Herding Efficiency as a Factor in the Human-carnivore Conflict in Kenya: A Comparative study of the Laikipa and Mbirikani Group Ranches

By

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ABSTRACT

This study compared herding mechanics of maasai community pastoralists during the dry seasons in Kajiado and Laikipia districts aimed at determining why herders lose livestock in the herding fields that are attacked by predators. The study was conducted on Mbirikani Group Ranch between December 2005 and March 2006 and on Laikipia Group Ranches between August and October 2006 with an overall objective of documenting the role of herding efficiency in the human-carnivore conflict in Kenya and recommend possible ways of reducing it. The two study areas were chosen for comparison because available data showed that there were differences in livestock predation patterns between them and hence the differences and similarities between them gives insights on what constitutes efficient herding practices. Data collection methods used included livestock predation incident verification, interviews and observations in order to validate and triangulate information.

A total of 46 (35 in Mbirikani and 11 in Laikipia) livestock predation incidents were reported and 71 livestock were killed. Due to the presence of experimental compensation programme on Mbirikani Group ranch, all Mbirikani incidents were verified but only three of the Laikipia ones were verified while the rest were not because they were reported much later when evidence was already obliterated. Most of the Mbirikani attacks were of lost livestock by cheetah (*Acinonyx jubatus*) and spotted hyaena (*Crocuta crocuta*) and those of Laikipia were mainly by spotted hyaena breaking into bomas.

111 opportunistically conducted interviews to household heads and herders in herding fields indicated that Laikipia household livestock holding was less that of Mbirikani but the general herding strategies were the same in both areas. Laikipia pastoralists prefer keeping of sheep to other livestock and discipline herders who lose livestock in the herding fields while in Mbirikani herd owners consider losing livestock as normal and do not discipline their herders when they lose livestock.

Herding observations showed that Laikipia herders were efficient in herding their livestock and hence losing livestock was less frequent than in Mbirikani. Their efficiency is attributable to consequences of trespass to private neighbouring ranches, high chances of encountering elephants and disciplinary action from herd owners. Mbirikani herders relaxed more in the herding fields and lost livestock more often because they expected no disciplinary action from herd owners, had unlimited ranging areas, did not count their livestock and returned to boma later than those of Laikipia. A chi square test revealed the differences in arrival time between the two study areas were significant and the t test showed that the ranging distances differences between the areas were also significant with Mbirikani herds ranging distances being more. The late arrival, long ranging distances plus several days Mbirikani herds taken without drinking water was the main cause of their getting lost.

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CHAPTER ONE

INTRODUCTION

1.0 General Introduction

To understand the role of herding efficiency in livestock depredation a comparative study of herding practices was initiated on Mbirikani and Laikipia Group Ranches. The findings of this dissertation research implemented through the Ol Donyo Wuas Trust and the Kilimanjaro Lion Conservation Project in Mbirikani and the Laikipia Predator Project in Laikipia are reported below. This chapter discusses general background and identifies strategies and challenges of pastoralists in sustaining their livelihoods in rangelands. The problem and study justification are stated including research questions, aims and objectives. Chapter two discusses related studies reviewed to identify areas previous researchers focused on. Since the study was aimed at understanding herding mechanics in relation to livestock depredation, herding strategies and associated factors that sustain or threaten pastoralists' livelihoods in rangelands are discussed followed by carnivore interactions with pastoralists and impact of livestock depredation with efforts that have been explored to minimise it. Chapter three focuses on general methodology where access, study areas and all methods used are described with results of the study reported in chapter four. Results are discussed in chapter five and conclusions plus recommendations in chapter six.

1.1 Background

Archaeological evidence suggests that livestock husbandry has been going on in the Eastern African rangelands for over 5000 years (Swift *et al*, 1996). Over this period, pastoralists have evolved herding strategies that enable them cope with unreliable environmental conditions of rangelands. Under current environmental conditions sustainability of pastoral livelihoods are uncertain. In the past, with vast grazing areas and low human population, pastoralists survived climatic changes through nomadic strategies that ensured long-term exploitation of fragile

rangelands. With enough space, human-wildlife conflict was avoided by wildlife moving out of areas that have been occupied by pastoralists and moved back once pastoralists moved out (Western and Gichohi, 1993; Western and Nightingale, 2004).

Currently, fast changing local, national and international socio-economic and environmental conditions put sustainability of rangeland resources at risk. Population growth, urbanisation and agricultural and other land management policies changes have put pressure on pastoralists, forcing them to change their lifestyles (Barrow, 1996; Campbell *et al*, 2005). Indigenous systems that controlled resource management to ensure their sustainability are now disintegrating (Karani, 1994). Resilience, after periods of prolonged environmental stress caused by drought, is no longer assured. Sedentary lifestyles that take over nomadic lifestyles do not allow enough time for ecosystem recovery (Herlocker, 1999; Campbell, *et al*, 2005). Faced with these unpredictable environmental and fast changing socio-economic conditions plus carnivores that have been attacking them and their livestock, pastoralists' livelihoods' sustainability is at risk.

Livestock depredation, disease and drought are challenges that pastoralists have to contend with. Even though some studies show that losses to predation are not significant compared to those to diseases, drought and cattle rustling, losses to predators excite a stronger reaction by pastoralists than other losses (Mizutani *et al*, 2005, Kristjanson et al, 2002; Mwangi, 1996). This over-reaction is commonly attributed to preconceived negative attitudes that might have developed due to the setting up of parks that restrict pastoralists free access to land they have exploited for many centuries (Mwangi, 1996; Karani, 1994). Firstly, grazing areas are reduced by the limitations imposed by wildlife protected areas. The available land is also degraded due to prolonged use that does not allow for resilience. Exclusion of these people from Parks that might have been dry season grazing areas can fan their dislike for carnivores and other wildlife irrespective of harm

caused. Even though most pastoralists detest carnivores, some appear to tolerate them more than others. For example Swift *et al* (1996) states that in south Turkana District, where lions were common, predators were not persecuted because pastoralists avoided conflict by properly corralling livestock and predators were not considered as a serious threat. What led them to develop the habit of carefully protecting their livestock unlike other pastoralists is not understood. Therefore, this comparative study aimed at identifying factors in livestock management among different pastoralist occupied lands that influence human-carnivore conflict, with intent of helping develop sustainable strategies to reduce conflict.

1.2 Problem statement and study justification

Throughout East Africa, large predators are in severe decline because they are being killed to protect livestock. The situation in Kenyan Masailand appears to be particularly acute because lion population has been drastically reduced in just the last few years, apparently due to recent changes in Masai culture which have eroded their former tolerance for predators. On three group ranches east of Amboseli, over 50 lions (11 of them in the first quarter of 2006) are known to have been speared and poisoned in the last two years (Laurence Frank and Seamus Maclennan per. Comm.).

To increase pastoralists' tolerance for carnivores, conservationists have recently set up experimental compensation schemes in areas around Nairobi National Park and in Mbirikani Group Ranch near Amboseli. Even though these compensation schemes have shown a decrease in carnivore killing since they were established, their sustainability is by no means assured because they are expensive and funding must be assured. If funds for compensation become unavailable chances are pastoralists will revert to carnivore killing to ensure minimal livestock losses. Hence a solution that will safeguard sustainable pastoralists' livelihoods and carnivore conservation has to be worked out. This

means, the compensation schemes must be accompanied with a process of strengthening the pastoralists' active participation in carnivore conservation which may enhance their tolerance for carnivores. The starting point of this process is by understanding the strategies the pastoralists have employed to cope with carnivores over the years by documenting their herding practices, livestock predation patterns and predation deterrence.

Where experimental compensation schemes exist, livestock depredation patterns in these areas are now emerging. It has been observed that there is variation in livestock depredation incident trends between Laikipia and Mbirikani Group Ranches (Seamus Maclennan and Laurence Frank per. Comm.). In Laikipia group ranches, depredation takes place at night when livestock have been gathered into their enclosures (bomas) and predators either break-in or panic livestock out (Ogada *et al*, 2003; Laurence per. Comm.). In Mbirikani Group Ranch, the case is different as over 70% of depredation incidents are as a result of livestock getting lost in grazing fields and are attacked at night in the bush (Seamus Maclennan, unpublished data). Why does the Mbirikani Group Ranch livestock unlike that of Laikipia get lost at grazing fields? What are the herding mechanics that make Mbirikani Group Ranch livestock vulnerable to being lost? Very little is known about the process of herding and what factors constitute good herding practice. A comparative study of Mbirikani and Laikipia group ranches herding practices may give insights into herding challenges of pastoralists in Kenya that can be used to develop sustainable livestock-carnivore co-existence strategies.

1.4 Research question

What are the herding mechanics that make livestock more vulnerable to depredation? To answer this question, a comparative study of herding practices was conducted on Mbirikani (December, 2005 to March 2006) and Laikipia (August to October 2006) Group Ranches.

1.5 Aims and Objectives of the Study

This was aimed at understanding the herding mechanics in the study areas, livestock depredation and general livestock husbandry challenges pastoralists face in Kenya. It was thought that understanding the mechanics of herding is essential to understanding the causes of the human-carnivore conflict in Kenya and the data gathered can be used to develop educational activities to enhance sustainable carnivore and pastoralists' coexistence.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Human-carnivore conflict is a long-standing issue that dates back to pre-history (Kerbis and Gnoske, 2001). Therefore, a lot of research has been conducted aimed at understanding and resolving it. These studies range from individual carnivores' ecology and behaviour to their socio-economic values. This chapter reviews some of the research literature consulted with a main focus on pastoralists' herding strategies (section 2.1) to help understand their social organisation, resource management techniques and how they dealt with their environmental challenges to sustain their livelihoods. To determine root causes of human-carnivore conflict, factors that have been identified to influence pastoralists-carnivores interactions and their consequences are reviewed in section 2.2. In order to identify any research gaps in human-carnivore conflict, previous work on efforts to understand and mitigate the interactions' impact are discussed in section 2.3.

2.1 Pastoralists Herding Strategies

Over many centuries, pastoralists have developed and perfected ways and means of exploiting the marginal lands they live on. Their mastery and response to the rhythms of their unstable environmental conditions exemplifies high level human adaptation to the local environment for subsistence without the advantage of modern technology. Pastoralists' social structure and livestock husbandry is organized in such away that ensure sustainability of their livelihood in their resource-poor environment. Their production system is characterized by mobility and flexibility to counter extreme environmental fluctuations and is labour intensive (Herlocker, 1999). They keep many and diverse livestock that serve as social capital, insurance against disaster as well as ensuring optimum range

utilization (Pratt and Gwynne, 1977). Barrow (1996), Herlocker (1999), Swift et al (1996) and Western and Nightingale (2004) give detailed descriptions of pastoralist's herding strategies that ensured sustainable rangeland exploitation while accommodating wildlife. The strategies emphasize:

- Milk production that support more people than meat;
- Maintenance of dry season grazing reserves;
- Mobility;
- Livestock diversity;
- Maximizing stock numbers;
- Herds splitting;
- Retention of animals past their prime age;
- Maintenance of herds with a high proportion of females and
- Social security through stock loans and redistribution.

These strategies enabled pastoralism's survival and maintenance of high biological diversity in rangelands.

Success of pastoralism is mainly attributed to pastoralist's pasture management techniques and the indigenous livestock breeds they keep. These selectively bred livestock are diverse and do better in rangelands than exotics due to their high resistance to most diseases and can survive on less and poorer quality forage. The diverse indigenous livestock are important gene pools for livestock development and these hardy cattle range 27-46 km per day in search of food while sheep and goats (shoats) range 5.7 – 13 km (Western and Nightingale 2004; Herlocker, 1999).

Large numbers of livestock and their high ranging distance require high labour inputs. To meet labour demands, most pastoralists have large families through marriage of several wives and maintain extended family ties that contribute to this. They have a defined division of labour system to ensure every member of family participates in livestock husbandry. During the dry season, when herd splitting increases and household labour is insufficient, pastoralists resort to co-

operative herding in poor families and hiring of herders in wealthy ones (Bekure *et al*, 1991). Bekure *et al* (1991) has a detailed discussion of herding strategies and their challenges in three group ranches in eastern Kajiado District. He states that hiring of herders is a recent development in pastoralist communities and it was not common in Mbirikani Group Ranch where co-operative herding or child borrowing were used to meet required labour. Child labour input in pastoral herding was quite significant with its recruitment starting at a very early age. In the Pokot of Kenya, child herding started at the age of four years (Herlocker, 1999) while in the Maasai of eastern Kajiado District it started at three years and its input was 92% of total herding labour input (Bekure et al 1991; Mbogoh et al 1999).

Exploitation of child labour and co-operative herding not only reduced herding costs but allowed for splitting of flocks and herds into as many categories as possible that enabled movement to exploit distant grazing areas (Bekure, *et al* 1991). Dry cows and other adult livestock that can cover longer distances were taken to temporary bomas by young men while shoats, weak cattle and calves were herded near home by women and children. Thus range degradation was avoided because livestock concentration near permanent settlements was reduced by sending some to distant temporary settlements ("bomas"). Also livestock survival of ravages of severe forage shortage increased with nomadic practices. However, today pastoralists' social organization is disintegrating for a variety of reasons: market economy that was being promoted with introduction of group ranch idea in early 1960's by Kenya government, school taking away child labour, and other socio-economic changes. One result of social change appears to be decline in people's tolerance for wildlife with which they have co-existed for centuries (Campbell *et al*, 2005; Bekure, *et al* 1991).

2.2 Pastoralists' Interactions with Carnivores

By virtue of their occupation of wildlife dispersal areas, pastoralist's interaction with carnivores cannot be avoided. This interaction is normally tense given that

sometimes they incur heavy losses of livestock to predators as well as occasional attacks on human (Frank, *et al*, 2006). However pastoralists influence, both positive and negative, on the ecology of savannah ecosystem cannot be underestimated. The use of fire as a pasture management tool and large livestock numbers influence wild herbivore movement in rangelands as well as their predators. Nomadic lifestyles of pastoralists allow for creation of patchy microhabitats as they selectively burn and cut woodlands to increase pasture for livestock, and once they move these habitats get occupied by wildlife, thus increasing biodiversity in rangelands (Western and Nightingale 2004; Jacobs, 1975; Western and Gichohi, 1993). Swift *et al* (1996) also affirms that even though pastoralism reduces abundance of mega-fauna in rangelands, it creates diverse habitats that increase diversity of micro-fauna. These positive influences are only possible where ideal conditions exist - where low human and livestock populations are maintained and access to large areas of land allowing free movement of pastoralists. However, in reality rapid human population growth, creation of wildlife protected areas (parks) and rapid local, national and international socio-economic changes are working against conditions that can sustain pastoralism and biodiversity. Hence tolerance for wildlife by pastoralists is deteriorating rapidly.

