THE ECONOMIC COST OF WILDLIFE DEPREDATION ON LIVESTOCK AROUND MELAKO WILDLIFE CONSERVANCY IN MARSABIT COUNTY, KENYA

BY

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DECLARATION

DECLARATION BY CANDIDATE

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DEDICATION

This work is dedicated to my wife Florence, daughters Stezy and Reena Narisha, sons Jesse and Brian Narisha, parents and brothers.

ABSTRACT

Human-carnivore conflict is a serious management issue often causing opposition towards conservation efforts. This study was conducted in Melako Conservancy in Laisamis District in Marsabit County of Kenya between October 2009 and June 2010. The study aimed at determining the economic value of livestock lost to wild carnivores. Specific objectives were to assess whether predation is a significant cause of livestock losses, evaluate the cost of livestock losses to wild carnivores, rank the predators based on their predatory damage, determine factors that influence livestock predation in the study area and assess the strategies used by the local residents in deterring/reducing depredation. A sample of 200 respondents was randomly selected from a target population of 10,297 (2626 households) people living in areas surrounding the conservancy. The locations were clustered and a sample proportional to the population in each cluster based on households selected randomly. Data was collected using questionnaires, focus group discussions and field observations. Direct field observation was used to determine and validate cases of predation. The marginal cost approach was used to determine the cost of livestock killed by predators, and the cost of predation ascertained by looking at the average total value of stock lost to each predator per year. The figures obtained were compared with the local area's per capita income. Anova was used to determine the significant difference between variables while the post hoc tukey test was used to calculate the mean difference in the number of livestock killed by each predator and by mortality type per household per year. Pearson correlation was used to determine whether the number of livestock killed per attack is dependent on the herd size while the Chi- square Goodness of Fit test was used to determine whether there is a significant difference in the number of livestock killed per attack in relation to herders' age and period of the day. The total number of livestock lost annually per household was significantly different among different causes of mortality within Melako Conservancy ($F = 118.7$, $df = 3$, $p < 0.001$). The costs for different causes of losses to livestock in the Conservancy was also significantly different ($F = 72.78$, $df = 3$, $p < 0.001$). The average total value of each type of stock lost annually to predation at an exchange rate of KES 84 per dollar was KES 17,417.02 representing a loss per household of KES 47.72 per day. This when compared to the local area's per capita income of KES 135 represents 35.3% of the per capita indicating a significant loss that depredation contributes to losses incurred by communities surrounding the Conservancy. There was also a significant difference in predation damage among different carnivores with the hyena killing most livestock ($F = 69.96$, $df = 5$, $P < 0.001$). The number of livestock killed was independent of time of the day ($\chi^2 = 0.25$, $df = 1$, $p > 0.05$) and herders' age ($\chi^2 = 1.158$, $df = 2$, $p > 0.05$), but insignificantly positively related to herd size ($r_s = 0.204$, $df = 61$, $p = 0.109$). There was no significant difference in the strategies used by the local community to deter predators ($\chi^2 = 81.6$, $df = 4$, $p > 0.05$). Melako Conservancy has diverse carnivores that require conservation attention to enhance their survival in its ranges. However, if the constant attacks on livestock are not mitigated, their future existence might be bleak. To enable the local community tolerate wildlife and in particular carnivores due to losses resulting from their attacks, compensation is necessary.

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LIST OF ACRONYMS AND SYMBOLS

DDP	District Development Plan
KES	Kenya Shillings
KWS	Kenya Wildlife Service
LMD	Livestock Management Department
NES	National Environmental Secretariat
NRT	Northern Rangeland Trust
SOK	Survey of Kenya
USD	United State Dollars

DEFINITION OF OPERATIONAL TERMS

Average Cost	The cost incurred by livestock farmers to protect their livestock from predators and veterinary cost of treating injured livestock.
Carnivore	An animal whose diet wholly or largely consists of animal matter and is a member of mammalian order *carnivora.*
Cat Species	Members of the order *carnivore, family felidae.*
Depredation	Predatory attack or losses due to predator activities.
Economic Cost	Average and marginal costs suffered by livestock farmers due to livestock depredation.
Livestock	A farm animal that is utilized for various purposes.
Loss per household	Is the number or cost of livestock lost per household
Marginal Cost	The value of livestock lost to predatory attacks by wildlife.
Percentage of the total losses	Is the number killed/lost to each predator/mortality type divided by the total killed or lost multiplied by 100%
.**Predation**	Is an interaction between species in which one species uses another species as food.
Total Annual Predation	Is the total cost and/ or the number of livestock killed by predators per year.
Total Annual losses	Is the total number and or cost of livestock lost to different mortality type per year.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Kenya's wildlife resources are economically important and represent a major source of employment and foreign exchange. Numerous people benefit directly and indirectly from the wildlife resources. Tour and hotel operators, tourists, scientists and commercial game ranchers are the principal beneficiaries of wildlife resources and their associated activities (Aboud, 1989; Burrow *et al*., 1993). It is estimated that wildlife related activities generate 25% of Kenya's per capita income and tourism has been identified as one of the principal drivers of vision 2030 (Government of Kenya, 2007). Despite this enormous contribution to the national economy, human-wildlife conflicts around conservation areas continue to impart substantial losses to the people leaving adjacent to such areas to the extent that this has jeopardized conservation efforts and diminished benefits that accrue from wildlife and related activities.

Human-wildlife conflicts can be described as any disagreements or contentions relating to destruction, loss of life or property, and interference with rights of individuals or groups that are attributed directly to wild animals (Waithaka, 1995). Human-wildlife conflict is real and practically experienced in all districts in Kenya (Kenya Wildlife Service, 1994). However, the conflict is most intense when agriculture is involved, particularly where cropland borders forested national parks and reserves and in pockets of agriculture surrounded by range lands.

Many rural communities in Kenya still hold the view that under the current law and management policy, wildlife is a liability imposed upon land owners. Hence, the enormous losses, costs and fear caused by wildlife destroying property and killing humans are the primary sources of conflict. For instance, loss of income from human death and injury by wildlife is usually devastating to families, and material losses often cause unbearable financial suffering, particularly when financial loans are involved.

Serious human-wildlife conflicts coupled with the violation of the integrity of wildlife reserves continue unabated in many parts of the world, with predation of livestock by carnivores being among the most common and major form of wildlife-human conflict. Many forms of conflicts have been documented among them wildlife destroying crops, feeding on livestock and attacks on humans resulting in serious injuries or deaths. Local communities therefore, view wildlife parks and reserves with hostility, perhaps because issues of human-wildlife conflict do not seem to be adequately addressed (Aboud, 1989).

Oli *et al*. (1994) contended that in Nepal although snow leopards (*Pathera unca* Schreber) killed between 2.6% and 5.1% of total livestock, but the economic value of the losses to affected households represented a quarter of the average per capita income. Jackson (1991) reported that although snow leopard predation on livestock in Tibett was insignificant relative to livestock holdings (1.2%), the losses incurred equivalent to 26 US dollars per household were significant compared to their per capita incomes.

Studies from African countries have shown that although livestock losses to wild predators are often negligible relative to total livestock holdings (Rudnai, 1979; Meshane and Grettenberger, 1984), economic losses incurred by livestock farmers cannot be underrated. However, it is estimated that natural mortality is often a more serious cause of losses than predation. For instance in Zimbabwe, Rasmussen (1996) reported that African wild dogs (*Lycaon pictus* Temminck), spotted hyena (*Crocuta crocuta* Eryleben) and leopard (*Panthera pardus* Linnaeus) together accounted for only 0.4% of cattle losses on ranches relative to the total herd size while diseases accounted for 2.2% and the rest(97.4) as result of drought. Likewise, findings of a study conducted by Mizutani (1993) on a ranch in Laikipia in Kenya revealed that wild carnivores killed only 2% and 0.8% of total sheep (*Ovis aries* Linnaeus) and cattle (*Bos indicus*) respectively while diseases killed 7.8% and 2.2% respectively.

From the foregoing results, it can be inferred that while losses due to livestock predation may look insignificant, but the cost involved in monetary terms cannot be underestimated. Hence, this study aimed at determining factors predisposing livestock to

predation, predators involved and quantifying the economic cost of wildlife depredation on livestock in Melako Conservancy in Kenya, with a view of proposing novel strategies that can minimize this.

1.2 Problem Statement

Melako Community Conservancy has in recent years greatly suffered from livestock depredation by carnivores. Despite this, there is no scheme currently in operation to offset these losses or strategies to harness the confidence of the people to appreciate wildlife and tolerate the losses. Although a lot of livestock in the Conservancy has been lost to carnivores, the economic value of this loss has not been quantified. Studies on the economic value of livestock losses to wild carnivores in other countries have also been few. However, those that exist indicate that although relatively few animals are taken, the cumulative costs incurred per household are significant.

1.3 Objectives of the study

The main objective of the study was to assess the economic cost of predation of livestock by carnivores. Specific objectives were;

i. To determine whether depredation is a significant cause of livestock loss in Melako Conservancy.
ii. To evaluate the cost of livestock losses to wild carnivores.
iii. To determine whether different carnivores differed in their predatory damage to livestock.
iv. To determine the factors that influence livestock depredation in the study area.
v. To assess the strategies used by the local communities in deterring/reducing depredation.

1.4 Study Hypotheses

H_0: Depredation is not a significant cause of livestock losses in Melako Conservancy.

H_0: The cost of livestock depredation is not significant

H_0: All carnivores cause equal predatory damage to livestock.

H_0: Predation on livestock by carnivores is not influenced by time, herd size and herder's age.

H_0: There is no significance difference in strategies used by local communities to deter predators

1.5 Justification and significance of the study

Predation prevalence has been on the increase in Melako Conservancy. Livestock owners have been losing a large number of livestock through predation yet it is their single source of livelihood. Because of this perennial problem, this research was conducted with the aim of assessing the economic value of livestock lost through predation by carnivores and natural mortality. Specifically the study aimed at generating information to guide conservationists, planners, managers and policy makers on making informed decisions to guide the management of the conservancy, conservation of wildlife particularly the carnivores, and mitigate human- wildlife conflicts. Findings of this study will guide the Conservancy managers in implementing novel and innovative measures that will enhance local support for and involvement in wildlife conservation. Results will also guide researchers and other people keen on undertaking similar studies. The thesis will be a reference for students and academicians with a keen interest in the study topic.

1.6 Study limitations

The study was limited to the determination of the marginal cost (value of livestock killed) in Melako Conservancy. It was also difficult to obtain information on veterinary costs because majority of the pastoralists depend on un-costed ethno-veterinary products, knowledge and skills.

CHAPTER TWO

LITERATURE REVIEW

2.1 Predator type and influence on predation

Species of the cat family differ in their selection of livestock prey and mode of predation. For example, on a ranch in Brazil, Pumas killed mainly calves and sheep while Jaguar killed 33% calves, 57% cows and 10% oxen and bulls (Crawshaw and Quingley, 1991). Mizutani (1993) examined predation by lions, leopards and cheetah on a mixed livestock ranch in the Kenyan highlands. The findings of this study showed that one leopard climbed into the new-born calf enclosure to take calves, at an average of one calf per month. Leopards also killed stray animals left outside fenced enclosures at night. On the other hand, lions roared outside the fenced enclosure holding cows and steers, causing the animals to panic and sometimes break through the fence resulting to too many kills. Cheetahs took sheep rather than cattle, attacking during the day when they were spread out grazing. All the three cats together took 1% of the ranch's total stock on an annual basis. From the above studies, it can be inferred that different carnivores have preference for different livestock, and their mode of predation also differs.

