches do not allow herders to have their families at the *bomas*. Of course in traditional societies bomas usually have large numbers of people and dogs. Dogs are also highly effective deterrents; they do not chase predators, but warn of their approach waking the herders who then chase the lions. Dogs can carry

lethal carnivore diseases but they are such an effective deterrent that vaccinated dogs are an essential component of livestock husbandry (Woodroffe *et al*. 2007). Donkeys were often used to defend livestock from predators in Namibia where European owned farms a century ago and are now making a comeback (Rigg, 2001).

In Switzerland, donkeys have been used to guard sheep since 1995. Donkeys are capable of providing a high level of protection at a relatively low cost and level of maintenance (Rigg 2001) and their use could be very beneficial in the study area where most pastoralists rear donkeys. Other husbandry practices successful in reducing livestock predation include reducing herd size and selecting grazing areas that are not frequented by predators (Bauer, 2003). In areas of high risk guarding the herds with more men could prevent the livestock from being attacked (Ogada *et al*., 2003). Livestock husbandry methods appear to have a major impact on reducing the severity of predation and livestock predation have been observed to rise where there are non existent since carnivores lose fear of humans (Frank, 1998).

2.6. Theoretical framework

2.6.1. Theory of Island Biogeography

The theory of island biogeography was first developed in the 1960s by E.O. Wilson and Robert MacArthur (MacArthur and Wilson, 1967). The basic theory states that on larger islands there is a larger number of species, while smaller islands have less species diversity. It explains species richness on various islands based on four fundamental concepts. First, larger islands host more species than small ones because they have varied habitats. Larger islands are also easier to find by migrating animals most of which take refuge here.

Secondly, smaller habitat patches closer to large patches host more species due to greater ease of immigration from the species rich mainland and are subject to distance effect. Thirdly, smaller habitat patches lose more species more quickly than large patches because their populations are small to begin with (area effect). Small populations are more vulnerable to extinction due to disturbance and chance. Lastly, the risk of extinctions in any patch closer to a large patch is lower than those further away due to increased chances of recolonization (rescue effect).

Although the theory's earlier focus was on islands, currently island biogeography doesn't just involve islands. In the theory, an "island" can be any ecosystem that is different from the ecosystems around it, such as an oasis in the desert or a small rainforest surrounded by farmland. Islands can occur through habitat fragmentation which is the process of breaking apart large areas of habitat into multiple smaller unconnected patches. It is generally used in the context of forested areas, but also applies to other habitat types, such as wetland, shrub or grassland habitats (Copenheaver *et al.* 2009), and savanna ecosystems such as the Amboseli ecosystem which is the focus of this study.

Wildlife corridors and landscape permeability are separate but related concepts. A permeable landscape is one where wildlife can move relatively freely from one area to another. Fragmentation reduces permeability and may result in areas connected only by one or two corridors, or in completely isolated habitats where animals are essentially trapped or in danger if they leave the habitat patch. Most of the group ranches surrounding ANP are key wildlife dispersal areas and migration corridors for wildlife (Okello and Wishitemi, 2006). The high cost of livestock predation

particularly by lions has led to the decline of pastoralism as a means of economic livelihood for the Maasai. Alternative economic activities like crop farming, even though incompatible with cultural and natural resource conservation, have started to gain popularity. A study on land use changes in the Tsavo-Amboseli ecosystems conducted by Okello and Conner in 2000 revealed that over 70% of the local community in the Amboseli Ecosystem now practice both pastoralism and agriculture, with only a few practicing pure pastoralism.

The expansion of agriculture and human settlement accelerated by changing land tenure and population increase in OGR and other group ranches is likely to make the ANP an unviable ecological island. Wildlife species with specialized diets, large home ranges, and reliance on other species like lions will be particularly susceptible to local extinction if the dispersal areas around Amboseli become blocked (Primack, 1998). This is likely to happen due to the decline in prey species and direct human persecution as lions and other carnivores turn to livestock as an alternative prey.

Eventually the loss of dispersal areas in the group ranches will limit the ability of ANP to support a viable and genetically diverse population of lions, rendering the lion population in the park prone to inbreeding depression and local extinction due to stochastic events and competitive exclusion. If the blockage of the dispersal areas is allowed to continue then the likelihood of reintroduction of the species would be very low in case a local extinction of lions occurs which has been experienced in the past. In the early 1990s the Maasai in the Amboseli ecosystem are reported to have poisoned lions in response to livestock predation, leaving only two lions in the entire Amboseli ecosystem (Chardonnet, 2002). In general Africa's history of political

instability and rapid human population growth, and the consequent HWC, may make lion populations to resemble tiger populations: scattered among small parks, few of which are sufficiently large and interconnected to maintain a viable metapopulation. It is a truism of population biology that small, isolated populations cannot survive indefinitely without gene flow among them (Harcourt *et al*. 2001).

Amboseli National park is currently like an island surrounded by a landscape occupied with humans and their livestock, grazing areas, wetlands which are a source of water and dry season pastures, some wildlife and farmlands. These lands outside the park serve as dispersal areas, and are frequently visited by lions and other carnivores in search of food. More often, they prey on domestic stock causing economic losses for the Maasai pastoralists thus resulting in retaliatory killings.

2.6.2 Risks and vulnerability theory

Dercon (2001) defines risks as uncertain events that can damage the well-being of people or any other phenomena like wildlife. Vulnerability is the degree to which a population or system is susceptible to, and unable to cope with, hazards and stresses, including the effects of climate change. Vulnerability also denotes the lack of resilience to the occurrence of these uncertain events (risks) (Dercon, 2001). Resilience refers to the ability of a system, community or society to resist, absorb, cope with and recover from the effects of hazards and to adapt to longer term changes in a timely and efficient manner without undermining food security or wellbeing. Vulnerability is therefore not only an important dimension of poverty, but also a potential cause (Fraser *et al*., 2011).

Pastoralists are particularly vulnerable to droughts or periods of unusually low rainfall which are part of the expected pattern of precipitation in semi-arid areas like the Amboseli ecosystem, and the risks and uncertainties associated with them. The study of pastoralist vulnerability thus becomes the study of diversification of pastoralists into non-livestock based strategies to avoid or alleviate poverty. Research suggests that the social and ecological context in which climatic problems occur is likely to be as important, if not more so, than the climatic shock itself (Turner *et al*., 2003, Ericksen, 2008). Small environmental problems can cause significant consequences depending on socioe-conomic constraints (Comenetz and Caviedes, 2002; Fraser, 2003).

Fraser *et al*. (2011) assessed vulnerability to social ecological systems including pastoralism to effects of climate change like drought in three contexts. Firstly, is the assessment of agro-ecological systems that provide livelihoods to shed insight on the ability of an agro-ecological system to remain productive or rebound following a drought. Secondly, is assessing the social economic status of different groups and the capacity of these groups to adapt themselves. Thirdly, is an exploration of the institutional capability to mobilize effective relief and increase resilience. According to Turner *et al*., (2003), three main factors affect the level of vulnerability, namely entitlement, coping and resilience. Entitlement, whether through legal or customary means, involves the ability to access resources needed in times of hardship (Hazzah, 2006).

In the study area, entitlement was traditionally achieved through communal ownership of land, which allowed pastoralists to move livestock to available pastures

during drought and to avoid areas prone to human wildlife conflict. Herders are equally exposed to the risk of drought, diseases, theft and livestock predation but the effects of these risks are dependent on a combination of factors including mobility and herd size. The survival, quantity and condition of livestock determine a household's wealth and ability to continue its traditional livelihood patterns during and after periods of drought. Mobility (usually within traditional migration routes) and the ability to access natural resources, such as pasture and water, are fundamental to the continuation of the traditional pastoralist's livelihood.

If pastoralists fully employ their well-adapted principles and strategies designed to overcome the harsh and variable conditions dominant in arid areas among which mobility across administrative boundaries is central – pastoralists are resilient to drought (Niamir, 1991). Rural household with extensive friends or other social relations may be able to maintain productivity without outside institutional help during a drought because they may be better able to move cattle between regions to obtain fodder (Reed *et al*., 2008). If mobile, Turkana herders, for example, can survive a failed rainy season or two without external assistance (Ellis, 1985). Having adequate coping strategies is therefore a key part of reducing vulnerability, and this has long been integral to traditional communities who regularly face environmental hazards (Campbell, 1999).

There have been major changes in land tenure in the study area ranging from group to individual ownership, subsequently resulting in land use being torn between pastoralism, agriculture and wildlife conservation. Land-use change is a major driver of habitat modification and can have important implications for the distribution of

species and therefore for entire ecological systems (Serneels and Lambin, 2001b). Growing human populations and expanding agricultural activities around protected areas have led to the declining wildlife populations and increasing people-wildlife conflicts (Carlsson, 2004; Gadd, 2005).

The high economic impact of livestock predation by lions is both a cause and effect of land tenure and land use change. Livestock predation by lions becomes an effect of land use change when agricultural activities changes land cover reducing forage for herbivore species which are the natural prey of lions, driving the lions to turn to livestock as the alternative prey. What people do in a crisis, depends on how hard hit they are and the choices available to them. Human - lion conflict motivates further land use change to cultivation by making livestock keeping unreliable as a source of livelihood.

High costs of livestock predation by lions are likely to increase pastoralist vulnerability to drought indirectly by increasing land conversion into agriculture which reduces forage for livestock as well as limiting mobility of livestock and wildlife. Decreased mobility of animals results in overgrazing of lands around settlements and invasion of range by unpalatable plants (Mwangi, unpublished). Ecologists suggest that traditional patterns, including livestock diversity, mobility, low energy efficiency, and biomass maintenance are cornerstones of environmental sustainability rather than prescriptions for degradation (McCabe, 1990).

Coping, on the other hand may include dependence on local networks for communal

resource sharing, on other sources of income, such as tourism (Campbell, 1999; Naughton-Treves and Treves, 2005). However, a study conducted in Ngorongoro revealed that less than 10% of Maasai households in the area received income from tourism, despite the high level of international tourism (Thompson and Homewood 2002). Around Ruaha National Park in Tanzania, less than 2% of the people received benefits from tourism (Dickman, 2008). A cross-border study of five sites across East Africa revealed that very few people studied received any income from wildlife, despite often living in close proximity to important wildlife areas (Homewood and Trench, 2008). Receiving benefits from wildlife would serve as alternative coping mechanism when pastoralists are faced with risks such as livestock predation and drought.

CHAPTER THREE

MATERIALS AND METHODS

3.0 Study Area

This study was conducted in Olgulului- Ololorashi Group Ranch located in the Southern part of Kenya (Figure 3.1), which lies between longitudes 36º5′ and 37º5′ East and Latitudes 1º0′ and 3º0′ (Wayumba and Mwenda, 2006). The ranch is bordered by Eselenkei Group Ranch to the north, Mbirikani Group Ranch to the northeast, Kimana Group Ranch to the southeast and the Kenyan - Tanzanian international border to the south (Figure 3.1). Amboseli National Park is almost completely surrounded by Olgulului-Ololorashi Group Ranch, thus making it an important wildlife dispersal area for the park. Overall, the ranch covers an area of 1,232 km^2 and surrounds 90% of Amboseli National Park (Okello and Kioko, 2010).

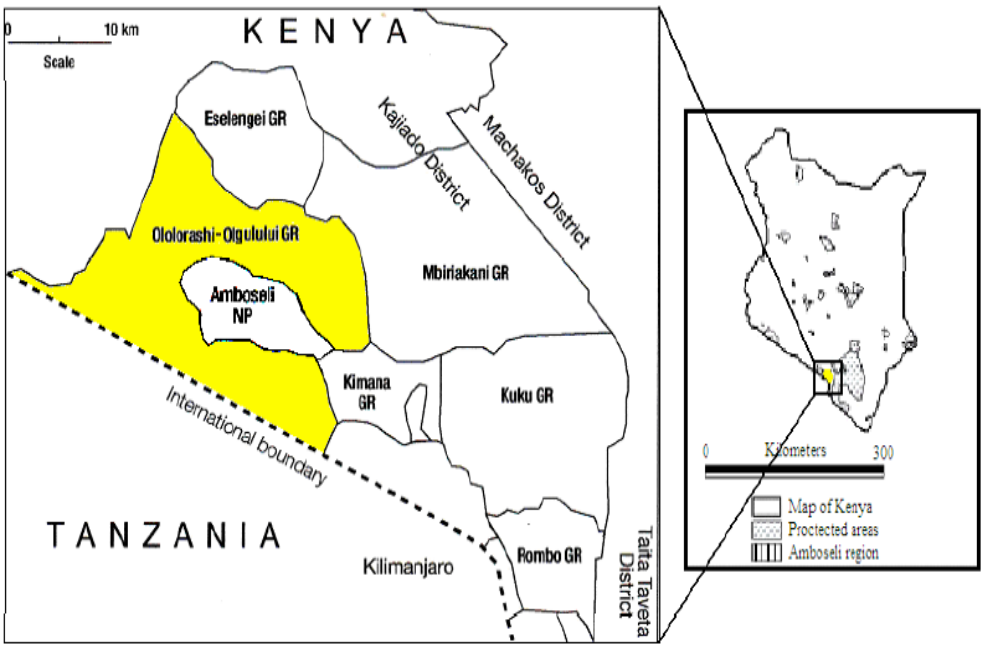

Figure 3.1: Map of Amboseli Ecosystem showing Amboseli National Park and surrounding Group Ranches

(Source: Kenya Wildlife Service, 1996)

Olgului-Ololorashi group ranch was established in 1975 as part of the government sponsored land settlement scheme of 1968 (Campbell *et al*. 2003), and its membership has steadily increased in the last couple of years with about 3,418 members in 2001 and 11,500 members in 2008. This represents a 236% increase in members in a span of eight years translating to about 30% annual increase in membership. Pastoralism is the primary economic livelihood in the GR and for most of the inhabitants of the other group ranches of the Amboseli ecosystem (Campbell *et al.*, 2003; Okello and Kioko, 2010).