Creation of wildlife conservation areas with restricted access to pastoralists is thought to be main cause of pastoralists' resentment for wildlife. Western and Gichohi (1993) argue that exclusion of pastoralists from parks encourage colonization of non-grazed grasslands by unpalatable woody plants and reduce diversity of herb layers in parks that force wild herbivores out of parks into pastoralists' land neighbouring them where continuous grazing by livestock has maintained palatable pasture. Most wild herbivores spend most of their time outside protected wildlife areas. About 60-80% of Kenyan's wildlife is found in pastoralist occupied wildlife dispersal areas (Kristjanson *et al* 2002; Western and Nightingale 2004; Western and Gichohi, 1993; Norton-Griffiths, 1993). With wild herbivores outside parks, their predators are forced to move out and follow them,

leading to increased contact and conflict with pastoralists. Rudnai (1979) observed the Nairobi National Park lions regularly leaving the park and hunting in Kitengela Conservation Unit due to depressed herbivore numbers resulting in their harassment by pastoralists. Effects of exclusion of pastoralists from wildlife protected areas in relation to predator persecution and pastoralist role in rangeland ecology in Kenya are discussed in Karani (1994), Mwangi (1997), Western and Gichohi, (1993) and Western and Nightingale (2004), but many other factors also contribute to conflict.

Closely related to exclusion of pastoralists from protected areas is inappropriate use of rangelands. Conversion of rangelands into agricultural land not only leads to marginalisation of pastoralists but also reduction of wildlife habitats and land degradation. With more land going to agriculture, encroachment on wildlife habitats increased and hence raised frequency of livestock and carnivore contact. The situation is worsened where changes in land use result in reduction of natural prey of predators, resulting in predators switching to readily available livestock. Karani (1994) reports that during dry season when Masai Mara National Game Reserve migratory wild herbivores moved to Serengeti National Park, livestock became vulnerable to predator attack and livestock depredation was highest in this season. Similarly, during rainy season when wild herbivores are widely dispersed in Nairobi National Park, Rudnai (1979) reported that lion depredation on livestock increased in Kitengela Conservation Unit. Patterson *et al* (2004) also noted a similar trend on Taita and Rukinga Ranches in south-eastern Kenya. Mizutani *et al* (2005) also state that in Marsabit District where wild prey has been almost eradicated, hyaena livestock predation has also increased. In their discussion of man-eating among lions, Kerbis Peterhans and Gnoske (2001) state that prey switching was common in lions during times of natural prey deficiency following natural disasters like disease (Rinderpest) that killed wild herbivores while Kingdon (1977) refers to lions as opportunistic/universal feeders killing more prey than they can eat if prey is an easy target like livestock. McNutt and Boggs (1996) state that conservation of

carnivores can only be sustainable where there is a viable population of wild ungulates prey to sustain them. Thus, conservation of carnivores can only be possible in totally protected areas, or where sustainable environmental conservation promotes and safeguards integrated land use that protects interests of both wildlife and humans. Therefore, habitat encroachment that drastically reduces wild prey can force remaining predators to switch to livestock predation and hence leading to predator resentment by agro-pastoralists who are taking over pure pastoralism that was undertaken in rangelands in the past.

2.3 The Impact of Livestock Predation and Efforts to Minimise it

Kenya's large carnivores have been declining rapidly in most of their former ranges and have been totally eliminated in the heavily settled high agricultural potential areas (Ogada *et al*, 2003). Their decline is mainly linked to habitat loss and livestock depredation. As in other parts of the world livestock depredation is currently a major threat to carnivore conservation in Kenya's rangelands that are inhabited by subsistence pastoralists and large scale commercial ranchers (Rainy and Worden, 2003; Ogada *et al*, 2003; Naughton-Treves *et al*, 2003, McNutt and Boggs, 1996;). Pastoralists appear to be losing tolerance for carnivores as many reports of poisoning and spearing of lions and hyaenas have been common recently (e.g. Daily Nation news paper of June, 23rd and 24th, and July 4th, 2003; Dougherty, 2003; Western and Nightingale, 2004; Kay Holekamp and Laurence Frank per. comm.). Holekamp and Smale (quoted in Mills and Hofer, 1998) witnessed poisoning of 14 spotted hyaenas in June, 1991 around Kenya's Maasai Mara National Reserve. Besides poisoning, spearing of carnivores on sight by farmers has been witnessed elsewhere (Kock *et al*, 1998, Ginsberg and Macdonald, 1990). Hence predator stock raiding poses a great challenge to sustainable conservation of carnivores and has intensified conflicts between conservation agencies and the pastoralists.

While it is argued that mixed wildlife and livestock systems are the best options for rangeland exploitation (Jacobs, 1975; Kristjanson *et al*, 2002; Mizutani, *et al*, 2005; Rainy and Worden, 2003; Ogada *et al*, 2003; Western and Nightingale, 2004), livestock predation can have a devastating effect on pastoralists' livelihoods that can undermine pastoralists' tolerance for predators. For example, Karani (1994) reports 631 livestock kills and injuries from 10 Maasai homesteads within a year while Mwangi (1997) reports a total of 1205 in the same area in eight months. Kock *et al* (1998) also reported sheep worth over 1 million Kenya shillings lost to wild dog predation in Timau near Mt Kenya. Mbogoh *et al* (1999) report livestock predation imposed a significant cost on livestock husbandry in the Kimana and Mbirikani group ranches in 1997 and 1998 with Mbirikani Group Ranch alone losing 717 shoats, 193 cattle and 29 donkeys in the two years. While absolute figures may appear alarming, the proportion of losses to total livestock holding is small. For example in Mbirikani less than 0.01% cattle are lost to lion predation annually compared to 0.69% cattle and 1.40% shoats in a community group ranch in Laikipia (Frank, *et al*, 2006).

Some of the attempts that have been made to enhance pastoralist tolerance by reducing the frequency of their encounters with the carnivores include:

1. Problem animal control,
2. Problem animal translocation and
3. Herding practices that ensure predator deterrence.

Of these, translocation has proved to be least successful. Kock *et al*, 1998 describes how translocation of wild dogs from Timau to Tsavo West National Park failed to deter them from preying on livestock. Hamilton (1980) has a detailed account on how attempts of translocations of livestock raiding leopards and cheetahs from various parts of Kenya was totally unsuccessful and recommended elimination of stock raiding carnivores as the only lasting solution to the problem. While elimination of problem carnivore is considered a better option by wildlife managers, identifying actual "culprit" may be difficult because most predation take place at night and this might lead to an innocent predator

getting killed whenever stock raiding takes place. Therefore, to reduce human-carnivore conflict requires livestock husbandry methods that deter livestock predation in order to prevent carnivores developing a taste for livestock.

Studies in Marsabit (Kruuk, 1980), Laikipia (Ogada *et al*, 2003) and Turkana (Swift *et al*, 1996) districts found out that proper livestock husbandry play a significant role in reducing livestock predation and predator persecution. Swift *et al* (1996) states that in areas where proper corralling of livestock and avoidance of carnivore is observed, persecution of carnivores is minimal. Kruuk (1980) also suggests that due to efficient night time protection of livestock by Marsabit district nomadic pastoralists probably led the lion to change its nocturnal hunting habits to day time livestock raiding. Therefore, developing ways that strengthen the role of pastoralists in ensuring sustainable carnivore conservation in Kenya through efficient livestock herding practices that minimize livestock predation is of enormous importance. Thus in next chapter the methods to determine herding efficiency in the two study sites are described.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

Human-carnivore conflict is a social problem with potential ecological negative consequences and its management puts local communities and wildlife management agencies in conflict. This is a delicate issue manifesting from complex social and ecological interactions that are difficult to quantify. Accordingly, it requires a combination of methods for its assessment. Therefore, this study adopted a methodology leaning more towards a qualitative approach to data gathering than a quantitative one. A qualitative approach is especially useful in policy development and analysis because it uses multiple methods of data gathering in order to expose different subjective perspectives of social issues under investigation to help resolve conflicts (Marshall and Rossman, 1995). Integrating various methods in data gathering is not only likely to expose various perspectives of the issue under investigation but various sources consulted and use of multiple informants can also help validate/triangulate data (Byers, 1996; Bennaars, 1995; Nachmias and Nachmias, 1996; Marshall and Rossman, 1995; Margoluis and Salafasky, 1998; Robson, 2002; Cohen et al, 2000; Wamahiu and Karuga 1995; Nyagah, 1995). Therefore, this study adopted several methods of data gathering and analysis, using both primary and secondary sources of information because herding is a human activity which is socially constructed and can be unpredictable as well as impossible to manipulate for experimental study purposes. The methods used in this study included participant observation, predation incident verification and documentation, interviews and record analysis. In the following sections I provide a brief account of each method used.

3.1 METHODS

This section describes the methods used to collect data beginning with description of the study areas where similarities and differences between them are noted. Then the data collection methods are described including analysis methods and finally the possible biases and limitations arising from the methods.

3.1.0 THE STUDY AREAS

3.1.1 Mbirikani Group Ranch

The Mbirikani Group Ranch is situated in the Amboseli plains Eco-zone of Kenya's Rangelands in eastern Kajiado District. The eastern boundary of the ranch is the Chyulu Hills that run south-east; volcanic uplands form the southern boundary and erosion plains in the western and northern boundaries. Its eastern part lies in the semi-arid zone of Kenya's agro-climatic zones, while the rest of it is in the arid zone (Bekure *et al,* 1991). The ranch has an area of 125,000 hectares (1250 square kilometres) and is the second largest group ranch in the district with a human population of around 10,000 people (Mbogoh, *et al* 1999)

Together with adjacent group ranches (Kuku and Kimana in the south, Olgulului and Selengei in the west and Merueshi in the north), the ranch is one of the most important wildlife dispersal areas for the Amboseli National Park to its west and Chyulu and Tsavo West National Parks to the east. All the large predators (except the African wild dog *Lycaon pictus*) and most of the wild herbivores found in Kenya are present in the ranch

The Ol Donyo Wuas Trust (ODWT) has the ranch divided into seven zones for administrative purposes in implementing its experimental livestock predation compensation programme and general wildlife conservation activities. The herding study was mainly conducted in four temporary/permanent settlements in

three zones (Lenkilorit in zone C, Ol Motoo in zone D and Kona Tatu and Centre - both in zone E) in the hilly section of the ranch where almost all the cattle and shoats (sheep and goats) had moved to due to drought during the study period. This hilly section serves as a dry season grazing reserve for the group ranch. Predation incidents verification covered almost the whole ranch. The livestock studied in Lenkitorit, Ol Motoo and Kona Tatu were mainly managed from temporary settlements ("bomas") in the Chyulu foot hills adjacent to Chyulu Hills National Park or inside the park, while those in Centre were from permanent bomas.

Like other arid and semi-arid areas of Kenya, Mbirikani's climatic conditions are characterized with unpredictable, local scattered and uncertain rainfall and temperatures range from 8ºC to 30ºC (Simiyu, 1999, Bekure *et al*, 1991). In normal years, rainfall is bimodal with first one coming in October to December followed by a dry spell in January and February and then the second rainfall comes in March to May followed by a long dry season lasting from June to early October (Bekure et al, 1991, Mbogoh *et al*, 1999). Rainfall patterns play a significant role in influencing location of settlements and pastoralists' movements within the ranch, as well as distribution of wildlife which depends on availability of pasture and water.

Except for the swamps on the southern boundary and a seasonal river in the northern boundary, there is no natural permanent source of water within Mbirikani Group Ranch. With its highly porous volcanic soils, water retention is difficult. But during the wet season, water accumulates in depressions on the plains that temporarily solve the water shortage problem, especially in the eastern part of the ranch where there is no access to any permanent water source. Nearly 60% of Mbirikani is more than 5km from a permanent source of water, with the eastern section being more than 20 kilometres away (Bekure *et al* 1991). The cool Chyulu hills remain relatively green most of the dry season and

the park has a lot of grass that attracts the pastoralists out of the overgrazed dry plains despite the long distances they have to move in search of water (figure1).

Figure1 with a herder in the grassy Chyulu Hills-Mbirikani Kona Tatu at the Peak of the dry season

3.1.2 Laikipia Group Ranches

Laikipia is situated on and north of the Equator (37° 2’ E, 0° 6’ N) in a semi-arid and arid agro-ecological zone with variable rainfall ranging from 400mm to 750mm (Mizutani *et al*, 2005; Ojwang, 2000). Like Mbirikani, most of Laikipia’s climatic conditions are characterized with unpredictable and scattered rainfall with highly variable diurnal temperatures. Most of the land is unsuitable for rain fed agriculture (Ojwang, 2000). Therefore, most of the district is occupied by livestock farmers who practice both large scale ranching in privately owned land and subsistence pastoralism in community owned land/group ranches.

Unlike Mbirikani which does not have a permanent river, Laikipia is in the drainage system of a permanent river (Ewaso Ng’iro) and its tributaries, whose

catchments are Mt. Kenya and the Aberdare Range. Therefore, the study sites were within a short distance from a permanent source of water or an artificial dam. The artificial dams that get filled by the surface run-off during the rainy season retain water for several months during the dry season (Ojwang, 2000).

Both Laikipia and Mbirikani support high densities of wildlife outside protected areas with an equal estimated biomass (11kg/ha) excluding elephants (Mizutani, 2005). All the large predators found in Mbirikani are present in Laipikia, plus the Wild Dog which is absent in Mbirikani. Hence the pastoralists from both areas experience livestock depredation with the predators residing on their land or coming from the neighbouring parks (in Mbirikani) and private conservancies or commercial ranches (in Laikipia). However, there is an experimental livestock predation compensation programme in Mbirikani which is absent in Laikipia. There is also no formal wildlife protected areas in Laikipia and most of the wildlife reside in private properties where there is high tolerance for them (Ogada *et al*, 2003).