Large bodied carnivores like lions, with extensive home ranges, often utilize a mosaic of patch types in their search for prey. Human interference alters the fluidity of this movement from one habitat type to another, by fragmenting the landscape with roads, grazing land, and timber deforestation (Woodroffe, 2001; Woodroffe and Ginsberg, 1998). Hunting, poaching, and feral dogs are also detrimental to endemic carnivore populations (Butler *et al*., 2004; Butler, 1998; Jhala, 2003; Seidensticker *et al*. 1990). Non-anthropogenic interactions, including intraguild predation and competition, create additional negative interactions (Creel and Creel 1996, Creel 2001, Creel *et al*., 2001, Johnsingh and Nigli, 2003; Seidensticker *et al*. 1990; Vucetich and Creel, 1999). As a result, a disparity between what is perceived as continuous and optimal, foraging habitat, and what is accessible and available for utilization occurs (Creel and Creel, 1996;

Garshelis, 2000; Johnsingh and Nigli, 2003). These factors in essence have an influence on how different predators kill their prey.

Ogada *et al.* (2003) reported that 75% of the kill of domestic stock occurred at night when livestock were in night corrals while 25% occurred during the day. Further, they allude that lions were most serious predators of cattle in kraals (bomas) and in the field. Lions also killed the largest number of sheep and goats in kraals (bomas) while the cheetah killed a larger number in the field. Cheetahs made no attack in kraal (bomas). They also contend that herd size did not determine the number of livestock killed. From these findings it can be inferred that although the time of the day and place where livestock were preyed upon varied, lions killed the largest number of livestock.

2.2 Economic cost of predation on livestock by carnivores

Studies on the economic cost of predation have shown that while the economic impact of livestock predation can be significant even for larger commercialized ranches in developing countries, the loss of just a few domestic animals can be a major economic setback for a peasant family. For example, Oli *et al.* (1994) surveyed the effect of snow leopard in villages in Nepal's Manang District, situated within the Annapurna Conservation Area, the largest reserve in Nepal. Results of this study revealed that 72 animals were lost to the snow leopard between 1989-1990 representing 2.6% of the livestock held by the households. In monetary terms the total loss value was equivalent to US Dollar 3,866 which represents an average household loss of 0.7 animals valued at about US Dollar 38. This is a substantial amount for local people in a country where average rural annual income is just US dollar 122 (Oli, 1994), and among the lowest in the world. Some households were however more affected than others.

Similarly, in another different but related study conducted in 29 villages in Bushman land province in Namibia, an underdeveloped area with rudimentary cattle raising, and an average stock holding of 16 cattle and 2 horses per square kilometer between 1992-1993, it was reported that lions killed livestock on nine occasions taking eight cattle which represented 1.7% of the total number kept in eastern Bushmen land and four horses

accounting for 9.3% of the total stock. The affected villages suffered an economic loss of US Dollar 56 (Stander, 1993). However, since the Bushmen have little cash income, and still depend mainly on hunting (20%) and gathering (80%) the loss chiefly represents a setback to efforts to establish a sustainable cattle industry for food supplementation (Annon, 1992). The losses contributed to the desire that lions should be eliminated of 84% of villages surveyed (Stander, 1993).

Against the above background, it can be inferred that livestock predation is a significant problem on a local rather than national or regional level. It causes the greatest amount of economic hardship in poorer, developing regions with few livestock per household. Predation incidents can therefore arouse considerable hostility toward wild cats and wildlife in general. These occurrences are also a setback to efforts aimed at integrating the livestock production, wildlife conservation and tourism industry development.

2.3 Factors influencing livestock depredation

Vulnerability of livestock to predators may be influenced by environmental and socio-ecological factors such as abundance and distribution of natural prey, habitat characteristics and livestock husbandry practices (Kolowski and Holekamp, 2006). In theory, if predation on a given prey species is opportunistic, individual prey should exhibit limited anti predator responses and, thus, have high vulnerability to predation (Fernadez-Juriscie *et al*, 2004)

Inappropriate husbandry practices and wild prey availability and vulnerability are factors reported to influence vulnerability of livestock to predation by jaguars particularly among calves (Quigley and Crawshaw 1992, Hoogesteijn *et al*, 1993, Polisar *et al*, 2003). It has also been reported that proximity to suitable habitats such as forests and permanent water sources would increase overall predation rate. Depredation extent (DE) is described as a function of (Jose and William 2010) DP, M, HT, HA, HS where:-

a. DP is the distance of the kill from the conservation area boundary.
b. M is the month of the year.

c. HT is the habitat type.

d. HA is the herder's age.

e. HS is the herd size.

2.4 Strategies to minimize/reduce livestock depredation

The traditional response to livestock predation has been to eliminate predators in an area. Nowak (1976) documented that government sponsored predator control efforts in western North America were responsible for the death of nearly 67,000 pumas between 1907 and 1978. However, this was found to be rather surprising given historical success in eradicating populations, that more modern attempt has generally failed (Lindzey, 1987). Following this, the complete elimination of pumas from problem regions in New Mexico has been attempted 3 times, two of which were to protect wild sheep. None of these methods resulted in reduction of predation and pumas still existing there today (Evans, 1983).

Currently, management measures to minimize livestock predation take three forms: attempts to eliminate the specific animal causing the damage through reporting to Kenya Wildlife Service Problem Animal management Unit mandated to do the control duties; improved anti-predator and general livestock management; and compensation for livestock loss to predators.

In their study on limiting depredation by African carnivores, Ogada *et al.* (2003) argue that depredation on livestock is, to some extent preventable if livestock were closely herded by day and kept at night in bomas with watchdogs and high levels of human activity. Other factors that enhance predation include the density of predators, the availability of wild prey and behavior of individual predators (Stander, 1991; Linell *et al*., 1999; Thirgood *et al.* 1999). Further, good husbandry may have the dual effects of reducing livestock losses in the short term and, in the long term preventing predators from developing "taste" for killing livestock. Stander (1991), Linell *et al.* (1999) and

Thirgood *et al* (1999), studies indicated that reducing livestock losses in this way should have a conservation benefit by reducing the number of predators killed by farmers.

Husbandry measures that effectively limit depredation on commercial ranches, in particular intensive herding of livestock and existence of bomas with high level of human activity closely resemble the traditional practice of local Maasai and Samburu pastoralists. However, the wire bomas found to be ineffective on commercial ranches are rarely if ever used in pastoralist areas. Further, acacia bomas built on commercial ranches are often of stouter construction than those in pastoralist areas, partly because the personnel in the ranch have access to tractors for hauling branches and small trees. Based on the foregoing, Kruuk (1981) concluded that construction of stouter bomas would help pastoralists in northern Kenya reduce the rate of livestock loss to predators.

2.4.1 Problem animal control measures/strategies

In most cat range states, it is permissible for predators which take livestock to be killed or removed. Regulation varies as to whether the livestock owner himself may take action, or must call upon a government animal control officer to do the killing, and to what degree predation must be verified before elimination of the problem animal is sanctioned. Examples in subsequent sections give an indication of the range of variation.

In India which supports 15% of the world's people, 15% of the world's cattle and 54% of the world's tigers, predation is common news in all parts of the country (Swarkar, 1986), yet the government prohibited the killing of big cats. The only exception, however, is the elimination of a confirmed deliberate man eater. In extreme (and rare) cases of persistent livestock predation, the offending animal may be captured and either translocated to a reserve or given to a zoo.

In Namibia, where Cheetahs are significant problem animals, the land owners are permitted to kill cheetahs in order "to protect life of livestock poultry or other domestic animals when the life of such livestock is actually being threatened". The owner is then

left without having to involve a government problem animal control officers, most whom are usually too few or too busy to respond to all reported predation incidents efficiently (Butler J.R.A, 2000). Another technique used is the placing of traps either lethal or steel jaw traps near livestock areas, but these traps are often indiscriminate and may catch innocent animals.

Mizutani (1993), reports of a case involving experimenting with aversion training by injecting the carcasses of livestock killed by leopards with the nauseating substance lithium chloride. One leopard which killed sheep came back to eat the treated carcass and did not return again to kill livestock. This in essence implies that the nauseating substance kept away the leopard thus reducing the number of kills and deaths that it would have made.

In other cases, rather than eliminate a problem animal, it can be translocated. Translocation has however, met with mixed success (Hamilton, 1976; Seidensticker *et al*. 1976; Mills, 1991; Anderson, 1992). For example, it has been reported that habitual problem animals often return to stock – killing (Robinowitz, 1986; Stander 1990). Stander (1990) reports of cases where occasional raiders were returned to their home ranges within Etosha National Park, with only one of the 12 translocated lions resuming stock raiding. However, in practice, the original home range of a wandering predator will seldom be known.

2.4.2 Improving general anti-predator livestock management

Improving basic livestock management, can empower owners reduce losses from causes other than the big cats, and increase their profitability. Such measures include vaccination of livestock against diseases and improved husbandry measures to increase pregnancy and juvenile survival rates. With specific regard to improving anti-predator management, Johnsingh and Nigli (2003) recommended the following general principles: Proper disposal of livestock carcasses so that, predators do not acquire a taste for livestock Changing from cow-calf to steer operations where losses to big cats are heavy. Guards or guard dogs for day time grazing (or even as the Cheetah Conservation fund of Namibia

has suggested, donkeys or baboons). Controlling birth seasons rather than allowing births to take place randomly; Keeping cows and calves under closer supervision when calves are young and away from areas of thick vegetation or rough terrain where cats may lurk.

Keeping, rather than selling or trading, experienced herd lead animals, so that they can teach appropriately cautious behavior to younger animals. Keeping a few cows or steers with horns in the in calving herd; Rounding up livestock at night into soundly fenced enclosures and posting armed guards with lights; Improving the security of fenced enclosures through better fencing.

Permitting wild prey species to co-exist with domestic livestock; and Fencing off ranch areas which adjoin prime cat habitat or avoiding grazing in such areas. A research by Mara and Laikipia Predator Project have shown that if traditional husbandry techniques of day- time herding and night- time bomas are refined and strengthened, they can be extremely effective against lion attacks (Laurence 1998).

The University of Minnesota conducted a study in early 1999 to determine if any livestock management practices could prevent wolf depredation. The study could find no management practices certain to prevent wolf depredation. The only method proven to prevent wolf depredation was removing the depredating wolves from the farm. However, farmers and ranchers have reported a few practices that may help in some cases. These include:

- Maintaining healthy, well-fed animals. Wolves typically select the weakest and easiest prey. Healthy animals are more difficult to take. Move lame or sick animals to a safe area when possible.
- Using guard animals. Although not always effective, the presence of guard dogs can be a deterrent. When using guard dogs against wolves it is important to use several dogs, as wolves may kill a single animal. Moving and consolidating sheep, as is done in rotational grazing, can help guard dogs be more effective. Keep in mind, however, that rotational grazing is less suitable during lambing as it may disrupt the bond between mother and offspring.

- Moving calving or lambing activities closer to the barnyard. Newborns are easy prey. Some farmers move calving or lambing closer to the barnyard because it allows for more frequent monitoring.

Recent research was unable to find a link between improper carcass disposal and wolf depredation. Regardless of research findings, Board of Animal Health regulations on proper carcass disposal must be followed (University of Minnesota, 1999).

2.4.3 Compensation for livestock losses

Paying compensation for livestock losses is a way of encouraging land owners or local people to tolerate predator presence. In some places compensation is paid by local or national governments, while in other cases it is paid by conservation groups. Compensation can be an effective tool when it is not abused (Oli, 1991).