Amboseli National Park which lies contiguous to Olgulului-Ololorashi group ranch covers an area of 392Km^2 and forms part of the larger 5,000 km^2 Amboseli ecosystem (Ntiati, 2002). During the wet season large carnivores including the lion and wild herbivores are dispersed throughout much of the Amboseli ecosystem but during dry seasons animals concentrate in the park because the park contains permanent springs originating from melt water from the nearby Mt Kilimanjaro (Western 1975; Campbell *et al*. 2003). In the dry season, the Maasai do access the park for salt licks and water for their livestock. Consequently, predation of livestock by lions and other carnivores is frequent both inside and outside the park and in Olgulului-Ololorashi group ranch which forms part of the wildlife dispersal area. As a result, livestock farmers incur a lot of costs due to high losses of livestock and these losses and costs incurred have a lot of implications on the economic, social and cultural well-being of the Maasai and other livestock keepers.

3.1. Land tenure and land use

Group ranches were formed under the land (Group representatives) Act of 1968 (Ntiati, 2002). This is an Act of parliament that provides for the incorporation of representatives of groups who have registered as land owners under the Land Adjudication Act and for the purpose connected to collective pastoral management and resource use. This arrangement can be maintained until the members decide to dissolve the group ranch as provided for in the Land Group Representative Act- Cap 287 (Ntiati, 2002).

Over the past 25 years there has been considerable tension in the group ranches of the Amboseli region over security of land tenure especially for the young people (Ntiati, 2002; Campbell *et al*.2003; Okello, 2005). This has created a demand for subdivision, a process that has been done in the wetland areas of Kimana and Mbirikani group ranches where locals are carrying out agriculture. Parts of the Olgulului-Ololorashi group ranch forming elephant migration corridors between Amboseli National Park and Tanzania have been subdivided and sold to private individuals thus blocking the migration corridor (Wayumba and Mwenda, 2006). The process of group ranch subdivision will eventually affect traditional land uses in the area including the Maasai pastoral system and wildlife that depend on availability of large landscapes that allow both livestock and wildlife to gain access to resources that are widely distributed in both spatial and temporal context.

Pastoralism of the semi-nomadic and trans-humance variety has been the land use of choice for hundreds of years in the study area and the whole region of Kajiado (Dahl

and Hjort 1976; Campbell, 1978; Campbell *et al*., 2000 and 2003; Reid *et al*., 2004). Livestock form the basis of economic livelihoods of the local people and is the focus of their social relations and a critical element of their ethnic self-definition (Mwangi, undated). Emerging land uses among them agriculture and wildlife-based land use in the ecosystem, will have to compete not only economically but also socially and culturally with 'having livestock herds'. Mbogoh and Munei (1999) reported that average cow herd composition per household on Mbirikani was 76.4 head of cattle. Some experts believe that high livestock population heightens opportunities for livestock-carnivore conflict (Kolowski and Holekamp, 2006). There is no doubt that in areas with little wildlife prey and large numbers of livestock, conflict between livestock and carnivores will be high (Rao, 1996).

Following changes in livelihood, social structure and pressure to subdivide land, majority of the Maasai have adopted a more individualistic view on life and in turn have shifted away from traditional communal livestock husbandry and land management to individualized livestock practices (Western and Nightingale, 2002). For wildlife to have a sustainable future in the Amboseli ecosystem, two fronts of potential conflict with pastoralism have to be addressed urgently. First is the economic front that squarely rests on the issue of distribution of benefits from wildlife. The Maasai quite reasonably ask, "Why should we tolerate the presence of wildlife on our lands if only a small portion of the benefits are going to only a few of us?"(Croze *et al*. 2006). The benefits range from short term cash to long term development of the region and alleviation of poverty.

The second issue is the day to day competition for essential resources: pasture, water and living space with wildlife. This competition according to the local people in the study area has led to increased vulnerability to livestock predation, drought and diseases transmitted by wildlife to livestock. If the presence of wildlife is made economically beneficial and the impacts of livestock predation, drought, disease and theft reduced to the local community, then the pressure to subdivide land and convert land use to agriculture perceived as "economically viable" would certainly reduce.

Over the past 50 years crop farmers have increasingly settled on the high ground fringes of the Amboseli ecosystem such as the slopes of Mt. Kilimanjaro along the Kenya-Tanzania border and in the unprotected central swamps scattered in the group ranches (Campbell *et al*., 2000). Whether there are immigrants from other parts of Kenya or Maasais engaging in crop farming this new form of livelihood strategy has led to land use changes that cannot be ignored (Rutten, 1992). The result of the changing livelihood strategy from pastoralism to crop farming is that the traditional tolerance of the Maasai to the presence of wildlife has sharply declined over the years as the people continue to suffer the opportunity costs of wildlife presence on their land, from physical conflict, loss of crops, competition for grazing and depredation of livestock without sharing in much of the benefits.

It is estimated that in 2004, community benefits from the Amboseli Park's entrance fees amounted only to about US$ 10,000 (Croze *et al.,* 2006). Unless this imbalance is addressed the agriculturalists will always be hostile to the presence of wildlife in the ecosystem. The principle land use change in the Amboseli ecosystem over the past three decades has been the expansion of the area under cultivation (Campbell *et al*.,

2003). Some of the Maasai have recently changed their land use practices from pastoralism to agropastoralism (a combination of cultivation and livestock) (Barrow *et al*., 1993; Hackel, 1999; Ntiati, 2002; Okello, 2005; Okello and D'Amour, 2008). As cultivation has expanded into wildlife habitats, human–wildlife conflicts have intensified.

Water is a critical resource in the region, but agriculture consumes over 400% more water than humans and animals combined (Barrow et al., 1993). Between 1973 and 2000 the forests cover on the lower slopes of Kilimanjaro above Oloitokitok declined by 2.3%, from 646 Ha to 417 Ha, a trend that impacted on the ecosystem's water catchment's capacity (Lambrechts *et al*., 2002). Since then, forest clearance seems to have continued and 76% of the 'shamba system' areas on Mt Kilimanjaro's slopes have not been fully replanted (Lambrechts *et al*., 2002). During the same period, rain fed agriculture in the Oloitokitok area increased by 177% (Lambrechts *et al*., 2002). Clearly this expanding agrarian front increases geometrically the probability of human-wildlife conflict.

The fenced areas around Namalok and Kimana swamps have been alienated from use by wildlife and pastoral livestock and given over entirely to intense irrigated agriculture (Okello and D'Amour, 2008). In general, land tenure system has shifted from communal stewardship to individual ownership as immigrants farmers have moved in and bought or leased land from the Maasai. The implications of these ongoing changes for the survival of wildlife are serious. Within the Mara-Serengeti ecosystem in Kenya, considerable land cover change due to human activity has led to a >50% decline in wildlife numbers in 20 years, while wildlife numbers have

remained constant in the Tanzanian dispersal areas, where land cover change has been negligible (Homewood, 2004).

The degree to which the habitat occupied by wildlife is controlled by human activities has increased as agricultural land use has expanded in the ecosystem. As a consequence, there is competition and conflict in the area over water and land resources critical to each of the three land uses namely farming, herding and wildlife (Campbell *et al*., 2003; Okello and D'Amour, 2008). While wildlife and livestock can share land, crop farming is exclusive of the two land uses meaning it is incompatible with both, and that it is likely to increase human wildlife conflict. The expansion of land under crop farming can be discouraged by reducing the economic impact of livestock killing by lions and other wildlife, which will make pastoralism economically attractive as a form of land use.

3.2 Geology and Soils

The geology of Amboseli area was formed thousands of years ago influenced by the nearby Kilimanjaro, a spectacular central volcano formed thousands of years ago. Much of the flat lying ground in the central parts of the Amboseli area is underlain by sediments which may attain a maximum thickness of several hundred feet (Thompson *et al*., 2002). A great deal of the material accumulated in the lake formed by the damming of the drainage by volcanic eruption during the upper Pleistocene giving rise to deposits known as the Amboseli lake beds.

Soils within the Olgulului-Ololalashi Group Ranch include reddish brown sandy varieties derived principally from metamorphic rocks, black cotton and dusty soils overlying the volcanic rocks (Githaiga *et al*. 2003). Windblown clayey silts and sands

in the western parts of the area locally attain a thickness of 9 meters. The porosity of the volcanic soil coupled with the structure of the rocks beneath act as a drainage bed and allows the melting snow and ice from Mt Kilimanjaro and rain water to percolate through the interior to appear at the base in the form of springs which are situated at the base of the foot hills. At Amboseli National Park and its environs almost level ground has resulted in the springs giving rise to swamps. Since most of the lowland soils are dominated by saline sodic conditions they are highly susceptible to erosion (Githaiga *et al*., 2003). Due to the relatively recent volcanic activity most of the top soils are shallow and unproductive, more suitable for pastoralism and wildlife (Katampoi *et al*., 1990).

3.3 Climate

Rainfall is the single most important factor influencing land use practices whether crop and livestock production or wildlife conservation. The annual rainfall in the Amboseli ecosystem is strongly influenced by mountains, hills and the rift valley (Norton-Griffiths, 1977). High rainfall in the Loitokitok District occurs around the slopes of Mt Kilimanjaro and the Chyulu Hills (Norton-Griffiths 1977). Other areas especially the lower rangelands are characterized by lower rainfall; these include the Amboseli basin especially in Mbirikani, Olugulului and Eselesnkei group ranches. The low rainfall is due to either the rain shadow effects from the neighboring mountains or to the divergent wind flow between the Chyulu Hills and Mt. Kilimanjaro (Ntiati, 2002).

Olgulului-Ololorashi Group Ranch is primarily a semi-arid to arid pastoral land unsuitable for agriculture. Rainfall in the area follows a seasonal pattern of short rain typically between October and December and long rains between March and May

(Okello and Kioko, 2010). The ranch area around Amboseli National Park receives low rainfall of 500 mm or less (Ntiati, 2002). Temperatures also vary and the coolest months of the year are June to August. Between October and February it is usually very hot. In 1998 the maximum daily temperature was 33º C (Altmann *et al*., 2002). During the coolest time of the year the minimum temperatures may fall to 12º C. The minimum night temperatures may fall to 4º C due to a combination of cool air brought from Mt. Kilimanjaro, the white soils which can absorb little of the day time heat and the high night radiation which results from the sparse vegetation in the basin. Relative humidity in the cool months can reach 40% and drop to 20% in the dry seasons.

3.4 Vegetation

The plant communities of the Amboseli basin are dominated by bush land and open grassland. A typical composition of *Acacia Commiphora* species can be found throughout the GR along with a varying gradient of grassland to open woodland habitat. Species such as *Acacia tortilis, Acacia xanthophloea, Azima tetracantha,* and *Suaeda monoica* are present within the lowlands (Githaga *et al*., 2003). Recent trends show reduction in the amount of woodland cover in most of the group ranches as bush encroachment takes place and both rain fed and irrigated agriculture expand. Shift from nomadic pastoralism to sedentarisation by the Maasai has led to severe rangeland degradation which has resulted in loss in range productivity and increased erosion (McCabe *et al*., 2003).

3.5 Methods

3.5.1 Research Design

The Causal comparative research design was used to compare different causes of livestock loss and the economic impact on livestock keeping. The cost of livestock killed by lions was compared to the cost of livestock killed by other wildlife species,

diseases, drought and loss due to theft. The local people may incur greater cost from other causes of livestock loss mentioned earlier but direct their revenge to lion either consciously or subconsciously. Perhaps because a lot of importance is attached to the lion being among the "big five" wildlife species that are most important for tourism and their voice could be heard more easily than if they killed other 'less important' wildlife species.

3.5.2 Target population

The target population comprised the local community living in the western side of the Olgulului Group Ranch located adjacent to ANP. Kenya Wildlife Service officers managing ANP and those from predator's compensation fund and the Amboseli Trust for Elephant were also included as key informants. A total of 230 people were interviewed consisting of 200 questionnaire respondents and 30 key respondents. The key respondents were drawn from three KWS officers (senior warden, community warden and a ranger), 3 focus group discussions with 5 members each, 2 officials of Provincial Administration (chief and sub chief), two group ranch officials (chairman and treasurer), 4 village elders, four verification officers from Amboseli Trust for Elephant and Predators Compensation Fund. The three focus group discussions consisted of elders from different Manyattas, Morans and young pre- Moran men in each group.

3.5.3 Sampling Procedure and Sample Selection

Olgulului group ranch covers an area of 392Km^{2}and the Maasai villages are distributed as clusters in the group ranch area, therefore Cluster sampling method was used to select villages included in the study to ensure the community views were well represented (Zar, 1999). The traditional Maasai manyatta consists of a collection of wooden-frame huts, covered with mud and dung, surrounding a central cattle

enclosure (Figure 3.2). A number of household heads may reside at a manyatta with their personal dwellings built in distinct sections of the manyatta. Each household head keeps his cattle in the shared central enclosure at night and maintains a separate enclosure among his huts, in which only his own sheep and goats are kept at night (Homewood and Rodgers, 1991; Burnsilver *et al*. 2003).

In the study area, manyattas and livestock enclosures are made from locally available Acacia thorny bushes placed together with little support from any other materials like barbed wires and poles. Cattle of all household heads are housed together in the shared central corral. Individual homesteads maintain separate enclosures for their own small stock (Spencer, 2003). The western side of the GR consisted of 26 villages (a village may contain more than one manyatta depending on settlement density of a particular area) in total from which 11 villages with a population of approximately 2000 were selected using cluster sampling. The household was used as the sampling unit, since manyattas often consist of more than one household. Using systematic sampling every 10^{th} household in each village was visited and a sample of 10% selected. With assistance of the research assistants, 200 respondents were interviewed within a period of four weeks.