The Laikipa study focused on maasai community subsistence pastoralists (as was the case with Mbirikani) in their group ranches (Il Motiok, Il Polei and Kimungandura) or in private ranches (Soit Ng'iro and Tomlinson's ranches where some of the pastoralists were herding on lease paying 400 Kenya shillings per cow per month or 45 shillings per a goat/sheep a month) at the peak of the dry. Therefore, unlike the Mbirikani pastoralists who turn to Chyulu National Park illegally in search of pasture at the peak of the dry season, the Laikipia ones are surrounded by private properties that are fenced or unfenced with strict daytime patrols to keep the pastoralists out. Their herding options are therefore, to either remain in their group ranches, to lease grazing on private ranches, or to occasionally go into the private ranches illegally at night (personal observation).

3.2.0 DATA COLLECTION METHODS

3.2.1 Predation Incident Verifications

Consistent predation incidents verifications were mainly done in Mbirikani due to presence of the livestock predation compensation programme. Therefore, all predation incidents within the ranch are closely followed and verified before they are compensated for. Hence, I followed the Mbirikani verification officer to document predation incidents during the study period. Since there is no compensation programme in Laikipia, the incidents verifications were very few as reports rarely came and whenever they came it was already too late for evidence to be discerned.

In order to collect consistent data, a data sheet (appendix II) was designed. Carcass remains were photographed and their condition, habitats of the incident sites, marks and signs of predation were described. The herder or owner of the attacked animal was interviewed to establish the circumstances leading to the attack, the time of the attack, whether the attack was witnessed or not, the sex and age of the victim and the carnivore involved in the attack among other details. If the predation occurred in a boma or near it the condition of the enclosure was recorded and any other anti-predator measures existing noted. The GPS coordinates of the predation site and that of the victim's boma were recorded.

To confirm predation and the predator involved any tale tells signs of predator activity were examined. Signs of struggle confirmed predation while their absence was considered a scavenging case. The predators' spoor, feeding patterns, tooth and claw marks on the victims' skin and the mode of dismembering and dispersal of the carcass parts can indicate the predator species involved (Brain, 1980; Hill, 1980; Leakey *et al,* 1994; Kerbis, 1990; Binford, 1981; Behrensmeyer and Boaz, 1980). Figure 2 for example confirmed a

lion predation by the carcass dismembering pattern and the characteristic lion grip of the victim's mouth.

Figure 2 verification of a lion victim in Mbirikani

3.2. 2 Interviews

Two standardized interview schedules were designed to collect herding and livestock predation data (appendix I and II). One was for herders encountered in the field and the other was for household members willing to be interviewed. These schedules were designed before commencement of fieldwork and were tested through individual and group interviews before putting them into any use to eradicate any design flaws. Each was translated to the local language (Maa) by a Masai and then retranslated back to English by my Mbirikani research assistant to ensure that it was understood and will serve its purpose. The same schedules were used in Laikipia without any alterations.

While standardized interview schedules are accused of being inflexible, they were considered appropriate in this study to capture comparable data and were to be complimented with other methods of data collection used (Robson, 2002). Self completed questionnaire survey was considered inappropriate because the majority of the research participants could not read or write and the human–carnivore conflict is a sensitive issue requiring its documentation to be

contextualised as opposed to being generalized from survey data. Open ended questions used allowed for participants' free expression of their feelings, while the face to face encounters allowed for probing and clarifications of any difficult questions. To ensure consistency in recording all the interviews were conducted by me with the field assistant helping in translations where necessary. Cohen *et al* (2000: 267-92); Best and Kahn (2000: 199-201); Nachimias and Nachimias (1996: 237-47); and Robson (2002: 269-91) have detailed accounts of disadvantage and advantages of the different questionnaire based data collection techniques. They assert that with proper rapport building, interviews can have an in-depth exploration of social issues under investigation.

Rapport building started during livestock predation incidents verification exercises in Mbirikani and random household visits in Laikipia where every opportunity was used to introduce ourselves. In each case we explained that participation in the research will be voluntary and anonymity will be observed. The assistants were well known in the areas making it easier for us to be accepted. It was during these visits prospective interviewees/study bomas were identified and requested if they would like to participate in the forthcoming formal interviews and appointments fixed.

Household heads interviews in most cases were done on the day of the visit but for the other members of the family appointments had to be made for the community is highly hierarchical. Women and children are not allowed to talk to visitors in the presence of elders (Mwangi, 1997). In this regard Mbirikani women were difficult to talk to when men were around compared to those of Laikipia. During the other members of the family interviews it was only the senior women of each household who allowed us to interview them while the other women congregated around listening occasionally throwing a comment to assist in answering. Surprisingly, when met away from bomas, Mbirikani women and children freely talked to us. They were asked about their family and livestock sizes, herding labour requirements and division of labour, their herding strategies

to counter livestock depredation, their opinion regarding predation deterrence and predator conservation among other livestock herding challenges.

Figure 3: Ongoing interviews in Laikipia (top left) and Mbirikani (right and bottom left and right).

Interviews of herders were administered randomly to herders who were encountered in the grazing fields. Any herder encountered was approached and requested for an interview after explaining the purpose of the interview and ensuring anonymity. They were interviewed about the challenges of herding including: how they evaded predators, which predators gave them a lot of problems, how they ensured their livestock did not get lost among other herding precautions that they observed to minimise livestock predation. GPS coordinates of the interview locations were recorded.

Figure 4 adopting the local dressing (interviewing herders in Chyulu National Park) in Mbirikani

3.2.3 Herding Observations

A similar approach as that of the household interviews was used to select herds/flocks to be observed to record herding practices. The herding observations and interviews were done alternately during the fieldwork. Two bomas were selected in each study site for herding observation for five days each. In most bomas each household herded its livestock separately and even the night time enclosures inside the boma kept each household's livestock separate. Thus despite of staying in the same boma each household handled its livestock independently.

The observations started in the morning, recording all activities taking place before observed livestock left boma. The observations were captured in a standard data sheet (Appendix IV). The purpose of the observation was to capture the division of labour in livestock husbandry, the herders' activities while herding, their predation deterrence precautions, differences in herding activities in different areas, and livestock ranging throughout the day. GPS coordinates of the cattle movements (the recordings were mainly of the cattle lagging behind for we always followed from behind) were recorded hourly from the time they left boma until they returned. A few were done overnight where we observed the herds during the day and spent the nights with the herders in their temporary bomas to record any night husbandry precautions.

3.3 DATA ANALYSIS

The data was cleaned and entered into excel spreadsheets where descriptive and inferential statistical analyses were performed. The cumulative ranging distances and those of the turning points was calculated using MapSource computer programme. To compare differences between the means of the data from each study area a two tailed t test at 0.01 and 0.05 levels of significance was performed. A similar test was performed to determine any differences in the time spent in the various activities the herders engaged in while herding. This test was considered appropriate for this analysis because small samples were involved (Best and Kahn, 2000). Similarly a Pearson's coefficients of correlation analysis was performed to determine any relationships between the livestock ranging distances and herders' age and between talking, sleeping, miraa collecting and searching.

For non-parametric data (departure and arrival times, herders' ages and categorical interview data) descriptive statistics were done. They were then subjected to a chi-square analysis to detect any differences and similarities existing between sites. The other data that could not be quantified was given a qualitative analysis taking into account of its context to reduce biased conclusions.

3.4 POSSIBLE BIASES AND LIMITATIONS OF THE STUDY

As any real world research issues of data validity and reliability of the findings arose in this study. First I do not speak or understand the local language of the participants and relying on a translator cannot ensure whether the questions were asked and answers translated properly. This is why the questionnaires had to be translated twice by different individuals who knew the language. Most of the Laikipia research participants spoke fluent Kiswahili and mostly a translator was unnecessary unlike in Mbirikani. This may lead to differences in interpreting the

data that was collected through a translator and that without one. However, this was countered by the use of different methods of data collection for validation and triangulation.

The Mbirikani herders encountered inside the park were initially difficult to interview because they thought we were the Kenya Wildlife Service (KWS) rangers and if they saw us in advance they ran away. Due to this (even though we did observe anything to suggest it) it raises the question whether the answers we got in the initial stages of the study were genuine or not. We had to change our attire and dress like them to help us approach them before they went hiding (Figure 4).This problem disappeared with time as most of them became aware of us. Similarly the responses from female household interviewees may not represent individual opinion because they were unavoidably done in the presence of other women and children who occasionally assisted in some answers. However, the effect of this was probably solved by the various methods used in this study.

Our constant presence in the herding fields during herd observations could influence herders' behaviour by either making them relax more thinking we could help in the herding or remain more careful to give an impression that herders are always careful in the herding fields. However, observed herder's behaviour was always cross-checked with the other herders herding next to us to check out for any differences.

Another issue is this study was conducted during the dry season and may not represent the overall picture of the conflict. A study covering all the seasons including school holidays could give any similarities and differences within seasons and holidays to enable comparison between school-going herders and non-going ones.

CHAPTER FOUR

RESULTS

4.0 Introduction

The general herding strategies in Mbirikani and Laikipia were similar as herding splitting and moving to temporary bomas were done in both areas during the dry season. Both males and females (majority being males) did the herding and were between seven and 56 years old. Both younger and older herders covered similar distances in their respective daily herding areas. However, there were some differences in the average distances covered in the study sites where Laikipia herders generally covered shorter distances (mean = 6.4 kilometres) compared to those of Mbirikani (mean = 8.4 kilometres). Similarly the Laikipia herders herded fewer herds than in Mbirikani (mean cattle herds were 20.3 for Laikipia and 339.8 for Mbirikani; mean shoats were 150.9 for Laikipia and 448 for Mbirikani). The differences and similarities in the herding strategies between the sites are reported below as per the observations and interviews conducted.

4.1.0 Herding Observations

4.1.1 Ranging Distances

A total of 51 (27 in Mbirikani and 24 in Laikipia) herding observations of 16 households' flocks/herds were done covering Ol Motoo, Lenkilorit, Kona Tatu and Centre in Mbirikani and Il Polei, Il Motiok, Kimungandura, Soit Ng'iro and Tomlinson's ranches in Laikipia. Of the observations, nine were day and night at the temporary bomas where only herders stayed with their livestock in the herding fields and moved on exhausting pasture. Unlike Laikipia where water was within a short distance from herding fields, Mbirikani water points were too far to afford a daily herd watering. Therefore, in Laikipia livestock drunk water

daily except on few occasions they skipped a day when herding fields were far but had to be taken to the river first thing in the morning following the skip. Mbirikani herds spent at least 3-4 days without drinking water even at the peak of drought.

Three observations in Mbirikani involved taking herds to watering points, first one covering 35.9 (Lenkilorit to River Merueshi and back), the second 51.3 (Kona Tatu to Ilnchalai and back to Ol Donyo Wuas) and the third 20.6 (Centre to Oltiasika Swamp and back) kilometres walk in a day. Some Ol Motoo-Mbirikani herd owners hired Lorries that brought in water for some of their herds to avoid long distances to water points. In Laikipia longest distance covered to a river and back was 10.2 kilometres, which is less than half the shortest distance covered by Mbirikani herders.

Hourly GPS readings of the trailing herd were used to map general movements of every herd observed and distances to turning points and daily cumulative distances covered calculated using MapSource computer programme. Table 1 has distances to turning points (Dtp) and cumulative distances (Cd) covered in each observation in the two study areas. In this study, cumulative distances are assumed to be approximately equal to ranging distances of the livestock observed.

Ranging distances of livestock for both study areas (excluding three watering days of Mbirikani for comparison purposes) was between 3 and 14 kilometres (N = 48, mean = 7.4 and SD = 2.8). Considering shoats alone, distances were between 3 and 10 kilometres (N = 18, mean = 5.6 and SD = 1.9).

Comparing ranging distances in the two study areas some differences were noted with Mbirikani herders covering longer distances (N = 24, mean = 8.4 and SD = 3 for all livestock excluding watering days and N = 7, mean = 6.4 and SD = 2.4 for shoats only) compared to Laikipia (N = 24, mean = 6.3 and SD = 2.2 for

all livestock and N = 11, mean = 5.1 and SD = 1.5 for shoats only). A t-test for cumulative distances indicated a significant difference (t = 3.57 at df = 46 and p = 0.009). These differences are also reflected in distances to turning points (N = 24, mean = 4.3 and SD = 1.5 for Mbirikani and N = 24, mean =2.5 and SD = 1 for Laikipia) with all Laikipia herders turning at distances less than 4 kilometres compared to 54% of Mbirikani herders who turned at distances more than 4 kilometres from boma.

Table 1: Distances to turning points and cumulative distances excluding Mbirikani watering days

Observation #	Mbirikani Dtp	Laikipia Dtp	Laikipia Cd	Mirikani Cd
1	5.9	1.39	3.85	13.1
2	1.73	1.15	4.54	3.48
3	4.79	1.11	3.56	9.97
4	2.26	1.15	4.57	4.79
5	2.89	1.93	5.05	5.76
6	3.35	1.52	3.52	6.75
7	5.36	1.74	4.6	9.73
8	5	2.73	6.49	9.82
9	6.62	3.03	6.63	13.3
10	6.19	3.11	7.63	12.3
11	6.49	2.39	5.97	12.4
12	5.21	2.39	6.93	10.5
13	4.54	3.4	7.18	9.48
14	2.51	2.47	7.11	5.37
15	2.95	3.58	9.87	5.71
16	3.01	1.51	3.23	5.93
17	6.57	2.67	5.43	12.8
18	4.69	1.53	3.79	10.6
19	6.06	4.16	8.73	7.72
20	2.24	4.47	10	4.21
21	3.28	3.59	10.2	6.38
22	4.07	1.46	6.03	8.17
23	3.4	3.42	6.97	6.8
24	3.75	3.59	10.1	7.29
Mean	**4.3**	**2.5**	**6.3**	**8.4**
STDEV	**1.5**	**1.0**	**2.2**	**3.0**
Variance	**2.4**	**1.1**	**5.0**	**9.1**

Pearson's correlation coefficients for Mbirikani mean distances against age of herders were not significant (F= 0.001 and r = 0.0095 with N – 2 = 12 and df =1). In contrast same analysis for Laikipia showed a significant difference at 0.05

level of significance (F = 8.916, N – 2 = 8, df = 1 and r = 0.7260) implying that mean distances covered tended to increase with age for Laikipia herders.

