"THE EFFECTS OF LAND USE SYSTEMS ON THE SOCIOECOLOGY OF THE

OLIVE BABOON (*PAPIO HAMADRYAS ANUBIS*) AND HUMAN-BABOON

INTERACTIONS IN LAIKIPIA DISTRCT, KENYA"

By

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ABSTRACT OF THE DISSERTATION

"The effects of land use practices on the socioecology of the olive baboon (*Papio hamadryas anubis*) and human-baboon interaction in Laikipia District, Kenya"

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The potential importance of food availability and predation as selective forces in social evolution has been hypothesized by the socioecological models (Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997). Traditional socioecological models explain primate social behavior in relation to factors such as the abundance and distribution of food resources as well as the risk of predation - all of which are potentially and substantially impacted by a range of anthropogenic processes. It is from this premise I studied the olive baboon's (*Papio hamadryas anubis*) adaptive behavior in contrasting land use systems. I further complemented this approach by exploring human–baboon interactions in various land use systems to better understand associated patterns of coexistence through tests of Wildlife value Orientation models (WVO) (Fulton et al. 1996; Ingelhart and Baker 2000; Manfredo and Dayer 2004; Teel et al. 2007). The premise of these models is human interactions with wildlife are derived directly from basic values people have towards nature. I, therefore, explored the values associated with land use practices. The overarching question for this study is – How do different anthropogenically modified habitats influence primate adaptive social behavior and patterns of human-primate symbiosis? I examined this question using baboon behavioral

data as well as semi-structured and structured interviews with people in different land use

system during a 21 month field study in Laikipia District, Kenya. I found that variation in

food availability in different land use systems was the most important factor influencing

baboon aggressive behaviors. This indicates that humans are also key agents in

reinforcing the selective pressures of ecological factors that potentially influence primate

adaptive behavior. Further, my interview data revealed that people's values towards

baboons were not associated with land use systems, but rather with the duration of living

in areas with baboons, level of education, and land tenure systems. Land use, on the other

hand, was a prominent factor associated with people's reported direct interactions with

baboons and the motivations underlying their encounters with them. My dissertation

contributes towards a more integrated synthesis of our understanding of primate social

evolution and coevolution of human-nonhuman primate symbiosis.

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during my field work phase in one way or another. I would, however, like to sincerely thank each and every one of them for their support and contribution to this dissertation. I hope this dissertation bears some fruit that is applicable in their lives.

This dissertation would have not been possible without my parents unwavering support throughout my upbringing and academic career. Studying primates and more specifically baboons was a source of great humor for many relatives and friends in Kenya. My parents constant encouragement, however, was one of the main reasons I eventually pursued my academic career to the PhD level. Their persistent belief that I could do it even when I had doubts made it more the worthwhile to endure. Their encouragement and support never ceased and presented themselves in various ways. .

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TABLE OF CONTENTS

CHAPTER 4: THE INLFUENCE OF HUMAN MODIFIED HABITATS ON THE

SOCIOECOLOGY OF THE OLIVE BABOON (PAPIO HAMADRYAS ANUBIS) IN

CHAPTER 5: THE INFLUENCE OF LAND USE PRACTICES ON PEOPLE'S

VALUES AND INTERACTIONS TOWARDS BABOONS (PAPIO

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF APPENDICES

CHAPTER ONE

OVERALL INTRODUCTION

The term "Anthropocene era", first coined in the 1980s by ecologist Eugene F. Stoermer, is an informal geo-chronological term that marks the period during which human activities have had a significant global impact on the Earth's ecosystems (Revkin 2011). While much of the environmental change on Earth is suspected to be a direct consequence of the Industrial Revolution, it has been proposed that the Anthropocene began approximately 8,000 years ago when humans gradually replaced hunter-gatherer subsistence with farming, animal husbandry, and sedentary lifestyles (Ruddiman, 2003). These innovations were followed by a wave of wildlife extinctions driven by both the direct activity of humans (e.g. hunting) and the indirect consequences of land-use changes that are still ongoing (Ruddiman 2003). The extent of the human impact is further supported by scientific evidence, using global geographic data and advanced GIS technology to map out "The Human Footprint", to illuminate how human activities affect almost every terrestrial system (Sanderson et al. 2002).

It is from this premise that I studied olive baboons (*Papio hamadryas anubis*). I examined baboon's adaptive behavior in different human modified habitats and complemented this approach by exploring human–baboon interactions in these shared ecologies in order to better understand associated patterns of coexistence. The overarching question for this study is – How do different anthropogenically modified habitats influence primate adaptive social behavior and patterns of human-primate

symbiosis? To answer this question, my study had two main intellectual components. The first component tests socioecological theory (Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997) by examining the baboon's behavioral response to human alteration of its habitats. The second component examines variation in different land practitioners' values towards wildlife in general and, baboons in particular, as well as the associated patterns of human-baboon interactions and co-existence. The goal was to test predictions of Wildlife Value Orientation (WVO) theories (Fulton et al. 1996; Ingelhart and Baker 2000; Manfredo and Dayer 2004; Teel et al. 2007).

By testing both the socioecological theories and the Wildlife Value Models, I integrate two theoretical perspectives to examine humans as sources of direct (e.g., predation, mutualism, commensalism) and indirect (i.e., modified ecologies) selective pressures influencing primate social evolution and the history of symbiosis between the two primate taxa.

Socioecological Theory

Baboons and humans share a long evolutionary history of sympatry (e.g., Isaac, 1968, 1969), which of course continues to the present day throughout Africa. Commensalism of baboons (*Papio hamadryas* subspecies) and modern humans suggests a pronounced adaptability of the former to anthropogenically modified habitats (e.g., Kemnitz et al. 2002; Ocaido et al. 2003). Little is known however, about the nature and flexibility of baboon's responses to human-altered habitats. More importantly, a study of this process can test models of primate social evolution that explicate how solutions to the problems of finding food influence females social interactions with one another (Hawkes 1992;

Sterck et al 1997). Anthropogenic alteration of habitat vegetation provides an opportunity to evaluate these models' predictions with respect to the influence of food resource variation on female social interactions (e.g., Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997). These models are the foundation of our general understanding of social evolution, and the principles derived from them not only help us understand nonhuman primate societies, but also the evolution of human societies as well as social evolution in general.

According to the socioecological models, females compete primarily for resources, and the nature of this competition shapes female social relationships (Wrangham 1980; van Schaik 1989; Isbell 1991; Sterck et al. 1997). Competition has two distinct components (i.e., contest or scramble) whose relative strength depends on resource distribution patterns (van Schaik 1989). Contest competition occurs when food resources with high or varying energetic value are relatively discrete ("patchy") allowing some individuals can systematically exclude others from these patches. Consequently, inter-individual distances are predicted to decrease among cohorts of related females who provide coalitionary support to one another for access to these resources. The result is "despotic" social relationships based on female dominance and alliances (Wrangham, 1980; Isbell, 1991; Sterck et al. 1997).

Scramble competition occurs over food resources that are either low in value, highly dispersed, or spread evenly over extremely large areas (relative to the size of the group). In this ecological scenario, inter-individual distances increase and the resulting social pattern is based on weak or non-linear hierarchies. Thus, the nature of female competition and social interaction are hypothesized to reflect particular patterns of food

availability (van Schaik 1989). Additionally, there are trade-offs between foraging efficiency and predation, as increasing group size potentially reduces the risk of predator attack, but simultaneously increases within-group foraging costs (van Schaik, 1989; Sterck et al., 1997). Thus, low predation risk facilitates dispersion of group members (to reduce foraging costs) (van Schaik, 1989).

I used an analytical comparative approach that studies baboons occupying land use systems in Laikipia, Kenya at a site characterized by pastoralism and commercial ranching. Pastoralist lands in Laikipia are typically characterized by heavy grazing. This is partly because fencing around the neighboring commercial ranches restricts the traditional practices of seasonally moving livestock and consequently increases local densities (Georgiadis et al. 2007a). Georgiadis et al. (2007a) found that commercial ranches generally had lower livestock densities (2.7 t km-2) than did the "transitional ranches" (4.6 t km-2), which I refer to in this dissertation as "occupied pastoralist lands." The effects of grazing vary with its intensity. For example, low levels of grazing are thought to exemplify man-made ecosystems that are the richest in plant species in central Europe (Wolkinger and Plank 1981; Fischer and Wipf 2001). Moderate levels of grazing, on the other hand, may enhance plant diversity (Naveh and Whittaker 1979; Waser and Price 1991; Noy-Meir et al. 1989), while excessive grazing may reduce it (Waser and Price 1991; Noy-Meir et al. 1989; Olsvig-Whittaker et al. 1993) or simply shift local vegetation composition (Naveh and Whittaker 1979; Milton et al. 1994; Todd and Hoffman 1999).

Predation risk also appears to vary meaningfully across these two land use systems in Laikipia. Using radio-telemetry data on 71 lions (*Panthera leo*) in the area, Frank et al.

(2005) concluded that lions strongly prefer the commercial ranches where both human and livestock densities are lower. It is likely that leopards (*Panthera pardus*)—a predator of baboons generally and locally (Cheney et al. 2004; Palombit pers. comm.)—similarly prefer commercial over pastoralist lands (Frank pers. comm.). The anthropogenic influences embodied by these contrasting habitats are moderate enough to allow baboons (and other wildlife) to subsist and reproduce successfully, but substantial enough to confront these primates with significantly different local ecologies.

While it can be argued that incorporating the human dimension in into tests of socioecological models can be perceived as "noise" that is interfering with the models' predictive powers, some have argued otherwise (Riley 2006; Fuentes 2006; Strier 2006). For example, Fuentes (2006) argues that incorporating the human dimension—beyond the "classic" studies of primate crop raiding and human hunting of primates—is critical for testing socioecological models. Strier (2006) supports this argument by adding that traditional socioecological models assess primate behavior in relation to factors such as distribution of food resources, presence and distribution of predators, resource availability, all of which are substantially impacted by a range of anthropogenic processes. Alteration of forest structure, mammalian biomass, and floral composition of habitats may directly impact the basic ecological constraints that are generally invoked in socioecological explanations. Conducting primatological studies in a putatively "natural" environment without considering the human dimension implies irrelevance of humans in influencing contemporary primates' socioecology. This view may not only be ecologically inappropriate in certain cases; it also overlooks the growing archeological evidence that some primates and humans have shared a long evolutionary history.

Other authors have criticized tests of the models for failing to incorporate actual measurements of vegetation (Matsumura 1999; Menard 2004; Thierry 2008). Another critique is that these models have not been evaluated in a large comparative test to directly explore the relationships between ecological characteristics and their corresponding social interactions (ShÜlke and Ostner 2012). My study redresses some of these issues by evaluating baboon feeding and social behavior explicitly in the context of ecological variation arising from contrasting anthropogenic land use practices.

Wildlife Value Orientations models

Wildlife Value Orientation (WVO) models argue that human interactions with wildlife derive from basic values towards nature (Fulton et al. 1996; Ingelhart and Baker 2000; Manfredo and Dayer 2004). Previous studies have identified different "cultural value orientations" that hypothetically influence those interactions: 'Materialism', 'Symbolism', 'Mutualism', 'Environmentalism' and others (see Dayer et al. 2007; Tanakanjana and Saranet 2007). 'Materialism' refers to people's focus on a utilitarian or dominant view of wildlife: wildlife exists to fulfill human needs for subsistence and economic well-being, as well as for higher order needs such as recreation, and/or humans' natural dominance over and control of wildlife (Tanakanjan and Saranet 2007). 'Symbolism' refers to people viewing wildlife and the environment as created and controlled by a higher power(s) and explains the way the natural world works through a spiritual or religious viewpoint (as opposed to a strictly scientific viewpoint) (Dayer et al. 2007; Tanakanjan and Saranet 2007). 'Mutualism' refers to viewing wildlife as meriting relationships of trust with humans, having rights like humans, and being part of an

"extended family" (Dayer et al. 2007). 'Environmentalism' is a general cultural concern about protecting the environment, which can be extended to conserving wildlife (Dayer et al. 2007). This orientation may also be expressed through cooperative organizations that coordinate wildlife management and conservation programs within communities. Lee and Priston (2005) note that "…societal expectations (myths, religious belief, economic or political contexts) establish initial principles for how humans are 'expected' to behave towards monkeys and …[is thus layered on a series of beliefs and expectations to produce perceptions of monkeys…" (pp. 9).

Thus, levels of aversion, tolerance, protection, and use of primates vary across cultural contexts (Biquand et al. 1992; Burton 2002), in part because of different wildlife value orientations. For example, Manfredo et al. (2003) found that people with more traditional values believed that wildlife should be managed and utilized to benefit people ('Materialists'). This value orientation is strongly and inversely related to people's level of income, urbanization and education (Manfredo et al. 2003; Inglehart and Baker 2000). In different cultures, primates are traditionally viewed as guardians of human settlements, spirits of ancestors, or kin (Lee and Priston 2005). Certain East African pastoralist communities ritually sacrifice cattle to protect sorghum and maize fields from nonhuman primates and birds (Fukui 1996). These observations respectively implicate 'Mutualism' and 'Symbolism', indicating that more than one type of value orientation may be expressed by a single person. Wildlife Value Orientations models have received extensive attention and empirical support in the social sciences (See Manfredo and Dayer 2004; Dayer et al. 2007; Teel et al. 2007). While theoretically significant, these models

also provide clear practical implications for conservation and management of wildlife in general.

I evaluated the role of land use practices relative to seven other socio-demographic factors that have been reported to influence people's value orientation towards wildlife. The values and ideologies that people have about nature, I argue, are also associated with land use practices (e.g., subsistence, management, conservation), which directly impact human-wildlife interactions as predicted by the WVO theory (Dayer et al. 2007). For example, many studies have illustrated how commercialization of wildlife can displace existing cultural values, and enhance or reduce tolerance and protection towards wildlife (King and Stewart 1996; Newmark and Hough 2000; Infield 2001).

Few studies, however, have successfully demonstrated how traditional knowledge incorporated with certain land use practices, such as ecotourism, can change human perceptions towards wildlife (Kuryan 2002; Igoe 2004). Additionally, ecotourism practitioners tend to be largely biased towards the charismatic species that attract tourist revenue, such as elephants and the great apes (Walpole and Leader-Williams 2002; Adams and Infield 2003; Gadd 2005). What is less well understood, however, people practicing different land use systems value other "less charismatic" wildlife, like the baboon, whose cultural or economic value to humans remains unclear. People's bias against baboons has been exceptionally prominent around agricultural land use systems, where baboons are largely perceived as "pests" due to the quantifiable costs of crop raiding (Kingdon, 1974; Hill 1997; 2000; Naughton-Treves et al. 1998; Obunde et al., 2005).

This study examines the role of land use systems on people values about wildlife in general and about baboons in particular, as well as the patterns of human-baboon interaction that result. How values towards wildlife and their interactions with humans are linked to land use practices will clarify the underlying theoretical basis of how these interactions eventually influence long-term patterns of sympatry (Manfredo and Dayer 2004) between humans, baboons and other wildlife. By testing predictions about baboon behavioral responses to human-modified habitats, and human-baboon interactions, this study links together theory and practice: it evaluates the utility of both the socioecological and WVO models as effective resource management and conservation tools for wildlife inhabiting human-modified habitats.

First, from an evolutionary perspective, olive baboons are an ideal subject for examining adaptive shifts in behavior in response to short-term ecological changes wrought by anthropogenic impact. What has become evident after more than 50 years of primatological research is that, like humans, behavioral flexibility in the face of varying ecological conditions is, in fact, shared by many other primates (Fleagle, 1999; Isbell and Young 2002). The olive baboon (*sensu lato*) is the most widely distributed of all extant *Papio* spp., and an apparently expanding geographical distribution over historical time suggests significant behavioral and ecological flexibility in relation to human modified habitats (Kingdon 1977).

My findings will also provide effective and practical recommendations that will yield tangible contributions to wildlife management and conservation practices. These findings will contribute to ongoing collaborations with local educational and research institutions as well as with various other national and international organizations that aim

to build long-term educational and conservation management activities. During my fieldwork, for example, I visited local primary schools in Laikipia to give talks to students about my experiences with baboons and inform them about my research on human-baboon interactions.

Synopsis of dissertation chapters

CHAPTER 2: I applied an interdisciplinary methodological approach in this study. Three different sets of data were collected to: 1) quantify differences in vegetation attributes, such abundance, distribution, and diversity of plants between humans land use systems and; 2) observe and record baboon behavior, particularly their responses to human modified habitats and; lastly measure; 3) people's values towards baboons and human interactions with them, as recorded via interviews with people in various land use practices.

Vegetation data: For the ecological aspect of the study, two land use systems were studied: 1) a commercial ranch (Segera Ranch) with lower livestock stocking densities; and 2) an overgrazed tract of land occupied by pastoralists (Thome B) (see Figure 1.1). The data collection protocol was designed to fully capture differences in temporal

(seasonal) and spatial (land use) plant productivity due in part to anthropogenic practices.
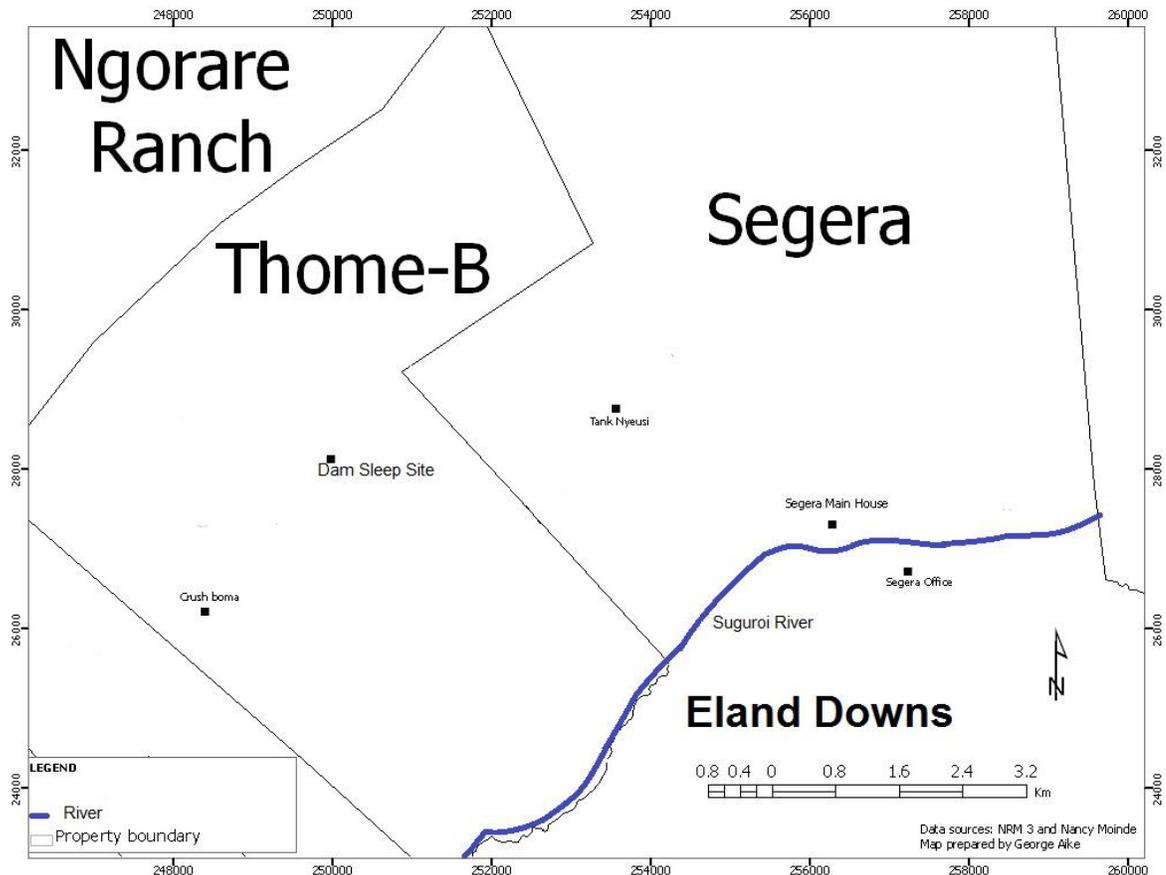
Figure 1.1: Map of the baboons'study site (George Aike, Mpala Research Center,

Laikipia, Kenya)

*Baboon behavioral data***:** From June 2009-December 2010, I collected data on two

groups of habituated olive baboons that Dr. R. A. Palombit and colleagues have studied

in Laikipia District since 2000. The composition of the larger group (Thome B – TDM)

was: 19 adult males, 30 adult females, 9 subadult males, 50 juveniles, 12 infants. The

smaller group (Kati Kati –KAT) comprised: 11 adult males, 10 adult females, 3 subadult

males, 4 juveniles, 3 infants. An experienced field assistant and I collected behavioral

data on both baboon groups from approximately 06:30 to 14:00; on certain

days data collection was extended to 17:30.

Baboon social behavior: Ten minute continuous focal sampling was used to measure

behavior of randomly selected adult females. I recorded the focal individual's nearest

neighbors at 2-minute instantaneous intervals. To measure variation in contest

competition across the two land use systems, I compared the levels of agonistic,

affiliative, and coalitionary interactions between the two land use systems. I also

measured the rates of a variety of agonistic interactions (e.g., supplants, threats, physical

attacks) and affiliative behaviors (e.g., grooming, lipsmacking, embracing as well as

spatial relations..

Assessment of predation risk: Predation risk was evaluated by recording ad libitum

rare and unusual, but conspicuous, behaviors (e.g., predation encounters). Potential

predators (lions – *Panthera leo*, leopards – *Panthera pardus*, spotted hyena – *Crocuta*

crocuta, black-backed jackal — *Canis mesomelas* were sighted within each of the two

land use systems while collecting baboon behavioral data.   Other evidence of predator

presence, such as predator vocalizations, spoor, and carcasses of baboons were used to

make a qualitative assessment of levels of predation risk between the two land use

systems. Baboons' perception of predator risk was also assessed by observing scanning

behavior using scanning rates that did not occur within the context of feeding to eliminate

biases against scanning for food competitors.

Data protocol on people's values towards baboons and human-baboon interactions

I used semi-structured interviews and questionnaires to examine values people have towards baboons and the interactions between humans and baboons.

*Semi-structured Interviews***:** The human-baboon interaction component of this research project entailed interviewing people from various land use systems about human-baboon/wildlife interactions. These interviews were conducted on men and women above 18 years of age in various regions of Laikipia District between September 2009 and May 2010. In several regions of Laikipia, a number of different ranches for each land use system were selected (see Figure 2.6).

Questionnaires: Information gathered from these semi-structured interviews was then used to construct a comprehensive questionnaire based on the variety of responses from a larger population. All questionnaire interviews were conducted from the 4th of November 2010 until the 25th of November 2010. Questionnaires were carried out one respondent at a time by the three assistants and myself. Questions were systematically presented to respondents and their responses were recorded by the assistants or myself.

CHAPTER 3: In this chapter I asked "How do two different management regimes, that is, pastoralism and a commercial ranching, with different livestock grazing densities influence vegetation attributes: abundance, distribution and diversity of vegetation species? To answer this question, I quantified human impact on these two land use systems — a pastoralist land (Thome B) and a commercial ranch (Segera) (see Figure 1.1). Since contrasting livestock densities and composition have been reported to impact

differently on the abundance, distribution and diversity of vegetation species, I predicted that woody plants in the pastoralist land would be characterized by: **1**) lower density; **2**) smaller canopy area; **3**) increased distances between neighboring plants; **4**) decreased height; and **5**) lower productivity.

Because gum production from the prominent woody tree *Acacia drepanolobium* increases with individual tree height, I also predicted that: **6**) these trees would exhibit increased gum production in the commercial ranches relative to conspecifics on the pastoralist land.

Due to the observed higher stocking densities and diversity of domesticated grazers (i.e., cattle and sheep) in the pastoralist land compared to the commercial ranch (only cattle), I also predicted: **7**) that herbaceous species would be more abundant in the commercial ranch than in the pastoralist land.

Because temporal changes in plant abundance and production are influenced by rainfall (McNaughton 1984), I predicted higher overall abundance of: **8**) woody plant production; and **9**) the herbaceous layer in the commercial ranch, relative to the pastoralist land.

Lastly, based from the increased occurrence of anthropogenic features, such as abandoned bomas and glades in the pastoralist land (Moinde unpublished data), which have been reported to increase plant diversity and habitat heterogeneity, I predicted that there will be a higher diversity of: **10**) woody plants; and **11**) herbaceous species on the pastoralist land, compared to the commercial ranch.

CHAPTER 4: In this study, I aim to clarify models of primate social evolution by addressing key questions regarding baboon behavior:

I asked the question: (1) Do socioecological models (e.g., Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997) accurately predict variation in baboon social behavior given different resource distributions and predation pressures arising from anthropogenic land use practices? In order to capture variation in feeding behavior in response to contrasting human modification, I hypothesized that on the land use system where resources are relatively more clumped and abundant, female competitive strategies will shift from a relatively greater emphasis on contest to scramble competition. I predicted that, compared to their activities on the pastoralist land, on the commercial ranch females will:

1) spend proportionally more time feeding; **2**) experience longer feeding bouts;

3) experience reduced number of feeding bouts and; **4**) show higher feeding rates.

I also predicted that in the land use system with more abundant and more clumped food resources, there will be**: 5**) reduced inter-individual distances; and higher rates of the following behaviors related to contest competition; **6**)

   a) increased displacements;   b) all displacements during feeding,

   c) all low intensity agonism;   d) all high intensity agonism and; e) all agonism

   I further predicted higher rates of **7**) affiliation (e.g., grooming, embracing, presenting, huddling, muzzling) among coalitionary partners and

8) coalitionary interactions (e.g., recruitments, joint attacks and joint defense).

I also predicted that **9**) increased visual scanning rates will be exhibited by baboons only while resting (but not necessarily while feeding) in the land use system with higher predation risk.

CHAPTER 5: In this component of my study, I employ an exploratory approach, rather than a predictive one. In this chapter I asked: "How do the different land us practices influence people's values and human-baboon interactions in Laikipia District?" To answer this question, I explored the influence of land use and six other factors (that is, gender, age, duration of residency in Laikipia, religion, ethnicity, and land tenure) on peoples' values, beliefs, and orientations towards baboons and human-baboon interactions. I evaluated the role these variables had on the responses of the following specific questions: **1**) What do feel you when you see to the following animals you listed? (in references to certain animals respondents mentioned); 2**)** What do think immediately after you have seen a baboon? **3**) Do you think that the presence of baboons can make you sick? **4**) What did you do when you last saw baboons? I also asked those respondents who indicated that they had used preventative measures against baboons: **5**) what method(s) did you use to prevent baboon(s) from coming near you/your property?

From preliminary studies, I also assumed that people who experience intense conflict with baboons will be more likely to request official preventative measures from the government for assistance relative to those who only used local preventative measures. To explore this aspect, I asked: **6**) Have you requested KWS[1] to assist you

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[1] Kenya Wildlife Services (KWS)

with scaring away baboons that were giving you problems at any one time?; **7)** Is it legal to kill baboons?; **8)** Do people still hunt baboons? I assessed people's sense of wildlife ownership by asking; **10)** Who owns the baboons in this area? This research is my attempt to achieve an integrated synthesis that places humans and primates (baboons) in shared social ecologies, and thereby contribute to the growing field of ethnoprimatology.

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CHAPTER TWO

GENERAL METHODOLOGY ON VEGEATION SAMPLING, BABOON

BEAHVIOR (Papio hamadryas anubis), HUMAN VALUES TOWARDS

BABOONS AND HUMAN-BABOON- INTERACTIONS

2.1 STUDY AREA

Laikipia District covers an area of approximately 9666 km^2 in north-central Kenya (36° 50' E, 0° 15' N) and it is dominated by semi-arid bush land and wooded savanna grasslands (Woodroffe and Frank 2005; Georgadis et al. 2007a; Young et al. 2007). Laikipia District is home to some of the most spectacular megafaunal populations in the world, such as elephants (*Loxodonta Africana*), giraffes (*Giraffa camelopardalis)*, buffaloes (*Syncerus caffer*), hippopotamuses (*Hippopotamus a*mphibious), oryx (*Oryx beisa*), and eland (*Taurotragus oryx*). In addition, the district also supports the highest species diversity in East Africa as well as the second highest density of wildlife in Kenya, after the famous Masaai Mara National Reserve. Yet this region is not formally protected and is an excellent example of a human-occupied landscape with adequate remaining habitat suitable for wildlife (Gadd 2005; Georgiadis 2007a; Perfecto et al. 2009). It is therefore an ideal scenario for examining the role of land use practices on wildlife-human interactions. The main ethnic inhabitants in the district are the Laikipiak Maasai, Pokot, Samburu, and Turkana as well as descendants of European settlers (Herren 1987). All of these groups are all predominantly dependent upon livestock (Herren 1987; Gadd 2005). The pastoralists are Laikipiak Maasai, Pokot, Samburu, and Turkana while the commercial ranchers are predominantly of European descent.

Pastoralism and commercial ranching are the predominant land use practices, but other complementary practices have been introduced. For example, the majority of "pro-wildlife" commercial ranchers also conduct ecotourism as a subsidiary activity supporting wildlife conservation efforts. While many of the pastoralist group ranchers continue to depend on subsistence pastoralism, some complement pastoralism with small-scale subsistence farming, while others carry out small scale, community-based tourism. Tourism is the second largest source of foreign exchange revenue in Kenya after agriculture (de Blij et al. 2010). The high population density and diversity of wildlife in Laikipia District has made it increasingly one of the most popular and lucrative tourist destinations in Kenya (LWF Newsletter, July Issue, 2007).

Over the last three decades, land use and management practices have varied widely as patterns of land ownership and wildlife attitudes changed (Gadd, 2005; Georgiadis 2007a). The outcome is a mosaic of histories, land use management attitudes and practices that form a patchwork of diverse human modified landscapes. The complexity of microhabitats in this district has arguably contributed to the richest diversity of wildlife within the country. Thus, the district presents an exceptional case that has significant potential to help improve our understanding of the diverse ways in which human cultural-ecological beliefs and practices shape contemporary patterns of resource (flora and fauna) utilization and management.

The successful maintenance of high densities and diversity of wildlife populations in an unprotected human-occupied landscape is largely attributed to the pro-wildlife practices promoted by the Laikipia Wildlife Forum (LWF). Established in 1992, the

LWF is an NGO managed and run by private and pastoralist landowners with the goal of managing, conserving, and profiting from wildlife through ecotourism (Parker, 2003; LWF Newsletter, July Issue, 2007).

In this current study, I define a land use system as any given area of land that is utilized in a manner to satisfy a specific anthropogenic objective(s) that involves the maintaining or modification of the environment through individual or management lifestyle practices. According to Di Gregorio and Jansen (1998), land use is characterized by human activities and inputs that change or maintain a certain land cover type. Land use defined in this way establishes a direct link between the actions of people in their environment and its land cover. Many of the local pastoralist ranches are communally-owned ranches inhabited predominantly by the Samburu and Turkana people and their cattle, goats, and sheep.   Those pastoralists who do not own land occupy abandoned tracts of land (squatter system). Many tracts of land that were previously bought by buying cooperatives in the 70s and 80s were later subdivided and sold to small landholders. The majority of these small holders eventually abandoned their land because crop raiding by wildlife made it difficult to cultivate (Anthony King, *pers comm.*). The pastoralist communities are typically bordered by the larger, privately owned commercial ranches, the majority of which are pro-wildlife and support as well as practice wildlife conservation initiatives (Georgadis 2007a).

The study area where the baboon subjects ranged was a wooded savanna grassland that is supported by poorly drained, seasonally waterlogged ("black cotton") vertisolic soils (Young et al., 1997). The baboon's home ranges straddled occupied pastoralist

land (Thome B) and a pro-wildlife commercial ranch (Segera Ranch). In Laikipia,

pastoralist lands in general are characterized by notably more heavily grazed and

browsed vegetation than on the commercial ranches (Moinde pers. observ), partly

because of fencing around the commercial ranches, which largely restricts the traditional

practices of seasonally moving livestock, forcing them to stay longer in one area, and

partly because of the high density of pastoralist livestock (Georgiadis et al. 2007a). This

semi-sedentary pastoralist lifestyle contrasts with the commitment of most of the pro-

wildlife commercial ranch owners in support of the Laikipia Wildlife Forum's

development and conservation goals. These ranches favor wildlife and therefore

encourage low to moderate livestock densities that reduce the impact on the natural

vegetation (Georgiadis et al. 2007a; Moinde *pers. observ*.). Georgadis et al. (2007a)

compared mean biomass densities of livestock in Laikipia and found that commercial

ranches generally had lower livestock biomass (2.7 t km^{-2}) (expressed in Tropical

Livestock Units or TLU kg per km^2) than in the pastoralist lands (4.6 t km^{-2}).

The main question for the vegetation aspect of my study is: "How do two different

livestock regimes with different livestock grazing densities influence vegetation

attributes: abundance, distribution and diversity of vegetation species? I measured

vegetation to compare how different livestock densities within a land occupied by

groups of pastoralists and a private commercial ranch influence abundance, distribution

and diversity of vegetation. The higher livestock densities and grazing intensities in

pastoralist ranches (Georgiadis et al. 2007a) appear to alter the local habitat (see Fig 1a

and 1b). Additionally, Georgadis (2007b) reported that long-term residents assert that

woody vegetation cover has increased over the last 50 years on commercial ranches due

to fire suppression - particularly in this land use system. Predation risk also appears to vary meaningfully across commercial and pastoralist land use systems. Using radio-telemetry data on 71 lions (*Panthera leo*) in the area, Frank et al. (2005) reported that lions strongly prefer the commercial ranches where human and livestock densities are lower. It seems likely that leopards (*Panthera pardus*)—a predator of baboons generally and locally—also similarly prefer commercial over pastoralist lands (Frank pers. comm).

2.2. DATA COLLECTION

Three different methods were employed to collect three types of data pertaining to different aspects of this study: (1) vegetation characteristics; (2) baboon behavior; and (3) human value and attitudes towards wildlife. Vegetation data were collected to evaluate differences in vegetation between the two land use systems (a pastoralist and a commercial ranch) that experience different grazing intensities. Baboon behavior was quantified in order to test socioecological hypotheses based on these vegetation differences. Lastly, semi-structured and structured interviews provided data on people's values towards, and interactions with, baboons (and other wildlife) as well as the influence of cultural beliefs and practices associated with the different land use practices throughout the district.

2.2.1 Vegetation Data Collection Protocol

In this component of the study, the two land use systems studied were: 1) a commercial ranch (Segera Ranch) with lower livestock stocking densities; and 2) an overgrazed tract of land occupied by pastoralists (Thome B). The data collection protocol was designed to fully capture differences in temporal (seasonal) and spatial

(land use) plant productivity due in part to anthropogenic practices. The baboons' natural diet is eclectic, largely comprising fruits, seeds, underground storage organs, exudates, leaves, shoots, buds, stems, galls, flowers, and fungi (Barton and Whiten 1994; Palombit, 2013; Palombit, in press). The majority of woody plant production (i.e., gall [2], pods, flowers, seeds) are from the *Acacia* trees, in particular *A. drepanolobium* (Moinde, in prep) (Fig 2.1).

Floristic and phenological measures were carried out to compare baboon food availability in these two different land use systems. Data were collected for 5-7 days per month from November 2009 until August 2010, except for a pause in April and June 2010, due to unusually heavy rainfall. To establish the ecological differences between these land use systems, a total of 20 vegetative plots were established following Kent and Coker (1992), Higgins et al. (1994); and Bonham (1989). These plots were situated within the study group's home range along three individual transects (see Fig 2.2). Two of the transects (T_1 and T_3) were each 2 km long. One was located in Thome B and the other in Segera ranch (Fig 2.2). Transect 2 (T_2), was the longest of the three transects at

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[2]   *Acacia drepanolobium*, is a swollen-thorn *Acacia* native to East Africa (Madden and Young 1992; Young et al 1997; Ward and Young 2002; Goheen and Palmer 2010). This acacia species produces a pair of straight thorns at each node, some of which have large bulbous bases. *A. drepanolobium*, ranges in height from less than 1 m to 7 m (Young et al., 1997). Like other *Acacia* trees found within the area, *A. drepanolobium* produces numerous hollow, oval swellings derived from swollen thorns called galls (See Fig 2.1). These 'galls' are part of a complex mutualism existing between *A. drepanolobium* and ants of several species of the genera *Crematogaster*, *Tetraponera*, *Camponotus* (see Hocking, 1970; Madden & Young, 1992). Colonies of these ants live symbiotically with *A. drepanolobium,* utilizing the galls as refuges and reproductive sites, and harvesting extrafloral nectaries on the leaves. The ants, particularly those of the genus *Crematogaster,* swarm and bite animals that disturb the branches, thereby reducing herbivory (Young et al., 1997). *Acacia drepanolobium* has leaves that contain tannins and the tree is covered with spines, both are thought to serve as deterrents to herbivory (Madden and Young 1992; Ward and Young 2002; Goheen and Palmer 2010) as well as herbivorous insects. Immature galls are soft, green, and succulent, and are consumed occasionally by baboons. Baboons do not usually consume the mature black galls themselves but break them open and consume the ant eggs, larvae, pupae and adults that are found inside. Old desiccated galls are typically devoid of ants, although they may support other invertebrates and small vertebrates (Moinde, pers observ.).

4.5 km and extended equally across each of the two land use systems. Along each

transect, a 25m x 25m vegetative plot (e.g., P_0 to P_4) was marked every 500m, giving a

total of 10 plots in each land use system (Fig 2.2). The distribution of these transects

and plots aimed to sample each land use system similarly. For example, the number of

seasonal rivers/swampy areas was represented equally in each land use system's plots.

Quantitative Vegetation Measures

Five types of quantitative vegetation measures were taken in each plot: (1) abundance of

woody plants, (2) dispersion of woody plants; (3) plant productivity of woody plants; (4)

abundance and (5) distribution of grasses and herbaceous plants. In the study site,

woody plants comprised perennial trees or shrubs. Herbaceous plants, however, were

mainly bi-seasonal and typically grew close to or along the soil surface, and had leaves

and stems that wilted at the end of the growing season (Filgueiras, 2002). Plants (i.e.,

woody plants, grasses and forbs) were identified taxonomically using established

vegetation keys for trees, shrubs, and grasses (Young and Isbell, Unpublished

Manuscript; Barton et al., 1993; Agnew, 2006) or at the National Museums of Kenya

herbarium where the plant samples were identified by John Kimeu Mbaluka. Due to

logistical issues not all plants species were taken to the herbarium for identification, thus

the remaining unidentified grasses and forbs were assigned code names (See appendix 1

and 2).

Abundance, dispersion of trees/shrubs: Data for establishing the abundance of

woody plants (trees/scrubs) were collected by scoring the number of trees per unit area

(hectare). Concurrently, information on the distribution of trees was collected using the

"wandering quarter technique" (WQT), in which the distance (m) from each sample tree's stem to its nearest (tree) neighbor was recorded (see Kell 2006; Bonham 1989). The starting point of the WQT was the middle of each of the four quadrats in a plot (See Fig 2.3). There were four WQT samples originating from each quadrat (Fig 2.3). Each plot quadrat was named according to the orientation of the plot (e.g. NE, NW, SE, SW) , which dictated the direction of each of the four WQT samples (See Fig 2.3). Since the WQT is a plotless sampling method, each of the four samples extended beyond the boundaries of the 25m x 25m plots by an additional 25m. Thus, a larger sample size of trees/shrubs was sampled (as compared to sampling only those trees that grew within the plot) to improve tests of the socioecological model. Additionally, tree canopy cover was measured two-dimensionally by recording the length and width of each focal tree's crown with a measuring tape.   Tree/shrub height was also measured using a Senshin SK202 8m height fiber glass pole with internal tape measure (© Accurate Instruments Ltd.).

Data Collection on Phenology: Food availability over time was tracked using the Focal Tree Monitoring Method (adapted and modified from Burton et al., 1992) which entailed marking focal trees/shrubs in each of the 20 vegetative plots. Each plot was subdivided equally into four parts (quadrats) that each measured 12.5m x 12.5m (See Fig 2.3). In each quadrat, 4 selected woody trees/shrubs were marked as focal trees, totaling 16 trees (4 x 4) per plot. Four was an arbitrary selected number, however the selection of the focal trees entailed marking the 4 closest trees/shrubs from the center of each the four quadrats in a plot. Within the 20 plots, a total of 7 woody tree/shrub species (i.e., *Acacia drepanolobium, A. seyal, A. xanthophloea*, *A. melifera, Balanites*

spp., Lycium europaeum, Scutia myrtina) were identified during the focal tree marking

process. In the pastoralist land, 3 species of trees (*Acacia drepanolobium, A. seyal, A.*

xanthophloea, A. melifera, Balanites spp) and 2 species of shrubs *(Lycium*

europaeum,and Scutia myrtina) were included as focal trees (see description of woody

tree and shrubs on Table 2.1).

Since each land use system had 10 vegetation plots, 160 focal trees/shrubs were

monitored in each land use system. Hence the total number of focal trees sampled in

both land use systems was 320 individuals. A total of 8 branches were selected per tree.

Branches that were used for vegetation sampling were initially marked with colored

flexible wired tags to facilitate easy identification for monitoring. Two branches in a

tree/shrub, each facing the same direction to represent all 4 orientations (i.e., North,

East, South and West) were selected. Thus, 8 tagged branches per focal tree plant parts

were sampled (Barton et al. 1992). Depending on the tree/shrub size, branch lengths

were scored categorically as follows:

Branch length 1: ≥ 0 cm ≤ 12.5 cm

Branch length 2: ≥ 12.5 cm ≤ 25 cm

Branch length 3: ≥ 26 cm ≤ 38.5 cm

Branch length 4: ≥ 39 cm ≤ 51.5 cm

Every other month, the number of plant parts (i.e., galls, fruit\pods, flowers, buds)

were counted on each branch moving from its proximal tip to the distal marked part of

the branch (Steenbeek and van Schaik 2001). Plant parts were scored according to

coloration to indicate condition, that is: green, yellow or brown. The "green" condition indicated the plant part was a fresh shoot, moist and edible to the baboons. "Brown" denoted a food source that was dry and, therefore, largely inedible. "Yellow" was an intermediate condition reflecting a shoot that was drier and less edible than a green plant part, but not yet dead.

Data collection on abundance of herbaceous layer: The grass and herbaceous layer was sampled using a 10-pin frame apparatus (See Fig 2.4). The distance between the 10 pin holes was 10 cm (Fig 2.4). The pin frame was placed systematically along a straight line at 4m intervals from North-South and then East-West along the center marked boundaries of each of the plot quadrats (Fig 2.5). Within each of the marked 25m x 25m plots, a total of eight systematic placements of the 10-pin frame were made (Frank and McNaughton, 1990; Augustine, 2003; McNaughton, 1983). The frame was set up over the vegetation and the pins/needles were lowered down through the plant canopy. This procedure is called a "drop". Every time there was a "drop" the point of a pin/needle touched a plant it was called a "hit". The needle could make several "hits" before it eventually touched the ground surface. A total of 80 pin drops or sampling points were achieved in each plot. With each pin hit, the indicated grass/herbaceous plant was first identified and the respective plant part consisting of the blade, leaf, stem, florescence and roots that came into contact with each of the 10 pins (hits) was recorded. As with woody plants, herbaceous parts (i.e., blade/leaf, florescence/flower, seed and stem) were also scored as green, yellow and brown to indicate the condition of the plant part as previously described.

For Woody Species and Herbaceous layer

Woody species

There were 5 species of trees (*Acacia drepanolobium*, *A. seyal*, *A. xanthophloea, A. melifera* and *Balanites spp*.) and 4 species of shrubs (*Lycium europium*, *Scutia myritina*, *Carissa edulis* and *Euclea racemosa*) sampled within the study area. The relative frequency, mean distance between trees, relative dominance and density were calculated for every tree/shrub species using the following formulas:

I.   *Relative frequency of woody trees*

Relative frequency was calculated as follows (Bonham 1989):

Relative frequency = (number of individuals of a species/total individuals of all species) × 100

II.   *Dispersion of woody trees*

Distances between individual woody plants were measured to evaluate the relative dispersion of species across the different land use systems. To calculate the mean distance (d_m) between trees (m) (see Bonham 1989; Kell 2006):

$$d_m = \frac{\text{sum of all distances between sampled trees/shrubs*}}{\text{\# of distance measurements}}$$

*Number of trees sampled varied because sampling extended 25 m beyond each quadrat as earlier explained when describing the WQT.

III.   *Density of woody trees*

Density was calculated as follows to test following Kell (2006):

Mean Area (MA) of all trees = $(d_m)^2$

Density (D) of all trees (in stems, i.e. tree trunks) per unit area was calculated as follows:

$D = A /(d_m)^2$, which I further concerted in hectares.

IV.   *Canopy area of woody trees*

The area for woody plants canopy was calculated from measurements of crown

width x length (m) of each individual tree/shrub sampled (Pruetz and Isbell 2000).

V.   *Productivity of woody trees*

Woody plant productivity was measured as the number of plant parts (i.e., galls, fruits/pods, flowers, and buds) in their various condition (i.e, brown (black for galls), yellow and green) on the focal trees following Burton et al. (1992).

VI.   Relative abundance of herbaceous layer

Grasses and forbs were counted recorded using a 10 –pin frame and the relative abundance calculated as follows (McNaughton 1983):

Relative abundance = <u>No. of hits that intercept species A </u>(per frame placement)

Total No. of points

This is the only point sampling method that can give an accurate estimate of absolute cover of each species of vegetation. Hence total number of blades, leaves, fluorescence\fruit and flowers of each were counted for each herbaceous plant sampled (Frank and McNaughton 1980; McNaughton 1983).

VII.   *Relative dominance of woody trees*

To estimate the relative dominance of woody trees, the basal area of each tree was first calculated (McNaughton 1983) as follows:

Basal area = $\Pi\ (r)^2$

Calculation for basal area for all species

Relative dominance =   <u>Total basal area of a given species</u>   x 100

Total basal area of all trees

VIII. *Gum abundance*

Unlike the other plant parts sampled, the abundance of exudates from the branches and stem was relatively difficult to score systematically and discretely. Hence qualitative measures were applied. Gum on *A. drepanolobium* are shaped like globs. In each of the 320 focal trees sampled, gum was searched for and recorded when seen on the main stem and branches of the woody plants. Trees generally have one or more globs of varying sizes, as described in Isbell (1998). Since gum is found on much fewer *A. drepanolobium* trees relative to other plant products (Isbell 1998; Pruetz 2009), there was no selection of a particular branch to sample. Rather, I scored the presence or absence of gum (globs) on each overall tree using the following 4 point estimated qualitative categories of diameters measurements (mm) listed as follows:

0 = no gum on the tree

1 = little gum - under 2 mm glob cumulatively

2 = moderate gum - 2mm-4mm glob cumulatively

3 = large gum amount - >4mm glob

2.2.2. Baboon Behavioral Data

Study Animals: From June 2009-December 2010, I collected data on two groups of habituated olive baboons that Dr. R. A. Palombit and colleagues have studied in Laikipia District since 2000. The composition of the larger group (Thome B – TDM) in total was: 19 adult males, 30 adult females, 9 subadult males, 50 juveniles, 12 infants. The smaller

group (Kati Kati –KAT) comprised: 11 adult males, 10 adult females, 3 subadult males, 4 juveniles, 3 infants. An experienced field assistant and I collected behavioral data on both baboon groups from approximately 06:30 to 14:00; on certain days data collection was extended to 17:30. The behavioral data (Table 2.3) were recorded using hand-held Psion Teklogix Workabout MX (Pulster ©) and later downloaded into a computer at the end of each day. Ten minute continuous focal sampling (Altmann, 1974) was used to measure behavior of randomly selected adult females. A total of 1300 hours of behavioral data were collected on both baboon groups 1217 hours of data were collected on the larger group (TDM) while 83 hours were collected from the smaller group (KAT). A total of 2219 ten minute focal animal sessions were collected. Focals were collected using a random list of adult female names that had been generated using a computer to avoid biased sampling.

Assessment of Predation Risk: In order to test socioecological models, I gauged predation risk by recording ad libitum rare and unusual, but conspicuous, behaviors (e.g., predation encounters). Potential predators (lions – *Leo panthera*, leopards – *Panthera pardus*, spotted hyena – *Crocuta crocuta,* black-backed jackal (*Canis mesomelas*) were sighted within each of the two land use systems while collecting baboon behavioral data.   Since predator sightings were very rare, other evidence of predator presence, such as predator vocalizations, spoor, and carcasses of baboons were used to make a qualitative assessment of levels of predation risk between the two land use systems. The predation data were recorded collectively by three field assistants on site (Boru Abdi Mohamed, Jarsa Burke, John Laiyon Lenguya), another PhD student

who was collecting data for her dissertation from the same baboon groups, (Lisa Danish), and myself.

We also used information reported by people who lived within the baboons' home range. We asked people within each land use to inform us of any predators seen or heard. On separate occasions pastoralists (N=9) informed us that they had heard predators vocalizing at night as their homesteads were close to the studied baboon sleeping trees (Nguar Lenguya Olenguya and Francis Lementile, *pers comm.*) (Table 2.3). In all these reported occasions the baboons were heard screaming and alarm calling. On a few occasions (N=4), only baboons screams and alarm calls were reported to us. However, on two of these occasions lions were seen within the baboon's home range (6th -8th Aug 2010), and were also heard near the sleep trees one night after an unidentified baboon body had been found by the sleep trees (Table 2.3). The total number of predator sightings was 33. Of the total number sightings, 29 of the predator sightings were on commercial ranch and 4 sightings in the pastoralist land. Additionally, there were 6 incidences where leopard calls were heard and 2 incidences where leopard spoor were noted around the baboons' sleep trees in the pastoralist land.

These reports were also accompanied by the informant stating that the baboons were also vocalizing at night at their sleep trees (Table 2.3). There were three separate occasions in the pastoralist land where a predator was neither heard or spoor found. However, dead baboons were found dead on two of these occasions under their sleep trees (Table 2.3). On the other one of these three occasions, the baboons were reported to be screaming and alarming at night in their sleep trees. Reports of leopards heard or

spoor observed were recorded as one predator incident. However, it is possible there could have been more than one leopard/lion heard vocalizing, hence the number of predators heard and spoors recorded were most likely conservative estimates. These reported vocalizations, spoor and observations of predators suggest there is a higher risk of predation on the commercial ranch as compared with on the pastoralist land. This is consistent with local research on predators in this area (Frank et al. 2005).

Baboon Social behavior: To test predictions involving inter-individual distances (**Prediction 1),** I recorded, the focal individual's nearest neighbors at 2-minute instantaneous intervals (Table 2.2). I define nearest-neighbor proximity as the distance of the closest individual to the focal animal within 6 m and then at 5 meter intervals of 10 m, 15 m, 20 etc as indicated in Table 2.2 (Cowlishaw 1999). To measure for contest competition across the two land use systems, I compared the levels of agonistic, affiliative and coalitionary interactions (see Table 2.2) between the two land use systems, I also tested **Prediction 2a** and **Prediction 2b** by measuring the rates of a variety of agonistic interactions (e.g., supplants, threats, physical attacks) and affiliative behaviors (e.g., grooming, lipsmacking, embracing). **Prediction 2c** was tested by measuring coalitionary interactions (e.g., recruitments, joint attacks and joint defense) (Table 2.2).

Predation risk: Baboons' perception of predator risk was also assessed by observing scanning behavior. To test for **Prediction 3**, I recorded baboon vigilance behavior using scanning rates (Treves 1999) (while not in the context of feeding). Scanning is the visual inspection of the surroundings beyond the immediate vicinity

(Treves, 1999). Baboon vigilant behavior such as frequency visual scanning (see Treves 1999) during baboon focal observations was recorded as a measure of predation risk in each land use system (Table 2.2). Visual typically involved standing on hind feet to apparently improve view. To control for scanning for feeding competitors, scanning rates that only occurred during resting periods were recorded. Resting was recorded when a focal individual did not move for at least 10 seconds while travel entailed walking, running for not fewer than 10 seconds.

Feeding behavior: Baboon feeding behavior was also measured. I define a feeding bout as a discrete unit of time, starting when an individual makes physical contact with a food source and putting items into the mouth and ending when an individual loses contact with the food source for either 5 seconds or simply switches to another food class (Altmann 1998). I also defined the number of bouts as the number of times an individual stops to feed at food sites (Isbell and Pruetz 1998; Pruetz 2009). Feeding rates, are a useful for examining feeding efficiency and were measured by the number of times an individual baboon's hand moved from the food resource to its mouth per unit time (Nagasawa 2004).

To compare differences in baboon feeding behavior between the different land use systems, I recorded duration of feeding bouts (**Prediction 4**), number of feeding bouts (**Prediction 5**) and feeding rates (**Prediction 6**).

2.2.3   Human-baboon Interactions Data Collection:

*Semi-structured Interviews***:** The human-baboon interaction component of this research project entailed interviewing people from various land use systems about human-baboon/wildlife interactions. The protocol for interviews was approved by the Rutgers University Institutional Review Advisory Board. These interviews were conducted in Laikipia District between September 2009 and May 2010 on men and women above 18 years of age after first requesting informed consent (see Appendix 3). I categorized Laikipia district into five regions: North, North Eastern, Eastern, South Central and West (See Fig 2.6). In each region, a number of different ranches from each land use system were selected (Table. 2.6). Interviews were not conducted within the central region of Laikipia District (i.e., Thome B, Segera Ranch, Eland Downs and Ngare Ranch). These ranches and occupied lands were part of the studied baboons' home range. This was a strategy taken to minimize biased responses towards baboons because many people inhabiting this area and its immediate environs knew that my assistants and I were studying baboons

A total of 39 semi-structured interviews were conducted: 19 people were interviewed individually, while the remaining 84 respondents were interviewed in a small groups of 2-7 (Table 2.4), with the exception of Lorora village in Narok, where 25 people were interviewed in a single large group. Group interviews were simply a more efficient way to obtain a variety of responses in one session or interview which was important for the later construction of the questionnaire. In this way, time spent traveling between households was minimized, while the time spent with respondents was

maximized. The caveat for using the group method approach rather than the individual approach is that respondents may not give their honest opinion in the presence of more senior or important group members. I expected this problem would be counteracted during the questionnaire phase since it was designed to capture one respondent at a time as well as capture other unlisted responses in the sections that had open ended answers.

My assistant, who was from the Maasai community, was also my key informant who was extremely familiar with Laikipia District and helped me liaise with key figures within the various communities in which we conducted semi-structured interviews. This process necessitated communicating with a contact person, i.e., a chief, sub- chief, or a known member of the community who would organize respondents beforehand. In some locations where there was no known contact person, an individual within the community who we would randomly come across would facilitate the process of organizing respondents for us. Identifying a contact person within a community to assist in recruiting respondents, though time efficient, could have incurred certain biases, especially if the contact person only recruited friends or relatives with similar backgrounds or beliefs. This could have resulted in under-representing certain opinions from other potential respondents within the community. To minimize this bias, my assistant and I would beforehand specify that we wanted to interview different people within the community other than their friends and relatives when necessary. My assistant also helped with the translation Maa (Masaai) into Kiswahili or English during the interviews. The majority of respondents spoke Swahili, followed by Maasai, while a fewer spoke English.

All commercial ranchers were interviewed by me in English. Commercial ranchers in Laikipia were generally few as compared to other land use practitioners. To further compound this issue, some of the commercial ranchers were foreigners who did not live in their ranches throughout much of the year.

Questionnaires: Information gathered from these semi-structured interviews was then used to construct a comprehensive questionnaire based on the variety of responses from a larger population (see Appendix 3). For this questionnaire phase, I recruited three Maasai field assistants who had lived in Laikipia all their lives. Together, they translated the questionnaire into Maa to ascertain that they would be consistent in their way they translated the questions from English to Maa. Since the assistants and I spoke fluent Kiswahili, we also went through the questionnaire together, prior to data collection, to ascertain that key concepts and their definitions (e.g., land use – "matumizi ya ardthi", tenure – "umiliki", were well understood and translated in a consistent fashion while later communicating with respondents who spoke only Swahili.

The field assistants and I pre-tested the questionnaire on 10 respondents within the environs of a small shopping center call Checkpoint, (not part of the regions where the final interviews were to be eventually conducted). The interviews took 20-30 minutes long. We modified it later as a result of these preliminary responses to improve on the final questionnaire. All questionnaire interviews were conducted from the 4th of November 2010 until the 25th of November 2010. Questionnaires were carried out one respondent at a time by the three assistants and myself.   Questions were systematically presented to respondents and their responses were recorded by the assistance or myself.

Some respondents who were previously interviewed during the semi-structured phase were approached again during the questionnaire stage. Interviews were conducted at shopping centers, by the roadside, in homes etc, by directly approaching potential respondents.

    People's values towards wildlife: Zinn and Shen (2007), Takanjan and Saranet (2007), Dayer et al. (2007), and Kaczensky (2007) explain in detail how information from semi-structured interviews can be used to categorize people as 'Environmentalist', 'Materialist', and other listed orientations, which I summarized in Table 2.5.