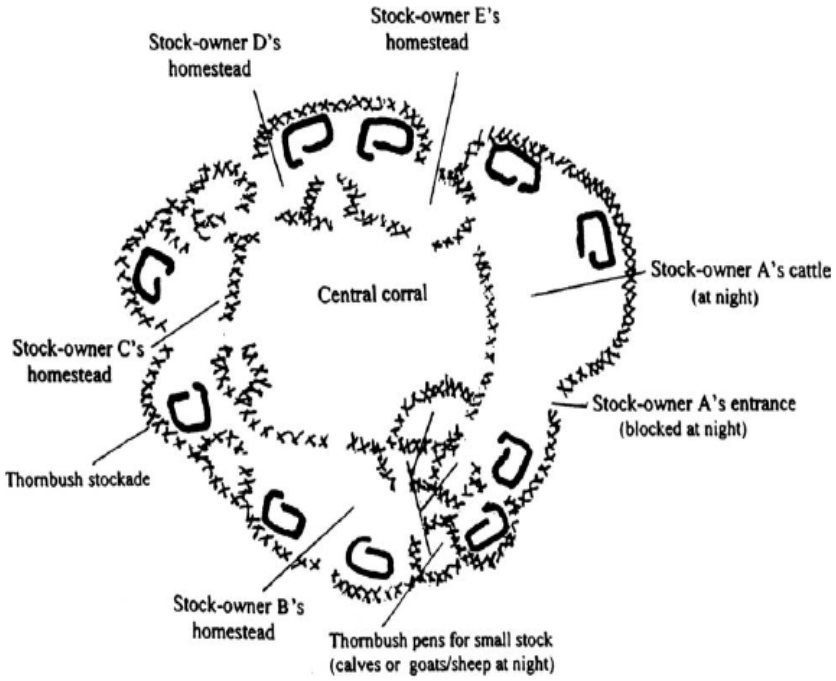

Figure 3.2: Configuration of a typical Maasai Manyatta

3.6 Data Collection

Three people from the community were recruited and trained as research assistants to administer the household questionnaire among the residents of Olgulului group ranch. Interview questions were written in English, and translated by the research assistants into Kiswahili or Maasai language. Since the interviews were done during the day, the researcher and her team had an opportunity to interview a few women and old men as they had been left in the bomas when young morans went out to herd livestock. Since the research assistants were from the GR, the research team was also able to interview morans at grazing sites as the assistants knew which boma each moran belonged to. The questionnaire survey was done using a semi-structured questionnaire (Appendix 1), which included both closed and open-ended questions.

The semi-structured questionnaire allowed for a much wider range in statistical comparisons, and also allowed interviewees to add their own personal experiences and elucidate subject matters that could have been too restricted in highly structured questionnaire format (Hazzah, 2006). The questionnaire was divided in four sections. The first section focused on demographic information (gender, age, level of education, employment, and livelihood strategy). The second section dealt with various aspects of land use and livestock production; including the type and number of livestock kept per household. The section also dealt with other economic activities such as agropastrolism and crop farming.

Questions on losses of livestock to wildlife including when and where attacks on livestock occurred and livestock lost to other causes of death were covered in section 3. The final section of the questionnaire dealt with interventions aimed at reducing livestock losses due to wildlife. Respondents' views regarding compensation schemes (schemes that compensate pastoralists for livestock lost to wildlife) were also captured in this section.

In addition to the household interviews, three focus group discussions were held with members of the community consisting of young pre-moran and morans who were livestock herders and old men from different villages. Efforts to hold similar discussions with women were fruitless as getting women in a group was hard because they were busy doing household chores and taking care of children. Men were easily found in groups drinking beer or at slaughter sites where they were interviewed on the history of livestock predation, the major causes of livestock deaths, and attitudes to

livestock predation by wildlife and potential solutions, benefits received from wildlife conservation and views about the predator compensation fund in the group ranch.

General discussions were also held with Kenya Wildlife Service officers, local leaders, Group ranch officials, Amboseli Trust for Elephant and Predators Compensation Fund officials. Issues discussed during the interviews included: which predators commonly caused livestock depredation, whether depredation had increased in recent years and how benefits from wildlife conservation were shared among group ranch members. Strategies on how they coped with livestock depredation were also examined. These group discussions provided crucial information which the household respondents were hesitant to provide like methods used to kill wildlife species that killed their livestock.

3.7 Data Analysis and Presentation

Data from the questionnaires was analyzed using the Statistical Package for Social Sciences (SPSS) version 12.0 (SPSS Inc., Chicago, USA) computer software. Data was coded for all questions and entered into spreadsheet software. The data was then transferred into SPSS format and coded into appropriate labels for each variable within SPSS. Multivariate analysis of variance (MANOVA) test was used to test the statistical difference in means of variables inclusive of: total number of different species of livestock kept, total number of livestock lost to various wildlife species, economic costs associated with the losses of livestock to different wildlife species and the comparisons of different causes of economic loss to livestock. Tukey's HSD Post-hoc test was used to determine which groups differ from each other. Level of significance used for all statistical tests is 0.05 (Zar, 1999).

The Chi-Square Goodness of Fit Test and Chi-square cross tabulations (Chi-square contingency Test) (Zar, 1999) were used to determine whether statistically significant relationships existed between different variables, and determine the trends in these relationships. These statistical tests helped to determine how variables like the age of herders, location of respondents and husbandry practices employed against livestock attacks by wildlife influence the level of predation. Quantitative data was presented using tables, bar graphs and pie charts. The information collected from focus group discussions and key informant interviews was used to validate, complement and supplement the results from the questionnaires.

Average prices of different livestock types (cattle US$332.33, shoats US$77.73, and donkeys US$58.36) were computed using different market prices livestock were sold at as given by respondents and used to calculate the value of livestock lost to various wildlife species. Values of economic losses are discussed in US$, using the exchange rate of 1 US$ = 78 Kshs at that time.

CHAPTER FOUR

RESULTS

4.0. Profile of Respondents

Men comprised 78.4% (n=218) of the respondents interviewed with women comprising 21.6% of the total respondents, an indication that men were significantly more than women (χ^2=70.5, df=1, p=0.00). The youthful population aged 20-29 years constituted majority of respondents (31.6%) followed by those aged 30-39 years (27.3%), those above 49 years (21.5%) and 40-49yrs (19.6%). The level of literacy among the respondents was low with more than half (70.1%) of the respondents having no basic formal education. Respondents who had attained primary education accounted for 15.5% of total population followed by those who had attained secondary and college level education at 9.2% and 5.2% respectively.

The education level obtained by different respondents were significantly different (χ^2=192.7, df=3, p=0.001). Most of the respondents were unemployed (72.4%), while only 27.6% were employed, the numbers of those who were unemployed were significantly higher than those who were employed (χ^2=34.97, df=1, p=0.00) (Table 4.1). The number of people employed was dependent on the respondent's level of education (χ2 = 39.05; df =3 p = 0.00).

Table 4.1: Profiles of Respondents in the Study area

Variable	Responses	Frequency	Percent	Chi – square goodness of fit
Gender	Male	171	78.4	χ^2=70.5, df=1, p=0.00
	Female	47	21.6	
	Total	218	100	
age of respondents	20-29	66	31.6	χ^2=7.478, df=3, p=0.058
	30-39	57	27.3	
	40-49	41	19.6	
	Above 49	45	21.5	
	Total	209	100	
education level	No school	122	70.1	χ^2=192.6, df=3, p=0.00
	Primary	27	15.5	
	Secondary	16	9.2	
	College	9	5.2	
	Total	174	100	
employed people	Yes	48	27.6	χ^2=34,97, df=1, p=0.00
	No	126	72.4	
	Total	174	100	

Pastoralism which was practiced by (98.2%) of the respondents was the primary source of livelihood. The types of livestock kept by individual respondents included a combination of cattle, shoats and donkeys (73.5%) and cattle and shoats (23.7%). The types of livestock kept by different respondents were dependent on the location (residence) of respondent ($\chi 2$ = 51.71; df = 25 p =0.001). Agro-pastrolism, a practice that involves a mixture of rearing livestock and crops was practiced by 46.9% of the population while 32.9% practiced only livestock keeping. There was a significant difference between respondents who practiced different economic activities (χ^2=84.25, df=3, p=0.00) (Table 4.2). Economic activities practiced by respondents were dependent on whether the respondents were formerly employed or not employed ($\chi 2$ = 15.23; df = 3 p =0.002) the unemployed people were more likely to practice pure livestock keeping (38.4%) while only (28.8%) of the employed practiced pure livestock keeping (Appendix 6).

The economic activities practiced by respondents were also dependent on the location of respondents ($\chi 2 = 56.57$; df = 15 p = 0.00), with the highest percentage of locals who practiced pure livestock keeping residing at Oldule (63.6%) (Appendix 7), and education level ($\chi 2 = 19.56$; df = 9 p = 0.021). More people without basic education practiced pure livestock keeping (40.5%) compared to those with primary level education (22.2%), secondary (18.8%) and collage (0%) (Appendix 6). Economic activities practiced by respondents were however independent of the respondents age ($\chi 2 = 10.79$; df = 9 p =0.29) (Table 4.5). According to the key informants the group ranch operates a camp site and cultural manyattas to support tourism activities. Other sources of income include sand harvesting. The revenue accrued from these activities is shared among the group ranch members inform of school bursaries and is also used in financing and maintaining projects proposed by the community (Appendix 4).

Table 4.2: Economic activities practiced in the study area

Variable	responses	frequency	percent	Chi – square goodness of fit
livestock ownership	Yes	216	98.2	χ^2=204.29, df=1, p=0.001
	No	4	1.8	
	Total	220	100	
livestock species	Cows, Shoats, Donkeys	158	73.5	
	Cows & shoats	51	23.7	
	Shoats & donkeys	1	0.5	
	Cows & donkeys	1	0.5	
	Cows	2	0.9	
	Shoats	2	0.9	
	Total	215	100	
other econ activities	farming	100	46.9	χ^2=84.25, df=3, p=0.001
	Farming & off farm	20	9.4	
	Off farm	23	10.8	
	Only Livestock keeping	70	32.9	
	Total	213	100	

4.1. Husbandry practices used to minimize livestock attacks

Results revealed that 91.2% of the respondents lost livestock to wildlife. Most livestock attacks by wildlife were reported to have taken place both during the day and at night (62%), 25% happened at day time and 12% occurred at night. The responses of respondents on the different times that livestock were attacked were significantly different (χ^2=84.25, df=2, p=0.00). The time that most livestock were attacked was independent of the respondent's location ($\chi 2$ = 12.74; df = 8 p =0.121) (Table 4.5).

According to key respondents most attacks of wildlife on livestock occurred during the rainy season (Appendix 4). Most of the respondents reported that significantly more attacks happened while women were herding livestock (98.6%) (χ^2=67.06, df=1, p=0.00) while only 4% of the respondents reported increased attacks when herding of livestock was done by men. Most herders were aged 11-17 (48.4%) while those above 18 comprised of 38.1%. The herders that offered the most protection to livestock were aged, 18-30 85.7%, while those aged between 6-10 offered the least protection (2.4%), thus indicating a significant difference between responses on the level of protection offered by herders of different age groups (χ^2=165.52, df=3, p=0.00) (Table 4.2). The age of herders was independent of location of respondents ($\chi 2$ =29.23; df = 20 p = 0.083) (Table 4.5).

Key informants reported that most livestock were attacked at Ilmarba location within the GR. According to the Amboseli Trust for Elephants officials attacks by elephants occur mostly in the dry seasons at watering points. They further eluded that although there are specific elephant families which are known to attack livestock, elephants are

noted to attack livestock if a family member has been killed by the Maasai and if they are provoked by barking dogs (Appendix 4).

Table 4.3: Livestock lost to wildlife and factors influencing attacks

Variable	Responses	Frequency	Percent	Chi – square goodness of fit
Loss of stock to wildlife	Yes	197	91.2	χ^2=146.67, df=1, p<0.001
	No	19	8.8	
	Total	216	100	
Time of attack	Day	18	25.4	χ^2=27.91, df=2, p<0.001
	Night	9	12.7	
	Both day& night	43	62	
	Total	70	100	
Livestock loss (gender)	Men herding	1	1.4	χ^2=67.06, df=1, p<0.001
	Women herding	70	98.6	
	Total	71	100	
Reasons	Scared of wildlife	32	49.2	χ^2=26.3, df=3, p<0.001
	Weak, lazy & careless	19	29.2	
	Don't carry weapons	8	12.3	
	Ignorance	6	9.2	
	Total	65	100	
Age of herders	6 to 10	4	3.2	
	11 to 17	61	48.4	
	Above 18	48	38.1	
	Both 2 & 3	9	7.1	
	Both 1 & 2	4	3.2	
	Total	126	100	
Age offering protection	6 to 10	2	2.4	χ^2=165.52, df=3, p<0.001
	11 to 17	6	7.1	
	18 to 30	72	85.7	
	30 & above	4	4.8	
	Total	84	100	
Thorn acacia boma	Very effective	55	64.7	χ^2=89.54, df=3, p<0.001
	Effective	26	30.6	
	Not effective	2	2.4	
	Don't know	2	2.4	
	Total	85	100	

Most of the respondents (76.7%) reported cases of livestock attack by wildlife to KWS while 19.5% reported to organizations that operate compensation schemes.

Further 60.1% of the respondents alluded that no action was taken after they reported, while 39.9% stated that they were compensated. The decision to kill or not to kill offending wildlife was dependent on the action taken after reporting cases of livestock attacked ($\chi 2=26.67$; df=4 p=0.00) (Table 4.4). A significant number of the respondents (67.9%) were aware of the existence of both elephant and predators compensation schemes in the area. Some respondents were only aware of Elephant compensation scheme (19%) while others mentioned only the predators compensation scheme (13.1%). These observations varied among respondents ($\chi^2=45$, df=2 p=0.00).

The Predators Compensation Fund was started in June 2008 in response to numerous killings of lions for attacking livestock. Key informants however, noted that lion killing had declined since then. Compensation is done after every two months and the amount depends on the quality of the boma (livestock shed). Local people with weak bomas are compensated half of the amount paid for each animal. The GR finances 30% of every claim from its revenue and contributions from KWS with the Predator's Compensation Fund meeting the rest. The amount paid in compensation has been on a declining trend, and an amount of Ksh 937,000 was paid in compensation in 2009, 600,000 in 2010 and 400,000 in 2011. The Amboseli Trust for elephants compensates an amount of Ksh 15,000 per cow and Ksh5000 for shoats which is paid two weeks after an attack (Table 4.5).