4.1.2 Herders' Ages

Table 2 summarizes herders' ages, their number of observations and percentages. Observed herders' ages ranged between seven and 56 years majority of whom were males (94%, N = 63 herders). Only four of 63 herders observed in the 51 observations were females (6%) aged 12, 16, and 18 years). Most herding was done by herders below 30 years who were observed 53 times (84%) while the older four aged 35, 45, 50 and 56 years respectively were observed 10 times (16%). Note that some observation herds had multiple herders' making their total number greater than the number of observations and for analysis purposes their ages were averaged.

Table 2: Herders' ages and number of observations of each and percentages

Age	# for Mbirikani	# Laikipia	# overall	% Mbirikani	% Laikipia	%Overall
7	1	2	3	3.4	5.7	5
8	1	0	1	3.4	0	2
9	0	2	2	0	5.7	3
10	3	3	6	10.3	8.8	10
11	0	4	4	0	11.8	6
12	2	0	2	7	0	3
13	2	3	5	7	8.8	8
14	0	5	5	0	14.7	8
15	1	0	1	3.4	0	2
16	0	6	6	0	17.6	10
17	0	5	5	0	14.7	8
18	7	0	7	24.1	0	11
20	1	0	1	3.4	0	2
22	1	0	1	3.4	0	2
23	2	0	2	7	0	3
25	1	0	1	3.4	0	2
30	1	0	1	3.4	0	2
35	0	2	2	0	5.7	3
45	0	2	2	0	5.7	3
50	3	0	3	10.3	0	5
56	3	0	3	10.3	0	5
Total	**29**	**34**	**63**	**99.8**	**99.2**	**103**

A notable difference between the sites was almost all (88%, N = 34) of Laikipia herders were 17 years and below compared to Mbirikani (35%, N = 29). Hence 65% of Mbirikani herders were 18 years and above compared to 12% of Laikipia. There were more shoats observations in Laikipai (N = 11) than in Mbirikani (N = 7) and household interviews results (Table 3) indicate that Laikipia pastoralists keep more shoats than cattle. Informal discussions with some household heads in Laikipia revealed that they prefer sheep to any other livestock because they are easy to herd during drought because they survive on poorer pasture conditions than other livestock.

Table 3: Household Interview Livestock numbers

Interview#	LaikipiaCattle	MbirikaniCattle	LaikipiaShoats	MbirikaniShoats	LaikipaDonkeys	MbirikaniDonkeys
1	5	40	15	50	0	0
2	9	200	40	200	0	2
3	4	300	80	400	0	3
4	18	2500	170	3700	0	40
5	20	250	60	300	0	0
6	36	-	112	-	0	0
7	35	130	253	220	3	4
8	15	-	300	-	0	3
9	100	-	550	-	2	0
10	30	150	80	180	0	9
11	3	100	40	100	1	2
12	1	-	20	200	1	3
13	10	-	200	-	0	0
14	31	250	354	10	0	5
15	3	176	56	100	4	9
16	4	300	85	2000	4	2
17		300		200		5
18		60		100		0
19		120		200		3
20		600		80		4
21		400		180		4
22		250		400		1
23		30		140		2
24		300		200		4
Total	**324**	**6456**	**2415**	**8960**	**15**	**105**
Mean	**20.3**	**339.8**	**150.9**	**448**	**0.9**	**4.4**
Range	**1-100**	**30-2500**	**15-550**	**10-3700**	**0-4**	**0-40**

4.1.3 Departure and Arrival Time

Table 4 summarises frequencies of departure and arrival times of herders in the two study areas. Observations lasted between 10 to 16 hours except three that lasted five, seven and eight hours respectively due to starting one late and the other two due to shifting camp and these are not included in arrival times analysis.

Table 4: Observation timing frequency for start and finish time

Start time	# for Mbirikani	# for Lakipia	**Finish time**	# for Mbirikani	# for Laikipia
5-5.59	1	0	**16-16.59**	0	2
6-6.59	2	2	**17-17.59**	6	12
7-7.59	5	9	**18-18.59**	5	8
8-8.59	9	9	**19-19.59**	14	1
9-9.59	8	2			
10-10.59	1	2			
11-11.59	1	0			
Total	**27**	**24**		**25**	**23**

Departure time ranged from 5.45 am to 10 am with 87.5% of departures lying between 7 and 10 am. Comparing departures in the two study areas, a chi-square analysis indicated there was no significant difference (x^2 = 7.04, df = 6 and p = 0.3274). Thus morning activities took almost the same time in both areas. However, there was a significant (x^2 = 15.91, df = 3 and p = 0.001) difference in arrival times with Mbirikani herders arriving mostly later than in Laikipia. 76% of Mbirikani herders arrived between 6 and 8 pm compared to 39% in Laikipia. None of Mbirikani herders arrived earlier than 5 pm but Laikipia ones arrived from 4 pm with majority (61%) arriving between 4 and 5 pm. This difference in arrival time corresponds with interview responses. All Laikipia herders interviewed (N = 30) responses to arrival time in the evening were between 4 and 5 pm while in Mbirikani (N = 41) they were between 4 and 7 pm. Therefore, Laikipia herders arrived when there was enough light to count and detect any lost livestock while majority of Mbirikani ones arrived in darkness.

Figure 5 Counting shoats on arrival at Lampasi-Kimungandura – Laikipia

No counting of livestock was done as it left dense vegetation or on leaving and returning home to ensure none was left behind or escaped at night in Mbirikani. While keen herd observation was done in both study sites in the morning, actual counting was neither observed at this time nor in the herding fields. Actual counting was only done in the evenings as the herds entered boma or inside it upon returning from the herding fields only in Laikipia (figure 5).

4.1.4 Herders' Activities in the Herding Fields

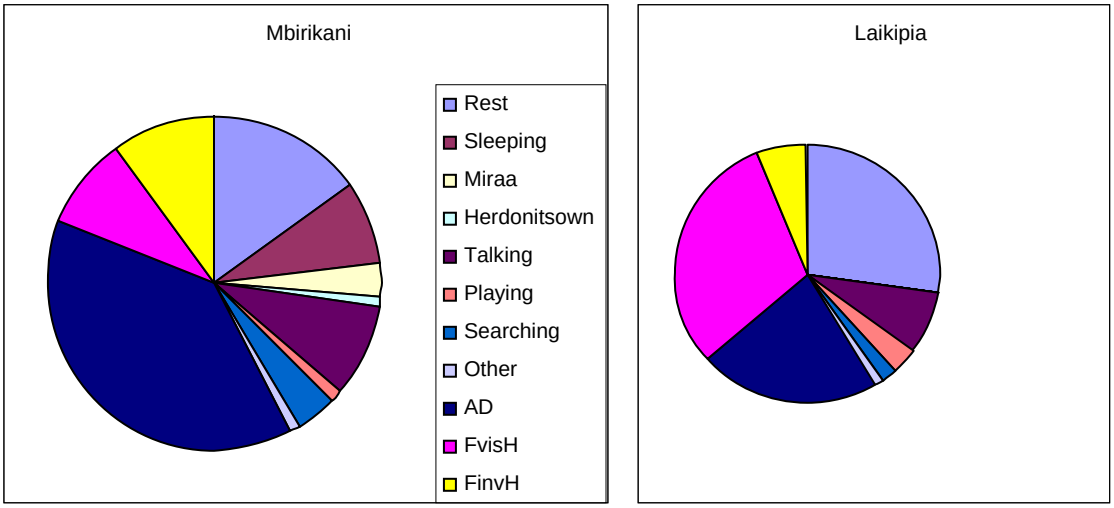
Total time in minutes taken in an activity per observation for the two study sites is shown in table 5. Activities were categorized as actively directing a herd **(AD),** following a visible herd **(FvisH),** following invisible herd **(F.invH),** resting with herd visible **(R.visH),** resting but herd invisible **(R. invH), Sleeping**, miraa (twigs that are chewed and are thought to stimulate and keep the chewer alert) collecting **(Miraa),** searching for lost herd **(Searching)**, herd on its own **(Herdonitsown),** playing with others **(Playing),** herders of different herds

together talking **(Talking)** and **Other** for bathing as herd moves back after drinking water, fruit & firewood gathering and herding stick carving that were occasionally observed. RinvH and RvisH time was summed together and categorized as resting **(Rest)** during analysis due to some recording inconsistencies that were noted for Mbirikani data for in some cases when resting was recorded it was not clearly indicated whether herd was visible or not. These categories were used to roughly indicate how attentive herders remained while tending their herds in herding fields.

Table 5: Total time (minutes and percentage) in each activity.

Activity	**Time spent in each activity**		**Percentages**	
	Mbirikani	**Laikipia**	**Mbirikani**	**Laikipia**
Resting	2654	3670	15	27
Sleeping	1290	15	8	0
Miraa	581	0	3	0
Herdonitsown	180	255	1	2
Talking	1474	1061	9	8
Playing	185	418	1	3
Searching	765	298	4	2
Other	200	125	1	1
AD	6580	2936	38	22
FvisH	1478	4023	9	30
FinvH	1801	831	10	6
Totals	**17188**	**13632**	**99**	**101**

Figure 6 activity time proportions (percentage)



Proportionally herders from both sites apportioned almost equal time in talking (mean = 54.6 minutes; about 9% of the total activities' time, SD = 73, N = 27 in Mbirikani and mean = 44.2 minutes; about 8% of the total activities' time, SD = 47.7, N = 24 in Laikipia), leaving herds on their own (mean = 6.7 minutes; about 1% of the total activities' time, SD = 20.9, N= 27 in Mbirikani and mean = 10.6 minutes; about 2% of the total activities' time, SD = 30.2, N = 24 in Laikipia) and other activities (mean = 7.4 minutes; about 1% of the total activities' time, N = 27 in Mbirikani and mean = 5.2 minutes; about 1% of the total activities' time, N = 24 in Laikipia). Even though t test shows that the difference in time spent in talking in the two sites is not significant ($p > 0.01$) Mbirikani herders' talking was less frequent (12 of 27 compared to 20 of 24 Laikipia observations) but each talking session was longer than in Laikipia.

A t test for playing ($p = 0.24$), searching ($p = 0.24$) and following an invisible herd ($p = 0.6$) shows that the differences in these activities are non-significant. Laikipia herders frequently came together to have a short play (9 out of 24 observations compared to 4 of 27 in Mbirikani), searched for lost livestock while in herding (7 out of 24 observations compared to 8 of 27 in Mbirikani) and followed invisible herds – (18 observations on each site) but time spent on each activity was usually shorter compared to that of Mbirikani herders. Laikipia herders in most

cases had their different herds close together with some mixing sometimes but remained alert to avoid herds wandering off into private property. In contrast Mbirikani herders mostly herded their livestock away from each other and avoided herd mixing (except for a few occasions in Lenkilorit, Kona Tatu and Centre). Deliberate letting herds move ahead or follow (leaving herds on their own - 3 observations in each site) and engaging in other activities (4 observations in Mbirikani and 5 in Laikipia) was infrequent in both sites.

Miraa collecting was only observed in Mbirikani with herders between 18 and 22 years. This activity though uncommon (4 out of 27 observations), sometimes left a herd abandoned for hours. The four miraa collecting activities took 50, 60, 231 and 240 minutes respectively. Sleeping was also mainly observed in Mbirikani where it was done in 48% of all observations (13 of 27 observations) compared to one in Laikipia that took 15 minutes which is proportionally negligible.

Unexpectedly, Pearson's correlation coefficients for sleeping and talking (in Laikipia) against searching were positive but low ($N = 27$, $r = 0.25$ for sleep, $N = 24$, $r = 0.22$ for Laikipia talking) while miraa collecting, playing and Mbirikani talking against searching had a negligible inverse relationship (Best and Kahn, 2000): $N = 27$ and $r = -0.15$ for miraa collecting, $N = 27$ and $r = -0.14$ for Mbirikani talking and $N = 27$, $r = -0.12$ for Mbirikani playing and $N = 24$, $r = -0.20$ for Laikipia playing. Despite the low positive relationship in sleeping and talking activities in some cases after sleeping or talking a substantial amount of time was spent in searching for a lost herd. For example in Centre-Mbirikani after the herder slept for more than two hours, we spent three hours searching for our herd.

When a t test was performed statistically significant ($p < 0.001$) differences in activity time apportioning appeared in actively directing herds (AD), following visible herds (FvisH) and resting between the two sites. Mbirikani herders spent the highest proportion (38%, mean = 243.7 minutes, SD = 146.6, N = 27) on

actively directing their herds (AD) compared to Laikipia who spent 22% (mean = 122.3 minutes, SD = 48.7, N = 24). On the other hand Laikipia herders spent highest proportion of their herding time (30%, mean = 167.6 minutes, SD = 124.1) in following a visible herd (FvisH) compared to Mbirikani who only spent 9% (N = 27, SD = 61.9 and mean = 54.7 minutes) while resting took 27% (N = 24, SD = 56.3 and mean = 152.9) of Laikipia time compared to 15% in Mbirikani (N = 27, SD = 96.2 and mean = 98.3 minutes).

As was the case with the distances covered, all the herders engaged in the above activities irrespective of their age. However, playing and miraa collecting tended to be age related (figure 8) with younger herders playing more than older ones and miraa collecting restricted to those between 18 and 22 years.

4.1.5 Overnight Observations

These were done in Chyulu National Park – Mbirikani (two observations), Kona Tatu – Mbirikani (three observations) and Kimungandura/Lampasi – Laikipia (four observations). In all observations there were no differences in the herders' behaviour noted. Herders slept throughout the night without any night vigilance or predator deterrence measures like lighting fire around the boma and in some occasions (two of four observations in Laikipia and three of five in Mbirikani) some cattle jumped out of boma and went grazing outside throughout the night. In all cases bomas were not strong enough to prevent livestock escaping or predator from entering boma at night. In Laikipia, noisy hyaenas visited every night (N = 4) to feed on carcasses of livestock that had died of starvation and were skinned and left outside the boma. Leaving carcasses outside boma, even though not quantified in this study, was a common practice in both study areas because we saw quite a number of them abandoned outside bomas at the peak of the drought.