The details of values solicited from the semi-structured interviews facilitated the compilation of a larger, quantitative sample through a structured interview survey (following Teel et al. 2005). These value statements were used to capture individual differences in value expression (i.e., 'Materialism', 'Environmentalism', 'Mutualism', 'Symbolism' and other orientations) that can be accounted for by basic beliefs associated with the values described by Dayer et al. (2007) and Zinn & Shen (2007) (Table 2.5). I recorded the frequency of each coded statement found under a particular orientation (e.g., "animals have no rights", "wildlife have financial benefits," etc. and then finally categorized the respondent according to the orientation with the highest frequency scored for various responses that were inclined towards a particular orientation (e..g., Mutualism, Symbolism, Materialism etc.).

For example, respondents who answered "yes" to "should wildlife be protected or conserved" or said "no" to the question "Do you think it acceptable to kill wildlife for money?" were in accordance with "Environmentalism" views. Respondents who said

"yes" to "animals can bring good luck or bad luck" tended towards "Symbolism". A "yes" to the following questions—"Do baboons have any economic value?" and "Do you think that wildlife exist on earth primarily for people to use?"— was considered consistent with a more Materialist view. On the other hand, affirmation of the following questions—"Do you think people and wildlife can live side by side without fear?" and "Should animals have rights similar to the rights of humans?"— suggested 'Mutualist' tendencies .

The questionnaire was used to gather information from targeted respondent (N = 250) within Laikipia District (Table 2.4) however, the final number of respondents totaled 242 as a result of logistical issues (e.g. availability of some respondents). As with the semi-structured interviews, respondents from all five categorized regions in Laikipia District (Fig 2.4) were interviewed. In total, 12 privately owned ranches and 16 pastoralist and farming communities were surveyed (Table 2.4). Since owners of privately owned ranches were not as accessible[3] as other land use practitioners in Laikipia District,   I targeted and recruited respondents using Bernard's (2006) snowballing sampling technique for selecting under-represented respondents of the sample population. A total of 242 questionnaires were completed by respondents between November and December 2010 (see Table 2.4). My initial aim was to capture at least a sex ratio of 1:1 in respondents during the questionnaire phase. This was difficult to achieve however, as women were less accessible then men as they were typically busy carrying out their daily chores (i.e., fetching water, firewood, cultivating)

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[2] A few commercial ranchers occasionally travel at abroad and some of these maintain their houses within these ranches as vacation homes whereby a manager is left in charge of running the ranch.

during the hours we typically conducted our questionnaires (8 am -6pm). Thus, the ratio

of women to men interviewed was biased towards the latter at approximately 1:3 with

total of 132 females and 331 males interviewed.

*Land use and land tenure***:** We also recorded socio-demographic data on age,

gender, income, ethnicity, education, land use practices, and tenure. Pastoralism and

commercial ranching were the predominant general land use practices in my baboon

study area. During the course of my initial interviews, I further differentiated these

categories, thereby creating a total of 7 land use categories: (1) commercial ranching; (2)

commercial-tourism; (3) pastoralism; (4) pastoralism-tourism; and (5) farming (6)

agropastoralism; and (7) agropastoralism and tourism. The rationalization for these

categories are as follows (see Table 2.6).   The majority of "pro-wildlife" commercial

ranchers also conducted ecotourism as a subsidiary activity (commercial-tourism), while

a few only practiced commercial ranching (commercial ranching). Although many of the

pastoralist group ranches continued to depend on subsistence pastoralism (pastoralism),

some complemented pastoralism with small-scale subsistence farming (agropastoralism)

or small scale, community-based tourism (pastoralism-tourism). Some areas currently

inhabited by pastoralists were actually ranches that had been abandoned by their

previous owners, largely due to ethnic land clashes during 1999-2003 (Georgadis,

2007a; Anthony King, June 2010 *pers comm.*). In total, people in 5 pastoralist, 9

commercial ranch, 15 pastoralism-tourism, 4 agropastoralism, 8 commercial-tourism, 4

farming and 4 Agropastoralism-tourism communities were interviewed (Table 2.6).

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FIGURES

Figure 2.1: A mature A. drepanolobium fall with ants
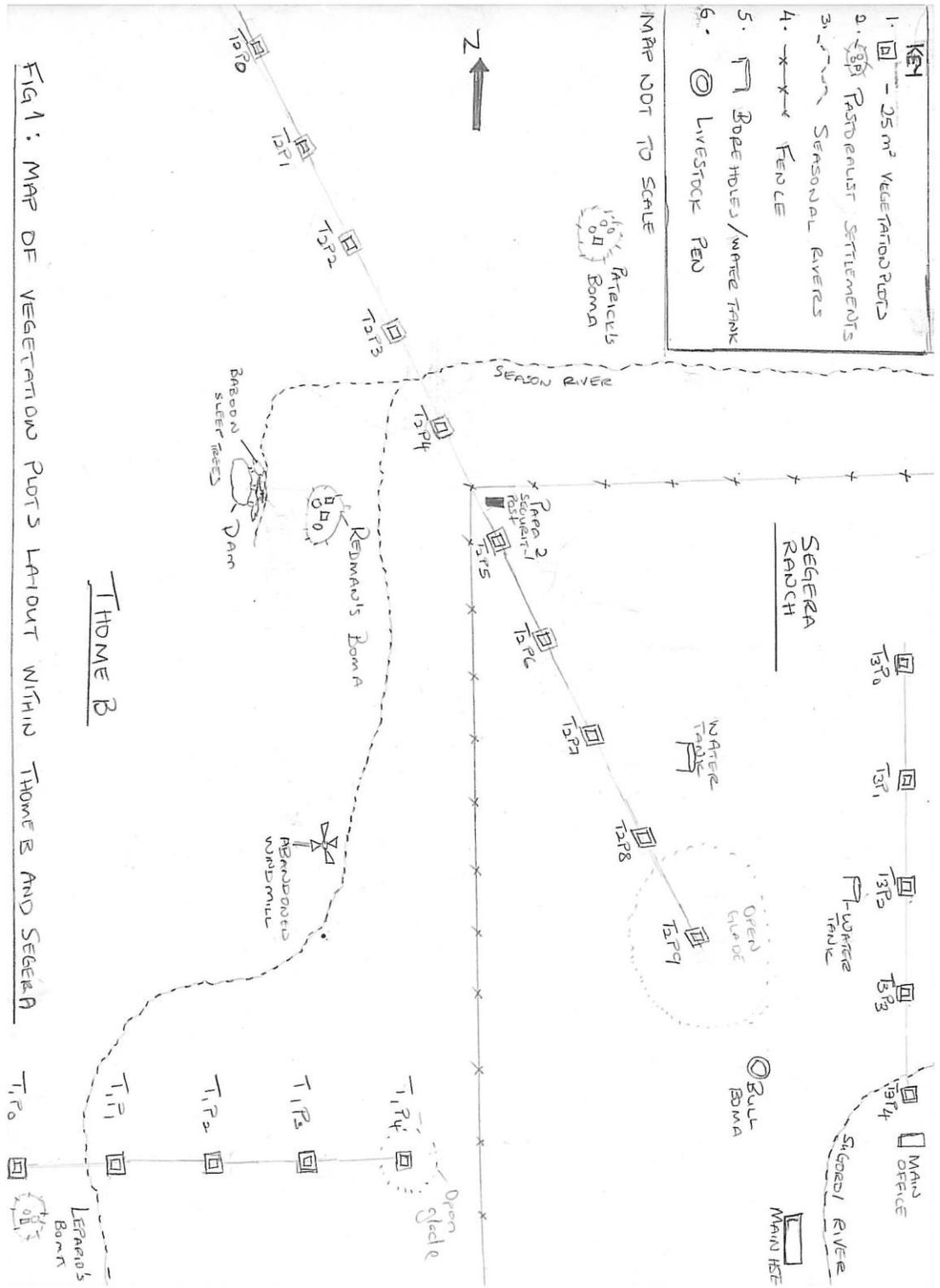
Figure 2.2: Map of the vegetation transects and plots layout within and across the two land use system   Segera Ranch (commercial) and Thome B (pastoralist land). Not drawn to scale (Nancy Moinde)
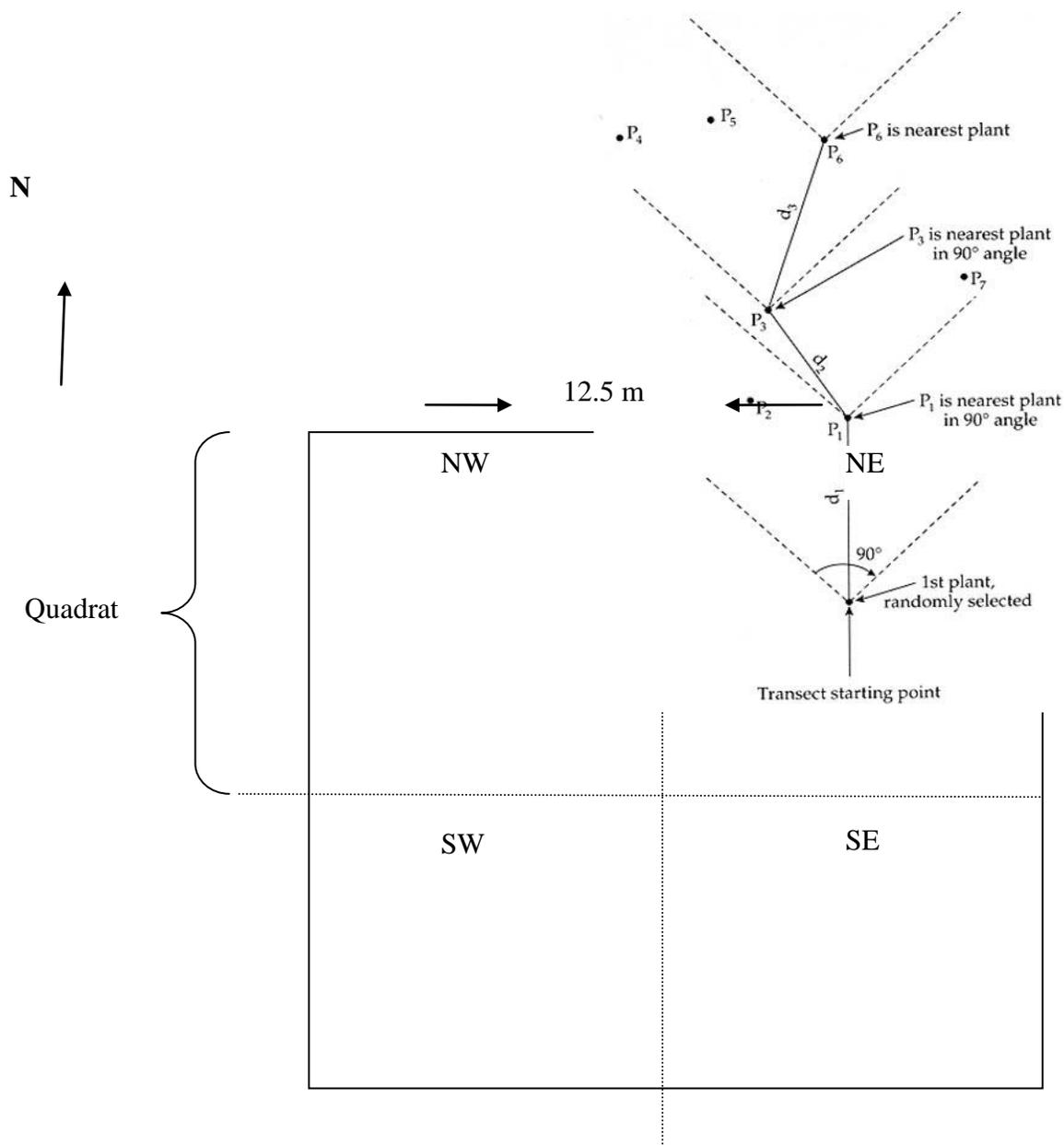
Figure 2.3: Example of the "Wandering Quarter Technique" sampling originating from the Northeastern quadrat of the plot and continues beyond the plot boundaries for about 25 m outside the plot.
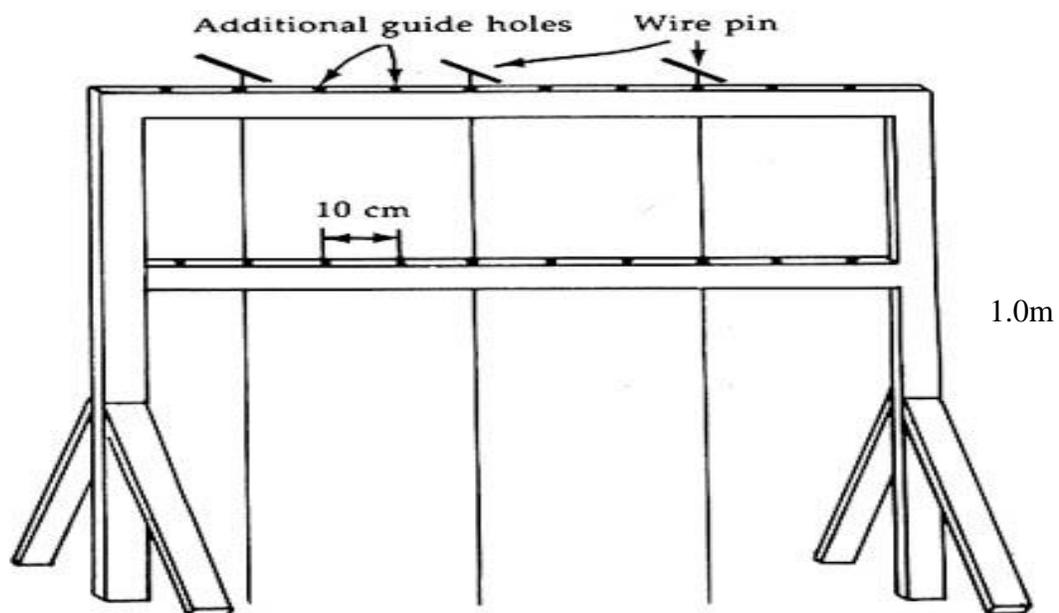
Figure 2.4*: Pin frame placements along the center of the four quadrants to measure %
cover of herbaceous layer.*
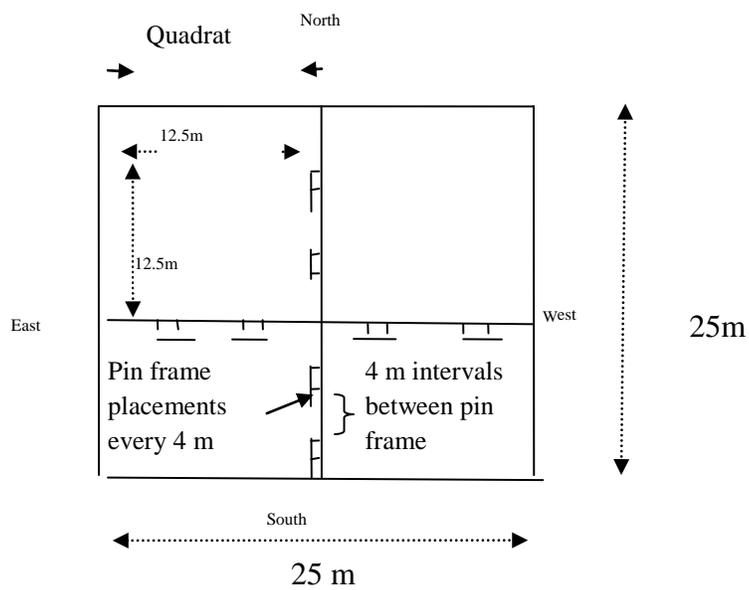
Figure 2.5: *10-pin point frame*
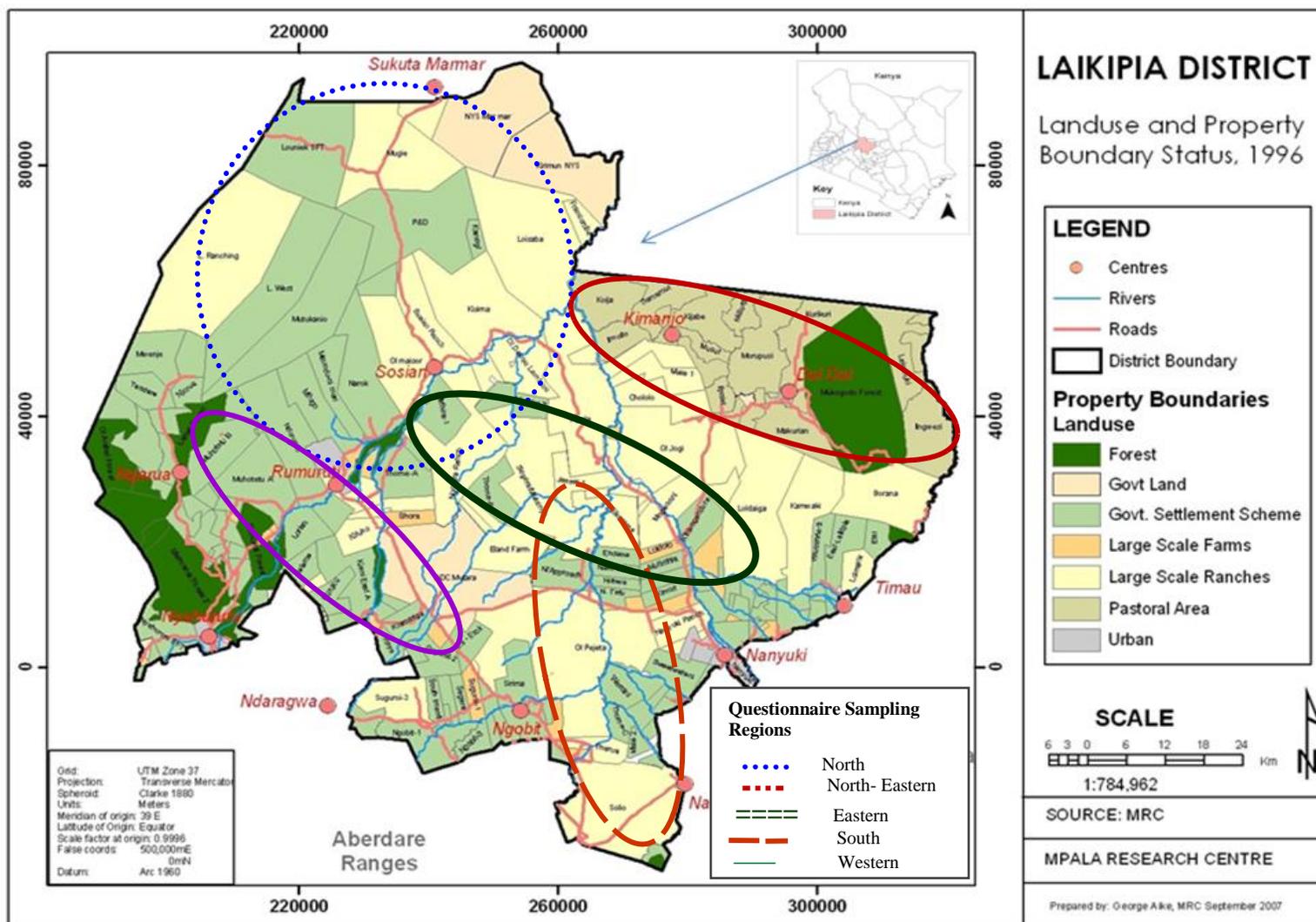
Figure 2.6: *Land use Map of Laikipia District (Provided by Mpala Research Center)*

Table 2.1: Description of woody plants (trees and shrubs) within the baboon's

homerange

Woody plant type	Scientific Name	Plant Description and anthropogenic use	Consumed by baboons
Tree	*A. drepanolobium*	- Height 15–25 m. - Common in black cotton soils	Galls, pods/seeds, flowers, buds and gum
Tree	*A. Seyal*	-Galls host symbiotic ants - Height commonly between 6–10 m. -Common in black cotton soils - A pale greenish or reddish bark. - Galls host symbiotic ants	Same as for *A. drepanolobium*
Tree	*A. xanthophloea*	Commonly found along permanent and seasonal rivers. Greenish yellowish backs Tallest of all the acacia spp and mature trees are typically < 15 m	Same as for *A. drepanalobium*
Tree	*A. Melifera*	- Height 7-9 m - Hard wood -Commonly used for construction of huts, boma fencing, wood and charcoal burning etc. …	Same as for *A. drepanalobium*

		- Often targeting for honey producing	
Tree	*Balanites aegyptiaca*	- Height – can reach 10m - Tolerates a wide variety of soil types (sand to heavy clay).	Greenish yellowish fruits
Shrub	*Lycium europaeum*	-Greenish-white petals - small berrylike multi-seeded berries.	Both flowers and berries
Shrub	*Scutia myrtina*	-Large scrambling shrub which uses its thorns to clamber through and up surrounding vegetation. - Greenish white flower -Small purplish berries	Both flowers and berries.

Table 2.2: Baboon Behavior and Activity Definitions

Behaviors and activities listed below were used to test the proposed hypotheses. (Modified from Palombit, unpublished data.)

Behaviors and their descriptions
1. Agonistic Behaviors
Chase: Involves an individual chasing another during an aggressive interaction
Hit: Involves an individual slapping another individual in an aggressive interaction
Bite: Involves using teeth to inflict harm on another during an aggressive interaction
Grapple fight: includes hitting, biting, rolling on ground, etc.
Supplant: individual comes within 2m of another who leaves 2m-range within 3 seconds.
Avoid: Movement away within 2 seconds following an individual's approach within proximity (5m), but not to beyond 2m.
Eye threat: Flashing eye lids
Ground slap Demonstrated within the context of a threat and other agonistic behaviors below
Lunge: Rapid movement towards another individual, no physical contact
Fear grimace: Lips pulled back exposing clenched teeth
Threat: Open-mouth threat
Cringe Submission posture which entails bending of knees mostly to avoid contact
Tail up Similar to cringe with tail raised up
Threat grunt A grunt that is made within an agonistic context
Fear bark Emitted along with submissive behaviors e.g., Fear grimace, tail up, cringe etc
Scream Sharp vocalizing emitted during agonistic interaction
2. Affiliative Behaviors
Grooming: Manipulating, scratching, or picking through the hair of another

	individual, or having one's hair groomed by another individual
Lipsmack:	Rapid movement of the lips
Present:	Movement of body part towards and in front of another individual's field of vision. Also includes presenting the rump and presenting for grooming.
Touch:	Includes muzzle-muzzle, huddle, touch rump (but not genitalia), and touch to other part of body/head.
Grunt:	In the context of social interaction

3. Coalitionary Behaviors:

Aiding someone in attacking or defending another.

4. Proximity Behaviors

Approach:	Movement within 2m
Approach & immediate withdraw: By same individual	
Long-range avoid:	Clearly avoids the approach of an individual from more than 2 meters away (i.e., without close proximity being attained, which would be a supplant)
Withdraw:	Leave 2m range of another

Nearest Neighbors distances: Every individual within 6 meters. If none is present, any adult beyond 6 meters (at every 5 meter intervals i.e., 5, 10,15,20,25 etc..).

5. Vigilant behavior:

Visual scan:	Visual inspection of the surrounding which sometimes also involves standing up on hind legs to optimize on better visual inspections of the surroundings beyond the immediate vicinity.

6. Activity
Feed: Reaching for food, handling food, placing food in mouth, chewing.
Rest: Sitting, or lying motionless and not obviously involved in any social activity.
Travel: Movement – walking running for not less than 10 seconds.

Table 2.3: Potential predators sightings and evidence of presence recorded in the Pastoralist land (Thome B) and the commercial Ranch (Segera Ranch) in 2012

Date	Predator	Evidence	# of Ind	Land Use System	Comments and observers
27th Feb	Hyena	Spoors	1	Pastoralist	Seen around the studied baboons sleep trees by (BORJARLIS)
7th Mar	Jackal	Sighted	1	Commercial	No evident reaction from studied baboons (LIS)
10th Mar	Leopard	Heard*	1	Pastoralist	Reported by Francis Lemantile & Peter Kasuku who also heard baboons screams and alarms call at sleep trees
21st Mar	Leopard	Heard*	1	Pastoralist	Reported by Francis Lemantile who also heard baboons screams and alarms call at sleep trees(Francis Lemantile and Morani#)
17th May	Leopard	Sighted	3	Commercial	A adult female with her 3 cubs were seen approx 200m by a Segera security guard.
21st Apr	Hyeana	Sighted	1	Commercial	Uncertain if spotted or stripped hyeana (JARLIS)
5th May	Jackals	Sighted	2	Pastoralist	No reactions from studied baboons (LIS)
25th May	Jackal	Sighted	1	Commercial	(JARLIS)
11th Jun	Jackals	Sighted	2	Pastoralists	No reaction from studied baboons (NCY)

19th Jun	Hyeana	Sighted	1	Commercial	In a bush studied baboons were emitting alarm calls and running away (NCY)
14th Jul	Jackals	Sighted	1	Commercial	No reaction from studied baboons (LIS)
6th Aug	Jackals	Sighted	1	Pastoralist	No studied baboons were in sight.
6th Aug	Lions	Sighted	12	Commercial	Both juvenile and adult female lions were seen. No studied baboons around (JARLIS)
7th Aug	Unknown	Dead baboon found	1	Pastoralists	1 unidentified dead baboon's body parts found by the sleep trees (Morani#)
8th Aug	Lions	Heard*	1	Pastoralist	Studied baboons screaming and alarming at the sleep trees at 3am (Stephen)
8th Aug	Lions	Sighted	1	Commercial	A lion was seen eating a hartebeest at 4 am. (Stephen)
8th Aug	Hyeana	Sighted	1	Commercial	Seen near the lion kill above (BORLYNLIS)
8th Aug	Jackals	Sighted	2	Commercial	Seen near the lion kill above (BORLYNLIS)
8th Aug	Lions	Sighted	1	Commercial	(BORLYNLIS)
8th Aug	Jackals	Sighted	2	Commercial	(BORLYNLIS)

Date	Predator	Evidence	# of Ind	Land Use System	Comments and observers
9th Aug	Leopard	Sighted	2	Commercial	2 leopards were seen on separate occasions one appeared to be a juvenile and the other and adult (BORJARLYNLIS)

Table 2.3 continued………..

Date	Predator	Evidence	# of Ind	Land Use System	Comments and observers
21st Sept	Leopard	Spoors	1	Pastoralist	People from the Redman's Boma approx.150m away from sleep trees reported that the studied baboons screaming at night from sleep trees
23rd Sept	Leopard	Spoors and heard	1	Pastoralist	6 missing baboons from studied groups and one identified dead adult female found at sleep trees and reports of baboon screaming and alarming at night (BORJARLISLYN)
24th Sept	Leopard	Spoors and heard	1	Pastoralist	Spoors found around sleep trees Studied baboons heard screaming from around sleep trees (Morani)
2nd Oct	Unknown	No evidence	1	Pastoralists	Studied baboons heard screaming at night at their sleep trees (Morani's boma). Remains of female baboons and a skull and young infant ((JARLISNCY)
13th Oct	Unknown	Evidence of a dead a baboons	1	Pastoralists	A dead baboon found under studied baboons sleep trees (LISLYN)

* A pastoralist who leaves near the baboon sleep trees in the pastoralist land reported to us when the studied baboons were screaming and emitting alarm calls at night as well as when leopards were heard growling as well
. # Ngaur Lenguya Olenguya aka Morani .

Table 2.4: Ranches and occupied lands within the 5 targeting regions for conducting interviews representing the various land use systems in Laikipia

#	Region	Ranch/Land	Targeted Locations	# of semi-structured Interviews conducted	# of Semi-Structured Interview respondents	# Question-naires completed	Main Land Use Practice	Land Tenure
1	**North**	Kirimon NYS	Kirimon Centre	0	0	12	Pastoralism	Occupied
		Lonyiek DSFT	Lonyiek Mrk	0	0	17	Pastoralism	Occupied
		Loisaba Ranch	Loisaba Main Office	1	1	1	Commercial-Ecotorism	Private
		Sabuk	Sabuk Lodge	1	1	1	Ecotourism	Private
		Mugie Ranch	Mugie Main Off	1	1	1	Commercial-Ecotourism	Private
		Laikipia Ranching	Laikipia Ranch	0	0	0	Commercial-Ecotourism	Private
		Mathira	Mathira	1	16	14	Pastorialism	Occupied
		Ole Maisor Ranch	Ole Maisor Off	1	1	1	Commercial ranching	Private
		Narok	Lorora	3	27	11	Pastoralism	Occupied
		Kisima Ranch	Kisima House	2	2	1	Commercial	Private

							ranching	
2	**North-east**	Chumvi	Chumvi	0	0	3	Agropastoralism	Private
		Ngare Ndare	Ngare Ndare Centre	1	2	2	Agropastoralism	Private
		Manyangalo	Manyangalo Centre	0	0	0	Agropastoralism	Private
		Tassia Group Ranch	Iltirim	1	2	10	Pastoralist-Ecotourism	Communal
			Kitejo	1	1	0	Pastoralist-Ecotourism	Communal
			Melita	2	6	4	Pastoralist-Ecotourism	Communal
			Tassia Lodge	0	0	4	Pastoralist-Ecotoursim	Communal
		Il Nguesi Group Ranch	Leparua	1	4	11	Agropastoral-Ecotoursim	Communal
			Ngare Sirikon	1	3	15	Agropastoral-Ecotourism	Communal
			Cultural Centre	1	1	0	Pastoralism-Ecotourism	Communal

#	Region	Ranch/Land	Targeted Locations	# of semi-structured Interviews conducted	# Semi-Structured Interviews respondents	# Questionnaire respondents	Main Land Use Practice	Land Tenure
			Il Nguesi Lodge	3	3	3	Pastoralism-Ecotourism	Communal
			Sang'aa	1	2	9	Pastoralism-Ecotourism	Communal
			Saramba	1	1	18	Pastoralism-Ecotourism	Communal
		Munishoi Ranch	Ilpolei	1	5	13	Pastoralism-Ecotourism	Communal
		Tiamamut Ranch	Tiamamut	0	0	5	Pastoralism-Ecotourism	Communal
3	East	Borana Ranch	Borana Office	1	1	2	Commercial-Ecotourism	Private
		Ole Naishu Ranch	Ole Naishu Office	1	1	3	Commercial Ranching	Private
		Loldaiga Ranch	Loldaiga Main House	1	1	3	Commercial Ranching	Private
		Ol Jogi Ranch	The Pyramid	1	1	0	Commercial-Ecotourism	Private

		Chololo Ranch	Chololo Research	0	0	3	Commercial Ranching	Private
		Kariunga	Kariunga	0	0	6	Farming	Private
		Ol Karama Ranch	Ol karama Main House	0	0	1	Commercial-Ecotourism	Private
		Mpala Ranch	Mpala Main House	0	0	2	Commercial	Private
		Lekiji	Lekeji	0	0	11	Pastoralism	Occupied
		Mogwooni Ranch	Mogwooni	0	0	1	Commercial Ranching	Private
		Koija	Koija Centre	3	8	18	Pastoralism-Ecotourism	Communal
		Il' Motiok Ranch	Il'motiok	0	0	7	Pastoralism-Ecotourism	Communal
		Sabuk	Sabuk	1	1	1	Ecotourism	Private
4	**West**	Muhotetu	Muhotetu	1	1	0	Farming	Private
		Limunga	Muhotetu Centre	1	1	0	Farming	Private
		Thome A	Thome A	2	6	0	Agropastoralism	Occupied

		Matigari	Matigari	0	0	16	Farming	Private
		Kifuko Ranch	Kifuko	1	1	1	Commercial Ranching	Private
		Lombora	Lombora	1	1	1	Commercial Ranching	Private
5	**South**	Endana	Endana	0	0	9	Pastoralism	Communal
		Ol Pajeta Ranch	Ol Pajeta	1	1	1	Commercial-Ecotourism	Private
		Sirima	Nobit Centre	0	0	0	Farming	Private
		Sugoroi Ranch	Sugoroi	0	0	0	Commercial Ranching	Private
		Solio Ranch	Solio	0	0	0	Commercial-Ecotourism	Private
	Total			**39**	**103**	**242**		

Table 2.5: Some Value Orientations and their the associated beliefs towards wildlife

Wildlife Value Orientations	Value Belief
Materialism	Wildlife exists for human use, human welfare is prioritized over that of wildlife.
Mutualism	Wildlife is viewed as capable of trust with humans, wildlife have rights like humans, wildlife as are part of an extended family of humans.
Environmentalism	General concern for protecting the environment which can be extended to wildlife and feelings that human beings are negatively impacting on the environment through their actions
Rational/Scientific	Belief that humans can solve environmental problems through science and technology and a rational and scientific explanations about the natural world works and the way animals behave (as opposed to spiritual and or religious explanations)
Spiritual/Religious	Viewing wildlife and environment as created and controlled by a higher power(s), explaining the workings of the natural world through a religious and spiritual viewpoint (as opposed to a rational/scientific viewpoint)

Symbolism	Assuming that certain wildlife as emblems of a clan, family, or group where they symbolize beliefs that humans will imbue species of wildlife with characteristics that are not necessarily inherent in those species themselves. For example wildlife can bring good or bad luck or can affect the course of your well being
Attraction/Interest	Interest and desire to know more about wildlife, feeling that wildlife enhances life experiences or even just based from morphological traits that are considered beautiful and therefore attractive to look at.
Ambivalence	Contradictory or polarized feelings expressed that cause uncertainty and the inability to make a choice to say and (re)act opposite to what has been expressed towards a particular animal due to existential behavioral or morphological traits they poses. For example, feelings of anger towards baboons because they are destructive but at the time feelings of mutualism or companionship are also expressed because baboons are also funny or interesting to watch because their infants play like human children*.

Adopted and modified from Dayer et al (2007); Zinn & Shen, (2007); Hamazaki &Tanno, (2002); Kalland, (1993); *Categorized in this study (see Moinde, Chapter 5).

Table 2.6: Description of land use systems in Laikipia District

Livelihood practices		*Land use systems*	People	Tenure	Description
Commercial	1	*Commercial ranching only* (N =10)	Both local and foreign people of European origin	Private	Breeding steers for commercial purposes*.
	2	*Commercial & Ecotourism* (N = 11)			Complement commercial ranching with ecotourism
Pastoralism	3	*Pastoralism only* (N = 53)	Pastoralist – mainly the maasai, samburu, Turkana	Communal or occupied abandoned land	Rely on livestock for subsistence living. However, some areas have local livestock markets that are expanding within Laikipia for local commercial purposes
	4	*Pastoralism & agriculture* (N = 63)	Mainly maasai, samburur and Turkana	Communal or occupied abandoned land	Mainly both subsistence pastoralism and farming

	5	*Pastoralism & ecotourism* *(N = 65)*	Mainly maasai and samburu	communal	Pastoralism and community based conservation development programs through ecotourism ventures
	6	*Pastoralism & ecotourism & agriculture* *(N = 16)*	Small subsistence farming	communal	Pastoralism supplemented with ecotourism and farming. Similarly as above , ecotourism is part of a communal development initiative
Agriculture	7	*Farming* *(N = 24)*	Mainly kikuyu and the meru people. Largely practiced for subsistence purposes and excess sold for local market	Private small holding**	Mainly subsistence but some sell farming produce to local markets. Cultivating maize, tomatoes, potatoes, kale, spinach, carrots, peas and other types of vegetables
Ecotouris m		****Ecotourism only* *(N =1)*	private		Ecotourism involves targeting high income tourism at lower impacts to the environment

* Two commercial ranches (i.e., Mogwooni and Kifuko ranch have completely have removed wildlife and fenced in only livestock

** A few may have been occupied or rented small holding plots subdivided plots of land.

***Sabuk Ranch in northern is the only ranch within the district that practices ecotourism as its only land use practice. Not used as part of the larger analysis in this study as a result.

Appendix 2.1: Grass species sampled within the study site

	Grass species
1	*Anthrobogon distachyes*
2	*Astrida Adoenisis Hochst*
3	*Bothnochloa insculpta*
4	*Brachiaria ruziziensis*
5	*Cenchrus ciliaris*
6	*Cynodon dactylon*
7	*Chloris virgata Spp.*
8	*Digitaria milanjiana*
9	*Eleusine multiflora*
10	*Eragrostis superba*
11	*Monsonia angustifohia*
12	*Microchloa kunthii*
13	*Pennicitum mezanium*
14	*Panicum maximum*
15	*Rynchelytrum repens*
16	*Setaria incrassata (Hochst) Hack*
17	*Tragus berteronionnus*
18	*Themeda triandtra*
19	UD spp C
20	UD spp G

UD –unidentified species were coded with letters

Appendix 2.2: Forbs Species sampled in the study site

#	Forb species	#	Forb species
1	*Aerva lanata (L.) Schulles*	22	*Portulaca oleacea L.*
2	*Aspilia massambi censis*	23	*Tetragonia acanthocarpa*
3	*Comelina spp*	24	*Trifolium semipilosum var.*
4	*Cyprus rotundus*	25	*Rhynchosia minima (L) D.C*
5	*Convolvulus sigittatus thunb*	26	*Rhinacanthus ndorensis*
6	*Dichondra repens*	27	*Solanum incanum*
7	*Euphorbia inaequilatera sond.*	28	*Solanum nigrum L.*
8	*Euphorbia spp*	29	UD spp. 2
9	*Erucastrum arabicum fisch*	30	UK spp. 3
10	*Hibiscus flavifolius ulbr*	31	UK spp. 4
11	*Helichryscum tubulosa (l.f.) Engl*	32	UD spp. 5
12	*Indigofera arrecta*	33	UD spp. 6
13	*Iponeoea oenotherae*	34	UD spp. 7
14	*Justicia calyculata*	35	UD spp. 8
15	*Leucas grabrata*	36	UD spp . 9
16	*Leucas Martinicensis*	37	UD spp 10
17	*Madicago Liciniata (L) D.C*	38	UD spp 13
18	*Monsonia augustifolia A. Rich*	39	UD spp. 14
19	*Monsonia augustifolia A. Rich*	40	UK spp. 15
20	*Oxygonum sinuatum*	41	UD spp 16
21	*Pelargonium glechomoides A. Rich.*	42	UD spp 17

Appendix 2.3: Questionnaire on land use and human-wildlife interactions

Introduction: The purpose of this questionnaire is to understand how people in different parts of Laikipia use their environment and interact with wildlife. [When we talk about wildlife, we mean wild animals that are not domesticated]. This questionnaire is part of an ongoing study conducted by Nancy Moinde, a Phd student from Rutgers University in the USA. Keep in mind that your participation in this study is voluntary and that all of your responses will remain confidential. We would be very grateful if you could participate. Thank you for your cooperation.

A. BACKGROUND INFORMATION

(Respondents details)

1. **Gender:** 1: Male   2: Female

2. **What year were you born?** _____

3. **Where were you born?** 1:   In Laikipia   2:   Out of Laikipia

4. **What is your level of education?**   1: None   2: Primary   3: Secondary

   4: Post Secondary (College, University).

5. **What is your denomination?**

   1: Christian   2: Muslim   3: Traditionist   4: Do not belong to any religion

   5: Other

6. **What ethnicity do you belong to?**

1: Kikuyu   2: Meru   3: Maasai   4: Samburu   5: Turkana   6: European

7: Other:_____

7.   What is the name of this land/Ranch that you live in?
_____

---

1.   What activities do you conduct on this land you live in? _____

1: Pastoralism

2: Commercial ranching

3: Farming

4: Tourism

5:   Agropastorialism

6: Other: (*specify*)_____

If only one land use is practiced go to question 3 below.

2. **Which land use practice do you benefit the most financially from?**

1: Pastoralism

2: Commercial ranching

3: Farming

4: Tourism

 5: Agropastorialism

6: Other: (*specify*)_____

3. How do the(se) land use practice(s) benefit you the most?\

1: Money   2: Food   3: Both   4: Other:_____

4. What type of landholding is this land you live in?

1: Privately Owned   2: Communal Group ranch 3:   Government owned   4: I just live here

5:   I don't know   5: Other: _____

5. What position do you hold on this land?

    1: Owner 2: Co-owner 3: Employee 4: Occupant 5: Other: _____

                                                                                                                                                  [ ]

    Specify: _____

        _____

6. How long have you lived in this area? _____

    1: Less than 5 years   2: Btw 5-10 years 3: btw 10-20 years 4: more than 20 years

                                                                                                                                                  [ ]

    5: All my life   6: Other:_____

If answer above is 5 then go straight to question 10.

7. Why did you move here?

1: Insecurity in area of origin   2: Lack of land in area of origin

3: Drought in area of origin   4: To find employment

5: Other: _____

8.   **Do you live here most of the time?**

1: Yes   2: No   3: Other:_____

9.   **If answer above is no, where do you live most of the time?** _____

10. **Where did you live before you moved here?** _____

11. **How did you acquire the land that you live on?**

1: I inherit it (ancestral)   2: I occupied it   3: I bought it   4: Rent it

5: Other (specify): _____

12. What are your goals (or future plans) with regards to how you use this land you live in?

_____
_____
_____

13. How do you go about achieving these goals?

_____
_____
_____

14. Do you Farm?

1: Yes   2: No

If NO, go to questions in category D next page.

C. FARMING CATEGORY

1. How big is your shamba?

1: Less then 5 acres   2: 5acres – 10acres   3: 10 acres -15 acres   4: More than 20 acres

2. What do you mainly plant in your shamba? _____

1: Maize

2: Beans

3: Sukuma

4: Cabbage

5: Tomatoes

6: Onions

7: Potatoes

8: Other: _____

3. What do you do with the crop that you harvest from your shamba?

1: Feed yourself (and family)   2: Sell the food   3: Both 1 & 2

4: Other (*explain*): _____

4. Do you do have any other means of supporting you and your family?

1: Yes   2: No

If NO, go to question 6 below.

5. If yes, what other means do you have to support you and your family?

1: _____   2: _____

3: _____   4: _____

6. Which of these means of supporting your family (including farming) do you benefit the most from? (*from the answer above*)

1: 1   2: 2   3: 3   4: 4   5: It depends   6: Other:

Specify: _____

7. Do you own your shamba?

1: Yes   2: No   3: I have rented or leased it   4: I just occupy it

5: Other: _____

8. Do you experience problems with farming?
a) Drought   1: Yes   2: No

b) Lack of water for irrigation   1: Yes   2: No

c) Crop raiding by wildlife   1: Yes   2: No

d) Pests   1: Yes   2: No

e) Other: _____

9. **Please rank the problems that you experience with farming that you have mentioned above in terms of the most to the least problematic.**
a) Drought   Rank: _____

b) Lack of water for irrigation   Rank: _____

c) Crop raiding by wildlife   Rank: _____

d) Pests   Rank: _____

e) Other: _____Rank: _____

If wildlife has not been indicated to cause problems in farming above, go to question 13.

10. **Which wildlife crop raid your shamba the most?**
1:       _____   2: _____

3:       _____   4: _____

4:       _____   5: _____

6:       _____   7:_____

11. **Which three of the wildlife mentioned above causes the most damage to the crops?**

1: _____   2: _____

3: _____

12. Which of the wildlife that crop raid your shamba are the most frequent crop raiders?

1: _____   2: _____

3: _____

13. **Do you derive any benefits of having wildlife in your land?**

1: Yes   2: No   3: I do not know

[ ]

4: Other: *Specify:* _____

14. Has your income been affected by crop raiding?
1:    Yes   2: No

[ ]

15. If YES, in what way(s)?
_____

[ ]

1. **Do you keep livestock?** 1: Yes   2: No

If NO, go straight to questions in category E.

D. PASTORIALISM AND COMMERCIAL RANCHING CATEGORY

2. **What kind of livestock do you keep?**

    1 : Cattle   1:

    2: Camel   2:

    3: Goats   3:

    5: Sheep   4:

    6: Donkey   5:

    7: Chicken   6:

    8: Other: _____   7:

3. **How big is the land that you keep livestock?**

    1: Less then 5 acres   2: 5acres – 10acres   3: 10 acres -15 acres   4: More than 20 acres

4. Where do you graze livestock in the dry season?

1: On my own land/ranch

2: In the forest reserve

3: In the community land

4: in the group ranch

5: anywhere where I can find grazing

6: Other: _____

5. Where do you graze livestock in the wet season?

1: On my own farm

2: In the forest reserve

3: In the community land

4: in the group ranch

5: anywhere where I can find grazing

6: Other: _____

6. Where did you graze your livestock in the 2009 drought?

1: On my own land/ranch

2: In the forest reserve

3: In the community land

4: in the group ranch

5: anywhere where I can find grazing

6: Other: _____

7. **Do you have any wildlife on this land?**

   1: Yes   2: No

8. **Do you think that wildlife compete with your livestock for food resources on this land?**

   1: Yes   2: No   3: I don't know

If NO, go to question 20.

9. **Which wildlife competes with your livestock the most?**

1: _____   2: _____

3: _____   4: _____

4: _____   5: _____

6: _____   7:_____

10. Do you own this land/ranch?

1: No   2: yes

11. If no, what do you do here?

1: I am employed here   2: I have rented or leased the land   4: I just occupy it

5: Other (Specify): _____

12. If employed, what is your employment position on this ranch?

_____

13. Do you conduct other activities on this land to financially support you and your family?

1: Yes   2: No

14. If yes, what other activities besides keeping livestock support you financially?

1: _____   2: _____

3: _____   4: _____

15. Do you have tourists coming here?

1. Yes   2.   No

If NO, go to category F.

E: TOURISM CATEGORY

1. **If YES, what do the tourist come to do on your land?**

   1: Cultural Manyatta

   2: See wildlife

   3: Lodge

   4: Camping

   5: Research

   6: Other:_____

2. **Which of these activities above do the tourist seem to enjoy the most?**

1: Cultural Manyatta

2: See wildlife

3: Lodge

4: Camping

4: Research

5: Other:_____

3. **Which tourist activities do you benefit financially from the most on this land?**

Benefit Type	Yes	No	
1 : Don't know	1	2	
2: None	1	2	
3: Hotel/Lodge bed nights	1	2	
4: Camping			
5:Wildlife viewing	1	2	
6: Gate entry fees	1	2	
7:Sale of farm produce to lodges	1	2	
8: Sale of craft items	1	2	
9: Employment	1	2	
10: Cash from cropping schemes	1	2	
11: Community project	1	2	
12: Other:	1	2	

4. **List the wildlife that tourist like to see the most** (*starting with the most liked to least liked*)
   a) _____
   b) _____
   c) _____
   d) _____

e) _____

5. Do you own this land/ranch you live in?

1: Yes   2: I have rented or leased it   3: I just occupy it

5: Other (Specify): _____

6. **If no, what do you do here?**

1: I am employed here   2: I have rented or leased it   4: I just occupy it

5: Other (Specify): _____

7. **Do you conduct other activities on this land to financially support you and your family?**

1: Yes   2: No

8. **If yes, what other activities besides tourism support you financially?**

1: _____   2: _____

3: _____   4: _____

1. Which wild animals do you see on this land?

a) _____   (f) _____

b) _____   (g) _____

c) _____   (h) _____

d) _____   (i) _____

e) _____   (j) _____

2.   What do you feel when you see the following animals?

a) _____ i. Fear   1: Yes   2: No   i.   ☐

ii. Interest/Attraction   1: Yes   2: No   ii. ☐

☐

iii. Concern for safety   1: Yes   2: No   iii. ☐

☐

iv. Concern for property   1: Yes   2: No   iv. ☐

v. Anger   1: Yes   2: No   v.   ☐

vi. Sad   1: Yes   2: No   vi.

vii. Happy	1: Yes	2: No	vii.	
viii. Respect	1: Yes	2: No	viii.	[ ]
ix. Other: _____			ix.	[ ]
x. Why? : _____				

b) _____

i. Fear	1: Yes	2: No	i.	[ ]
ii. Interest/Attraction	1: Yes	2: No	ii.	[ ]
				[ ]
iii. Concern for safety	1: Yes	2: No	iii.	[ ]
				[ ]
iv. Concern for property	1: Yes	2: No	iv.	[ ]
				[ ]
v. Anger	1: Yes	2: No	v.	
vi. Sad	1: Yes	2: No	vi.	
vii. Happy	1: Yes	2: No	vii.	
viii. Respect	1: Yes	2: No	viii.	[ ]
ix. Other: _____			ix.	[ ]
x. Why? : _____				

c) _____ i. Fear   1: Yes   2: No   i.   ☐

ii. Interest/Attraction   1: Yes   2: No   ii.   ☐

☐

iii. Concern for safety   1: Yes   2: No   iii.   ☐

☐

iv. Concern for property   1: Yes   2: No   iv.   ☐

v. Anger   1: Yes   2: No   v.

vi. Sad   1: Yes   2: No   vi.

vii. Happy   1: Yes   2: No   vii.   ☐

viii. Respect   1: Yes   2: No   viii. ☐

ix. Other: _____   ix.   ☐

x. Why? : _____

d) _____ i. Fear   1: Yes   2: No   i.   ☐

ii. Interest/Attraction   1: Yes   2: No   ii.   ☐

☐

iii. Concern for safety   1: Yes   2: No   iii.   ☐

☐

iv. Concern for property   1: Yes   2: No   iv.   ☐

☐

v. Anger   1: Yes   2: No   v.

vi. Sad   1: Yes   2: No   vi.

vii. Happy	1: Yes	2: No	vii.	
viii. Respect	1: Yes	2: No	viii.	☐
ix. Other: _____			ix.	☐
x. Why? : _____				

e) _____ i. Fear	1: Yes	2: No	i.	☐
ii. Interest/Attraction	1: Yes	2: No	ii.	☐
				☐
iii. Concern for safety	1: Yes	2: No	iii.	☐
				☐
iv. Concern for property	1: Yes	2: No	iv.	☐
				☐
v. Anger	1: Yes	2: No	v.	
vi. Sad	1: Yes	2: No	vi.	
vii. Happy	1: Yes	2: No	vii.	
viii. Respect	1: Yes	2: No	viii.	☐
ix. Other: _____			ix.	☐

x. Why? : _____

f) _____ i.   Fear   1: Yes   2: No   i.   [   ]
               ii.   Interest/Attraction   1: Yes   2: No   ii. [   ]
                                                                                        [   ]
               iii. Concern for safety   1: Yes   2: No   iii. [   ]
                                                                                        [   ]
               iv.   Concern for property   1: Yes   2: No   iv. [   ]
                                                                                        [   ]
               v.   Anger   1: Yes   2: No   v.

               vi.   Sad   1: Yes   2: No   vi.

               vii. Happy   1: Yes   2: No   vii.

               viii. Respect   1: Yes   2: No   viii. [   ]

               ix. Other: _____   ix. [   ]

               x. Why? : _____

                                                                                        [   ]
                                                                                        [   ]
g) _____ i.   Fear   1: Yes   2: No   i.   [   ]
               ii.   Interest/Attraction   1: Yes   2: No   ii. [   ]
                                                                                        [   ]
               iii. Concern for safety   1: Yes   2: No   iii. [   ]
                                                                                        [   ]
                                                                                        [   ]

iv. Concern for property	1: Yes	2: No	iv.
v. Anger	1: Yes	2: No	v.
vi. Sad	1: Yes	2: No	vi.
vii. Happy	1: Yes	2: No	vii.
viii. Respect	1: Yes	2: No	viii.

ix. Other: _____ ix.

x. Why? : _____

h) _____
i. Fear	1: Yes	2: No	i.
ii. Interest/Attraction	1: Yes	2: No	ii.
iii. Concern for safety	1: Yes	2: No	iii.
iv. Concern for property	1: Yes	2: No	iv.
v. Anger	1: Yes	2: No	v.
vi. Sad	1: Yes	2: No	vi.
vii. Happy	1: Yes	2: No	vii.
viii. Respect	1: Yes	2: No	viii.

ix. Other: _____ ix.

x. Why? : _____

i) _____ i. Fear   1: Yes   2: No   i

ii. Interest/Attraction   1: Yes   2: No   ii

iii. Concern for safety   1: Yes   2: No   iii

iv. Concern for property   1: Yes   2: No   iv.

v. Anger   1: Yes   2: No   v.

vi. Sad   1: Yes   2: No   vi.

vii. Happy   1: Yes   2: No   vii.

viii. Respect   1: Yes   2: No   viii.

ix. Other: _____ ix.

x. Why? : _____

3. Is it acceptable for people to kill wildlife if they think it poses a threat to their life?

1: Yes   2: No   3: I am not sure   4: It depends on the circumstances

5: Other _____

4. Is it acceptable for people to kill wildlife for money (e.g. game sporting) through tourism?

1: Yes   2: No   3: I am not sure   4: It depends on the circumstances

5: Other _____

5. Is it acceptable for people to kill wildlife if they think it poses a threat to their property?

1: Yes   2: No   3: I am not sure   4: It depends on the circumstances

5: Other: _____

6. Do you believe its good luck to kill certain wildlife?

1: Yes   2: No   3: I am not sure   4: Other: _____

If NO, go to question 9.

7. Which wildlife bring good luck when you kill them?

a) _____   (f) _____
b) _____   (g) _____
c) _____   (h) _____
d) _____   (i) _____
e) _____   (j) _____

8. Why do you believe it will bring you good luck to kill the above named wildlife?
a) _____

b) _____

c) _____

d) _____

e) _____

f) _____

g) _____

h) _____

i) _____

j) _____

9. Which wildlife bring bad luck when you kill them?

f) _____   (f) _____

g) _____   (g) _____

h) _____   (h) _____

i) _____   (i) _____

j) _____   (j) _____

10. Why do you believe it will bring you bad luck to kill the above named wildlife?

a) _____

b) _____

c) _____

d) _____

e) _____

f) _____

g) _____

h) _____

i) _____

j) _____

11. Is it acceptable to hunt wildlife for food?

1: Yes   2: No   3: I am not sure   4: Other: _____

12. Do you think wildlife has any economic value?

1: Yes   2: No   3: I am not sure   4: Other :_____

13. Why?
    Explain:_____

14. Do you think wildlife have rights like human beings?

1: Yes   2: No   3: I am not sure   4: Other _____

15. Why?
Explain:_____

16. What are the costs or disadvantages you have experienced due to living with wildlife?

1: Crop raiding

2: Damage of property (fence, pipes, buildings etc..).

3: Competing for food resources with livestock.

4: Threat to human life.

5: Other:_____

17. Do you believe that some wildlife have more value than others?

1: Yes   2: No   3: All wildlife are equal   4: I am not sure

5: Other: _____

If NO, go to question 20.

18. If yes, which wildlife in Laikipia do you consider to have more value than others?

Wildlife   Reason for higher value

a) _____

     Why?: **i)**   Source of Food   1: Yes   2: No

           ii)   Tourism Attraction   1: Yes   2: No   :

           iii) Traditional Belief   1: Yes   2: No

           iv)   Customary Use   1: Yes   2: No

           v) Spiritual beliefs/taboos   1: Yes   2: No

           vi)   Other:_____   1: Yes   2: No

        Explain:_____

b) _____

Why?:	**i)** Source of Food	1: Yes	2: No
	ii) Tourism Attraction	1: Yes	2: No
	iii) Traditional Belief	1: Yes	2: No
	iv) Customary Use	1: Yes	2: No
	v) Spiritual beliefs/taboos	1: Yes	2: No
	vi) Other:_____	1: Yes	2: No

Explain:_____

c) _____

Why?:	**i)** Source of Food	1: Yes	2: No
	ii) Tourism Attraction	1: Yes	2: No
	iii) Traditional Belief	1: Yes	2: No
	iv) Customary Use	1: Yes	2: No
	v) Spiritual beliefs/taboos	1: Yes	2: No
	vi) Other:_____	1: Yes	2: No

Explain:_____

d) _____

Why?:	**i)** Source of Food	1: Yes	2: No
	ii) Tourism Attraction	1: Yes	2: No
	iii) Traditional Belief	1: Yes	2: No
	iv) Customary Use	1: Yes	2: No
	v) Spiritual beliefs/taboos	1: Yes	2: No
	vi) Other:_____	1: Yes	2: No

Explain:_____

e) _____

Why?:	**i)** Source of Food	1: Yes	2: No
	ii) Tourism Attraction	1: Yes	2: No
	iii) Traditional Belief	1: Yes	2: No
	iv) Customary Use	1: Yes	2: No
	v) Spiritual beliefs/taboos	1: Yes	2: No

vi) Other:_____   1: Yes   2: No

Explain:_____

19. Which wildlife in Laikipia do you consider to have the least value of all wildlife?

Wildlife   Reason for lower value_____

f) _____
    Why?:   **i)** Source of Food   1: Yes   2: No

          ii) Tourism Attraction   1: Yes   2: No   :

          iii) Traditional Belief   1: Yes   2: No

          iv) Customary Use   1: Yes   2: No

          v) Spiritual beliefs/taboos   1: Yes   2: No

          vi) Other:_____   1: Yes   2: No

    Explain:_____

g) _____
    Why?:   **i)** Source of Food   1: Yes   2: No

ii) Tourism Attraction   1: Yes   2: No   :

iii) Traditional Belief   1: Yes   2: No

iv) Customary Use   1: Yes   2: No

v) Spiritual beliefs/taboos   1: Yes   2: No

vi) Other:_____   1: Yes   2: No

Explain:_____

h) _____

Why?:   **i)** Source of Food   1: Yes   2: No

ii) Tourism Attraction   1: Yes   2: No   :

iii) Traditional Belief   1: Yes   2: No

iv) Customary Use   1: Yes   2: No

v) Spiritual beliefs/taboos   1: Yes   2: No

vi) Other:_____   1: Yes   2: No

Explain:_____

i) _____

Why?:	**i)** Source of Food	1: Yes	2: No
	ii) Tourism Attraction	1: Yes	2: No :
	iii) Traditional Belief	1: Yes	2: No
	iv) Customary Use	1: Yes	2: No
	v) Spiritual beliefs/taboos	1: Yes	2: No
	vi) Other:_____	1: Yes	2: No

Explain:_____

j) _____

Why?:	**i)** Source of Food	1: Yes	2: No
	ii) Tourism Attraction	1: Yes	2: No
	iii) Traditional Belief	1: Yes	2: No
	iv) Customary Use	1: Yes	2: No
	v) Spiritual beliefs/taboos	1: Yes	2: No
	vi) Other:_____	1: Yes	2: No

Explain:_____

20. Does Kenya receive any benefits from wildlife in Laikipia?

   1:   Yes   2: No   3: I am not sure   4: Other _____

21. **Which wildlife brings in the most benefits to Kenya in general?**

   1._____   6. _____

   2. _____   7. _____
   3. _____   8. _____
   4. _____   9. _____
   5. _____   10. _____

Explain:_____

_____

22. What are the threats to your income stability?

threat	Yes	N o	Rank	
1. None	1	2		
2. Drought	1	2		
3. Disease	1	2		

	Yes	No			
4. Cattle rustling	1	2			
5. Wildlife	1	2			
6. Illegal grazing	1	2			
7. Fire	1	2			
8. Poaching	1	2			

Only if wildlife is indicated as a threat to your security go to question 23 below otherwise skip to question 24.