The use of a combination of dogs and human guards was considered more effective in deterring livestock attacks by most wildlife species by 76.3% of respondents compared to the use the use of human guards (23.7%) only. Dogs and human guards were considered very effective by 80% of the respondents, effective by 17.6% and not

effective by 2.4%. The thorn acacia boma was considered very effective and effective in protecting livestock against attack by wildlife by 64.7% and 30.6% of the respondents thus indicating a significant difference in the responses (χ^2=89.54, df=3, p<0.001). The effectiveness of the thorn acacia enclosure against livestock attack was dependent on the location of the respondents (χ2=26.15; df=12 p=0.01) (Table 4.6).

Key respondents were in agreement that well-made enclosures can keep away hyenas and that dogs are successful in chasing away hyenas but retreat if they encounter a lion. Lions are also known to either jump over enclosures or scare livestock to a stampede consequently breaking the enclosure after which they attack them (Appendix 4). From observations during the study period most enclosures were weakly made by placing thorn acacia bushes along their perimeter which barely exceeded a height of one meter. Most respondents (90.1%) confessed that they kill wildlife when they attack livestock. Methods used in killing wildlife include trapping (7.1%), poisoning (21.2%) spearing (33.3%) and both poisoning and spearing (17.2%). The decision to kill (χ2=11.19; df=3 p=0.011) and the method used for killing wildlife after they attacked livestock (χ2=34.35; df=12 p=0.001) were dependent on the age of respondents (Table 4.4).

Table 4.4: Action taken following livestock attack by wildlife

Variable	Responses	Frequency	Percent	Chi – square goodness of fit
Reporting livestock lost	KWS	161	76.7	χ^2=185.23, df=2 p=0.00
	Compensation scheme	41	19.5	
	Don't report	8	3.8	
	Total	210	100	
Action taken	Compensation	83	39.9	χ^2=39.9, df=1 p=0.004
	No action	125	60.1	
	Total	208	100	
Compensation schemes	Elephant	16	19	χ^2=45, df=2 p=0.00
	Predators	11	13.1	
	Both elephant & predators	57	67.9	
	Total	84	100	
Methods of husbandry	Human guards	49	23.7	χ^2=57.4, df=1 p=0.00
	Dogs & human guards	158	76.3	
	Total	207	100	
Effectiveness of methods	Very effective	68	80	χ^2=86.28, df=2 p=0.00
	Effective	15	17.6	
	Not effective	2	2.4	
	Total	85	100	
Action after attack	Kill	118	90.1	χ^2=84.16, df=1 p=0.00
	Report	13	9.9	
	Total	131	100	
Methods of killing	Trapping	7	7.1	
	Poisoning	21	21.2	
	Spearing	33	33.3	
	No action	21	21.2	
	Poisoning & spearing	17	17.2	
	Total	99	100	

Table 4.5: Livestock attacks by wildlife and community characteristics

Number	Hypotheses	Chi-Square cross contigency	Conclusion
1	Other economic practiced keeping activities were independent of the employed people	$\chi 2$=15.23, df=3 p=0.002	Other economic activities were dependent on whether the respondents were employed
2	Economic activities practiced were independent of the location of the respondents	$\chi 2$=56.57, df=15 p< 0.001	Economic activities practiced were dependent on the location of the respondents
3	Time of the day that livestock were attacked was independent of the location of respondents	$\chi 2$=12.74, df=8 p=0.121	The time of the day that livestock were attacked was independent of the location of respondents
4	Effectiveness of thorn acacia enclosure a was independent of location of respondents	$\chi 2$=26.15, df=12 p=0.01	The effectiveness of thorn acacia enclosure was dependent on the location of respondents
5	Economic activities practiced were independent of the respondents age	$\chi 2$=10.79, df=9 p=0.291	Economic activities practiced were independent of the respondents age
6	Whether respondents killed or reported wildlife after they attacked livestock was independent of age	$\chi 2$ =11.19, df=3 p=0.011	Whether respondents killed or reported wildlife after they attacked livestock was dependent on age
7	Methods used for killing wildlife after they attacked livestock was independent of age	$\chi 2$ = 34.35, df = 12 p =0.001	The methods used for killing wildlife after they attacked livestock was dependent on age
8	Decision to kill or not to kill offending wildlife was independent of the action taken after reporting attacks	$\chi 2$=26.67, df=4 p=0.00	The decision to kill or not to kill offending wildlife was dependent on the action taken after reporting attack cases
9	Economic activities practiced were independent of the level of education	$\chi 2$=19.56, df=9 p=0.021	The economic activities practiced were dependent on the level of education
11	Species of livestock kept were independent of the location of respondents	$\chi 2$=51.71, df=25 p =0.001	The species of livestock kept were dependent on the location of respondents
12	Age of herders was independent of location of respondents	$\chi 2$=29.2,3 df=20 p= 0.083	The age of herders was independent of location of respondents

4.2. Livestock kept

Respondents kept a total of 51,789 livestock with an average of 259 heads of livestock per household. The shoats population was the highest representing 63.2% (n=32719) of the total livestock kept followed by cattle population (34%, n=17601) while donkey population was the least (2.8%, n=1469).

4.3. Livestock lost to lions and other wildlife species

A total of 7177 livestock heads were lost to wildlife between 2008 to June 2009. The highest number of kills were reported on shoats representing (73%, n=5298) of the total livestock killed by wildlife a number which was three times more than that of cattle killed by wildlife (21.6%, n=1552) and almost twenty times greater than the total number of donkeys lost to wildlife (4.6%, n=327) (Figure 4.1). There was a significant variation in the mean number of livestock types lost to wildlife ($F=288.016$, $df=2, 4158$, $p=0.00$). On average each household lost 27 shoats, 8 cattle and 1 donkey.

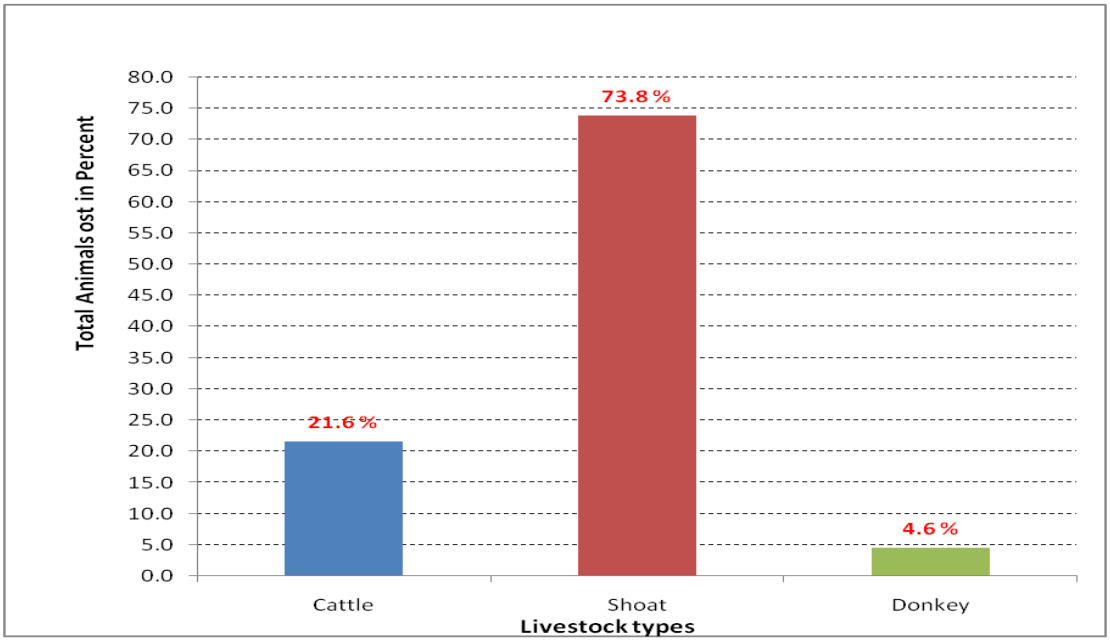

Figure 4.1: Percent of livestock killed by predators

Seven wildlife species (see Figure 4.2) were reported to kill livestock reared by respondents. Most kills executed by the predators were attributed to the hyena (41.3%), while attacks by the lion claimed 17.7% of all livestock lost to wildlife. Overall percentages of total livestock losses lost to other wildlife species were as follows, leopard (20.9%), cheetah (8%), jackal (5.8%), elephant (4.5%) and baboon (1.7%) (Figure 4.2). There was a significant variation in the mean number of livestock killed by the various wildlife species ($F=101.053$, $df=6, 4158$, $p=0.00$).

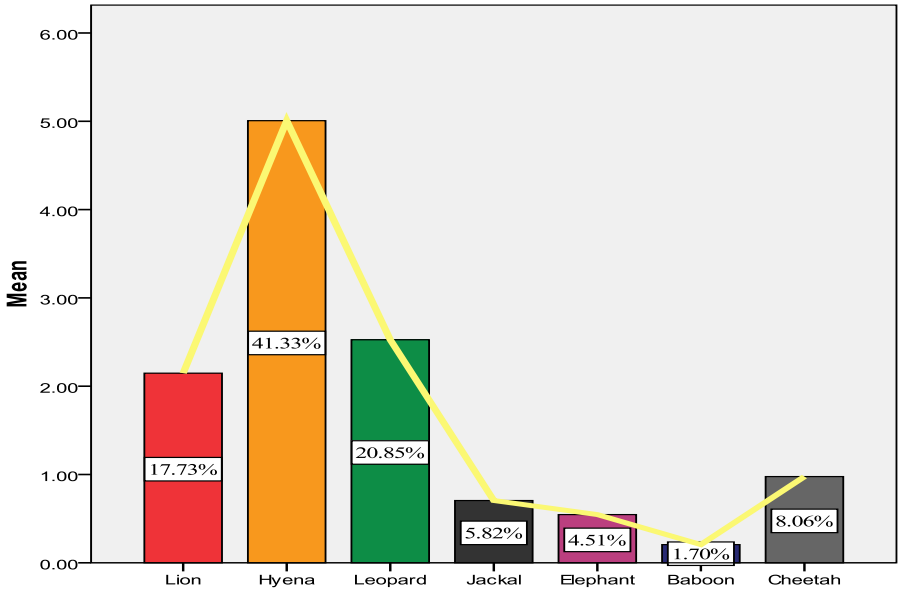

Figure 4.2: Percent of livestock killed by each predator

Wildlife killed 13.9% (n=7177) of the total (n=51789) livestock kept by the respondents. The three major predators of livestock which included hyena, leopard and lion killed 5.6% (n=2989), 2.9% (n=1508) and 2.5% (n=1282) of the total livestock lost by the respondents respectively. There was a significant difference in the mean number of livestock killed by the leopard, lion and hyena (f=34.9, df=2, 1782, p = 0.00). The numbers of livestock preyed on by the lion and hyena were significantly different (q=7.52, p=0.00), while those preyed on by the lion and leopard were not significantly different (q=0.58, p=0.83) (Table 4.6).

Table 4.6: Tukey test and multiple comparisons for major predators

(I) Predator	(J) Predator	Mean Difference (I-J)	P
Lion	Leopard	-.0353	.830
	Hyena	-.4560*	<0.001
Leopard	Lion	.0353	.830
	Hyena	-.4206*	<0.001
Hyena	Lion	.4560*	<0.001
	Leopard	.4206*	p<0.001

Most of the attacks by various wildlife species were directed at shoats. The hyena and the leopard attacked shoats more frequently claiming the lives of 47% and 28% of all the shoats lost to wildlife respectively. Lions killed the lowest number of shoats (1.6%), but killed more cattle (71.8%), which was more than six times those killed by hyenas (13.8%) (Figure 4.3).

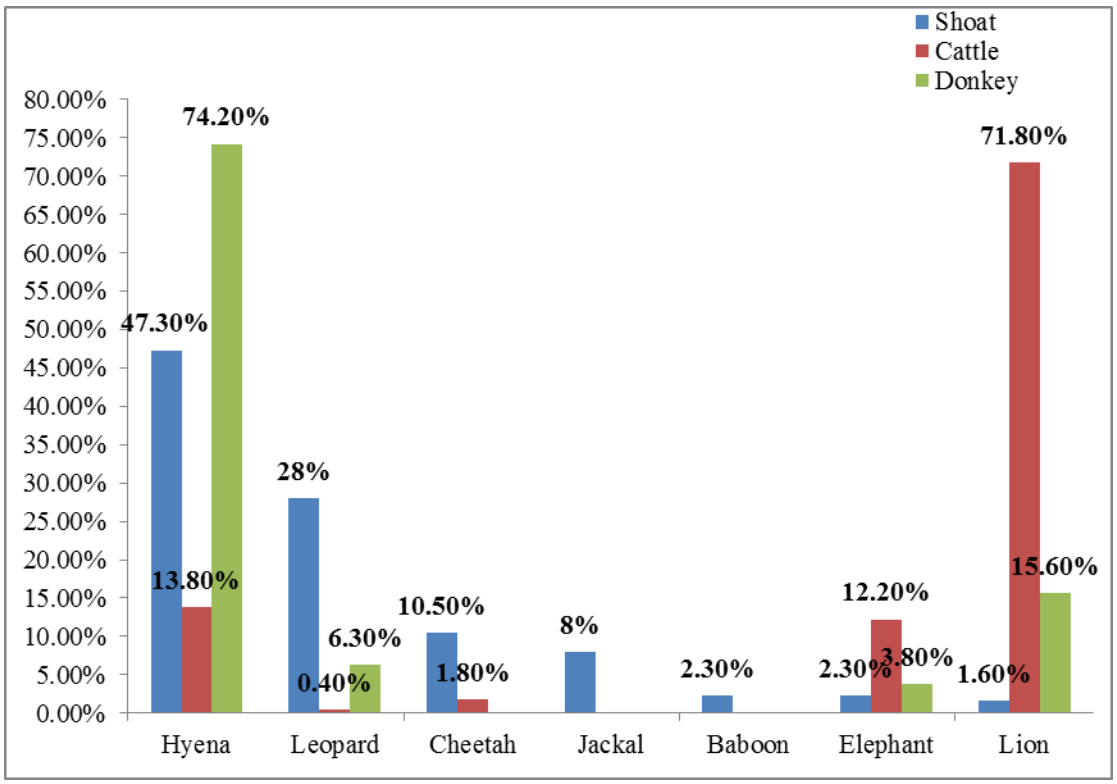

Figure 4.3: Comparisons between livestock types killed by different wildlife species

4.4: Economic cost of livestock lost to wildlife

The total economic loss attributed to livestock deaths amounted to US $946,699 with cattle accounting for 54.48 % (US$515,775), shoats 43.50 % (US$411,840) and donkeys 2.02% (US$19,084), (Appendix 12). With reference to individual wildlife species, the lion accounted for 40.2% of total economic losses followed by the hyena (29.6%), leopard (12.6%), elephant (7.6%), cheetah (5.6%), jackal (3.5%) and baboon (1%) respectively (Figure 4.4). The differences between the mean costs incurred due to losses attributed to the lion, hyena and leopard were significant (F=34.297, df=2, 1782, p=0.00). The costs of livestock lost to hyena and the lion were not significantly different (q=0.24, p=0.968) (Table 4.7).