Figure 7: Herders begin sleeping (1a and 2a), herders deeply a sleep (1b and 2b), herder a sleep as I make notes (3) and herder a sleep next to my field assistant (4) in Mbirikani as herds feed out of sight.

1a 

2a 

1b 

2b 

3 

4 

Figure 8: Relationship between and herders' activities.

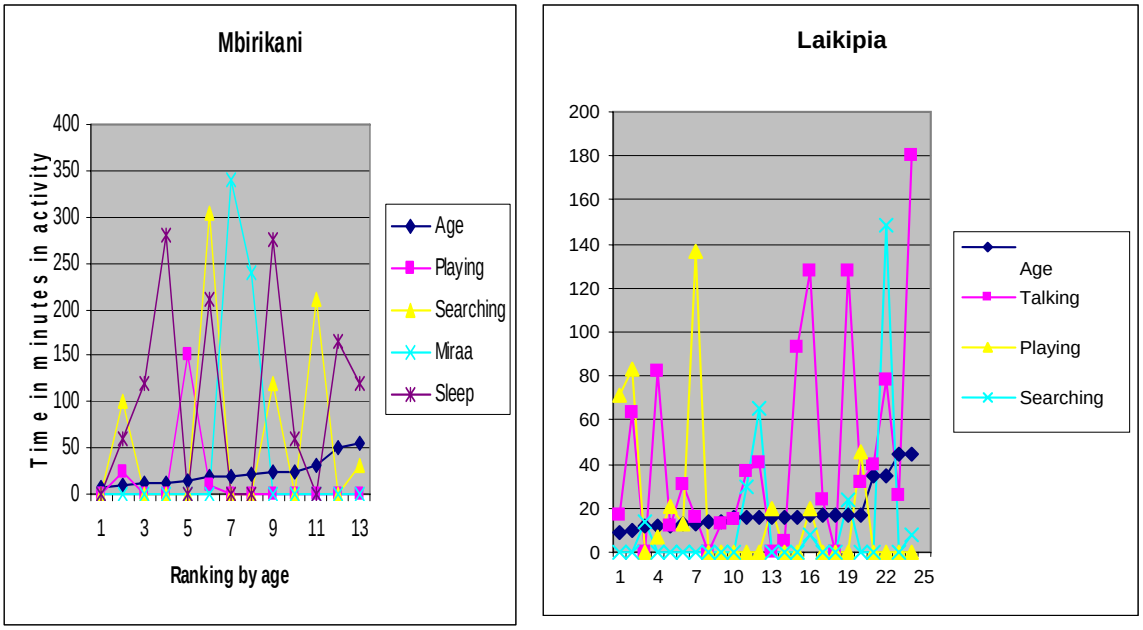


Figure 9: Temporary boma in Chyulu National Park, herder sleeps inside it with calves as the herd is left feeding on its own most of the day during the day.

Figure 10: Clockwise my assistant having tea (we slept in the open to keep “awake”) at a night time observation camp in Chyulu National Park and herders having supper - Mbirikani, warming myself with herders at a night time observation and herders having a morning meal before going herding - Laikipia in temporary bomas

4.1.6 Livestock Losing Incidents

Losing of the livestock we were observing was not common in both study sites. We never lost any livestock in Laikipia but we lost five times (19%, N = 27) in Mbirikani. Similarly reports of/encountering lost livestock near where we were observing (even though not quantified) were less common in Laikipia than Mbirikani. Only one incident of cattle escaping at night to go grazing was reported in Laikipia while there were several such reports in Mbirikani. The herd owners and herders claimed the night escapes were due to hunger for the

Laikipia herd and the Mbirikani ones included thirst and finding their way to the old boma in the first few days after moving to a new one they were unfamiliar with.

4.1.6 Efforts to Detect Predators While Herding

No deliberate efforts of herders trying to detect predators were observed while in the herding fields. There was no attack on the herds we observed neither did we encounter any predator very close to the herd except for the night hyeana visits in four overnight observations of Laikipia and two daytime occasions at Centre – Mbirikani. In the first one sighting a cheetah was seen about one kilometre away on a hill while searching for our lost herd and the herder was alerted to its presence by alarm calls made by Lesser Kudus (*Tregelaphus imberbis*). In the second one another cheetah was accidentally spotted on a different hill about a kilometre away.

4.2.0 Predation Verifications

A total of 35 verifications were done in Mbirikani and 11 reports/verifications in Laikipia. Only three of 11 Laikipia incidents had remains that were examined with the rest of the incidents having happened some days earlier, there was no evidence to confirm them. There were16 attacks in Laikipia consisting of five cattle, one donkey and ten shoats. Two of the cattle attacks were by lions (one was a commercial ranch steer panicked out of boma at night and the other a community herd heifer being herded in a private commercial ranch during the day) while the other cattle were of hyaena (two calves left unattended in a temporary boma during the day and a lost steer attacked at night). A leopard that had reportedly become a habitual livestock raider in Soit Ng'iro killed two shoats during the day. The rest of the attacks (nine: a donkey and eight shoats) were done by hyaena at night inside boma except three sheep that were lost when they were attacked.

Table 6: Number of victims by species and age, number witnessed or not, time of incident and the predator involved with the number of its victims of the Mbirikani verified incidents.

VICTIM SPECIES	ADULTS	YOUNG	TOTALS	WITNESSED	UNWITNESSED	NIGHT	DAY
SHEEP	19	9	28	13	15	10	18
GOATS	6	2	8	4	4	4	4
CATTLE	8	10	18	2	16	16	2
DONKEYS	0	1	1	0	1	1	0
TOTALS	**33**	**22**	**55**	**19**	**36**	**31**	**24**
Predator/Victims	**LION**	**CHEETAH**	**LEOPARD**	**HYAENA**	**JACKAL**		
SHEEP	0	14	0	12	2		
GOATS	0	4	1	3	0		
CATTLE	12	2	1	3	0		
DONKEYS	0	0	0	1	0		
TOTALS	**12**	**20**	**2**	**19**	**2**		

Verified Mbirikani victims were 55 livestock consisting of 36 shoats, 18 cattle and one donkey with lion responsible for eight, leopard two, jackal two, hyaena 11 and cheetah 12 incidents. 18 incidents occurred at night with lion responsible for eight, hyaena nine and leopard one while 17 occurred during day mainly executed by cheetah (12), hyaena (two), leopard (one) and jackal (two). Table 6 summarises incident verification information gathered from incident sites in Mbirikani.

4.3.0 Interviews

A total of 111 interviews were conducted excluding those conducted at predation verification points. Of these 71 (41 in Mbirikani and 30 in Laikipia) interviewees were herders encountered in herding fields and 40 (24 in Mbirikani and 16 in Laikipia) were household members visited in their bomas. Interviewees' lack of confidence that was observed at the beginning of the study faded with time as they got used to my presence and freely talked to me. Interviewing females of all ages was particularly difficult initially in Mbirikani as they were shy to talk to me at bomas in the presence of men for cultural reasons mentioned above. However, when met away from boma they were confident and freely talked to us (figure 3).

Table 7: Herders' responses to questions 19, 23 and 26 and those of households to question 24

Question	Responses	#Mbirikani responses	#Laikipia responses	Total responses
Q19 Herders responses	Knows area to encounter Predator	30 (88.2%)	22 (73.3%)	**52**
	Doesn't know area to encounter predator	4 (11.8%)	8 (26.7%)	**12**
	Missing data	7	0	**7**
Totals		**41**	**30**	**71**
Q19Approach action	Do nothing when approaching area	4 (11.8%)	0 (0%)	**4**
	Avoid the area	10 (29.4%)	4 (13.8%)	**14**
	Approach it cautiously	20 (58.8%)	25 (86.2%)	**45**
	Missing data	7	1	**8**
Totals		**41**	**30**	**71**
Q23Herders' responses	Never lost	1 (2.5%)	3 (10%)	**4**
	Expects nothing	30 (75%)	8 (26.7%)	**38**
	Expects disciplinary action	8 (20%)	12 (40%)	**20**
	Depends on circumstances	1 (2.5%)	8 (26.7%)	**9**
	Missing data	1	0	**1**
Totals		**41**	**31**	**72**
Q26Herders' responses	Have never been attacked	19 (47.5%)	8 (26.7%)	**27**
	Daytime attack	15 (37.5%)	7 (23.3%)	**22**
	Nighttime attack	8 (20%)	16 (53.3%)	**24**
	Missing data	1	0	**1**
Totals		**43**	**31**	**74**
Q24Household responses	No action	12 (54.5%)	6 (37.5%)	**18**
	Will take action	7 (31.8%)	9 (56.3%)	**16**
	Depends on circumstances	3 (13.6%)	2 (6.3%)	**5**
	Missing data	2	0	**2**
Totals		**24**	**17**	**41**

4.3.1 Factors that Influenced Herders' Attention to their Livestock

To find out what would make herders more attentive to their livestock movement to avoid losing them, they were asked what they expected a herd owner's reaction will be if their herd got lost (Table 7). Majority (75%, N = 40) of Mbirikani herders said they expected nothing except assistance to do a search from owner compared to 26.7% in Laikipia (N = 30). In contrast 40% (N = 30) of the Laikipia herders expected disciplinary action compared to 20% (N = 40) of Mbirikani. Mbirikani household interview responses to the action they will take against a herder who lost their livestock was consistent with herders' responses as 54.5% (N = 22) said they will not take action compared to 37.5% of Laikipia (N = 16).

Herd owners who could not take action said they could also lose livestock if they were herding.

Asked whether their livestock have been attacked, a substantial number (47.5%, N= 40 compared to 26.7%, N=30 in Laikipia) of Mbirikani herders said their herds have never been attacked by a predator. However, more reported experiencing daytime attacks (37.5%) than night (20%) compared to Laikipia who reported more (53.3%) night attacks than (23.3%) daytime (table 7). Verifications of Mbirikani (Table 6) suggested night attacks (51% of 35 attacks) were almost equal to daytime attacks (49%). This suggests that Mbirikani herders would have expected more daytime attacks and avoided areas they would encounter predators while herding and the reverse could be true for Laikipia herders. When interviewed most of the herders knew where they could encounter carnivores (88.2% and N = 34 for Mbirikani and 73.3% and N = 30 for Laikipia) and would approach it cautiously (58.8%, N=34 for Mbirikani and 86.2%, N=29 for Laikipia) rather than avoid it.

4.3.2 Livestock Frequently Lost and Attacked by Predators

Table 8 summarises responses to household interviews regarding which of their livestock get lost and get attacked often, why they think this happens and which seasons it happens. All Laikipia respondents (N = 16) said shoats get lost often compared to 26% of Mbirikani (N = 19) who said cattle get lost more often (42%) than other livestock. Of Mbirikani respondents, 21% said there was no difference in the frequency of getting lost between cattle and shoats.

A range of reasons were given why some livestock get lost often than others and majority of Laikipia households said shoats get widely dispersed (63%, N = 16 compared to 21%, N = 14 in Mbirikani) in herding fields while others said they are small to notice if left behind (25% in Laikipia compared to 21% in Mbirikani). While there was a mention of herders' laxity as a cause of losing livestock in

Laikipia, nobody mentioned it in Mbirikani. Majority (43%) of Mbirikani households did not know why their cattle get lost frequently.

Responses to which livestock is frequently attacked followed the trend to those of frequently lost. Laikipia households maintained that shoats are frequently attacked by predators (63%, N = 16 compared to 24%, N = 17 in Mbirikani) while Mbirikani said it is cattle (35% compared to 0% in Laikipia). Some said the rate of attack was the same (31 % in Laikipia and 24% in Mbirikabi). While donkeys were not mentioned in the frequently lost livestock, they were mentioned in the frequently attacked question (18% in Mbirikani and 13% in Laikipia) and the reason given for their frequent attacks was they are left outside boma at night (19%, N = 16 in Laikipia and 17%, N = 18 in Mbirikani).

Reasons for frequent attacks were also given for the other livestock. Laikipia shoats were frequently attacked because they are small and have more predators than cattle (57%, N = 16 compared to 11%, N = 18 in Mbirikani) while 33% of the Mbirikani households compared to 25% of Laikipia said the frequently attacked are those that get lost often. Of these respondents 33% in Mbirikani said their livestock has never been attacked compared to 13% in Laikipia. 13% of the Laikipia respondents did not know why some livestock are frequently attacked while 6% of the Mbirikani who mentioned young shoats are often attacked said the jackals that attack them are small to detect.

Frequency of attacks was reported to vary seasonally. There was a general agreement that attacks are most frequent (75%, N = 20 in Mbirikani compared to 63%, N = 16 in Laikipia) in dry season in both sites. However, in Laikipia attacks were relatively high (38% compared to 20% of Mbirikani respondents) in wet season. Some respondents said their livestock have never been attacked (10% of Mbirikani and 6% of Laikipia) in either season.

Table 8: Households responses to Questions 21, 28, 30 and 31: Frequently lost and attacked Livestock/Season and why

Species lost often Q21	**#Laikipia responses**	**# Mbirikani responses**	**% Laikipia**	**% Mbirikani**
Shoats	16	5	100	26
Cattle	0	8	0	42
Donkeys	0	0	0	0
No difference	0	4	0	21
Never lost	0	2	0	11
	N = 16	**N = 19**		
Why lost often Q21				
Range widely	10	3	63	21
Mixing of different flocks	1	0	6	0
Shoats small to notice	4	3	25	21
Herders' laxity	1	0	6	0
When left on their own	0	0	0	0
Herded in bushier areas	0	1	0	7
Herded by young herders	0	1	0	7
Large flock per herder	1	1	6	7
I don't know	0	6	0	43
	N = 16	**N = 14**		
Often attacked Q30				
Shoats	10	4	63	24
Cattle	0	6	0	35
Donkeys	2	3	13	18
Never been attacked	0	0	0	0
No difference	5	4	31	24
Calves	0	0	0	0
Young shoats	1	1	6	6
	N = 16	**N = 17**		
Season often attacked Q28				
Dry	10	15	63	75
Wet	6	4	38	20
Never attacked	1	2	6	10
	N = 16	**N = 20**		
Why often attacked Q31				
Donkeys stay outside boma	3	3	19	17
Shoats small	7	2	44	11
Get lost often	4	6	25	33
Shoats have more predators than cattle	2	0	13	0
Never been attacked	2	6	13	33
Jackals not easy to detect	0	1	0	6
I don't know	2	0	13	0
	N = 16	**N = 18**		

CHAPTER FIVE

DISCUSSION

5.0 Introduction

Conservation of large carnivores poses great challenges given that their interactions with pastoralists have often had negative consequences (Frank et al. unpub.; Mishra, 1997; Ogada et al. 2003). Cases of carnivore stock raiding and human attack greatly threaten sustainable carnivore conservation due to retributive action by livestock owners whose lives and livelihoods are threatened (Frank et al. unpub; Hazzah, 2006). Carnivore and pastoralist interaction is thought to increase with human population, wildlife habitat reduction, natural causes/poaching that reduce the normal wild prey of carnivores (Kerbis and Gnoske, 2001; Kock *et al.*, 1998, Frank *et al*, 2006). Natural prey reduction can force carnivores to switch to preying on livestock; making co-existence of pastoralist communities with carnivores and their sustainable conservation impossible.