23. Which wildlife threaten your income stability?

Animal	Yes	No	Rank		
1. Baboons	1	2			
2. Monkeys	1	2			
3. Porcupines	1	2			
4. Birds	1	2			
5. Bush pigs	1	2			
6. Elephants	1	2			

7. Lions	1	2			
8. Leopards	1	2			
9. Hyenas	1	2			
10. Other_____	1				

H. HUMAN-BABOON INTERACTIONS CATEGORY

1. **What do you think immediately after you have seen a baboon?**

   1: Fear   1: Yes   2: No   1.

   2: Anger   1: Yes   2: No   2.

   3: Curiosity   1: Yes   2: No   3.

   4: I do not know   1: Yes   2: No   4.

   5: Other:_____

2. **In the last year have you seen baboons in this area during the rains?**

1: Yes   2: No   3: Other_____

3. **In the last year have you seen baboons in this area when it was dry?**

 1: Yes

         2: No

     3: Other: _____

4. **Have you ever kept a baboon (or other wildlife) as a pet**?

 1: Yes 2: No

5. **If Yes, what do you think about baboons because of the experience of keeping a baboon?**
 Explain:_____

6. **How many times have you witnessed a leopard/lion kill a baboon?**

 1: None 2: Once 3: A few times 4: Many times 5: Other:_____

7. **How many times have you heard a leopard/lion threaten baboons?**

1: None   2: Once   3: A few times   4: Many times   5: Other:_____

8. **Do you think livestock presence influences whether leopards/lions will kill baboons?**

1: Yes   2: No

9. **Do you think that the presence of baboons can cause you to be sick*?***

1: Yes   2: No   3: I don not know

10. **If Yes, why?**
Explain:_____

11. **When did you last see baboons in this area?**
1: In the last week   2: In the month   3: In the last three months   4:   In the last six months

5: More than six months ago   6: Other:_____

12. **What were you doing when you saw them?**
1: traveling on foot/bicycle   2: traveling by motorbike/vehicle

3: tending crops 4: looking after livestock   5: collecting wild foods

6: fetching water   7: collecting firewood

8: other_____

13. **What did you do when you saw them?**
    1: nothing   2: I ran away and tried to hide

    3: I tried to scare it/them away   4: I tried to kill it/them

    5: Other_____

14. **Why?**
    1: they were too far away to be of concern   2: I like them   3: they don't bother me

    4: I feared for my life   5: they were in my crops   6: they were damaging my infrastructure

    7: they were competing with my livestock for grazing/water

    8: Other_____

15. **Do you mind baboons coming into this area?**

    1: Yes

                       2: No

    3: Why?_____

16. **Are there occasions when you have tried to prevent baboons from coming near you and/or your property (cattle/your crops/infrastructure)?**

1: Yes

2 : No

If NO, go to question 21.

1. **Under what circumstances have you tried to do this?**

i. Circumstances	Yes	No	
ii. When they entered my crop field	1	2	
iii. When they entered my land/ranch	1	2	
iv. When they damaged my property	1	2	
v. When they damaged my water pipes	1	2	
vi. When they prevented my livestock from drinking	1	2	
vii. When they blocked my path	1	2	
viii. When they threaten my life	1	2	
ix. Other:_____	1	2	

17. **What method did you use to prevent the baboon(s) from coming near you/your property?**

Method Used	Yes	No	
i. Gun shots (Rifle/shotgun) near baboons	1	2	
ii. Throw stones at baboons	1	2	
iii. Thunderflashes/Fireworks/Flares	1	2	
iv. Chasing	1	2	
v. Dogs	1	2	
vi. Traditional (details):	1	2	
vii. Other:_____	1	2	

18. How did the baboon(s) respond?
 1: no response   2: ran away 3: charged   4: Other: _____

19. Did anyone else help you try and scare away the baboon(s)?
 1: Nobody else helped me

 2: My neighbours and friends

3: KWS

4: Other:_____

20. Do you use any preventative measure to prevent baboons from moving into certain areas?
   1: Yes   2: No

Barrier	Yes	No
1: Wall (*details*)	1	2
2: Electric Fence (*details*)	1	2
3: Trench (*details*)	1	2
4:Chasing (*details*)	1	2
5: Hire other people to chase (*details*)	1	2
6: Other: (*details*)	1	2

21. **Is it legal to kill a baboon**

      1: Yes   2: No   3:   I don't know   4:   Other:_____

22. **If yes, why is it legal?**

Explain: _____

23. **Have you requested the KWS to assist you with scaring away baboons that were giving you problems at any one time?**

1: Yes   2: No   3. Other: _____

24. **If yes, describe what they did to assist you and when?**

_____
_____

25. **Did this solve the problem?**

1: Yes   2: No

Notes: _____

_____

26. **Do people still hunt baboons?**

1: Yes   2: No   3: I don not know

27. **If YES, why?**

1: Because they eat their goat and sheep   1:

2: They raid crop in the *shambas*   2:

3: For traditional medicinal purposes   3:

4: For customary practices or beliefs   4:

5: Other: (*Explain*) _____

_____

28. **What are the benefits of having baboons in this area?**

1. _____   6. _____
2. _____   7. _____
3. _____   8. _____
4. _____   9. _____
5. _____   10. _____

29. **What are the costs of having baboons in this area?**

6. _____   6. _____
7. _____   7. _____
8. _____   8. _____
9. _____   9. _____
10. _____   10. _____

30. **Who owns the baboons in this area?**

1: Nobody   2:   the neighbouring ranch

3:

2:Kenyan government   5:   Other_____

HUMAN PERCEPTIONS OF OTHER PRIMATES

1. **Which of these pictures makes you more uncomfortable?**

     1: Picture A   2: Picture B

2. **Why?**

_____

_____

3. **Which one of these pictures looks more human?**

1:Picture A   **2:**   Picture B

Thank you very much. You have been very helpful. That's all I have for the interview unless there is anything else you would like to add or do you have any questions?

CHAPTER THREE

THE EFFECTS OF ANTHROPOGENIC LAND USE PRACTICES ON

VEGETATION IN LAIKIPIA DISTRICT, KENYA: IMPLICATION FOR

WILDLIFE MANAGEMENT AND BIODIVERSITY CONSERVATION

3.1 INTRODUCTION

Land use has generally been considered a local environmental issue, but it is acquiring global importance as scientists increasingly demonstrate how practices such as deforestation (Meher-Homji 1991), intensive grazing (Balling 1990; 1998; Bryant et al. 1990) and agriculture (Pielke et al. 1991; Burke et al. 1991; Baron et al. 1997a,b) affect regional climate ecosystems and, ultimately, global climate (Foley et al. 2005; Stohlgren et al. 1998). Various forms of land use, such as croplands, pastures, plantations, and urban areas have extended in recent decades and are exerting increasing demand and competition for ecosystem resources shared by humans and wildlife (Meher-Homji 1991).

Semi-arid ecosystems account for the majority of the land area in sub-Saharan Africa, and most of this is *Acacia* savanna. (Cole 1986; Menault et al. 1985). These *Acacia* savannas vary from open grasslands, to scattered bush, and to open woodlands (Harris 1980). These ecosystems have been manipulated by people of traditional cultures for many centuries and are experiencing rapidly increasing pressure from both intensive cattle production and arid-land farming (West 1971; Bernard et al. 1989, Gichohi et al. 1996). These pressures can produce in local, regional, and global environmental problems (Gichohi et al. 1996, Herlocker 1996), including soil erosion, threats to endangered species and

desertification. In particular, the economic and conservation effects of livestock grazing and browsing on larger mammalian vertebrates and biodiversity have become increasingly scrutinized. Over the last three decades, the intrinsic value of wildlife has potentially increased due to tourism (Georgadis et al. 2007a; 2007b). Land users and managers, therefore, are continually faced with the dilemma of maintaining a sustainable balance between livestock and wildlife.

The effects of livestock grazing and browsing on ecosystems have been well documented globally (Lamprey 1979; Naveh and Whittaker 1979; Noy-Meir et al. 1989; Waser and Price 1991; Olsvig-Whittaker et al. 1993; Fleischner 1994; Milton et al. 1994; Todd and Hoffman 1999). Grazing, in particular, influences both biotic and abiotic variables (i.e., soil, moisture, temperature, etc. aspects of the ecosystems) (Fleischner 1994; Belsky and Blumenthal 1997). Ecological consequences of grazing include loss of biodiversity, reduced of floral and faunal population densities, disruption of ecosystem function as well as shifts in biomass/abundance, composition, diversity and structure of vegetation (Lamprey 1979; Fleischner 1994; Oba et al. 2001. The effects of grazing vary with its intensity. For example, low levels of grazing are thought to exemplify man-made ecosystems that are the richest in plant species in central Europe (Wolkinger and Plank 1981; Fischer and Wipf 2001) and that provide very important habitats for many animal species (Erhardt 1995). Moderate levels of grazing, on the other hand, may enhance plant diversity (Naveh and Whittaker 1979; Waser and Price 1991; Noy-Meir et al. 1989), while excessive grazing may reduce it (Waser and Price 1991; Noy-Meir et al. 1989; Olsvig-Whittaker et al. 1993) or simply shift local vegetation composition (Naveh and

Whittaker 1979; Milton et al. 1994; Todd and Hoffman 1999) in various parts of the world.

Various studies have also demonstrated how grazing influences invertebrate and vertebrate communities (Gunnarsson 1988; Uetz 1991; Jepson-Innes & Block 1989; Welch 1991; Rypstra et al. 1999; Halaj et al. 2000, Fleischner 1994). For example, grazing can reduce grasshopper (Arrididae) densities (Jepson-Innes & Block 1989; Welch 1991) or change species composition (Quinn and Walgenbach 1990). Another study also reported that densities of sheep positively correlated with density of ants (Hutchison and King 1980).

Similarly, grazing influences vertebrate populations indirectly through changes in habitat structure, or prey availability (Wagner 1978; Jones 1981; Mosconi & Hutto 1982; Szaro et al. 1985; Quinn & Walgenback 1990). For example, livestock grazing has been shown to increase or reduce the abundance and species richness of small mammals (Reynolds and Trost 1980; Medin and Ckary 1989), birds (Duff 1979; Crouch 1982; Bowen and Kruse 1993; Musconi and Hutto 1982; Taylor, 1986; Taylor and Littlefield 1986), lizards (Jones 1988), snakes (Szaro et al. 1985) and tortoises (Berry 1978; Campbell 1988). In the semi-arid ecosystems of Africa, and other parts of the world where livestock and wildlife share much of their respective ranges, the need to evaluate or critically examine the impact of livestock on large mammal species is increasingly vital for land use managers. Sheep, for example, are often depicted as notorious agents of disturbance, creating gaps in the herbaceous layer (e.g. Gillman et al. 1993; Bullock et al. 1994) that expose soil to erosion and colonization the of unpalatable species (Bahre and Shelton 1993; Milchunus and Laurenroth 1993; Beeskow et al 1995; Moinde 1997).

Sheep can have positive effects on plant population growth, however, by reducing plant competition and creating gaps or microhabitats for seedling recruitment (reviewed in Belsky 1986).

The effects of browsing of both flora and fauna are potentially just as important as grazing. The decade long degradation of woody plants in arid zone ecosystems in North Africa has been attributed to goats, a browsing species (Lamprey, 1981; Martin and Huss 1981; Kenneni and Van der Maaral, 1990). Lamprey (1981) noted that the mechanism for this loss may be poor tree regeneration and growth due to the impact of goats. There are, however, contradictory reports on the effects of goat browsing on the growth of woody trees and shrubs. For example, some studies estimated that the goat browsing of young *Acacia* spp. consequently led to compensatory browse production expressed through increased twig and thorn growth as a tolerance response to herbivory (Young 1987; Milton 1998). More specifically, Oba and Post (1999) showed that goat browsing did not affect tree growth rates, but did enhance twig growth. Gabay et al. (1998) argued that landscape and vegetation patch structure is crucially important for analyzing the effect of herbivory on plant communities based on their findings that goats modified the structure of woody plants.

Management of savanna rangeland ecosystems needs to address multiple factors beyond the dynamic livestock/wild herbivore interactions. For example, rainfall, fire, wild forbivores, and livestock are the dominant forces shaping short-term and long-term savanna community dynamics. They have been the subjects of numerous experimental and descriptive studies (e.g., Kelly and Walker 1976; Lock 1977; Young et al. 1998). One such example is the Kenya Long-term Exclosure Experiment (KLEE) project which

was initiated 1995 in Laikipia District. The KLEE Project, revealed that the presence of elephants (*Loxodonta africana*) potentially mitigates competition between cattle and other wild forbivores, possibly through elephant suppression of livestock resource extraction (Young et al. 1997). Further, common zebra (*Equus burchelli*) Grevy zebra (*Equus quagga*), Grant's gazelle (*Nanger granti*), eland (*Aurotragus oryx)*, and oryx (*Oryx beisa)* populations increased by almost 50% over a five year period when cattle were excluded, indicating cattle's ability to competitively suppress not only grazing wildlife, but also mixed feeders (Young et al. 1997; Odadi et al. 2007).

These findings provide a strong rationale for careful study of the influence of livestock grazing on vegetation. Such data would clarify the underlying mechanism(s) of the livestock-wildlife interactions and potentially influence management practices. This is particularly important because growing evidence over the last two decades, refutes the notion that livestock and wildlife are incompatible (reviewed in MacMillan 1986, Prins 1992). Hopcraft (1990) argued that a mixed strategy of including wildlife with cattle may, in fact, be economically optimal and help maintain biodiversity. There is a growing consensus that livestock, at least at moderate densities, may not only be less damaging to rangeland resources than previously thought (Boyd et al. 1999; Reid 2012) but even be beneficial to biodiversity (Gregory and Sensenig 2010; Soderstrom and Reid 2010; Augustine et al. 2011; Woodroffe 2011; Reid 2012).

Fire is an important dynamic for many semi-arid rangelands. In fact, many systems thrive on ecological disturbance (e.g., grazing), which potentially creates habitat mosaics at the landscape level, which are essential for maintaining biodiversity (Adler et al. 2001; Fuhlendorf and Engle 2001; Fuhlendorf et al. 2006). Many pastoralist communities in

East Africa, traditionally used controlled fire to induce recruitment of new green grass for

their livestock after periods of protracted drought (Gregory et al. 2010). This practice has

effects similar to those produced when zebra remove dry and less nutritious grass during

the dry season, which ultimately improves the rangelands for both grazing livestock and

wildlife. Since grazing pressure can alter fuel loads, the spatial patterns of fire and

ungulate density have important effects on savanna ecology as a whole (Archibald et al.

2005; Holdoetal et al. 2009). While the effects of browsers and grazers on their own are

limited, their interaction with fire influences the amount of woody cover on the savanna

landscape (Roquesetal 2001; Holdoetal 2009).

Another anthropogenic practice with a potentially important impact on the district's

landscape is "boma" use by pastoralists. Bomas are dense rings of thorn-scrub branches

that are temporarily constructed by pastoralists to contain and protect livestock overnight

from theft and predation (Augustine 2003; Augustine al. 2010). Historically and

currently the creation of bomas has altered the landscape by clearing woody vegetation

(Augustine 2003; Gregory 2010) and by redistributing and concentrating nutrients from

the surrounding savanna into a small area as livestock excrete large quantities of dung

and urine within the bomas (Augustine 2003). Following abandonment, boma sites

undergo further changes, often supporting a nutrient-enriched plant community and

potentially altering the spatial pattern of nutrient cycling within the ecosystem. Several

studies in East Africa report that recently abandoned boma**s** support unique herbaceous

plant communities characterized by nutrient enrichment, in both constituent soils and

grasses (Stelfox, 1986; Augustine, 2003a; Treydte et al., 2006; Muchiru et al., 2009).

Once abandoned, bomas progressively become productive grazing lawns called "glades" (Augustine 2003). Established glades are dominated by mat-forming *Cynodon plectostachyus* (star grass), *Pennisetum stramineum* (cluster grass), unidentified species of mushrooms, *Amaranthus hybridus* (pigwood), and *Cucurbita pepo* (a pumpkin like plant) (Moind, *pers. observ*.). Thus, glades form distinctly different microhabitats that may persist for decades on the landscape (Stelfox 1986; Young et al. 1995, Augustine 2003) (Fig 3.2). Long-term accumulation of urine and dung within the bomas enclosures consequently lead to higher soil concentrations of phosphorous, calcium, and nitrogen than in the surrounding soils (Augustine 2003a; 2003b). Local studies in South Africa even suggest that plant communities on abandoned sites of human occupation can persist in a nutrient-enriched state for centuries (Blackmore et al. 1990).

In this study, I evaluate the effects of land use practices on vegetation in Laikipia District, central Kenya. In order to quantify human impact on vegetation in two different land use systems, my central question is for this study is "How do two different livestock regimes, that is, pastoralism and a commercial ranch with different livestock grazing densities influence vegetation attributes: abundance, distribution and diversity of vegetation species? Over the last three decades, land use and management practices in Lakipia have varied widely as patterns of land ownership and wildlife attitudes have changed (Georgiadis et al. 2007a). The result is a mosaic of diverse land use management attitudes and practices (Gadd 2005; Georgiadis et al. 2007b). Laikipia District, thus, offers an ideal scenario for examining the role of land use practices on wildlife-human interactions. The district is unique in that it is home to some of the most spectacular megafaunal populations globally, supporting the highest species diversity in East Africa,

and the second highest density of wildlife in Kenya (after the famous Masaai Mara National Reserve) (Georgiadis et al. 2007a; Perfecto, et al. 2009). Yet this region is not formally "protected", (Graham 2006) and is an excellent example of a coexistence human-occupied landscape and wildlife suitable habitat. Tourism is the second largest source of foreign exchange revenue in Kenya. The high population sizes and diversity of wildlife in Laikipia has made the district gain prominence as an international wildlife tourist destination and economic resource for Kenya (Laikipia Wildlife Forum Newsletter, July Issue, 2007).

The district, thus, presents an exceptional case that has significant potential to improve our understanding of the diverse ways in which human cultural-ecological practices shape contemporary patterns of resource utilization and management. The successful maintenance of high density wildlife populations in an unprotected human-occupied landscape is largely attributed to the "pro-wildlife" practices promoted by the Laikipia Wildlife Forum (LWF). Established in 1992, the LWF is an NGO managed and run by local and foreign private and pastoralist landowners with the goal of managing, conserving, and profiting from wildlife (Parker 2003; LWF Newsletter 2007).

In this study, the two prominent land use practices I compare are pastoralism and commercial ranching. The pastoralist occupied tract of land and a privately owned "pro wildlife" commercial ranch differ significantly in livestock grazing regime. According to Georgadis (2007a), pastoralist lands maintain higher biomass of livestock (4.586 t km^{-2}) than the commercial pro-wildlife ranches (2.730 t km^{-2}) in Laikipia and therefore, the former reflects the more heavily grazed and disturbed land use systems within the district. Pastoralists in Laikipia not only herd a higher density of livestock, but a more diverse

range of livestock that includes various breeds of cattle (*Bos* sp.*)*, camels (*Camelus* sp.*)* goats (C*apra* sp.*)*, and sheep (*Ovis* sp.). This contrasts with the commercial ranches, where typically only cattle are stocked (Georgadis et al. 2007a).

Cattle and sheep are the grazers that mainly consume a wild variety of grass and forbs a well as leaves from shrubs and trees. Livestock generally prefer tender new vegetation when available and avoid older, mature plant parts, as these contain less protein and are more difficult to digest (Estes 1991; Green and Lewell 1982; Vallentine 1990; Holechek at al. 2011). Besides grass, legumes are consumed by cattle and sheep (Rath 1998). Goat and camels, on the other hand, are predominantly browsers that feed on the foliage from a wide variety of woody plants (Bartolomé et al. 1998).

Weisburg and Bergmann (2003) emphasize that a current challenge is how to use our knowledge of foraging ecology to predict effects on local vegetation. While important, most foraging ecology studies have largely focused on implications for the livestock/wildlife herbivore interaction (e.g., Bugalho and Milne, 2003; Mayer et al., 2003). Weisburg and Bergmann (2003) further argue that most studies examining the effects of browsing or grazing on vegetation typically focus on theoretical or empirical modeling of biomass removal of vegetation. These studies, however, do not consider the factors that influence the level of livestock consumption affecting vegetations in the first place. The integrated approach they recommend focuses on the dynamic influence of varying anthropogenic practices (management regimes) on plant-herbivore interactions and the plant response to varying interactions with both domestic and wild herbivore.

Based on contrasting livestock densities and composition between the two land use systems, I hypothesized that there would be differences in vegetation cover, structure,

and diversity between the commercial ranch and the pastoralist land. The following predictions were made:

Because browsers (primarily goats), were stocked in the pastoralist land but not in the commercial ranch, I predicted that woody plants in the pastoralist land would be characterized by: **1**) lower density; **2**) smaller canopy area; **3**) increased distances between neighboring plants; **4**) decreased height; and **5**) lower productivity.

Because gum production from the prominent woody tree *A. drepanolobium* increases with individual tree height (Isbell 1998), I predicted that: **6**) these trees would exhibit increased gum production in the commercial ranches relative to conspecifics on the pastoralist land.

Due to the observed higher stocking densities and diversity of domesticated grazers (i.e., cattle and sheep) in the pastoralist land compared to the commercial ranch (only cattle); I predicted: **7**) that herbaceous species will be more abundant in the commercial ranch than in the pastoralist land.

Because temporal changes in plant abundance and production are influenced by rainfall (McNaughton 1984), I predicted that irrespective of rainfall; higher overall abundance of **8**) woody plant production and **9**) the herbaceous layer in the commercial ranch relative to the pastoralist land.

Lastly Due to the increased occurrence of anthropogenic features such as abandoned bomas and glades in the pastoralist land (Moinde unpublished data), which have been reported to increase plant diversity and habitat heterogeneity, (Augustine 2003; Veblen 2006, Gregory et al. 2010; Rigonos et al 2012), I predicted that there will be a

higher diversity of; **10**) woody plants and **11**) herbaceous species on the pastoralist land as compared to the commercial ranch.

This direct comparison in vegetation between two contrasting livestock management systems also eliminates the controversial approach of applying grazing intensities instead of livestock densities as measures of various levels of disturbance. For example, Fleischner (1994), argues that the term "intensities" (i.e., low, moderate, heavy) to describe levels of grazing or browsing disturbance is largely subjective and therefore has been applied inconsistently across various studies. My study, thus, applies a comparative approach by incorporating the influence of different anthropogenic land use practices on the herbivore-plant relationship. Such a comparative quantification of the effects of current livestock regimes on vegetation can reveal how vegetation differences within diverse human-modified landscapes act as the underlying mechanism of varying livestock-wildlife dynamics and biodiversity.

3.2   METHODS

Study Site

Laikipia District is situated in north-central Kenya (between 0^0 17^0S and 0^0 45^0N, and 36^0 15^0E and 37^0 200E) and covers an area of approximately 9666 km^2 of semi-arid bush land and savanna (Fig. 3.1) (Woodroffe and Frank 2005). The main megafaunal species observed during the study period between the two land use systems were elephants (*Loxodonta africana*), common zebras (*Equus burchelli)*, giraffes (*Giraffa camelopardalis)*, Grant's gazelles (*Nanger granti*), Thompson's gazelles (*Gazella thomsoni*), impalas (*Aepyceros melampus)*, with the occasional sightings of dikdiks

(*Madoqua kirkii*), Grevy zebras (*E. grevyi),* oryx *(Oryx beisa),* elands (*Taurotragus oryx*), buffalo (*Syncerus caffer*), and waterbucks (*Kobus ellipsiprymnus*).
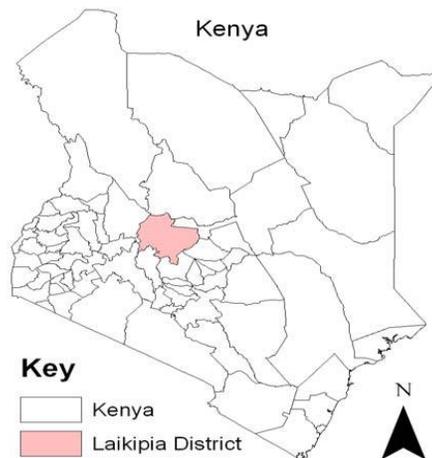
Figure 3.1: *Map of districts in Kenya, highlighting the geographic location of Laikipia*

A qualitative survey I conducted in 2006 and 2007 suggested that the higher livestock densities and grazing intensities in pastoralist ranches were characterized by reduced abundance and height (maturational state) of grasses such as *Pennisetum mezianum*, *P. stramineum*, and *Themeda triandra*, and lower abundance of *Acacia* trees (Moinde-Fockler *pers observ*.; see Fig. 3.2a and b). Here I present a more rigorous quantitative investigation of vegetation differences.

Glades in Laikipia District have been characterized as isolated, open, and usually treeless patches (Fig. 3.3) of approximately 0.5 – 1.0 ha (Veblen 2006) and their ecological attributes vary with their age, (i.e., the time of abandonment). Glades are thus characterized as "old" or "new". According to Augustine (2003b) Old glades (>39 years

old) typically support nutrient rich grass, whereas newer glades (< 39 years old) are more

"barren" floristically.

a)	b)

Figure 3.2: Habitat differences due to varying grazing intensities in Laikipia
District,Kenya.

a) Pastoralist ranches with dominant woody i.e. Acacia drepanolobium*, between patchy
grass cover with intermittent bare gap (Photo by Lisa Danish).*
b) Commercial ranchlands with woody *Acacia* spp. and grass cover (Photo by Ryne
Palombit).

Using aerial photos from between 1961 and 1969, Augustin (2003) was able to

approximate the age of current glades based on evidence of estimated time of

abandonment.

Figure 3.3: Baboons subject of part of this study feeding on green
grass in a glade (Photo by Nancy Moinde)

The pastoralist land had a higher percentage (69%) occurrences of abandoned bomas and glades than the commercial ranch (31%) (Moinde, unpublished data) within the study area.   Since boma construction and abandonment is a more common practice in the pastoralist communities in general, I predicted (see prediction 8 and 9) that both old (glades) and newly abandoned bomas, (which later transition to glades) would occur more frequently on the pastoralist lands. In this study, glades that were distinguish as "new" were those that still had evidence of recent anthropogenic activities, which included signs of temporary building structures and piles of accumulated dung from livestock.   In contrast "old" bomas have more vegetation cover and had no such indication of recent anthropogenic activity.

As earlier mentioned, glades support distinctly different grasses and typically devoid of the otherwise locally dominant grasses (e.g., *Bracharia* sp*., Lintonia* sp*.*, *Themeda* sp*.*, and *Mezianum* sp.) (Veblem 2006). These maturing new glades also support distinctly different herbaceous plants, not found in "old" glades, such as

unidentified species of mushrooms, pigwood (*Amaranthus hybridus*), and pumpkin

leaves (*Cucurbita pepo*) (Moinde, unpublished data).

Vegetation data collection

Vegetative Plots

Data were collected for 5-7 days per month from November 2009 until August

2010, except in April and June 2010, due to unusually heavy rainfall. Gum data,

however, was only collected for three months in the months of November 2009, January

2010 and May 2010. To establish the ecological differences between these land use

systems, a systematic evaluation of vegetative plots and line transects was conducted, as

described by Kent and Coker (1992), Higgins et al. (1994), and Bonham (1989). Twenty

25m x 25m vegetative plots were established within the study group's home range along

three individual transects. Two of the transects (T_1 and T_3), each measured 2 km long,

one situated entirely in Thome B and the other entirely in Segera ranch, respectively. The

third transect (T_2) was the longest, covering a distance of 4.5 km and stretching equally

across both land use systems. Along each transect, vegetative plots were marked every

500m (e.g., P_0 to P_4). Thus, a total of 10 plots were situated in each land use system. The

distribution of these transects and plots aimed to sample each land use system similarly.

For example, the number of seasonal rivers and swampy areas were represented equally

in each land use system's plots.

Quantitative Vegetation Measures

Five types of quantitative vegetation measures were taken on the sample plots: (1) abundance of woody plants; (2) dispersion of woody plants; (3) food productivity of woody plants; and (4) distribution of grasses and herbaceous plants. Woody plants comprised perennial trees or shrubs. Herbaceous plants were mainly bi-seasonal and typically grew close to or along the soil surface, with leaves and stems that wilted at the end of the growing season (Filgueiras 2002). Plants were identified either by using established vegetation keys for trees, shrubs, and grasses (Young and Isbell Unpublished Manuscript; Barton et al. 1993; Agnew 2006) or by a technical assistant, botanist John Kimeu Mbaluka , of the National Museums of Kenya herbarium. Plant species that remained unidentified were coded with letter codes (grasses) and number codes (forbs).

Abundance, dispersion and height of trees/shrubs: Data on density and dispersion of trees were collected using the "wandering quarter technique" (WQT), in which the distance (m) from each sample tree's stem to its nearest (tree) neighbor was recorded (see Kell 2006; Bonham 1989). The starting point of the WQT was the middle of each of the four quadrats in a vegetative plot; therefore, there were four WQT samples originating from each quadrat. Using a compass, each plot quadrat was named according to the orientation of the plot (e.g. NE, NW, SE, SW), which dictated the direction of each of the four WQT samples. Since the WQT is a plotless sampling method, each of the four samples extended beyond the boundaries of the 25m x 25m plots by an additional 25m, following the orientation of each plot. Thus, a larger sample size of trees/shrubs was achieved relative to a method limiting sampling trees only found within the plot. Due to

the changes in tree distribution on the sample plots, the number of trees sampled within the additional 25m outside of the plots varied (N = 556-650). Tree canopy cover was measured two-dimensionally by recording the length and width of each focal tree's crown with a measuring tape.   If the canopy was too high, dimensions were estimated visually. Tree/shrub height was also measured using a Senshin SK202 8m fiberglass pole with internal tape measure (Accurate Instruments Ltd).

Phenology: Plant growth and reproduction over time were tracked using the Focal Plant Monitoring Method (sensu Burton et al. 1992). Each plot was subdivided equally into four parts (quadrats) that each measured 12.5m x 12.5m. In each quadrat, 4 woody trees and shrubs were randomly selected and marked as focal plants. Thus, the sample was 16 trees per plot. Since each land use system had 10 vegetation plots in total, thus, 160 focal trees/shrubs were monitored in each land use system. The total number of focal plants sampled in both land use systems was 320. A total of seven woody tree/shrub species were identified during the focal tree marking process within the 20 plots measured. In the pastoralist land, three species of trees (*Acacia drepanolobium , A. seyal, A. xanthophloea)* and two species of shrubs, *(Lycium europaeum* and *Scutia myrtina*) were included as focal plants.   In the commercial ranch, five species of trees (*Acacia drepanolobium, A.seyal, A. xanthophloea, A. melifera, Balanites spp*., and 3 shrub species *(Lycium europaeum, Euclea racemosa and Scutia myrtina*) were the focal plants found and sampled.

Due to its ecological prominence, *Acacia drepanolobium* merits special attention. This tree is a swollen-thorn *Acacia* native to East Africa (Madden and Young 1992;

Young et al 1997; Ward and Young 2002; Goheen and Palmer 2010). Similar to other

Acacia trees found within the area, *A. drepanolobium* produces numerous hollow

swellings derived from thorns called "galls" (Fig. 3.5) as well as flowers, and leguminous

pods. The "galls" are part of a complex mutualism between *A. drepanolobium* and ants

from the genera *Crematogaster*, *Tetraponera*, and *Camponotus* (see Hocking, 1970;

Madden & Young, 1992). *Acacia drepanolobium* have leaves that contain tannin and

stems covered with spines (thorns), which are both thought to serve as deterrents to

forbivores, such as, elephants and giraffes (Madden and Young 1992; Ward and Young

2002; Goheen and Palmer 2010) as well as insects (Young and Okello 1998; Young et. al

2003). Gum from the *Acacia* spp. also contains condensed tannins (Nash and Whitten

1989), minerals, such as, manganese, calcium, iron, zinc and secondary compounds, such

as, favonoids (Nash 1986; Isbell et al. 2013).   The rest of the trees and shrubs in the

sample (i.e., *Balanites aegyptiaca*, *Lycium europaeum*, *Euclea racemosa* and *Scutia

myrtina*) produce fruits, flowers or berries. The fruit of *Balanites aegyptiaca* is a greenish

yellow when ripe, while *Lycium europaeum* is a long-lived perennial thorny

Figure 3.4: *A mature* A. drepanolobium *gall with symbiotic ants* (Photo by Nancy
Moinde)

shrub with greenish-white petals and small berrylike multiseeded fruits. *Euclea racemosa* is a small to medium-sized evergreen shrub-like tree with exceptionally dense leathery leaves that produce small multicolored black, blue and red berries. *Scutia myrtina* is a large, scrambling shrub which uses its thorns to climb through surrounding vegetation.

A total of 8 branches were selected per focal tree for phenological monitoring. Two branches each facing the same direction to represent all 4 orientations (i.e., North, East, South and West) of the tree/shrub canopy were sampled following Barton et al. (1992). Depending on the tree/shrub size, branch lengths were scored categorically as follows:

Branch Length 1: ≥ 0 cm ≤ 12.5 cm

Branch length 2: ≥ 12.5 cm ≤ 25 cm

Branch length 3: ≥ 26 cm ≤ 38.5 cm

Branch length 4: ≥ 39 cm ≤ 51.5 cm

Each of the branches selected was measured, then marked using thin flexible red wire that was not too visible but detectable for regular monitoring purposes. On a monthly basis, the numbers of plant parts were counted on each branch moving from its proximal tip to the distal marked part of the branch (Steenbeeck and van Schaik 2001). These included galls, buds, pods/fruits, flowers and gum. Plant parts were scored according to coloration (i.e., green, yellow, or brown) as an indication of their condition. The "green" condition indicated as shoots or a plant part that was fresh and moist. "Brown" was

denoted as dry or dead. "Yellow" was an intermediate condition reflecting a shoot that was drier than a green plant part, but not yet dead. The color "black" was only used when referring to dry galls as they turn completely black when no longer green and succulent.

Abundance of herbaceous layer: Grass and forbs were sampled using a 10-pin frame apparatus (1m x 1m). The distance between the 10 pin drops was 10 cm. The pin frame was placed systematically along a straight line at every 4m intervals from North-South and then East-West in each transect plot as illustrated in Fig 2.4 (Moinde ,Chapter 2). Within each of the marked plots, a total of eight systematic placements of the 10-pin frame were made (Frank and McNaughton, 1990; Augustine, 2003; McNaughton, 1983). The frame was set up over the vegetation and then lowered down through the plant canopy. This procedure is called a "drop".   During the "drop", a "hit" was scored for sampling when the point of a pin/needle touched any plant part. The needle could make several "hits" before it eventually touched the ground surface. A total of 80 pin drops or sampling points were achieved in each plot. With each pin hit, the indicated grass/herbaceous plant was first identified and the respective plant part consisting of the blade, leaf, stem, florescence and roots that came into contact with each of the 10 pins (hits) was recorded. As with woody plants, the parts of herbaceous plants (i.e., blade/leaf, florescence/flower, seed and stem) were also scored as green, yellow and brown.

Analysis on woody species and herbaceous layer

The relative density of woody trees, mean distance between trees, density dominance and relative dominance were calculated for every tree species using the following formulas:

IX.   *Relative frequency of woody trees*

Relative frequency was calculated following (Bonham 1989):

Relative frequency = (number of individuals of a species/total individuals of all species) × 100

X.   *Dispersion of woody plants*

To test **Prediction 3**, distances between individual woody plants were measured to evaluate the relative dispersion of species across the different land use systems. To calculate the mean distance (d_m) between plants (m) (see Bonham 1989; Kell 2006):

$$d_m = \frac{\text{sum of all distances}}{\text{\# of distance measurements}}$$

XI.   *Density of woody plants*

Density was calculated as follows to test **Prediction 1** following Kell (2006):

Mean Area (MA) of all plants = $(d_m)^2$

Density (D) of all trees (in stems, i.e. tree trunks) per unit area is calculated as follows:

$$D = A / (d_m)^2$$

where A = unit of area in hectares.

Total density of all species = $10000m^2$/ MA

This calculation gives density of woody plants per hectare. This was based on the sample of how many trees there were per hectare, assuming the sample taken is representative of the larger area.

XII. *Canopy area of woody plants*

To test **Prediction 2**, the area for woody plant canopy were calculated from average crown width and crown height (Pruetz and Isbell 2000).

XIII. *Height of woody plants*

Height of woody plants was measured for each plant sampled, to test **Prediction 4**.

XIV. *Productivity of woody trees*

To test **Prediction 5**, woody plant productivity was measured. To accomplish this, the number of plant parts were counted in their various condition (i.e., dry, semi-dry and green) from the focal plants following Burton et al. (1992).

XV. *Relative abundance of herbaceous layer*

To test **Prediction 7**, grasses and forbs were counted and recorded using a 10 – pin frame and the relative abundance calculated following (McNaughton 1983):

Species A = <u>No. of hits that intercept species A </u>(per frame placement)

Total No. of points

This is the point sampling method that can give an accurate estimate of absolute cover of each species of vegetation, and hence an estimate of total leaf area for each herbaceous species (Frank and McNaughton 1980; McNaughton 1983).

XVI. *Species diversity of woody plants and herbaceous species*

To test **Prediction 8** and **Prediction 9** woody plants and the herbaceous layer (grass and forbs) were identified respectively during data collection. Plants that could not be identified in the field were collected and preserved in a plant press for further identification at the herbarium in the National Museum of Kenya. Due to logistical issues not all plants species were taken to the herbarium for identification, thus the remaining unidentified grasses and forbs remained with their assigned code names and numbers (See Appendix 2 and 3).

XVII. *Relative species dominance of woody plants*

To report the relative species dominance of woody trees, the basal area of each tree was first calculated (McNaughton 1983) as follows:

Basal area = $Л (r)^2$ or for r use dbh /2.

Calculation for the total basal area for each species

Relative dominance = $\dfrac{\text{Total basal area of species}}{\text{Total basal area of all trees}} \times 100$

XVIII. *Gum abundance*

The occurrence of gum was recorded to test **Prediction 6**. Unlike the other plant

parts sampled, exudates were difficult to score systematically and discretely.

Hence qualitative measures were applied. Gum found on *A. drepanolobium* is

typically in the form of a glob. Trees have one or more globs of varying sizes

(Isbell (1998). In each of the 320 focal plant sampled, gum was searched for and

recorded when seen on the main stem and branches of the woody plants

consumed by baboons. There was no sampling selection of a particular branch.

Rather, the presence or absence of gum (globs) was scored on each tree using the

following 4 qualitative categories listed as follows:

0 = no gum on the tree

1 = little gum - under 2 mm glob

2 = moderate gum - 2mm-4mm glob

3 = large gum amount - >4mm glob- could also be many small globs whose total

would be estimated to be larger than >4mm).

Statistical Analysis

ANOVA and t- test analyses were used to test for differences in means of abundance,

canopy size, distances between plants, height and plant productivity of woody trees and

shrubs between the two land use systems. The Cochran–Mantel–Haenszel test for

repeated tests of independence was used to examine spatial and temporal differences in

the abundance of gum between the land use systems. Herbaceous species abundance was

also analyzed using ANOVA and t-test analyses. Species diversity of both woody and herbaceous species was analyzed using Shannon Weiner index (H') (Shannon and Weiner 1963).

3.3 RESULTS

Comparison of overall abundance, relative dominance and density of woody plant species between commercial ranch versus the pastoralist land

The mean density and relative density of overall woody plants did not differ significantly in the two land use systems (Table 3.1). *Acacia drepanolobium* was the woody plant species with the highest relative dominance in both land use systems was (pastoralist land: 97.4%; commercial ranch: 82.9%) (Table 3.2). *Lycium europaeum* and *A. xanthophloea* had the lowest relative dominance (0.0%) in the pastoralist land (Table 3.2), whereas, *L. europaeum* , *A. seyal* and *Balanites spp*, had the lowest relative dominance (0.0%) in the commercial ranch and these two latter species were also not found on any of the sampled plots on the pastoralist land. Similarly, *Acacia xanthophloea* also had the lowest relative dominance (0.0%) in the pastoralist land but was not found on the sampled plots in the commercial ranch (Table 3.2). Contrary to prediction (**Prediction 1**), the density of overall woody trees was 877.5/ha on the pastoralist land and 675.3/ha in the commercial ranch. Whereas, the dominant woody plant species in both land use systems *Acacia drepanolobium* had 98.4% relative dominance in the pastoralist land and 88.5% in the commercial ranch (Table 3.3).

Comparison of canopy size of woody plants between the two land use systems

As predicted (**Prediction 2**), the mean canopy volume of the woody plant species was significantly higher in the commercial ranch (7.024 $\pm$ 0.53m^3 SEM) than in the pastoralist land (3.678 $\pm$ 0.39m^3) (t = 3.964, df = 1799, $p < 0.001$) (Fig 3.5).
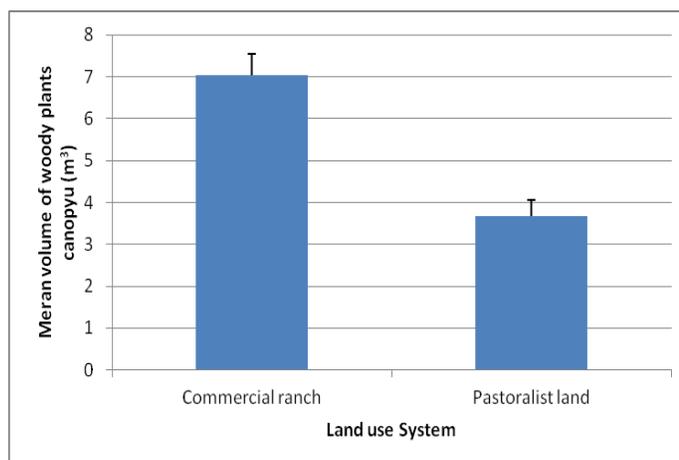
Figure 3.5: Mean canopy volume (SEM) of woody plant species in the commercial ranch and the pastoralist land

Comparison of dispersion of woody plants in the two land use systems

Contrary to prediction (**Prediction 3**), the mean distance between woody plants was significantly higher in the commercial ranch (4.03 $\pm$ 0.1 m) than in the pastoralist land (3.56 $\pm$ 0.09 m) (t = 3.452, df =1740, $p < 0.001$) (Fig. 3.6).
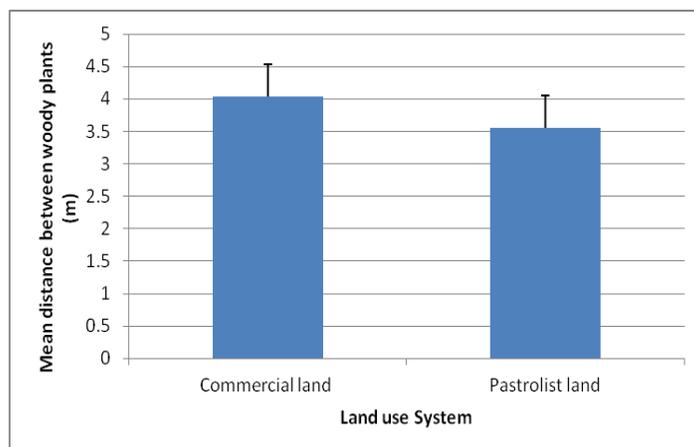
Figure 3.6: *Mean distance (SEM) between woody plants in the commercial ranch and the pastoralist land*

Comparison of woody plant height between the two land use system

As predicted (**Prediction 4**), the height of woody trees and shrubs in the commercial ranch (2.3 ± 0.05 m) was significantly higher than in the pastoralist land (1.3 ± 0.04 m) (t $= 16.296$, df $= 1821$, $p = 0.0001$) (Fig 3.7).
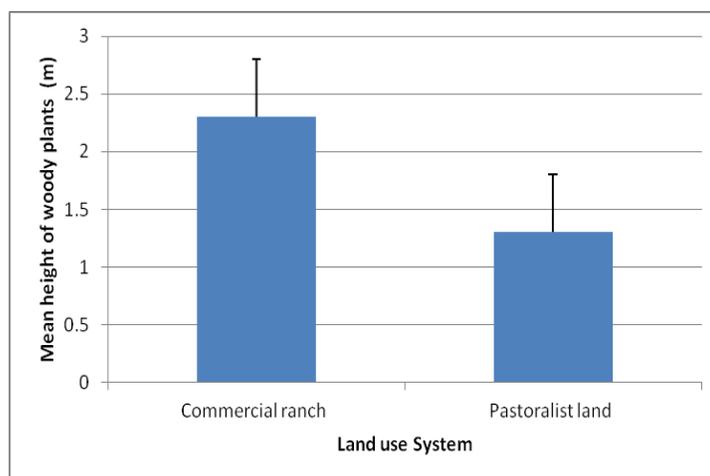
Figure 3.7: Height (SEM) of woody plants between the two land use systems

Comparison of production of woody plant in the two land use system

Contrary to prediction **(Predition 5)**, the abundance of galls and buds was significantly greater in the pastoralist land than in the commercial ranch (Table 3.4). There was no land use difference, however, in the abundance of both fruit/pods and flowers (Fig 3.8, Table 3.4).
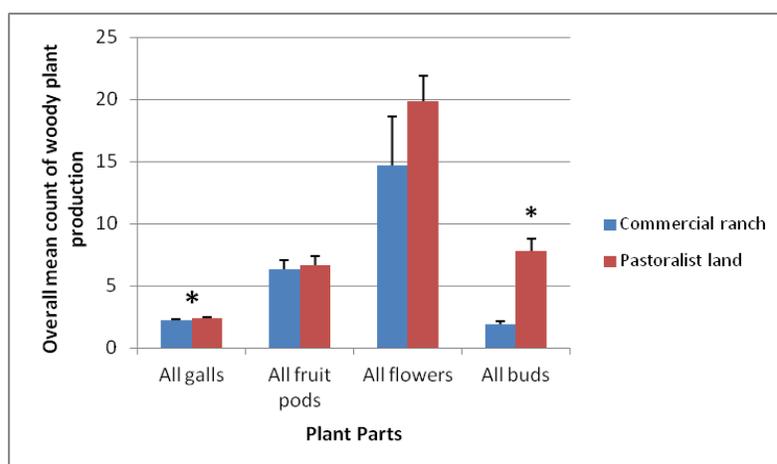
Figure 3.8: *Mean production (SEM) of general plant parts among woody plants in the commercial ranch and pastoralist land. Asterix (*) indicates significant differences (p < 0.05)*

Analysis of the finer categories of plant parts, based on condition yielded somewhat different results. In particular, green galls, dried fruit/pods, dried flowers and green buds were more abundant in the pastoralist land than in the commercial ranch (Fig. 3.9, Table 3.4). There was no difference between the two land use systems, however, in the abundance of dry galls, green fruit/pods, and dried buds between the two land use

systems (Table 3.4). There were virtually no yellow flowers, black flowers and yellow

buds in the commercial ranch (Fig 3.9; Table 3.4).
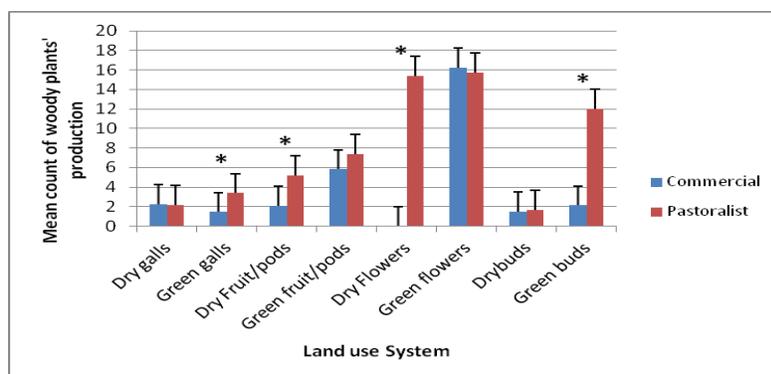
Figure 3.9: *Woody plant production (SEM condition based plant parts (i.e., dry and green) between the commercial ranch and the pastoralist land system.*
* indicates woody plants parts that were significant between the commercial and pastoralist land.

Abundance of gum between the two land use systems

A total of 1414 trees were sampled for gum in both land use systems with 712 trees

in the commercial ranch and 700 in the pastoralist land (Table 3.5). The size category

with the highest occurrence of gum was the "little" globules (N = 294) while the "large"

globules had the least occurrence of gum (N = 76). Within the "little" size category, gum

consistently had higher percentage of occurrence through all three months (November

2009, January 2010 and May 2010) in the commercial ranch than on the on the pastoralist

land (Table 3.5). The same was true of the "large" size category with the exception of

January 2010, where no gum occurred (Table 3.5). Through all the three months, gum

occurred in higher percentages in the commercial ranch relative to the pastoralist land

with the exception of May 2010, where gum occurrence was higher on the pastoralist

land (47%) than on the commercial ranch (7%) within the "moderate" size category

(Table 3.5).

Gum abundance, also varied significantly between the two land use systems (3. 6).

As predicted (**Prediction 6**), there was a higher abundance of gum within the commercial

ranch in both January 2010 ($X^2{}_{MH}$ = -0.106, df = 2, p < 0.0001) and May 2010 ($X^2{}_{MH}$ = 0.28,

df = 2, p < 0.001) (Table 3.6). Gum abundance, however, was the same between the two

land use systems in November 2009 (Table 3.6).

Comparison of grass and forb species abundance between the commercial ranch and

pastoralist land

As predicted (**Prediction 7**), grass was significantly more abundant in the

commercial ranch (2.78 ± 0.04) than in the pastoralist land (2.55 ± 0.04) (t = 4.283, df =

10220, p < 0.001), whereas, forbs were equally abundant in both land use systems (t =

1.025, df = 587, p = > 0.05) (Fig 3.10, Table 3.7).
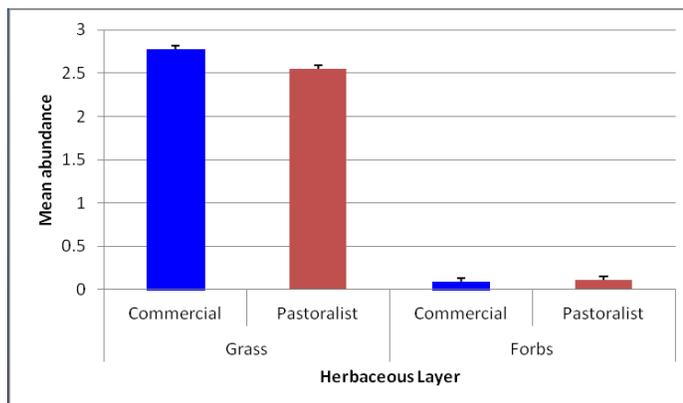
Figure 3.10: *Abundance of grasses and forbs (SEM) between the commercial ranch and pastoralist land.*

Comparison of herbaceous species by condition in the commercial ranch versus

   pastoralist land

   There was a higher abundance of green grass in the pastoralist land (2.12 ± 0.03) than in the commercial ranch (2.08 ± 0.03) (t = -03.92, df = 5024, p < 0.05) (Fig 3.11, Table 3.7). Whereas, dried grass was more abundant in the commercial ranch (2.21 ± 0.08) compared to the pastoralist land $(1.75 + 0.12)$ (t = 8.358, df = 3218, p < 0.0001) (Fig 3.11, Table 3.7). In contrast, there was no difference in abundance of forbs of two consition categories in the land use systems (Fig 3.11, Table 3.7).
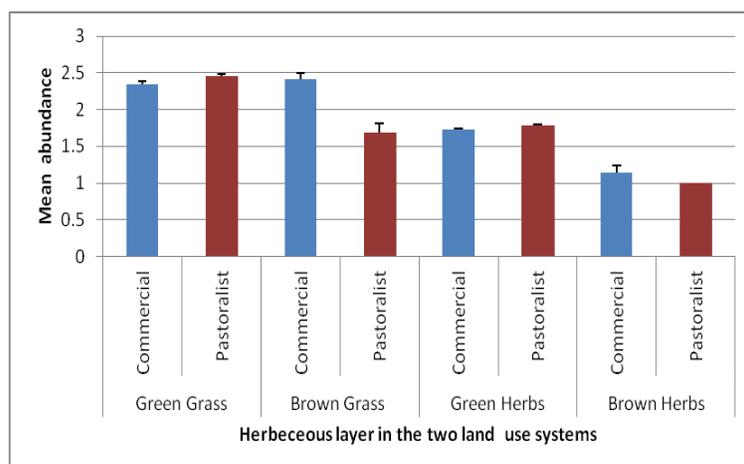
Figure 3.11: *Mean abundance of green and dry condition of grasses and forbs (SEM) between the two land use systems*

Comparison of woody plant production in wet and dry period

   The total rainfall from November 2009 through August 2010 was 997.4 mm. The highest amount of rainfall was experienced in March 2010 (135.3 mm) followed by May 2010 (129.6 mm) (Fig. 3.12). The least amount of rainfall (84.1mm and 48.2 mm) was experienced within the first two months of vegetation sampling, that is, November 2009 and January 2010 respectively (Fig 3.12). The following three alternating months of

vegetation sampling - March, May and July 2010 experienced increased rainfall of 135.3 mm, 129.6 mm and 102.1 mm, respectively (Table 3.8). Thus, the first two months of vegetation sampling with lower rainfall were categorized, in this study, as the "dry period" while the "wet period" was March, May and July 2010 (see Table 3.8).
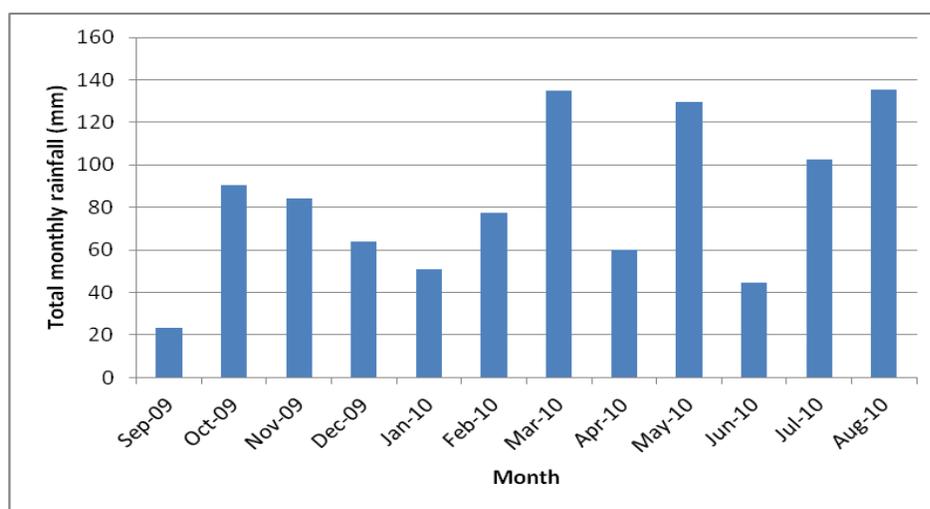
Figure 3.12: *Monthly rainfall during the study period*

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Dry galls were the most abundant woody plant products throughout the sampling period irrespective of rainfall levels (Table 3.9). The abundance of plant parts (black and green galls, dry flowers, green flowers, and green buds), was greater during the first increase of rainfall experienced in March 2010 (Table 3.9). This was with the exception of the abundance of fruits/pods, which unlike the rest of the plant parts, did not increase in March 2010 when rainfall was highest (Table 3.9, Fig 3.12).