Table 4.7: Tukey test and multiple comparisons for value of livestock lost to major predators

(I) predator	(J) predator	Mean Difference (I-J)	p.
Lion	Leopard	5.6757*	<0.001
	Hyena	-.1945	.968
Leopard	Lion	-5.6757*	<0.001
	Hyena	-5.8702*	p<0.001
Hyena	Lion	.1945	.968
	Leopard	5.8702*	<0.001

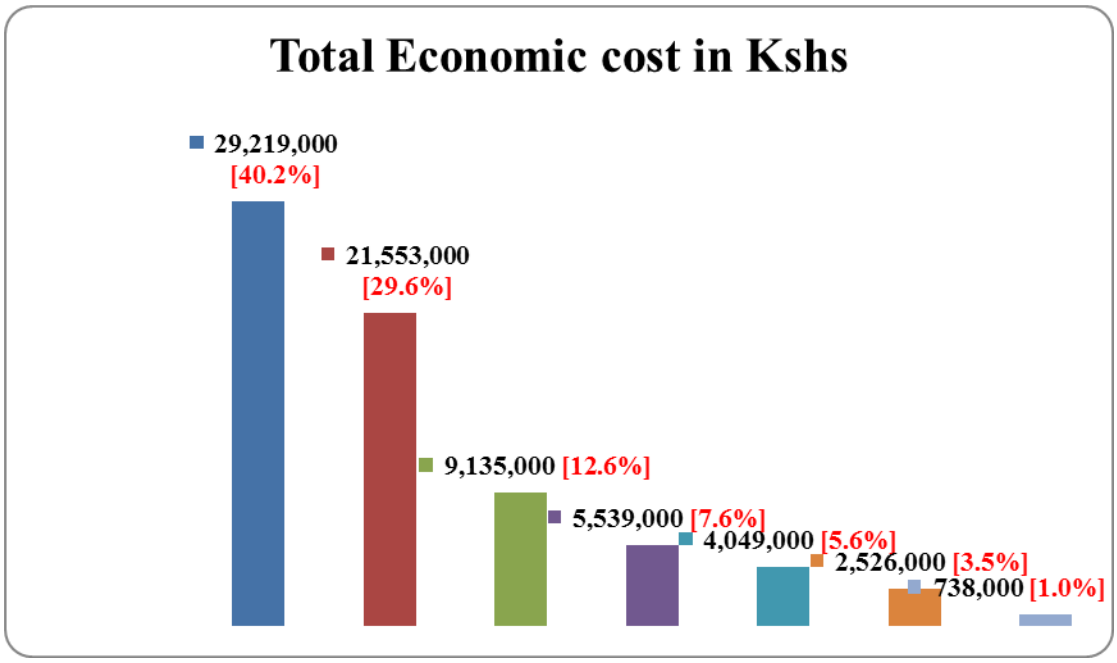

Figure 4.4: Economic value of livestock lost to different wildlife species

4.5. Livestock losses to diseases, wildlife, theft and drought.

Losses of livestock were classified into four major categories based on the cause of loss including wildlife, diseases, drought and theft. A total of 16,585 representing 32% of the total livestock were lost to different causes of mortality for a period of 18

months (January 2008 up to June, 2009) (figure 4.5). The breakdown of various causes of mortality showed that drought and wildlife which accounted for 43.4% and 43.3% of the total livestock lost caused the highest mortality while losses from diseases and theft were lower at 12.7% and 0.6% respectively (figure 4.5). The different causes of loss including drought, wildlife, diseases and theft accounted for 13.9%, 13.86%, 4.06% and 0.19% losses of the total livestock population in that order. The numbers of livestock lost to different causes of death were significantly different (F=181.74, df= 3, 2376, p=0.00). The numbers of livestock lost to both wildlife and drought were significantly different (q=2.63, p=0.023) (Table 4.8).

Table 4.8: Tukey test, multiple comparisons for causes of death

(I) cause	(J) cause	Mean Difference (I-J)	p
Wildlife	Diseases	1.2468*	<0.001
	Drought	.2842*	.023
Diseases	Wildlife	-1.2468*	<0.001
	Drought	-.9626*	p<0.001
Drought	Wildlife	-.2842*	.023
	Diseases	.9626*	<0.001

4.6. Economic losses to livestock due to different causes of death

The total estimate of economic value of livestock lost to different causes of mortality was US$2,661,892 for a period of 18 months. Drought cost US$1,334,718 (50.1%) and wildlife US$946673 (35.6%) which were the highest losses, while diseases accounted for US$370813 (14 %) of the total loss, while loss from theft was only US$ 9688 (0.4%) (Figure 4.6). The economic losses of livestock lost to different causes of death were significant by different (F=61.484, df=2, 1782, p=0.00), while the

economic costs resulting from drought and wildlife were not significantly different (q=0.93, p=0.618) (Table 4.9). Lion attacks on livestock were blamed for 16% of the total economic cost of livestock lost due to different causes. Cattle were the most vulnerable to drought accounting for 38% of total economic loss with the least economic cost being incurred due to diseases in donkeys representing only 0.05%.

Table 4.9: Tukey test and multiple comparisons for economic costs due to different causes of death

(I) Cause	(J) Cause	Mean Difference (I-J)	Sig.
Wildlife	Diseases	15.3400*	<0.001
	Drought	1.4283	.618
Diseases	Wildlife	-15.3400*	<0.001
	Drought	-13.9117*	p<0.001
Drought	Wildlife	-1.4283	.618
	Diseases	13.9117*	<0.001

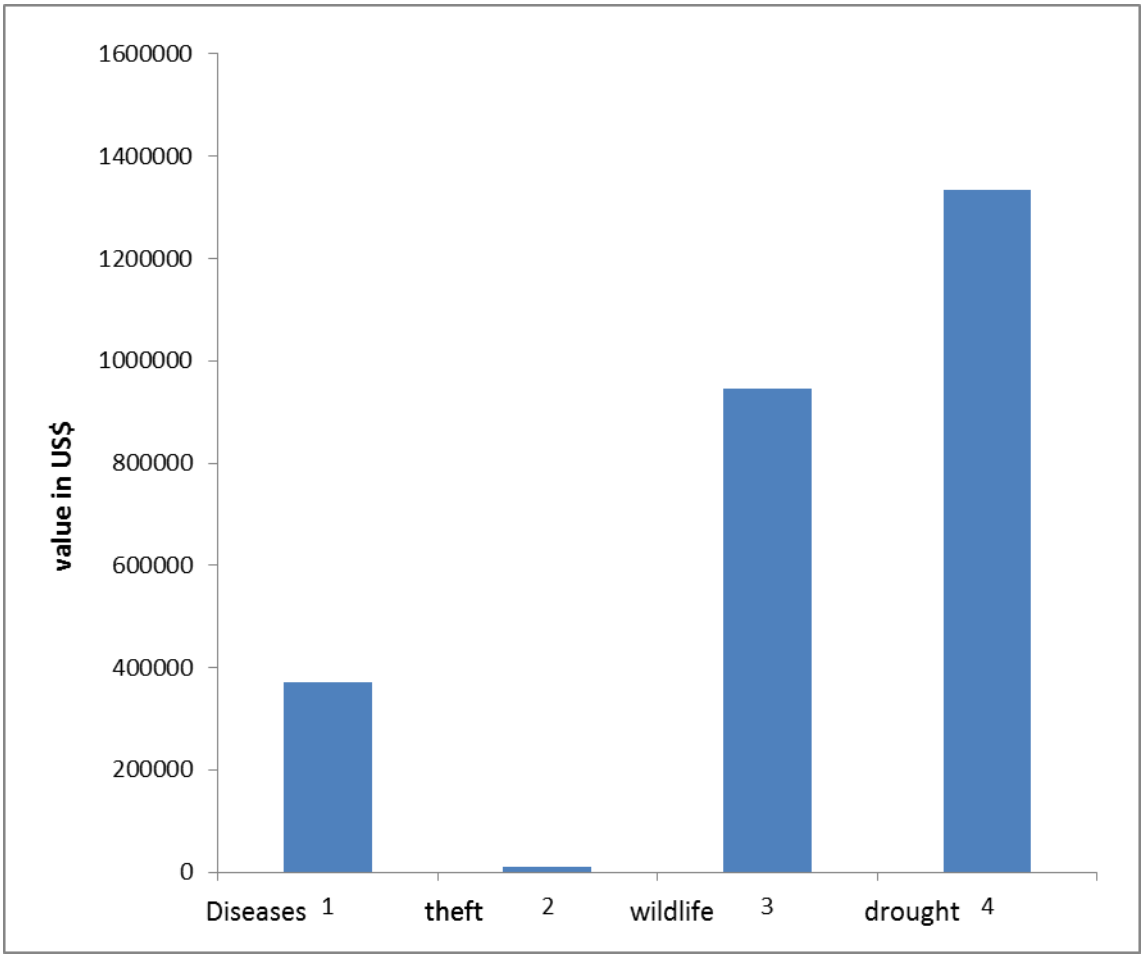

Figure 4.5: Total Economic **loss of livestock due to different causes**

CHAPTER FIVE

DISCUSSION

5.0. Numbers of livestock lost to lions

Compared to other economic activities like crop farming the traditional pastoral approach to livestock husbandry has always been considered compatible with and complementary to wildlife conservation (Mizutani, 1993). If this holds then the profitability of pastoralism as an economic activity has to be maintained. Where predators make pastoralism grossly unprofitable, rangelands that support countless native wildlife species may be converted to sterile agricultural farms or herders may resort to snaring or poisoning of predators (Patterson, 2004a). While some studies have reported relatively low rates of livestock losses to predators, others have documented high rates of livestock predation. Considering the low rates of livestock losses to predators including the lion reported in some areas, information on other causes of livestock losses including attacks by other wildlife species, drought, diseases and theft was necessary to shed light on the lion's contribution to the economic losses incurred by the Maasai pastoralists and impact on pastoralism.

The results of this study are at par with many African studies. For instance, in the neighboring Mbirikani Group Ranch lions killed 0.1% of the total livestock herd in 2006, while commercial ranches adjoining Tsavo lost 2.2% of cattle to lions annually from 1996 to 1999 (Maclennan *et al*,2008 and Patterson *et al*. 2004). Despite this, skepticism regarding the 'actual' damage caused by problematic species should be avoided, as it is more important to accept local peoples' perceptions of conflict and

use these as the baseline for investigating and addressing any antagonism towards wildlife (Wallace, 2006).

Low predation levels may also mask important variation between households, with some experiencing devastating losses while others suffer few or no attacks. The fear alone of possible attacks can influence negative attitudes towards carnivores even where little or no predation occurs (Sillero-Zubiri and Laurenson 2001). Gusset *et al* (2008) reported a loss of 86% of livestock kept by farmers to lions in Northern Botswana in 2005. Kisuui (2008) working in Tanzania reported a loss of 25% of livestock reared to lions in Northern Tanzania between January 2004 and July 2005. Ranchers in Zimbabwe lost 2% of their stock to depredation (Rasmussen 1999) while pastoralists in Botswana reported a predation rate of 2.2% (Schiess-Meier *et al*., 2007). Holmern *et al* (2006) reported a 0.1% economic loss by lions to farmers outside Serengeti National park in 2003.

Patterson *et al* (2004) noted that lions were responsible for 86% of all livestock kills in commercial ranches in southeastern Kenya while Ogada *et al* (2003) have documented that lions accounted for about 63% of livestock kills in commercial ranches in Northern Kenya. Karani (1994) in a study of group ranches surrounding Masaai Mara National Reserve reports that lions were responsible for 19% of livestock killed by different predators. In the current study results revealed that lions were responsible for 17.7% of all livestock killed, a fact that concurs with the results of Karani (1994). In the neighboring Mbirikani Group Ranch lions were blamed for 7% of predation cases in 2006 (Maclennan *et al.*, 2008). Predation on livestock is an important cause of human wildlife conflict (Frank 1998, Ogada *et al*. 2003). Most

studies have shown that tolerance of predators by local communities usually depends on the extent of predation on their livestock (Rasmussen 1999, Patterson *et al*., 2004, Woodroffe *et al*., 2005, Kolowski and Holekamp 2006, Holmern *et al*., 2007). The differences between the results of the present study and those of other regions cited above could be attributed to densities of different carnivores in different regions. Some researchers have documented increases in livestock depredation rates with increases in carnivore density (Stahl *et al*., 2001; Stoddart *et al*., 2001). A significant increase in killing and poisoning of lions has been reported in Mbirikani Group Ranch and adjacent group ranches in Amboseli ecosystem since 2001. These killings have no doubt reduced lion numbers in the study area implying reduced numbers of killings of livestock particularly cattle. This observation explains to some extent the deviation in the findings of Maclennan *et al.* (2008), Patterson *et al* (2004) and Ogada *et al.* (2003) with those of the present study.