This comparative study attempted to document the role of pastoralists in reducing the conflict and hence their contribution to sustainable conservation of carnivores. While it may be the first to attempt documenting herders' activities as a measure of how careful they remain in herding fields, it does not give a complete picture as it only focused on the dry season. A more comprehensive study would have focused on comparisons between and within seasons including predation rates at the beginning and end of each season. However, our findings reinforce previous findings from related studies that pointed out that careful livestock husbandry can reduce depredation and lethal carnivore control that may lead to sustainable carnivore conservation on pastoralist community occupied areas in Kenya (Ogada *et al*, 2003; Kruuk, 1980; Woodroffe, *et al*, in review; Patterson, *et al*, 2004).

In attempting to resolve conflict, Kenya Wildlife Service – KWS (a state corporation that is mandated to manage wildlife) policy is to translocate or kill problem animals. This solution is not sustainable given that the animals revert to their behaviour in the new areas and more others develop this behaviour (Hamilton, 1980; Kock *et al*, 1998). It is estimated that 60 – 70% of wildlife in Kenya lives outside protected areas most of the year, making predator contact with livestock unavoidable (Norton-Griffiths, 1993). Hence reducing the conflict to a certain tolerance level is required.

It is commonly argued that for conservation to be sustainable, wildlife must justify their existence through subsistence utilization or economic returns (Norton-Griffiths, 1993; UNEP, 1988; Frank et al, 2006). But the challenge is how those that cannot justify their conservation can be sustained. It is documented that some Kenyan communities like the Samburu, Maasai and other pastoralists/farmers exhibit extreme tolerance for some carnivores but the motivation behind it is not well documented even though culture is sometimes cited as the motivating factor (Kock et al, 1998, Mills and Hofer, 1998, Woodroffe, Ginsberg and Macdonald, 1997). However, this tolerance can be highly dynamic for a subsistence pastoralist who loses his invaluable livestock to a predator that may trigger a dislike for predators that no amount of consolation compensation can dissuade. A comment from a female household interviewee may echo how most pastoralists value their livestock that can be impossible to measure:

> The compensation we are paid is worthless for when a female livestock is killed by a predator it means losing many generations of livestock that would come out of that to feed many generations of people into the distant future. The only solution to livestock depredation is killing all predators in Mbirikani (field interview 21 December, 2005).

This comment also suggests that livestock valuing among the pastoralists is not based on modern commercial perspectives but is focused more on the socio-cultural perspectives. Therefore, the promotion of economic returns from tourism as a means of increasing tolerance for predators may not be as appealing to a subsistence pastoralist as to a commercial farmer. Hence avoiding depredation

through proper husbandry can be a better solution than any other incentives. The sections below discuss herding practices in relation to depredation as per the findings of this study that identifies the challenges faced by both pastoralists and conservationists in addressing the conflict.

5.1 Livestock Ranging Distances and Herders' ages

Livestock ranging distances in rangelands are influenced by availability of pasture and water. The ranging distances in both study areas including those of Mbirikani watering days were within the range reported elsewhere (see Herlocker, 1999 and Karani, 1994) suggesting that herders cover approximately similar distances in their daily movement with their livestock. However, when Mbirikani watering days were excluded the ranging distances for both shoats and cattle in the observation areas were below the overall Kenyan pastoralists' ranging distances; 27-46 km for cattle and 5.7-13 km for shoats (Herlocker, 1999). This means that ranging distances vary with the environmental conditions that influence the freedom of movement of herders within their herding fields.

Laikipia group ranches' neighbouring ranches are private properties with strict entry restrictions to herders - a goat is confiscated per a trespass. Therefore, Laikipia herders' movements were restricted. Mbirikani herders had almost free access to Chyulu National Park and free access to the neighbouring Kuku Group Ranch where most of the herding was done during the study. This explains why ranging distances and turning points of Laikipia herders were shorter than Mbirikani and a t-test showed that differences were significant ($t = 3.57$, $df = 46$ and $p < 0.01$). Restrictions/freedom of movement on ranging area may also influence how alert herders have to remain in order to control movement of their livestock and avoid trespass. Some private ranches in Laikipia are unfenced requiring herders to remain alert always to avoid trespass.

Besides restrictions, there were no other major differences in herding strategies to explain the above differences. The only observed herding strategy difference was herding of sheep and goats separately in Laikipia and the reason given for this was sheep are slower than goats. Mbirikani shoats were always mixed and one herder herding shoats and calves together was a common practice here. All shoats' observations in Laikipia were done in community ranches as in Mbirikani yet ranging distances were higher in Mbirikani.

A factor that would be thought to have influenced differences in ranging distances is age of herders. Older herders are expected to move longer distances than young. However, there was no significant differences ($F = 0.001$, $r = 0.0095$, $N-2 = 12$ and $df = 1$) between herders' age and distances moved in Mbirikani. But differences were significant ($F = 8.916$, $r = 0.7260$, $N-2 = 8$ and $df = 1$) in Laikipia. This interesting observation is probably due to movement restrictions rather than age differences. There were more shoats observations that are known to be mainly herded by children (Herlocker, 1999) in Laikipai ($N = 11$) than in Mbirikani ($N = 7$) and Laikipia cattle that are herded by older herders were observed in commercial ranches where ranging space is larger than in community ranches where shoats were observed (mean ranging distance of cattle in private ranches was 8.2km, $N = 7$ compared to 6.4km, $N = 6$ in community ranches). However, it must be pointed out that those families that could afford moving whole family and their livestock to commercial ranches had their children herding in same areas as older cattle herders as was observed in Mbirikani. Therefore, given similar conditions both young and old herders moved same distances to herding fields.

5.2 Role of Herding Timing and Counting in Livestock Depredation

Counting livestock while herding or upon returning can help detect those missing as well as save on searching time but it requires daylight. As per results in section 4.1.2 the difference in herding timing between the sites was only

significant (x^2 =15.91, df = 3, p =0.001) in arrival time in the evening with Mbirikani herders arriving later than in Laikipia. For Laikipia, limited ranging space and fear of encountering elephants could be the reason for this. Frequent encounters with elephants in Il Motiok, Soit Ng'iro, Tomlinson's and Il Polei ranches was always the reason given for earlier return to cross the luggas used by elephants before darkness. For Mbirikani longer distances to herding fields and more ranging space are probably reasons for this and could expose livestock to predators. Kruuk (1980) observed that nocturnal predators mainly preyed on stray and late arriving domestic stock in Marsabit. Thus Laikipia lost livestock may be discovered and searches started in daylight or make their way home before it is too dark since they cover shorter distances unlike Mbirikani. The importance of arrival time and counting of livestock is illustrated below by some incidents in Mbirikani not observed in Laikipia.

While herding in Lenkilorit-Mbirikani a breeding bull was discovered missing and herders only pointed out that the bull was missing with unknown number of others. It was found the next day with six others in an area we were herding in a day before it was discovered missing. This means that we lost it a day before it was discovered missing and nobody noted and they spent two nights outside a boma's protection. In this particular case counting if ever done would have been impossible to do for we always left and arrived in darkness (5:45 am to 7:30 pm).

Counting in the herding fields instead of waiting until livestock returns home may help avoid the lost to spread widely. However this was not observed in both study sites because herders claimed to use knowledge of behaviour of their livestock to detect those missing. They said they knew their livestock by colours and identified those that were always fast moving or trailing with their associates and if they detected either of them missing they would know some are missing. But Mbirikani herders and herd owners unlike in Laikipia did not count their livestock even when they returned in daylight. Probably this is why during interviews majority of Mbirikani herders could not give exact number of their herd while

Laikipia ones gave exact numbers and went a head mentioning the number of their other herd that was being herded somewhere else by different herder(s). The exact number of the lost was always unknown in Mbirikani until they were found.

The reasons why Mbirikani pastoralists do not count their livestock are unknown. Probably this is related to cultural, educational or security differences. In Laikipia, having commercial ranches surrounding them, the pastoralists might have learned the counting habit of commercial ranches compared to Mbirikani where there is no commercial ranch nearby. Livestock thefts may be another possible reason that can make herd owners count their livestock to ensure they have not been stolen while in the herding fields. Probably cattle rustling are more common in Laikipia than Mbirikani. A comment from one herd owner in one of the household interviews in Mbirikani suggests that culture of sharing and redistribution of livestock may have a role in failure to count ones herd:

> I do not want to know how many livestock I have. Over the years I have had many livestock that I have given out to my children and friends. Even though these livestock are with them, they are still mine and I cannot go round counting them (Field interview 4th January 2006).

This gives the impression that Mbirikani pastoralists may be more conservative than in Laikipia. Thus they keep large numbers of livestock that they redistribute. This is consistent with early studies which indicated that there is a difference in livestock holding in the two study areas with Mbirikani pastoralists considered to be wealthier than Laikipia (Mizutani, *et. al.* 2005).

5.3 Herders' Activities as Measure of Herding Efficiency

Herders from both study sites engaged in same activities while herding except miraa collecting that was only observed in Mbirikiani. Engaging in resting, talking, playing and staying alert always may indicate how careful a herder is. Comparison of activities from the study areas, show significant differences in time apportioning to actively directing, following a visible herd and resting. A

higher proportion of Mbirikani herders' time in actively directing their livestock was because they travelled longer distances to herding fields, went to new herding fields often and left their herds to disperse a lot as they slept or went miraa collecting rather being more careful. They spent more time in the morning and evening directing their herds to and from the fields and gathering their dispersed herds. In all the Mbirikani observations at least one hour was required to direct herds to herding fields while in Laikipia herding started almost immediately the herd left boma. Laikipia herders started resting in the first hour and that is why a greater proportion of their time was spent in resting than in Mbirikani but they had to stay closer to the herd to avoid trespass and hence spent more time following a visible herd compared to Mbirikani.

Interview responses suggested (section 4.3.1) losing livestock was considered normal in Mbirikani while Laikipia herders expected some disciplinary action if this happened. This may explain why Mbirikani herders appeared to relax more by engaging in sleeping and miraa collecting. Miraa collecting was only in Mbirikani and this is probably because this plant is common in Chyulu hills but absent in Laikipia. But sleeping which was proportionally negligible in Laikipia would have been equally done in both areas if conditions were the same. Even if desired by Laikipia herders, sleeping would be impossible with twin problems of encountering elephants and trespass.

Our expectation was that there would be a strong relationship between searching and activities like playing, sleeping, talking, and miraa collecting times as they could lead to dispersal and getting lost of livestock. Unexpectedly this was very weak and negative between talking and searching. This was probably due to small sample sizes as sometimes substantial time was spent searching after these activities in Mbirikani. Visibility as influenced by terrain could be another reason as a herder on top of Chyulu hills could easily locate his herd and went to gather it. Laikipia herders had to enhance visibility by climbing trees (figure11). Inverse relationship between talking and searching for Mbirikani could be due to

herders talked when it was very hot and herds were mainly resting under shade then (figure12). Going under shade for Laikipia herds was very rare for they mostly ranged in search for scarce grass.

Figure 11: Getting the scarce grass from under a fallen tree (right) and herders on top of a tree (left) to locate elephants in Laikipia.

5.4 Other Factors Leading to Livestock's Vulnerability to Depredation

Livestock obeyed herders' commands because even single three years old children were observed easily controlling several hundreds of shoats outside boma before they were released. Therefore, control a herd in the herding fields could not be difficult provided the herd remained close to it. Leaving herds on their own in herding fields, herding in unfamiliar area, dense vegetation and livestock of different species together plus thirst/hunger may contribute to livestock getting lost and hence increase their vulnerability to depredation. The incidents discussed below were mainly observed in Mbirikani.

Household interviews (section 4.3.2) indicate it is during the dry season livestock get lost and are attacked frequently. This is when cattle mostly escaped from the temporary bomas inside Chyulu National Park. As mentioned earlier Mbirikani livestock spent at least three days without drinking water at the peak of drought and is not unusual for a study in Marsabit report cattle spent 4-6 days without drinking water (Kruuk, 1980). But moving the whole day to distant waterholes without feeding can make cattle jump out of boma at night in search of grass thus

exposing themselves to predators. Similarly hungry goats spread widely in bushes unlike sheep and cattle that are grazers. Due to this difference, herding of different species of livestock together can lead to an increased probability of losing some (personal observation). It was observed when left, sheep quietly fed without bothering about the whereabouts of their group unlike goats that upon realising they were left started calling. Encountering lonely sheep that were lost was observed during the study in both areas (figure12). Thus livestock movement differences may be the reason we lost eight weaners and five sheep while herding sheep, weaners and goats together.

As per verification results (section 4.2.0) 70.6% of daytime Mbirikani incidents were undertaken by cheetah which is a diurnal predator and the victims were mainly sheep (70% of 20 victims).The higher number of sheep victims than goats supports the observation that when goats and sheep are herded together, sheep are more likely to be left behind and get attacked. However, with low predation reporting in Laikipia and records in literature lumping together sheep and goats as shoats, there is no comparative information to justify the observation. Another possible reason for the difference is that the sheep may be more abundant in Mbirikani thus had higher chances of being attacked than goats.