Paying livestock compensation can be a relatively low-cost way of encouraging livestock owners to tolerate the presence of predators particularly the cats, for even with the most advanced stock husbandry, some losses to predators are likely to occur. Oli (1991) reviewed various management options available to reduce livestock predation by snow leopards in Nepal's Annapurna Conservation Area. He concluded that, a livestock compensation fund locally administered had the best potential to reduce the conflict between local people and snow leopards. He suggested that a snow leopard conservation committee composed of prominent village representatives, an NGO representative (Annapurna Conservation Area Project) and local wildlife authority be formed. It was recommended that it would be up to the committee to develop the details of the scheme including procedure for filling claims and levels of reimbursement, and informs the villagers about it.

Under the Ontario Livestock, Poultry and Honey Bee Protection Act (LPHBPA), livestock and poultry producers are entitled to make claims to their local municipality for livestock losses attributable to attacks by wolves, coyotes or dogs. When the owner of

livestock or poultry believes that they have suffered a loss of livestock due to predation by a coyote, wolf or a stray dog, the owner should immediately notify the valuer for their local municipality. If the producer doesn't know the valuer, he or she can contact the Municipal Clerk. The Clerk, in turn will notify the municipal valuer of the producer's claim. The valuer will then immediately make a full investigation and submit a written report within 10 days to the Municipal Clerk. A copy of the report is also provided to the producer. The valuer's report will give details regarding the extent of the damage to the livestock or poultry and the amount of the compensation claim awarded. The valuer must also state in the report whether or not the livestock or poultry was killed or injured by coyotes, wolves or dogs.

Producers are also responsible for filing an affidavit with the Municipal Clerk within ten days of notifying the clerk or the valuer of the attack on their animals. The affidavit must contain a statement that to the best of the producer's knowledge, the animals in question were killed by a coyote, wolf or stray dog. Where it is determined that the claim is valid, the municipality is not liable to pay more than is required by the regulations under the LPHBPA. Conversely, the municipality may not set the maximum amounts of compensation lower than those established in the regulations. Maximum amounts of compensation $200 per sheep/goat/swine, $1,000 per head of cattle, $500 per horse, $1,000 per year for poultry of one owner, $20 per rabbit, maximum of $1,000 per year, $100 per fur bearing animal, $35 for bees, $75 for hive equipment (Barry, P and Anita O., 2013).

In Kenya, a compensation scheme for loss of livestock and crops existed until 1990 (Frank, 1998). This system was however, never effective in operation and was marred with a lot of cheating on the side of claimants and corruption by government officers. Other factors that undermined the success of this compensation policy include mismanagement of funds, over exaggeration of claims, delays in paying claims and lack of a supportive legislative framework. Therefore it was abolished by the Kenya Government in 1990; however, compensation for livestock losses has since been reinstated in the new wildlife act of 2010 and is now in its formative stages of

constituting Wildlife Compensation Committees. This has brought a sigh of relief to farmers and would likely change the attitude of farmers to wildlife conservation.

2.4.4 Local community mitigation strategies

If wildlife conservation is to be compatible with livestock husbandry, techniques aimed at minimizing carnivore depredation on livestock, especially from lions, leopards and spotted hyenas must be developed (Frank, 1998). From millennia, pastoral peoples in Africa have developed sophisticated husbandry methods to reduce depredation from carnivores. However, there has been remarkably little modern scientific research conducted that seeks to improve these-time honored practices. This contrasted with use of firearms and poison that have been the western world's main solution to the problem of large carnivore depredation. There is therefore urgent need for a more innovative and sophisticated approach to be developed to minimize livestock predation. Other methods employed by communities include fencing using *Acacia sp* or *Commiphora sp*. It was discovered that the stouter the fence the lower the rate of predation. Use of domestic dogs during the day and as night guard to deter predators has also been shown to be effective in reducing the rate of predation by carnivores. Lighting fire around the kraal, use of torches and scare crows has also been used by local communities as mitigation strategies towards preventing predation (Ogada *et al.*, 2003).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

Before the survey was conducted the population size of the division and various locations were determined by visiting locational chiefs and obtain data from them. The data obtained assisted in determining the sample size required by applying a formula as discussed on pages 27 and 28. The household that makes a certain cluster were also determined by counting the number of household. A pretest interviews were done in order to determine whether the research assistance understood the entire question in a questionnaire. The assistants were also briefed on how to select a household to interview and also balancing on gender.

3.2 Study area

3.2.1 Geographical location

Laisamis District is one of the districts of Eastern Province having carved out of the larger Marsabit district. It covers an area of 20265.7 km2 and is situated between longitudes $36^0$40" east and latitude 0^0 15^0 south. The district borders Marsabit district to the east, Turkana district to the west, Chalbi district to the north, Isiolo district to the southeast and Samburu district to the south west (http://www.kenya-information-guide.com/marsabit-county.html, 2015). Administratively the district is divided into three divisions of Laisamis, Korr and Loiyangalani. The district is further subdivided into 10 Location and 29 sublocations

Melako Conservancy is located in Laisamis Sub-county, Marsabit County, Kenya, and is about 500km from Nairobi, and 230 km from Isiolo town (Figure 3.1). Melako conservancy borders Sera and Namunyak wildlife conservancies (Figure 3.2). These Conservancies, together with Shaba and Samburu National Reserves and the adjacent ranches form the Northern range lands covering about 3000 Km^2. This extensive wilderness area straddles the Rift Valley and Eastern Provinces of Kenya, and

incorporates Trust land and Group ranches from three Counties namely Samburu, Marsabit and Isiolo. Being a conservancy integrated land use approach was used where livestock farmers utilize the area for grazing and watering livestock as well as wildlife conservation. This coexistence usually displaces wild prey as result predators resort to predation on livestock and that aggravate human carnivore conflict within the conservancy.

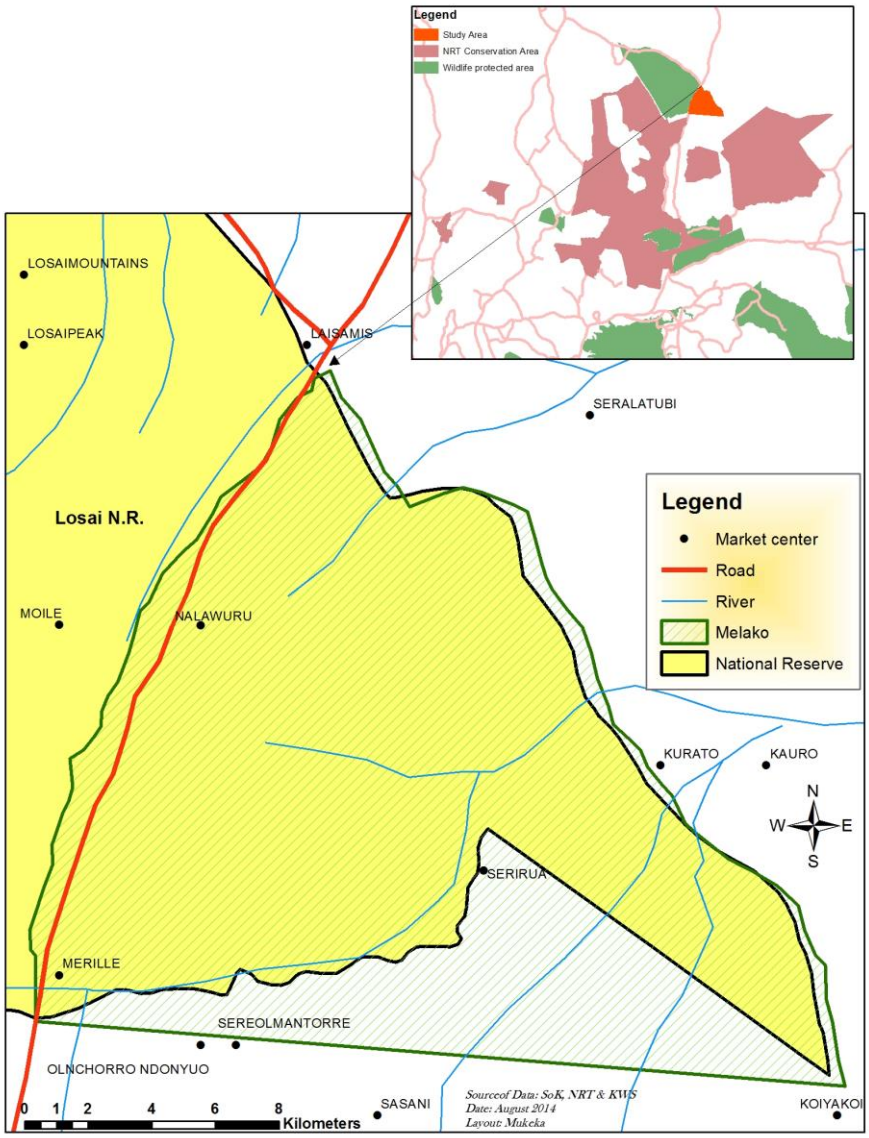

Figure 3.1: Map showing the study area.

(Source: SoK, NRT, KWS, 2014)

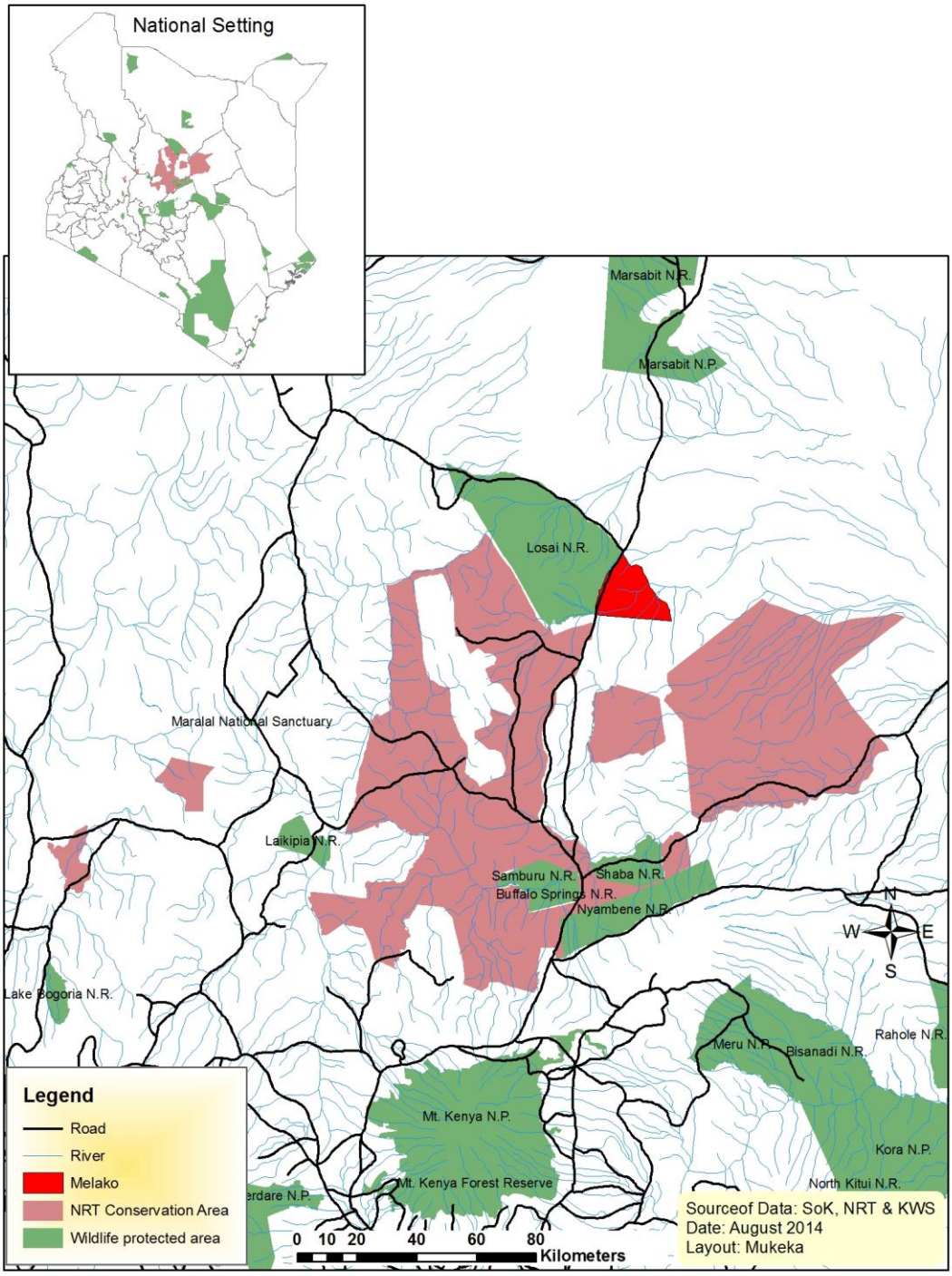

Figure 3.2: Map showing conservancies that make up the Northern Rangeland Trust.