As predicted, (**Prediction 8**) overall production (galls, fruits/pods, flowers and buds) of woody trees was significantly higher during both the dry and wet period in the pastoralist land relative to the commercial ranch (Table 3.10, Fig 3.13).
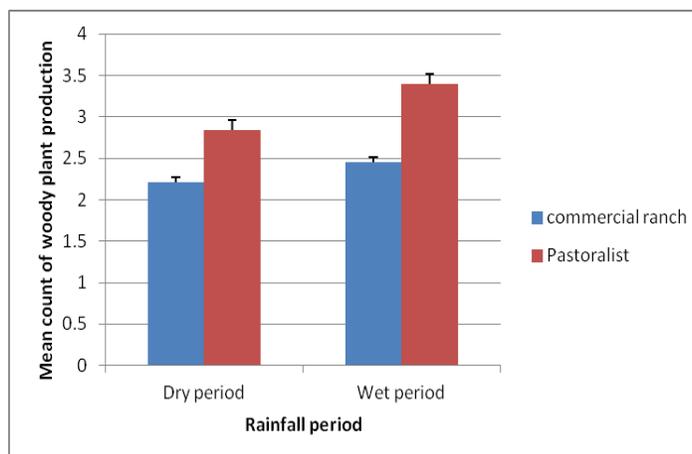
Figure 3.13: *Comparison of mean woody plant production (galls, fruit/pods, flowers and buds)(SEM) in the dry and wet period between the commercial ranch and pastoralist land*

Comparison of overall herbaceous layer in wet and dry period

As predicted, (**Prediction 9**), the herbaceous layer (grasses and forbs) was more abundant in the wet period than in the dry period (Fig 3.14; Table 3.11). Similarly, the abundance of the herbaceous layer was greater in the commercial ranch as compared to the pastoralist land during the dry period (Fig 3.14; Table 3.11).
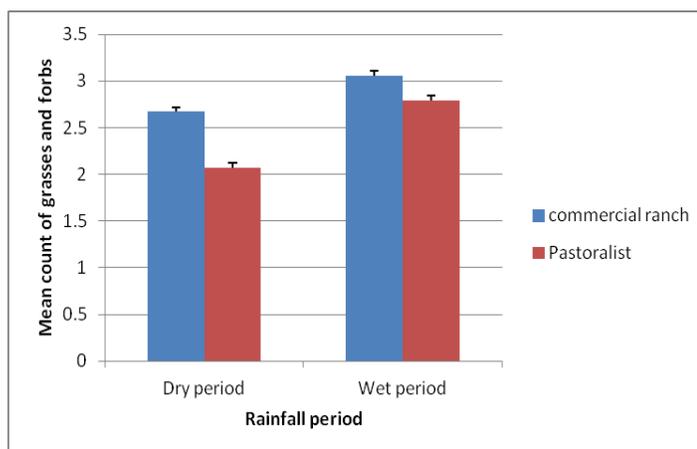
Figure 3.14: *Comparison of herbaceous layer abundance (SEM) in the dry and wet period between the commercial ranch and pastoralist land*

Woody and herbaceous plant diversity

Seven woody species were found in the commercial ranch, while five were found in the pastoralist land (Table 3.12, Appendix 3.1), however, there was no difference in species diversity for woody plants between the commercial ranch and the pastoralist land (p > 0.05) (Table 3.12).

A total of 20 grass species were found on in each of the land use systems (Appendix 3.2). The diversity indices indicate that grass species diversity was the same in the pastoralist land and the commercial ranch (p > 0.05). A total of 42 species of forbs were documented, with 32 species on the commercial ranch and 30 on the pastoralist land (Appendix 3.3). The diversity of forbs species was higher in the commercial ranch relative to the pastoralist land (p < 0.05) (Table 3.13).

3.4   OVERALL SUMMARY OFPREDICTIONS VERSUS OUTCOMES OF RESULTS

Table 3.14 summarizes the predictions of all vegetation attributes, and their actual outcome. Contrary to prediction, the density and abundance of woody plants was higher on the pastoralist land than on commercial ranch, whereas, both grasses and forbs were more abundant on the commercial ranch. The outcome of woody plant production also revealed unexpected results. Contrary to expectations, overall abundance of galls and buds were relatively higher on the pastoralists land while gum abundance was higher on the commercial ranch (Table 3.14). The overall abundance of fruit/pods, flowers,

however, was the same across land use systems. Collectively, overall food production for woody plants was relatively higher in the pastoralist land relative to the commercial ranch during both the dry and wet periods. Further, species diversity for woody species remained the same across the land use systems. Within the herbaceous layer, however, the diversity of forbs was surprisingly higher on the commercial ranch (Table 3.14). Findings also revealed that the habitat structure also contrasted across the two land use systems (Table 3.14). Woody plants were generally more dispersed with increased height, larger sized canopies while increased abundance of herbaceous plants was supported in the commercial ranch (Table 3.14).

3.5.   DISCUSSION

Occupied pastoralist lands in general, and Thome B in particular, are characterized by pronounced overgrazing (Moinde *pers. observ*), partly because fencing around the commercial ranches restricts the traditional practices of seasonally moving livestock and partly because of the high density of livestock (Georgiadis et al. 2007a). This contrasts with the mutual commitment to wildlife of most of the local commercial ranch owners in support of the Laikipia Wildlife Forum's development and conservation goals. These ranches favor wildlife, partly by maintaining a lower biomass of cattle, which has been argued to consequently lower the impact on the natural vegetation (Georgiadis et al. 2007a; Moinde *pers. observ.*). Consequently, the vegetation differences between the two land use systems, was such that, woody plants were individually comparatively smaller, and, unexpectedly more densely distributed on the pastoralist land than the commercial ranch. Surprisingly, woody plant

production of all plants save gum was higher during both the dry and wet periods on the pastoralist land. It was only in terms of gum accumulation that the commercial ranch exceeded the pastoralist land.

As expected, the abundance of the herbaceous layer was relatively higher in the commercial ranch during the entire study duration, irrespective of the dry and wet period. The following sections discuss these results in the content in two land use systems. The later discussion explores possible reasons for differences in species diversity of forbs in the two land use systems and the implications of habitat heterogeneity for wildlife diversity. Finally the last section focuses on the implications of these results on biodiversity conservation and management within an acacia savannah ecosystem dominated by and wildlife.

Differences between the two land use systems in the attributes of woody and herbaceous

species

In contrast to predictions, pastoralist land supported a higher density of *A. drepanolobium* than did the commercial ranch. On the other hand, these trees had smaller canopies and shorter statures than conspecifics found in the commercial ranch. Another unexpected finding was that woody trees were more dispersed in the commercial ranch. The larger trees tended to have larger overlapping canopies, giving the appearance of a more clustered conglomeration of trees. This scenario created a more clustered appearance, which suggests that woody species were more patchily distributed in commercial ranch than in pastoralist land. Many studies, however, have reported a positive relationship between canopy size and the dispersion of trees of the same species

(Gutierrez and Fuentes 1979, 1986; Smith and Walker 1983; Smith and Grant 1986). This relationship between dispersion and canopy size of neighboring woody plants may be driven mainly by competition, which typically characterizes habitat structures of savanna biomes (Smith and Grant 1986).

Another aspect to consider is that the greater abundance of herbaceous plants in the commercial ranch may lead to the interference of seed dispersal for the sympatric woody trees (Riginos and Young 2007). It is generally assumed that, herbaceous plants in savannahs have very little to do with the growth of already established woody plants because of the latter's biomass and latent spread of woody roots (Knoop 1982; Knoop and Walker 1985). Riginos (2009) found that grasses in a savanna ecosystem limit the growth of *A. drepanolobium* at various stages (i.e., seedling, sapling and adult). Findings from this current study indicated that the higher abundance of grasses in commercial ranches could be limiting the growth of woody plants as well as interspecific competition between them.

Wild herbivores, such as antelopes (e.g., elands, Grants gazelle, and dikdiks) depend on *A. drepanolobium*, as it remains the dominant woody species in the region (Estes 1991). *A.drepanolobium* is also the main food source for omnivorous nonhuman primates, such as olive baboons (*Papio hamadryas anubis)* (Palombit 2013; Moinde *in prep*) and patas monkeys (*Erythrocebus patas*) (Isbell 1998). The larger and more dispersed canopy cover on the commercial ranch increases animal feeding bouts and travelling distances between feeding sites (Isbell et al. 1998; Pruetz 2009). The longer distances between the woody plants, thus, could consequently increase the ranging

patterns of wildlife (Pruetz 2009) and livestock (Bailey 1996) that depend on these woody trees for food.

My findings also indicate that both livestock composition and density are important factors to consider when evaluating their influence on vegetation attributes across different land use regimes. Woody trees and shrubs found on the pastoralist land appear to be notably stunted (Moinde *pers. obs.*) largely, due to intense pruning/browsing from goats. Such evidence of browsing was not observed in the commercial ranches where there were no goats. Goats, sheep, and cattle prefer browsing on, highly palatable shrubs, such as *Lyceum europium* (Moinde *pers observ.*).

Livestock grazing may reduce the herbaceous cover by decreasing perennial grasses and tall shrubs (Orr et al. 1993; Milton 1994; Bisigato and Bertiller 1997). This was more evident in pastoralist land than on the commercial ranch. Higher stocking densities can lead to an increased seeding recruitment of herbaceous plants (Orr et al. 1993; Milton 1994; Beescow et al 1995; Bertillier 1996) and alter herbaceous species abundance and composition. Major shifts in the abundance and composition of herbaceous species can notoriously lead to bush encroachment (Coetzee et al 2003) or to the spread of invasive species (Moinde 1998). Bush encroachment is the conversion of a grassland dominated vegetation type to one that is dominated by woody species, through selective grazing, overgrazing, or invasion by alien species (Roques, O'Conner & Watkinson 2001). A major concern for land managers is the invasive nature of bush encroachment, which can effectively reduce wild floral and faunal diversity in addition to the carrying capacity of available grazing land (Wiegnand et al. 2005; Coetzee et al. 2003; Archer et al. 2000).

In Laikipia, the negative effects of bush encroachment and invasive plants on livestock carrying capacity and wildlife diversity could have detrimental consequences towards the sustainability of the three key land use practices, that is, pastoral subsistence, commercial ranching, and the tourism economy. These three livelihoods collectively represent Laikipia's economy both at the subsistence and the district level. Both domestic and wildlife populations, thus, need to be managed sustainably in order to optimize subsistence returns and economic profitability.

There was no indication in my findings, however, that the higher stocking density of the pastoralist lands had led to any threat associated with bush encroachment or an increase in the representation of invasive species. Furthermore, of the two most common shrubs species - *L. europaeum* and *Scutia myrtina* both occurred at negligible densities in the two land use systems. These negligible densities of the majority of woody trees in the study area (with exception of *A. drepanolobium*) appear to be contributing to the generally low diversity of the woody/shrub species.

The proximate causes for woody plant encroachment are still poorly understood. Other than heavy grazing, other land use practices, such as, the reduction prescribed fire regimes to manage vegetation, are believed to facilitate the process of bush encroachment (Coetzee et al. 2003). Georgadis et al. (2007a) argue that the higher woody cover found in commercial ranches in Laikipia, particularly, of *A. drepanolobium*, is the result of years of fire suppression. Other non-woody invasive plant species may also persist at relatively insignificant densities for a period of time, until ideal conditions arise for the spread and eventual domination of local vegetation (Coetzee et al. 2003). The lower livestock densities maintained in the commercial ranches seem to curb the potential

spread of invasive species. The process of encroachment has already occurred in the North and North-eastern regions of Laikipia, where a cactus species *Optunia stricta* appears to be thriving and spreading fast in overgrazed areas (Kang'ara and Gitari 2011; GISD 2010; (Moinde *pers observ.*).

Woody and herbaceous plant diversity

The relatively low livestock densities on the commercial ranch appear to favor some herbaceous species, but have no obvious effect on woody plant diversity. Woody plants in the study area, irrespective of land use, were predominantly a monoculture of *A. drepanolobium*. The low diversity of woody plant species generally appears to be typical of regions where vertisolic soils are prevalent in the district (Young et al. 1998; Palmer et al. 2002). Thus, livestock densities appear to have little influence on woody species diversity as a whole in this area.

The low livestock densities on the commercial ranch, however, appeared to favor higher abundance of forbs, but not grasses. Several studies have shown that moderate levels of grazing may enhance plant diversity (Naveh and Whittaker 1979; Waser and Price 1991; Noy-Meir et al. 1989). Low levels of grazing have been reported to regionally support the richest plant species diversity (Wolkinger and Plank 1981; Fischer and Wipf 2001). From a management and conservation perspective, low density grazing should, thus, be encouraged to foster biodiversity, in general, as high species diversity has shown to also support important habitats for many animal species (Erhardt 1995).

Since grass species diversity did not vary across land use, this also indicates that both higher and lower livestock densities on the pastoralist land and commercial ranch,

respectively, were at levels that did not influence diversity of grasses. I had anticipated that the different stocking densities characterizing two land use systems would influence the herbaceous species diversity since various grazing intensities have been documented to have different effects on the diversity of vegetation (see above). It is important to note that my results were based on different grazing intensities, rather than livestock densities. From a management perspective, a better understanding of which livestock densities favor different types of vegetation provides a more practical advantage that can be applied across different locations and geographical regions. This knowledge can provide long-term benefits that can facilitate improved livestock quality as well as support wildlife numbers and diversity in Laikipia and other areas in savannah woodland regions.

Qualitative measures that gauge different grazing intensities instead of densities of livestock are often subjective and difficult to interpret across study sites (reviewed in Fleichner 1994). What could be considered comparatively 'light' or 'moderate' grazing/browsing in one study site might be qualified as 'heavy' in another. It was, therefore, difficult to predict which land use system would most likely have higher plant diversity based on such an approach. The direct comparative approach of sampling vegetation was applied across the two land use systems. The more controversial approach of using different grazing intensities (instead of densities) did not apply in this study. These predictions were based on the frequencies of abandoned bomas and glades, instead of the notable grazing disturbance observed between the two land use systems. Bomas and glades were more frequent on the pastoralist land than the commercial ranch (Moinde unpublished data). These abandoned bomas gradually transform into established glades after decades and are scattered all over the study site (Augustine 2003). The prevalence

of these distinct anthropogenic features were more pronounced on the pastoralist land,
than on the commercial ranches, due to the ongoing and long term practices of creating
and abandoning bomas on the former land use system.

Glades are common anthropogenic features on the district's landscape and they
support a floristically unique array of grasses and forbs that are not found in the
surrounding area (Augustine 2003; Veblen 2006; Augustine et al. 2010; Moinde *pers
observ.*). Another notable aspect of glades is the differential utilization by animals
(Veblem 2006; Riginos 2012). For example, Veblen (2006) found that the total dung
density of all herbivores found in the areas was higher inside than outside new glades.
More specifically, Zebra dung density was highest outside of glades, while Grant's
gazelle dung was highest inside glades. Elephants appeared to strongly prefer new glades
while cattle showed a slight preference for new glades. Whereas, newer glades are also
preferred by baboons (*Papio hamadryas anubis*), especially after a dry period (Moinde
unpublished data) (see 3.3). As result, these localized, anthropogenically disturbed
(abandoned boma) sites in various stages of transformation into glades) are often referred
to as "hotspots" because they attract higher numbers these herbivore species as well as
birds a result of the unique vegetation they sustain (Riginos et al. 2012).

In this study, two glades (one from each land use system) were among the sampling
plots used to quantify vegetation differences between the two land use systems. To fully
capture the contrasting differences in content between glades and the surrounding areas,
however, further studies need to undertake a longer term temporal framework that can
provide insights on bomas-glade dynamics in relation to surrounding areas. For example,
a noteworthy observation I made was the potential influence of glades on insect

distribution, abundance, and diversity. Arthropod communities, such as the dung beetles (subfamilies: Scarabaeinae and Aphodiinae), which are commonly found in Laikipia (Gordon & Barbero, 2008, Gordon et al. 2008), appear to be more abundant in "new" glades than in "old" glades (Moinde *pers observ*.). This could be attributed to the rich nutrients environments provided by accumulated dung still found more recently abandoned bomas.

These "hotspots" have also been reported to locally increase herbaceous species diversity, as well as habitat heterogeneity (Young et al. 1995; Gregory et al. 2010; Riginos et al. 2012). As a result, I had predicted that these vegetation "hotspots", occurring more frequently within the pastoralist land, would increase herbaceous species diversity relative to that found on commercial ranch. Forbs, however, were more diverse in the commercial ranch. According to Riginos et al. (2012), commercial ranchers in Laikipia have utilized "mobile bomas" in recent years. These modern "mobile bomas" are metal fencing that can be folded and moved more frequently than the tradition bush bomas, and are managed in various ways within commercial ranches to intentionally create nutrient rich grazing hotspots (Riginos et al. 2012).

Creating "hotspots" using mobile modern bomas was practiced in several areas of the commercial ranch I studied. Whether this could have contributed to the increased diversity of forbs on this land use is still unclear. The increased species richness in forbs could have also been due to the overall longer and more abundant grass layer in the commercial ranch. Longer more abundant grasses most likely could have increased forb species diversity simply because such a scenario would provide a more suitable environment for forbs (protective shield form the sun and grazing herbivores).

The effects of different livestock densities on woody plant productivity

Despite the distinctly shorter stature and smaller canopy of woody plants in pastoralist areas, the overall productivity of woody plants was greater than in commercial ranches. This was contrary to the assumption that larger canopies found in commercial ranches should translate into higher plant production. With the exception of green (versus dry) fruit/pods, the most abundant condition - green was typically found in the pastoralist land. This suggests greater plant production or growth of various plant parts in this land use system than in the commercial ranch. Cattle, sheep, and goats prefer newer (green) vegetation because plants in this condition are easier to digest and contain more protein (Estes 1991; Green and Lewell 1982; Vallentine 1990; Holechek at al. 2011).

The higher occurrence of new growth in pastoralist lands could be attributed to the pruning effect caused by higher densities of livestock. The difference in *A. drepanolobium* plant production between the land use systems, therefore, could be due to an adaptive compensatory response mechanism found in *Acacia* species (Young 1987; Milton 1998; Oba and Post 1999), expressed differentially due to contrasting stocking densities. In other words, the higher livestock densities in pastoralist land areas appear to be stimulating increased new plant production (i.e., green galls, green flowers and green leaf buds). Goats can better reach the lower canopy of smaller and shorter woody trees and shrubs found on the pastoralist land, and potentially stimulating re-growth of new plant parts more effectively. Following this argument, browsing on *A. drepanolobium* and *A. tortilis* plant parts by goats encourages an increase of gross

morphological defenses, expressed through longer thorns, which appears to be an
adaptive response to fluctuating long-term browsing intensities.

Where densities of *A. tortilis* are high and rainfall is not limited, studies have shown
that goats do not negatively affect regrowth (Perevoltosky and Seligman 1998; Oba and
Post 1999). Perevoltosky and Seligman (1998) have further argued that, goat browsing
has beneficial effects on plant species that tolerate herbivory in the Mediterranean arid
and semi-arid grasslands found in the Middle East. Oba and Post (1998), however, argue
that where tree density levels are low and goat densities high, persistent goat browsing
will damage tree growth in the more arid zones of Turkana in northern Kenya. In my
study, the higher livestock densities in the pastoralist land, coupled with the unusual
higher rainfall that occurred during the study period, promoted woody plant production
more so than that found in the commercial ranch. These studies, and the findings of this
study, provide potentially valuable insights for both livestock and wildlife managers.
Certain levels of anthropogenic disturbance can promote food availability for livestock
and wildlife, in some conditions (higher plant density and rainfall).

Another implication of this study is that increased *A. drepanolobium* production
(galls, flowers, pods, and buds) in the pastoralist land could have been the result of better
protection from longer and denser thorns (compensatory defense) in response to
increased herbivory. This suggests that compensatory defense expressed through thorns
may reduce herbivory more effectively in the pastoralist land than in *A. drepanolobium* in
the commercial ranch. In addition, thorns, coupled with the presence of some species of
ants (genus *Crematogaster*) enhance defense against herbivory (Milewski et al. 1991;
Stapely 1998; Young et al. 2003). Symbiotic ants that inhabit *A. drepanolobium* trees

attack browsing wildlife, and this provides an additionally defense from herbivory (Young and Okello 1998, Palmer and Broder 2013).

Collectively, findings from these studies, and the outcome of my findings from this study, raise important questions. The extent to which these ant species numbers are influenced by differing livestock densities, across land use systems, and consequently contribute to the differences in the abundance of flowers and fruits was beyond the range of this study. Preliminary, inferences, however, can be made. Since there were more galls found in the pastoralist land relative to the commercial ranch, it is probable that, as a result, the pastoralist land hosts more of these ants than the commercial ranch. There are two pertinent questions that come to mind: 1) are *Crematogaster* ant species' densities, distribution, and composition influenced by different livestock densities; and 2) if this is the case, do these differences influence woody plant production? For livestock managers, a clearer understanding of how management decisions influence variation in livestock/wildlife food availability is critical to their livelihood as well as conservation endeavors.

The influence of ants on animal feeding behavior has been documented (Young et al. 2007; Stapley 1998; Pruetz 2009). Longer feeding bouts by vervets and patas monkeys were observed while feeding on *A. drepanolobium* than on other trees (Pruetz 2009). This indicates that ant defense influences primate feeding, and potentially ranging, behavior. Confirming the influence of ants on wildlife feeding strategies, Stapley (1998) found that the combinative presence of ants and thorn defense significantly reduced herbivore browsing on *A. drepanolobium.*

Most important for rangeland conservation managers is understanding how the multifaceted link between stocking densities, ants, and plant production modifies food availability for both domestic and wildlife species. This could be particularly important for species that are vulnerable to ecological changes or undergoing a decline in population size, such as the "kongoni" (*Alcelaphus buselaphus*) in Laikipia (Georgadis et al. 2007b). Applying a direct comparative evaluation of land use systems with different livestock densities is recommended to answer these pivotal questions.

Gum, another product of *Acacia* trees, and a preferred food by primate species like patas monkeys, olive baboons and vervet monkeys (*Chlorocebus pygerythrus*) (Palombit 2013; Isbell et al. 2013; Moinde *in prep*) and the Kori bustard (*Ardeotis kori*) (Ginn et al. 1989), was more abundant in commercial ranches than in pastoralist areas. Isbell (1998) found that gum was present on 30% of all sampled *A. drepanolobium* trees but only 3% of all trees had more than one glob. In this study, gum was only found on 8% of the overall *Acacia* spp. sampled, with both land use systems collectively taken into account. Indeed, gum occurrence in this study was generally much lower than those observed by Isbell. The reason for this discrepancy is not clear, but could be attributed to methodological differences in the way the gum was quantified.

In addition, *Acacia spp.* trees were generally taller on the commercial ranches and gum is more difficult to see in the taller trees. This most probably explains why no gum globules were seen on branches in the commercial ranches. Thus, gum abundance in the commercial ranches was most likely underestimated, and the data should be interpreted with caution. Isbell's (1998) findings, however, also indicated that gum exudes increased

with increasing tree height of *A. drepanolobium*. In this respect, the results of this study confirmed Isbell's (1998) findings.

Another possible reason for the generally relatively low abundance of gum, during the cause of my study, may have also been attributed to the long term effects of the protracted drought that ended just before the initial rains started in October 2009. Drought is considered to be among the main factors that have led to fluctuations in gum yield in different *Acacia* species (Awouda 2000; Seif El Din 1995). This could be true of the dominant woody plant, *A. drepanoloblium* and other *Acacia* species that were in my study area. In November 2009 when rainfall was relatively low and less consistent, gum abundance was at its lowest and there was concurrently no difference in its availability between the two land use systems. By January 2010 and in May 2010, when rainfall had become increasingly abundant as well as more established, gum abundance increased and differed in the two land use systems. The higher abundance of gum with increasing rainfall does suggest the importance of adequate rainfall for exudates production in *A. drepanolobium* woodland. Further, the compounding influence of land use also indicates the higher rainfall favors gum production more so on the commercial rancher than in the pastoralist land.

Woody plant production, particularly flowers, appeared to also have been affected by the prolonged drought in 2009, followed by unusually high amounts of rainfall that continued throughout 2010. It appears that the extreme rainfall patterns from virtually no rainfall to erratic and heavy rainfall may have affected the timing of the recruitment, growth and production of woody plants. One indication of this was the ostensibly low honey yields in 2010 (Gilfred Powys *pers comm*.) which indicates that the lack of

flowers, as a consequence affected bee honey production. The significance of rainfall

(seasonality) in understanding the dynamics of livestock-wildlife interactions in the

savanna woodlands has also been highlighted in many studies (Sullivan 1996; Oba and

Post 1999; Georgadis et al. 2007a, 2007b; Georgadis et al. 2007a, 2007b; Odadi et al.

2011). Within the nine month period of vegetation sampling, annual rainfall totaled

748.1 mm. Previous studies of the area totaled much lower rainfall of 568 mm in 1993

(Isbell 1998) and 500mm (Shur 2008). Thus, this study reports 40% more rainfall within

a much shorter time frame of eight months during which vegetation sampling occurred.

Prior to the vegetation sampling period, there had been a protracted drought for more

than a year (Huho et al. 2012), followed by an extended period where it rained every

month. During the study period, rainfall peaked in March, May, and August, with

intermittent months of considerably lower rainfall in April and June. This pattern is

atypical for the region.

   According to Ogotu et al. (2011), the protracted drought followed by the unusually

heavy and erratic rainfall patterns throughout 2010 had been linked to El Niño-Southern

Oscillation and the Indian Ocean Dipole. Therefore, the distinct dry seasons, which

typically occur from December through February and from June through September in

Laikipia were not experienced during my study. In a typical year, the wet seasons occur

from March through May (long rains) and from October through November (short rains)

(Huho et al. 2012). Huho et al. (2012) examined rainfall trends in the district from 1976-

2005 and concluded that the March rainfall had generally declined and become more

unreliable, while May rains ended earlier than usual. Rainfall amount and patterns that

was experienced while I was conducting this study contradicted the typical rainfall

pattern. As a result of these atypical rainfall pattern, during the vegetation sampling period, there was no clear and distinct wet and dry season that emerged. Hence the use of 'wet period' and 'dry period' was applied in this study instead.

Despite this unpredictable rainfall patterns, overall woody plant production and the herbaceous layers' abundance increased with increasing rainfall in both land use systems. Rainfall increase was associated with an increase in the overall production of woody plants and abundance of herbaceous layers during the wetter periods in March, May and July 2010 for both pastoral and commercial land. An overall increase of green plant parts, with the exception of fruit and pods, occurred in March with the initial heavy rains, indicating that most production and growth of woody plant parts occurred during this month. This was followed by a decline in green plant production thereafter in May, most likely due to the atypical lower rainfall experienced in the month of April 2010.

Previous studies have indicated the influence of rainfall on herbivore-plant interactions. For example, Odadi et al. (2007; 2009, 2011) showed that the effects of rainfall on both wild herbivore and cattle differed noticeably between the dry and wet periods. More specifically, cattle feeding rates decreased while step rate increased in association with reduced overall food intake (forage, perennial grasses and forbs) during the dry periods when they shared resources with wild herbivores. When wildlife was excluded, cattle increased in weight by 37%. Such experiments were extremely useful in providing evidence that wild herbivores presence suppress cattle grazing, especially during periods of varying rainfall, as previously assumed by scientists and managers. In particular, the distinct spatial and temporal variation in vegetation between the commercial ranches and pastoralist lands implies that each of these land use systems

presents varying types of resources (e.g., food, shelter, etc..) that support a variety of wildlife. For instance, antelopes, such as, eland, oryx, Grant gazelles, Thompson gazelles, waterbucks and impalas, eat shrubs, *Acacia*s, young shoots and, grasses (Estes 1991). These ungulates mainly consume this particular vegetation while spending most of their time grazing on green short grass or browsing on leaves and twigs on woody species (Estes 1991). What is important for wildlife and livestock managers alike, is gaining a better understanding of how temporal patterns of resource variation are directly or indirectly influenced by spatial (land use) changes. Such an understanding will provide managers with information that can assist in sustainably upholding the rich wildlife diversity for which Laikipia is renowned.

The influence of diverse human modified habitats, habitat heterogeneity, and wildlife diversity in Laikipia

This study clearly illuminates the contrasting differences in habitat structure, abundance, production, and diversity between two land use systems with diverse livestock management regimes. How the habitat heterogeneity influences Laikipia at a landscape level has yet to be documented. This study, however, provides useful insights at a smaller scale highlighting habitat differences across contrasting land use systems. Also, the distinctly nutrient rich levels of soils found in glades also have some management and conservation implications since wild herbivore biomass is also strongly affected by large-scale variation in geology and soil nutrient availability (Bell, 1982; Fritz and Duncan, 1994). Spatial heterogeneity in soil and plant nutrients in African rangelands have been argued to strongly influence the distribution of wild herbivores at

multiple spatial scales (McNaughton, 1988, 1990; Blackmore et al., 1990; Ben-Shahar and Coe, 1992; Murray, 1995; Muchiru et al., 2008).

Numerous studies, such as this current study, have also shown that livestock densities directly influence the abundance and diversity of both woody and herbaceous species and, in turn, affect the abundance, composition and assortment of different species of wildlife (reviewed in Fleischner 1993). Studies that have examined the relationship between plant and wildlife diversity, however, have produced mixed results (Tomoff 1974; Hunter 2007). A review by Tews et al. (2004) found that the majority of studies (n = 85) had a positive correlation between habitat heterogeneity and animal species diversity, suggesting that higher grass diversity found on commercial ranches could be supporting a higher faunal variety.

Monitoring species population dynamics in relation to changes in habitat diversity can be a useful method for measuring the effects of anthropogenic disturbance (Leis et al. 2007; Uehara et al. 2009). Studies indicate that faunal diversity increases with habitat structural complexity. For example, an increase in the number of vertical structures within a habitat led to an increase in the number of bird species, which occupied newly available nesting, feeding and breeding niches (Tomoff 1974; Millsrap 1981). Additionally, an increase in both perennial and annual vegetation escalates the abundance and diversity of avian species (Serventy 1971; Tomoff 1974).

Spiders, in particular, offer valuable insights on the invertebrate response to changes in habitat structure and heterogeneity because they species inhabit a large variety of microhabitats (Gunnarsson 1988; Uetz 1991; Rypstra et al. 1999). Warui et al. (2005) found that spider communities in Laikipia were excellent indicators of mammalian

activity at different levels of the vegetation. They reported that three spider species from the genera *Araneidae* and *Thomisidae*, experienced a decrease in abundance within cattle-grazed plots. In contrast, *Aelurillus* species became more prevalent in areas where cattle grazed. The study suggested that spider populations reflect land use changes. Thus spiders are useful for bio-monitoring, and can be used to integrate and evaluate activity or disturbance on vegetation by different guilds of forbivores (e.g., cattle, elephants, buffaloes, zebras) (Warui et al 2005).

According to Tingley (1989), the importance and relevance of bio-monitors is that certain plant or animal species are useful indicators of the status of a species or a system. Bio-indicators are less ambiguous than directly sampling vegetation and assessing all taxa in plants and animal communities (Simberloff 1998; Dale and Beyeler 2001). Bio-markers are therefore useful indicators for evaluating anthropogenic habitat disturbances (Tingley 1989; Dickens et al. 2002; Warui et al. 2005). They are potentially a powerful tool that can be applied to facilitate the management and conservation of the rich biodiversity found in Laikipia and elsewhere.

Implications for wildlife management and biodiversity conservation in a savannah woodland landscape

Pastoralists in both occupied tracts of land and communally owned group ranches in Laikipia are becoming more sedentary, and stocking less livestock than they did historically (Moinde, Chapter 5). Higher densities of pastoralists occur much more frequently within these two types of land use systems (Moinde *pers observ*.). As a result, pastoralists' traditional migrations towards greener pastures have been largely limited by

an increase in the human population within Laikipia. This trend is evidently similar to other semi-arid regions of Kenya and East Africa (Homewood et al. 2001), and is mainly based from documented larger sized mature glades that suggests that historically pastoralists stocked larger herds of livestock that they currently are (Augustine 2003).

The creation of abandoned boma "hotspots" on the Laikipian landscape appears to contribute positively to the modern livestock boma practices that constitutes the growing "Holistic Livestock Management" (HLM) strategy in commercial ranches. The HLM (reviewed by Butterfield et al. 2006) has received global recognition for its aim to restore rangelands and recreate the desired herbivore impact, while eliminating the deleterious effects of conventional livestock management. This strategy implements grazing designed to stimulate plant growth, provides natural fertilization, and keep herds from returning to consume the same plants until they are fully re-grown (Butterfield et al. 2006). A few commercial ranches in Laikipia appear to have adapted the newer livestock management regime.

The "mobile bomas" are an attempt by commercial ranchers, as it has been practiced by pastoralists, to counteract the permanency and deleterious effects of fixed bomas on vegetation viability. These mobile bomas also do not require clearing of large number of trees, as is needed to construct brush bomas, similar to those found on the pastoralist land. The "hotspot" effects (glades) they create are seemingly similar to those that are eventually generated by the traditional pastoralist system of creating and then abandoning bomas after some time.

Another important anthropogenic activity that has not yet been fully discussed, in this study, is the use of controlled fire to manage vegetation. Fire has been used all over

the world to manage vegetation and to improve livestock productivity (Weekem and Strang 1983). In Laikipia, prescribed fire is a traditional practice that is still used, but with less frequency, by contemporary pastoralists and largely suppressed by commercial ranchers for decades (Georgadis et al. 2007a). Livestock herbivory and fire are known to reduce the composition and abundance of woody plant species (Lamprey 1979; Oba et al. 2001; Bowman and Murphy 2010) in various biomes. Fire, thus, could have contributed to the shorter, smaller woody species found in the pastoralist land in my study site. The effect of past fires on woody plant structure in the study area, however, was beyond the scope of this study. The potential long-term effects of fire, besides livestock grazing, should be acknowledged as contributing to differences in vegetation structure between the two land use systems.

The use of fire in the study site was not observed during the course of this study. There were, however, some specific areas within the pastoralist land where the darker *Acacia* spp. trunks indicated that there had been a fire, but the cause or reasons (e.g., human induced versus natural) were not confirmed. Boma construction, abandonment, and the use of fire to improve forage yields for livestock are all anthropogenically induced disturbances that are part of the pastoralist lifestyle still being practiced, albeit to a much lesser extent than in the past (Van de Vijver et al. 1999; Roques et al. 2001; Fratkin 2001; Little et al. 2001). Pastoralists all over East Africa practice grazing with controlled fire to mainly remove rank (dry unpalatable vegetation), promote new growth, and control shrubs and live-stock parasites.

Further, since fire suppression has been mainly practiced disproportionally in the commercial ranches (Georgadis et al. 2007a; Gregory e. al. 2010), some plant species can

be eliminated as a result of competitive superiority of dominant plant species. More specifically, prescribed fires can improve quality of vegetation, create better habitats for wildlife and domestic animals, and reduce the intensity of naturally occurring wildfires (Webster and Halpern 2010). Indeed these factors are integral processes in some ecosystems. Thus, altered fire regimes may generate significant ecological change (Whelan 2002). Land managers, therefore, should engage in fire management strategies that help control wildfires, promote biological diversity and ecosystem processes (Gill 2001).

3.6 CONCLUSION

This study provides baseline information regarding the impact of different livestock regimes on the abundance, heterogeneity and, diversity of local vegetation. The spatial distribution of disturbance, through different livestock management regimes, can influence spatial aggregation, abundance and diversity of vegetation in unexpected ways. The fact that smaller *A. drepanolobium* trees are generally more productive on the pastoralist land (where there was higher browsing densities as compared to the commercial ranches), provides some indication that this *Acacia* spp. has an established mechanism to adaptively respond to varying intensities of herbivory. Examining the effects of different livestock densities as well as rainfall on plant production is important for commercial managers and pastoralist alike. Comparative studies of this kind have clear and direct conservation and management implications.

This study revealed important insights that can provide practical knowledge and insights to land managers, ecologists and conservationist about the impact of how

different livestock regimes on vegetation and potentially on the distribution and diversity wildlife. At the same time, the nature of this comparative study has raised pertinent questions concerning the outcome of anthropogenic disturbance on dynamic ecological complex interactions that occur between livestock and vegetation. In livestock dominated landscapes, that also support coexisting wildlife herbivores, better management practices depend crucially on an understanding of the mechanism underlying wildlife dynamics, and their interactions with livestock. (Georgadis et al. 2007a; 2007b). This knowledge would provide further insights that can contribute directly to biodiversity management in human occupied systems that maintain varying densities of livestock and wildlife.

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TABLES

Table 3.1: Mean and relative density of dominant woody plant species between the Pastoralist land and Commercial Ranch

	Land use system	N	Mean	Std. Dev	statistic
Mean density (#/ha) of overall woody plants	Pastoralist Land	7	175.49	384.3	t = -0.453, df = 10, $p >$ 0.05
	Commercial Ranch	5	96.46	222.7	
Relative density of overall woody plants	Pastoralist Land	7	14.28	33.00	t = -0.503, df, 10, $p >$ 0.05
	Commercial Ranch	5	20.00	43.80	

Table 3.2: Comparison of density, relative density and relative dominance of woody plant between the Commercial ranch and Pastoralist land /ha

Commercial ranch					Pastoralist land			
Woody Spp.	N	Density (#/ha)	Relative Dominance (%)		Woody Spp.	N	Density (#/ha)	Relative Dominance %
AD	765	597.9	82.9		AD	951	862.9	97.8
AM	91	71.1	16.5		AS	9	8.2	1.8
AS	3	2.3	0.0		AX	1	0.9	0.0
AX	2	1.6	0.5		LE	1	0.9	0.0
BL	1	0.8	0.0		SM	5	4.5	0.4
LE	1	0.8	0.0		TOTAL	967	877.5	100.0
SM	1	0.8	0.0					
TOTAL	864	675.3	100.0					

AD-*Acacia drepanolobium* , **AS** - *A. seyal,* **AX** - *A. xanthophloea,* **AM** - *A. melifera,* **BL** - *Balanites spp.,* **LE** - *Lycium europaeum, and* **SM** - *Scutia myrtina*

2

Table 3.3: Comparison of *A. drepanolobium* density with other woody species in both land use systems

	Commercial ranch	**Pastoralist land**
N (*A. drep*)	765	951
N (all woody tree species)	864	967
Overall density woody trees	675.3/ha	877.5/ha
Density	597.9/ha	862/ha
Relative density	88.54%	98.35%

Table 3.4: Comparison of woody plant parts abundance between the commercial ranch and the pastoralist land

Plant parts	Land Use	Number of plant parts per branch	Mean	SE Mean	p-value
Overall galls	Commercial	8038	2.26	0.03	t = -2.450, df =8227, p < 0.001
	Pastoralist	11287	2.41	0.05	
Black galls	Commercial	7703	2.23	0.03	t = 1.379, df=7993, p > 0.05
	Pastoralist	9840	2.17	0.03	
Green galls	Commercial	335	1.44	0.05	t = -3.151, df=658, p < 0.001
	Pastoralist	1447	3.39	0.46	
Overall fruit/pods	Commercial	373	6.29	0.75	t = -0.292, df = 268, p > 0.05
	Pastoralist	1431	6.69	0.67	
Brown fruit/pods	Commercial	48	2.08	0.33	t = -1.372, df =101, p < 0.05
	Pastoralist	468	5.2	0.86	
Yellow fruit/pods	Commercial	86	9.56	2.81	t = 2.355, df =14, p < 0.05
	Pastoralist	13	1.86	0.71	
Green fruit/pods	Commercial	239	5.83	0.77	t = -0.939, df=168, p > 0.05
	Pastoralist	950	7.36	0.89	
Overall flowers	Commercial	147	14.7	3.94	t = -0.741, df =116, p > 0.05
	Pastoralist	2141	19.82	2.07	
Brown flowers	Commercial	0	.	.	***
	Pastoralist	600	15.38	2.01	
Yellow flowers	Commercial	1	1	.	***
	Pastoralist	0	.	.	
Green flowers	Commercial	146	16.22	4.06	t= 0.076, df =105, p < 0.05
	Pastoralist	1541	15.72	1.94	

Overall buds	Commercial	27	1.93	0.25	t= -1.743,df = 183, p < 0.05
	Pastoralist	1341	7.84	0.97	
Brown buds	Commercial	6	1.5	0.29	t = -0.356, df = 84, p > 0.05
	Pastoralist	138	1.68	0.11	
Yellow buds	Commercial	1	2	.	***
	Pastoralist	25	4.17	1.17	
Green buds	Commercial	19	2.11	0.35	t = -1.923, df = 105, p < 0.05
	Pastoralist	1178	12.02	1.55	

*- Significant $p < 0.05$

**- Significant $p < 0.001$

**** - number of plant parts could not be computed because at least one of the groups is empty or too few for statistical analysis.

Table 3.5: Comparison of gum in different size categories on branches and main stems between the land use systems using a Cochran–Mantel–Haenszel. Total number of trees sampled was 1414 with 712 sampled in the commercial ranch and 700 in the ppastoralist land.

Sampling period*	Land use	Gum size Category (glob size)			
		Little (< 2mm)	Moderate (2-4mm)	Large (>4mm)	Total (N)
Nov-09	Commercial ranch	25% (28)	43% (47)	15% (16)	91
	Pastoralist land	7% (8)	0% (0)	10% (11)	19
	Subtotal (N)	**36**	**47**	**27**	**110**
Jan-10	Commercial ranch	47% (112)	20% (48)	0% (0)	160
	Pastoralist land	33% (80)	0% (0)	0% (0)	80
	Subtotal (N)	**192**	**48**	**0**	**240**
May-10	Commercial ranch	26% (58)	7% (16)	15%(33)	107
	Pastoralist land	4% (8)	42% (96)	7% (16)	120
	Subtotal (N)	**66**	**112**	**49**	**227**
	Overall Total	**294**	**207**	**76**	**577**

*Gum data was only recorded for Nov 2009, January 2010 and May 2010.

Table 3.6: Differences in the occurrences of gum on woody trees between the commercial ranch and the pastoralist land using the Cochran–Mantel–Haenszel

Sampling period	Land use	N	(X^2_{MH})	df	p value
Nov 2009	Commercial ranch Pastoralist land	110	-0.267	2	p > 0.05
Jan 2010	Commercial ranch Pastoralist land	240	0.248	2	p < 0.0001
May 2010	Commercial ranch Pastoralist land	227	-0.106	2	p < 0.001

Table 3.7: Comparison of the abundance of herbaceous plants (SEM) between the commercial ranch and pastoralist land

Herbaceous plants	Land Use	# of Obs (N)	Mean count	Mean SE	Statistical test
Total grass in all conditions	Commercial	3319	2.78	0.04	t = 4.283, df = 10220, p < 0.05*
	Pastoralist	2811	2.55	0.04	
Total green grass	Commercial	2647	2.08	0.03	t = - 0.392, df = 5024, p < 0.05*
	Pastoralist	2379	2.12	0.03	
Total yellow grass	Commercial	1805	1.74	0.03	t = 4.461, df =2727, p = 0.0001**
	Pastoralist	924	1.54	0.03	
Total brown grass	Commercial	2123	2.21	0.08	t = 8.358, df = 3218, p = 0.0001**
	Pastoralist	1097	1.75	0.12	
Total forbs in all conditions	Commercial	309	0.09	0.01	t = -0.530, df= 614, p = 0.0001 **
	Pastoralist	307	0.11	0.01	
Total green forbs	Commercial	236	1.73	0.07	t = - 0.577, df = 505, p > 0.05
	Pastoralist	271	1.79	0.01	
Total Yellow grass	Commercial	38	1.24	0.01	t = 0.290, df = 61, p > 0.05
	Pastoralist	25	1.20	0.01	
Total Brown Forbs	Commercial	35	1.14	0.07	t- = 1.093, df = 44, p > 0.05
	Pastoralist	11	1.00	0.00	

Table 3.8: Months when vegetation data was collected during the study period categorized into dry and wet period

Dry period		Wet period	
Month	**Mean Rainfall (mm)**	**Month**	**Mean Rainfall (mm)**
*Nov 2009	84.1	March 2010	135.3
Jan 2010	48.2	May 2010	129.6
-	-	*Jul 2010	102.1
	66.15		**122.30**

*Rainfall disrupted vegetation data collection in Nov 2009 resulting to vegetation data collection into the 3 initial days of Dec 2009 and August 2010. Since data continued for a few days within the month of Dec and August, the rainfall data for both the intended months (Nov'09 and Jul'10) were used since the cumulative rainfall for these respective more of the real representative of the indicated rainfall. "Period" was used instead of season because there was not distinct wet and dry season during the study period as is normally the case.

Table 3.9: Temporal patterns of growth and reproduction of woody plants

Month	Plant part per branch	Land use	N	Mean	Stdev	Statistics
November 2009	Overall Galls	Commercial	1741	1.52	1.72	t = 1.58, df = 2164, *p* > 0.05
		Pastoralist	1682	1.63	1.7	
	Overall Fruit/pods	Commercial	124	0.11	1.32	t = -1.419, df = 1814, p > 0.05
		Pastoralist	46	0.04	0.73	
	Overall Flowers	Commercial	1	0	0.03	t = 1.309, df = 1814, p > 0.05
		Pastoralist	5	0	0.07	
	Overall Buds	Commercial	19	0.02	0.20	t = 1.583, df = 1134, p > 0.05
		Pastoralist	61	0.06	0.84	
January 2010	Overall Galls	Commercial	1075	1.67	1.45	t = 5.273, df = 1851, p < 0.0001
		Pastoralist	2431	2.10	2.33	
	Overall Fruit/Pods	Commercial	67	0.10	2.12	t = 2.716, df = 2311, p < 0.05
		Pastoralist	418	0.29	2.42	
	Overall Flowers	Commercial	142	0.22	2.34	t = 2.361, df = 641, = < 0.05
		Pastoralist	0	0.0	0.07	
	Overall Buds	Commercial	0	0.0	-	t = 5.607, df = 1671, p < 0.0001
		Pastoralist	563	0.41	3.02	
March 2010	Overall Galls	Commercial	1707	1.60	1.77	t = -5.276, df = 1348, p < 0.0001
		Pastoralist	2989	2.61	6.06	
	Overall Fruit/Pods	Commercial	10	0.01	0.17	t = 6.123, df = 1155, p < 0.0001
		Pastoralist	527	0.46	2.40	

	Overall Flowers	Commercial	142	0.13	1.78	t = -6.310, df = 1245, p < 0.0001
		Pastoralist	2055	1.80	8.73	
	Overall Buds	Commercial	586	0.55	6.58	t = -0.277, df = 1839, p > 0.05
		Pastoralist	566	0.49	4.31	
May 2010	Overall Galls	Commercial	1891	1.90	2.29	t = -4.790, df = 1427 p < 0.0001
		Pastoralist	1706	1.51	1.14	
	Overall Fruit/Pods	Commercial	286	0.29	1.7	t = 0.645, df = 2126, p < 0.05
		Pastoralist	380	0.34	1.94	
	Overall Flowers	Commercial	4	0	-	t = 2.628, df = 1150, p < 0.05
		Pastoralist	98	0.09	1.05	
	Overall Buds	Commercial	6	0.2	0.24	t = 1,618, df = 1546, p > 0.05
		Pastoralist	21	0.52	5.46	
July 2010	Overall Galls	Commercial	1728	1.80	1.68	t = 0.107, df = 1432, p >0.05
		Pastoralist	1390	1.79	1.67	
	Overall Fruit/Pods	Commercial	19	0.01	0.25	t = 0.872, df = 2696, p > 0.05
		Pastoralist	3	0	0.11	
	Overall Flowers	Commercial	0	0	-	*
		Pastoralist	0	0	-	
	Overall Buds	Commercial	0	0	-	*
		Pastoralist	0	0	-	

Table 3.10: Comparison of overall woody trees' production between the commercial ranch and the pastoralist land between the dry and wet season

	Period	Land use	N	Mean	Std. Error	Statistical test
Overall woody plant production	*Dry*	Commercial	1359	2.21	0.07	t = - 5.056, df = 3789, p = 0.0001
		Pastoral	2432	2.84	0.09	
	Wet	Commercial	2275	2.45	0.04	t - = - 6.037, df = 5009, p = 0.0001
		Pastoral	2736	3.40	0.14	

Table 3.11: Comparison of abundance of overall herbaceous layer between the commercial ranch and the pastoralist land between the dry and wet period

	Season	Land use	N	Mean	Std. Error	Statistical test
Overall grass and forbs	Dry	Commercial	1702	2.67	.051	t = 9.070, df = 3128, p = 0.0001
		Pastoral	1428	2.07	.040	
	Wet	Commercial	3054	3.06	0.05	t = 3.938, df = 5191, p < 0.05
		Pastoral	2139	2.79	0.05	

Table 3.12: Comparison of woody plants diversity between the Pastoralist land and commercial ranch

	Land use	# of species	Shannon Weiner Index (H')	Std. Error	p value
Woody trees species	Commercial	7	0.402	0.13	t = 0.988, df = 6, p > 0.05
	Pastoralist	5	0.101	0.63	

Table 3.13: Comparison of herbaceous species diversity between the Pastoralist land and commercial ranch

Herbaceous layer	Land use	N	Shannon Weiner Index (H')	Std. Error	p value
Grass	Commercial	20	0.5079	0.06	t = -2.710, df = 37, p > 0.05
	Pastoralist	19	0.7213	0.05	
Forbs	Commercial	17	0.5965	0.06	t = 1.705, df = 29, p < 0.05
	Pastoralist	14	0.4648	0.04	

Table 3.14: Summary of overall predictions and outcomes

Vegetation types	Vegetation Attributes		Prediction #	Land use predicted with higher value	Land use predicted with observed value	Summary outcomes of prediction
Woody Plants	*Density (#/ha)*		1	C	P	×
	Structure	*Canopy size (m²)*	2	C	C	√
		Dispersion (m)	3	P	C	×
		Height (m)	4	C	C	√
	*Abundance**	*Galls*	5	C	P	×
		Fruits/pods		C	=	ND
		Flowers		C	=	ND
		Buds		C	P	×
		Gum	6	C	C	√
	Diversity		8	P	=	×
Herbaceous Layers	Abundance*	Grass	7	C	C	√
		Forbs		C	=	ND
	Diversity (H')	Grass	9	P	=	ND
		Forbs		P	C	×

C = Commercial ranch, P = Pastoralist land
*Quantified by actual counts
ND – No differences between the two land use systems in relation to the vegetation attribute in question.

Appendix 3.1: Diversity indices of trees

# of species	Commercial ranch			Pastoralist land		
	Plant Species	Count	H'	Plant Species	Count	H'
1	AD	765	0.108	AD	951	0.016
2	AM	2	0.014	-		-
3	AS	3	0.020	AS	9	0.044
4	AX	91	0.237	AX	1	0.007
5	BG	1	0.008	-		-
6	LE	1	0.008	LE	1	0.007
7	SM	1	0.008	SM	5	0.027
	Overall **H'**		0.402	Overall **H'**		0.101

The Shannon Weiner Diversity Index (H') of species diversity takes into account diversity and evenness and has to be calculated using the ln of the number of hits. So, where there was a single pinhit, the Shannon index is 0 as the ln of 1 is always zero. The value of a diversity index increases both when the number of species increases and when evenness increases.

Appendix 3.2: Grass species diversity Index

	Grass species	Shannon Weiner index (H')	
		Commercial	Pastoralist
1	*Anthrobogon distachyes*	0.937	0.788
2	*Astrida Adoenisis Hochst*	0.330	0.762
3	*Bothnochloa insculpta*	0.375	0.558
4	*Brachiaria ruziziensis*	0.712	0.880
5	*Cenchrus ciliaris*	0.367	0.755
6	*Cynodon dactylon*	0.324	0.458
7	*Chloris virgata Spp.*	0.693	0.693
8	*Digitaria milanjiana*	0.117	0.697
9	*Eleusine multiflora*	0.154	0.257
10	*Eragrostis superba*	0.693	0.868
11	*Monsonia angustifohia*	0.813	0.697
12	*Microchloa kunthii*	0.381	0.829
13	*Pennicitum mezanium*	0.439	1.082
14	*Panicum maximum*	0.4101	0*
15	*Rynchelytrum repens*	1.036	0.9949
16	*Setaria incrassata (Hochst) Hack*	0.1158	0.608
17	*Tragus berteronionnus*	0.588	0.8236
18	*Themeda triandtra*	0.3241	0.6654
19	UD spp C	0.3936	0.8995
20	UD spp G	0.9549	0.3906

UD –unidentified species were coded with letters

Appendix 3.3: Forbs Species Diversity

	Commercial		Pastoralist	
	Forb species	**Shannon Weiner (H') index**	**Forbs Species**	**Shannon Weiner (H') index**
1	*Aerva lanata (L.) Schulles*	0	-	
2	-		*Aspilia massambi censis*	0.1849
3	*Comelina spp*	0.3602	*Comelina spp.*	0.5263
4	*Cyprus rotundus*	0	-	
5	*Convolvulus sigittatus thunb*	0	-	
6	*Dichondra repens*	0	*Dichondra repens*	0
7	*Euphorbia inaequilatera sond.*	0.5402	*Euphorbia inaequilatera sond.*	0.3251
8	*Euphorbia spp*	0.9389	*Euphorbia spp.*	0.4634
9	*Erucastrum arabicum fisch*	0.9075	-	
10	*Hibiscus flavifolius ulbr*	0	*Hibiscus flavifolius ulbr*	0
11	*Helichryscum tubulosa (l.f.) Engl*	0.3927	-	
12	*Indigofera arrecta*	0.2338	*Indigofera arrecta*	0.4101
13	-		*Iponeoea oenotherae*	0
14	*Justicia calyculata*	0.9405	*Justicia calyculata*	0.5983
15	*Leucas grabrata*	0	*Leucas grabrata*	0
16	-		*Leucas Martinicensis*	0.6931
17	*Madicago Liciniata (L) D.C*	0	*Madicago Liciniata (L) D.C*	0
18	*Monsonia augustifolia A. Rich*	0	-	
19	*Monsonia augustifolia A. Rich*	0	-	
20	*Oxygonum sinuatum*	0	-	
21	*Pelargonium glechomoides A. Rich.*	0	-	
22	*Portulaca oleacea L.*	0.5342	-	
23	*Tetragonia acanthocarpa*	0	*Tetragonia acanthocarpa*	0
24	*Trifolium semipilosum var.*	0	-	
25	*Rhynchosia minima (L) D.C*	0.4741	*Rhynchosia minima (L) D.C*	0.5983
26	*Rhinacanthus ndorensis*	0.3927	*Rhinacanthus ndorensis*	0.4195
27	*Solanum incanum*	0	*Solanum incanum*	0.4702
28	*Solanum nigrum L.*	0.6365	*Solanum nigrum L.*	0

29	-		UD spp. 2	0
30	-		UK spp. 3	0
31	-		UK spp. 4	0
32	UD spp. 5	0.9743	UK spp. 5	0
33	UD spp. 6	0.3768	UK spp. 6	0
34	UD spp. 7	0.2573	UK spp. 7	0.2868
35	UD spp. 8	0.8676	UK spp. 8	0
36	UD spp . 9	0	UK spp. 9	0
37	-		UD spp 10	0.6931
38	-		UD spp 13	0
39	-		UD spp. 14	0.5402
40	-		UK spp. 15	0
41	UD spp 16	0.6194	UD spp 16	0
42	UD spp 17	0	-	
Overall H'		0.5965	Overall H'	**0.4648**

* The Shannon Weiner index (H')for species diversity takes into account diversity and evenness and has to be calculated using the ln of the number of hits. So, where there was a single pinhit, the Shannon index is 0 as the ln of 1 is always zero. UD –unidentified species were coded with numbers.

CHAPTER FOUR

THE INFLUENCE OF DIFFERENT HUMAN MODIFIED HABITATS ON THE SOCIOECOLOGY OF THE OLIVE BABOON (*Papio hamadryas anubis*), IN LAIKIPIA DISTRICT, KENYA.

4.1   Introduction

A major area of anthropological and evolutionary theory concerns the adaptive influence of resource abundance and distribution on social behavior (Crook and Gartlan 1966; Gartlan 1968; Budnitz 1978; Wrangham 1986; Janson 1988; van Schaik 1989; Muruthi et al. 1991; Isbell and Pruetz 1998; Boinski et al 2005b; Faulkes and Bennett 2007). Since female reproductive success is likely to vary as a function of the quantity and quality of food attained (Trivers 1972), the theoretical starting point of virtually all socioecological models is that females compete primarily for food resources, and the nature of their competition determines the patterning of female social relationships (Wrangham 1980; van Schaik 1989; Isbell 1991; Sterck et al. 1997, Koenig, 2002). Competition may take two distinct forms, "contest" and "scramble," whose relative strengths depend on resource distribution patterns (van Schaik 1989). Contest competition generally occurs when food resources of high or low nutrient value are relatively discrete and some females can systematically exclude others from these food "patches." Scramble competition, on the other hand, arises over food resources that are either low in nutrient value,

uniformly dispersed, or found in extremely large patches (relative to the size of the group).

The nature of female competition and social interaction is hypothesized to reflect the particular patterns of food availability (van Schaik 1989). The predicted result of contest competition is a system of "despotic" social relationships based on female dominance maintained by permanent alliances (Wrangham, 1980; Isbell, 1991; Sterck et al. 1997). In such a system, inter-individual distances are predicted to decrease among cohorts of closely associated females that provide coalitionary support to one another for access to these resource patches. Under scramble competition, however, inter-individual distances are predicted to increase because it is not economically beneficial to compete directly for these types of food resources. The resulting social pattern comprises "egalitarian" social relationships based on weak or non-linear hierarchies.