Figure 12: Lonely sheep in Laikipia (left) and in Mbirikani (centre) and some cattle under shade (right)

The day after drinking water, livestock appeared to range widely and fed non-stop. This was also the case in a cool day unlike in a hot one when herds mostly went under shade and were reluctant to feed. In these cases a herder needed to be careful to control their movement if herding in dense vegetation where all livestock was not visible always. For instance we lost a herd of 28 cattle in one incident and in another an entire herd in each case a day after the herds drank water. Also on a hot day we lost five cattle that were left behind unnoticed under shade in dense vegetation.

Herding in dense vegetation required undivided attention and staying close to the herd. Leaving a herd to move far ahead out of sight can lead to its changing direction unnoticed and hence getting lost. This was the case when two girls lost their entire herd of 20 calves and flock of 150 while going home through a dense forest from herding in Chyulu National Park. Herding in dense vegetation together with distraction might have been the reason a herder herding next to us lost his entire flock and 10 were found killed the next day. Similarly herders of different herds together distract their attention as they engage in other activities and their herds move out of sight making it difficult to figure out the direction they moved to in dense vegetation. This was the case when a shoats and cattle herder spent some time together talking and sleeping and we lost our entire flock that took the herder 40 minutes to find and in another incident five herders herding shoats and cattle rested and slept and an adult woman herder among them lost her entire herd of 20 that was later found heading towards a waterhole at night.

Deliberate leaving livestock behind while calving or sick exposes them to predators. Such livestock were usually left on their own the whole day as the others were herded. In figure13 the cow photographed with a child spent a night in the Park on calving and the white cow (right) calved and the tethered shoat was discovered it was sick as we went herding in the morning and both were left on their own the whole day until we returned. These incidents suggest that there

was no fear of day time predation or livestock predation is rare due to probably low densities of predators in the incidents areas. The case of low predator density may be true where a sick cow (figure13 bottom photos) abandoned in the Chyulu National Park for three days was not attacked and remained intact even after it died.

Figure 13: Livestock deliberately left behind when calving or sick

Deliberately leaving some livestock behind could be a common practice that made the livestock vulnerable to predator attack as was leaving livestock carcases outside boma. Disposal of livestock carcases near bomas observed in both study areas cannot only habituate predators to bomas and lead them to develop a taste for livestock but exposes livestock inside them to possible attacks. Noisy hyaenas that came to the carcases could attract other predators like lions to boma, increasing chances of cattle stampeding out.

5.5 Precautions Against Depredation

Herders are not likely to avoid areas they think they may encounter carnivores if sufficient pasture is available there (interviews sections 4.3.1). This is why herding in the commercial ranches at night was done in Laikipia and yet the

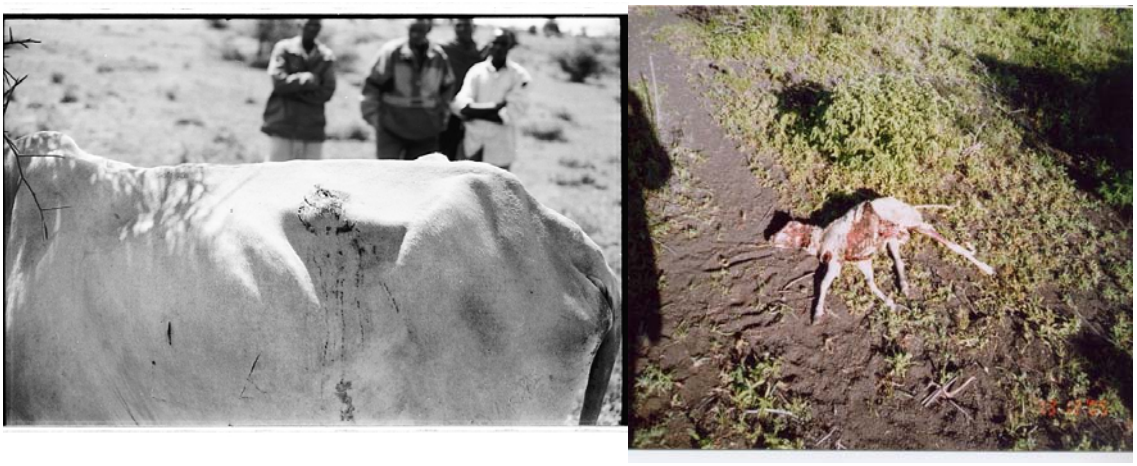
herders claimed the troublesome carnivores resided there. A comment from a herder in Laikipia who was taking his herd to a neighbouring private ranch at night indicates there was no fear of areas where encountering predators was likely provided there was enough pasture there:

> I cannot stop taking my cattle to the next private ranch at night even if I know that is where lions live. There is a lot of grass there while my cattle are dying of hunger. I better lose one to a lion rather watch them die in the group ranch (Field interview 29th September 2006)

Similarly majority of Mbirikani herders said day and night depredations were equal - a point that was also supported by predation verifications (section 4.2.0), yet they relaxed a lot while herding. This suggests that herders know that daytime livestock attacks in their presence may be unlikely or they can deter them. Herders are known to fiercely defend their livestock from predator attacks (Karani, 1994; Patterson *et al*, 2004) and herders' presence and the general harassment predators get from humans can deter them from attacking accompanied livestock and shift to night attacks or unaccompanied livestock during the day (Kruuk, 1980; Rudnai, 1979, Karani, 1994). Karani (1994) states that hyaena livestock attacks during the day in the group ranches adjacent to the Masai Mara National Reserve were usually on unaccompanied livestock.

However, evidence gathered in this study suggests that Mbirikani herders mostly left their herds unaccompanied or lost them as they engaged in other activities despite their knowledge of a possible predator attack. For example losing an entire herd of 40 weaners (among other similar cases in Mbirikani) five of which were killed by lions at night suggests that the herder must have been doing something else that totally distracted his attention to the herd. Thus verification of remains of some carcases that were claimed to have been attacked during the day in presence of a herder in this area were consumed to a level that suggested they were un-witnessed and the victims might have been lost at the time of attack (figure14).

Figure 14: Rescued victim of a night lion attack (left) a cheetah victim claimed to have been witnessed (right) in Mbirikani



These findings suggest that a combination of careful herding, strong night corrals/bomas and change of attitudes towards predation/predators together with pastoralists appreciating their role in livestock predation control can enhance sustainable predators' conservation in Kenya.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study found out that given similar conditions herders' behaviour will be the same while herding. Herders from both study areas engaged in similar activities but the frequency and time spent in each activity varied due to differences in the consequences of losing livestock between the areas. Laikipia herders remained more responsive to the movement of their livestock than Mbirikani to avoid trespass into surrounding private ranches and expected disciplinary action from herd owners on losing livestock. Therefore, Laikipia herders spent less time in the activities that could distract them from monitoring their livestock thus spending more time in following their visible herds compared to Mbirikani herders who mostly left their herds to disperse out of sight. An activity like sleeping that distracted herders' attention to livestock movement for a long time was negligible in Laikipia.

Chyulu National Park is an important dry season grazing area for Kajiado pastoralists. During the study livestock from all over the district entered the park illegally and stayed until the end of drought that affected most parts of Kenya.

Returning to boma late increases chances of losing livestock and hence their vulnerability to depredation for it is in late evening predators become active and have high chances of intercepting lost livestock as they find their way home. Laikipia herders' returned earlier from herding fields than in Mbirikani. Even though this can be attributed to fear of encountering elephants and limited ranging space rather than to efficient herding, the earlier return allowed for

counting and detecting of any lost livestock in day light unlike in Mbirikani where arrival was mostly in darkness.

Counting of livestock always to detect those missing in the herding fields was not considered important in both study areas. While this is important in earlier detection and searching for lost livestock it was only done in the evening at boma in Laikipia upon return of herds and it was not done at any time in Mbirikani.

Long distances to herding areas from boma and unlimited ranging space may increase livestock depredation. Both contribute to late arrival of herds and unlimited ranging space makes herders relax. Thus Mbirikani herders relaxed: spending time in activities that distracted them, leaving their livestock to disperse widely as they had no movement restrictions and hence lost their livestock frequently.

Similarly livestock staying long periods without drinking water and feeding contribute to their getting lost and finally losing them to predators. Livestock get lost more frequently in the dry season when both water and pasture are scarce. However, Laikipia herds that drank water and foraged daily in this season did not get lost as frequently as in Mbirikani. Long distances to waterholes led to Mbirakani livestock spending several days without drinking and spent whole day without feeding the day they travelled to drink. Therefore, due to thirsty they escaped in search of water while the night after drinking they jumped out of boma in search of pasture.

Herders of different herds coming together to engage in activities and mixing of different herds increase chances of losing livestock. Except for playing that was restricted to young herders, herders of all ages came together and engaged in similar activities and young herders (six to10 years) cover same distance as adults while herding.

Possibility of encountering a predator in an area does not deter herders from herding in that area provided it has enough pasture; neither do herders check for presence of predators before going herding in an area. Lack of night vigilance at temporary herding fields where bomas are not strong, and deliberate leaving of sick or calving livestock behind indicate that herders do not fear predators or predator densities are very low that attacks are least expected. Probably lack of fear of livestock predation and expecting no disciplinary action from herd owners made Mbirikani herders relax while herding. In Mbirikani, equal chances of day and night attacks were expected. Most of the day livestock attacks in Mbirikani took place while the livestock was lost contrary to the claims that they were attacked in herders' presence. Mbirikani herd owners considered losing of livestock as normal and hence could not discipline herders who lost livestock unlike in Laikipia.

Mbirikani herd owners and herders whose livestock were attacked while lost during the day could not admit this probably because of compensation penalties on laxity. The carcasses of the victims whose attacks were claimed to have been witnessed level of consumption suggested they were un-witnessed. Most of such victims were sheep.

Herding of sheep, goats and calves together increases chances of losing some due to their differences in movement speed and feeding habits. Goats move faster and spread widely than sheep/calves and sheep or calves are likely to be left behind as the herder runs around gathering goats. Herding these species separately may have contributed to fewer incidents of losing livestock in Laikipia.

Laikipia households preferred shoats (especially sheep) to cattle and had generally fewer livestock compared to Mbirikani who had both in larger numbers. This suggests that Mbirikani households are relatively wealthier and hence more conservative than Laikipia.

Disposal of carcasses near bomas can be sources of predator attraction to bomas and raises risks of predators breaking into bomas or livestock stampeding out and can get attacked. But this was not considered so as carcasses of livestock that died of hunger or disease were disposed outside bomas in both study areas and hyaenas were always attracted to them.

Overall livestock depredation due to losing livestock in the herding fields is preventable if herders improved their herding efficiency. Fear of disciplinary action together with herd owners' acknowledgement that losing of livestock is preventable can improve herders' efficiency. Even though environmental conditions forced them; Laikipia herders were more efficient in their herding than in Mbirikani. Hence staying close to livestock and remaining alert to monitor their movement and counting them always, watering them regularly, returning to boma in daylight, short ranging distances, and strong bomas can reduce losing livestock and their vulnerability to depredation.

6.2 RECOMMENDATIONS

To reduce losing livestock in the herding fields and hence their vulnerability to predator attacks during the dry season, herding efficiency must be improved. Main causes of losing livestock in herding fields identified in this study were lack of herders' vigilance, weak night enclosures in temporary herding fields, livestock spending many days without drinking water due to long distance to the watering points and long distances to the herding fields. To reduce the problem both husbandry improvement and further research are recommended.

6.2.0 Husbandry Improvements

6.2.1 Strict Herder Supervision

Laxity of herders in Mbirikani could have been as a result of not expecting disciplinary action from the herd owners. Therefore, if herd owners impose disciplinary action on them as was the case in Laikipia and supervise their herding, laxity may be eliminated. This can be achieved if herd owners stopped believing that livestock predation as well as its getting lost at herding fields is normal and there is nothing they can do to reduce it except total elimination of the predators. To reverse the situation, educational extension activities need to be developed that will be aimed at changing the people's attitudes towards and actively involve them in reducing livestock depredation. This education should not take the traditional way of teaching that is based on instruction but that which initiates a negotiation process where the community will actively be involved in developing and implementing predator deterrence techniques. The starting point will be by predator conservation agencies and other stake holders involved in pastoral communities development identifying the people whose livestock is frequently attacked and start talking to them to identify the unique herding constraints that they think lead to their losing more livestock to predators than the other people. Learning from their experiences, livestock husbandry techniques can be developed to demonstrate that efficient herding can reduce livestock depredation. For example experimental employment of some people by conservationists/other stakeholders to regularly supervise the affected people's herders will demonstrate the importance of supervision.

6.2.2 Regular Livestock Watering

To reduce chances of their escaping in search of water or grass, livestock has to drink water and forage daily as was the case in Laikipia. However, this can be impossible in Mbirikani due to long distances between herding fields and the water points in the dry season unless alternative sources of water provision are provided. One way of doing this is by bringing in water by Lorries to the point where livestock stay as some herd owners were doing to selected livestock in Ol Motoo-Mbirikani. However, this can be very expensive considering some people

have large herds while others cannot afford even if they had fewer livestock. A second option would be provision of piped water in designated areas that are accessible only during the dry season and must be closed in the wet season. This can be the best option that will require negotiations involving group ranch members and other stakeholders (development partners and conservation agencies) for its implementation will be impossible without support. Its disadvantages are the socio-political issues regarding control/management as well as ecological consequences of overstocking plus encouragement of permanent human settlements in fragile rangelands as experienced elsewhere provision of piped water has been tried (Swift *et al*., 1996). Hence if this option has to be considered, it has to be accompanied with education that will identify and discuss socio-ecological issues associated with this and proper regulations set to counter them. The third option that may reduce the above mentioned consequences would be building of strong bomas to prevent livestock escape at night from herding fields.

Strong and solid (reusable for several dry seasons) communal bomas can be built in designated areas that are regularly used by pastoralists during the dry season where several herds can be brought every day to spend the night. In the presence of such bomas holding livestock in the open or poorly constructed bomas should be discouraged and livestock owners have to give strict instructions to their herders that they have to return to the bomas daily. Therefore location of such bomas should be near herding fields where livestock can come back to daily. The building of such bomas can be done communally with donor funding or individual member contributions in cash or labour and their location decided by group ranch members with external advice to avoid high livestock concentration in one point that may lead to environmental deterioration and they should be used strictly in dry seasons only.