(Source: SoK, NRT, KWS, 2014)

3.2.2 Climate

The rainfall regime is characterized by two rainy seasons, with peaks in April and November. The annual rainfall is between 250mm to 1000mm and the evaporation rate is 2400 to 2600mm per year (Marsabit Weather Report, 2013).

3.2.3 Topography, Geology and Drainage

The main physical feature of the Marsabit County is Mount Kulal (2355 metres) located in Loiyangalani Sub-county. The western part of the Sub-county is flat, whereas further southwards, the topography is often characterized by steep ridges and valleys, occasionally interrupted by hills such as Ndoto and Sori Adi. The major sources of water found in the County are sub surface water resources such as springs, dams and shallow wells which are used for domestic and livestock development. The Sub-county has gazetted forests like Mount Kulal biosphere reserve which covers about 45,729 hectares (Laisamis Sub-county Contingency Plan, 2009).

The County is drained by Melgis River, which also drains Samburu County and flows through Kaisut desert between Marsabit and Lenkiyoi (Mathew Range), Sori Adi floods plains then south east wards until it joins Ewaso Nyiro. Laga Urr river originating from Mathews range drains through Korr and ends up in the flood plains of Halisirwa. The district is drained by other short lagas some only 30 km which end up in the perennial Lake Turkana .Most lagas originate from Mount Kulal and Mount Ngiro in South Horr. The climatic conditions are characterized largely by desert like temperatures where days are very hot with soaring temperatures and cool breezy nights .The hottest areas are low lying plains and plateaus, except for the areas on the slopes like Ngurunit, Oltorut, Ilaut and Nolpilpil.

3.2.4 Soils

The higher parts of Mt. Kulal, Marsabit and Hurri Hills have rich well developed volcanic soils with high water retention capacity. On the lower slopes of the mountains, the soils are basically cambi-soils. In some areas the soils are moderately deep clay

loams, while in others, the soils are stony or rocky. These soils are generally suitable for agriculture and dairy farming in those places with sufficient rainfall. The rest of the district consists of rocky, stony and rugged lava plains and sandy clay loams on alluvial plains and basement rock. The Chalbi area is completely devoid of plant life, due to its salinity, and in some other isolated areas the soils are too acidic to allow the growth of vegetation (Laisamis Sub-county Contingency Plan, 2009).

3.2.5 Establishment of Melako Conservancy

Melako Conservancy was established in 2004 after the Rendille community approached the Lewa Wildlife Conservancy for assistance in developing their own wildlife conservation initiative in order to recognize real development opportunities presented by wildlife conservation and eco-tourism in their area. Melako Conservancy has a total population of 6000 people of Rendille community who inhabit Merille, Lontolio, Laisamis and Koya sub- locations. The overall goal of Melako Conservancy is to develop a successful community conservation initiative with the aim of conserving and increasing viable populations of the Grevy's zebra and other wildlife, and to enhance the capacity of the local Rendille community found in the area to benefit from conservation and sustainable use of natural resources. Although traditionally used by pastoral communities as a seasonal watering point for livestock in times of drought, there has been no permanent settlement in the region, largely due to its isolation and the insecurity of the area. The area has experienced decades of instability from armed gangs poaching wildlife and raiding livestock, and as a result most people are settled closer to towns where they are afforded greater protection (NRT Open Data, 2013).

3.2.6 Flora and Fauna

Melako Conservancy vegetation is composed of thorny *Acacia sp.and Comiphora* bushland trespassed with open grasslands and wide luggas (dry river beds) .Although the study area lies in a remote semi-arid landscape, it has historically supported a wide diversity and abundance of wildlife, including gerenuk (*Litocranius walleri)*, Beisa Oryx (*Oryx gazzela. beisa)*, reticulated giraffe (*Giraffa c. reticulate)*, buffalo (*Cyncerus caffer)*, Grevy's zebra (*Equus gravyii)*, wild dog (*Lycaon pictus)*, hyenas (*Crocuta crocuta and hyena striata)*, lions (*Panthera leo)*, Leopard (*Panthera pardus)*, Cheetah (*Acynoyx*

jubatus) and elephants (*Loxodonta Africana)* among others. Resident populations of wildlife are still found in the area and large numbers of elephants also continue to use the area on a seasonal basis. Melako Conservancy hosts an estimated 200 Grevy's zebra representing approximately 9% of known global population. This population is relatively unknown and under pressure from poaching and competition with livestock. Melako Conservancy is also re-known for enormous flocks of sand grouses that come and water in thousands every morning during the dry season (NRT Open Data, 2013).

3.3 Materials and methods

3.3.1 Research design

The exploratory research design was used to determine the economic cost of depredation, where the economic losses were hypothesized to be as a result of factors like disease, drought, theft and predation. Marginal cost of predation was considered as a total value of livestock lost (goat, sheep, cattle, camel, donkey and any other livestock) to different predators specifically lion, leopard, cheetah, hyena, jackal and any other predators. Predators were ranked based on their predatory damage; the value obtained is then compared with per capita income in order to determine how much does predation contributes to poverty index of people surrounding Melako Conservancy. Other factors contributing to the occurrence of predation among them the herder's age, herd size and when predation or attacks occurred were also studied.

3.3.2 Target population

The survey targeted the local pastoral community living around Melako Conservancy who face the problem of predation. Other people targeted included personnel from Northern Rangeland Trust and Kenya Wildlife Service. In total, the local population targeted was 10,297 people.

3.3.3 Sampling procedures, sample selection and sample size

The study sample was selected from a population of 10,297 people living in the surrounding area of the Conservancy. In total there were 2,626 households in the targeted

area. The conservancy cuts across 4 administrative Locations namely; Laisamis, Koya, Lontolio and Merille. These Locations were designated as clusters, and in each cluster the number of households to be interviewed was chosen in proportion to the population size

A total of 200 people were selected randomly and interviewed. Only one individual per household was selected. Target persons were mainly household heads or their Adults aged 18 years and above, while the herders interviewed while grazing were aged at least 17 and above . Households were selected by first determining the number of manyattas making up a particular Location and the target number of households/individuals in a particular manyatta was determined by the number of households in that manyatta divided by total households in the sampled Location multiplied by the sample in that location. Within the manyatta the first house targeted for interview was randomly selected and subsequent ones chosen systematically by skipping the subsequent one (that is 1, 3, 5……). The gender factor was taken into consideration at the time of selection of interviewees. The number of individuals interviewed from Korr location was few because only few of the sampled households fell within designated study area. Table 3.1 shows the distribution of the sampled population

Table 3.1: Distribution of the sampled population

Location	**Sex**		**Population Distribution**		
	Male	**Female**	**Totals**	**Households**	**Sample**
Laisamis	2707	3002	5709	1456	108
Koya	509	205	714	259	14
Lontolio	373	511	884	231	17
Merille	1524	1466	2990	680	57
Korr	1837	2073	3910	837	4
Totals	**6950**	**7257**	**14207**	**3463**	**200**

Source: 1) Laismis population data, 2009

2) Population survey data Kenya Bereau of Statistics, 2009

The Formula applied to determine sample size is (SS) = $Z^2 \times (P) \times (P-1)/C^2$.

Where: SS is sample size

Z is Value of confidence level of 95% which is proportional to 1.96

P is percentage population picking a choice express in decimals

(Estimated population size) in my case 60%

C is confidence intervals expressed in decimals in my case 0.06

3.3.4 Data collection

The study was conducted from October 2009 to June 2010. This coincided with both the wet and dry periods. The cold dry period ran from June to September 2009 and hot dry period between January to March 2010 while the wet short rainy period was October to December 2009 and long rainy period was between March to May 2010. The wet season in the study area is defined as the period when rainfall occurs with high intensity and generates higher runoff with precipitation of (200mm to 1000mm) while the dry season is the period when the months are more or less dry and is generally characterized by hot, sunny and windy days. Data were collected from 200 households using questionnaires (Appendix 1) and focus group discussions between December 2009 and June 2010. The survey focused on asking respondents to recollect on the livestock losses that occurred from October 2009 and June 2010. Rendille and Samburu languages were used as the mode of communication because they are the most widely spoken languages in the study area. Local economic values of livestock were ascertained from the households, Ministry of Livestock, and Merille Livestock Management Committee. The values were translated to US Dollars at the then exchange rate of 1 US dollar to KES. 84 in the year 2010

To determine troublesome predator(s) and the methods used to keep away these predators, interviews were conducted and respondents were asked to name some of the predators which attacked and killed their livestock and the methods used to keep away the predators.

3.3.4.1 Questionnaire survey

Questionnaires with open and close ended questions (Appendix 1) were issued to heads of sampled households. The questionnaires were which had earlier been pre-tested were administered by the researcher and his assistants. The questionnaires solicited for information on various issues guided by study objectives.

3.3.4.2 Direct observation

Direct field observations and knowledge of predators were used to verify and validate cases of predation. Information on carnivore type, livestock type and the number of livestock killed, habitat type where predation occurred and period of predation, time and size of the animal killed, herd size, and distance from conservation area were all recorded in a data sheet (Appendix 3). A predesigned data recording sheet guided in obtaining the above information.

Carcasses of domestic animals were scrutinized for evidence of hemorrhage, bites and claw marks, and information on the age and sex of the animals recorded. The carcasses were then photographed. Verification of predators responsible for the kill was established by scrutinizing remains of the animal, claws or bite marks on the animal hide, identifying spoors of the predator and blood at the spot of the attack. Further, for each carnivore species respondents were asked about their degrees of certainty in identifying the predator responsible for a particular livestock kill. For every kill identified respondents were to report with certainty the predator causing the kill or death of the livestock. Although occasional mistakes can occur because one carnivore can displace the other from the kill during the survey every effort was made to ensure that most of the carnivore kills were correctly diagnosed and the predator or killer identified.

Plate 3.1 Identification of predators by toe prints (Source: Narisha, 2014)

Plate 3.2: Hyena tracks (Source: Narisha, 2014)

There exists a working relationship between Kenya Wildlife Service game rangers and the Melako Conservancy management committee and scouts, local leaders (chiefs and their assistants, village head men and women group) leaders, based on this relationship the affected individuals within and around the study area were encouraged to give information on predation cases and reports of any livestock predation incidents in the study area to the researcher or field assistants that were recruited from among the local community. The later were based in different parts of the study area.