In socioecological models, feeding behavior can also be used to make inferences about the characteristics and quality of the habitat in which primates' range. For example, Isbell et al. (1998) argue that the richness of food sites can be estimated by the total number and duration of "moves" (or food stops) that individuals make between food sites. (Garber 1986; Iwamoto 1992; Isbell et al. 1998; Pruetz 2009). For example, the more quickly a food site is depleted, the more moves between food sites an individual makes per unit time which indicates food sources that are relatively less abundant. The contrary pattern of longer feeding bouts and

fewer food stops is assumed to be indicative of higher food availability or patchiness (Garber 1986; Iwamoto 1992; Isbell et al 1998).

The potential importance of predation as a selective force in social evolution has also been long appreciated (e.g., Alexander 1974). Variation in predation pressure is another ecological factor that has been posited to influence spatial cohesion within groups (van Schaik 1989, van Hooff and van Schaik 1992, Sterck et al. 1997). According to socioecological models, food distribution and predation risk influence inter-individual distances in group living primates (van Schaik 1989) and ultimately influence female relationships in primate groups (Sterck et al. 1997). These later models incorporated two hypotheses - 'Predation hypothesis' (Alexander, 1974), and the 'Food distribution hypothesis' (Wrangham, 1980). The Predation hypothesis assumes that predation ultimately forces females to live in groups and variation in predation pressure causes variation in spatial cohesion within groups and among species (Sterck et al. 1997, van Hooff and van Schaik 1992, van Schaik 1989). The Food distribution hypothesis assumes that when food resources are spatially clumped, females decrease inter-individual distances, hence, increasing direct intraspecific competition (Wrangham 1980; Isbell 1991).

The dynamic trade-offs between foraging efficiency and predation risk are highlighted in arguments that increasing group size will reduce predation risk, while simultaneously increasing the within-group costs of feeding competition (van Schaik 1989; Sterck et al. 1997; Isbell and Enstam 2002). Thus, van Schaik (1989) proposes that low predation risk will consequently facilitate dispersion of group members (to reduce foraging costs). From this fundamental premise, these models explicate how

solutions to the problems of finding food and reducing predation risk influence

female social interactions (Hawkes 1992; Sterck et al 1997). These socioecological

models are the foundation of our current understanding of social evolution and

provide insights into how both ancestral and modern human, as well as nonhuman

primates, adaptively respond to ecological variation.

Other authors have criticized tests of the models for failing to incorporate actual

measurements of i.e., that is food availability, vegetation, into the models (Matsumura

1999; Menard 2004; Thierry 2008). Another critique is that these models have not

been evaluated in a large comparative test to directly explore the relationships

between ecological characteristics and their corresponding social interactions (Shülke

and Ostner 2012).

This study redresses some of these issues by evaluating baboon feeding and

social behavior explicitly in the context of ecological variation arising from

contrasting anthropogenic land use practices. Most studies of socioecological models

have focused on one species (Whitten 1983; Janson 1985; van Schaik and van

Noordwijk 1988; Borries 1993; Saito 1996 Kappeler 1999; Izar 2004; Vogel 2005),

while comparative field studies have focused on different primate species in the same

habitat (Isbell et al. 1998; Pruetz and Isbell 2000; Isbell and Enstam 2002) or on

closely related subspecies in different habitats (Barton et al. 1996; Boinski et al.

2005a; Boinski et al. 2005b). These previous studies have necessarily been primarily

observational. Experimental tests hold great potential to test predictions of

socioecological models, but the few experimental studies testing these predictions in

primates are primarily in captivity (Boccia et al. 1988; Gore 1993; Andrews 1986; Andrews and Rosenblum 1988).

My research is inspired by the example of these captive studies by treating contrasting human modification of habitat as a kind of experimental manipulation of food availability, to which the dynamic responses of primates can be measured. Thus, the potentially valuable aspect of this research is the unique opportunity to exploit a "natural" experiment —human modifications of the habitat to which the olive baboon is well adapted — to test the socioecological model in a manner rarely possible in the wild.

The subject baboons' home range straddled a pro-wildlife[4] private commercial ranch and was an occupied[5] pastoralist land holding. In Laikipia District, occupied pastoralist lands in general, and Thome B in particular, are characterized by vegetation that is notably more heavily and browsed than vegetation in the commercial ranches (See Fig 2a-b; Moinde Chapter 3). These two land use systems have different livestock densities that have evidently influenced vegetation abundance and distribution in different ways (see Table 3.14, Chapter 3). Overall, there was relatively higher abundance of woody vegetation on the pastoralist land whereas, in contrast, herbaceous vegetation was more abundant on the commercial ranch (Table

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[4] The term "Pro-wildlife" indicates that support conservation management and entail relatively lower livestock densities thereby maintaining vegetation cover and fostering wildlife abundance (Georgiadis et al. 2007a;b). Most pro-wildlife practitioners in the district also typically carry out ecotourism ventures and some have actively reintroduced predator species (.e.g., lions, leopards etc.) (Romanach et al. 2009) and even exotic species such as the white rhino to enrich the tourist experience.

[5] "Occupied" lands are frequently legally owned by a few individuals who belong to part of a larger co-operative of landowners. Typically this collective has purchased pieces of land resulting from the subdivision of a ranch or holding area under a land settlement scheme. The majority of legal owners of occupied lands comprises of absentee co-owners who leave the remaining few owners occupying the land to manage it and make "agreements" with others to occupy the land (Francis Lemantile *pers comm*s).

3.14, Chapter 3). There were also quantifiable contrasts in the structure (i.e., height) and distribution (i.e., dispersion) of the overstory i.e., (i.e., woody trees and shrubs) as well as the understory layer (i.e., herbaceous layer – grasses and forbs) (Table 3.14, Chapter 3). Woody vegetation, despite its lower abundance in the commercial ranch, was more patchy or "clumped' while grasses in the herbaceous layer were notably taller on the commercial ranch relative to the pastoralist land (Table 3.14, Chapter 3).

In Laikipia district, predator abundance also appears to vary systematically across the different land use systems (Woodroffe and Frank 2005; Georgiadis et al. 2007b). The management of some commercial ranches in Laikipia over the last two decades has actively augmented predator numbers and /or maintained relatively lower livestock densities (than pastoralist lands) to promote habitats favorable to wildlife, including large predators (Woodroffe and Frank 2005; Georgiadis et al. 2007b). Additionally, evidence of predator presence and actual sightings were recorded during the study period (See Chapter 2, Table 2.3) suggests that predation risk for baboon subjects varied systematically between the different land use systems. Thus, the contrasting ecological attributes of these land use systems offer an ideal scenario in which to test variables that are predicted to influence primate feeding and social behavior.

In this study, I aim to clarify models of primate social evolution by addressing key questions regarding baboon behavior:

(1) Do socioecological models (e.g., Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997) accurately predict variation in baboon social behavior given different resource distributions and predation pressures arising from anthropogenic

land use practices? To capture variation in feeding behavior in response to contrasting types of human modification of a landscape, I hypothesized that on the commercial ranch where food resources are relatively more clumped and abundant (the pro-wildlife commercial ranch area), female competitive strategies will shift from a relatively greater emphasis on contest to scramble competition. I predicted that females will

1) spend proportionally more time feeding and;

2) experience longer feeding bouts (Garber 1986; Iwamoto 1992; Isbell et al. 1998; Pruetz 2009);

3) experience reduced number of bouts (Garber 1986; Iwamoto 1992; Isbell et al. 1998; Pruetz 2009) and;

4) show higher rates of food acquisition (feeding rates) (Isbell et al. 1998; Nagasawa 2004), on the commercial ranch

I also predicted that in the commercial ranch with more clumped food resources, there will be**:**

5) reduced inter-individual distances (Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997);

and higher rates in the following measures related to contest competition;

 6) a) all agonism during feeding (Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997),

b) all high and low levels of agonism (Wrangham 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997)

Moreover, in the commercial ranch, where clumped food resources are predicted to promote contest competition, I also further predicted higher rates of;

7) Affiliation (e.g., grooming, embracing, presenting, huddling, muzzling) among coalitionary partners (Langergraber 2012; Gilby 2013; Aureli et al. 2012); and

8) coalitionary interactions (e.g., recruitments, joint attacks and joint defense) (Wrangham, 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997).

I also hypothesized that higher risk of predation on the commercial ranch habitat will promote more vigilance. I therefore predicted

9) increased visual scanning rates will be exhibited by baboons only while resting (but not necessarily while feeding) in the land use system, the commercial ranch, with higher predation risk (Treves 1999).

4.2   Study Area: Human modified habitats

Anthropogenic land use practices and management regimes

Laikipia District is situated in northern Kenya (between $0^0 17^0$S and $0^0 45^0$N, and $36^0 15^0$E and $37^0 200$E) and covers an area of approximately 9666 km^2 of semi-arid bush land and savanna (Woodroffe and Frank 2005). The area where the subject baboons ranged was *Acacia drepanolobium* wooded savanna grassland that is supported by poorly drained, seasonally waterlogged ("black cotton") vertisolic soils (Young et al., 1997). The predominant land use systems found in Laikipia are commercial ranching and pastoralism. According to Di Gregorio and Jansen (1998), land use is characterized by human activities and inputs that change or maintain a

certain land cover type. Land use defined in this way establishes a direct link the actions of people and land cover in their environment.   Pastoralist lands in Laikipia are typically characterized by pronounced grazing. This is partly because fencing around the neighboring commercial ranches restricts the traditional practices of seasonally moving livestock and consequently increases local densities (Georgiadis et al. 2007a). This is in contrast to the mutual commitment of most "pro-wildlife" commercial ranch owners to support the Laikipia Wildlife Forum's (LWF) development and conservation goals. These ranches favor wildlife partly by encouraging low to moderate livestock densities (Georgiadis et al. 2007a; Moinde *pers. comm.*). Georgiadis et al. (2007a) found that commercial ranches generally had lower livestock densities (2.7 t km-2) than did the "transitional ranches" (4.6 t km-2), which I referred in this paper as "occupied pastoralist lands."

Differences in baboon food availability between the commercial ranch and pastoralist land microhabitats

The impact of the higher density and composition of livestock on the pastoralist land relative to the commercial ranch was especially evident in the highly browsed appearance of woody trees, shrubs and grasses (Moinde, Chapter 3). The majority of woody plant production (i.e., galls, pods, flowers, seeds, buds) was from the *Acacia* trees; in particular the dominant *A. drepanolobium* (Moinde, Chapter 3). The availability of baboon woody food resources, also, varied differently across these two land use systems (Table 3.14; Appendix 4.1). In the commercial ranch, ripe fruit and

gum were relatively more abundant than on the pastoralist land, whereas dried seed pods and various green food items consumed by baboons, such as, galls, flowers and buds were relatively more available on the pastoralist land than on the commercial ranch (See, Table 3.14; Appendix 4.1). In terms of herbaceous food resources consumed by the baboons, only green grass was relatively more abundant on the pastoralist land than on the commercial ranch.

Individual woody trees which included the dominant *A. drepanolobium* trees and shrubs found in Laikipia District are feeding sites which have previously been documented to incite contest competition (Isbell et al. 1998; Pruetz and Isbell 2000; Pruetz 2009). In terms of overall differences in the distribution of baboon food resources, however, the woody baboon feeding sites on the commercial ranches where therefore relatively more dispersed and larger (i.e., height and canopy size) (see Chapter 3, Table 3.14), The woody vegetation structure on the commercial ranch presented a relatively more patchy distribution of baboon food resources, in particular for fruits and gum, where they were more abundant than on the pastoralist land (Appendix 4.1).

Differences in predation risk between the commercial ranch and pastoralist land

Laikipia District sustains a rich diversity of predator species which include lions (*Panthera leo*), wild dogs (*Lycaon pictus*), hyenas (*Crocuta crocuta*), cheetahs (*Acinonyx jubatus),* and leopards (*Panthera pardus*) (Woodroffe and Frank, 2005). Cowlishaw (1994) identified, in order of importance, leopards, lions and hyenas as the primary predators of baboon. Empirical studies in Laikipia have shown that

predation risk appears to vary meaningfully across commercial and pastoralist land use systems (Frank et al. 2005). For example, using radio-telemetry data on 71 lions in the area, Frank et al. (2005) reported that lions strongly prefer the commercial ranches where human and livestock densities are lower. It seems likely that leopards —a predator of baboons generally (Cowlishaw 1994) and locally (Table. 2.3, Chapter 3) —also similarly prefer commercial over pastoralist lands (Frank *pers. comm.*). According to Georgiadis et al (2007b), the principal factor causing an increase in predator densities in Laikipia was a shift in land use from cattle ranching —where both predators and plain zebra had been previously suppressed— to more recently introduced wildlife conservation management practices, promoted particularly in the commercial ranches in Laikipia (Romañach et al 2009). Thus, predators' presence and absence within the district appears to be a direct result of differing human modified habitats and management practices (Georgadis et al 2007b).

4.3 Methods

Baboon behavioral data

Study Animals: From June 2009-December 2010, I collected data on two groups of habituated olive baboons that R. A. Palombit and colleagues have studied since 2000. The larger group (TDM: N= 120) had 30 adult females, whereas the smaller group (KAT: N=74) had 8 adult females (see Tables 4.1 and 4.2). In January 2010, TDM underwent a group fission event which was maintained throughout the duration of the study. One of the adult females later returned to TDM and data collection continued

throughout the process of fission with the remaining females in TDM (See Table 4.1a). An experienced field assistant and I collected behavioral data on both baboon groups from approximately 6:30 am to 2:00 pm. On certain days data collection was extended to 5:30pm in the aim of collecting more behavioral data to compensate for rainy days.

Ten-minute continuous focal sampling (Altmann, 1974) was used to measure the behavior of randomly selected adult females. Behavioral data (Table 4.3) were recorded using hand-held Psion Workabout MX data collectors in the field and later downloaded onto a computer at the end of each day. A total of 1300 hours of focal animal data were collected (TDM 1217 hours, KAT 83 hours).

Monthly rainfall patterns: Rainfall (mm) was recorded on a daily basis in order to calculate total rainfall for each month (Fig 3.13). Monthly rainfall data were used to make inferences about monthly temporal changes in baboon food availability within the study duration since temporal availability of food resources is influenced by rainfall (reviewed in Chapman et al. 2002)**.**

Feeding behavior: To compare differences in female baboon feeding behavior between the different land use systems, I analyzed the proportion of time spent feeding (**Prediction 1**); duration of feeding bouts (**Prediction 2**); the number of feeding bouts (**Prediction 3);** and the feeding rates (**Prediction 4**). I defined a feeding bout as a discrete unit of time, beginning when an individual makes contact with a food and puts it in its the mouth and ending when an individual loses contact with the food for either 10 seconds, switches to another food class (Altmann 1998), or

moves to another feeding site (Isbell et al. 2008; Pruetz 2009). According to Isbell et al. (1998), a food site in quadrupedal primates, a food site has been defined as being separated from other food sites by hindlimb locomotion. Feeding rates, which are a useful assay of feeding efficiency, were measured during focals by the number of times an individual baboon's hand moved from the food resource to its mouth per unit time (Isbell et al. 1998; Nagasawa 2004).

Baboon Social Behavior: To test the predictions involving inter-individual distances (**Prediction 5),** I recorded the focal individual's nearest neighbors at 2-minute instantaneous intervals (Table 4.3) during focal sampling. I recorded the distance (to one meter) and identity of: 1) all adult females within 6 m of the focal animals and 2) the identity and distance of the nearest adult male and female (in five meter intervals if absent from the 6m-range). To compare the levels of agonistic, affiliative behaviors, and coalitionary interactions (Table 4.3) (**Prediction 6**) I measured the rates of a variety of agonistic interactions; "Displacements" (**Prediction 6a**) were defined as those that occurred outside the context of food, while "food displacements" (**Prediction 6b**) were those that occurred within the context of food. Agonistic behaviors were also divided into categories (Table 4.4). Low intensity (indirect) aggression (**Prediction 6c**) entailed behavioral signaling of conflict (e.g., supplants, threats, grunts, avoids), whereas high intensity agonistic (direct) (**Prediction 6d**) behaviors involved direct physical contact and are likely to be more costly in terms of risk of physical harm (e.g., chases, hits, grapple fights and chases) (Higley et al. 1996). Overall agonistic behaviors (**Prediction 6e**) collectively entailed all agonistic behaviors list above (6a-6d). To test rates of affiliative behaviors

(**Prediction 7**), I measured rates of embracing, presenting, huddling, muzzing to test

for affiliative behaviors **(Prediction 7a)** and duration of grooming within the context

of resting (**Prediction 7b**), which entailed scratching, and picking through the hair of

another individual.   **Prediction 8** was tested by measuring coalitionary interactions

(e.g. recruitments, joint attacks and joint defense). A "coalition" was defined as the

intervention of a third individual towards the aggression between two others (see

Ferreira et al., 2006).

Vigilance: To test for **Prediction 9,** baboon vigilant behavior, the frequency and

duration of visual scanning by the focal while resting was recorded (see Treves 1999)

during baboon focal observation. This was recorded as a measure of vigilance for

predators in each land use system (Table 4.3). Scanning was defined following Treves

(1999) as the visual inspection of the surroundings beyond the immediate vicinity. To

control for scanning for feeding competitors, scanning was scored only during resting

periods were recorded. Resting was defined operationally as an activity in which the

focal individual did not move for at least 10 seconds. If a potential predator was

observed while the baboons were foraging, however, vigilant behavior of the focal

was then recorded.

Adult female dominance rank was determined using David's score (Gammell et

al 2003). I then used the linear hierarchy to determine the proportion of adult females

dominated by each female, which was the measure of rank used in analysis Table

4.1b.

Assessment of predation risk between the two land use system

Predator encounters were recorded *ad libitum* since they were rare and conspicuous. Potential predators (lions, leopards – *Panthera pardus*, spotted hyena – and black-backed jackal – *Canis mesomelas*) were sighted within each of the two land use systems.   Since predator sighting was very rare, other evidence of predator presence, such as predator vocalizations, spoor, and carcasses of baboons were also noted whenever detected. The predation data were recorded collectively by three field assistants on site, another Ph.D. student who was collecting data from the same baboon groups, and myself.   I also used information reported by local people who lived within the baboons' home range. I asked people within the study baboons' home range in Thome B and Segera ranch to inform us of any predators seen or heard. This information on predator presence was used to qualitatively asses, levels of predation risk between the two land use systems.

The total number of actual predator sightings was 34 (see Table 2.3, Chapter 2). Of these sightings, 29 sightings were on commercial ranch and five sightings in the pastoralist land, indicating that predation risk in the study area was higher in the commercial ranch than on the pastoralist land. Although more actual predator sightings were observed in the commercial ranch during time of behavioral data collection, there were more baboon deaths recorded on the pastoralist land at the baboon sleep trees during the study period.   However, the larger number of predator encounters on the commercial ranch is a preferential way to gauge the levels of predation between the two land use systems in relation to the socioecological models

since baboons do not feed at night. In summary, the evidence collected of predator

presence suggests there is a higher risk of predation on the commercial ranch

compared to the pastoralist land.

Analysis

Feeding behavior

I ran four generalized linear mixed models (GLMM) in the statistical software R

v2.1.5.1 (R Development Core Team 2010) using Poisson distribution to assess 4

response variables: (1) time spent feeding (seconds); (2) duration of feeding bouts

(seconds); (3) number of feeding bouts and; (4) number of bites per minute (feeding

rates). Goodness-of-fit tests were run for all models to confirm that the standard

errors were Poisson distributed and therefore that Poisson distribution was

appropriate. I also used the glmmPQL function in R to account for overdispersion by

using a Wald t test. Adult female identity was included in all models as a random

effect. Fixed effects for the model were land use, adult female dominance rank, and

month of the year of the study period.

Social behavior

Social behaviors were analyzed by running GLMM model similar to that used

for the feeding behavior analysis i.e., I used the same fixed effects (i.e., land use,

adult female dominance rank, and month of the year) and random effects (i.e., adult

female identity) and used the Poisson distribution. I, however, ran GLMM models to

assess the following 10 response variables as categorized in Table 4.4.

Vigilance

A similar GLMM was employed to analyze variation in vigilance behavior. The

same fixed effects (i.e., land use, adult female dominance rank, and month of the

year) and random effects (i.e., adult female identity) were applied also using Poisson

distribution.

4.4. Results

Feeding behavior

As predicted (**Prediction 1**), baboons spent a greater amount of their time

feeding (sec) on overall food resources when they were in the commercial ranch

relative to the pastoralist land   ($t_{1827} = -8.57$, $p = 0.0001$) (Fig 4.3; Table 4.5a-b).
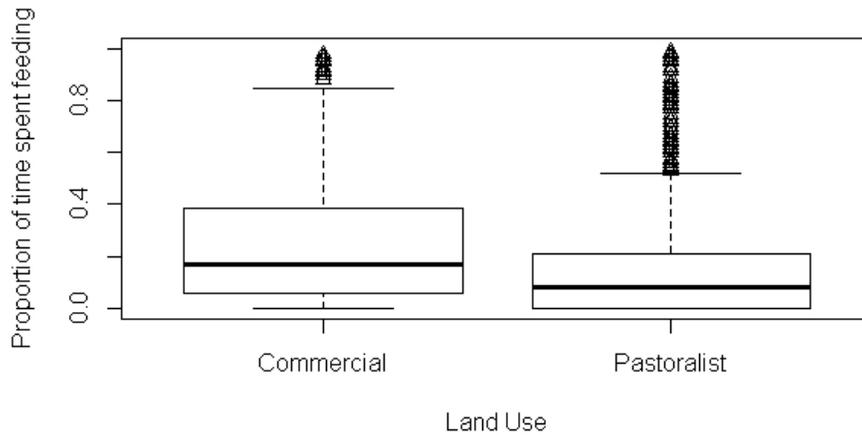
Figure 4.1: Proportion of time spent feeding (Mean $\pm$ SD) in the commercial ranch the pastoralist land

As predicted (**Prediction 2**), the duration of feeding bouts was longer when baboons fed in the commercial ranch compared to the pastoralist land (t_{1327} = -3.32, *p* = 0.001) (Fig 4.2; Table 4.5a-b).
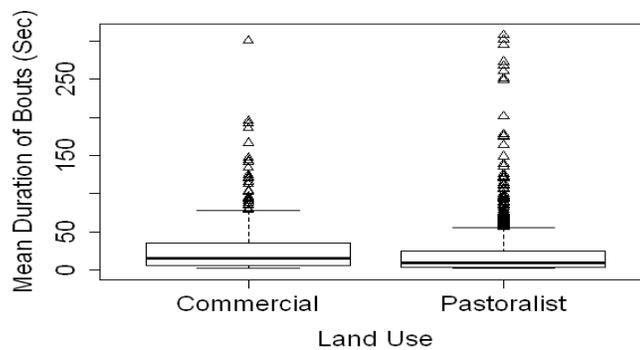
Figure 4.2: Duration of feeding bouts (Mean $\pm$ SD) in the commercial ranch (N = 382) and the pastoralist land (N = 1081)

As predicted (**Prediction 3**), the overall number of feeding bouts was greater when baboon baboons were fed on the pastoralist land than on commercial ranch ($t_{1327} = 2.31$; $p = 0.021$) (Fig 4.3; Table 4.5a-b).
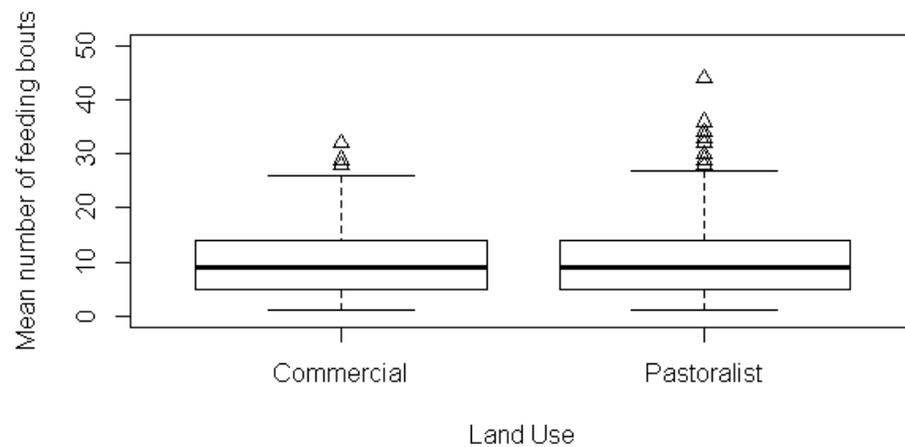
Figure 4.3: The mean number of feeding bouts (Mean $\pm$ SD) while feeding on all foods observed between the two land use systems

As predicted (**Prediction 4**), baboons feeding rates were higher while feeding on the commercial ranch relative to the pastoralist land ($t_{1327} = -3.05$; $p = 0.024$) when all food resources were taken into account (Fig 4.4; Table 4.5a-b).
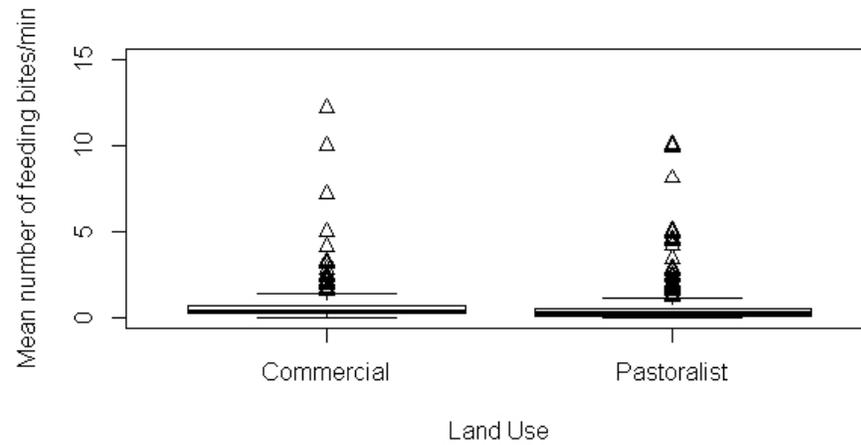
Figure 4.4: Baboon mean feeding rates (Mean $\pm$ SD) while baboons fed on overall food resources between the two land use systems

Individual distances

Contrary to predictions (**Prediction 5**), baboons' nearest neighbor distances were higher on the commercial ranch relative to the pastoralist land (t_{1853} = -2.98; p = 0.003) (Fig 4.5; Table 4.6).
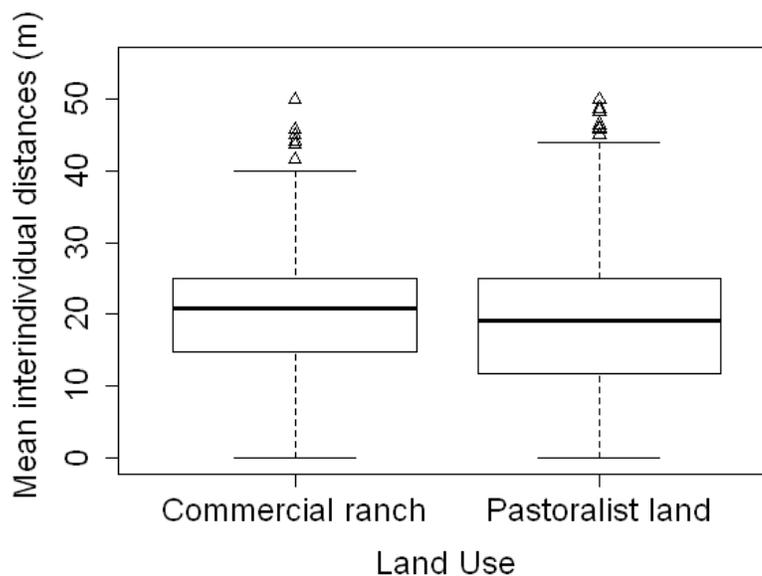
Figure 4.5: Baboon mean nearest neighbor distances (Mean $\pm$ SD) in the two land
use systems

Differences in social interactions in the two land use systems

Rates of agonistic behaviors in the land use systems

Displacements: The rates of displacements (**Prediction 6a**) that did not occur
within the context of feeding were the same in the two land use systems ($t_{1853} = 0.82$;
$p = 0.411$). Baboon rates of food displacements (**Prediction 6b**), however, were
higher on the commercial ranch relative to the pastoralist land ($t_{1853} = -2.48$; $p =$
0.0132) (Fig 4.6; Table 4.6). Overall displacements (**Prediction 6c**), however, did
not vary between land use systems ($t_{1853} = 0.09$; $p = 0.931$) (Table 4.6).
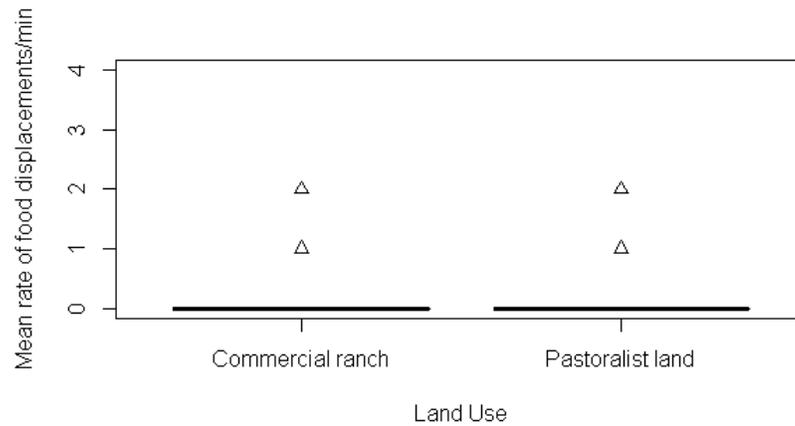
Fig 4:6. Rates of food displacements while feeding (Mean $\pm$ SD) in the two land use systems

Agonistic interactions: Similarly, rates of both low intensity ($t_{1872} = -0.21$; $p = 0.835$) and high intensity agonistic interactions ($t_{1872} = 0.41$; $p = 0.681$) did not vary across land use as did rates of all agonistic behaviors ($t_{1872} = -0.06$; $p = 0.954$) (Table 4.6).

Rates of affiliative behaviors in land use systems

Affiliative interactions: As predicted (**Prediction 7**), rates of all affiliative behaviors where higher in the pastoralist land relative to the commercial ranch ($t_{1872} = 1.97$; $p = 0.049$) (Fig 4.7, Table 4.6)
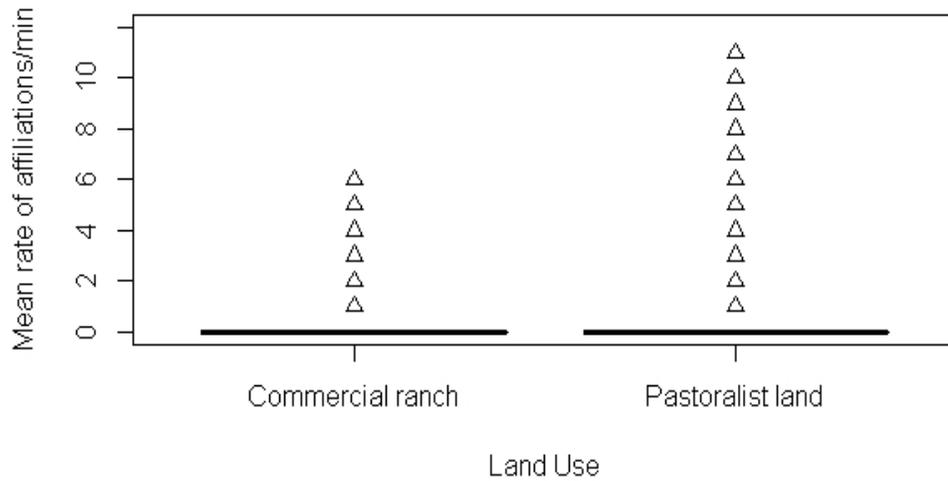
Figure 4.7: Rates of affiliative behaviors (Mean $\pm$ SD) in the two land use systems

As predicted (**Prediction 8**), the proportion of time baboons spent grooming was higher in the commercial ranch relative to the pastoralist land (t_{1613} = -4.22; p = 0.0001) (Fig 4.8; Table 4.6).
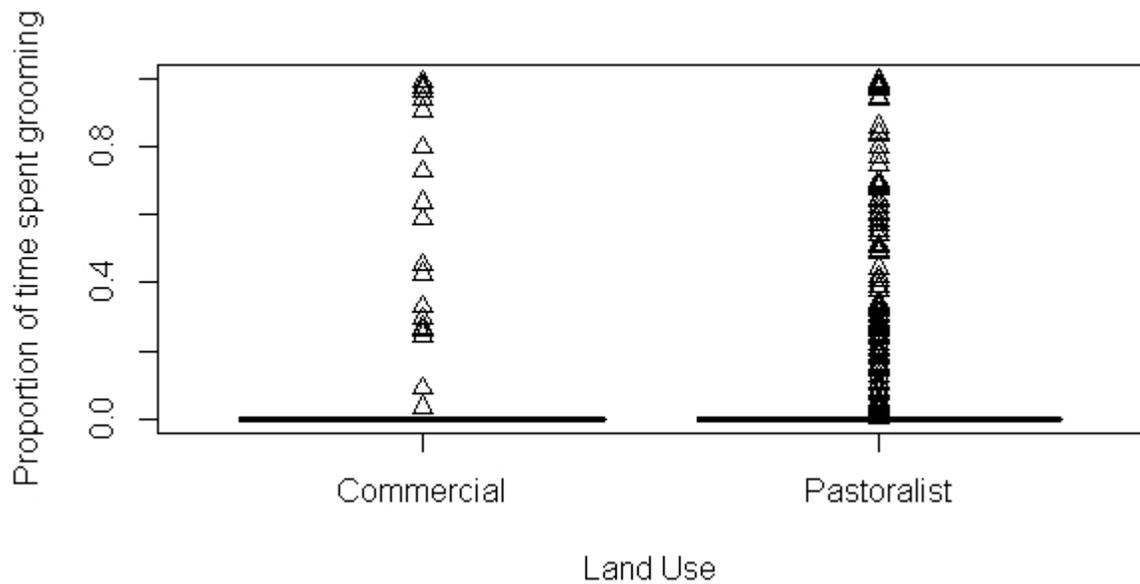
Figure 4.8: Mean grooming duration (min) (Mean $\pm$ SD) between the two land use systems.

Coalitionary behaviors

Coalitionary rates (**Prediction 9**) did not differ between the two land use systems as only one coalitionary instance was observed on the pastoralist land (0.004/hr of observation time while none were observed on the commercial ranch.

Vigilant behavior in the land use systems

As predicted (**Prediction 10**), females displayed higher vigilance while on the commercial ranch relative to the pastoralist land (t = -5.19; p < 0.001) (Fig 4.9; Table 4.8).
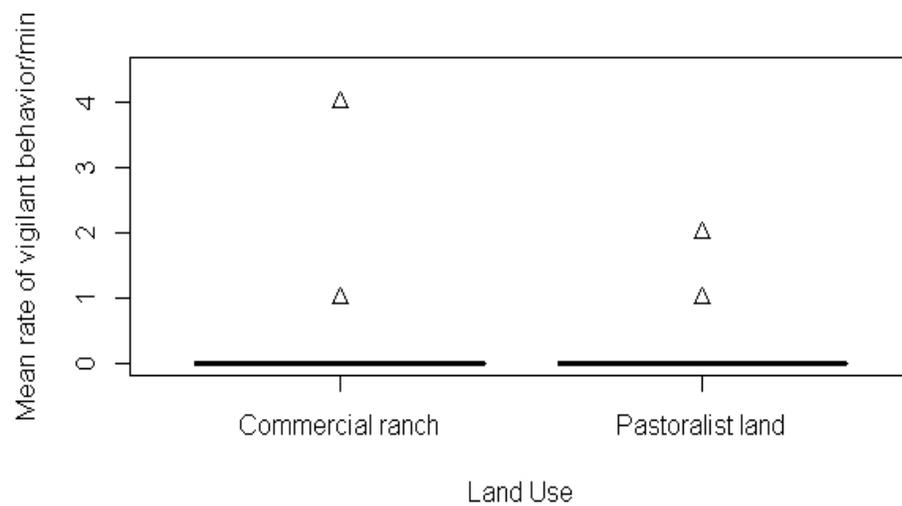
Figure 4.9: Mean number of vigilant behavior (SEM) between the land use systems

4.4 Discussion

Several aspects of feeding behavior — proportion of time spent feeding, feeding bouts and rates — were higher when baboons were in the commercial ranch than in the pastoralist land. This patterns suggests that the commercial land use system offers a relatively richer habitat than the pastoralist land when all food resources are taken into account. A greater proportion of time spent grooming in the commercial ranch

relative to the pastoralist land may have been a consequence of conciliatory behaviors due to higher rates of food-related displacements. The higher rates of other types of affiliative behaviors (i.e., embracing, presenting, huddling, muzzling, and ritualized touching of different body parts) on the pastoralist land, however, was indicative of the relatively lower availability of food resources that was less clumped. Food-related agonism was only observed through displacements which suggest that these resources were generally not intensely competed for by the baboons in both land use systems, thus, only low level aggressive interactions on both land use systems indicated weak contest competition for food resources in the study site. Nevertheless, my findings, however, reveal that contest competition for food resources was, however, more intense in the commercial ranch relative to the pastoralist land. Weak related-contest competition could have been attributed to high availability of baboon food resources due to the unusually heavy rainfall during the study period and therefore warranted weak or low intensity contest competition.   Another argument in relation to the observed weak food-related contest competition could have also be attributed to the reduced availability of clumped food resources found on woody plants that are consumed by baboons. This was mainly due to the combined presence of thorns and attacking housed obligate ants on the dominant *Acacia* plants as I later discuss in more detail.

Increase rates of vigilance on the commercial ranch accorded with the socioecological models, given the higher levels of predation risk suggested for this land use relative to the pastoralist land system. These findings have evolutionary significance in that they provide insights on the potential role humans have (or may

have had) in influencing the social behavior of primates, as well as other species, in environments in which they co-exist. The implications of applying socioecological models as a practical tool for management and conservation of primates and other faunal species that occupy unprotected human occupied landscapes are discussed below.

Baboon feeding behavior on the commercial ranch and pastoralist land

The baboons spent a higher proportion of time feeding, with longer duration of bouts and fewer food stops in the commercial ranch, compared with the pastoralist land. The combination of these attributes was indicative of higher availability of food resources with larger, but fewer food patches, in the commercial ranch than those found on the pastoralist land (Garber 1986; Iwamoto 1992; Isbell et al 1998). The higher feeding rates that occurred in the commercial ranch were also an additional indicator of overall better habitat quality for the baboon relative to those observed on the pastoralist land. Feeding rates arguably provide the most precise assessment of food availability and an indirect assay of the energy derived from each food items (Byrne et al. 1990; Barton et al. 1992; Nakagawa 2000).

This study provides clear evidence of differences in baboon feeding and social behavior in response to different (anthropogenically modified) habitats. The land use where livestock densities were lower (commercial ranch) had a higher abundance of grasses, but the land use with higher stocking rates (pastoralist land) had relatively greater abundance of smaller woody plants that were less spread out (Moinde, Chapter 3). Due to the differences abundance and distribution of the

herbaceous understory and the woody overstory between the commercial ranch and

the pastoralist land described in Chapter 3, it was unclear which land use system had

overall higher abundance of food resources for the studied baboons. The patterning

of baboon feeding behavior suggests, however, indicate that food resources in the

commercial ranch were relatively more abundant and patchily distributed than the

pastoralist land.

Variation in baboon social interactions between the commercial ranch and the

pastoralist land

Baboons exhibited increased food-related agonism and the proportion of rest

time spent grooming on the commercial ranch where availability of food resources

and predation risk were relatively higher than on the pastoralist land. In contrast,

higher levels of other affiliative interactions (i.e., embracing, presenting, huddling,

and ritualized touching of different body parts or muzzling) occurred on the

pastoralist land. Socioecological models predict that food resources that are relatively

high in abundance, patchily distributed and/or have higher nutrient value compared to

other surrounding food resources intensify contest competition compared to food

resources that have relatively lower nutrient value and are uniformly distributed

(Wrangham, 1980; van Schaik 1989; Isbell, 1991; Sterck et al. 1997). Further, these

models also posit that since individuals cannot successfully contest for food resources

alone, increased affiliative (e.g., grooming) and coalitionary interactions (e.g., joint

attack or defense) are likely to be selected for amongst individuals.

Other studies have provided evidence that within-group contest competition leads to higher rates of aggressive interactions in many species (Isbell and Pruetz 1998; Koenig 2000; Vogel 2005; Robbins 2008).   The higher rates of food-related displacements within the studied baboon groups consequently increased the duration of grooming on the commercial ranch as predicted by the socioecological models. Contrary to prediction, however, there were no rank related differences between the land use systems in relation to food-related displacements. There were, however, rank related differences between the two land use systems within the context of grooming as predicted by the socioecological models between the land use systems.   Grooming was relatively more intense on the commercial ranch, suggesting that this could have further alleviated these aggressive interactions in general, which may explain why only differences in low intensity aggressive interactions (versus high intensity) were observed between the two land use systems.

The lack of female rank in influencing low level food-related displacements between the two land use systems suggests that food-related contest competition was at best present but weak. It's possible that food was abundant enough, due to the unusually high rains, to reduce overall levels of contest competition. Thus, rank differences were not necessarily exhibited amongst adult females while contesting for food resources. Alternatively, the lack of rank related differences in the context of food competition could also have been attributed by the fact that baboon feeding and social behavioral analysis were carried while applying overall food availability. Future analysis on these same behaviors, therefore, also need to be conducted while finer level of analysis using different food categories (e.g., woody – clumped,

herbaceous –non-clumped) to further clarify which specific food resources evoke contest competition as predicted by the socioecological models. This approach may serve to capture any rank related differences on both feeding and social behavioral between the two land use systems.

In contrast, higher levels of other affiliative interactions occurred on the pastoralist land where there was relatively lower availability of food resources. These results indicate that availability of food resources in the pastoralist land had the predicted effect of lessening contest competition relative to those on the commercial ranch.

Glades" are r common anthropogenic feature of pastoralist activities and; in the more recently past, increasingly a commercial ranching activity in Laikipia (See Moinde Chapter 3). The spatial distribution and high nutrient content of grasses found in glades relative to the surrounding grasses (Augustine 2003a, 2003b; Veblem 2006) also has important socioecological implications for local primates (Moinde, pers obs.) For example, grass shoots on glades in the study site were especially contested for as soon as they become available just after the initial protracted rains begun in October 2009 and after brief periods of lower rainfall during the study period. This appeared to be due to other grasses outside of glades taking relatively longer to recruit as they were not supported by the fertile soils like those found in glades (Augustine 2003a; 2003b). Thus, the growth of grass shoots on glades occurred at a time when these shoots were virtually absent elsewhere in their home range (See chapter 3 Fig 3.3) which may have stimulated contest competition.

At the same time, sustaining high nutrient grass on glades is highly dependent on rainfall; during brief periods of lower rainfall these grass shoots were also the first to wither and dry up. According to Janson (1985), if within-group contest competition is strong, higher ranking female's gain better access to high quality resources; thus, the tendency to engage in aggressive interactions is likely to be enhanced. Contest competition is thought to occur when resources are limiting, defendable and worth defending (Shülke and Ostner 2012). Food resources found within the context of glades fit the predicted profile that would evoke contest competition. Of the total number of glades (N =67) within the baboons' home range, the pastoralist land had a higher occurrences of glades (69%) than the commercial ranch (31%) (Chapter 3). Given that the baboons spent a proportionally higher amount of time feeding in the commercial ranch, it is also interesting to note that they were recorded feeding in glades 38 times in this land use system relative to 35 times in the pastoralist land. This also suggests that there was a preference to feed on glades in the commercial ranch despite their lower occurrence in this land use system.

Adult female aggressive interactions in primates that occur outside the context of food, such as, competing for mates, space, and access to infants and grooming partners can enhance the complexity of social relationships more than ecological factors alone (Pruetz 2009). Findings from this study indicate that adult female baboons competed for non-food-related resources equally across the two land use system when agonistic interactions outside the context of food were only taken into consideration. Food, therefore, appears to be the most important resource that influenced differences in aggressive behaviors across the land use systems.

In this study, the overall longer feeding bouts and the lower number of bouts in the commercial land system indicates that there were more abundant and/or larger discrete food patches on this land use systems. van Schaik (1989) maintains that contest competition is likely to be observed when feeding sites are not large enough such that all group members can feed simultaneously. I applied van Schaik's (1989) definition of factors that promote contest interactions amongst individuals within a group because it does not focus on the physical attributes (i.e., distribution or abundance) of food resources). Rather, this definition of food availability emphasizes individual response to variation in food resources in relation to group size. Inferences from patterns of baboon feeding behavior, thus, suggest that the longer feeding bouts in the commercial ranch provided the scenario for which food can be better monopolized by individuals and predicted to promote contest competition (Wrangham, Isbell 1991, Isbell et al 1998).

In addition, the higher abundance of (swollen) *A. drepanolobium* thorns stimulated by browsing from higher livestock densities on the pastoralist land, as compared to the commercial ranch, may have contributed to the reduced feeding rates on this land use system compared to the pastoralist land (see details in Chapter 3). That is, woody food resources from *Acacia* plants, in particular, might have been more limited – and harder to monopolize- in the pastoralist land than in the commercial ranch. For example, even though the majority of woody food resources (i.e., all galls, green buds, pods and young flowers) were also more abundant on the pastoralist land (Moinde, Chapter 3), the availability of *Acacia* woody plants, in both

land use systems was limited due to the presence of attacking obligate ants (Moinde, Chapter 3).

According to Isbell (1998), the monopolizability of food resource is supposed to promote contest competition. However, a larger number of swollen thorns (galls) with symbiotic attacking ants on the pastoralist land may have further contributed to the lower rates of food related displacements. The increased presence of thorns alone has been reported to reduce feeding rates, while the combined effects of both thorns and ants shorten herbivore feeding bouts (Stapley 1998). Thus, the pastoralist land may have consisted of more food resources from the dominant *A. drepanolobium* plants but with limited availability due to the greater number of swollen thorns that house attacking obligate ants that may have potentially contributed to the shorter feeding bouts there than on the commercial ranch. The scenario, on the pastoralist land, therefore, may have been promoted scramble competition relative to the social interactions observed on the commercial ranch.

In this study, the distribution and abundance of baboon food resources (i.e., gum and fruits) in the commercial ranch appeared to be patchier and relatively more monopolizable relative to those resources found on the pastoralist land. The higher rates of low level contest competition observed through displacements, within the context of food alone on the commercial ranch, are interesting as they suggest a flexible ability to monopolize woody food resources when the number of anti-herbivore swollen thorns and their concomitant symbiotic ants are reduced (Moinde, chapter 3).

The example of ants and thorns on *Acacia* plants emphasizes the importance of quantifying biological features of food resources besides simply their abundance and distribution. More importantly, this study identifies how other ecological factors, through indirect anthropogenic manipulation of vegetation, may also potentially support and even complicate socioecological predictions. Further studies are needed to compare the effects of ants and thorns alone on baboon feeding behavior. This will help to ascertain the extent to which these two factors influence the monopolization of food resources found in the dominant *Acacia drepanolobium*, a primary food resource for the baboon in the study area.

This study demonstrates co-variation in feeding and social behaviors due to contrasting ecologies resulted from different anthropogenic disturbances. Concurrently comparing feeding and social behavioral variation within the same group in different sites increased the "experimental" rigor by controlling for intrinsic individual/group differences that potentially influence the same behaviors that are used to test socioecological theories.

More recently, the validity of socioecological theories has been the called into question by some primatologists. Some have argued that phylogenetic inertia is the primary force that influences primate social behaviors (Thierry 2008; Borries 2009) this argument threatened, if not nearly debunked, food as one of the key fundamental bases of female social behavior as posited by socioecological theories (Schülke and Ostner 2012). While it is well documented that parental care, mate guarding, and sexual conflict are key factors that have also contributed to the evolution of social

systems (reviewed in Mitani et al. 2012), it is still unclear to what extent the strength

and mode of feeding competition influences female social relationships as predicted

by the socioecological models (Schülke and Ostner 2012). The flexible adjustment of

social behavior of olive baboon subjects to contrasting human modified ecologies

provides support for the socioecological model and serves to reiterate the importance

of food resources as at least one important evolutionary force influencing social

behaviors in primates.

Some implications of differences in contested resources across land use systems

Olive baboons are classified as typical Cercopithecines with *resident-nepotistic*

female social relationships (Sterck et al. 1997).   The *resident-nepotistic* regime is

found in groups where females are philopatric and establish stable matrilineal

hierarchies. "Nepotistic" refers to hierarchies in which female relatives tend to

achieve similar ranks as a result of coalitionary support from one another against non-

kin. "Despotic" refers to dominance relations characterized by often formalized

dominance and usually have linear hierarchies in primates (de Waal 1989; Sterck et

al. 1997).

During my studies, however, only one coalitionary interaction amongst females

was observed. It is not certain what initiated this particular triadic interaction, but it

was not clearly related to food or feeding given that it occurred near the group's sleep

trees where the baboons typically do not forage. Coalitionary rates in this study

(1/355h) were also comparatively lower than those observed by Barton et al. (1996)

on olive baboons in another site in Laikipia (1/13.7h). It is possible that the higher availability of food resources in my study site did not necessitate   promotion of higher rates of coalitionary support from kin.

An alternative explanation is that the potential proximate costs of coalitionary behavior (i.e., retaliation, physical injury) exceed its the benefits (i.e., increased chances of gaining access to contested resource), hence the relatively low rates of coalitionary support. Female chacma baboons intervene in conflicts among other adult females at very low rates (Barrett and Henzi (2001; 2002), even when resource competition is intense (Ron et al. 1996). This suggests, like chacma baboons, coalitionary interactions play little role in maintaining the stability of dominance hierarchies in olive baboons within the *A. drepanolobium* habitat where this study was conducted.

However, others have argued that the low rate of interventions may underestimate their importance. The presence of potential allies, and knowledge of alliance partnerships between kin and other affiliations, may be enough to deter challenges (Cords 2002). Moreover, Silk (2007) found that females primates sometimes give vocal threats when they witness agonistic interactions. These vocalizations also appear to play a similar salient role of interventions than active interventions themselves (Wittig et al. 2007). Although adult females in this study group were heard to emit vocalization within several contexts (e.g., grooming, approaches from different individuals etc.), vocalizations that occurred specifically within the context of low intensity agonistic behaviors may have been overlooked.

In contrast to socioecological predictions, affiliative interactions were unexpectedly higher on the pastoralist land, while rates of food contest competition were practically doubled on the commercial ranch. This suggests that food-related aggression is unlikely to have contributed to the conditions that promoting higher rates of affiliation, at least in the short term. The reason for differences in the intensity of affiliative behaviors between the two land use systems, therefore, is still not clear. Affiliative behaviors such as embracing, presenting, huddling, and ritualized touching of different body parts (e.g., rump) or muzzle interactions in primates may have provided immediate benefits (i.e. easing tension) after an escalated display of aggression. Another tentative explanation that may explain the more frequent affiliative interactions on the pastoralist land concerns the distribution of woody food resources. These resources were relatively less dispersed than in the commercial ranch. Differences in woody trees dispersion between the two land use systems (Moinde, Chapter 3) appeared to have a strong influence on the subject baboons' group spatial interactions. On the pastoralist land baboons were more spatially cohesive. Closer proximity combined with food attributes promoting scramble competition may have facilitated in interactions that were more affiliative rather than agonistic.

One prediction of socioecological models that was fulfilled was that relatively higher rates of agonistic interaction in the commercial ranch may have induced higher rates of affiliative behaviors such as grooming. Of all the affiliative interactions, grooming appears to play a central role in influencing behavior among female primates because it has been reported to facilitate services such as coalitions, food

sharing, cooperative hunting, or collective territorial defense (Langergraber 2012; Gilby 2013; Aureli et al. 2012). Some of the best studied examples of the effective role of grooming on influencing cooperative behaviors or tolerance have been conducted in captivity or manipulated studies in the wild (de Waal 1997; Hemelrijk 1994; Mitani and Watts 1999; Mitani 2006). For example, de Waal (1997) found that food sharing among captive chimpanzees (*Pan troglodytes*) was more likely to occur between dyads that had groomed within 90 mins.

Field studies have found a strong, positive correlation in dyadic rates of exchange within different types of affiliations, which include grooming and meat sharing (Mitani and Watts 1999; Mitani 2006). Hemelrijk (1994) artificially manipulated grooming rates, then provoked within-group conflict and found that females were more likely to collude with individuals who had been their previous grooming partners.   In my study, the relatively longer grooming bouts observed when baboons were on the commercial ranch may have been promoted by the greater foraging competition in the areas, since food-related aggressive interactions occurred at higher rates on this land use system. Thus, it is possible that on the commercial ranch lower ranking females performed longer grooming bouts in exchange for social tolerance that enhances feeding on the more available but more contestable food resources there.

The influence of predation risk on ranging behavior

In this study, predation risk was judged to be higher in the commercial ranch than the pastoralist (see Table 2.3, Chapter 2 for more details). Baboon vigilance

behavior was correspondingly higher in the commercial ranch relative to the pastoralist land. In accordance to the predation hypothesis, the baboons should also have maintained more cohesion, i.e., decreased inter individual distances when on the commercial ranch. In this study, however, inter-individual distances were larger when baboons ranged on the commercial ranch, despite the higher predation risk in this area. These results suggest that individual cohesion strategies were more strongly affected by food distribution than predation risk.

The relatively higher incidences of humans and livestock disturbing baboons' foraging on the pastoralist land (Moinde, unpublished data) also might have contributed to greater time feeding on the commercial ranch. Despite these potentially disruptive negative effects, baboons continued going to use the same trees located on the pastoralist land and, in fact, stopped using the sleep trees in the commercial ranch. It is possible that baboons in this study site sought out sleep trees in human modified habitats because the presence of humans may lower predation risk. Fuentes (2006), for example, hypothesized that primate groups under predation pressure could move into higher human density habitats in order to exploit this context. Future studies aimed at evaluating the role of predation risk on primate behavior need to include the effect of human presence on predation pressure, as argued by Fuentes (2006).

Implications of applying theory into primate management and conservation strategies

A better understanding of how baboons respond to varying levels of anthropogenic impact on the landscape increases our understanding of primate behavioral adaptations to human-modified habitats. This study demonstrates baboon behavioral flexibility to ecological changes induced by humans. This study also has some implications for the management and conservation of primates in human occupied landscapes. Within the current anthropocene era, humans are modifying primate habitats at an accelerating rate throughout the world (Myers 1987; Estrada 2006). Some species, including some nonhuman primates, exploit human modified habitats successfully (Richard et al. 1989; Estrada 2006), whilst others suffer decline and extinction (Myers 1987; Gillespie et al. 1999; Yongzu et al. 1989; Boinski 1994; Mugambi et al. 2008). Within the framework of CITES Appendix II, the olive baboons are not a threatened or endangered species (Palombit 2013). The olive baboon (*sensu lato*) is the most widely distributed of all extant *Papio* spp. and an apparently expanding distribution over time suggests a possible competitive edge over other baboon morphs (Palombit in 2013). One possible reason for this may be the superior adaptability of the olive baboon to human modified environments as the findings from this study suggests.

Conducting primatological studies in a putatively "natural" environment without considering the human dimension implies irrelevance of humans in influencing contemporary primate socioecology. This view may not only be ecologically inappropriate in certain cases, but it also overlooks the growing

archaeological evidence that primates and humans have shared a long evolutionary history. A better understanding of how wildlife species adapt to human-modified habitats, is critically important for implementing conservation and management strategies. The evidence of feeding and social behavioral flexibility of the olive baboon in response to contrasting human modified habitats clarifies why members of the genera *Macaca* and *Chlorocebus* remain exceptionally resilient to anthropogenic disturbance even to the point of thriving in such circumstances (Richard et al. 1989; Hill 2005; Lee and Preston 2005; Fuentes 2006). The evidence from this study indicates that anthropogenic modifications of habitats, through different land use systems are indicative of the contemporary (in) direct role humans have in influencing baboon feeding and social behaviors in Laikipia. Thus, theoretical approach taken in this study contributes to the practicalities of solving issues for the continued coexistence between humans, baboons and other species.