From the results of this study it is clear that respondents have almost reached a point of zero tolerance towards lions. This is probably because lions are resistant to most mitigation measures used in the study area against livestock attack by wildlife. However the fact that bomas in the study are constructed to control livestock not to exclude predators (see also Patterson *et al.*, 2004 and frank, 1998) may increase livestock attacks by lions even when other husbandry like the use of dogs are practiced. Lethal control of predators is however a short-term respite from losses, because the same or other predator species rapidly re-establish themselves (Linnell *et al*.,1999; Stahl *et al*., 2001; Herfindal *et al*., 2005). Furthermore this would mean that any benefits accrued from the conservation of lions are lost.

5.1. Value of livestock lost to other wildlife species

This study considered a wide range of other wildlife species which killed livestock like elephants even if not necessarily for food. In the neighboring Mbirikani Group Ranch the spotted hyena, leopards/cheetahs and the lions were blamed for 43%, 37% and 7% of predation cases in 2006 respectively (Maclennan *et al.* 2008). The foregoing attacks by hyena and leopards/cheetahs are in tandem with those of the present study, although the percentage of lion kills differs between this study and that of Maclennan (2008) by 10%. The present study's results are however consistent with those the results of a study carried out in group ranches around Maasai Mara National Reserve by Kolowski and Holekamp in 2005 which showed that hyenas were involved in 53% of the reported incidents of predation, with leopards and lions involved in 32% and 15% respectively. Within the same area, Karani (1994) notes that leopards were the most serious livestock predators accounting for 50% of total livestock attacks, with lions and hyenas being responsible for 19% and 31% of recorded attacks respectively.

In Northern Tanzania three wildlife species were involved in livestock losses: 58% were by hyenas, 25% by lions and 17% by leopards (Kisuui, 2008). In the Gowke communal land, in Zimbabwe, rural villagers experienced livestock attacks by baboons, lions and leopards which contributed to 52%, 34% and 12% of the livestock kills respectively between January 1993 and June 1996. Despite baboons killing more animals, lions caused the greatest economic loss because of the high value of cattle, which is mostly preferred by lions over other lowly valuable animals (Butler 2000).

The differences in predator involvement in depredation could be explained by the relative availability of diverse livestock including small and large stock animals. In their study Patterson *et al* (2004) reported low hyena depredation on ranches where majority of stock animals were cattle. Similarly the low frequency of hyena and leopard depredation in some areas may also be due to the rarity of their preferred livestock prey, sheep and goats.

In a study carried out in ANP and the surrounding group ranches by Okello between 1999 and 2002, it was reported that predator density was higher inside the park compared to the surrounding group ranches including Kuku and Kimana. Lions and spotted hyenas had densities of 0.03 lions/Km^2 and 0.93 hyena/Km^2 respectively. In the present study, high depredations by hyenas could be due to high densities of hyenas in the Amboseli ecosystem. On the other hand the low lion densities in the study area explains their lower depredation levels although as evidenced by the results they can become a major cause of conflict if their densities increase without strict measures of reducing depredation rates being put in place.

Evidence from study results and others reviewed suggest the spotted hyenas, leopards and lions are the major predators of livestock. Although there was no significant difference between the cost of livestock killed by both the lion and the hyena, the lion is more vulnerable to retaliatory killing since lions normally defend a livestock carcass against humans thus exposing them to frequent confrontation while hyenas shy away from people and leopards are good at hiding (Kissui 2008). In addition, lions kill cattle more frequently which are of more monetary and cultural value to pastoralists than sheep and goats. The economic value of one cattle is equivalent to

about four goats or sheep. Most critical is that although lions are mainly nocturnal hunters they mostly attack livestock during the day when people are armed to protect their livestock leading to direct confrontations whereas leopards and hyenas mostly attack livestock at night, hence avoiding to a big extent confrontation (Packer and Kissui 2007).

Maclennan *et al* (2008) documented 7% kills by jackals and 6% kills by both buffalos and elephants in Mbirikani Group Ranch. According to Patterson *et al* (2004) the highest kills by cheetah were 4.9% while the highest elephant kills reached 3.6% from 1996 to 1999 in ranches adjoining Tsavo East National Park. Butler (2000) recorded baboon among the major predators of livestock accounting for the highest livestock kills at 52% followed by lions at 34% and leopards at 12%.

Elephants normally concentrate in the Amboseli basin especially around the permanent swamps in the dry season, thereby excluding other species especially browsers and mixed feeders and causing habitat degradation (Okello and Kioko, 2010). This dominance by elephants indirectly creates human - wildlife conflicts when carnivores follow displaced herbivores outside the park where the density of livestock is high. This concentration of elephants in the Amboseli basin may also explain the increase in elephant attacks on livestock in the study area compared to other areas. Although hyenas predated on more livestock, their number of attacks and kills could be lower because they also feed on carcasses of livestock killed by other wildlife species like elephants. Other wildlife species like the jackal and the baboon normally attack the young of goats (kids) and sheep (lambs). Baboons mostly attack lambs near bomas where they normally scavenge on waste food materials. The fewer

kills by baboons could be explained by the fact that the Maasai rarely waste food as it is a rare commodity in Maasai land. It is important to note that most studies have recorded the lion as having killed livestock of higher economic value compared to other wildlife species even in cases where other species killed significantly higher number of livestock.

5.2. Comparison of livestock losses to diseases, wildlife, drought and theft.

The impact of drought has been intensified by the decline in use of distant pastures due to increased land subdivision and settlement. Drought contributes indirectly to predation because local people move their livestock to the park for grazing and watering during the dry season and thus interaction between livestock and wildlife leads to increased conflict during drought seasons. Livestock also becomes increasingly vulnerable to attack by wildlife when they are weak from drought.

During the study period there was a severe drought and according to the Predators Fund verification officers, weak dying livestock were deliberately neglected to be predated on by wild animals after which the owners would claim compensation. Consequently most lions and other carnivores changed their behavior preferring livestock than wild prey. This was exacerbated by the fact that most herbivores died from drought leaving the lion and other carnivores with few alternatives. In the Amboseli region, the drought of 2009 killed 70-85% of lions' wild prey, forcing them to turn to the remaining Maasai livestock, which were already reduced to approximately 60% by the drought. Starving lions started invading Maasai homesteads (bomas) to kill cattle, and consequently in the first three months of 2010, 18 lions were killed in retaliation (Living With Lions Annual Report, 2010).

The prey population had reduced so much that translocations of zebras from Naivasha were carried out to increase the population in the Amboseli ecosystem. Wildebeest numbers fell from over 6,000 to less than 150, zebra from 7,000 to 1,500 and buffalo from 600 to 185 (Russell 2009). In the year 2009 an amount of Ksh 937,000 was paid in compensation which was higher than the following years, and this can be explained by the indirect effects of drought which increased predation that year. Plates 2 and 3 give a pictorial view of Amboseli ecosystem during and before the 2009 drought.

Plate 2. Amboseli Ecosystem before drought in 2008 (Source: Author, 2008)

Plate 3. Amboseli Ecosystem during the drought in 2009 (Source: Author, 2009)

A study by Rabinowitz (1986) in the Cockscomb basin of southern Belize revealed that jaguar predation on cattle accounted for only a small percentage of cattle dying annually with many of the deaths resulting from drowning, diseases and starvation. Karani (1994) also reported more deaths from diseases than from predation in the group ranches adjacent to Masaai Mara National Reserve. Compared with predation, the impact of diseases was 10 times greater for cattle and 5 times higher for goats and sheep in Northern Tanzania (Kissui, 2008). The differences between the present study's results and those cited above could be accounted for by the different rainfall patterns between the regions during the study periods. Most studies also do not include drought in their study making generalization difficult. Although drought is unpredictable occurrence, it is an important risk in arid and semi-arid areas which often leads to comparatively high loses and should not be ignored.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 Conclusions

Economic losses caused by lions in the study area are among the highest reported in East Africa. Therefore, the belief that carnivore conservation particularly the lion is a non-affordable luxury is wide among the local community in the study area because of the opportunity cost in the form of lost livestock. Most of the local people believe that a choice has to be made between economic development and lion conservation. The most significant impact of the high cost of livestock predation by lions might include change in land use with more people turning to crop farming in future. Effective conservation of lions and other wildlife species however demands resolution of conflicts between people and wildlife. This is only achievable if the impact of wildlife on livelihoods can be reduced to a level that local people will tolerate. Therefore management options that balance the needs for lion conservation, human well-being and ecosystem sustainability must be developed.

Results of this study provide insights into the extent of livestock lost to 7 species of wildlife including the cost of livestock lost to each wildlife species. The hyena and leopard killed higher numbers of livestock compared to the lion. In terms of economic cost the value of livestock lost to the lion was the highest. This cost was however not statistically different from the value of livestock lost to the hyena making the hyena an equally important predator of livestock.

Although losses of livestock to wildlife are high, the costs of livestock lost to drought

are comparatively higher while the cost of livestock lost to theft is negligible. Extreme droughts disrupted economic development of the area. This implies that livestock husbandry can be improved on the basis of identified major problems in the livestock production system including drought and diseases.

The use of thorn acacia boma, coupled with a combination of human guards and dogs, and herding by youth aged between 18-30 years were found to be effective against livestock attacks by most wildlife species. However none of these husbandry practices was effective against reducing livestock attacks by lions.

6.1. Recommendations

6.1.1 Management and policy recommendations

Given that lions in Olgulului group ranch cause financial loss that is high enough to motivate retaliatory killing by pastoralists, direct compensation for livestock killed by wildlife should be given to affected pastrolists to offset the economic losses incurred. Compensation for livestock and other property losses to wildlife was stopped by the Kenyan government in 1989, and it neither replaces nor repairs any installations destroyed by wild animals (Kenya Wildlife Service, 1996). There is need for compensation schemes to be re-evaluated, and local people compensated for losses to enhance positive attitudes towards wildlife, stop retaliatory killings, and garner local support for conservation.

Although the Amboseli Predator's Compensation Fund and Amboseli Trust for Elephant compensate pastoralists in the study area for livestock killed by predators and elephant respectively, the two funds pay only a fraction of the real value of the livestock lost which creates a negative opinion towards wildlife. Additionally the

process of verifying claims may cause delay in payments of lost livestock bringing more resentment towards wildlife conservation. The compensation funds are also not very sustainable as they rely heavily on donors for funding, yet they can pull out any time. This strategy is also not sustainable since it does not encourage villagers to protect their livestock from wildlife attacks.

For example in the neighboring Mbirikani Group Ranch penalties put in place for poor herding by the Mbrikani Predator Compensation Fund did not reduce negligent herding from 2004 to 2006 (Maclennan *et al*, 2008). In the study area as mentioned earlier pastoralists were said to neglect weak livestock to be predated on so that they could be compensated. Financial sustainability of any direct incentive scheme is a priority (Nyhus *et al*. 2005); more so if the motivation to conserve wildlife becomes purely financial, since withdrawal of the financial incentives can be detrimental to long-term conservation (Gadd, 2005).

An alternative strategy to compensation would be an insurance scheme where livestock insurance offered to pastoralists covers livestock from the risk of wildlife attack, and involves the local community and local governing bodies paying a premium share of the insurance, thus allowing rural inhabitants to make a minimum annual cost to be refunded in the event of livestock losses (Madhusudan, 2003). All stakeholders including the local community who suffer the cost of living with lions, private investors who benefit from the presence of lions, KWS and others should be involved in funding and management of such insurance. These insurance programs can encourage good livestock husbandry by giving cash rewards to livestock owners. This could be replicated locally as it happens in the Spiti valley in India where a

livestock insurance program provides cash rewards to farmers who have the fewest livestock predation cases (Mishra *et al.* 2003). Another alternative to compensation would be to pay communities for the number of living lions instead of dead livestock. This would greatly avoid the pitfalls of compensation mentioned earlier and the secret killing of lions (Frank, 2010).

A well-established education and extension program should be mounted in the study area to promote awareness about co-existence with wildlife, value of lions and other carnivores and the importance of conserving wildlife. Education and training activities at different levels would enable the local community to acquire and develop new tools and techniques for defending their livestock (Distefano, unpublished). During the study period, most of the livestock bomas in the study area were weak and most predators were able to surmount the simple acacia thorn brush barriers. The local community should be trained on construction of effective and economical bomas that are wildlife proof. Over time, education and training would result in a change of attitude, behavior and perception among local population, and would contribute to reduced risks, improvements in local livelihoods and a reduction in the vulnerability of the community. It would also equip the local residents with knowledge and skills on how to co-exist with wildlife and how to minimize frequent interactions with wildlife.

Information on the spatial temporal movements of lions and other wildlife would identify important wildlife refuge areas, and also help incorporate such information into village land-use plans that would help pastoralists to avoid herding their livestock in areas frequently used by lions.

In addition, given that the current Maasai community is no longer homogenous but more heterogeneous consisting of farmers, wildlife entrepreneurs and traders among others (Western, 1994) the need for co-existence can no longer be overemphasized. This means that tools for land use planning should integrate the diverse uses of the natural resources and the protection of the lion and its habitat.

Livelihoods of pastoralists in the study area can also be improved by limiting the losses of livestock to drought and diseases through improved livestock production practices, veterinary services involving vaccination, destocking and improvement in basic hygiene for young stock Alternative sources of livelihoods should be developed to reduce the reliance on livestock as the only source of livelihood.