Data on the number of domestic stock killed were collected by visiting different homesteads and predation sites in the grazing fields within the study area to verify any cases cited. During the visits the number of stock killed, type of predator responsible for

the kills and the distance of the incidence from the protected area boundary was recorded on a monthly basis. Individual livestock owners and respective complainants were also interviewed on the same to validate any information given.

3.3.4.3 Focus Group Discussions

Three focus discussion groups composed of 15 members, each among them 5 females and 10 males selected randomly from the 4 administrative locations within the study area were constituted and discussed issues pertaining to the problem of livestock predation around Melako Conservancy. They were also asked to rank the carnivores based on their severity of their predatory damage. Membership of the groups consisted of opinion leaders, local administrators who included chiefs and their assistants as well as local community members with different education, age, social and occupational backgrounds. During the discussions, participants were encouraged to feel free and give true and accurate information guided by questions in appendix 5. Plate 3.1shows a focus group discussion in session.

Plates 3.3: A Focus Group Discussion Session in Laisamis Location in 2010

(Source : Narisha, 2014)

3.3.5 Data analysis and presentation

The data was transformed using square root (SQRT +3/8) because the data was not normally distributed after the scatter plots were run. This particular transformation is applicable in situations where data is small and/ or when most values are zeros (Zar, 1999). The obtained means were then subtracted by 3/8 to obtain actual means.

The marginal cost (value of livestock killed) was used to determine the direct cost of livestock killed by predators. Average cost was not considered because the socio-economic structure of pastoralists differs from that of commercial ranching since pastoralists do not generally pay others to look after their stock. Consequently, it was difficult to calculate average and marginal costs. Obtaining information on veterinary costs proved difficult since veterinary services are rarely sought as majority of respondent depended on their ethno-veterinary knowledge, skills and natural products for treatment. The cost of depredation was ascertained by looking at the average total value of stock lost to each predator per year. The figure obtained was then compared to the per capita income and what proportion of per capita income it represents.

ANOVA test was used to determine whether predation is a significant cause of livestock losses in Melako Conservancy, whether the cost of predation is significant and whether different predators differed in their predatory damage to livestock. The Tukey post hoc test was used to compare the means on number of livestock lost to different mortality types and predator types. Pearson correlation was used to determine whether the number of livestock killed per attack is dependent on the herd size, Chi- square was used to determine whether there is a relationship or difference between the number killed per attack and herders' age, and period of the day. Descriptive statistics involving frequencies and percentages was used in analyzing general information on the respondents In addition to ranking predators and determine measures used pair wise ranking matrix was used.

This method allows for the comparison of each predator and/or method used to keep predators away with other predators (and or other methods used) thus ensuring that the most troublesome predator and/or most appropriate and widely used prevention measure is selected without bias. Chi- square analysis was also used to determine the attitudes of respondent if compensated for the losses as a result of predation. Data is then presented using tables, graphs and charts.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics of respondents

Responses were received from a total of 200 respondents. Most of the respondents came from Laisamis and Merille locations because of their high population size and also the study area falls under the mainly 4 locations Laisamis, Merille, Koya and Lontolio, therefore they are the ones mostly affected by predation, while the least came from Korr location (2%) because they were not part of target population but were found randomly during the interviews. A slight higher proportion of respondents were males as compared to females. This slight skewedness towards males was as a result of most husbands being heads of families, and traditionally most women virtually refused to be interviewed in the presence of the men.

Most of the respondent interviewed came from Rendille ethnic group because they are the dominant tribe around this Conservancy. Also they are major livestock keepers in this area and thus mostly affected. The age group that were mostly interviewed are in the age category of 21 to 30 years because these is the active age that are looking after the livestock moving with the livestock from one area to the other in search of pasture and water. The age group of 31 to 40 years is the married group whom most of them are livestock owners as well as household heads. These results show that the study sample was composed of people of varied ages and occupations among them herders and livestock owners. Table 4.1 gives a summary of the foregoing results.

Table 4.1: Socio-demographic characteristics of respondents

Variable	Responses	Frequency	Percentage
Residence	Laisamis	108	54
	Merille	57	28.5
	Koya	14	7
	Lontolio	17	8.5
	Korr	4	2
Total		200	100
Gender	Male	108	54
	Female	92	46
Total		200	100
Tribal affiliation	Rendille	181	90.5
	Samburu	19	9.5
Total		200	100
Age	12-20 Years	40	20
	21-30 Years	63	31.5
	31-40 Years	55	27.5
	Above 40 Years	42	21
Total		200	100

4.2 Losses of livestock to different mortality types in Melako Conservancy

The total number of livestock lost annually per household was significantly different among different causes of mortality within Melako Conservancy (F- test=118.7, df= 3, $P<0.001$). Post hoc Tukeys test of mortality type showed that the mean number of livestock lost per household to drought was significantly higher than the rest of mortality types, those lost to diseases were significantly higher than those lost to theft whereas

those lost to predation showed ambiguous results as they were placed in both subset 1 and 2 (Table 4.2).

Table 4.2: Mean number of livestock lost to different mortality types around Conservancy

Mortality Type	N	Subset for alpha = 0.05		
		1	2	3
Theft	1200	2.41		
Predation	1200	4.08	4.08	
Disease	1200		4.31	
Drought	1200			14.49
Sig.		.091	.988	1.000

Drought causes the highest losses to cattle, goats and sheep as compared to other mortality types, however, the three most affected livestock to all mortality types were goats, sheep and cattle. Donkeys and camels were mostly lost due to predation (Figure 4.1).

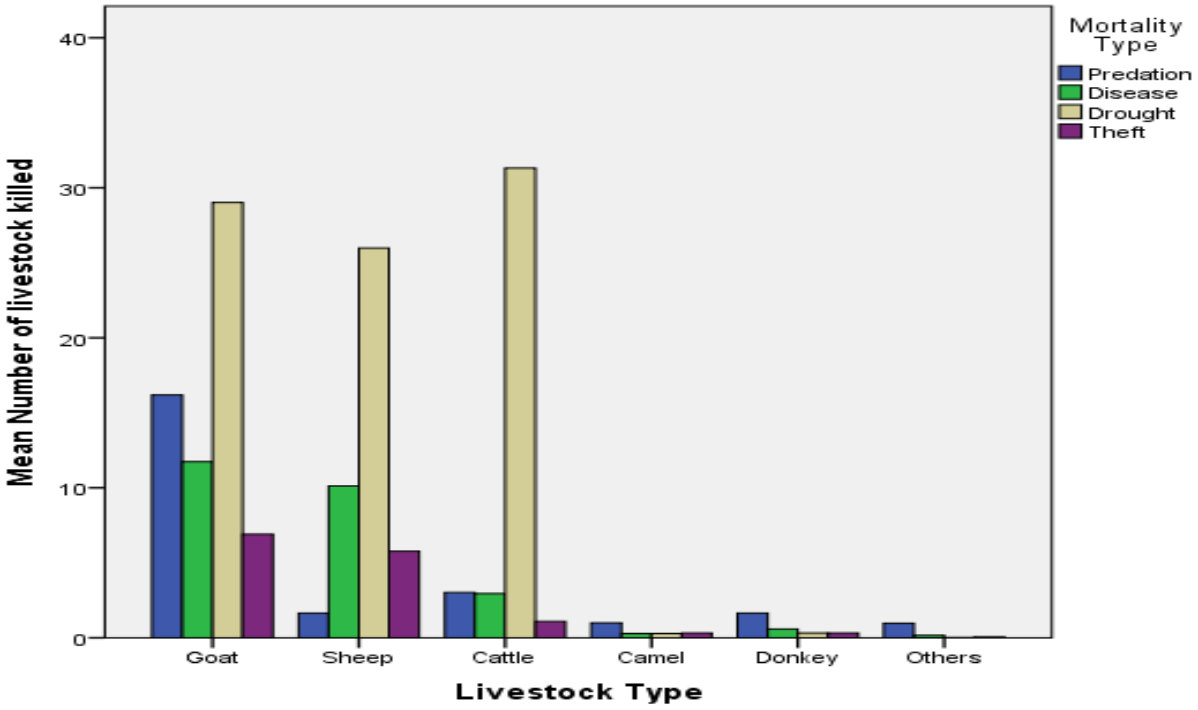

Figure 4.1: Mean annual number of livestock lost to predation, disease, drought and theft per household in Melako Conservancy

The losses for different livestock were significantly different (F- test= 124.02, df= 5, P< 0.001). Post hoc analysis showed that the mean number of other livestock types (chicken and dogs), camel and donkey lost per household in Melako Conservancy were not significantly different from one another but formed the lowest subset. Similarly the mean number of cattle and sheep lost were not significantly different a formed the middle subset. However, the mean number of goats lost as result of all mortality types per household was significantly higher than the rest of livestock types (Table 4.3).

Table 4.3: Mean number of livestock type lost to mortality in Melako Conservancy

Livestock Type	N	Subset for alpha = 0.05		
		1	2	3
Others	800	.30		
Camel	800	.47		
Donkey	800	.72		
Cattle	800		9.59	
Sheep	800		10.88	
Goat	800			15.97
Sig.		.997	.661	1.000

4.3 Cost of losses to all mortality types

Analysis result of the cost of different mortality type showed that there is a significance difference among them F- test= 72.78, df= 3, P< 0.001. Post hoc result showed that the mean cost for theft, disease and predation were not significantly different from one another but for drought the cost was significantly different from the rest of mortality types with drought contributing to the highest mean cost of KSH. 83,653.8 Per household per year around the Conservancy (Table 4.4)

Table 4.4: Mean annual cost for different mortality type per household in Melako Conservancy

Mortality Type	N	Subset for alpha = 0.05	
		1	2
Theft	1200	7468.42	
Disease	1200	14592.92	
Predation	1200	17417.27	
Drought	1200		83653.83
Sig.		.329	1.000

In terms of cost of losses for different mortality type per household per year cost as result of drought was found to higher as compared to all other mortality types (Figure 4.2)

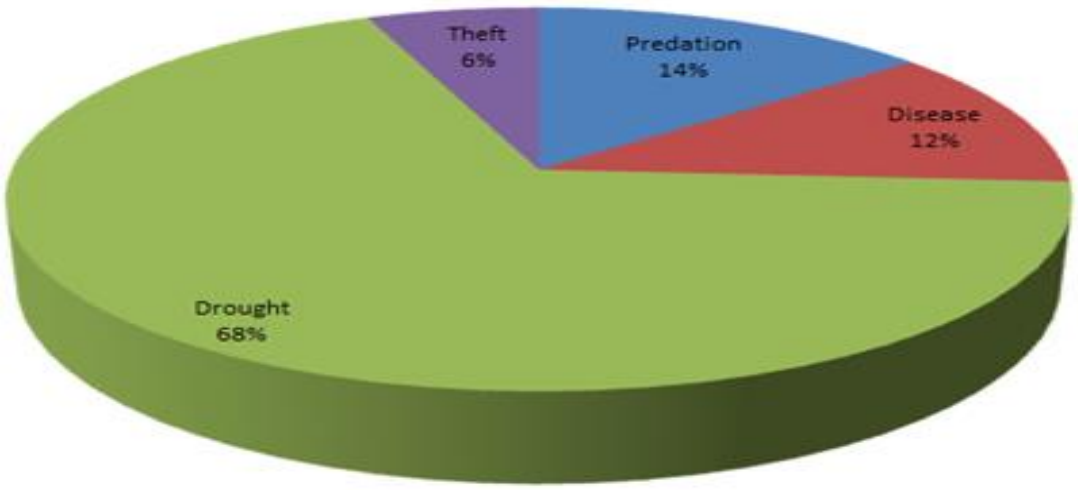

Figure 4.2: Percentage cost of losses per household for each mortality type

Result of the cost of different livestock type lost to all mortality type showed that there were significance different among them (F- test= 82.26, df= 5, P< 0.001). Post hoc

analysis showed that the mean cost of other livestock, camel, donkey and sheep were not significantly different, similarly the mean cost of sheep and goats were not significantly different but cost of cattle losses per household in the conservancy was significantly different from the rest of the cost of losses for different livestock (Table 4.5).