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Table 4:1a: Names and list of adult females in TDM group with incidences of disappearance and a fission episode

#	Code ID	Disappearances and departures to other groups	Returns
1	AT	Disappeared in Aug/Sept'10[1]	
2	BE	Disappeared in Sept'10[1]	
3	CA		
4	CI	Departed with SUB group in Feb'10[3]	
5	DI	Departed with SUB group in Feb'10[3]	
6	DO	Disappeared in Aug/Sept'10[1]	
7	EU		
8	EV		
9	FL		
10	HZ	Departed with SUB group in Feb'10[3]	
11	JU	Departed with SUB group in Feb'10[3]	
12	KR		
13	KT	Disappeared in Aug/Sept'10[1]	
14	LO		
15	LU	Disappeared in Feb'10[2]	
16	MA	Departed with SUB group in Feb'10[3]	Moved from TDM to SUB in Sept'10
17	NO		
18	OV		
19	PA	Departed with SUB group in Feb'10[3]	Moved from SUB to TDM in Sept'10
20	RC		
21	SA		
22	SL	Disappeared in May'10[2]	

23	TL	Disappeared in Aug/Sept'10[1]	
24	UL	Disappeared in Sept'10[1]	
25	VL	Departed with SUB group in Feb'10[3]	
26	VN		
27	VY		
28	WH	Disappeared in Sept'10[1]	
29	YO		
30	ZA	Disappeared in Aug/Sept'10[1]	

[1] Disappeared during a periods of multiple predation events
[2] Reason for disappearance unknown
[3] Left group due to a fission event to form a smaller subgroup (SUB)

Table 4.1b: Rank changes during the study period using David's score (DS)

Code Name	Oct-09		NCY- Feb 20		from 27th May 2010		from 1 Jun	
	rank	DS	rank	DS	rank	DS	rank	DS
KT	1	1.00	1	1.00	1	1.00	1	1.00
VY	2	0.97	2	0.95	2	0.95	2	0.96
LO	3	0.93	3	0.91	3	0.90	3	0.91
OV	4	0.90	4	0.86	4	0.86	4	0.87
YO	5	0.86	5	0.82	5	0.81	5	0.83
MA	6	0.83	6	0.77	6	0.76	6	0.78
SL	7	0.79	7	0.73	7	0.71	7	0.74
RC	8	0.76	8	0.68	8	0.67	8	0.70
AT	9	0.72	9	0.64	9	0.62	9	0.65
FL	10	0.69	10	0.59	10	0.57	10	0.61
EV	11	0.66	11	0.55	11	0.52	11	0.57
EU	12	0.62	12	0.50	12	0.48	12	0.52
HZ	13	0.59	13	0.45	13	0.43	13	0.48
NO	14	0.55	14	0.41	14	0.38	14	0.43
VL	15	0.52	15	0.36	15	0.33	15	0.39
CI	16	0.48	16	0.32	16	0.29	16	0.35
ZA	17	0.45	17	0.27	17	0.24	17	0.30
JU	18	0.41	18	0.23	18	0.19	18	0.26
KR	19	0.38	19	0.18	19	0.14	19	0.22
LU	20	0.34	20	0.14	20	0.10	20	0.17
BE	21	0.31	21	0.09	21	0.05	21	0.13
TL	22	0.28	22	0.05	22	0.00	22	0.09
PA	23	0.24	23	0.00			23	0.04

VN	24	0.21				0	0
UL	25	0.17					
DI	26	0.14					
SA	27	0.10					
CA	28	0.07					
WH	29	0.03					
DO	30	0.00					

Table 4.2: Names and list of adult females in the Kati Kati (KAT) group with one incidence of disappearance

#	Code ID	Disappearances
1	CB	
2	GW	
3	IY	
4	LT	
5	NV	
6	OY	
7	RG	Disappeared in Aug[1]
8	TN	

[1]Disappeared during the period of multiple predations

Table 4.3: Baboon Behavior and Activity Definitions

Behaviors and activities listed below were used to test the proposed hypotheses. (Modified from Palombit, unpublished data.)

Social behaviors and their descriptions
1. Agonistic Behaviors
High Intensity Agonistic
Chase: identity and role recorded.
Hit: single event
Bite: single event
Grapple fight: includes hitting, biting, rolling on ground, etc.
Low Intensity Agonistic
Supplant: Individual comes within 2m of another who leaves 2m range.
Eye threat: Flashing eye lids
Ground slap Demonstrated within the context of a threat and other agonistic behaviors below
Lunge: Rapid movement towards another individual, no physical contact
Fear grimace: Lips pulled back exposing clenched teeth
Threat: Open-mouth threat.
Long-range avoid: Moving away from the approach of an individual from more than 2 meters away (i.e., without close proximity being attained, which would be a supplant) within proximity (5m), but not to beyond 2m.
Cringe Submission posture which entails bending of knees mostly to avoid contact
Tail up Similar to cringe with tail raised up
Threat grunt A grunt that is made within an agonistic context
Fear bark Emitted along with submissive behaviors e.g., Fear grimace, tail up, cringe etc
Scream Sharp vocalizing emitted during agonistic interaction
2. Affiliative Behaviors
Embrace: One individual puts one or two arms around body of another

Grooming:	Manipulating, scratching, or picking through the hair of another individual, or having one's hair groomed by another individual
Lipsmack:	Rapid movement of the lips
Present:	Movement of body part towards and in front of another individual's field of vision. Also includes presenting the rump and presenting for grooming.
Touch:	Includes muzzle-muzzle, huddle, touch rump (but not genitalia), and touch to other part of body/head.
Grunt:	In the context of social interaction

3. Coalitionary Behaviors:

Recruit: Involves dyadic interaction between two or more individuals and involves soliciting for help to defend or attack others.

Joint Attack and Joint defense: Involves dyadic interaction between two or more individuals and involves aiding in attacking, defending or recruiting others.

4. Proximity Behaviors

Nearest Neighbors distances **(NN)***:*

Every individual within 6 meters. If none is present, any adult beyond 6   meters (at every 5 meter intervals i.e., 5, 10,15,20,25 etc..).

5. Vigilant behavior:

Scan: Scanning which sometimes also involves standing up on hind legs to optimize on better visual inspections of the surroundings beyond the immediate vicinity.

6. Activity

Feed:	Reaching for food, handling food, placing food in mouth, chewing.
Rest:	Sitting, or lying motionless and not obviously involved in any social activity.
Travel:	Movement – walking running for not less than 10 seconds.

Table 4.4: Categorize of analyzed behavioral interactions

Behavior	Description	GLMM models #	Analyzed behavioral categories*
Group cohesion	*Proximity*	1	Near neighbor distances
Dyadic	*Low intensity agonism*	2	Displacements
		3	Food displacement
		4	All displacements
		5	Low Intensity aggression
	High intensity agonism	6	High Intensity aggression
	Overall agonism	7	Overall aggressive interactions
	Affiliative	8	Overall friendly or non-aggressive
		9	Grooming
Triadic	*Coalitionary*	-	Recruits and joint aggression and defense
Vigilance	*Predators risk*	10	Scanning for predators

*Analyzed behavioral categories are described in more details in Table 4.2

Table 4.5a: Summary of GLMMs analyzing feeding behavior

	Feeding behavior	Fixed effect	Estimate± SE	t value	P value	As predicted?
Overall Food Resources	**Proportion time spent feeding**	Land use (Pastoralist)	-0.50 ± 0.06	-8.57	0.001	**Prediction 1**
		Rank	-0.12 ± 0.12	-1.00	0.317	Yes
		Month Oct '09	0.20 ± 0.20	1.00	0.317	
		Nov '09	0.04 ± 0.12	0.35	0.725	
		Dec '09	-1.3 ± 0.35	-3.77	0.001	
		Jan '10	-0.21 ± 0.10	-1.97	0.048	
		Feb '10	-0.40 ± 0.12	-3.43	0.001	
		Mar '10	0.02 ± 0.20	0.15	0.879	
		Apr '10	-0.10 ± 0.66	1.00	0.317	
		May '10	-0.26 ± 0.12	-2.09	0.037	
		June '10	-0.29 ± 0.12	-2.37	0.018	
		Jul '10	00.34 ± 0.20	-1.71	0.087	
	Feeding duration (s) (Bouts)	Land use (Pastoralist) Rank	-0.34 ± 0.10	-3.32	0.001	**Prediction 2**
		Month Oct '09	-0.18 ± 0.19	0.95	0.345	Yes
		Nov '09	0.9 ± 0.37	0.26	0.797	
		Dec '09	-0.12 ± 0.22	-058	0.561	
		Jan '10	-1.35 ±0.81	-1.66	0.098	
		Feb '10	0.04 ± 0.19	0.19	0.851	
		Mar '10	-0.32 ± 0.21	-1.50	0.134	
		Apr '10	0.56 ± 0.19	2.92	0.003	
		May '10	-2.04 ± 0.19	-0.95	0.344	
		June '10	-0.11 ± 0.22	-0.51	0.612	
		Jul '10	-0.21 ± 0.23	-0.90	0.367	
			-0.60 ± 0.19	-1.35	0.177	
	Number of feeding bouts	Land use (Pastoralist)	0.32 ± 0.14	2.31	0.021	**Prediction 3**
		Rank	0.13 ± 0.20	0.67	0.505	Yes
		Month Oct '09	-0.26 ± 0.48	-0.55	0.584	
		Nov '09	0.03 ± 0.26	0.12	0.905	
		Dec '09	1.82 ± 0.44	4.09	0.0001	
		Jan '10	-0.28 ± 0.24	1.54	0.122	
		Feb '10	0.36 ± 0.24	1.48	0.139	
		Mar '10	-0.53 ± 0.26	-2.04	0.041	
		Apr '10	2.59 ± 0.69	3.75	0.001	

	May '10	0.21 $\pm$ 0.26	0.83	0.407	
	June '10	0.36 $\pm$ 0.05	1.37	0.171	
	Jul '10	0.88 $\pm$ 0.38	2.31	0.021	
Feeding rates (min^{-1})	Land use (Pastoralist)	-0.74 $\pm$ 0.24	-3.05	0.024	**Prediction 4**
	Rank	-0.02 $\pm$ 0.04	-0.50	0.616	Yes
	Month Oct '09	2.23 $\pm$ 0.08	-2.88	0.004	
	Nov '09	0.06 $\pm$ 0.04	1.40	0.161	
	Dec '09	0.38 $\pm$ 0.13	2.83	0.005	
	Jan '10	0.06 $\pm$ 1.54	1.54	0.125	
	Feb '10	0.06 $\pm$ 0.04	1.39	0.164	
	Mar '10	-0.01 $\pm$ 0.04	-0.24	0.809	
	Apr '10	0.59 $\pm$ 0.30	-0.50	0.051	
	May '10	0.04 $\pm$ 0.04	0.96	0.338	
	June '10	-0.03 $\pm$ 0.05	-0.65	0.518	
	Jul '10	0.08 $\pm$ 0.09	1.00	0.334	

Table 4.5b: Descriptive for feeding behavior between the land use systems

Feeding behavior	Land use systems	N	Mean ± SD
Proportion of time spent feeding	Commercial	444	0.3 ± 0.2
	Pastoralist	1552	0.2 ± 0.2
Duration of bouts	Commercial	382	32.1 ± 61.6
	Pastoralist	1081	23.0 ± 47.3
Number of feeding bouts	Commercial	444	8.3 ± 6.5
	Pastoralist	1552	7.1 ± 7.4
Number of bites (min^{-1})	Commercial	382	3.4 ± 5.7
	Pastoralist	1080	2.6 ± 4.6

Table 4.6a: Summary of GLMMs analyzing social behaviors and vigilance between the commercial and the pastoralist land use systems

Behavior	Fixed effects	Estimate and SE	t value	P value	As predicted?
NN (m)	Land use (Pastoralist)	-0.08 ± 0.03	-2.98	0.003	**Prediction 5**
	Rank	-0.02 ± 0.02	-1.04	0.300	**No**
	Month Oct '09	0.08 ± 0.10	0.84	0.399	
	Nov '09	0.08 ± 0.08	0.98	0.328	
	Dec '09	0.05 ± 0.05	0.85	0.394	
	Jan '10	0.07 ± 0.05	1.56	0.120	
	Feb '10	0.05 ± 0.05	1.02	0.306	
	Mar '10	-0.03 ± 0.05	-0.50	0.614	
	Apr '10	-0.18 ± 0.10	0.10	0.653	
	May '10	-0.11 ± 0.05	-2.02	0.043	
	June '10	-0.15 ± 0.06	-2.72	0.007	
	Jul '10	-0.35 ± 0.09	-3.90	0.0001	
Displacements	Land use (Pastoralist)	0.18 ± 0.22	0.82	0.411	**Prediction 6a**
	Rank	0.07 ± 0.08	0.86	0.389	**No**
	Month Oct '09	0.47 ± 0.57	0.82	0.410	
	Nov '09	-0.35 ± 0.67	-0.52	0.604	
	Dec '09	0.38 ± 0.36	1.05	0.293	
	Jan '10	-0.34 ± 0.35	-0.98	0.328	
	Feb '10	-0.53 ± 0.38	-1.40	0.162	
	Mar '10	-0.24 ± 0.38	-0.63	0.530	
	Apr '10	-1.34 ± 1.11	-1.21	0.228	
	May '10	-0.12 ± 0.38	-0.32	0.752	
	June '10	-0.21 ± 0.39	-0.54	0.590	
	Jul '10	-0.99 ± 0.80	-1.23	0.219	
Food Displacement	Land use (Pastoralist)	-0.82 ± 0.3	-2.48	0.013	**Prediction 6b**
	Rank	-0.11 ± 0.2	-0.50	0.615	**No**
	Month Oct '09	28.40 ± 1.21	0.00	1.000	
	Nov '09	28.04 ± 0.88	0.00	1.000	
	Dec '09	26.84 ± 0.21	0.00	1.000	
	Jan '10	25.86 ± 0.76	0.00	1.000	

	Feb '10	0.07 ± 0.61	0.00	1.000	
	Mar '10	27.84 ± 0.88	0.00	1.000	
	Apr '10	0.20 ± 0.67	0.00	1.000	
	May '10	26.71 ± 0.85	0.00	1.000	
	June '10	27.97 ± 0.90	0.00	1.000	
	Jul '10	29.26 ± 0.25	0.00	1.000	
All Displacement	Land use (Pastoralist)	0.02 ± 0.20	0.09	0.931	**Prediction 6c**
	Rank	0.03 ± 0.07	0.35	0.729	No
	Month Oct '09	0.79 ± 0.50	1.57	0.116	
	Nov '09	0.14 ± 0.55	0.26	0.793	
	Dec '09	0.46 ± 0.36	1.30	0.193	
	Jan '10	-0.28 ± 0.34	-0.82	0.415	
	Feb '10	-0.53 ± 0.38	-1.38	0.167	
	Mar '10	0.06 ± 0.35	0.16	0.873	
	Apr '10	-1.24 ± 1.10	-1.13	0.258	
	May '10	0.004 ± 0.37	0.01	0.990	
	June '10	0.19 ± 0.36	0.52	0.600	
	Jul '10	0.57 ± 0.45	1.25	0.210	
All Low Intensity agonistic	Land use (Pastoralist)	-0.03 ± 0.16	-0.21	0.835	**Prediction 6d**
	Rank	0.01 ± 0.08	0.12	0.902	No
	Month Oct '09	0.32 ± 0.49	0.64	0.522	
	Nov '09	-0.19 ± 0.49	-0.39	0.696	
	Dec '09	0.29 ± 0.29	1.02	0.310	
	Jan '10	-0.33 ± 0.27	-1.23	0.219	
	Feb '10	-0.39 ± 0.29	-1.36	0.174	
	Mar '10	-0.13 ± 0.28	-0.46	0.649	
	Apr '10	-2.00 ± 1.17	-1.70	0.089	
	May '10	-0.38 ± 0.31	-1.20	0.232	
	June '10	-0.04 ± 0.29	-0.14	0.887	
	Jul '10	0.01 ± 0.41	0.03	0.978	
All high Intensity agonistic	Land use (Pastoralist)	0.15 ± 0.40	0.41	0.682	**Prediction 6e**
	Rank	-0.27 ± 0.50	-0.54	0.587	No
	Month Oct '09	-0.42 ± 0.10	-0.14	0.708	
	Nov '09	0.83 ± 0.70	0.16	0.248	

	Dec '09	-0.09 ± 0.70	-0.14	0.888	
	Jan '10	0.13 ± 0.50	0.24	0.813	
	Feb '10	-0.72 ± 0.70	-1.09	0.277	
	Mar '10	0.19 + 0.60	0.33	0.740	
	Apr '10	-25.65 + 0.59	-0.01	1.000	
	May '10	-0.59 ± 0.70	-0.83	0.408	
	June '10	-0.61 ± 0.70	-0.86	0.392	
	Jul '10	-25.64 ± 0.85	0.00	1.000	
All Agonistic	Land use (Pastoralist)	-0.01 ± 0.16	-0.06	0.954	**Prediction 6f**
	Rank	-0.003 ± 0.09	-0.04	0.971	**No**
	Month Oct '09	0.32 ± 0.49	0.66	0.512	
	Nov '09	0.02 ± 0.44	0.05	0.958	
	Dec '09	0.23 ± 0.28	0.87	0.386	
	Jan '10	-0.26 ± 0.26	-1.00	0.319	
	Feb '10	-0.43 ± 0.29	-0.49	0.135	
	Mar '10	-0.08 ± 0.28	-0.29	0.781	
	Apr '10	-2.14 ± 1.24	-1.72	0.085	
	May '10	-0.40 ± 0.31	-1.28	0.201	
	June '10	-0.09 ± 0.29	-0.34	0.733	
	Jul '10	-0.13 ± 0.43	-0.30	0.767	
All Affiliative	Land use (Pastoralist)	0.29 ± 0.15	1.97	**0.049**	**Prediction 7**
	Rank	-0.06 ± 0.06	-0.24	0.807	**No**
	Month Oct '09	-0.12 ± 0.55	-0.02	0.821	
	Nov '09	0.728 ± 0.33	2.21	0.027	
	Dec '09	0.11 ± 0.28	0.39	0.699	
	Jan '10	0.089 ± 0.24	0.38	0.707	
	Feb '10	-0.29 ± 0.26	-1.10	0.270	
	Mar '10	0.14 ± 0.25	0.56	0.578	
	Apr '10	0.16 ± 0.42	0.39	0.697	
	May '10	-0.02 ± 0.27	-0.09	0.930	
	June '10	0.341 ± 0.25	1.37	0.172	
	Jul '10	0.11 ± 0.37	0.28	0.776	

Grooming Duration	Land use (Pastoralist)	-0.74 $\pm$ 0.27	-2.75	0.006	**Prediction 8**
	Rank	1.05 $\pm$ 0.49	2.2917	0.035	**Yes**
	Month Oct '09	-1.10 $\pm$ 1.70	-0.65	0.518	
	Nov '09	-0.09 $\pm$ 0.52	-0.17	0.863	
	Dec '09	-0.36 $\pm$ 0.48	-0.76	0.045	
	Jan '10	-0.28 $\pm$ 0.46	-0.62	0.539	
	Feb '10	-0.42 $\pm$ 0.50	-0.85	0.396	
	Mar '10	-0.08 $\pm$ 0.49	-0.17	0.869	
	Apr '10	0.24 $\pm$ 0.64	0.37	0.712	
	May '10	-0.69 $\pm$ 0.58	-1.18	0.239	
	June '10	-0.43 $\pm$ 0.55	-0.78	0.434	
	Jul '10	0.01 $\pm$ 0.71	0.01	0.992	
All coalitionary	Land use (Pastoralist) Rank Month	-	-	-	**Prediction 9** -
Vigilance	Land use (Pastoralist)	-1.8 $+$ 0.4	-5.19	0.0001	
	Rank	-1.8 $\pm$ 0.4	-5.14	0.001	**Prediction 10**
	Month Oct '09	-0.37 $\pm$ 0.4	-1.03	0.300	**Yes**
	Nov '09	27.09 $+$ 0.51	0.001	1.000	
	Dec '09	-0.36 $\pm$ 0.48	0.76	0.045	
	Jan '10	25.36 $+$ 0.51	0.0001	0.100	
	Feb '10	27.62 $\pm$ 224.12	0.0001	1.000	
	Mar '10	0.16 $\pm$ 3202.0	0.0001	1.000	
	Apr '10	0.38 $\pm$ 6091.5	0.0001	1.000	
	May '10	0.03 $\pm$ 3290.9	0.0001	1.000	
	June '10	28.82 $\pm$ 2411.1	0.0001	1.000	
	Jul '10	0.60 $\pm$ 5200.0	0.0001	1.000	

- based from one incident of coalitionary interactions that was observed in the pastoralist land

NN – Neatest neighbor

Table 4.6b: Summary of means for social interactions and vigilance between the commercial (N = 450) and the pastoralist (N = 1596) land use systems

Model #	Behaviors	Land use	Mean $\pm$ SD
1	Near neighbor distances (m)	Commercial	20.32 $\pm$ 9.24
		Pastoralist	18.51 $\pm$ 9.61
2	Displacement	Commercial	0.06 $\pm$ 0.28
		Pastoralist	0.01 $\pm$ 0.30
3	Food displacement	Commercial	0.02 $\pm$ 0.18
		Pastoralist	0.01 $\pm$ 0.12
4	All displacements	Commercial	0.08 $\pm$ 0.32
		Pastoralist	0.09 $\pm$ 0.32
5	Low Intensity aggression	Commercial	0.15 $\pm$ 0.48
		Pastoralist	0.14 $\pm$ 0.46
6	High Intensity aggression	Commercial	0.02 $\pm$ 0.16
		Pastoralist	0.02 $\pm$ 0.16
7	Overall aggressive interactions	Commercial	0.17 + 0.55
		Pastoralist	0.16 + 0.52

8	Overall affiliative interactions	Commercial	0.37 ± 1.03
		Pastoralists	0.48 ± 1.26
9	Grooming	Commercial	0.30 ± 1.66
		Pastoralist	0.25 ± 1.20
10	Vigilance	Commercial	$0.02 + 0.27$
		Pastoralists	0.004 ± 0.07

Appendix 4.1: Summarized comparison of overall vegetation abundance and availability of baboon food resources between the commercial ranch and the pastoralist land (Modified from Moinde, Chapter 3)

Vegetation attribute	Food category	Plant productivity	Relative abundance	
			Commercial ranch	*Pastoralist land*
Woody plants	*Abundance*	Overall galls	-	+
		Overall fruit/pods	=	
		Overall flowers	=	
		Overall buds	-	+
		Overall gum	+	-
Herbaceous plants		Overall grass	+	-
		Overall forbs	+	-
Woody plants	*Availability*	Black galls	=	
		Green galls	-	+
		dried seed pods[#]	-	+
		Ripe fruit [##]	+	-
		Green flowers	-	+
		Green buds	-	+
		Gum	+	-
Herbaceous plants		Green grass	-	+
		Green forbs	=	
Woody plants	*Diversity*	All woody plants	=	
Herbaceous plants		Grass	=	
		Forbs	+	-

+ Symbolizes higher abundance, availability or diversity relative to the other land use systems
- Symbolizes lower abundance, availability or diversity relative to the other land use systems
= Symbolizes equal abundance, availability or diversity between both land use systems.
[#] Since *Acacia* seeds found in pods can also be consumed dry by the baboons and dried fruits are not, only dried seeds were indicated instead dried fruit/pods as it has previously been indicated.
[##] Since seed pods are sampled as either green or dried with no intermediary condition (yellow) like other food condition, only ripe fruit from woody plants

CHAPTER FIVE

THE INFLUENCE OF LAND USE PRACTICES ON PEOPLE'S VALUES AND INTERACTIONS TOWARDS BABOONS (*Papio hamadryas anubis*) IN LAIKIPIA DISTRICT, KENYA

5.1 INTRODUCTION

The global human population has more than doubled over the last 50 years from two billion in the 1950s to just over seven billion to date (U.S. Census Bureau 2013). By the 1990s it appeared that there was a strong negative correlation between human and mammalian densities due to increased hunting, pastoralism, and habitat modifications (reviewed in Happold 1995). A noted global trend over the last two decades, however, is that wildlife populations are increasing, typically in response to implemented state managed conservation measures (Fall and Jackson, 1998; Linnell et al 2001). In fact, Linnell et al. (2001) argue that the existence of effective wildlife management structures is currently more important than human density in influencing wildlife densities globally. Many contemporary rural and urban environments, as a result, are inhabited by a larger population of wildlife, compared to thirty years ago (Messmer 2000). Consequently, this trend has led to increased human-wildlife interactions, such as rising incidences of crop raids and attacks on livestock and even people (Woodroffe et al. 2005).

In particular, the relationship between humans and nonhuman primates has taken on a special significance as expanding human populations rapidly deplete

294

natural resources and modify habitats at an accelerating rate throughout the world (Myers 1987; Estrada 2006). Fuentes (2010) argues that as humans, we are literal and figurative kin to the non human primates, which necessitates employing an inclusive view that places human and nonhuman primates in an integrated ecological level of inquiry. He further argues that understanding human-nonhuman primate interactions within mutual ecologies and how they co-produce and co-construct each other's niches at the behavioral, ecological, and physiological level is important for understanding the long history of conflict and coexistence between these taxa. To date, few studies have attempted to incorporate specific aspects of cultural conceptualizations of nature and nonhuman primates into explanations of either human or nonhuman primate behavioral and ecological patterns. Furthermore, previous studies have largely dwelt on the conflict between humans and nonhuman primates. Fewer studies have incorporated the socioecological aspect of the human-nonhuman primate interface to include how people's beliefs, values, and even customary use of primates influence their interactions with these animals.

Ethnoprimatology[6] intergratively examines this interface between humans and primates. The methodological and conceptual approach of ethnoprimatology integrates human social (i.e. mythical, economic, and historical) ecological and behavioral characteristics within a multispecies system. More specifically, rather than focusing solely on the behavior and ecology of nonhuman primates, as in traditional

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[6] Ethnoprimatology is a relatively new and growing interdisciplinary approach that merges primatology with cultural anthropology. Its main mode of inquiry is viewing humans and other primates (nonhuman primates) as co-participants in active, inclusive ecosystems that are made of interacting niches (Sponsel 1997; Riley 2006; Fuentes 2006; Fuentes 2010).

primatology, or on the symbolic meanings and uses of primates, as in socio-cultural anthropology, ethnoprimatology attempts to merge these two perspectives (Fuentes and Hocking 2010).

Human- nonhuman primate interactions can produce different outcomes. Some species suffer decline and extinction as a consequence of human interaction and modification of their shared ecologies (Myers 1987; Gillespie et al. 1999; Yongzu et al. 1989; Boinski 1994; Geissmann, 2008). Other taxa are integrated into the local human cultural-ecological context whose constituent beliefs and practices allow them to be beneficially exploited in human modified habitats (Richard et al. 1989; Riley 2006; Estrada 2006; Fuentes et al. 2005; Fuentes 2010). For example, species from the genera *Papio*, *Macaca* and *Chlorocebus* remain exceptionally resilient to anthropogenic disturbance and appear to have superior adaptability to human modified environments (Richard et al. 1989; Hill 2005; Lee and Preston 2005; Fuentes 2006). Primates of these genera are also the most frequently cited crop raiders, and this is largely attributed to their highly social nature, cooperative behavior, manual dexterity, extreme agility, and dietary and behavioral flexibility (Hill 2005).

Perceptions of and values expressed towards nonhuman primates by people also vary considerably within and across cultures. For example, in some cultures, primates are traditionally viewed as guardians of human settlements, spirits of ancestors or kin (Lee and Priston 2005). Conversely, certain East African pastoralist communities ritually sacrifice cattle to protect sorghum and maize field from

nonhuman primates and birds (Fukui 1996). A central aim of this study is to examine how human- nonhuman primate interactions are influenced by the values people have towards local primates, and what influences those values and attitudes. Studies have shown that people's strong attitudes towards nonhuman primates, whether negative or positive, are intensified by direct exposure to primate crop damage (Reviewed in Patterson and Wallis 2005). Hill (2005) maintains that human attitudes towards nonhuman primates are a function of past contact between them, while other studies demonstrate that both direct and indirect interactions with wildlife affect cognitions (e.g. beliefs) and emotions (e.g. worries) towards wildlife (Saberwal et al., 1994; Wang et al., 2006).

Beliefs are broadly defined as associations that people establish between the attitude object (in this case baboons) and its various attributes (Eagly and Chaiken 1993; 1998). Consequently, beliefs mediate the relationships between broad, abstract values (e.g. honesty) and human behavior (Fulton et al., 1996). Thus, values are basically "abstractions from which attitudes and behaviors are manufactured" (Homer and Kahle 1988:638). Certain beliefs that mediate the value of a particular species of wildlife are, therefore, based on both beneficial and undesirable attributes associated with them. These types of values towards wildlife also stem from cultural, religious, economic (e.g. tourism), ecological, and existential attributes (Kellert, 1985). Negative values stem from undesirable attitudes, such as nuisance behavior (e.g., garbage exploitation) and resource competition or conflict (e.g., crop raiding, livestock predation) (Sharma, 1990; Kissui, 2008).

These beliefs-value concepts form the framework of the Wildlife Value Orientation (WVO) theories (Fulton et al. 1996; Ingelhart and Baker 2000; Manfredo and Dayer 2004).

These are ideologically shaped beliefs that orient and provide personal meaning to one's more basic values in relation to wildlife. Commonly held values give rise to ideologies. Ideology is defined as consensually held beliefs that enable people who share them to understand meaning, to know who they are, and to relate to one another (Manfredo et al. 2009; Pratto 1999). An ideology, therefore, is a concept used in cultural groups to understand societal shifts at a broad or societal level (Manfredo et al. 2009). It is mainly described through dimensions such as communal sharing versus authority ranking (Fiske 1992), or individualism versus collectivism (Triandis 1995).

Wildlife Value Orientation approaches are based on the argument that human interactions with wildlife derive from the basic values people have towards nature (Fulton et al. 1996; Ingelhart and Baker 2000; Manfredo and Dayer 2004). These models have received extensive attention and empirical support in the social sciences as they offer a conceptual approach to integrate the link between human attitudes and behavior towards wildlife. Students of Wildlife Value Orientation have identified different "cultural value orientations" that hypothetically influence those interactions: 'Materialism', 'Symbolism', 'Mutualism', 'Environmentalism' and others (see Dayer et al. 2007; Teel et al. 2007). 'Materialism' refers to a utilitarian view of wildlife: wildlife exists to fulfill human needs for subsistence and economic well-being, as

well as higher order needs (such as recreation), and/or humans enjoying natural dominance over and control of wildlife (Tanakanjan and Saranet 2007).

'Symbolism' refers to a view of wildlife and the environment as created and controlled by a higher power(s). It hereby explains the way the natural world works through a spiritual or religious viewpoint (as opposed to a scientific perspective) (Dayer et al. 2007; Tanakanjan and Saranet 2007). 'Mutualism' is defined as an orientation towards wildlife as meriting relationships of trust with humans, having rights like humans, and being part of an "extended family" (Dayer et al. 2007). 'Environmentalism' is a general cultural concern about protecting the environment, which can be extended to conserving wildlife (Dayer et al. 2007). This orientation may also be expressed through cooperative organizations that coordinate wildlife management and conservation programs within communities.

Socio-demographic factors, such as economic status, religion, education and, gender influence the relationships people maintain with wildlife (Manfredo et al 2003, Teel et al. 2009). For example, Manfredo et al. (2003) found in various regions of the United States, people with more traditional values believed that wildlife should be managed and utilized to benefit people ('Materialists'). This value orientation is strongly and inversely related to people's level of income, urbanization, and education. 'Post materialist' values tend to be found in people who are more educated, self-expressive, and financially affluent (Manfredo et al. 2003; Inglehart and Baker 2000). Consideration of the effects of socio-demographic characteristics can enrich our understanding of covariation in social attributes within communities as

well as the interactions of humans and wildlife. While previous WVO studies

conducted in Europe, Asia, China and the Unites States have demonstrated how value

orientations affect normative beliefs regarding acceptable management practices

(Wittman and Vaske 1998; Zinn et al. 1998). No WVO studies, however, have

directly compared the association between different land use practices and human-

wildlife values and interactions.

The premise of this study is to apply the WVO models to examine directly the

influence of land use practices on people's values towards wildlife in general and

towards baboons in particular. The values and ideologies that people have about

nature influence the patterns of human-wildlife co-existence (Dayer et al. 2007).

From this perspective, I argue that these ideologies extend to land use systems. Land

use practices are mode(s) of subsistence or economy that involve land (or nature) to

sustain human lifestyles. Incorporating land use as a factor that influences people's

interactions with wildlife also has important conservation management implications.

For example, many studies have illustrated how commercialization of wildlife can

displace existing cultural values and enhance or reduce tolerance and protection of

wildlife (King and Stewart 1996; Newmark and Hough 2000; Infield 2001; Gadd

2005).

Few studies, however, have successfully demonstrated how traditional

knowledge incorporated with certain land use practices, such as ecotourism, can

change human perceptions towards wildlife (Kuryan 2002; Igoe 2004). Additionally,

ecotourism practitioners tend to be largely biased towards charismatic species, such

as elephants and the great apes, which attract tourists and revenue (Walpole and

Leader-Williams 2002; Adams and Infield 2003; Gadd 2005). Thus, charismatic

species are awarded more value as a result of the (in)direct economic benefits people

derive through tourism. In contrast, people's bias against baboons has been

exceptionally prominent around agricultural land use systems, where baboons are

largely perceived as "pests" due to the quantifiable costs of crop raiding (Kingdon,

1974; Hill 1997; 2000; Naughton-Treves et al. 1998; Obunde et al., 2005).

Many studies have demonstrated the baboon's affinity for crop raiding as they

are most often ranked highest when it comes to crop raiding impact relative to other

wildlife (Kingdon, 1974; Naughton-Treves 1997; 1998; Muoria 1999; Hill 2005;

Wambugu 2006). Crop raiding has been a major problem in Laikipia District, Kenya,

and the olive baboon (*Papio hamadryas anubis*) has been ranked second after the

elephant as the most notorious raider in locales where agriculture is practiced

(Graham 2006). At the same time 'baboon tourism' involves allowing tourists to pay

and observe a habituated group of baboons at close range. It has been practiced since

the mid 2000s in a couple of pastoralist ranches that conduct ecotourism in Laikipia.

This suggests that the diverse land use (i.e., pastoralism, commercial ranching,

ecotourism etc…) practices in Laikipia could be influencing how people perceive,

and therefore interact with, wildlife in general, and baboons in particular.

Land use practices, such as pastoralism, commercial ranching, farming and,

ecotourism, are modes of subsistence or economy within the various land use systems

within Laikipia District. Gadd (2005) found that fundamental differences in attitudes

towards elephants were attributable to primary land use in Laikipia. In particular, people practicing agriculture were less tolerant of elephants than were people practicing pastoralism. Within the pastoralist communities, those who received indirect financial benefits from wildlife expressed positive attitudes towards elephants for aesthetic reasons, while those that received direct benefits from tourism alluded that both financial rewards and aesthetic values were attained from living with elephants (Gadd 2005).

What is even less well understood, however, is how different communities within the various land use systems value "less charismatic" wildlife, like baboons, whose cultural or economic value to humans remains unclear. The interplay between various cultural beliefs and ecotourism, for example, could potentially influence human-baboon interactions in specific ways. More specifically, such an examination can provide a better understanding of how values towards baboons and the consequent interactions with them influence adaptive patterns of co-existence across different land use systems (i.e., mutualistic, conflict etc.).

This study was conducted in Laikipia District in North-central Kenya. The district is unique as it supports a high abundance and diversity of wildlife that is unprotected (i.e., not a gazetted park or reserve) in a human occupied landscape (Georgiadis 2007a). This region encompasses four major distinct land use systems (pastoralism, commercial ranching, agriculture and ecotourism). Some land practitioners have complemented these practices with one of the other three land use practices (e.g. agro-pastoralism with ecotourism or commercial ranching with

ecotourism). In this study, I explicitly incorporate the human cultural–ecological dimension into primatological research by evaluating how different human land use practices influence the relationships that humans have with baboons. I applied WVO theories to compare people's values and interactions in relation to the different land use systems in operation in Laikipia.

More specifically, I argue that ideologies towards nature (which includes wildlife) are intricately intertwined with land use practices (i.e., pastoralism, farming, commercial ranching, and ecotourism). A better understanding of the link between wildlife values and land use is important. This is because knowledge of people's wildlife values has practical implications that can be applied by land use practitioners and managers alike to mitigate conflict or promote social, economic and ecological benefits from wildlife. Moreover, such an approach serves to clarify the underlying theoretical basis of how these interactions eventually influence long-term patterns of sympatry (Manfredo and Dayer 2004) between humans, baboons, and other wildlife.

I aim to answer the following questions: 1) What are people's general values towards wildlife, (i.e., pastoralism, commercial ranching, ecotourism etc…) baboons in particular? 2) how do these values, in turn, influence human-baboon interactions and consequently patterns of sympatry (e.g., commensalism, mutualism, and conflict) between the two species? 3) due to cultural beliefs and practices associated with different land use practices, how can Wildlife Value Orientation models be used to examine patterns in people's values towards baboons and their influence in human-baboon interactions? 4) how can this information be applied to make management

decisions about baboons and other wildlife in order to facilitate co-existence between humans, baboons, and other wildlife?

To answer these research questions, I examine how land use influences people's values (e.g. "Mutualism", "Materialism", "Symbolism", Resentment", "Environmentalism") (see Table 2.5; Chapter 2) and interactions towards baboons (e.g., levels of aggression, protectionism, tolerance, avoidance or management) relative to other socio-demographic factors.

METHODS

Study area

Location and wildlife population: Laikipia District is situated in northern Kenya (between $0^0\Box17^0$S and $0^0\Box45^0$N, and $36^0\Box15^0$E and $37^0\Box200$E) and covers an area of approximately 9666 km^2 of semi-arid bush land and savanna (Woodroffe and Frank 2005). The district is unique in that it is home to some of the most spectacular megafaunal populations globally, for example elephant (*Loxodonta africana*), giraffe (*Giraffa camelopardalis)*, buffalo (*Syncerus caffer*), hippopotamus (*Hippopotamus a*mphibious), oryx (*Oryx beisa*) and eland (*Taurotragus oryx*). In addition, the district also supports the highest species highest diversity in East Africa and sustains a density of wildlife in Kenya; second only to the famous Masaai Mara National Reserve (Georgiadis 2007a). Yet this region is not formally "protected" ,and is an excellent example of a human-occupied landscape with adequate remaining habitat

suitable for wildlife (Gadd 2005; Georgiadis 2007a; Perfecto, et al. 2009). It is, therefore, an ideal scenario for examining the role of land use practices in human-wildlife interactions. Tourism is the second largest source of foreign exchange revenue in Kenya. The high population and diversity of wildlife in Laikipia District has made it one of the most popular and increasingly lucrative tourist destinations in Kenya (LWF Newsletter, July Issue, 2007).

Local livelihoods, economical strategies and attitudes: The predominant land use practices in Kenya are pastoralism, commercial ranching, tourism and farming. Farming, is largely restricted to the south-western regions of the district, where annual rainfall is relatively high (Georgiadis et al. 2007a), or along rivers and streams in various other parts of the district. Since it was introduced in the late 1980s, ecotourism has increasingly been spread as a subsidiary land use activity. For example, during my research the majority of "pro-wildlife" commercial ranchers also conducted ecotourism. While many of the pastoralist group ranchers continue to depend on subsistence pastoralism, some complement pastoralism with small-scale subsistence farming, and others carry out small scale, community-based tourism. Thus, over the last three decades land use and management practices have changed as patterns of land ownership and wildlife attitudes developed (Gadd, 2005; Georgiadis 2007a). The outcome is a mosaic of diverse histories, land use management attitudes and practices that have generated myriad human-modified landscapes and microhabitats (Moinde per observ). It is this feature of that presents an exceptional opportunity for improving our understanding of how human cultural-ecological

beliefs and practices shape contemporary patterns of resource utilization and management**.**

The successful maintenance of large wildlife populations in this unprotected human-occupied landscape can be attributed largely to the "pro-wildlife" practices promoted by the Laikipia Wildlife Forum (LWF). Established in 1992, the LWF is an NGO managed and run by private and pastoralist landowners with the goal of managing, conserving, and profiting from wildlife (Parker, 2003; LWF Newsletter, July Issue, 2007). Many of the local "pastoralist" ranches are typically communally-owned ranches inhabited predominantly by the Masaai and Samburu people, along with their cattle. Those pastoralists who do not own land typically occupy abandoned tracts (the "squatter" system)[7]. These pastoralist communities are typically bordered by the larger, private commercial ranches whose owners generally support and practice locally wildlife conservation initiatives (Georgiadis 2007a).

Thus, the pro-wildlife awareness or "Environmentalism" orientation towards wildlife is likely to be expressed by the majority of commercial ranchers (Georgiadis 2007a) as well as by some pastoralist group ranches (LWF Newsletter, July Issue, 2007). Furthermore, the LWF plays a pivotal role in the development of world class community-owned tourism projects, such as the Il N'gwesi, Tassia, and Koija communal ranches (LWF Newsletter, July Issue, 2007). These ranches were

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[7] These huge tracts of land were previously bought by cooperatives and later subdivided and sold to small landholders. Some people still live on these lands while other tracts of land have been abandoned or rented out. Abandonment was a result of inability to cultivate land due to crop raiding by wildlife (Anthony King 2010 *pers comm*) or unavailability of adequate water sources in drier regions of the district (Moinde, *pers observ*)

previously undeveloped and maintained little economic activity except for subsistence pastoralism until the growth of tourism in the early 1990s. Thus, communal pastoralist communities that carry out ecotourism ventures have an increased likelihood of expressing "Materialism" tendencies towards wildlife, due to the tangible economic benefits they accrue from such land use practices.

Land use practices in Laikipia also appear to be related to ethnicity. The district is inhabited mainly by the pastoralist Masaai and Samburu communities, while the Kikuyu, (who are predominantly farmers) inhabit the Southeastern and Eastern parts of the district (Fig 2.6*). Commercial ranchers are predominantly of European descent (foreign or local "white Kenyans"). Since the late 1980s, the majority of commercial ranchers have introduced ecotourism ventures. Later, in the 1990s, the pastoralist communities, especially those that inhabit the north-eastern parts of the district, also started adopting these particular land use practices (Parker 2003) (Moinde *pers observ.*).

According to Gadd (2005; 53) "[m]any people are counting on tourism to support or subsidize the local economy, but the district has become a complex mosaic of wildlife-friendly and wildlife-intolerant places". Indeed, Georgiadis (2007a) has proposed that successful conservation on the "pro-wildlife" ranches in Laikipia has intensified human-wildlife conflict on adjacent pastoralist land. This is partly because pastoralists are usually denied access to "pro-wildlife" areas, but are expected to tolerate grazing and browsing competition from wildlife herbivores wandering out of these ranches as well as predatory attacks on livestock by large

carnivores that use these ranches as ranging refugia. For example, pastoralist groups practicing agriculture were less tolerant of elephants than those practicing only subsistence pastoralism, partly because elephants may compete with livestock for forage (Gadd 2005; Young et al. 2005).

On the other hand, these arguments may not be true of all pastoralist ranches. For example, pastoralists from Il'Ngwesi ranch ran a community-based tourism lodge, a cultural center, and guided tours to view wild baboons. These ventures operated until 2007 when political violence surrounding the presidential election erupted in other parts of the country and diminished flow of the foreign tourists. Another example is the Twala Cultural Project at Il Polei community, which is an initiative run by local women to conduct cultural activities with tourists, such as habituated baboon visits, cattle walks, and Masaai beadwork exhibitions. The emphasis on baboon tourism in this location suggests that people may exercise significant tolerance towards baboons within this particular land use system (pastoralism/community-based tourism) despite the occasional incidences of baboons preying upon kids and lambs in the neighboring homesteads. Further study of this is warranted, not only to evaluate people's cultural values towards the baboon, but also more generally to further scrutinize how anthropogenic land use practices contribute to these values and influence human-baboon interactions.

Study animals

Olive baboons inhabit diverse habitats that range from semi-arid, thorn scrub to savanna, woodland, gallery forest, and rain forest (Wolfheim, 1983

The baboon's natural diet is eclectic, largely comprising fruits, seeds, underground storage organs, exudates, leaves, shoots, buds, stems, flowers, fungi, and animals (Barton and Whiten 1993; Palombit, 2013). As members of the CITES Appendix II, the olive baboon is not a threatened or endangered species (Palombit in press). On the contrary, the olive baboon (*sensu lato*) is the most widely distributed of all extant *Papio* species, with an apparently expanding distribution over historical time, suggesting a possible competitive edge over other baboon morphs (Kingdon 1977). The olive baboon's apparent resilience to human modified ecologies may be due to a superior adaptability.

Human attitudes and interaction with wildlife

Several methods were used to collect data on attitudes and interaction of humans towards wildlife.

*Semi-structured Interviews***:** The human-baboon component of this research project entailed interviewing people from the various land use systems. Prior to collecting information from respondents from the field, the proposal for this study had been approved by the Rutgers University Institutional Review Advisory Board.

Interviews were conducted in Laikipia District between September 2009 and May 2010 after first having sought informed consent from potential participants (See Appendix 1). Respondents were above 18 years above of age. Laikipia district was categorized into five geographic regions: North, North- Eastern, Eastern, South-

Central and West (See Fig 2.4). In each region, a number of ranches from each land

use system were selected (Table. 2.4). Interviews were not conducted within the

central region of Laikipia District (i.e., Thome B, Segera Ranch, Eland Downs and

Ngare Ranch) because these ranches and occupied lands were part of the home ranges

of two study groups of baboons, whose socioecology I was studying simultaneously

(see Chapter 4). This was a strategy that I took to minimize biased responses towards

baboons because many people inhabiting this area and its immediate environs knew

that I was studying baboons in this area.

There was a preliminary phase of interviews to generate data from which the

systematic questionnaire would be constructed. A total of 39 semi-structured

interviews were conducted: 19 people were interviewed individually, while the

remaining 84 respondents were interviewed in groups of 2-7 (Table 2.5), with the

exception of Lorora village in Narok, where 25 people were interviewed collectively

as a group. Group interviews were simply a more efficient way to obtain a variety of

responses in a single interview session. These preliminary responses were important

for the eventual construction of the questionnaire used later. In this way, time spent

traveling between households was minimized while maximizing the time spent with

the respondents. A possible limitation of this group approach, rather the individual

approach, is that respondents may not give their "honest opinion" in the presence

other group members. I expected, however, that this problem would be counteracted

during the subsequent questionnaire phrase, which was designed to interview one

respondent at time. My field assistant, who was my key informant, knew his way

around Laikipia District and helped me liaise with key figures within the various communities. This process necessitated communicating with a contact person, i.e., chief, sub-chief, or with known individuals within the community, who would then organize respondents to participate in the subsequent interviews.

This process of occasionally selecting the "important" people within the community, though time efficient, could introduce certain biases, especially if the contact person were to recruit only recruits friends or relatives with similar backgrounds or beliefs. This practice could have therefore resulted in under-representing certain opinions. To minimize this bias, my assistant and I would beforehand explicitly inform the contact person specify that we wanted to interview different people within the community besides the contact's friends and relatives. My assistant also helped with the translation of Maa (Masaai) into Kiswahili or English during the interviews. Interviews at the private commercial ranches typically necessitated calling or emailing weeks ahead in order to make an appointment with the manager or owner to arrange the semi-structured interviews and questionnaire. Commercial ranchers in Laikipia are generally less numerous than pastoralists and other ethnic groups (Appendix 5.2). Twenty-four semi-structured interviews were carried out one-on-one, while the rest of the 15 interviews were conducted as a group response, with a total of 86 people interviewed (Table 2.5).

Questionnaires: Information gathered from the semi-structured interviews was used to construct a questionnaire (see Appendix 5.1) that sampled variation in responses more systematically and quantitatively. My assistants and I pre-tested the

questionnaire between 13 -16 October 2010 on 10 people in the environs of a small

shopping center called Checkpoint (not part of the regions where the interviews were

eventually conducted). Each of the interviews took 20-30 minutes. The

modifications made to the questionnaire as a result of these preliminary responses

were then used to improve the final questionnaire survey, which was carried out

between November 4th and 25th 2010. Interviews were administered by three field

assistants from the Masaai community and myself. In many cases interviews were

completed in Swahili; a few were carried out in English, while the rest were in Maa,

which were then transcribed into English by the field assistants.

My assistant or I presented questions to the subjects and recorded their

responses. Some respondents who had previously been interviewed during the

qualitative survey were again approached as respondents during the questionnaire

phase. Interviews were generally conducted at shopping centers, by the roadside, in

homes, or by directly approaching potential respondents. With commercial ranchers,

appointments were made prior to the interview date.

Value orientations towards wildlife: Previously published works by Zinn and

Shen (2007) in China, Takanjan and Saranet (2007) in Thailand, Dayer et al. (2007) a

multicultural review, and Kaczensky (2007) in Mongolia, explain in detail how

information from semi-structured interviews can be used to categorize people into the

various wildlife orientations. The details of values solicited from the semi-structured

interviews facilitated the compilation of a larger, quantitative sample acquired

through the structured interview survey (following Teel et al., 2005). These value

statements were used to capture individual differences in value expression (i.e.,

'Materialism', 'Environmentalism', 'Mutualism', 'Symbolism' and other

orientations) that are associated with basic beliefs (Dayer et al. 2007; Zin and Shen

2007) (Table.2.5). I recorded the frequency of each coded statement found under a

particular orientation (e.g., "Is it legal to kill a baboon?", "What are the benefits of

living with baboons in this area?" etc.). I then categorized the response according to

the orientation using various statements that defined a particular orientation (e.g.,

Mutualism, Symbolism, Materialism etc.) For example, if a respondent indicated

"anger" on the questionnaire when asked about his/her feelings towards a particular

wildlife it would be categorized under the "Resentment" value orientation. If a

respondent indicates "beautiful," this response was categorized into the "Interest-

Attraction" value orientation.

To examine the values people had towards baboons and their behavioral

interactions with baboons, I used section H of the questionnaire (see Appendix 2.3,

Chapter 3). For example, if people indicated "yes" for anger when asked "what do

you think immediately when you see a baboon?", then their response was categorized

as "Resentment", whereas if a person indicated "Other" reasons, such as baboons

"behave like humans", this indicated "Mutualistic" tendencies and respondents were

categorized accordingly.

The influence of land use systems and to other socio-demographic factors:

I examined the potential effects of a number of socio-demographic factors; length of residency, gender, education, ethnicity income and religion. These variables have been reported to influence people's environmental values in Germany and Japan (Hanada 2003) and interactions with wildlife (Thapa 2004; Manfredo et al. 2007; Teel et al. 2009) in Nepal, various cross-culturally regions and in the USA respectively. Every respondent's age, gender, ethnicity, birth place (i.e., born in or out of Laikipia), education, religion, land tenure, and land use system was recorded at the beginning of each interview. I analyzed how these six socio-demographic factors were associated with the different WVOs and the diverse patterns of human-baboon interactions, cultural beliefs, and practices.

These socio-demographic factors were subdivided into various categories (see Appendix 5.1). In particular, ethnicity, land use and tenure were categorized using the following criteria:

Ethnicity: 14 different ethnic communities found in Laikipia were re-categorized into four broad categories (i.e., Bantu, Nilote, Cushite, and European) (See Appendix 5.2).

The questionnaire was targeted at gathering information from 250 respondents within Laikipia District (Table 2.4); however, the final number of respondents totaled 242 as a result of logistical issues (e.g. availability of some respondents). Data were collected between November and December 2010 (see Table 2.4). As with the semi-

structured interviews, respondents from all five regions in Laikipia District (Fig 2.4) were interviewed. In total, 12 privately owned ranches and 16 pastoralist and farming communities were surveyed (Table 2.4). Since owners of privately owned ranches were not as accessible[8] as other land use practitioners in Laikipia District, I targeted and recruited respondents using Bernard's (2006) snowballing sampling technique for selecting under-represented respondents of the sample population.

Land use categories: To examine the association of land use systems and the other socio-demographic factors with WVO towards baboons**,** statements made by respondents about their direct interactions and experiences with baboons were compared across each of the land use systems. The contribution of each of the socio-demographic factors (relative to land use) on people's values and interactions towards baboons was evaluated in relation to people's responses to Section H of the questionnaire (see Appendix 2.3; Chapter 2).

Pastoralism and commercial ranching were the predominant general land use practices in Laikipia. During the course of my initial semi- structured interviews, I further subdivided these categories, thereby creating a total of seven land use categories: (1) commercial ranching; (2) commercial-tourism; (3) pastoralism; (4) pastoralism-tourism; (5) farming; (6) agro-pastoralism; and (7) agro-pastoralism and tourism. The rationale for these categories is as follows (see also Table 2.6). The majority of "pro-wildlife" commercial ranchers also conducted ecotourism as a

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[3] A few commercial ranchers occasionally travel abroad and some of them maintain their ranches as vacation homes, whereby, a manager is left in charge of managing the daily activities of the commercial ranch.

subsidiary activity (commercial-tourism), while a few practiced commercial ranching (commercial ranching). Although many of the pastoralist group ranches continued to depend on subsistence pastoralism (pastoralism), some complemented pastoralism with small-scale subsistence farming (agro-pastoralism) or with small scale, community-based ecotourism (pastoralism-tourism). Some areas currently inhabited by pastoralists were actually former ranches that had been abandoned by their previous owners, largely due to ethnic land clashes during 1999-2003 (Georgiadis, 2007a; Anthony King, June 2010 *pers comm.*). In total, people in five pastoralist, nine commercial, fifteen pastoralism-tourism, four agro-pastoralism, eight commercial-tourism, four farming, and four agro-pastoralism-tourism land use systems were interviewed within Laikipia (Table 2.6).

Land tenure: Land in Laikipia exists under private, communal, and government ownership. During my study, large-scale ranches were mainly privately owned, but in some cases they were owned by the Kenyan government. Ranch size varies from 5000 to 100,000 acres, extending across 42% of the district (Graham 2006). Smallholder plots, varying in size from one to five acres, represented 37% of the district's arable land that was under cultivation. Where not arable, such holdings have effectively been abandoned and were occupied or used opportunistically by pastoralists Graham (2006). Communally owned group ranches with traditional livestock production covered about 8% of Laikipia and were located in the relatively more arid northern part of the district (Graham 2006). The remaining 13% of Laikipia was covered by government forest reserves, swamps, and urban areas.

For the purpose of this study, tenure was categorized into four categories: (1) Privately owned land (PRV); (2) communally owned and occupied lands, which were further subdivided into (3) formal or (4) informal occupation as outlined in Appendix 5.3. Formal occupied lands were either government resettlement schemes or rented land, whereas occupied lands were those that were opportunistically occupied without formal or legal arrangements (Anthony King 2010 *pers comm.*).

Analysis

To assess respondents' values and feeling towards baboons and wildlife for comparative purposes, I considered answers to Section F of the questionnaire (see Appendix 2.3, Chapter 2). In Section F2 I asked respondents to indicate which of the following feelings they felt when they saw certain wildlife (they had listed in Section F2). For example, some respondents answered "yes" to questions about feelings of "Anger", and some further complemented their responses by stating their reasons for these feelings with statements such as "…….kill my livestock", or "…compete for grass with livestock", or "raid my crop". These responses and statements were classified as the "Resentment" value orientation. The orientation towards "Fear" was expressed by indicating fear on the questionnaire and complementing this response with statements such as, "I am concerned for my safety", or "They kill people". An affirmation towards feelings of "Attraction" and/or "Interest" was expressed through statements such as "they are interesting" or "beautiful" or "they are funny" while referring to specific wildlife. I then calculated the frequency of each coded statement

found under a particular orientation and finally categorized a respondent according to the orientation with the highest frequency scored (See Table 2.6).

To compare respondents' value orientations towards wildlife in general and for baboons specifically, I examined responses to question 1 and 2 of section F (wildlife) and question 1 of section H (baboons) in the questionnaire. A list of wildlife mentioned by respondents in Laikipia was first generated (Table 5.4). To summarize respondent's feelings about wildlife in general, I used feelings or statements made about the ten most frequently mentioned wildlife (Table 5.4). Even though the baboons were the third most mentioned wildlife in this study, I excluded expressions and statements made towards baboon when categorizing values stated for the 10 most frequently mentioned wildlife to avoid any biases while comparing values between these wildlife with baboons in particular. To do so, I then categorized people's orientations towards these ten wildlife species based on the feelings and values they expressed in answer to questions 2 in section F. Values expressed were categorized accordingly into the respective WVOs and their frequencies accumulated into each orientation for all ten species of wildlife collectively. Similarly, I used respondents' statements from question 1 Section H to get responses about what they think when they see baboons and categorized their responses into WVOs in the same way I generated them from people's feelings and values about the "ten most commonly mentioned wildlife in Laikipia". Selected questions between Section H2 and H29 in the questionnaire (Appendix 1 – Chapter 2) were used to gather information about people's perceptions and interacts with baboons across the different land use systems.

Values expressed for the ten most mentioned wildlife (question 2 Section F) were compared to those expressed for baboons (question 1 Section H).

Testing for multicollinearity

Prior to all posthoc analysis, linear regressions were run in order to determine whether there was evidence of multicollinearity between the seven independent variables. Table 5.2 presents an example of such as analysis using the Pearson coefficient (r). When the Pearson coefficient r is > 0.7, it indicates multicolinearity or a strong correlation between two indicated variables (Freund and Wilson, 1998; Petrucci 2009). In accordance with Freund and Wilson (1998), although a number of correlations were significant between the independent variables, values for most coefficients fell well below those levels indicating multicollinearity ($r < 0.7$) (See Appendix 5.2) Descriptive analyses were thereafter cross tabulated using SPSS (Version 21 ©) to generate descriptive analysis to examine the proportion of people's responses to the various questions in section H of the questionnaire (Appendix 1, Chapter 2).

Posthoc analysis

Multinominal logistic regression analysis (henceforth MNL) was used to test whether land use system influences people's value orientation towards baboons as well as their interactions with baboon. Multinominal logistic linear regression models

were run using IBM SPSS Version 21 ©. To compare respondents' expressed value

orientations towards wildlife in general and baboons in particular, I concurrently

examined the influence of land use relative to six other socio-demographic factors

(see Table 5.2) on respondents' wildlife value orientations. Excel was used to

categorize values expressed towards baboons before being transferred into SPSS for

analysis. These statements and responses were used as dependent (response)

variables for the models.