When considering alternative sources of livelihood some economic activities like farming should be avoided as they are neither viable in the region nor compatible with wildlife as a form of land use. Several ecotourism activities currently in the group ranch including cultural manyattas should be encouraged, although currently few people benefit from this. Rutten *et al*. (1991) argues that community based tourism is neither a perfect nor foolproof way for communities to share in tourist revenue. Community based tourism activities in the GR should be designed and implemented to encompass full and equal participation of local people. More studies should however be done to determine the full impacts of these activities to the local community in the study area.

A program for continual monitoring of large carnivore densities in Amboseli ecosystem and other regions and their selection of habitats should be implemented. This will contribute to a better understanding of the patterns of livestock depredation and the ways of minimizing predation.

An early warning system for drought combined with timely market interventions and the establishment of financial institutions will allow herders to convert livestock that cannot withstand the stress drought into other assets such as cash, fodder or food grain. This coupled with other strategies aimed at reducing the impacts of drought to both wildlife and livestock should be developed since drought is both a direct and indirect cause of economic costs associated with both land uses encompassing wildlife and livestock keeping particularly because wildlife recover faster from drought compared to livestock herds. Additionally initiatives introduced to curb climate change conditions and effects should be directed introduced at grassroots level and towards minimizing livestock losses due to drought and promoting sustainable livelihoods.

Wildlife conservation and development should be linked and treated as integral aspects of sustainable development (KWS 1990). This entails embracing conservation activities that seek to reduce high poverty levels outside protected areas as conservation of lions and other carnivores cannot be achieved without addressing this. This can be achieved through employing risk coping strategies that provide incentives for destitute pastoralists to invest in alternative income generating activities outside the pastoral sector that help these pastoralists to cope with the loss of their main livelihood. Likewise, addressing human-lion conflict adequately and enhancing the

benefits resulting from the presence of the lion and other wildlife species would reduce the cost of supporting the lion to the local community and promote the conservation of the lion as a result.

This can be achieved through formulating and implementing harmonious and comprehensive legal and institutional frameworks that provide for the wildlife integrated land-use, lion conservation and associated socio-economic benefits not only Kenya but also in countries with potential lion range. Finally, a land use plan that is co-developed by local communities and the Amboseli ecosystem stakeholders should be implemented to restrict land uses that are incompatible with local ecology and culture (Okello and Kiringe, 2004). This entails adapting development and biodiversity conservation to the highly variable local conditions and actions of diverse rural people. As Mellor (2002) notes this adaptation requires rural people to become organized, local unit by local unit to most effectively meet their economic needs while conserving local biodiversity (Mellor, 2002).

6.1.2 Recommendations for further research

Further research should be undertaken on the following:

- Other reasons that motivate the Maasai to kill lions more than other carnivores.
- Mechanisms for adapting development and biodiversity conservation to local conditions to promote sound wildlife and sustainable livelihoods.

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Appendix 1: Questionnaire for local community

Section 1: General Information

Name…….Age ……Education Level…….

Male……Female……Location……

How many are you in the Manyatta?

Section2: Land use and livestock production

1) Do you own any livestock? ..... Yes ____No

2) If yes, what types of livestock do you own and how many?

Livestock type	**Number**
a) Cows	
b) Goats	
c) Donkeys	
d) Sheep	
e) Others (specify)	

3) What other activities besides livestock keeping do you do?

a) Crop Farming b) Tourism

c) Weaving and crafts d) Business

Section 3: Livestock Predation

4) Have you lost any of your livestock to wild animals? Yes……. No……..

5) If yes which species of wildlife attacked your livestock in the year 2008? (Fill the table below)

Predator	Cows	Goats	Sheep	Donkeys
Lion				
Cheetah				
Leopard				
Jackal				
Hyena				
Baboon				
Elephant				

6) Where were your livestock when they were predated on? (Specify the area)

a) At the watering point? b) At home in their enclosure?

c) During grazing? d) After they got lost

7) During what season and time were your animals attacked? (Tick below)

Dry season Wet season

During the day? During the day?

At night? At night?

8) When do you lose more livestock to wildlife?

a) When women are herding b) when men are herding

9) What are your reasons for the answer above?

10) What age group of herders is more protective of livestock against attack by wild animals?

a) 6 to 10 b) 11 to 17 c) 18 to 30 (Morans)

d) 18 to 30 (non Morans) e) 30 and above

11) How effective is the thorn acacia enclosure in preventing livestock attacks from wildlife?

a) Very effective b) Effective c) Not effective

12) Did you lose your animals to other causes of death in the year 2008 (fill the table below).

Livestock	Diseases	Theft	Drought
Cow			
Sheep			
Goat			
Donkey			

Section 4: Action taken to minimize Livestock Attacks by Wildlife

13) To whom do you report cases of livestock killed by lions and other predators?

a) Kenya Wildlife Service b) The police

c) Chief d) Others (specify)

14) What action is taken after you report?

a) No action b) Compensation

c) Tracking the predator to kill it d) Others (specify)

15) How many compensation schemes operating in this area are you aware of?

a) Elephant consolation scheme b) Lion consolation scheme

c) Others (specify)----------

16) What methods of animal husbandry do you use to protect your livestock from predation?

a) Guard dogs b) Human guards c) Others (specify)----------

17) How effective are the methods mentioned above?

a) Very effective b) Effective

c) Not effective d) Don’t know

18) What action do you take against the predators which kill your livestock? (Tick appropriately)

a) Trapping b) Poison

c) Spearing d) No action

Appendix 2: Focus Group Discussion Guide Questions

1) Has the number of livestock killed by wildlife been increasing or decreasing?
2) Comparing inside and outside the park, where are livestock mostly attacked by wildlife?
3) What some the factors that influence the attack of livestock by wildlife?
4) What husbandry methods do you use as a community to deter predation?
5) How effective are the methods mentioned in four above?
6) How do different wild species approach and attack livestock
7) Do you consider compensation as an effective strategy in making people tolerate loss of livestock to wildlife?
8) What do you think is the lasting solution to the problem of human wildlife conflict?
9) When are livestock most vulnerable to wildlife attacks?

Appendix 3: Key Informants Interview Guide Questions

Section A: Officials of the Predator's Compensation Fund

1) When was the predators' compensation fund started?
2) What motivated the initiation of the compensation fund?
3) What action do you take when locals report cases of livestock attacked by elephants?
4) Do you have any conditions which should be met by locals before you compensate for livestock killed?
5) Have you noticed any increase or decline in predation levels since you started compensation?
6) Have you noticed any particular area where predation is higher than other areas?
7) Where do get financing for compensation and carrying out other operations related to compensation?
8) Have you noticed any change in the locals' attitude towards predators as a result of compensation?
9) When do most attacks of livestock by wildlife occur

Section B: Officials of the Amboseli Elephant Trust

1) When was the Amboseli elephant trust started?
2) What motivated the initiation of the Amboseli elephant trust?
3) Have you indentified particular elephants which frequently attack livestock?
4) What action do you take when locals report cases of livestock attacked by elephants?
5) What provokes elephants to attack livestock?

6) Do you have any conditions which should be met by locals before you compensate for livestock killed?
7) How much do you compensate for each species of livestock killed?
8) Where do get financing for compensation and carrying out other operations related to compensation?
9) Have you noticed any change in the locals' attitude towards elephants as a result of compensation?

Section C: Kenya Wildlife Service Officials

1) What is role of KWS in reducing human wildlife conflict
2) Does the KWS participate in the management of the GR
3) How does the locals in the GR benefit from the park
4) How do you respond when locals report cases of livestock attacked by wildlife
5) Do you collaborate with compensation scheme?

Section D: Group Ranch Officials

1) What are the economic activities that take place within the GR?
2) How are the revenues from the economic activities shared?
3) When are livestock attacks by wildlife more intense?
4) What action do you as the group ranch officials take when cases of livestock attacks by wildlife are reported to you?
5) Do you work with the two compensation schemes within the group ranch?

Appendix 4: Opinions of Key informants on issues relating to livestock attacks by Wildlife

Information sought	Group ranch officials	KWS officials
Livestock attacks by wildlife, Strategies of reducing human wildlife conflict, benefit sharing, compensation, economic activities	• The group ranch owns a camp site, cultural manyattas and sand harvesting also takes place within the GR • Revenue from these economic activities and contribution from the KWS is distributed to members inform of bursaries for school children. The revenue is also used in financing and maintain various projects • HWC is more intense in rainy season • The group ranch contributes 30% compensation of every claim. • All stake holders should contribute towards compensation.	• Problem animals are chased away or shot by problem animals control rangers. • Educate the public on the importance of wildlife and their conservation. • Compensation schemes were started in response to numerous killings of lions for attacking livestock • KWS collaborate with compensation schemes in verifying attacks. • KWS provide water to the community • The locals from the group ranch receive bursaries from the park • Finance project proposed by the community members
Information sought	Focus group discussions	Village elders
Wildlife attacks on livestock, strategies against livestock attack,	• The number of livestock attacked by wildlife has been increasing • Livestock attack by wildlife is equally high both inside and outside the park • Lions jump over enclosures and attack livestock • Leopards normally attack livestock during day time • Jackals attack lambs during the day • Livestock are most vulnerable to attack when giving birth in the bush, when lost, when women and children are herding, when a big herd is looked after by few herders, when livestock are weak from drought.	• Livestock attacks by wildlife has been happening from the beginning but has increased recently. • Dialogue with KWS is more important in solving HWC than the use of law and guns • The only lasting solution to the problem of HWC is fencing all wildlife inside the park. • Spearing is the most common method used in killing wildlife that attack livestock but poisoning is becoming popular. Lions are most affected since livestock carcasses they leave behind are normally poisoned.

	• Hyenas enter enclosures through weak areas, therefore well made enclosures can keep away hyenas • Dogs are successful in chasing away hyenas but retreat if they encounter a lion. • Lions either jump over enclosures or scare livestock to a stampede consequently breaking the enclosure after which the lion attacks them. • The only lasting solution to the problem of predation is either fencing off all lions inside the Amboseli National Park or killing all of them whether they are responsible for predation or not. • The amount of money paid in compensation is way below the market price of livestock. Killing the offending wildlife was therefore seen as a better solution. • The community would tolerate wildlife if they were fully compensated	
Information sought	Amboseli Trust for elephant officials	Predators compensation fund officials
Strategies of reducing HWC, compensation.	• The fund compensates 15000 KSH for a cow and 5000 for shoat. • The amount is paid one to two weeks after the livestock has been killed • Compensation makes the community appreciate the compensation of elephants • The fund also partially pays for funeral expenses for victims killed by elephants • Elephants kill livestock mostly in the dry season	• The fund started activities in June 2008 • The fund is financed by different organizations and donors. • Lion killing had declined after they started compensating pastoralists for livestock killed by predator • They paid KSH 937,000 in compensation in 2009, 600,000 in 2010 and 400,000 in 2011.

	because they interact with livestock during grazing • Elephants are mostly known to kill livestock if they are provoked by barking of dogs and if a member of a family has been killed by the Maasai. • There are specific families which are known to attack livestock particularly those with calves. • Verification officers verify elephant attack by looking for tusks and foot injuries on the dead livestock. • Most livestock are attacked at ilmarba location which is nearest to the park • Livestock are mostly attacked at watering points. • Hyenas are mostly opportunistic feeders and feed on livestock already killed by elephants if they notice the carcass before the herders do.	• Compensation is done after every two months. • The amount compensated also depends on the quality of the boma, locals with weak bomas are compensated half of the amount mentioned above. • Most livestock are attacked at Ilmarba location which is nearest to the park • Livestock are only compensated for if they are killed within the GR and within a perimeter of 1km outside the GR • The fund have also been giving scholarships to the best youth • Several locals have also been employed • Compensation makes community to appreciate predator's conservation. •

Appendix 5: Relationship between employment and economic activities

			other economic activities				
			farming	farming and off farm(bussiness, weaving and crafts, tourism)	off farm (bussiness, weaving and crafts, tourism)	no other activity	*Total*
number of employed people	yes	Count	25	12	1	10	48
		% within number of employed people	52.1%	25.0%	2.1%	20.8%	100.0%
	no	Count	66	7	4	48	125
		% within number of employed people	52.8%	5.6%	3.2%	38.4%	100.0%

Appendix 6: Relationship between education level and economic activities

			other economic activities				
			farming	farming and off farm(bussiness, weaving and crafts, tourism)	off farm (bussiness, weaving and crafts, tourism)	no other activity	Total
education level	no school	Count	61	7	4	49	121
		% within education level	50.4%	5.8%	3.3%	40.5%	100.0%
	primary	Count	15	5	1	6	27
		% within education level	55.6%	18.5%	3.7%	22.2%	100.0%
	secondary	Count	9	4	0	3	16
		% within education level	56.2%	25.0%	.0%	18.8%	100.0%
	College	Count	6	3	0	0	9
		% within education level	66.7%	33.3%	.0%	.0%	100.0%

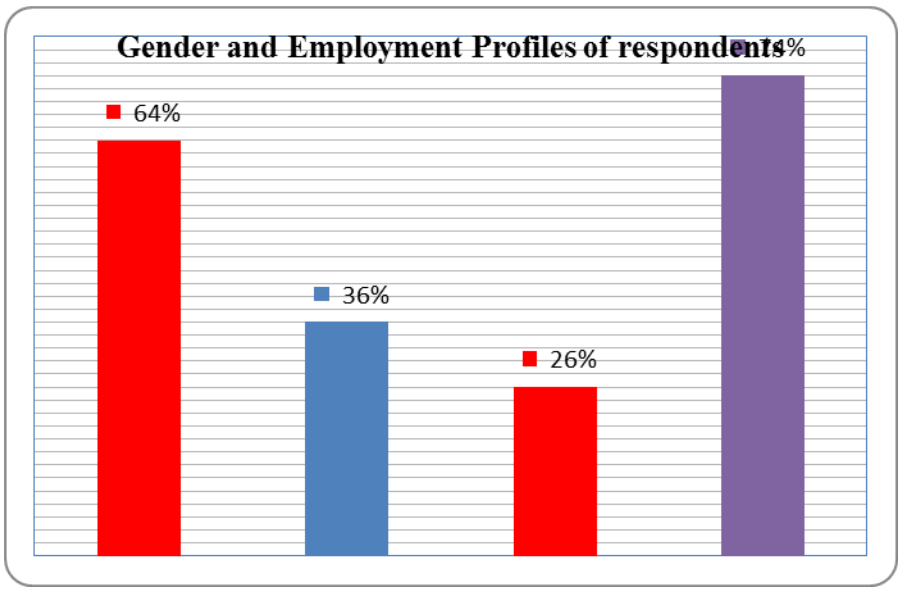
Appendix 7: Relationship between the location of respondents and economic activities