Table 4.5: Mean annual cost of livestock type lost to all mortality type per household in the Conservancy

Livestock Type	N	Subset for alpha = 0.05		
		1	2	3
Others	800	336.09		
Camel	800	5655.00		
Donkey	800	6816.25		
Sheep	800	16862.06	16862.06	
Goat	800		35123.00	
Cattle	800			119906.25
Sig.		.180	.102	1.000

The total losses of different livestock type to mortality type was found to be 184,690.5 (USD 2,198.7) per household annually representing KSH 506.0 per household per day which four times higher than the per capita income (KSH135) of the local residence (Table 4.2) .

Table 4.6: Cost of losses as a result of predation, disease, drought and theft for different livestock type

Livestock Type	**Goat**	**Sheep**	**Cattle**	**Camel**	**Donkeys**	**Other Livestocks**	**Total Cost (Kshs, USD)**
Mean	15.97	10.88	9.59	0.47	0.72	0.3	
Average cost (KSH) from LMD	2200	1550	12500	12000	9500	1125	
Total cost(KES) USD	35134 (418.26)	16864 (200.76)	119875 (1,427.08)	5640 (67.14)	6840 (81.43)	337.5 (4.20)	**184,690.5 (2,198.70)**

Note: one USD converted to KES 84

The livestock that contributes to the highest total cost as result of all mortality type per household in Melako Conservancy is cattle which contributes to 66% of the total cost followed by goat and sheep respectively (Figure 4.3)

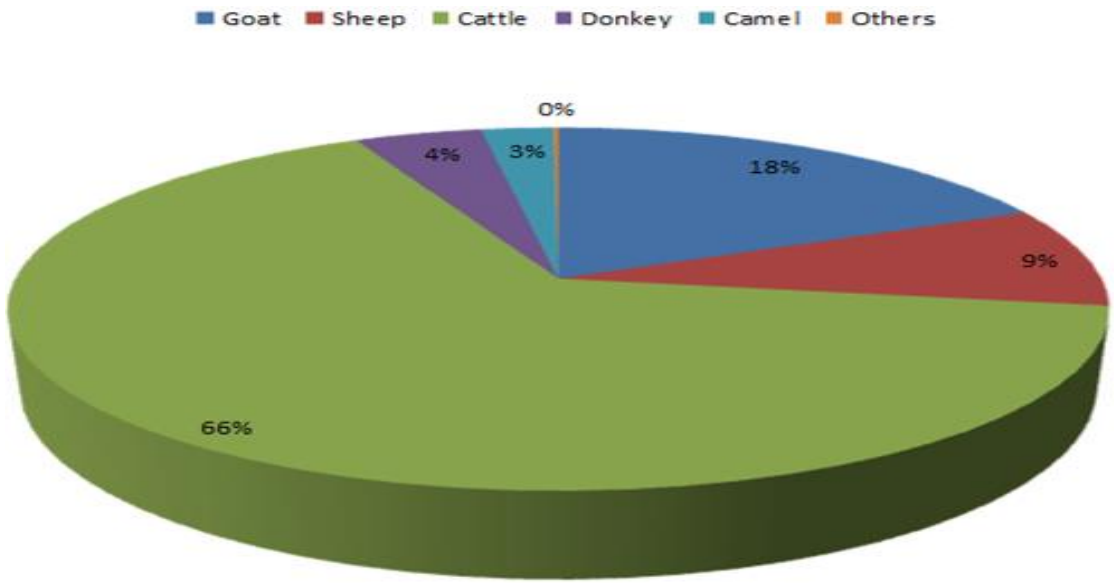

Figure 4.3: Percentage cost of livestock type lost to carnivores in the Conservancy

However, predation alone contributed to KSH 17,417.02 loss annually which represents KSH 47.72 per day per household which translates to 35.3% of per capita (Table 4.4). However in terms of total cost a loss of cattle is greater to livestock farmers because of its high price tag despite few of them being preyed upon (Figure 4.3).

4.4 Losses to predators

Predatory levels for different carnivores on livestock(goat, sheep, camel, cattle, donkey and other livestock) was significantly different (F- test= 69.96, df= 5, $P<0.001$). Post hoc result showed that the mean number of livestock killed by other predators (Wild cat, Mongoose) and Jackal were not significantly different, however, the mean number killed by cheetah were significantly different from the rest of predators. Also the mean number of livestock killed by lion and leopard were not significantly different, similarly the mean number killed by leopard and hyena were not sinificantly different(Table 4.7).

Table 4.7: Mean number of livestock killed by different predators in Melako Conservancy

Predator type	N	Subset for alpha = 0.05			
		1	2	3	4
Other pred	1200	.06			
Jackal	1200	.09			
Cheetah	1200		.61		
Lion	1200			1.23	
Leopard	1200			1.56	1.56
Hyena	1200				1.93
Sig.		1.000	1.000	.123	.060

When the number killed by different predators is compared to the livestock type the result showed that there is a significant difference in the number of different livestock killed (F-test= 130.29, df= 5, P<0.001). Post hoc result showed that the mean number of other livestock(dogs and chicken), camel, donkey and cattle killed are not significantly different from one another, however, the mean number of sheep and goats killed are significantly different from the mean of rest of the livestock killed(Table 4.8)

Table 4.8: Mean number of livestock type killed in Melako conservancy

Livestock type	N	Subset for alpha = 0.05		
		1	2	3
Other liv	1200	.14		
Camel	1200	.17		
Donkey	1200	.27		
Cattle	1200	.50		
Sheep	1200		1.73	
Goat	1200			2.67
Sig.		.062	1.000	1.000

Hyena was found to be the predator responsible for most of the livestock killed in the Conservancy predating in almost all livestock type. Lion has a preference for larger bodied animals like cattle and camel contributing to their losses.Hyena and leopard are responsible for most of the kills of goats and sheep.

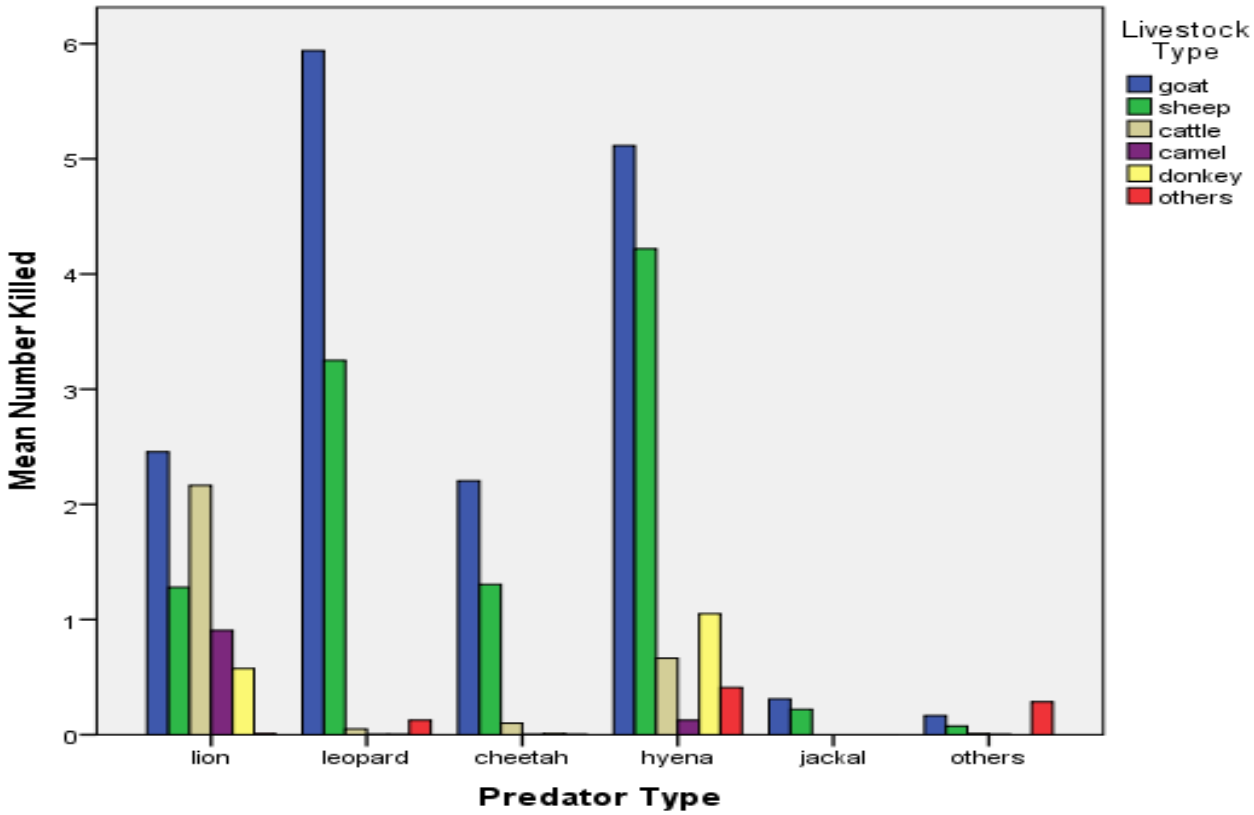

Figure 4.4: Mean livestock lost to predators per household annually

Result of cost by different predators showed that there were significant difference among them (F-test= 119.2, df= 5, P<0.001). Post hock analysis showed that the average cost by other predator types, Jackal and cheetah were not significantly different, but the cost by Leopard, Hyena and lion are significantly different from one another and the rest of predator types (Table 4.9). Lion contribute to 42% of the total predation cost followed by hyena contributing to 34% and leopard 16% with the rest of the predators contributing minimal losses to the livestock farmers in Melako Conservancy.

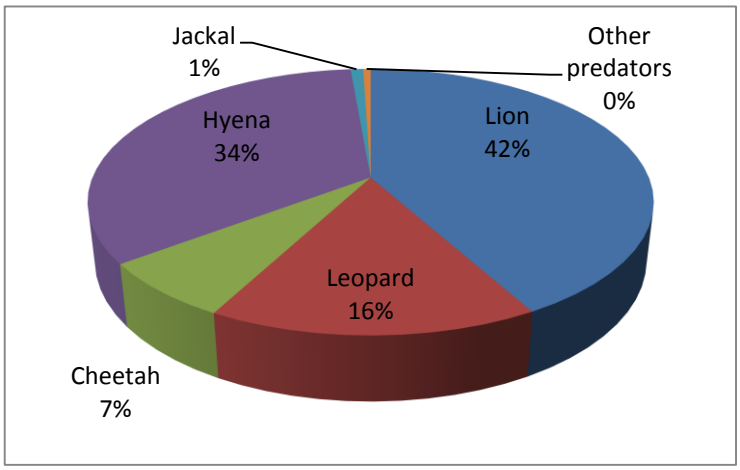

Figure 4.5: Percentage cost of predation by each predator in Melako Conservancy

Table 4.9: Average cost of livestock killed by different predators

Predator type	N	Subset for alpha = 0.05			
		1	2	3	4
Other predators	1200	101.56			
Jackal	1200	170.50			
Cheetah	1200	1382.81			
Leopard	1200		3163.10		
Hyena	1200			6725.88	
Lion	1200				8326.04
Sig.		.052	1.000	1.000	1.000

The cost of livestock type killed by predators results showed that although few cattle a killed there cost to livestock farmers is high compared to other livestock type. The number of goats killed by predators are many which then implies that there cost to livestock farmers were high (Table 4.10).