The advantage of MNL is that it permits an analysis across two or more nominal

categories (Menard 2002; Christensen 1996). The stepwise method (as opposed to

backward stepwise entry etc.) was selected to run all MNL regressions because this

selection is preferred for the exploratory approach analysis and prediction testing

(Menard 2002; Christensen 1996). Each MNL regression analysis assigns a reference

group to which all other levels of the dependent variable are compared. For example,

to assess how religious beliefs influence perceptions, responses to "Is it legal to kill a

baboon?" were compared across the four religious variables (Christian, Muslim,

Traditionist, Atheism) and referenced to the "I don't know" response. The reference

category for each separate analysis is indicated in the tables presenting the results.

For every model run, a Likelihood Ratio Test analysis table report is followed

by another table reporting estimate values for the MNL regression (Estimate Table).

Each Likelihood Ration Test table reports the significance of each socio-demographic

factor to the response variable. The estimate table, on the other hand, reports

significance levels between the different categorical levels of each socio-demographic

variables (e.g., EDUCATION: none, primary, secondary, post-secondary). In some cases, as in this study, a socio-demographic factor may indicate statistically significant level ($p < 0.05$), and yet does not do so at the categorical level of the same socio-demographic factor in the following estimate (Neter et al. 1996). The reverse can be true of categorical levels of a particular socio-demographic factor, which indicates significance at the estimate table but not at the Likelihood Ratio Test level. I reported only the socio-demographic factors indicating significance at the Likelihood Ratio Test table and, if the corresponding categorical levels of the same socio-demographic factor also indicated statistical significance for both results. In cases where the categorical levels for a particular socio-demographic factor indicated significance in the estimate table but not for the Likelihood Ratio Test table, I reported these results with the use of the word 'despite' or 'although". This was to indicate the lack of statistical significance of a particular socio-demographic factor in influencing the response variable, but indicated significant differences ONLY at the categorical level in the estimate table (Professor Min-ge Xie, Department of Statistics, Rutgers University, pers comm.). For example, "Despite land use not influencing people's use of preventative measures taken against baboons, farmers were more likely to indicate that they used preventative methods against baboons than those who practiced tourism." Another example , "Although land tenure did not significantly influence people's perception towards the ownership of wildlife, people in privately owned land were less likely than communal owners to agree that wildlife belongs to the government".

Only overall models that were statistically significant were reported. The model fit was then assessed by the Likelihood Ratio Test. For each model run, the Likelihood Ratio Test generated a chi-square statistic which is the difference in -2 log-likelihoods between the overall model (overall model with all seven socio-demographic factors) and a reduced model. The reduced model is formed by omitting an effect, as part of the alterations of the stepwise method, from the overall model, as explained by Petrucci (2009). The null hypothesis is that all parameters of that effect are 0. Thus, the Likelihood Ratio Test (chi-square statistic) is then used to determine if the improvement is statistically significant, (with p values less than 0.05 indicating model fit) and indicates which of the socio-demographic factors contribute significantly to the overall model. The p-values of the B coefficient are derived from the Wald chi-square analysis, which tests for the probability that the predictor regression coefficient in question is 0 in the presence of other predictor variables (null hypothesis). If the probability of the overall model chi-square analysis is less than or equal to the level of significance (0.05), then there is a relationship between the independent variables and the dependent variable (alternate hypothesis).

Prediction accuracy is generated automatically in the NML analysis for each of the final overall models (Chan, 2005; Hosmer - Lemeshow, 2000; IBM SPSS Statistics 22 Command Syntax Reference, 2005). I reported the prediction accuracy with each overall model's result. SPSS generates three different pseudo R^2 summary statistics (Cox and Snell; Nagelkerke, and McFadden) (Petrucci, 2009), to assess model fit by determining the effect size of the model. In this study, I used

McFadden's Pseudo R^2, which is a transformation of the likelihood ratio statistic. It is computed by the following equation:

1 − (the ratio of the loglikelihood of the full model)

    (the log likelihood of the constant only model)

Values from 0.2 to 0.4 for the McFadden's pseudo R^2 are considered "highly satisfactory" in respect to assessing model fit (Hensher and Johnson 1981; Tabatchnick and Fidell, 2007). Pseudo R^2 values are typically lower in MNL regression analyses than in linear regression.

I ran nine MNL models to examine the influence of land use system and other factors (i.e., gender, age, birth place, education, denomination, ethnicity and land tenure) on peoples' value orientations towards baboons and human-baboon interactions. More specifically, I examined people's: value orientation towards baboons (**Model 1**); opinions that stem from the idea that baboons' presence can cause sickness (**Model 2**); reaction(s) when they last saw baboons (**Model 3**); reasons for their reactions towards seeing baboons **(Model 4);** decisions to use preventative measures against baboons (**Model 5**); opinion on the legality of killing baboons (**Model 6**); hunting of baboons (**Model 7**); and decisions to request help from Kenya Wildlife Services (KWS) as an alternative preventative measure against baboons (**Model 8**). Finally, to evaluate people's sense of ownership towards wildlife, I also examined perceptions on baboon ownership **(Model 9)**.

For all of the nine MNL models run, three different results were reported. I reported the statistics for the overall model, the Likelihood Ration Test, and finally the regression estimates and their significance using the Wald's Test (SPSS Command Syntax Reference, 2005). Various categories for land use systems and each of the other six socio-demographic factors were incorporated into all the models for analysis (see Appendix 5.1).

RESULTS

Respondents' land use and socio-demographic data

Proportion of respondents within the different land use systems

The overall socio-demographic information recorded from the 242 respondents is summarized in Appendix 5.1. The proportional representation of the seven land use systems in this sample is represented in Figure 5.1.
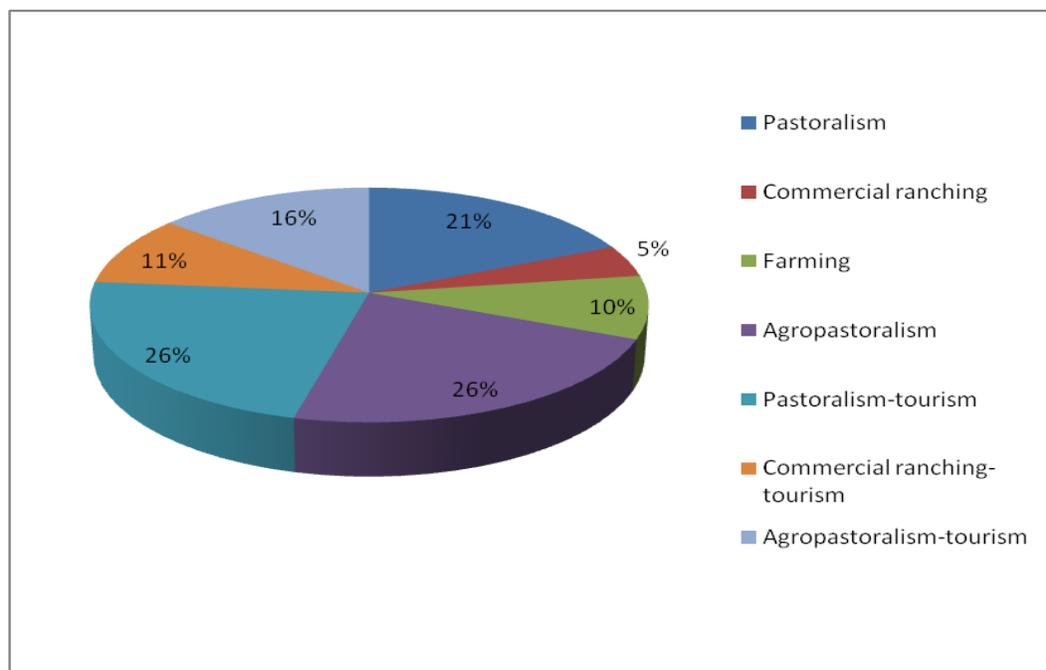
Figure 5.1: *Percentage of respondents (N =242) across the seven land use systems in Laikipia District*

The highest percentage of respondents practiced agro-pastoralism (27%), and

pastoralism-tourism (26%), followed by pastoralists (22%) and farmers (10%).

a) Gender
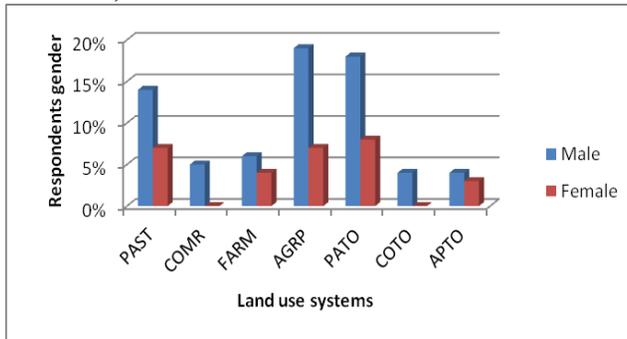
b) Age
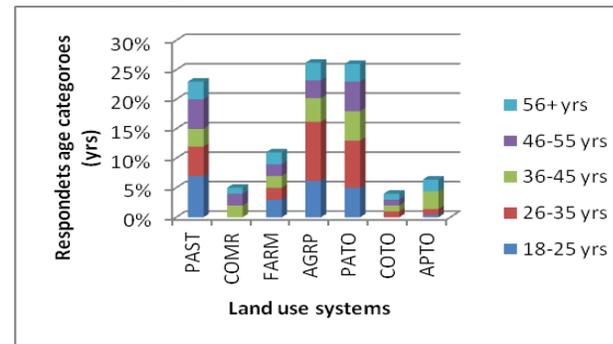
c) Birth place
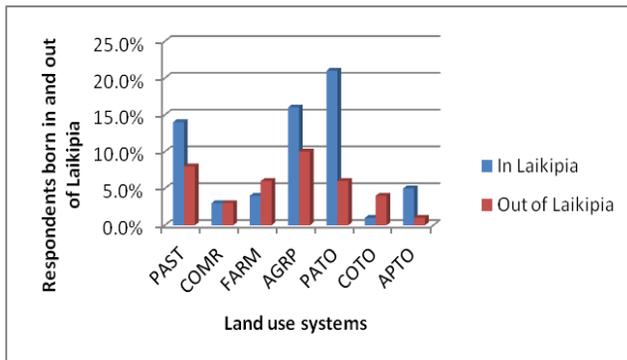
d) Education
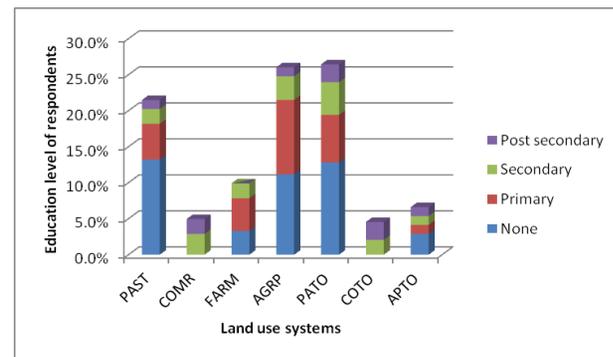
e) Denomination
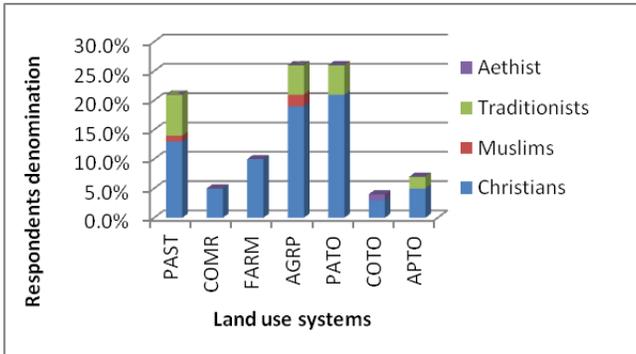
f) Ethnicity
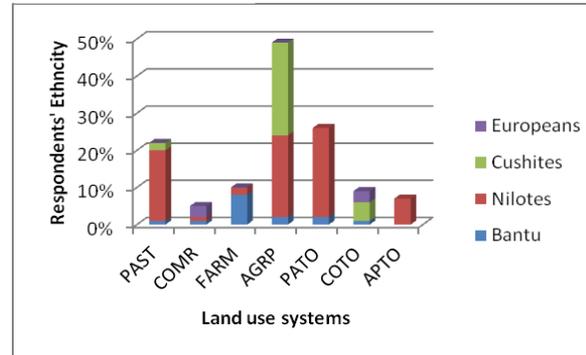
Land use system key:
PAST- Pastoralism   **COMR** – Commercial ranching   **FARM** – Farming
AGRP – Agro-pastoralism   **PATO** – Pastoralism-tourism   **COTO** – Commercial ranching-tourism

Figure 5.2 (a-f): Socio-demographic profiles of respondents (N = 242) across different land use systems

g) Land tenure

Land use system key:
PAST- Pastoralism   **COMR** – Commercial ranching   **FARM** – Farming
AGRP – Agro-pastoralism   **PATO –** Pastoralism-tourism   **COTO –** Commercial ranching-tourism
APTO – Agro-pastoralism-tourism
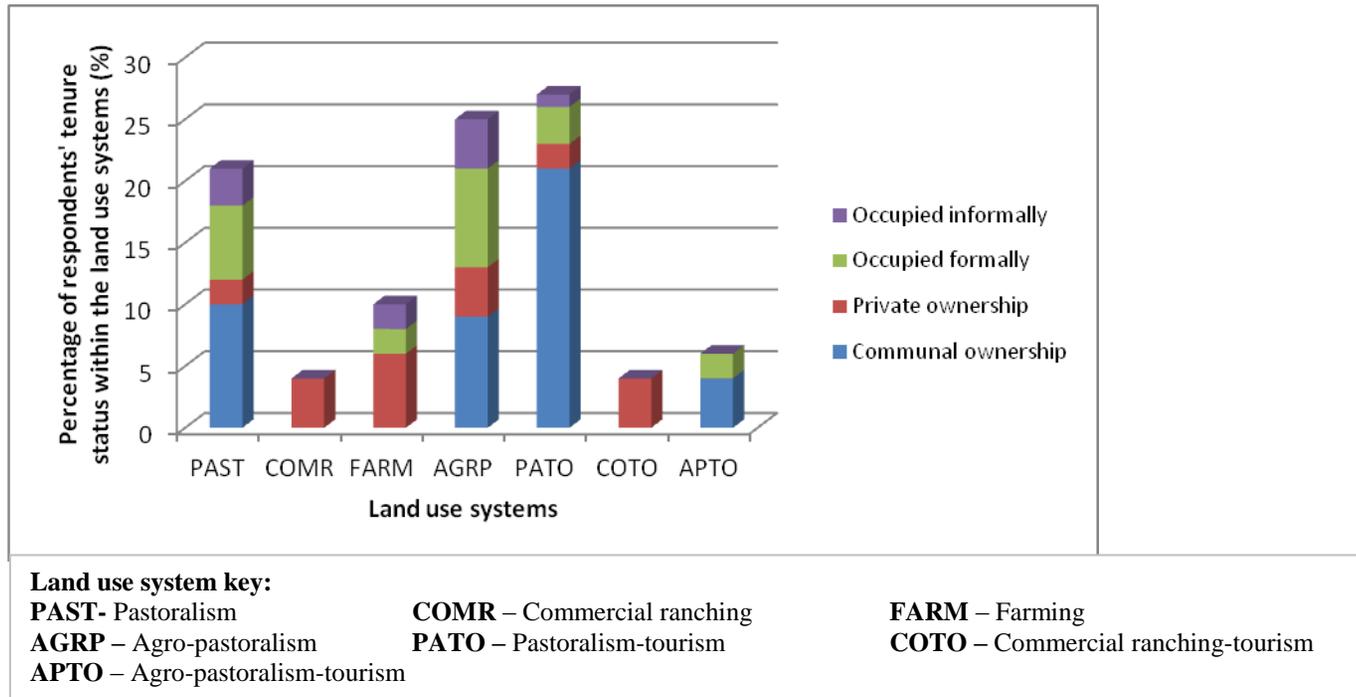
Figure 5.2g: *Socio-demographic profiles of respondents (N = 242) across different land use systems (cont..)*

Commercial ranchers (4%) were the least represented, followed by those who practiced commercial ranching-tourism (5%) and agro-pastoralism-tourism (7%).

Overall, females constituted 30% of the respondents, while 70% were male. The highest percentage of female respondents was in pastoralist-tourism ranches (8%), followed by those who practiced agro-pastoralism (7%) and pastoralist-tourism (7%) (Fig 5.2a; Table 5.3). Both types of commercial ranching land use systems had only one female respondent (Fig 5.2a; Table 5.3). The percentage of males was highest in all pastoralist lands (i.e., agro-pastoralists – 19%; pastoralism-tourism – 18% and pastoralism – 14%) with the exception of those found in the agro-pastoralists-tourism and the commercial ranching-tourism land use system where they were both equally least represented (4%) (Fig 5.2a; Table 5.3).

Respondents' socio-demographic attributes across the land use systems in Laikipia District

Respondent age varied from 18-25 yrs (Fig 5.2b, Table 5.3). The highest percentage of respondents came from the 26-35 years age category (28%), whereas people who were 56 years and older were the least represented (16%). This was followed by 6% in the 18-25 age category in the agro-pastoralist lands (Fig 5.2b, Table 5.3). The same percentages (5%) of respondents interviewed were in the 46-55 years age category in both the pastoralist and pastoralist-tourism lands.

Sixty-three percent of respondents interviewed were both born within Laikipia and 37% were born outside of the district (Fig 5.2c, Table 5.3). The highest percentages of those born in Laikipia were found on the pastoralist-tourism lands (12%), followed by those in the agro-pastoralist land. Agro-pastoralists (1%) were the lowest percentage of respondents born out of Laikipia followed by those in the commercial ranch (3%). The majority of respondents had not attained any formal education (43%).

The highest percentage of respondents with no formal education was found in the pastoralism and pastoralism-tourism (13%) land use system and the agro-pastoralism system (11%) (Fig 5.2d, Table 5.3). Respondents who had achieved the highest level of education were also more frequently pastoralists who practiced pastoralism-tourism (9%) as well as those who conducted commercial ranching - tourism (2.5%) (Fig 5.2d; Table 5.3).

The majority of respondents self identified as Christians (75%) followed by Traditionists (45%) (Fig 5.2e, Table 5.3), while atheists (6%) were the least represented. Among Christians, the highest percentages of respondents were in the pastoralist - tourism (21%) and agro-pastoralism (19%) land use systems, whereas, all farmers interviewed were Christians (9%). Traditionists were found only within the pastoralism land use systems (pastoralism - 7%, agro-pastoralism, and pastoralism-tourism- 5%) (Fig 5.2e; Table 5.3).

The ethnic group yielding the highest percentage of respondents was Nilotes (75%), and the least represented was European origin (6%) (Fig 5.2f; Table 5.3). Europeans were found only within the commercial ranches (commercial ranching and commercial ranching - tourism (3%) (Fig 5.2f; Table 5.3).

Communal ownership was the most frequently identified land tenure system of respondents (46%), followed by private ownership (23%), informally occupied land (21%), and formally occupied land (10%) (Fig 5.2g; Table 5.3). The communal tenure system was most common in pastoralism-tourism land use system (21%) (Fig 5.2g). The highest percentage of people claiming private ownership was derived from the farms (6%), followed equally by those who practiced commercial ranching, commercial ranching-tourism, and agro-pastoralism (4%) (Fig 5.2g, Table 5.3). There were 12 respondents (5%), from whom information on tenure has unavailable (N/A).

Respondents value orientations towards wildlife in Laikipia

The ten most frequently mentioned wildlife species

A total of 32 species were identified when respondents were asked which animals were seen on their land (Table 5.4). Antelopes and birds were generally mentioned without specifying their common names; hence their scientific names were unknown (see Table 5.4). Of the ten most frequently indicated wildlife species, elephant (16%), common zebra (11%) and baboon (11%) were mentioned by the

highest percentage of respondents, whereas gazelle (5%), vervet monkey (5%) and leopard (5%) were the least mentioned (Table 5.4).

Value orientations towards the 10 most frequently mentioned wildlife species

Eight wildlife values orientations were identified from 3203 statements and feelings expressed by respondents about the 10 most frequently mentioned wildlife species (Table 5.5). The value wildlife orientations expressed were: "Resentment", "Symbolism", "Materialism", "Fear", "Neutral", "Interest-Attraction", "Mutualism" and "Environmentalism". The most frequently expressed WVO was "Interest-Attraction" (31%), followed by "Resentment" (25%) and "Fear" (18%). "Environmentalism "(1%) and Materialism (2%) were the least expressed orientations (Table 5.5).

Value orientations towards baboons in particular

Six value orientations towards baboons alone were categorized from a total of 295 feelings and statements expressed in response to questions addressing thoughts and feelings when baboons were seen (Table 5.6). The most expressed value orientation towards baboons was "Resentment" (38%), followed closely by "Interest-Attraction" (34%) (Table 5.6). "Ambivalence" (2%) was the least expressed value orientation, followed by "Mutualism" (7%) and "Fear" (8%). The "Neutral" value orientation (11%) towards baboons was moderately expressed relative to the other value orientations (Table 5.6).

Comparison of peoples' value orientations towards baboons relative to those expressed towards the ten most frequently mentioned wildlife

In total, eight value orientations were expressed towards the 10 most mentioned wildlife species in Laikipia, while only six were expressed for baboons in particular (Fig 5.3). "Symbolism" (10%), "Materialism" (2%), and "Environmentalism" (1%) were expressed toward the 10 most frequently mentioned wildlife, but not for baboons. Conversely, "Ambivalence" was the wildlife value orientation expressed only towards baboons (2%), but not towards the 10 most frequently mentioned wildlife (0%). "Resentment" was expressed more towards baboons (38%) than for the ten most mentioned wildlife (28%). Similarly, "Interest-Attraction" value orientation was also expressed more towards baboons (34%) than for these 10 wildlife species (31%) (Fig 5.3).

Conversely, "Fear" was expressed more towards the 10 most mentioned wildlife (18%) than for baboons (8%). "Neutral" was the respondents' third most common value orientation towards baboons (11%), but ranked fifth for these 10 wildlife taxa (9%) (Fig 5.3). Respondents also expressed "Mutualism" towards baboons (7%) and only 2% of them expressed the same value orientation towards wildlife in general (Fig 5.3).
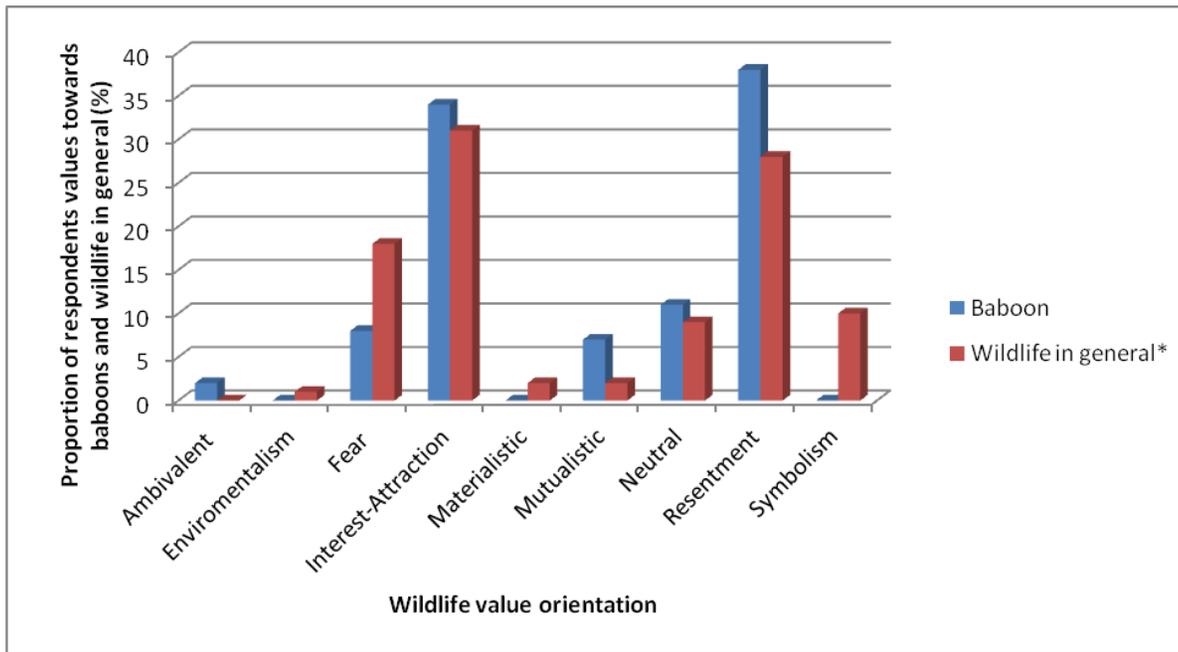
Figure 5.3: *Comparison of the Wildlife Value Orientation (WVO) expressed towards baboons (N =295) versus those expressed towards the 10 most frequently mentioned wildlife (N = 3203) in Laikipia. *Including only the 10 most frequently mentioned wildlife, (which does not include baboons) during the interviews and not all wildlife mentioned by respondents*

The influence of land use and other socio-demographic factors on people's values towards baboons

Baboon value orientations

The overall model indicated that the socio-demographic variables influenced people's value orientations towards baboons (x^2 = 184.507, df = 120, p = 0.0001) at prediction accuracy of 55.6%. Of these variables, three had significant effects on respondents' values towards baboons: birthplace (p = 0.004), education, (p = 0.044) and land tenure (p = 0.001) (Table 5.7a) Specifically, compared to "Neutralism" towards baboons, "Mutualism" was more likely to be expressed by people who were born in Laikipia than those who were born out of Laikipia (p = 0.014) (Table 5.7b). "Resentment," relative to "Neutralism", was more likely to be expressed by people who had attained secondary level of education than those who had achieved post-secondary education (p = 0.015) (Table 5.7b)

The belief that the presence of baboons can make people sick

The overall model 2 indicated that socio-demographic factors influenced significantly the belief that the presence of baboons can make people sick (x^2 = 87.792, df = 48, p = 0.0001; R^2 = 0.195) at prediction accuracy of 58.1%. In particular, the Likelihood Ratio Test indicated that age (p = 0.014) and gender (p = 0.023) affected the belief that the presence of baboons can make people sick (Table 5.8a). Specifically, among those who agreed that baboons can cause sickness, those

within 26-35 yrs of age category were less likely to agree with this opinion than those who were 56 years and older (p = 0.017) (Table 5.8b). Moreover, people who had attained only primary education were more likely than those attaining secondary education to also agree that baboons can cause sickness in people (Table 5.8b).

Compared to women, men were significantly less likely to agree that the presence of baboons could cause sickness (p = 0.008) (Table 5.8b). Further, among those people who disagreed that baboons caused sickness, those within the 18-25 years of age category were also more likely to disagree that the presence of baboons causes sickness than those people who were 56 years and older (p = 0.0001) (Table 5.8b). Also, both Christians and Muslims were less likely than atheists to disagree that baboon presence could cause sickness (p = 0.0001) (Table 5.8b).

Lastly, despite land tenure's lack of influence as socio-demographic factor on the opinion that baboon cause sickness (Table 5.8a), there were differences in this opinion between the tenure systems (Table 5.8b). Specifically, people who claimed communal ownership were less likely to disagree that baboons cause sickness (p = 0.010) (Table 5.8b).

Human-baboons interactions

Respondents' reactions towards baboons when they last encountered them

Of peoples' stated reactions to their last encounter with baboons, the majority said "I did nothing" (69%), followed by "I tried to scare [them]" (26%) (Fig. 5.4; Table 5.9c). The rest of the respondents said "I ran away" (3%) or "I tried to kill it/them" (1%). The remaining 1% gave different variable responses generally indicating that they just watched the baboons (i.e., "I was watching them….", I tried to get closer to watch…' "..they [baboons] were mating...").

The overall model 3 was significant, indicating that socio-demographic factors influenced peoples' reports of reactions to baboons when they last saw them ($x^2 = 175.275$, df = 100, $p < 0.001$, pseudo $R^2 = 0.458$) at a prediction accuracy of 78.2%. Land use system (p = 0.0001) influenced people reactions to seeing baboons, as did education (p = 0.006) (Table 5.9a). There were no detected differences using the Wald's Test in respondents' reactions towards baboon among the various land use systems and educational levels (Table 5.9b).

Lastly, despite the variable land tenure not significantly contributing to peoples' reactions when they last saw baboons (Table 5.9a), there were differences in people's reactions towards baboons between the tenure systems (Table 5.9b). People who informally occupied land ("squatters") were more likely to say they did "nothing" when they last encountered baboons than those who formally occupied land (i.e., renters and people resettled by the government). (Table 5.9b)

With respect to land use systems, the "I did nothing" response was most frequently recorded from people in the commercial-tourism land use system (91%), followed by those in commercial ranches (83%) and pastoralist land (81%) (Fig 5.4; Table 5.9c). Conversely, the "I tried to scare [them]" response was most common among people in the farm lands (63.3%) as well as in agro-pastoralism-tourism system (50%) (Fig 5.4; Table 5.9c).

An equal proportion of people from both the pastoralist and agro-pastoralist lands admitted to trying to kill baboons when they last saw them (Fig 5.4; Table 5.9c).

Reasons given for peoples' reaction when they last saw baboons

The overall model 4 was significant, indicating that socio-demographic variables influenced the reasons people cited for their interactions with baboons (x^2 = 217.057, df = 175, p < 0.017; pseudo R^2 = 0.303) at the prediction accuracy of 54.6 %. Land use system influenced these reasons (p = 0 .001), though there was no significant differences with the Wald's test between the land use systems (Table 5.10b).
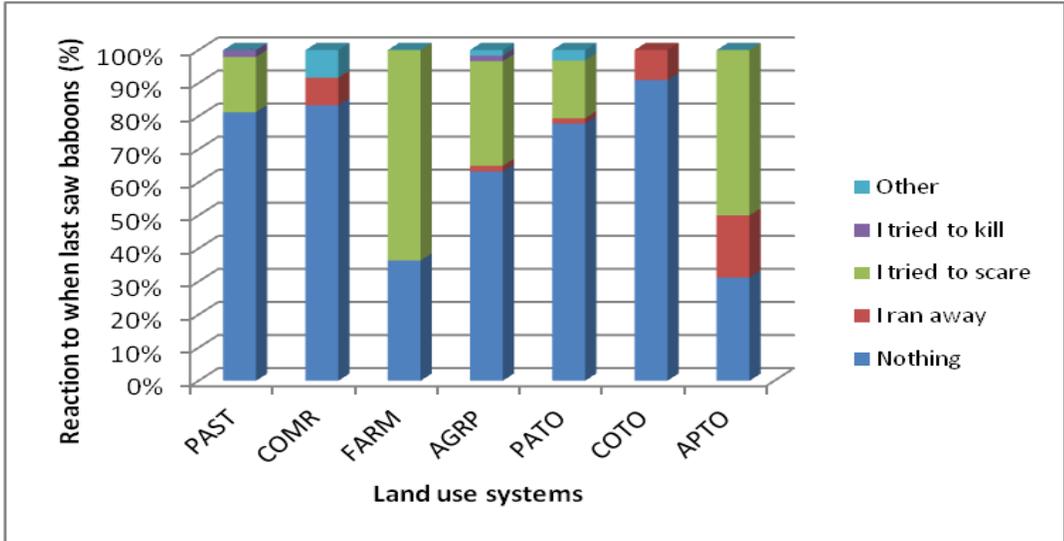
Land use system key:
PAST- Pastoralism   COMR – Commercial ranching   FARM – Farming
AGRP – Agro-pastoralism PATO – Pastoralism-tourism   COTO–Commercial ranching-tourism

Figure 5.4: *Peoples' reactions to baboons within the land use systems (N = 232)*

Religion (p = 0.0001) and ethnicity (p = 0.0001) significantly influenced reported interactions with baboons in accordance to the Likelihood Ratio Test (Table 5.10a). The Wald's test indicated that in particular farmers (p = 0.038) and agro-pastoralists (p = 0.047) were more likely than those who practiced agro-pastoralism-tourism to give the reason that baboons "were too far away to be of any concern" when they last encountered baboons (Table 5.10a). The respondents who said "they [baboons] do not bother me" were more likely to be from the commercial-tourism ranches than those who practiced agropastoralist-tourism (p = 0.031) (Table 5.10b).

Use of preventative measures against baboons

Different preventative measures used by land users against baboons in Laikipia

A total of 55.7% (N=135) of the respondents admitted to using preventative measures against baboons. The most commonly applied methods were "chasing" baboons (80%) and "throwing stones" at them (63%) (Fig 5.5; Table 5.12). The use of domestic dogs (30%) to chase baboons away was also employed across the different land use systems, although to a lesser extent than "chasing" and "throwing stones". The exception to this pattern was seen among people found in the commercial-tourism land use, who did not employ dogs to chase baboons (Fig 5.5, Table 5.12). Other preventative methods (5%) employed against baboons included erecting standard or electric fencing, cutting down trees, planting cactus, or just shouting at baboons to scare them away (Fig 5.5 Table 5.12).

The highest percentage of people who said they take preventative measures against baboons were those who practiced agro-pastoralism (26%) and pastoralism-tourism (22%) (Fig 5.5). The smallest percentages of respondents citing the use of preventative measures against baboons were subjects who practiced commercial ranching (6.2%) and commercial ranching-tourism (7%) (Fig 5.5).

The overall model 5 was significant, indicating that socio-demographic factor influenced people's reported use of preventative measures against baboons

Land use system key:
PAST- Pastoralism   **COMR** – Commercial ranching   **FARM** – Farming
AGRP – Agro-pastoralism **PATO** – Pastoralism-tourism   **COTO**–Commercialranching-tourism
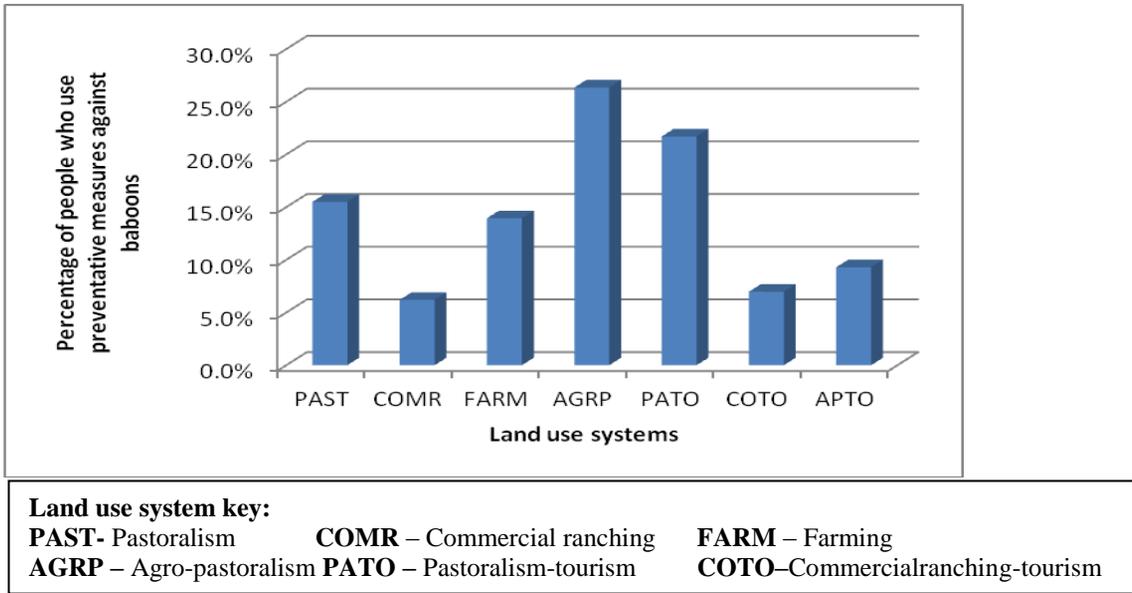
Figure 5.5: Reported use of preventative measures against baboons across land use systems (N = 129)

(x^2 = 38.830, df = 24, p = 0.028; pseudo R^2 = 0.122), at prediction accuracy of 67.4%. Gender was the only socio-demographic factor to influence the use of preventative measures against baboons (p = 0.018) (Table 5.11a). In particular, men were less likely than women to report taking preventative measures against baboons (p = 0.02) (Table 5.11b).

In addition, despite the lack of significance in land use system as a variable factor influencing the use preventative measures against baboons (Table 5.11a), there were differences between the land use systems regarding this matter (Table 5.11b). More specifically, people who practiced pastoralism (p = 0.041) and pastoralism-tourism (p = 0.043) were less likely than those who practiced agro-pastoralism-tourism to use preventative measures against baboons (Table 5.11b).
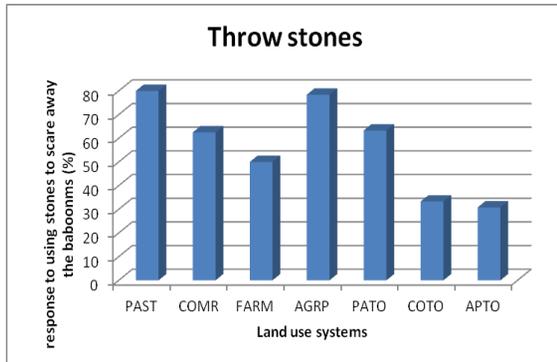
Figure 5.6a: Proportion of people who reported using guns (N = 11) to scare baboons in different land use
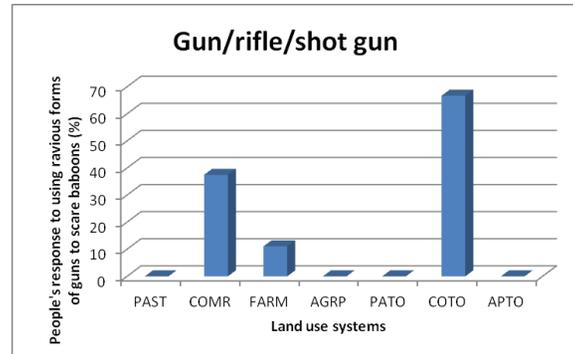
Figure 5.6b: Proportion of people who reported throwing stones (N = 85) to scare baboons in different land use
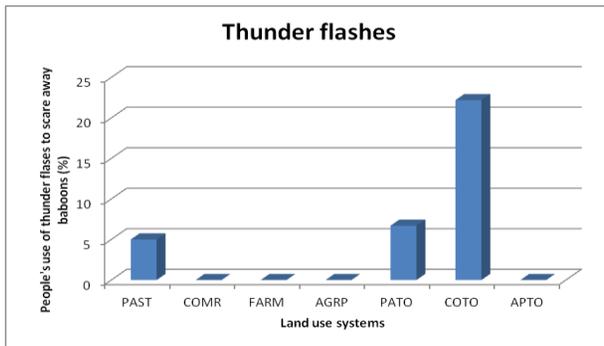
Figure 5.6c: Proportion of people who reported the use of thunder flashes (mild explosives that are also loud) to scare off baboons in different land use systems (N=5)
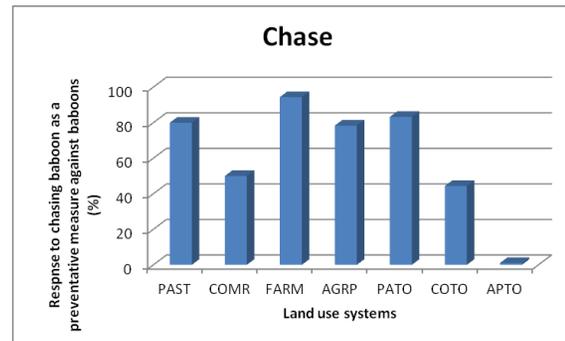
Figure 5.6d: Proportion of respondents' who reported chasing baboons as a preventative method against them in different land use systems (N=108)

371
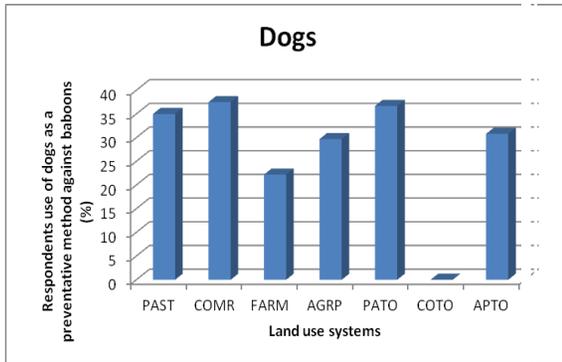
Figure 5.6e: Proportion of respondents' in land use systems who reported using dogs to baboons(N= 40)
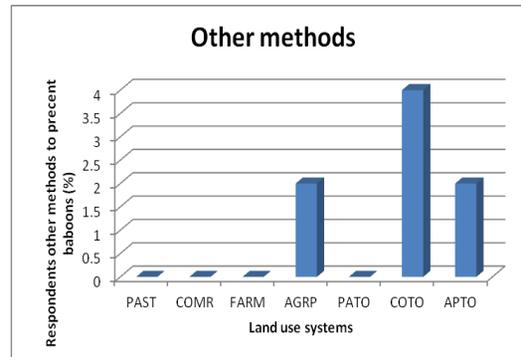
Figure 5.6f: Proportion of people who reported' using other methods (N=7) to scare baboons in different land use systems

Land use system key:
PAST- Pastoralism   **COMR** – Commercial ranching   **FARM** – Farming
AGRP – Agro-pastoralism   **PATO –** Pastoralism-tourism   **COTO –** Commercial ranching-tourism
APTO – Agro-pastoralism-tourism

Figure 5.5: Reported use of preventative methods against baboons within the different land use systems in Laikipia District

People's opinions concerning the legality of killing baboons in Laikipia

The overall model 6 was significant, indicating that peoples' stated opinions concerning the legality of killing baboons were influenced by socio-demographics factors ($x^2 = 154.670$, df = 68.461, p = 0.028; pseudo $R^2 = 0.299$) at a prediction accuracy of 82%. Land tenure was the only socio-demographic factor to have influenced peoples' opinion on the legality of killing baboons (p = 0.049) (Table 5.13a).

Despite the lack of significance of religion as a variable influencing the legality of killing baboons, Wald's test indicated differences between religions regarding this opinion (Table 5.13b). In particular, among those who said it was legal to kill baboons, both Christians (p < 0.001), and Traditionists (p < 0.001), were more likely to express this opinion than atheists (Table 5.13b). At the same time, compared to Atheists, Christians were less likely to agree that it was illegal to kill baboons (p < 0.001) (Table 5.13b).

When people were asked if it was legal to kill a baboon, the majority of those who responded (N = 206) said "no" (82%), while 14% said "yes", and the rest stated "I don't know" (5%) (Fig 5.7; Table 5.13c). The largest percentage of people who said it was illegal to kill baboons was found in the pastoralist ranches (pastoralist 86%; pastoralists - tourism - 86%, agro-pastoralist-tourism - 81.3%), (Fig 5.7; Table 5.13c), while the land use with the highest percentage of respondents affirming the legality of killing baboons derived from the commercial ranches (commercial

373

ranches – 45%; commercial ranching - tourism) (Table 5.14). Approximately 5% to 8% of the respondents from each of the pastoralist land use systems was uncertain about the legality of killing baboons, while both types of commercial ranchers (i.e., commercial, commercial- tourism) were not (0%) (Fig 5.7; Table 5.13c).
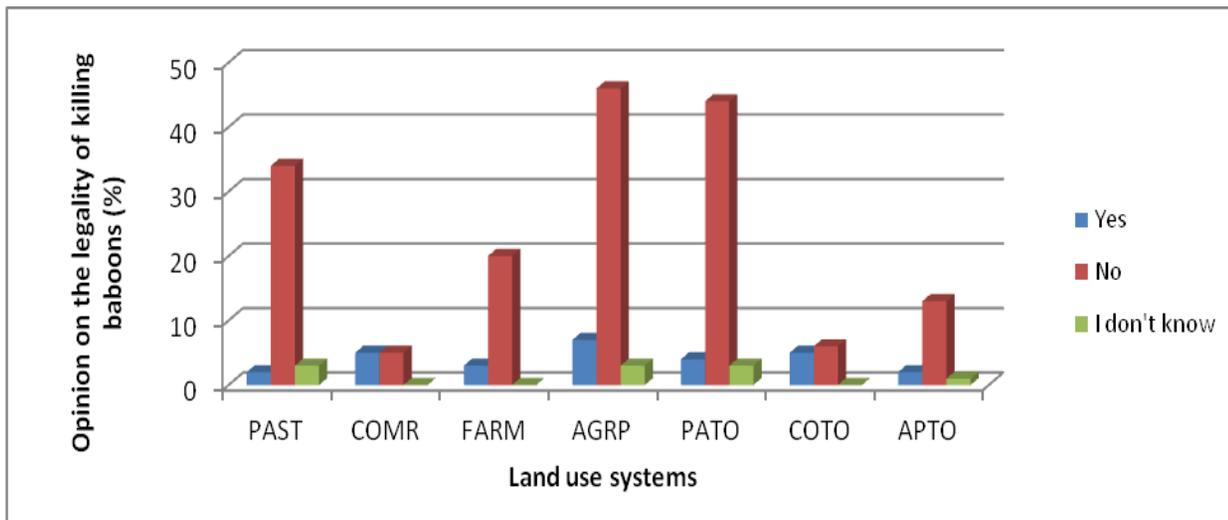
Land use system key:
PAST- Pastoralism   **COMR** – Commercial ranching   **FARM** – Farming
AGRP – Agro-pastoralism   **PATO** – Pastoralism-tourism   **COTO** – Commercial ranching-tourism
APTO – Agro-pastoralism-tourism

Fig 5.7: Opinions on the legality of killing baboons amons respondents (N = 206) within the land use systems and there opinion on the legality of killing baboons

Of the few people who gave reasons explaining why it was legal to kill baboons (N = 27), the majority (66%) claimed that baboons were destructive (i.e., crop raiding or predation on sheep or goats) or a threat to human life ("preying on you"), while only 7% of the respondents said the legality of killing baboons depends upon whether or not they are destroying property. On the other hand, 18% said that it was illegal to kill baboons because all wildlife is protected by the Kenyan government.

Baboon hunting in Laikipia

When asked if people still hunt baboons in Laikipia, the highest percentage of respondents said "No" (84%), while 19% said "yes" and only 5% said "I do not know" (Fig 5.8; Table 5.14c). The overall model 6 was significant, indicating that socio-demographics factors significantly influenced people's response to the question of whether or not people in Laikipia still hunt baboons (x^2 = 97.927, df = 48, p = 0.0001; pseudo R^2 p = 0.548) at a prediction accuracy of 91.4%. In particular, land use significantly contributed to the response that people still hunted baboons (p = 0.0001); as did age, (p = 0.037), education (p = 0.003) and religion (p = 0.023) (Table 514a); however, the Wald's test did not dictate any significant differences among these particular socio-demographic variables.

Although land tenure did not significantly influence people's response to this question, among those who affirmed that hunting of baboons still occurs in Laikipia,

tenants who informally occupied land ("squatters"),were less likely to agree than those who formally occupied land (i.e., renters and government resettled occupants (p < 0.001) (Table 5.14b).
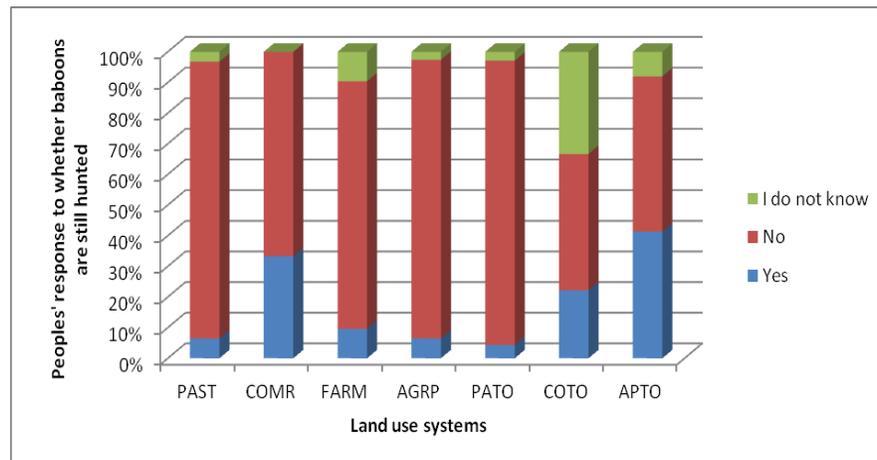
Figure 5.8: *Proportion of respondents who reported to the occurrence of baboon hunting within the different land use systems (N = 174)*

Within the land use systems, the highest percentages of people who said "no" were all found within the pastoralist communities (agro-pastoralism – 91.7%; pastoralists-tourism 91.1% and pastoralist – 91%), with the exception of those who practiced agro-pastoralism-tourism, in which only half of the respondents reported that people do not hunt baboons (Fig 5.8; Table 5.14c). The land use systems with the highest proportion reporting knowledge of baboon hunting were agro-pastoralism-tourism (42%), followed by commercial ranching –tourism (22%). The land use system yielding the highest proportion of respondents (22%) who did *not* know baboons were still being hunted was mainly from the commercial ranch-tourism land use system (Fig 5.8; Table 5.14c).

The benefits people co-existing with baboons in Laikipia

When asked what benefits derived from co-existing with baboons, a majority of respondents (41%) said they do not gain any benefits from baboons (Table 5.15). For those who identified benefits from baboons, the majority listed tourism (25%) as the prime benefit followed by security (11%) and employment (7%) created through tourism-based endeavors (Table 5.15). The remaining benefits included educational bursaries and various community development projects (6%), as well as the notion that baboons were important for both the ecosystem and as a source of food for leopards (6%) (Table 5.15). The remaining respondents, 3%, stated that baboons were living creatures that are part of nature while another respondent indicated they [baboons] also provide a sense of companionship to people. Two other respondents claimed that baboons also help livestock get food resources that are hard to reach since they drop them on the ground while foraging up on trees (e.g., Aca*cia* pods)[9].

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[9] During the drier season when the *Acacia* trees produce pods that livestock cannot reach higher up on the trees, the presence of baboons on the trees attracts livestock to forage underneath these trees. As the as the baboons, feed they drop the pod sheaths on the ground. The livestock, in turn, consume the dropped empty pods sheaths from the ground.

Figure 5.9a
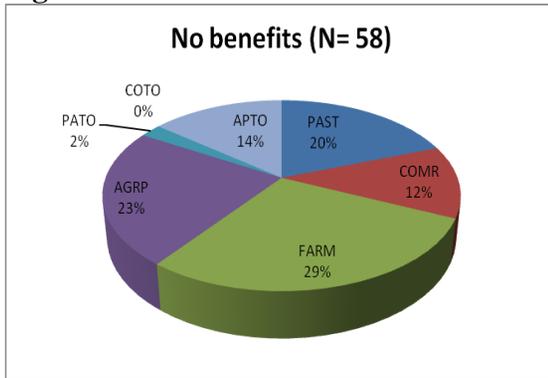
Figure 5.9b:
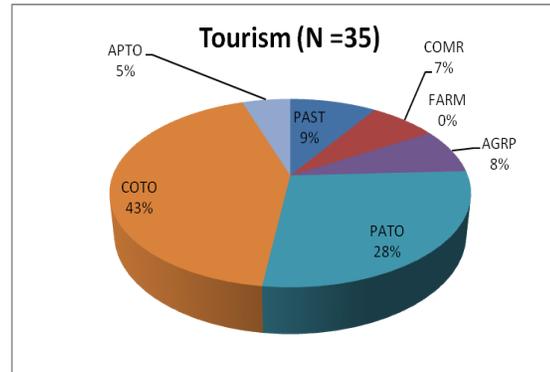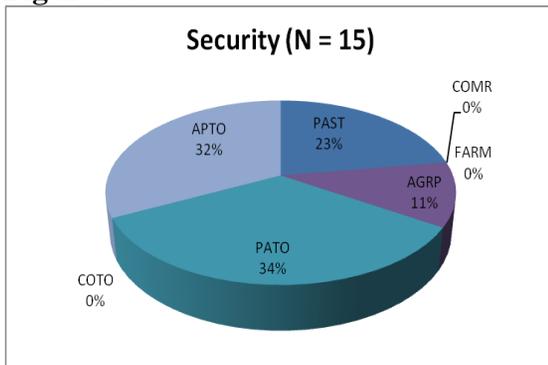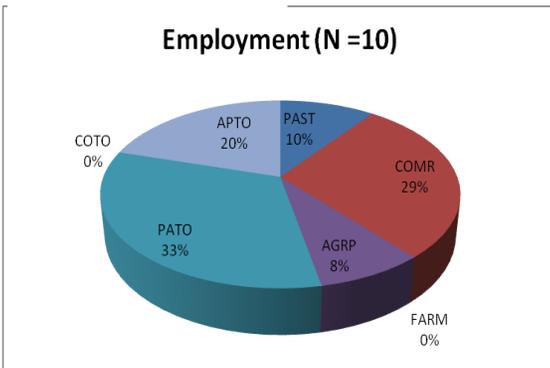
No benefits (N= 58)

COTO 0%
PATO 2%
APTO 14%
PAST 20%
COMR 12%
FARM 29%
AGRP 23%

Tourism (N =35)

APTO 5%
COMR 7%
FARM 0%
PAST 9%
AGRP 8%
COTO 43%
PATO 28%

Figure 5.9c

Figure 5.9d

Security (N = 15)

COMR 0%
PAST 23%
FARM 0%
APTO 32%
AGRP 11%
PATO 34%
COTO 0%

Employment (N =10)

APTO 20%
PAST 10%
COMR 29%
COTO 0%
PATO 33%
AGRP 8%
FARM 0%

Land use system key:
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APTO – Agro-pastoralism-tourism

Figure 5.9a-d: *Stated benefits derived from co-existing with baboons in different land use system*

The highest proportion of people from a particular land use system who felt that they do not derive any benefits from baboons came from those who practiced pastoralism only (68%), while the majority who benefitted from tourism due to baboons were from the pastoralism-tourism land use system (28%) (Fig 5.9a-b). People who claimed that they gained a sense of security from baboons were mainly from the pastoralism-tourism (21%) and agro-pastoralism-tourism (20%) land use systems. During the semi-structured and questionnaire stages pastoralists in different parts of Laikipia revealed that the alarm calls that baboons emit forewarns people of potential danger. This is also useful for alerting herders to be more vigilant against any potential livestock predators (e.g., leopards and lions). People who claimed that they gained benefits through employment related to baboon tourism were primarily those who practiced pastoralist-tourism (16%) and commercial ranching (14%) (Fig 5.9c-d).

The costs of co-existing with baboons in Laikipia District

Of the number of people who indicated there were costs for living alongside baboons, crop raiding (48%) was the most cited, followed closely by livestock predation (46%) and damage of property (18%) (Table 5.16). Disease (4%) and physical threat to human lives (4%) were the least mentioned costs (Table 5.16).

Of the people who complained of baboon crop raiding, most were farmers (23%) or people who practiced agropastoralism-tourism (17%). Similarly, pastoralists (27%) and those who practiced agro-pastoralism-tourism (25%) complained the most about baboons killing young goats and lambs (Fig 510a-b). Commercial ranchers (31%) and people who practiced agro-pastoralism-tourism (30%) complained the most about baboons damaging their property (i.e., breaking into their homes and causing havoc or raiding their homes for food) (Fig 5.10c). Pastoralists (42%) provided the largest number of responses affirming that they were no costs associated co-existing with baboons (Fig 5.10d)**.**
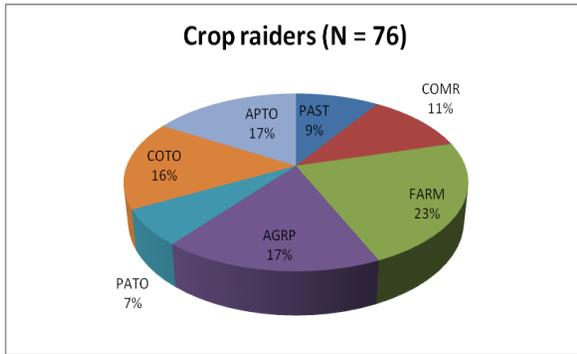
Fig 5.10a
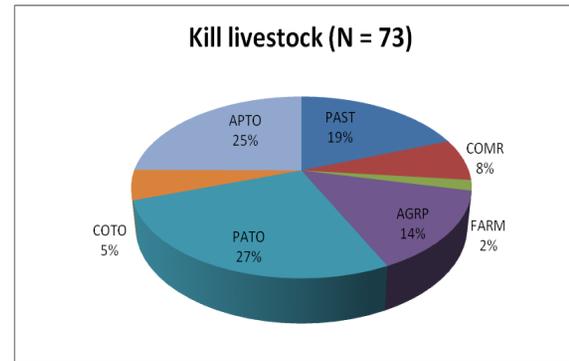
Fig 5.10c
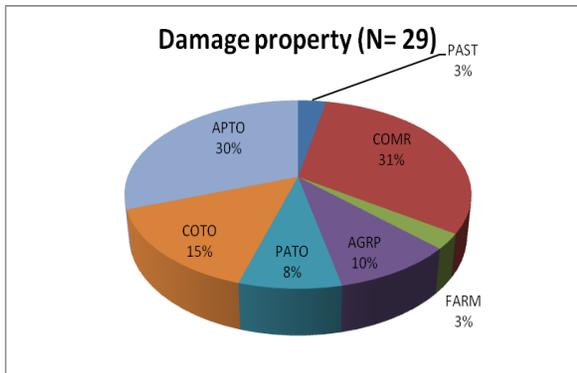
Fig 5.10d
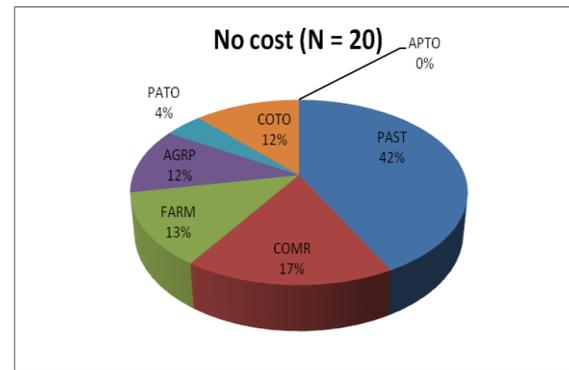
Land use system key:
PAST- Pastoralism   **COMR** – Commercial ranching   **FARM** – Farming   **APTO** – Agro-pastoralism-tourism
AGRP – Agro-pastoralism   **PATO –** Pastoralism-tourism   **COTO –** Commercial ranching-tourism

Figure 5.10a-d*: Stated costs of co-existing with baboons in different land use systems*

Baboon management in Laikipia District

Request for KWS assistance as an alternative preventative measure against baboons

The overall model 7 was significant, indicating that the decision of respondents to request

assistance from the for Kenya Wildlife Services (KWS) was influenced by socio-

demographic factors (x^2 = 30.3, df = 23, p = 0.018; pseudo R^2 = 0.237) at 76.3%

prediction accuracy. In particular, age (p = 0.007) and land tenure (p = 0.023)

significantly influenced this decision (Table 5. 17a). More specifically, people within the

36-45 age category (p = 0.014) were more likely than older respondents, 56 years and

above, to request additional assistance from KWS to counter baboons from their property

(Table 5.17b). There was, however, no significant difference between the educational

levels in accordance to the Wald's test (Table 5.17b)

Although land tenure as a socio-demographic variable did not significantly

influence peoples' decision to solicit the KWS, there were differences in this decision

within the tenure systems (Table 5.17b). That is, communal tenants were less likely than

those who formally occupied land (i.e., resettled by the government or rented) (p = 0.046)

to request KWS assistance against baboons (Table 5.17b).