6.2.3 Returning to Boma Early and Regular Livestock Counting

Regular livestock counting in the herding fields should be encouraged. This has to be done in the herding fields as livestock forage and change vegetation cover to ensure some have not been left behind as well as detecting those missing early enough to start a search before they get dispersed a lot. Late returning to boma must be discouraged by all means. This can be done by herders leaving early in the morning to herding fields and come back to boma in daylight where final counting of livestock should be done on arrival to ensure all livestock are present and if some are missing a search is initiated immediately.

6.2.4 Proper livestock Carcass Disposal

Disposal of livestock carcasses outside bomas should stop and general disposal hygiene be observed to minimise predator habituation to livestock meat as well as well boma break-ins.

6.2.4 Initiation of Education Programmes to Encourage Integrated Land use

Increasing the capacity of pastoralists to tolerate carnivores may be the only way to their sustainable conservation. Therefore, educational programmes that will enable them participate in decision making processes on the use and management of their rangelands and equitable distribution of any benefits accruing therein will be the first step in that direction. The attitudes that pastoralists have developed over the years that wildlife belong to the government and conservationists need to be reversed through education that will make them realise they have a stake in the management of the wildlife they interact with on daily basis. This educational process has to be aimed at enabling them assess and appreciate both monetary and non-monetary wildlife values and integrate that to their livelihoods. Thus creating a situation where a pastoralist appreciates conservation of wildlife as a personal role must be the ultimate aim of education. This boils down to striving to eliminate mistrust between conservation stakeholders and pastoralists.

6.3 Further Research

This study was conducted in the dry season only and I recommend that a similar study be initiated in the wet season to compare any differences in herding mechanics and predation patterns in this seasons.

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APPENDICES

Appendix I

Household Questionnaire

Household/site No…….. Date……Time…….

A. Household details

1. Interview Location/site name_____ GPS readings _____

2. Interviewee Name (Optional) _____ Age (under10, 10-14, 15-18, 19-25, 26-32, 33-39, 40-46, 47-53, 54-60, over 61) Sex_____(Specify interviewee relationship to the entire household) _____

3. How many bomas does your family occupy? _____.If the family occupies more than one boma, are the bomas nearby or widely spread? _____

4. For how long have you lived here? _____

   Where were you living before moving to this place (if moved in recently)____

5. How many people of the following age range live in this family?

	Males	Females
Under 5yrs		
6-10 yrs		
11-15yrs		
16-20yrs		
21-25yrs		
29-30yrs		
31-35yrs		
36-40yrs		
41-45yrs		
46-50yrs		
51-55yrs		
Over 55years		

   Total _____

6. How many children who are over 5yrs but do not attend school? _____

7. How many children who are over 5yrs attend school? _____

B. Livestock numbers and herding practices

8. How many livestock does this household own? Cattle _____Shoats ____ Donkeys

9. Is this herd all yours or it belongs to other people as well? _____ **(If only owner go to Q11)**

   If the herd is shared, what is the relationship between you and the other owners?

   _____

10. Do all the other owners of this herd stay here all the time? Explain_____
11. How many herders herd your livestock? Indicate as shown below:
    Cattle _____(Males _____ Age_____ Females _____ Age _____)

    Calves and weaners _____ (Males _____ Age _____ Females_____ age ____)

    Shoats _____ (Males _____ Age_____ Females _____Age _____)

    Kids and Lamps _____ (Males _____ Age _____ Females _____ Age_____)

12. What is the daily role of each of the following members of your family in the **LIVESTOCK HERDING:**
    Husband_____
    Wife _____
    Morans _____
    Young boys _____
    Young girls _____
13. Are you satisfied with your current herding arrangements? **<u>Y/N</u> (If yes go to Q15**)

    If no, what problems do you face with your current herding arrangements?

    _____

14. What do you do to correct these problems? _____
15. Do the children who go to school in your household also herd livestock? _____

Who herds when they are in school?

_____
_____

16. Are there times of the year when you move with your livestock to a temporary boma? **Y/N** **(If no go to Q19)**

17. What difficulties do you encounter in the temporary boma?_____
18. When you are in this temporary boma, what do you do to ensure that livestock remain together throughout the night? _____

19. Are there times when your livestock spend a whole night/part of the night outside the boma? **Y/N**. If yes, why? _____

20. What measures do you take to ensure that your livestock are safe when outside a boma during the night? _____

21. Does your livestock get lost in the herding fields sometimes? **Y/N.** If yes, why do they get lost? _____

    Of your cattle and shoats which ones get lost often? _____. Please give reasons:_____

22. Do you employ a herder? **Y/N. (If no, go to Q23)**
    If you employ a herder and he loses some of your livestock, what is your reaction? _____

23. What is your reaction as a herd owner when you lose livestock while you are herding? _____
24. What will be your reaction if a member of your family loses some livestock while herding?
    _____

C. Livestock predation and attitudes towards livestock Predators

25. Which major **HERDING** problems do you face here? Please list them starting with the most to the least serious one: _____

26. Are there areas you would not like your livestock to go grazing in? **Y/N** **(If no, go to Q27)**

    If yes, why don't you like these areas? _____

27. Has a carnivore ever attacked your livestock? **Y/N** **(If no go to Q29)**

If yes, please indicate the species and number of livestock you have lost in the last:
Six months _____
Three months _____
One month _____
Two weeks _____?

28. Were the livestock staying in a **temporary** or **permanent** boma when they were attacked? **Season**_____? **Time of the day**_____? **Inside** boma or **outside**?

29. Where and when are livestock frequently attacked by carnivores in this area?
_____

30. Between cattle, shoats and donkeys, which ones are frequently killed by carnivores? (Categories of the victims to be recorded as per the table below)

	Never	Sometimes	More often
Female cows			
Bulls			
Heifers			
Weaners			
Calves			
Goats			
He goats			
Kids			
Rams			
Ewe/female sheep			
Lamb			
Donkeys			

31. Why do you think a certain group of livestock are often eaten by carnivores as you have indicated above(Q30)_____
32. Have you been compensated for any of your livestock killed by carnivores? **Y/N** Please explain:_____

33. Which carnivore species do you think are the worst threats to livestock here?
_____
_____Why?_____

D. Predator deterrence measures

34. Do you own dogs in this family? **Y/N.** If yes, how many? ___ **(If no, go to Q36)**

35. Why do you keep these dogs? _____

36. What do you do to protect your livestock from being attacked by the following predators while you are herding?
    Lion_____
    _____
    Leopard_____
    _____
    Hyaena
    _____
    Cheetah
    _____
    Jackal
    _____

37. How will you protect your livestock from carnivores day and night?

Day time measures	Night time measures
_____	_____
_____	_____

38. Who do you think should be responsible for controlling predator livestock-raiding in this area? _____
39. What do you think you can do to control your livestock predation?
    _____

40. Do you think it is possible for people to continue living with carnivores in this area? **Y/N**. Please give reasons for you r answer: _____
41. Are there benefits of having carnivores in this area? _____

42. Do you have any comment you will like to make regarding carnivores and herding in this area?

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION TO THIS SURVEY AND I HOPE YOU WON'T MIND IF I COME BACK AGAIN FOR ANY CLARIFICATIONS IF NEED BE.

APPENDIX II

Herders Questionnaire

Questions for the Herders who are encountered at grazing fields

1. Location name _____GPS_____ Date_____ Time _
2. Herder's name_____ Age _____ Sex _____
3. What time did you let your cows to go grazing this morning? _____. Do you let them out this time always? _____.

4. Did you come from a **permanent** or **temporary** boma this morning? **Y/N**
   If from a temporary boma, for how long have you been staying in this boma? Where is the permanent boma? _____

   If a child, do you attend school sometimes? **Y/N**
5. How many livestock in this herd? (a) Cattle_____ (b) Shoats_____ (c) Donkeys_

6. Are you hired? **Y/N.** If not hired, specify relationship to herd owner/**OWNERS**.

7. Does this herd/flock belong to one owner? **Y/N.**
   (a) If shared, what is your relationship to the other owner(s)?

   (b) Are you accompanied with the other owner always when you go out herding?**Y/N**. Please explain_____

8. How many of you are herding this livestock?

9. Do you always/sometimes herd alone? **Y/N (Accompanied with others boys/girls/young men/elders/women)**

10. What other activities do you engage yourself in while your herd/flock is grazing?
    _____
    _____
    _____
    _____

11. What time of the evening do you mostly **ARRIVE** home with your livestock? _____

12. Are there times you let cows out of the boma before sunrise or bring them home after sunset? _____
    (a) When do you let them out before sunrise? _____ Why? ____
    _____
    _____
    (b) When do you let them out after sunset? _____ Why? ___
    _____
13. Do you herd here all year round? _____
14. Are there times you move your cows/shoats to other places? **Y/N.** Why do you go there? _____
15. What is the first thing you look for before taking your cows out grazing in a certain area? _____
16. Are the other areas where you herd always like this area you are now? **Y/N.** Please tell me whether they are **OPEN/BUSHY** than this?
    _____
    _____
    _____
    _____
17. Is your herding activity different when the habitat is more open from when it is bushier? _____ Please tell me the precautions you observe when herding in an open habitat and when in bushier habitat:
    Open habitat
    _____
    _____
    _____
    Bushier habitat _____
    _____
    _____
18. What alerts you of the presence of a predator near where you are herding? _____
19. Are there areas you always know you will encounter predators when you are herding? **Y/N**

    When you approach these areas what do you do? _____
20. Are you accompanied by a dog (s)? **Y/N.** How many? _____
21. How do you ensure that you have not lost some of your livestock? _____

How often do you do this: _____

22. Have you ever lost some of your livestock you were herding? **Y/N.** If yes, were you staying in a **permanent** or **temporary** boma when this happened? _____.

23. What is your reaction when you discover that some livestock in your herd are missing?
    _____
    If not owner, what is the owner's reaction when you lose his livestock?

24. Have carnivores ever attacked the livestock you herd? **Y/N. (If no, go to Q29)**
25. Which carnivores were these? _____

26. What time did the carnivores attack?
    _____
    _____
    _____
    _____
    _____
27. Where were the livestock that were attacked? _____
28. Is there a difference in the number of attacks between when you are herding far away from the permanent boma and when you are herding near it?_____
    _____
    _____
    _____

29. **If in a temporary boma**, can you recall how many of each of the livestock you herd you lost to a predator(s) when you first started herding here?
    a) Shoats_____ b) Cattle _____ c) Donkeys_____

30. If carnivores attacked your livestock recently, can you recall how many of your livestock have been killed in the past:
    Six months _____
    Three months _____
    One month _____?

31. How many of each of your livestock i.e. cows, shoats, donkeys were attacked within the last six months by the following carnivores?

	Shoats	Cows	Donkeys	Other (specify)
Lion	_____	_____	_____	_____
Leopard	_____	_____	_____	_____
Hyaena	_____	_____	_____	_____

Cheatah _____ _____ _____ _____
Jackal _____ _____ _____ _____

32. Which carnivores cause problems to you most times? _____

33. What is your reaction when you know that any of the following carnivores is close to where you are herding?
Lion
_____
Hyena_____
Leopard
_____and
cheetah _

APPENDIX III

PREDATION INCIDENT DATA SHEET

Incident No._____ Credit note no. _____

1. Did the incident take place near a temporary boma or a permanent one? _____

2. Interviewee name_____ Sex ( ) Age _____ Owner/Herder

3. If herder, relationship to the herd owner (Wife, Son, Daughter, Cousin, Employee, Other specify _____).

4. Do the herder(s) go to school? Y/N How many go_____ How many don't ___

5. Was the incident witnessed? Y/N. Explain how it happened _____
   _____

6. Date and time carcass was discovered _____

7. Habitat description of the incident site _____
   _____
   _____

8. Carcass description _____
   Claw and tooth marks/signs of struggle (_____
   _____)

9. Where was the livestock that was attacked? _____. If victim was lost, how many were lost? _____. When was it discovered missing? _____. What did you do when you discovered this?
   _____
   _____

10. What was the habitat the whole herd was grazing before the incident like? _____
    _____
    _____
11. How long have you been herding in this area this season? _____
12. Have some of your livestock been killed by a carnivore before? Y/N When was this? ___
    Which Carnivore(s) was/were this/they?_____.
13. Were you compensated for all you lost? Y/N. If no please give details: _____
    _____
14. Is there anything else you would like to mention with regard to livestock herding and livestock predation?
    _____
    THANK YOU FOR TAKING PART IN THIS SURVEY.

APPENDIX IV

OBSERVATION CHECKLIST

Monitored Herd

1. Total number of livestock _____ Adult cattle _____ Calves_____ Sheep/Goat _____ Donkeys _____ Other (specify _____
2. GPS location of manyatta _____ Permanent/Temporary _____
3. Activities taking place before the herd leaves the boma:
    a) Who is milking _____
    b) Livestock counting and who is doing it _____
    c) Assigning of herding duties and who is doing the assigning _____
    d) Who is assigned what? Men _____ Women _____ Children _____ (Boys _____ Girls _____)
    e) How long do the above activities take? _____
4. Time left manyatta _____ and direction taken when leaving _____
5. How different livestock are moved out? _____
6. How many herders and their gender accompanying each livestock? _____
7. Number of dogs in each manyatta_____ and do they accompany the herders? _____
8. Weapons carried by herders? _____
9. GPS reading hourly since livestock left boma in the morning until they return in the evening _____
10. Sketch the dispersal pattern of livestock after every two hours, noting the positions of the breeding bulls, cows and the young _____
11. Record the vegetation cover and visibility after every two hours _____
12. Record the activities herders engage themselves in and the time taken in each activity _____
13. Describe terrain (Flat/Rolling/Single escarpment/Hilly) and habitat (open grassland/light bush/dense bush/forest) the livestock move through and the time taken in each while at the same time the precautions to of the herders will be noted for each terrain and habitat type._____

14. GPS reading and the time at the point where herders start returning home. _____
15. Whether the same route is used when herders return home. _____
16. Same recording procedures (as those in the morning when the herders left the boma) when the herders move back home. _____.
17. Activities that take place when the herders arrive in the evening. _____.
18. Any overnight anti-predator precautions taken._____
19. What is the livestock watering regime like i.e after how long are the animals taken to drink water and what distance is covered from the grazing fields or Boma ____. What time is the watering done? _____ Number of hours taken to the watering point? _____