Table 4.10: Annual cost of losses for livestock to predators in Melako Conservancy

Livestock type	**Goat**	**Sheep**	**Cattle**	**Donkey**	**Camel**	**Other Livestock**	
Mean	2.67	1.73	0.50	0.27	0.17	0.14	
Average cost(KSH)	2200	1550	12500	12000	9500	1125	
Total (KES) USD	5874 (69.9)	2681.5 (31.9)	6250 (74.4)	3240 (38.6)	1615 (19.2)	157.5 (1.9)	**19,818.0 (235.9)**

Note: one USD converted to KES 84

When respondent were ask to rank predators based on their predatory damage hyena and leopard were rank as the most dangerous predators causing severe damage followed by cheetah and lion high damage and jackal causing low damage to livestock farmers (Table: 4.11)

Table 4.11: Ranking of problem carnivores according to their predatory damage to livestock

Problem Carnivores	Total Score	Ranking
Lion	546	4
Leopard	825	5
Cheetah	560	4
Hyena	825	5
Jackal	245	3

5- Severe damage, 2- High damage, 3- Low damage, 2- Occasional damage and 1- No damage

4.5 Number of Livestock killed in relation to time of the day

Out of the 64 incidences of livestock killed in Melako Conservancy during the period of study, 30(47%) attacks were at night and 34(53%) were during the day. Despite this, results showed that there is no relationship between the number of livestock killed and the time when attacks occurred (χ^2 =0.25, df =1, p >0.05).

4.6 Number of Livestock killed in relation to the herd size

The result of the number of livestock killed per attack and herdsize showed that there is an insignificant positive correlation (r_s =0.204, df =61, p =0.109).

4.7 Number of livestock killed in relation to herder's age

Out of 64 livestock killed during the period of study 21(32%) animals were killed while being herded by children, 18(28%) while being herded by adults, and the rest 40% while livestock were in the kraals. Statistical results revealed that there is no relationship between the herder's age and the number of livestock killed per attack (χ^2= 1.158, df =3, p >0.005).

4.8 Strategies used by local communities to deter predators

The result of strategies used by local communities which include, fencing with dense wall acacia or comiphora species of twigs, dogs, scare crow, lighting fire and torches at night and making noises showed that there are no significant differences (χ^2 =81.6, df =4, p>0.05) with more people using fencing as a strategy and less using scare crow because of its in effectiveness. Effectivenes of a particular deterrence means to a particular predator was tested by using pairwise ranking and showed that most predators are sensitive to light and therefore commonly applied to all predators.

Predation of hyena was found to be detered by dense fence because of its in ability to jump. Leopard and cheetah whose attack frequency are during the day have been shown to be sensitive to human noises thus deterring them from attacking livestock. In most of

the times dogs has been used to alert the shephard of the imminent attacks, however, most fierce dogs are usually targets to leopards who usually kill them.

Table 4.12: Strategies used by local community to deter predator attacks

Deterrence used	**Number of respondent**
Fencing with twigs from acacia and comiphora	179
Dogs	120
Scare crow	50
Lighting fire and torches at night	152
Making noise both day and night	100

4.9 Attitudes of respondents towards compensation for livestock losses

An analysis of the attitudes of respondents towards carnivore conservation if compensation for livestock losses is provided for revealed that 44% (n= 200) of the respondents indicated very good, 22%, reported good, 16.5% stated fair, less than 0.5% stated bad and the rest 0.5% were un-decided (Table 4.12). Chi square test results on relationship between the attitudes of the respondents and compensated showed that there is a difference in respondents attitudes when compensation is given (χ^2=155.8, df= 5, $p<0.05$).

Table 4.13: Attitudes of respondents towards conservation of carnivore if compensated for livestock losses

	Compensation		**No Compensation**	
Attitude	**Frequency**	**Percent (%)**	**Frequency**	**Percent (%)**
Very good	88	44	0	0
Good	44	22	0	0
Fair	33	16.5	0	0
Bad	33	16.5	60	30
Very bad	1	0.5	137	68.5
Not decided	1	0.5	3	1.5
Total	**200**	**100**	**200**	**100**

The result of the attitudes in the absence of compensation showed that there is a significance differences in the attitudes of the livestock farmers (χ^2=471, df= 5, $p<0.05$) implying that the attitude is generally very bad and bad when no compensation is availed as shown in the table above.

CHAPTER FIVE

DISCUSSION

5.1 Cost of carnivore predation on livestock

Study results showed that depredation is a significant cause of livestock losses in Melako Conservancy contributing to losses of 35.3% of household per capita income while 65.7% is as a result of other causes of mortality. Annually, each household living in the vicinity of or around Melako Conservancy lost an average of 4 livestock to depredation totaling to a loss of USD 207.3 or KES 17,417.02. However, drought and disease were found to be major causes of losses in the Conservancy accounting for half of the total cost of livestock loss annually. Predation in Melako conservancy is aggravated by the displacement of wild prey as result of people settlements and livestock utilization of the conservancy which therefore leaves the carnivore with no option but killing livestock.

The study also showed that cattle were more prone to drought compared to camel because cattle require more water frequently and when drought strikes, the grass withers leading to scarcity of pasture. On the contrary, camels can browse on twigs and also go without water for a period of three to four months. However, loss of a camel or a cow to depredation is a huge loss for a household and cannot be easily recovered given that there is a lot of cultural attachment to the two. This influences the negative attitudes of the community towards conservation of predators leading to retaliation against problem carnivores through mass killings.

The foregoing findings concur with those of Oli (1994) who conducted a similar study in various villages in Nepal's Manang District that is situated within Annapurna Conservation Area. In this study, Oli reports that between 1989 and 1990 the snow leopard killed 72 livestock representing 2.6% of total livestock held by households and this amounted to a total value of USD 3,866. This loss represented an average household loss of 0.7 animals valued at about USD 38- a substantial amount for the local people in a

country where average income is USD 122. Likewise, Mishara (1997) reports that livestock farmers in the Himalayas lost an average of 12% of livestock per family to the snow leopard and other carnivores. These two examples clearly point to the magnitude of the suffering livestock farmers undergo when part of their stock is preyed on. In a different but related study, Frank (1998) and Mizutani (1993) found that depredation by large carnivores contributes to 20-25% of the total losses which closely compares favorably with the current study where results have shown that depredation by carnivore accounts for 25.3% of the total losses. These observations concur with the responses from the key informants interviewed who reported that predation is a major cause of losses in Melako Conservancy.

Results showed that predation of livestock by carnivores are a serious problem in the study area that needs management intervention. The study found that although the marginal cost of predation per household in Melako Conservancy is KES 47.72 per day, that is KES 17,417.02 per year, there was no existing compensation scheme since Kenya Wildlife Service abolished compensation for property damage because of abuses and the Melako Conservancy has no capacity to compensate for these damages because it is still in its formative stage. However, in the new wildlife act cap 376 of 2010 compensation for property damage by wildlife has been reviewed which is still in its implementation face of constituting Wildlife Compensation Committees that will drive the process.

Compensation for livestock losses is viewed as one way of encouraging landowners and/or local people to tolerate predator presence. In some countries compensation is done by local or national governments while in others it is by conservation organizations. Compensation has also been reported to be a low cost effective tool when not abused. In a study of snow leopard predation in Nepal's Annapurna Conservation Area, Oli (1991) recommends that a livestock compensation fund that is locally administered had the best potential to reduce the conflict between local people and snow leopard.

5.2 Predation levels of different carnivores on livestock in Melako Conservancy

According to the results lions posed the most serious threat preying mostly on cattle and camel whose market prices are high and the loss they caused represents 42% of the total annual marginal cost per household. The hyena attacked almost all the livestock types owned by respondents and the local community in general making it the most dangerous predator and was ranked number one together with the leopard which mostly preyed on sheep and goats during the day. Results from interviews with selected members of the local community revealed that hyena attacked mostly stray livestock. Predation on cattle mostly by lions accounts for KES 2076 per household annually which is a major loss to livestock owners. Hyena endurance predation success is very high while leopard attacks many livestock at one go because it mainly sucks blood from its victims and goes for another kill usually it ensures that all moving livestock are dead before it goes to eat, thus making them the most dangerous predators. Lions have preference for larger sized livestock because of energy cost and benefit maximization factors thereby making lions to attack mostly camel and cattle.

In a study conducted under the Laikipia Predator Project, Laurence (1998) reports that lions were the major threat to cattle contributing to losses amounting to KES 321 per head for individual landholdings and KES 80 per head on group ranches. Findings of the current study however, contradict those by Laurence (1998) which suggested that there were virtually no losses to hyena in pastoral areas since in Melako Conservancy the hyena attacked almost all livestock. Findings of this study also agree with Laurence's (1988) study findings which indicated that the hyena mostly takes stray livestock in the ranches. Likewise, according to the findings of a study conducted on ranches bordering Tsavo East National Park in Kenya, Bruce *et al* (2003) reports that lions were responsible for 86.1% of the total economic losses by wildlife, estimated at USD 8,749 annually. Each adult lion cost the ranchers approximately USD 290 per year in depredation. From these findings it can be inferred that carnivores accounted for significant losses to the households sampled.

Findings further showed that leopards and cheetah preyed generally on goats and sheep while lions and hyenas preyed almost entirely on all types of livestock. These study results concur with those of Carol (1994) on selection by predators who reported that attacks depend on the body size of the prey, with the leopard, cheetah and hyena taking smaller size stocks like goats and sheep which are equivalent to their natural prey like gazelles and impalas, and at times preferred neonates and calves. On the contrary the larger and more social hunters like lions and hyenas attacked both large and small prey at approximately equivalent frequencies (Mizutani, 1993). Current study findings which show that leopards and cheetah preyed on goats and sheep while lions and hyenas preyed on almost all type of stock corroborate with the foregoing findings.

Results from interviews with key informants as well as focus group discussions showed that there are variations in the spatial distribution of carnivores and the mode of selection of their prey. Most people from Lontolio Location blamed the leopard for most of the attacks on their livestock because of the presence of a nearby hill called Kotira which was reported to harbor leopards. Leopards were also reported to be the most notorious predator within Sere Supeni area which is a dry river that is close to Laisamis Location and acts as a refuge to leopards. Lions and hyenas were widely distributed in the study area and attacked livestock in all the four Administrative Locations.

5.3 Factors influencing livestock depredation in the study area

Investigations on the relationship between the number of livestock killed per attack and the period of the day in Melako Conservancy revealed that there is no significant correlation between the two. However, descriptive statistics indicate that higher percentages a killed during the day than the night time. This can be attributed to the high level of vigilance by pastoralists at night while guarding their livestock since livestock is the only source of livelihood as compared to the ranching situation where livestock is guarded by employed watchmen who might lax in performing their duty. Similarly most of the livestock in Melako Conservancy are herded by children during the day and this might have contributed to slight difference in attacks. Despite this, Ogada *et al.,* (2003)

reports that there is a relationship between the numbers of livestock killed and the time, since 75% of the kills reported in his study were at night and 25% during the day.