			Other economic activities				
			farming	Farming and off farm (bussiness, weaving and crafts, tourism)	off farm (bussines s, weaving and crafts, tourism)	no other activity	Total
location of respondent	Ormoti	Count	11	1	12	10	34
		% within location of respondent	32.4%	2.9%	35.3%	29.4%	100.0%
	ositet	Count	19	6	2	8	35
		% within location of respondent	54.3%	17.1%	5.7%	22.9%	100.0%
	endonet	Count	7	0	1	1	9
		% within location of respondent	77.8%	.0%	11.1%	11.1%	100.0%
	oldule	Count	0	1	3	7	11
		% within location of respondent	.0%	9.1%	27.3%	63.6%	100.0%

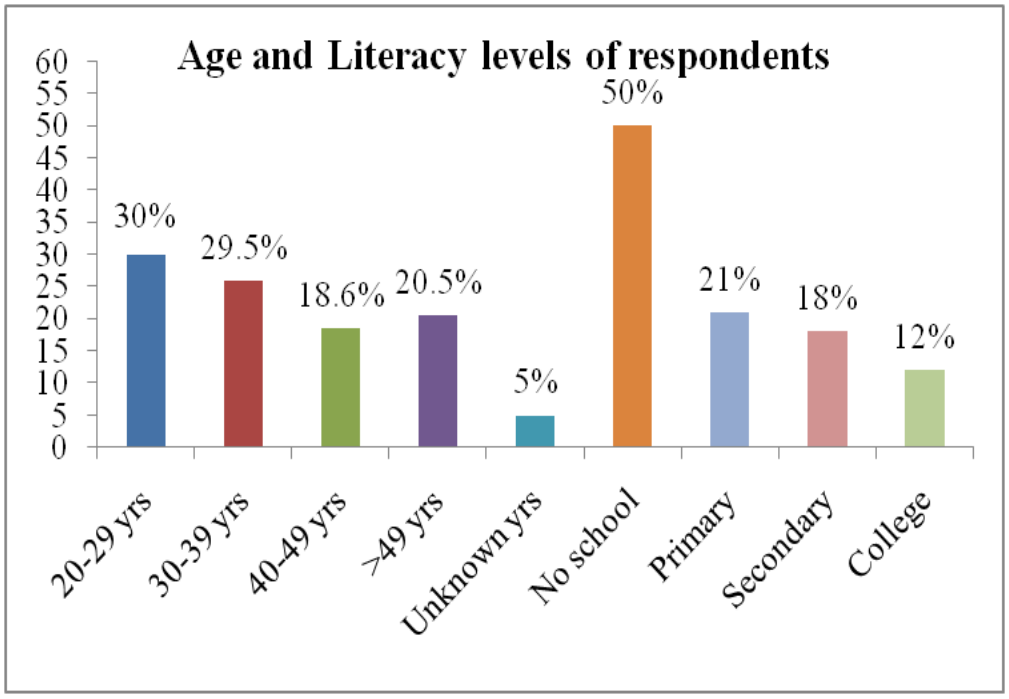
Appendix 8: Relationship between age of respondents and method used to kill wildlife

			Which action do you take against wildlife that kills livestock					
			trapping	poisoning	spearing	no action	poisoning and spearing	Total
age of respondent	*20-29*	Count	1	4	18	5	1	29
		% within age of respondent	3.4%	13.8%	62.1%	17.2%	3.4%	100.0%
	30-39	Count	2	5	6	4	7	24
		% within age of respondent	8.3%	20.8%	25.0%	16.7%	29.2%	100.0%
	40-49	Count	0	2	3	6	6	17
		% within age of respondent	.0%	11.8%	17.6%	35.3%	35.3%	100.0%
	above 49	Count	4	10	3	3	3	23
		% within age of respondent	17.4%	43.5%	13.0%	13.0%	13.0%	100.0%

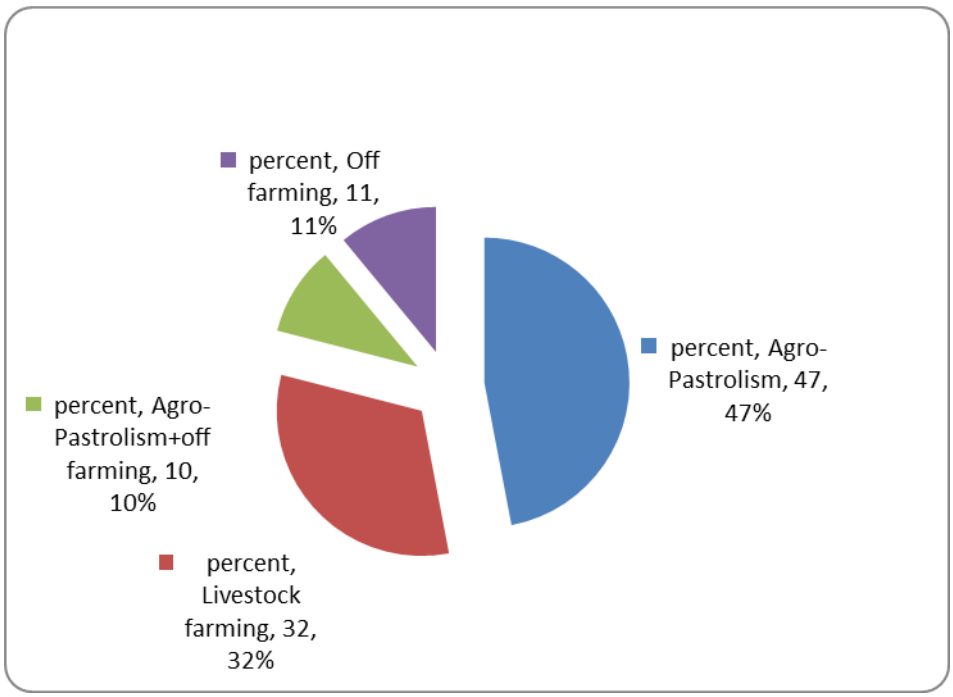
Appendix 9: Gender and Employment profiles of respondents



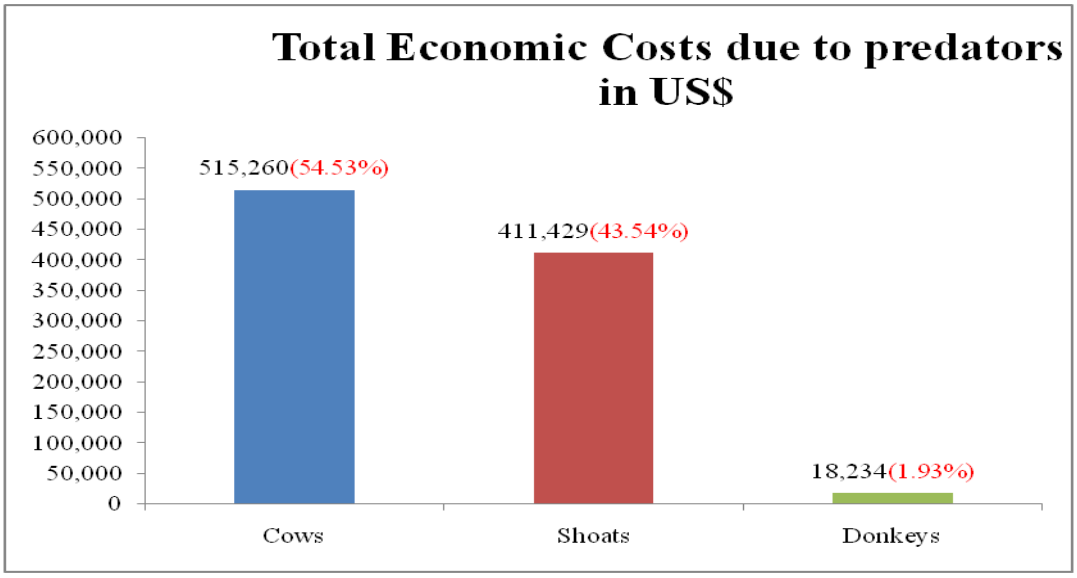
Appendix 10: Age and Literacy levels of respondents



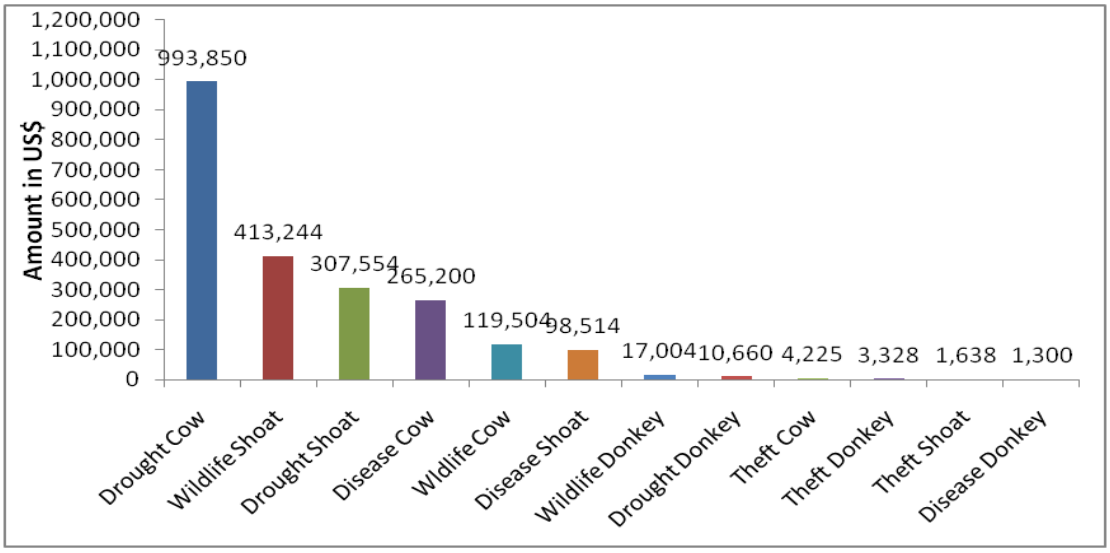
Appendix 11: Economic activities practiced by respondents



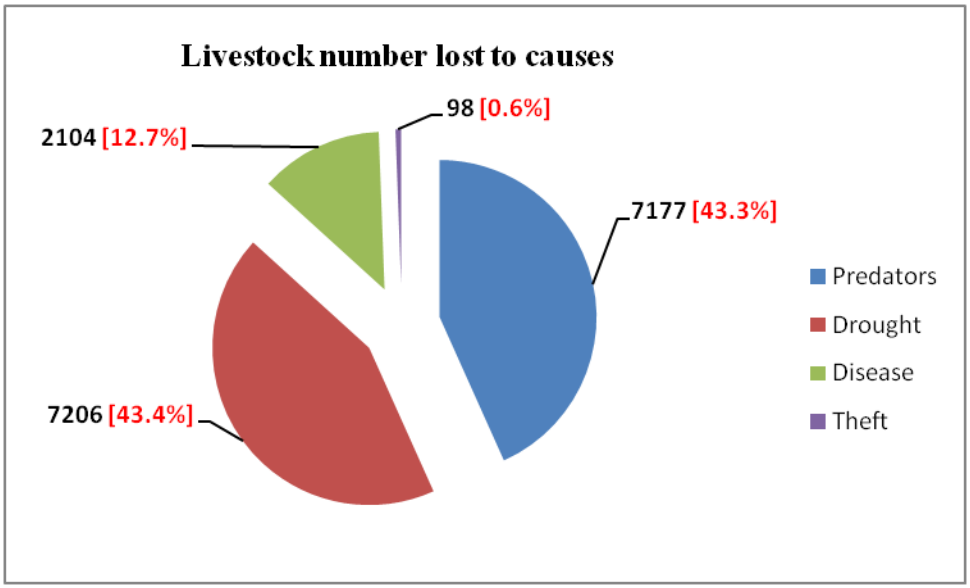
Appendix 12: Total economic losses of livestock



Appendix 13: Economic losses of livestock due to different causes



Appendix 14: Numbers of livestock lost to various causes



Appendix 15. Percentage of livestock lost to total livestock kept

	LIVESTOCK LOST AS A PERCENTAGE OF TOTAL LIVESTOCK KEPT				
ANIMAL	**DROUGHT**	**WILDLIFE**	**DISEASES**	**THEFT**	**TOTALS**
SHOAT	12.05%	16.18%	3.86%	0.06%	**32%**
CATTLE	17.37%	8.80%	4.63%	0.07%	**31%**
DONKEYS	14.14%	22.76%	1.72%	4.40%	**43%**
TOTALS	**43.56%**	**47.74%**	**10.21%**	**4.53%**	

Appendix 16. Economic losses from various causes of livestock mortality

	ECONOMIC COSTS INCURRED ON LIVESTOCK [US$]				
ANIMAL	**DROUGHT**	**WILDLIFE**	**DISEASES**	**THEFT**	**TOTALS**
SHOAT	$ 307,554.00	$ 413,166.00	$ 98,514.00	$ 1,638.00	**$ 820,872.00**
CATTLE	$ 993,850.00	$ 503,750.00	$ 265,200.00	$ 4,225.00	**$ 1,767,025.00**
DONKEYS	$ 10,660.00	$ 17,160.00	$ 1,300.00	$ 3,328.00	**$ 32,448.00**
TOTALS	**$ 1,312,064.00**	**$ 934,076.00**	**$ 365,014.00**	**$ 9,191.00**	**$ 2,620,345.00**