In relation to herd size, results of this study showed that there was no relationship between the number of livestock killed per attack and herd size, though not significant but higher percentages are killed when the herd is many than when they are few. These findings are contradicts to those study by Ogada *et al.,* (2003) who found out that there was correlation between herd size and the number of livestock killed per attack. This might be due to the fact that the number of livestock killed is dependent on the number of predators present per attack and also the predator type and size. Thus when predators on an attack mission are many, the number of livestock killed is higher and vice versa, and that most large predators were reported to have killed many animals, but the actual cause of death was stampeding, especially when the livestock are within an enclosure.

As indicated in the result chapter, there was a weak no relationship between herder's age and the number of livestock killed per attack. But descriptive statistics indicated that most livestock are killed when they are in the enclosure than when they are herded this is because enclosure creates a barrier while livestock are escaping from the predators. In terms of herders age higher percentages are killed while herded by children than when herded by adults. This implies that, the frequency of losses is high when livestock are herded by children as compared to the times when herded by adults. Children usually engage themselves in some childhood games especially when they are many at the expense of their vigilance thus increasing the number and frequencies of livestock attacks and /or kills.

5.4 Strategies used by local communities to avert or minimize predation

In the current study it was found that pastoralists surrounding Melako Conservancy use various deterrent measures to guard their livestock against predators such as the use of dense wall fences made of acacia species, dogs, scare crows, lighting fire at night, use of torches and making noises at night. The study evaluated the effectiveness of each method for different predators. It was found that fencing with dense twigs from acacia and

comiphora species was mostly effective to all predators because these fences are acting as a barrier between predators and livestock and the denser the fence the secure the livestock are. Lights and use of torches at night discourage most of the predators since most predators are sensitive to lights which therefore make livestock more secure. Gourd dogs deter mostly Hyenas and leopards at night and cheetah during the day.

The problem of predation by carnivores on livestock is not a recent phenomenon. Communities have lived with this problem since time immemorial. Among the strategies listed in addressing problem of predation were fencing bomas, noise, light fire and using scare crows. Fencing bomas using thick and high fences of acacia have shown to lessen the problem of predation compared to the less thick and low fences especially where less thorny Comiphora branches are used. Noises and songs are used as means of averting predation showing that the herders are attentive and predators are less likely to attack.

Lighting bonfires and night human guards are also employed as a strategy in minimizing predation frequencies. In addition, increased vigilance and use of older people as herders are also used, although it has been shown that the frequency of attacks is not dependent on herders' age. Lastly, use of scare crows as well as avoiding grazing areas where carnivores are likely to attack livestock are used. The latter involves avoiding thick vegetated areas which pastoralists do at times set on fire to scare away predators.

According to past results on livestock husbandry in Africa's community rangelands, Rosie Wodrofe *et al.,* (2006) report that the different measures adopted were effective against different predators. However, overall the risk of predators by day was lowest for small herds grazing in open habitats accompanied by herd dogs as well as human herders. At night the risk of herders was lowest for herds held in enclosures (*bomas*) with dense walls, pierced by few openings where both men and domestic dogs were present.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Depredation is a significant cause of livestock losses in Melako Conservancy leading to a total annual loss of KSH 10,410.5 (USD 123.9) representing KSH 28.4 per household per day equivalent to 21.1% of household per capita income.

The most damaging predator is Hyena which on average preys on one livestock per household annually, but in terms of cost to the livestock keepers lion kills mostly larger sized animals whose price tag is high.

Predation of livestock by carnivores in Melako Conservancy is not influenced by herder's age, herd size or Period of the day.

The strategies used by respondent and the local community to deter predation are, fencing livestock holdings (bomas), making noise, lighting fire, use of dogs and use of Scare crow.

6.2 Recommendations

6.2.1 Management and Policy Recommendations

i. A community-based carnivore attacks and sighting reporting strategy using local people should be established to enhance data collection on carnivore distribution, and also give a wider picture of the problem. This strategy will also create employment for the local people.

ii. There is need for a Predator coloring project to be established in the study area in order to determine the seasonal ranges of carnivores. Once the ranges are established the data can be used as an early warning system to help livestock

farmers know about the distribution of carnivores and the level of vigilance required to deter them from livestock attacks.

iii. Compensation for the livestock lost need to be established forming County Wildlife Compensation Committees (Wildlife Act 2003) who will verify the reports on attacks and kills and deliberate on the agreed level of compensation, to minimize conflict.

6.2.2 Recommendations for further research

a. Research should be done on the indirect costs of predation, For example cost of stress levels as a result of attacks, cost of time spent on security among others), in order to establish the accurate cost of living with carnivore in Melako Conservancy. The total cost of predation including both marginal and average costs which can then guide the management on the levels of compensation.
b. Attitudes and perceptions of the community towards carnivores should be researched further.
c. A research on strategies to be adopted in creating awareness on co-existence with wildlife in general and carnivores in particular is recommended.
d. Research more technical predator deterrents

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APPENDICES

APPENDIX I: QUESTIONNAIRE SURVEY

Questionnaire no…….

I am Luka L. Narisha from Moi University, Department of Wildlife Management. I am conducting a research on **"the economic cost of predation of livestock by carnivores in Melako conservancy".** The information you provide in this questionnaire will be treated with outmost confidentiality and used for academic purposes only.

1) Use the table below to indicate information on your area of residence, tribe and gender

Area	**Tribe**	**Sex**
Serolipi		
Merille		
Logologo		
Laisamis		
Korr.		

2) Age a) 12-20 Years b) 21-30 Years

c) 31-40 Years d) 40 and above

3) How many livestock do you have?

Goat……. Cattle……..

Sheep…….. Camels……

Donkeys……

4) Apart from livestock keeping what other sources of income do you have?

Business (specify)…… Farming……..

Salary …….. Others (specify)…….

5) How many livestock have you lost to carnivores from January 2006 to October 2008?

Goat…….. Cattle …….....

Camel……. Sheep…….....

Donkeys…… Others (specify)…….....

5) Of the livestock lost above how many were adults, sub-adults or young?

Livestock	**Adults**	**Sub Adults**	**Young**
Goat			
Sheep			
Camels			
Donkeys			
Cows			
Others (specify)			

6) Apart from livestock losses to predators how many animals have you lost as result of other causes of mortalities between June 2009 to October 2010

Livestock	**Disease**	**Drought**	**Theft**
Goat			
Sheep			
Camels			
Donkeys			
Cows			
Others (specify)			

7) Of the livestock mentioned in question three, how many animals have you lost to these predators indicate in the table below?

LIVESTOCK	LIONS	LEOPARD	CHEETAH	HYENA	JACKAL	OTHERS (SPECIFY)
Goat						
Sheep						
Camels						
Cows						
Donkeys						
Others (specify)						

8) To what degree of certainty is the predator mentioned in the table above responsible for the deaths indicated?

a. 80- 100%
b. 60-79%
c. 0-59%
d. 20-39%
e. Below 20%
f. Not certain/sure

9) How many animals have been lost during the season given below?

a. Wet season
b. Dry season
c. No seasonal trend.
d. I do not know

10) Where were the animals attacked mostly (tick where applicable)

a. While grazing
b. In the kraal
c. Others (specify)
d. When lost/left behind

11) Of the carnivores responsible for livestock predation as listed in question six describe their mode of attack

Carnivore	**While livestock grazing**	**While resting**	**Others (specify)**
Lions			
Cheetah			
Leopard			
Hyena			
Jackal			

12) What time of the day were most animals attacked? (Tick where applicable)

a. Day time b. Night time c. Both day and night time

13) In what types of habitat were most animals attacked?

a. Within the bushes b. On the open plains

c. Watering points d. Others (specify).....

14) How far from conservation area were the animal(s) attacked?

a. Within the conservation b. 500m to 1km away

c. 2km- 20km away d. More than 20km away

15) Among the problem carnivores you have mentioned above, rank them according to the most problem carnivore?

a. Lion b. Leopard

c. Cheetah d. Hyena

e. Jackal f. Others specify).....

16) According to the losses you have experienced when were the animal(s) attacked most

a. When herded by children b. When herded by women

c. When herded by men d. When un-herded

e. Others specify if any …….....

17) What strategies/measures do you use to deter/prevent predation?

a.……

b……

c…….

c……

d……..

e……..

f……..

18) Suppose you are compensated for livestock losses due to predation, what would be your attitude towards carnivores?

a. Very good
b. Good
c. Fair
d. Bad
e. Very bad
f. No decided

APPENDIX II: Livestock Population Data and Price Range for Laisamis Division in 2007 and 2008

LIVESTOCK TYPE	NUMBER	PRICE RANGE IN KSH.
Cattle	33,500	4000 to 21000
Goats	91,781	500 to 3900
Sheep	95,950	600 to 2500
Camels	17,848	6000 to 18000
Donkeys	4,725	7000 to 12000
Bees	180 HIVES	
Poultry	200,000	200 to 500
Dogs	10,650	50 to 1500

Source: 1. Ministry of Livestock, Laisamis District

2. Merille Livestock Marketing Department

Appendix III: Number of Livestock killed in relation to Herd Size

LIVESTOCK TYPE	No. Killed	HERD SIZE
Shoats	2	80
Camel	1	25
Shoats	3	39
Cattle	7	23
Camel	3	20
Shoats	1	210
Shoats	1	90
Shoats	11	72
Shoats	6	170
Shoats	1	30
Shoats	11	200
Shoats	1	100
Shoats	1	180
Cattle	1	20
Shoats	1	230
Cattle	1	40
Camel	1	60
Cattle	1	80
Shoats	1	32
Shoats	1	200
Cattle	1	5
Shoats	1	4
Shoats	3	15

LIVESTOCK TYPE	No. Killed	HERD SIZE
Shoats	8	21
Shoats	4	80
Cattle	1	20
Donkey	4	5
Shoats	2	75
Shoats	10	150
Shoats	20	220
Shoats	2	50
Shoats	15	120
Shoats	1	10
Shoats	1	122
Shoats	1	53
Shoats	1	202
Donkey	1	26
Shoats	1	200
Shoats	1	50
Shoats	2	70
Shoats	1	50
Shoats	1	56
Cattle	1	102
Shoats	1	72
Shoats	5	27
Cattle	3	18
Shoats	3	180
Shoats	2	50

LIVESTOCK TYPE	No. Killed	HERD SIZE
Shoats	3	40
Shoats	3	200
Shoats	1	60
Shoats	11	200
Shoats	2	40
Shoats	2	200
Cattle	2	26
Shoats	2	220
Shoats	3	346
Shoats	1	146
Shoats	1	74
Cattle	1	30
Shoats	80	150
Shoats	7	150
Shoats	59	200
Cattle	6	50
Totals	**337**	**6086**

Appendix IV: Observation Sheet for Livestock Predation by Carnivores in Melako Conservancy between 2008 and 2009

Case Number	Livestock Age	Carnivore Type	Time	Habitat Type	Distance from Protected Area	Distance from Water	Where Attacked	Herders Age

Appendix V: Focus Group Discussion Questions

1. Are carnivores causing any threat to livestock in this place?

2. If yes, name some of the carnivores that mostly prey on livestock in this area

3. Among the carnivores mentioned above rank them according to their predatory damage using the key below (**1- Being the carnivore that causes more damage and 5- being the carnivore that causes lower Damages)**

4. What are some of the strategies that you have put in place to prevent the problem of predation on livestock?

5. Is there any compensation in place for losses incurred?

6. If you are compensated for the losses incurred, what will be your feeling towards conservation of carnivores?