Respondents' decisions to appeal to the KWS as an alternative anti-baboon measure

varied across the land use systems (Fig 5.11; Table 5.17c). The majority of people had

never requested KWS assistance with baboon-related problems (68%), and only 32% had

done so at least once before (Fig 5.11; Table 5.17c). The land use system that had yielded

the highest of proportion of respondents who had never requested KWS came from those

practicing commercial ranching (88%), followed by pastoralism (78%), pastoralism-tourism (77%) and commercial ranching-tourism (75%) (Fig 5.11, Table 5.17c). The land use systems which were characterized by the highest percentage of respondents who reported past requests for KWS assistance against baboons were agropastoralism-tourism (55%), followed by farming (43%) and agro-pastoralism (40%) (Fig 5.11; Table 5.17c).
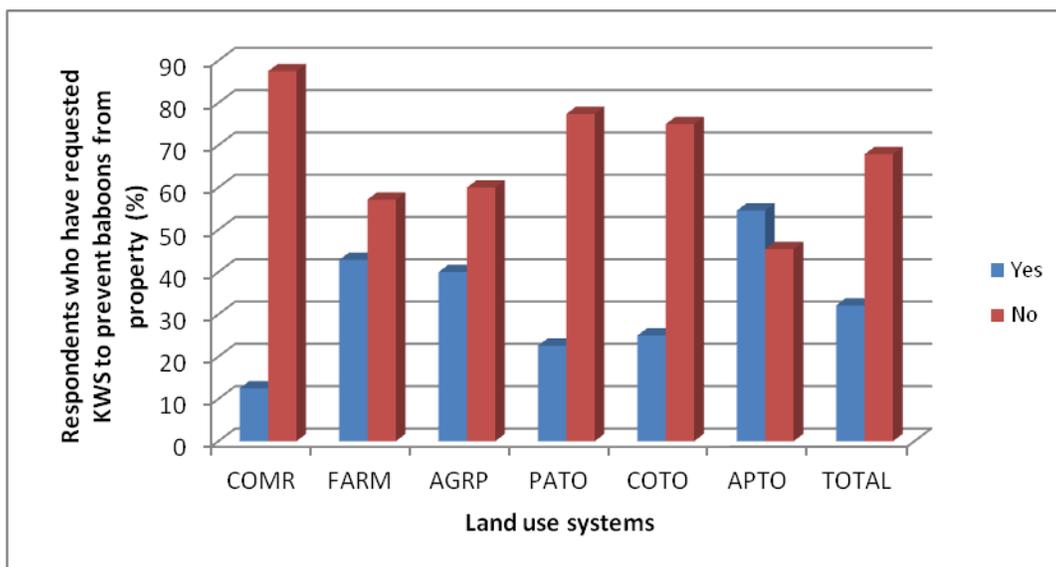
Land use system key:
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APTO – Agro-pastoralism-tourism

Figure 5.11: *Percentage of respondents (N = 137) who requested for Kenya Wildlife Services (KWS) as an alternative preventative measure against baboons*

Out of the 45 respondents who responded to the question about the effectiveness of the KWS, the majority said that the KWS did not solve their baboon problem(s) (87%, while only 13% indicated that their problem(s) with preventing baboons had been ameliorated by KWS intervention.

The question of baboon ownership in Laikipia District

The overall model 8 was significant, indicating that socio-demographic factors influenced peoples' opinions concerning human ownership of baboons (x^2 = 124.04, df = 72, p = 0.0001; pseudo R^2 = 0.206) at a prediction of 54.6%. Particularly, gender (p = 0.014), education (p = 0.005), and land tenure (p = 0,060) were the factors that influenced this opinion (Table 5.18a). More specifically, men were more likely than women to say that baboons were owned by the neighboring ranch owners or by the KWS (p = 0.021) (Table 5.18b). Further, people who informally occupied land ("squatters") were more likely than those who formally occupied land to have the opinion that the neighboring ranches/land owned the local baboons (p = 0.025) (Table 5.18b).

Even though there was no significant effect of land use system influencing on peoples' opinions about baboon ownership, the Wald's Tests reported differences related to land use system concerning this opinion (Table 518b). Specifically, compared to those who practiced agropastoralism-tourism people who practiced commercial ranching-tourism were more likely to say that the baboons were owned by their neighbors

Land use system key:
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AGRP – Agro-pastoralism   PATO – Pastoralism-tourism   COTO–Commercial ranching-tourism
APTO – Agro-pastoralism-tourism
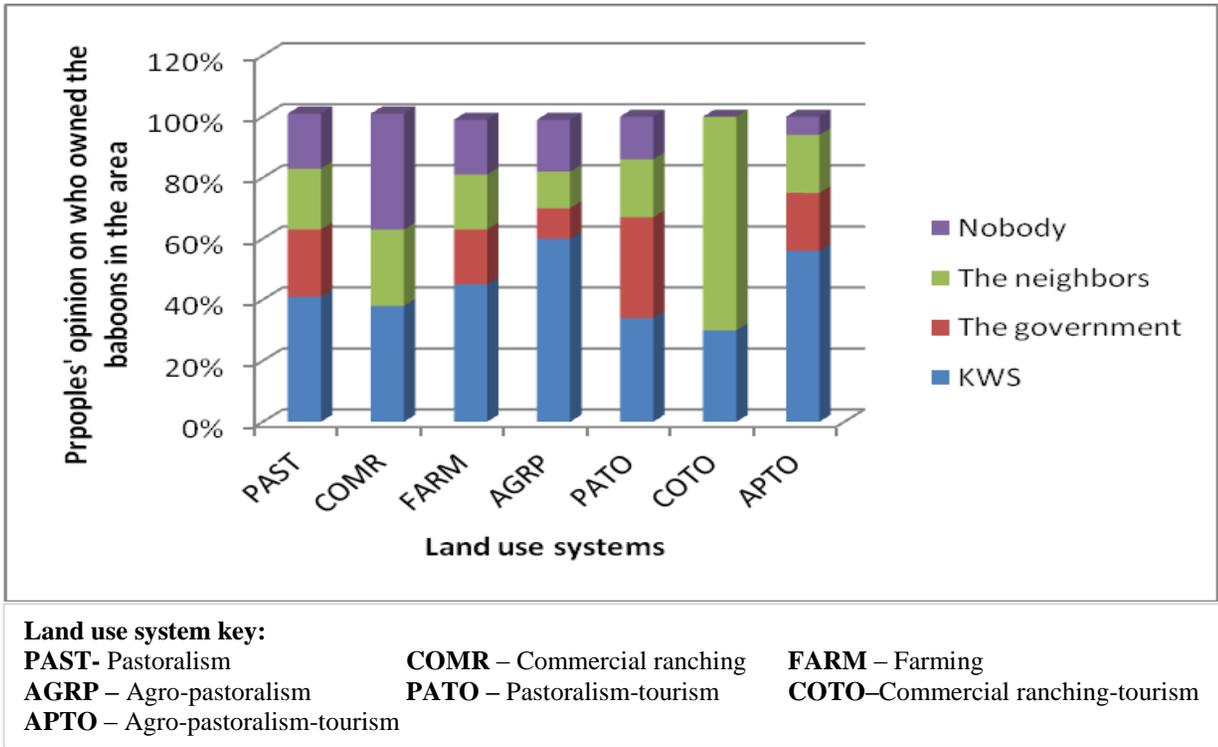
Figure 5.12: *Opinions concerning who owned local baboons across land use systems (N = 229)*

(p = 0.0001) (Table 5.18b). Similarly, birth place did not significantly influence peoples'
opinion on baboon ownership either, but, people born within Laikipia were less likely
than those born out of Laikipia to have the opinion that the KWS owned the baboons (p =
0.045) (Table 5.18b).

All the pastoralists within the different land use systems (i.e., pastoralism, agro-
pastoralism, pastoralist-tourism and agro-pastoralist-tourism) and farmers shared the
opinion that baboons in their area belonged to the KWS and the Kenyan government (Fig
5.12; Table 5.18c). None of the commercial ranchers (i.e., commercial ranching and
commercial ranching-tourism), however, expressed this opinion about baboons (Fig 5.12,
5.18c).

DISCUSSION

Brief summary of results

Wildlife value orientations towards baboons: Land use did not influence any of
the WVOs generated from people's responses and statements about baboons in this study
(Table 5.19). Rather, whether a respondent was born in or out of Laikipia (birth place) or
their level of education influenced only two value orientations, that is, "Mutualism" and
"Resentment". This result suggests that people's long-term residency in Laikipia is
important for building familiarity and therefore more reports of affiliative feelings or/and
interactions towards baboons, as expressed through the "Mutualistic" value orientation.

The "Resentment" value orientation, on the other hand, was influenced by education. The lack of formal education as well as lower levels of education appear to foster "Resentment" towards baboons. An implication of these results for management policy is that ongoing LWF and KWS public educational awareness programs targeting communities where formal education is lacking may reduce hostility towards baboons.

Perceptions of baboon as disease carrying agents: Education and ethnicity were two factors that influenced the belief that baboons can cause sickness in humans (Table 5.19). In particular, people who had attained a primary level education, as well as Christians and Muslims, were more likely to express this attitude. Why people at the primary level of education were more likely to express this notion than those who achieved lower or higher levels of education is not clear. Religious affiliation or "Symbolism" in this case may influence how certain animals are categorized e.g., as "clean" versus "unclean" for consumption. Although Laikipians do not eat baboons, one of the most common complaints expressed about baboons was that they drink from or defecate in sources of water for people and livestock. These two factors appeared to be the main root of people's beliefs that baboons cause sickness. The baboon as a disease-carrying agent is a negative belief that appears to be largely linked to the "Symbolism" WVO which is based on people's religious beliefs. This belief may also contribute to values of "Fear" that lead to repulsive (avoidance) reports of interactions with baboons. Similarly, this belief could also build into values of "Resentment" towards baboons (for polluting water). Other characteristics of respondents, such as age and gender, could

contribute to this influence because it is primarily younger women who fetch the water for the household.

People's opinions on the legality of killing baboons: People's opinion on the legality of killing baboons was only influenced only by land tenure. This result indicates that ownership of land, and its resources, is crucial in determining the decision to eliminate baboons and possible other wildlife. Interestingly, both Christians and Traditionists were less likely than atheists to say it was legal to kill baboons. At the same time, Christians were also less likely than any of the other religious affiliations to say it was *illegal* to kill baboons. This clearly indicates that Christians in general were more polarized or opinionated about matters pertaining to the legality of killing baboons.

People's perception on baboon ownership: Education is important for sensitizing community members about ownership of wildlife in Laikipia as the majority of people were under the opinion that the KWS owns the baboons and not the government. In particular, it was evident from my results that all land use practitioners, with the exceptions of commercial ranchers (i.e., commercial ranchers and commercial-tourism practitioners), held the opinion that KWS and the government were two separate entities. Apparently people were not aware that the KWS is a parastatal body of the government. This incongruency in perception of wildlife ownership further serves to demonstrate the need to educate people about matters pertaining to baboon ownership in particular and wildlife ownership in general.

Land tenure systems did not significantly influence people's sense of ownership towards baboons. This is surprising since it is a socio-demographic factor that pertains to entitlement of resource utilization on occupied land (Table 5.19). There was, however, a trend for land tenure to influence notions of ownership of baboons.

People's motives and their corresponding interactions with baboons: Land use and education were the only two socio-demographic factors to influence both people's reports of their interactions towards baboons and the reasons given for them. In particular, education played a pivotal role in influencing people's motives as well as values, such as "Resentment". Thus, management practices directed towards baboons should focus on public education in order to promote awareness and as a means of ameliorating values that are detrimental to human-baboon interactions. This is especially important where literacy levels are low. This approach will serve to enhance people's knowledge (through formal education) and experience (through onsite visits of habituated baboons), which can be developed as part of educational programs. Both knowledge and experience are prerequisites for familiarizing and fostering "Mutualistic" values that can promote affiliative interactions with people who had the advantage of long-term residency as revealed in this study. Both religious denomination and ethnicity also influenced people's reasons for reacting to baboons when they last saw them. These factors, however, did not influence people's reports of their interactions with them. Land use systems significantly influence the people's indication that hunting is still ongoing in Laikipia. Those who occupied land ("squatters"), however, were less likely to indicate

that baboon hunting still goes on which further reiterates the importance of *both* land use and tenure in matters pertaining to baboon survival. Thus, since land use and education are important for people's motivation; their immediate interactions with baboons, and hunting of baboons. Both these aspects are crucial for formulating management strategies that can alleviate negative values and interactions towards baboons. This approach can in turn encourage people to make informed land use decisions aimed at facilitating the human-baboon coexistence in Laikipia.

A comparison of value orientations expressed towards the baboon in particular and wildlife in general.

Respondents expressed six different value orientations about baboons. The two main value orientations expressed towards baboons were "Resentment" and "Interest-Attraction", whereas "Fear", "Mutualism" and "Ambivalence" were less frequently expressed. The value orientations "Environmentalism", "Symbolism" and "Materialism" were indicated for wildlife in general, but not particularly for baboons.   The "Environmental" value orientation entailed expression of concern for wildlife in two contexts, either as rare or endangered species or as a threat to the environment (e.g., elephants destroying trees). Thus, it was not surprising that value orientations towards baboons did not include "Environmentalism" since baboons are considered neither rare nor endangered nor as damaging to the natural environment as elephants.

"Resentment" towards baboons, however, was expressed mainly because of perceptions of baboons' destructive tendencies, which consequently led to respondents' concern for their property and further contributed to their feelings of anger. In particular, respondents said that baboons entering homesteads to find something to eat can result in various forms of property destruction. For example, in the Ngare Silikon location where most people in the Il Ngwesi communal ranch practice agropastoralist-tourism, baboons destroy property by breaking into buildings where the food harvest was stored. In this location, I sensed the most intense feelings of "Resentment" towards baboons during the semi-structured interviews during which people openly admitted to killing baboons. People reported that they had been occasionally forced to take matters into their own hands and actively wait under the baboons' sleep trees early in the morning and then kill them, one by one, as they tried to descend and escape. Feelings of frustration towards the Kenya Wildlife Services (KWS) were also expressed because of its inaction following repeated reports of baboon destruction of property and crop raiding. This also contributed to the expression of feelings of sadness towards the situation.

Only one commercial rancher expressed "Environmentalism" reasons for his source of "Resentment" towards baboons when he stated that baboons in particular "destroy birds' nests, insects and kill baby impalas". Thus, his direct feelings of "Resentment" were caused by the environmental concern that baboons damage the natural environment. This finding also clearly demonstrates how feelings of "Resentment" can also be evoked towards particular wildlife by people with strong "Environmentalism" or protectionist views of nature.

The majority of "Fear" value orientation expressed towards baboons derived from people's reports of direct interactions with them. For example, one respondent claimed that baboons "seem to want to fight with me", while another stated that "they sometimes fight back".   Only one respondent, however, stated explicitly that baboons are a threat to human life. During semi-structured interviews both men and women conveyed anecdotes that baboons feared women less than they feared men.   In contrast to the situation for baboons, the "Fear" value orientation towards wildlife, on the other hand, appeared to originate from the view of wildlife as a threat or danger. Respondents who expressed this value orientation towards baboons claimed baboons were a threat to their lives, not because they prey on humans like other wildlife but because of their aggressiveness. My findings, however, revealed that people in Laikipia feel less threatened by baboons than by wildlife as a whole. The obvious reason for increased fears of the top ten most mentioned wildlife is that most of them are either predators, such as, like lions, hyena and leopards, or are very large animals, such as elephants.

Previous studies in various parts of Africa have highlighted the incongruency between peoples' perceptions and actual events (Anderson & Grove, 1987, Bell, 1984, Gillingham & Lee, 2003, Naughton-Treves, 1997). Perceived risks are sometimes exaggerated in order to highlight current ongoing events, such as crop raiding by baboons or elephants. Thus, it is possible that people's claims of fear towards baboons in this study are related to perceptions of baboons as the most notorious crop raiders. For example, Graham (2006) reported the knowledge that elephants had either killed or

injured people increased the likelihood that respondents ranked elephants as one of the three worst wildlife pests in Laikipia county, Kenya.

The "Ambivalence" value orientation has not been categorized in previous WVO studies. Ambivalent statements constituted distinctly polarized feelings that appear to potentially lead to actions contradictory to people's expressed feelings about a particular animal. "Ambivalence" is thus linked to certain beliefs that mediate the value of a particular species of wildlife, and are therefore, based on both its beneficial and undesirable attributes. In the case of the baboon in this study, the animal's anthropomorphic tendencies, both behaviorally and physically, combined with their well known nuisance behaviors, appeared to contribute crucially to contradictory feelings towards baboons.

This combination of both types of existential traits (i.e., anthropomorphic and nuisance) evokes indecisive feelings and statements about baboons in Laikipia. Furthermore, all "Ambivalent" feelings that were expressed towards baboons in this study were entirely based on factual (as opposed to symbolic) nuisance behaviors (e.g., destruction of property, such as crop raiding). The "Ambivalence" value orientation was observed in baboons because people recognize the "humanness" in baboons ,which causes contradictory feelings. Therefore, it is not surprising that "Ambivalence" was also the only value orientation not expressed towards other wildlife in general. These conflicting feelings – on the one hand, nuisance and destructive behaviors (e.g., crops raids, breaking into homes to find food), on the other hand, positive descriptions of

baboons as "very intelligent because they think like humans" – were not expressed for any another wildlife.

Surprisingly, most respondents who expressed "Mutualism" orientations stated 'curiosity' (85%), while at least 7% said baboons made them 'happy', mainly as a variation on expressed statements of their seemingly humanlike behaviors (such as respondent's observations of playing or grooming interactions). It appeared that the majority of people who indicated the "Interest-Attraction" WVO towards baboons mainly attributed it to their uncanny anthropomorphic behavioral and physical tendencies. Thus, the "Interest-Attraction" and "Mutualism" values expressed towards baboons were mutually inclusive. One frustrated respondent indicated that he would not do anything harmful to a baboon because it "looks like a human being".

Similarly, a preliminary study testing WVO models in western Uganda indicated that long narratives elicited from people illuminate the internally diverse and sometimes contradictory values people have for wildlife (Lisa Naughton-Treves *pers. comm.*). For example, people complained about baboons publicly and usually tried to kill them in their farms where they raided crops, yet they also described feelings of 'Mutualism' and connection with baboons. In one family, a brother killed several baboons with a machete, and his sister rescued an injured one and nursed it back to health as "God's creature" (Lisa Naughton-Treves *pers. comm.*)

Surprisingly, the "Symbolism" value orientation was not evoked for the baboon. And yet, when people were asked which animals brought bad luck if killed, baboons were

mentioned (see Appendix 5.4). For example, one respondent specifically stated that killing a female baboon, especially one that is nursing an infant, was bud luck because "they are like human mothers". What was interesting and distinctly different about why killing baboons (versus other wildlife) would bring bad luck was that respondents equated killing a baboon with killing a human being. Others said baboons … "look like humans" or "… are almost like humans and killing them will cause psychological issues" while another respondent stated … "they resemble humans and when killed it cries like "human" being". No other animals were similarly depicted as human beings. However, Gadd (2005) reported that of the respondents from Laikipia District in Kenya who would not eat elephant meat, half offered the explanation that elephants should not be eaten because they resembled human beings in their social behavior, their intelligence, or their external anatomy. In my study, such views were limited to baboons with the exception of the two occasions when respondents claimed that elephants have "breast like humans" or they are like "human mothers" in reference to why they would not kill them (Appendix 5.4).

Some animals were utilized for making traditional ornaments or used for customary functions. The buffalo or the kudu horns and hides have for instance traditional purpose or symbolic meaning respectively. The kudu in the Maasai tradition is regarded with reverence due to the symbolic role that the greater kudu's horns play in special traditional ceremonies concerned with the rites of passage into manhood. Older boys and young men of particular age group or *Rika* are circumcised and become "men" or *morans* (Ole Ndala, Entalaban, Il Nguesi Ranch). During these ceremonies, the kudu horn is

symbolically passed on to the new *Rika*. Historically, the kudu's horn was also used to alert people from afar of special occasions or to prepare people for war.

"Materialism" was not expressed towards baboons, but it was towards wildlife in general. This was unexpected, and it was not clear exactly why this was the case, as "baboon tourism" is currently practiced in the Il Polei area and was previously practiced at Il Ngwesi ranch. Both ranches are Masaai communal ranches that practice pastoralism and sustain what appear to be strong community-based conservation projects. Only one person explicitly stated that he was "happy because I earn a living from them [baboons]".

Manfredo et al. (2003) found that people in Alaska with more traditional values believed that wildlife should be managed and utilized to benefit people. This "Materialist" value orientation is strongly and inversely related to people's level of income, urbanization and education. In modern societies in various parts of the globe, 'Post materialist' values tend to be found in people who are more educated, self-expressive, and economically affluent (Manfredo et al. 2003; Inglehart and Baker 2000). Other statements within the "Materialism" WVO were expressed specifically towards larger antelopes, such as the eland, oryx, as well as smaller antelopes (i.e., impala, gazelles, dikdik) whose physical attributes were perceived to be similar to those of domestic livestock. This was expressed in traditional stories recounted during the semi-structured phase of the study. A commonly expressed story of ungulates of various sizes, which physically resemble domesticants, such as goats and cattle, suggest that the Maasai realize their potential to be utilized as domesticants.

In the past, elephants and hippos were traditionally a good source of food because the large quantity of meat they provided could easily feed a village (Mzee Legei, Sangaa' village).   Generally, Masaai in Kenya currently do not eat wildlife, except in droughts (Collet, 1987). The evidence of snares during my field study indicated that bush meat is indeed a viable source of protein when livestock are dying from drought, as was the situation in 2009. Georgiadis et al. (2007b) argued that the incidents of bushmeat consumption in Laikipia were generally far from frequent or severe enough to cause declines in ungulate species such as plains zebra, Grant's and Thomson's gazelles and impala.

Culturally, larger livestock (cattle) are herded by Masaai men and older boys, while the smaller goats and sheep are tended by women, girls and younger boys of less than ten years of age (Moinde, pers observ.). Thus, according to the myth, the larger wild antelopes were once believed to belong to men while the smaller ones belonged to the women. Occasionally, during some of the interviews, these antelopes were referred to as *wafugo wa porini,* which directly translated from Swahili means "bush" or "wild" livestock because of their physical resemblance to livestock, and thus they have symbolic potential utility as domesticates. Additionally, de Pinho et al. (2014) found in Amboseli Park, Southern Kenya, that the species most frequently described as beautiful by the Masaai were large herbivores, which people praised for their colors and their morphological or behavioral likeness to domestic animals.

In Laikipia, the impala, a common ungulate and favored bush-meat species, has declined on transitional properties but not on "pro-wildlife properties" (Georgiadis et al.,

2007b) which are essentially the commercial ranches. Transitional properties are those that I refer to in this study as the private smallhold property, government resettlement areas, and occupied land. These properties are inhabited mainly by people from the Bantu groups, who were essentially farmers, and a few from the Cushitic and Nilotic ethnic groups, who were sedentary pastoralists (see Table 5.2). The people in the Bantu ethnic groups whom I interviewed tended to inhabit areas where there was water availability (from rivers, streams or rainfall) for farming. Nearly all the Bantu people that I interviewed were found in the relatively drier areas in south-eastern Laikipia along rivers and streams occupying private or rented small smallholding that had been converted into farms. As a result, these areas appeared to be largely devoid of most of their natural vegetation and wildlife, but farms still experienced crop raiding from baboons and, occasionally, from elephants. This could be the reason why the Bantu respondents did not express anecdotal stories about wildlife compared to the pastoralists who lived in greater proximity to wildlife and reported increased interactions with them.

The Samburu are part of the Maa speaking people and are also semi-nomadic pastoralists. Like the Masaai, Samburu people in Kenya are extremely dependent on their livestock for survival and livelihood, though bush meat is collected during periods of drought (Ocholla et al. 2013). The Samburu hunt only some kinds of wild animals for food, especially those that resemble livestock, such as giraffes, antelopes (elands, gerenuk, grants gazelles, oryx, dikdik) and buffalo (Ocholla et al. 2013). Moreover, the Samburu, like the Maasai, traditionally do not consume pig-like animals such as like warthogs or bush pigs. Nor do they eat reptiles and amphibians, insects (except honey

from bees) or donkey-like animals (Ocholla et al. 2013). For other pastoralists, such as the Turkana in Kenya, hunting was historically practiced primarily by the very poor (Soper, 1985), but Clarfield and Lowe (1991), reported that in more recent times hunting has been an important means of survival for some Turkana.

"Materialistic" values were also expressed towards wildlife by the European community in Laikipia, who were restricted to commercial ranching. Furthermore, a large proportion of these commercial ranchers supported game hunting and quota cropping of wildlife (Moinde, unpub data). Licensed game hunting and quota cropping had been carried out in Laikipia until the 1990s in order to reduce wildlife numbers (primarily zebras), and thereby minimize grazing competition (Georgiadis et al. 2007b). Commercial ranchers also profited from the sale of game meat and hide collected in culling operations and hunts (i.e., zebra, gazelles, buffaloes). It is not clear how people in other land use systems previously profited from quota cropping and game hunting. One man from a formally occupied ranch (Thome A) expressed his hope that quota cropping be legalized again because it was beneficial in the past for reducing zebra competition with their livestock. He also commented, however, that quota cropping was grossly mismanaged in his area before it was banned by the government. Similarly, the resumption of quota cropping and game hunting was also supported by most commercial ranchers but on condition that proper and more stringent management policies were properly implemented.

Though the commercial ranchers and the pastoralists both expressed "Materialist" values towards wildlife, the pastoralist communities, particularly the Maasai and the

Samburu, tended to do so more implicitly through anecdotal statements and stories of wildlife that resembles livestock. Commercial ranchers expressed the "Materialistic" values towards wildlife more explicitly from their past experience of quota cropping and game hunting. Except for one, all commercial ranchers I interviewed expressed the wish for the ban against quota cropping and game hunting to be lifted by the government in order to reduce the rising number of zebras that compete with their livestock. "Materialistic" values based on food were mainly orientated towards ungulates and expressed by both pastoralist and commercial ranchers and to some extent their customary use by the former land practitioners. For example, pastoralists in the past used buffalo hide for clothing and as mats because it was durable. Their horns are still used to make tobacco containers, however, especially by the older generation. The commercial ranchers before the ban would sell jerky meat from wildlife for local consumption, which was also sold in the local towns (Moinde pers observ.) and possibly elsewhere. One commercial rancher reported that good quality hide from quota cropping and game hunting was selected carefully, tanned, and sold to the local and international market.

"Interest-Attraction" was the second most expressed value orientation after "Resentment" for baboons. Of significance to this study is that proportionally more people expressed the "Interest-Attraction" WVO toward the baboon (34%) than did for the ten most frequently mentioned wildlife in Laikipia (31%). This indicates that even though people generally felt more "Resentment" towards baboons, they also felt more "Interest-Attraction" towards baboons than they did for the ten most mentioned wildlife.

These findings further exemplify contradictory or polarized feelings expressed towards baboons evoke feelings of "Ambivalence" towards this primate specie.

The "Interest-Attraction" value towards baboons was derived mainly from anecdotal stories about baboons. The majority of these statements reflected peoples' curiosity about baboon behaviors and observed social interactions. One person specified that baboons made him happy because they are 'interesting and intelligent' or are 'friendly and can be tamed'. Another respondent who earned a living from them was 'happy with baboons', which suggests that direct financial benefits from baboons through ecotourism ventures are also acknowledged.

It appears that the "Interest-Attraction" value orientation is influenced by desirable morphological traits of wildlife. A number of studies in various part of the globe have explored visual features, such as color, size, and distinctive species-specific morphological characteristics, which partly explain human preferences for animals (Reviewed in Stockes 2007). In East Africa, pastoralists express appreciation of wildlife aesthetic attributes such as stripes, color patterns, and horn shapes (de Pinho et al. 2014). Gadd (2005) noted that aesthetic and moral regard for wildlife was prevalent in pastoralist communities with and without tangible benefits derived from wildlife. Similarly, in my study, the majority of pastoralists (Nilotes) in Laikipia expressed appreciation of the aesthetic attributes of wildlife (Moinde unpub. data). These views contributed to the "Interest-Attraction" value orientation people had towards wildlife in general. For example, giraffes, zebras, leopards and cheetah were thought to be beautiful because of their coat patterns.

Although members of the Bantu communities inhabited areas mostly devoid of vegetation and wildlife due to farming, they also expressed "Interest – Attraction" values towards wildlife that they considered to have beautiful traits, e.g., the patterns on the giraffe's coat or the majestic spiral horns of the greater kudu. This attitude indicated the appreciation of wildlife mainly for aesthetic reasons or economic gain (tourism) rather than for their potential and actual utility as foods, as expressed by pastoralists.

Studies have shown that many diverse qualities influence the appeal of animals to humans including economic value, phylogenetic relatedness, and threat to humans. However, one of the most important qualities appears to be physical appearance or aesthetic quality (Kellert, 1996; Kellert and Berry, 1980). In various parts of the globe, physical traits of animals that have been most consistently shown to be preferred by humans are large size (Kellert and Berry, 1980; Coursey, 1998; Ward et al., 1998) and neotenic (juvenile) features (Lorenz, 1971; Gould, 1980; Hirschman, 1994; Lawrence, 1989). Other physical traits that may influence preference for animals include similarity to humans, shape, type of locomotion, posture, texture and color of hides (Morris, 1967; Burghardt and Herzog, 1980; Kellert, 1996).

In Laikipia, approximately 11% of the statements indicated that people found wildlife physical attributes beautiful (i.e., color, coat patterns, size), while 18% of the statements described attributes of behavior that made them interesting to watch. None of the physical attributes of baboons were considered "beautiful", but terms such as "funny", "clever", "creative" were used to describe them. It thus appeared that people

found baboons interesting largely due their humanlike attributes, both behavioral and morphological.

Further, in relation to economic benefits attained for tourism, baboons were not mentioned on as the list of wildlife that tourists come to see, as compared to the "Big Five", which refers to the five most difficult animal species to hunt in Africa (lion, leopard, buffalo, elephant and rhinoceros). Consequently this term is adopted by *safari* tour operators for marketing purposes (Capstick 1984; Du Toit 2001). Some respondents mentioned the value of the "Big Five" in enriching the tourist experience. Baboons were not identified as possessing any of the traits that make the "Big Five" charismatic.

One male respondent from Il Polei ranch, which currently operates an ongoing "baboon tourism" community conservation project, indicated the value orientation of "Interest-Attraction" towards baboons. This was because he expressed a seemingly perplexed curiosity when he stated that "I want to know what attracts tourists [to them]". This statement indicates an important aspect of perceptions of baboons where "baboon tourism" projects are conducted. People who do not find baboons inherently interesting or even attractive may nevertheless develop certain orientations based on other mechanisms, such as, curiosity. The fact that tourists come from very far to watch baboons, as they do for the Big Five, appeared to perplex the male respondent from Il Polei ranch, as it was also clear from most respondents that baboons were not generally valued as tourist attraction. More importantly, for Laikipia, there is some indication that the economic advantages offered by baboons through ecotourism can enhance perceptions of them as beneficial to community well being.

The influence of land use practices and other socio-demographic factors on values towards baboons.

My findings revealed that land use did not significantly influence any of the six value orientations expressed towards baboons: "Ambivalence", Fear", "Interest-Attraction", "Mutualism", "Resentment" and "Neutralism". The only socio-demographic factors that influenced people's values towards baboons were birth place, education, and land tenure system. In particular, birth place was influential in that people born in Laikipia were more likely to express the "Mutualism" value orientation than those who were born out of Laikipia. Formal education, on the other hand, was instrumental in influencing "Resentment" values towards baboons, whereby people who had attained secondary level of education were more likely to express "Resentment" than those who had attained the highest level of education.

The "Mutualism" value orientation towards baboons was particularly influenced by long-term residency. This is suggested by the result that people born in Laikipia were more likely to express "Mutualistic" values towards baboons. Laikipia is unique in Kenya in supporting the second highest wildlife densities in the country and yet is also a human occupied ecosystem (Georgiadis et al 2007a). Thus, it seems likely that long-term Laikipia residents are used to coexisting with baboons, and therefore develop stronger attachments than people born out of Laikipia. The experience of time spent living in Laikipia could facilitate observations of baboons in their social environment, which

promote appreciation of humanlike behavioral and physical, which further fosters,
people's feelings of companionship towards them. In their study in Colorado, Zinn et al.
(2002) also found that residential stability or length of residence in a place was positively
related to traditional utilitarian values towards local wildlife.

Wildlife Value Orientation studies in the United States and Europe have further
shown that people are more likely to express the "Mutualistic" value orientation and view
wildlife in human terms if they had previously engaged in welfare-enhancing behaviors
(e.g., support conservation efforts) for animals. Thus, people who expressed
"Mutualism" are also less likely to support action resulting in death or harm to wildlife.
The "Mutualism" value orientation reflects the influence of egalitarian ideology as
opposed to the "dominant" view of wildlife manifested by people with the "Materialistic"
values. Thus, the "Mutualistic" view of wildlife is viewed as "Post- Materialism", and
tends to be found in people who are more educated, self-expressive, and affluent
(Manfredo et al. 2003; Inglehart and Baker 2000).

Surprisingly, however, people who communally owned their land in Laikipia,
who essentially are the pastoralists, and who presumably held longer residential tenure
there were *less* likely to express mutualistic tendencies towards baboons than those
people who had more recently been resettled by the government into Laikipia. The
reasons for this unexpected finding are still not clear. One possibility is that the
humanlike tendencies of baboons draw more empathy from people who have experienced
less conflict with baboons (i.e., cropping, livestock predation, nuisance behavior) relative
to other people who have lived a similarly long time in Laikipia.

The "Resentment" value orientation, on the other hand, was influenced only by peoples' level of education. People who had no formal education, as well as those who had attained secondary level of education, were more likely to feel "Resentment" towards baboons compared to those who had attained the highest level of education (post-secondary). Again, this finding was difficult to interpret. Why only people who had attained secondary level of education showed greater "Resentment", and not those who had no formal education or lower levels of education, was not clear. Interestingly, the influence of education on wildlife has also been reported to vary (Groom and Harris 2008). Some studies in Botwana, Tanzania and Cameroon reported no significant effect of education on local peoples' attitudes to wildlife (Parry and Campbell 1992; Newmark et al. 1993; Weladji et al. 2003), or only a weak effect in Kenya and Tanzania (Gadd 2005; Kaltenborn et al. 2010; Groom and Harris 2008), while others found a significant influence in Nepal and Equador (Heinen 1993; Fiallo and Jacobson 1995). In another study in Laikipia, Gadd (2005) found that education and wealth were not associated with positive attitudes towards wildlife. Gadd (2005) attributed this result to the positive effect of tourism on people's outlook on wildlife independently of education and material wealth.

In North America, it is very likely that level of education interacts with wealth to influence peoples' value orientation towards wildlife (Zinn et. al. 2002). My study did not evaluate the influence of wealth on people's values towards baboons. In the Masaai community, the size of a man's herd and the number of his children determines his socioeconomic and social status. Asking a Masaai directly how many cows, goats or

sheep he has however, is considered rude in their culture (Polonet Kinyaga *pers comm.*).

This question was therefore not included in the questionnaire. Other methods of scoring

wealth could have been used, such as scoring an index of material wealth for each

household in terms of store-bought goods (on a scale of 1 to 5, with 1 being minimal

possessions and 5 maximum (Infield 1988; Gadd 2005). However, many of the

interviews that my assistants and I conducted were held opportunistically, away from

respondents' homesteads. For example, on some occasions we interviewed respondents at

shopping centers or while they were out herding or collecting firewood or water. In these

scenarios, the index measures of collecting data on material wealth could not be applied.

Further, Gadd (2005) also reported that the two measures of wealth, that is number of

livestock and material wealth in households, did not always correlate with one another.

Given the method of selecting respondents for this study, collecting data on wealth from

respondents was beyond the scope of this study and not taken into account.

   Previous WVO studies have shown that education does indeed influence people

values towards wildlife, whereby people who had less education tended to have more

utilitarian or "Materialistic" values towards wildlife (Zinn et. al. 2002). The fact that

people who had no formal education and those who had secondary education were the

only category of people who expressed "Resentment" values more than people who had

attained post-secondary education does suggest that there was a tendency for more

educated people to harbor less resentment (and therefore shows more tolerance) towards

baboons.

People's opinion of baboons as disease carrying agents

In this study, land use system did not influence peoples' perception of baboons as health risks. Other factors such as gender, age, and education influenced peoples' perceptions of baboons as health risks. The link between these factors in how they work collectively to influence this perception is not entirely clear. More in depth studies are necessary to clarify how these socio-demographic factors influence people's orientation towards baboons, in turn, affect human-baboon interaction.

Numerous studies have found that baboons are a potential risk for transmitting myriad gastrointestinal parasites (i.e., helminthes, protozoans), (Kalter et al. 1968; Meade, 1983; Muller-Graf et al., 1996; Altmann et al. 1993; Eley et al., 1989; Hahn et al., 2003; Muriuki et al. 1998; Weyher et al., 2006). Others parasitic zoonotic diseases, such as schistosomiasis, are more detrimental and can also be maintained by sympatric baboons. The presence of schistosomiasis in both baboons and humans in an endemic area is proof that zoonotic pathogens can be transmitted through environmental media, such as contact with contaminated. I did not find any evidence of reported cases of schistosomiasis in Laikipia. However, the issue of common water-related diseases, such as typhoid and cholera, was mentioned by respondents in semi-structured interviews; typhoid was more commonly mentioned in relation to baboons. From my own experience while collecting baboon behavioral data in Laikipia for almost two years, one of the key concerns mentioned by local pastoralists was that of baboons defecating in the source of drinking water. The level to which baboons are perceived as a health risk is yet to be examined in Laikipia. Since women are the ones who fetch water for the

homesteads, they were more aware than men when baboons had defecated in water, which explains why women were more likely to agree with the statement that baboons are a potential health risk. Additional longitudinal studies of zoonotic disease that are shared between the two species within the district are needed to evaluate the link between perceived risk and actual infection rate.

Decker et al. (2012) argue that while perceptions of various kinds of economic and physical harm have been studied, disease as a special class of human–wildlife interactions has only recently gained notice. Data about people's concerns with wildlife-associated diseases are sparse, and people may have other salient concerns about the effects of wildlife diseases (e.g., Shadick et al. 1997, Wilson et al. 2005). In Canada and the United States, negative impacts of wildlife-associated disease, including the potential risks of diminished public support for wildlife (Brook and McLachlan 2006, Stronen et al. 2007) are of growing concern (Wobeser 2006, Vaske et al. 2009). Evidence suggests this is also the case in various parts of the globe (Reviewed in Decker et al. 2010).

Few studies have provided insights on the interchange of parasites in the human-baboon interface. For example in South-western Kenya, food enhancement from human refuse and crop raiding can decrease the intensity of helminths infections in nonhuman primates (Altmann et al. 1993; Eley et al., 1989; Hahn et al., 2003). Weyher *et al.,* (2006) also found that members of a crop raiding olive baboon group maintained lowered levels of *helminths,* but higher rates of *Balantidium coli* than the wild ranging group, suggesting that crop raiding exposes nonhuman primates to higher levels of zoonotic diseases due to increased anthropogenic contact (Weyher *et al.,* 2006).

My data suggest that gender, age and education influence people's perception that baboons are potential health hazards. Thus, from an anthropozoonosis perspective, an examination within the human-baboon interface is necessary at the social, ecological, and management level of their interaction, and we need more nuanced information to guide management practices. Such an approach is important for answering questions of not only *why* but *how* these factors influence peoples' opinion of baboons as disease carrying agents. This can facilitate managerial progress within the human-baboon interface.

The influence of land use and other socio-demographic factors on human-baboon interactions

Even though land use played a minimal role in influencing people's value orientation towards baboons, it accounted for some variation in the way people reacted towards baboons when they last encountered them. The majority of people who claimed they "did nothing" or just "watched the baboons" were from the commercial ranches, while the highest percentage of people who reacted with "Fear" was from the agro-pastoralist land use systems. Moreover, those who acted most aggressively towards baboons, by either trying to kill them or chase them away, were mainly from the agro-pastoralism land use systems followed by farmers. This finding accords with Gadd (2005) who reported that the agropastoralism land use system was the strongest predictor of negative attitudes towards elephants in Laikipia District, Kenya. This result is likely due to the fact that practitioners of agropastoralism, compared to other land use systems

in Laikipia, are faced with all manner of costs incurred by wildlife (i.e., wildlife-livestock disease transmission, livestock predation, crop raiding).

Surprisingly, gender was the only socio-demographic factor to influence the use of preventative measures against baboons (Table 5.19). Women were more likely than men to say that they employ various tactics (i.e., throwing stones, shouting, thunder flashes etc). Among people who practice only farming, this result is probably due to the fact that it is women who tend the farm. Also, women are the ones who tend to herd or stay home with the young sheep and goats that baboons may prey upon. This helps explains the strong influence of gender on employment of preventative measures against baboons.

Among the people in the various land use systems, commercial ranchers (i.e., commercial only and commercial-tourism) were the people, who most frequently reported to "doing nothing" when they saw baboons. Some of these respondents indicated they did nothing because they were, in fact, just watching baboons. What was contradictory is that commercial ranchers in general also provided the highest percentage of respondents who reported using the most aggressive methods against baboons (i.e. guns and thrown stones). The fact that there were distinct differences between commercial ranchers and pastoralists in the use of firearms further highlights the need to examine human predation on baboons in Laikipia.

The legality of killing baboons and hunting of baboons

Land tenure system, was the only socio-demographic factor to significantly influence peoples' opinions on the legality of killing baboons and professed knowledge of the hunting of baboons in Laikipia. A connection between the legality of killing and patterns of hunting baboons is suggested by the influence of land use and other socio-demographic factors such as, age, education, religion and land tenure on the belief that people still hunted baboons. Land tenure in particular, is the only socio-ecological factor to influence *both* the issues of the legality of killing baboons and the actual hunting of baboons (Table 5.19). Specifically, people who indicated that hunting for baboons was still an ongoing activity in Laikipia were less likely to be those who occupied the land they lived on (i.e., were likely to be "squatters"). This indicates that ownership of land, and its resources, is crucial in determining the decision to eliminate baboons and possible other wildlife. Thus, tenure is crucial on matters pertaining to baboon survival in Laikipia.

Interestingly, there were non-significant differences between the different religious affiliations about the legality of killing. In particular, Christians were less likely than atheists to affirm both the legality and illegality of killing baboons. Whereas, Traditionists compared to atheists were less likely to affirm only on the legality of killing baboons. This clearly indicates the conflicting nature of such opinions or acts due to spiritual reasons. This results suggests that for religions or "Symbolic" reasons, Christians were more opinionated on matters pertaining to killing baboons. Preliminary data also indicated (see Appendix 5.4) that symbolic reasons (i.e., ancestral beliefs,

curses, forbidden by God..etc..) were given when people indicated why they believed it was bad luck to kill certain wildlife, with the exception of baboons, elephants and on one occasion even wildlife dogs. My findings therefore suggest that although the majority of people in Laikipia were well aware of the illegality of killing baboons, "Symbolism" value orientations towards baboons interceded to significantly influence a person's final opinion concerning whether or not it was legal to kill baboons. This was evident when respondents from the agropastoralist-tourism land use systems expressed the highest intensity of "Resentment" by explicitly admitting to killing persistent, crop raiding baboons. Even though most respondents' reported knowing that baboon hunting goes on, this does not necessarily mean that the respondents were themselves performing this activity. But it does suggest that the hunting of baboons continues in Laikipia.

The "Symbolism" value orientation appears to play a contrary role in fostering tolerance in parts of Asia (Wheatley 1999; Fuentes, 2005). Cultural traditions appear to have considerable influence on the nature of interactions between humans and nonhuman primates. For example, Hindu culture is a major factor influencing the tolerance of primates in agricultural-based communities in Asia (Wheatley 1999; Srivastava and Begum, 2005). Chakravarthy and Thyagaraj (2005) reported that in Nepal, cultural reverence alone protects commensal primate populations. Yet, traditional attitudes towards wildlife in parts of Asia and in East Africa are changing, and people who were once aversed to harming primates are becoming increasingly indifferent to trapping and even killing them (Srivastava and Begum, 2005; Lee and Priston 2005). Repeated crop raiding events cause people to become increasingly intolerant of primates, in spite of

religious sentiment (Lee and Priston, 2005; Srivastava and Begum, 2005). Thus, primates

are worshipped in Buddhist temples in Thailand and Japan but are shot in the neighboring

fields (Lee and Priston, 2005). In some parts of India, Hindus now espouse religious

beliefs and trap or kill crop raiding macaques (e.g. Srivastava and Begum, 2005).

Livelihoods take precedence, and religious or societal expectations are ignored

(Chakravarthy and Thyagaraj, 2005). Similarly in my study, agropastoralists are the most

intolerant of baboons.

These patterns suggest that ownership of land and the resources therein (including

baboons) affect peoples' decisions or sense of entitlement concerning the killing of

baboons. These findings are further supported by preliminary results suggesting that

respondents who owned the land they occupied had more concrete long-terms goals for

utilizing their land and/or managing wildlife profitably (Moinde, unpub. data). The

politics of natural resource control is contentious (Ribot and Pelusso 2003; Unruh 2006).

The complexity of land tenure systems involves problems and disputes relating to claims

of legal ownership of land and resources, including wildlife (Unruh 2006). All wildlife in

Kenya however, is legally owned by the government, irrespective of land ownership or

tenure (Shikwati 2003). This jural arrangement further complicates the sense of private

or communal property rights and control of resources.

The Kenya Wildlife Service (KWS) is a state corporation mandated by the

government to facilitate the managing and conserving of wildlife. The KWS, therefore, is

the only Kenyan agency authorized to shoot wildlife, such as wildlife that is problematic

due to crop raiding or livestock predation. Some of the respondents expressed frustrations

towards the KWS due to its lack of response when solicited for assistance. One main reason that was repeatedly cited during interviews was that KWS was very quick to protect wildlife from people (i.e., hunting, poaching etc.), but was not quick to protect people from wildlife. Thus, the general feelings I gathered from respondents was that they felt that the KWS cared more for wildlife than it did for them.

Education, however, was the only factor to consistently influence perceptions of the KWS's role in managing and ownership of baboons. Requests for such assistance from the KWS as a means of discouraging baboons from crop raiding were influenced by age, education, and land tenure. People between 36-45 years of age were more likely than those 56 years and older to solicit the KWS. It appears that people who had gone through formal education were well aware of the role of the KWS in managing and protecting wildlife and were also frustrated by the apparent KWS favoritism towards wildlife over people. The connection between age and education could reflect that respondents at that age group (i.e., 36-45) were more educated and therefore more likely to express their rights to KWS assistance when needed. Some of these reasons stated above may also explain why the public's perception of the KWS tends to be negative in Laikipia (Moinde pers observ). In the next section of the discussion, I examine the question of baboon ownership and address the issue of land tenure in relation to wildlife ownership and management and revisit people's perceptions of KWS in relation to wildlife.

The issue of baboon ownership in Laikipia

My analysis indicated that land use system did not significantly influence people's beliefs about who owned the local baboons, but there were differences between the land use practitioners on this opinion. For example, agropastoralists were more likely to have the opinion that nobody owns baboons, whereas commercial ranchers were more likely to say that baboons belonged to their neighbors. Similarly, land tenure did not significantly influence people's opinions regarding baboon ownership, but there was a trend in its influence on the issue of baboon ownership. Thus, there were also differences within the tenure systems regarding this issue. People who did not own the land they occupied ("squatters") were also more likely indicate that their neighbors owned the baboons in that area. The latter result is arguably understandable since one could argue that if one has no legal rights to the land one occupies, feelings of entitlement to utilize its natural resources are less likely to develop than they are among those who own the land they live on. The fact that land tenure specifically did not influence the entitlement of owning baboon resonates with Theories of Access, whereby the theoretical framework is not based on land tenure, as the fundamental influence on how control of resources (e.g., wildlife) by individuals or institutions affects peoples' decisions to maintain access through *those* who have control (Ribot and Peluso 2003).

Access analysis also helps to explain why some people or institutions benefit from resources whether or not they have legal rights to them. My data reveal that people in Laikipia have very diverse opinions on who owns baboons. Interestingly, in my study gender influenced peoples' beliefs that the KWS owns the baboons in their area. Men

were more likely to hold this opinion than women. It is probably the case that men generally deal with matters pertaining to wildlife conflict or management on their land and are therefore are more likely than women to request KWS aid in controlling baboons. Birthplace also influenced peoples' beliefs of baboon ownership. Those born in Laikipia were less likely to recognize KWS ownership of baboons, which could be attributed to feelings of "a sense place" (Basso 1996) and knowledge of resource or wildlife ownership, arising from long-term residency in an area.

The Laikipia Wildlife Forum, African Wildlife Foundation, other nongovernmental organizations, and commercial landowners have all been helping local communities to gain title deeds to their land in the region. Promoting group landownership could have positive implications for predator and other wildlife conservation over large areas in Africa (Norton-Griffiths, 2007). Property rights provide residents with incentives for the sustainable use of natural resources, given that they will have access to those resources in future. Norton-Griffiths (2007), for example, found that community members living on group ranches (i.e., those with title deeds) were more positive toward predators compared to those on government land or "squatters". Group ranches have the benefit of being large enough to sustain suitable populations of wildlife species. Such a model is preferable to the subdivision of formerly communally owned land into small, privately owned parcels (e.g., small holdings), which are associated with declining diversities and densities of wildlife in Kenya generally (Norton-Griffiths, 2007) and in Laikipia specifically (Georgiadis 2007a;b). The tentative conclusion is that land ownership promotes a feeling

of greater control over wildlife and thereby enables management and conservation strategies that optimize current land use practices for future potential gains.

Surprisingly, only 20% of respondents correctly informed that baboons belong to the government, and equal number of people also thought that their neighbors owned the baboons in their area. Approximately half of the respondents were under the impression that baboons belong to the KWS, which was more than twice the number of people who knew that all wildlife belongs to the government. From these results it was evident that respondents were under the opinion that the KWS and the government were two separate entities rather one. This may also help to understand why public ratings for KWS effectiveness are usually low. Similar trends have been observed in many parts of the country because the KWS does not compensate but is only called up to facilitate prevention of problematic pests such as baboons and elephants in Laikipia (Moinde pers observ.). According to respondents, wildlife pest management by the KWS entails the use of guns, either to scare animals away by shooting in the air or to kill them. Most respondents pointed out that shooting at baboons was ineffective because it was temporary; baboons would eventually return and cause destruction again.

Most respondents who practiced farming in Laikipia were generally frustrated and discouraged by the lack of a more effective alternative method of limiting baboon crop raiding. What was also notable was that people in the commercial ranches were more aware than other land use practitioners of the role of the KWS because none of these two land practitioners (i.e., commercial ranching and commercial ranching-tourism) mentioned government ownership of baboons. Not surprising, people who practiced

farming (i.e., agropastoralism, agropastoralism-tourism and farming) yielded the highest

proportions of respondents with the opinion that the KWS (and not the government) owns

the baboons in the area. This clearly indicates that the KWS and the government are

perceived as two distinctly different legal wildlife managerial entities. This could also

correspond with the fact that those who farm and complement this practice with other

land use practices had the highest percentage of people to request KWS assistance to

prevent baboons from entering their property.

The costs and benefits of co-existing with baboons in Laikipia

Overall, almost half of the respondents claimed baboons did not provide any

benefits to people. Of the remaining respondents, approximately 10% stated no costs

were incurred from co-existing with baboons, while more than a third of them were well

aware of the benefits that they derive from existing with baboons. Interestingly, despite

the rarity of "Materialistic" values expressed towards baboons 65% of those who

indicated that baboons provided benefits explicitly stated that baboons were beneficial

(i.e., in attracting tourism, providing employment, education bursaries, and promoting

community development). Surprisingly, these "Materialistic" values were the most

expressed by respondents (38%) followed by 22% who expressed "Mutualistic" values to

described benefits attained from co-existing with baboons. For example, the

"Mutualistic" benefits explicitly stated were – baboons provide security (i.e., alarm

calling to alert others of potential danger), drop food from trees for their livestock, and

also provide companionship.

Also, surprisingly approximately 10% of those who indicated benefits from baboons expressed "Environmentalism" values towards them. These respondents said baboons are important for the ecosystem and are living creatures that are part of the landscape. These "Environmentalism" values indicate that some people in Laikipia see the intrinsic value of baboons and their importance to the environment.

With respect to land use, the percentage of people who mostly frequently expressed "Materialistic" values towards baboons were those who practiced commercial ranching-tourism, followed by people who practiced pastoralism-tourism and pastoralism alone (64%). It is possible that people who practiced pastoralism alone were more aware of the "Materialistic" value of baboons than those pastoralists who carried out farming activities (i.e., agropastoralists and agropastoralist-tourism). This is likely because the latter two systems bear the costs of crop raiding. It is important to highlight that people who practiced agropastoralism–tourism and agropastoralism alone offered the lowest percentages of people expressing "Materialistic" values towards baboons (after farmers who did not express any "Materialistic" values or benefits to co-existing towards baboons at all).

Other studies have shown that people's bias against baboons in West and East Africa has been exceptionally prominent around agricultural land use systems, where baboons are largely perceived as "pests" due to the quantifiable costs of crop raiding (Kingdon, 1974; Hill 1997; 2000; Naughton-Treves et al. 1998; Obunde et al., 2005). Thus, pastoralists who carry out agricultural practices are less likely to see the benefits of co-existing with baboons whether or not they carry out tourism ventures or accrue any

economic benefits from them. Similarly, Gadd (2005) also reported that people who

practiced agropastoralism in Laikipia were the least tolerant towards elephants. These

studies are line with Graham's (2006) findings that highlighted elephants and baboons as

the two most notorious crop raiders in Laikipia. As a result, baboons (and elephants) are

least tolerated by agropastoralists relative to other pastoralists in Laikipia.

Another point worth noting is that crop raiding by baboons was mentioned by most

respondents (48%), followed closely by livestock predation, which was mentioned by

45% of the people. With respect to land use, the highest percentage of people who

indicated the cost of livestock predation by baboons was mostly from the pastoralism-

tourism, followed by agropastoralism and pastoralism land use systems. Commercial

ranchers and farmers appeared to experience the cost of livestock predation from baboons

at lower levels than did pastoralists, practicing agriculture. This is because these three

types of land use practitioners do not typically keep goats and sheep, which are the

livestock specifically reported to be preyed upon by baboons. Of the people who

generally practiced farming, farmers, followed by agropastoralists, yielded the highest

percentages of people to bear the cost crop raiding from baboons. Pastoralists who

practiced ecotourism, that is, pastoralism-tourism and agropastoralism-tourism yielded

the highest percentages of people to bear costs of livestock predation from baboons.

This is probably due to the fact that those who practice tourism generally supported more

wildlife on their land as a result of ecotourism endeavors.

In the last two decades, the Laikipia Wildlife Forum has worked to include both

private and communal land-owners in wildlife management decision-making and

activities. The participation of local people in wildlife management activities outside of protected areas has been argued to be indispensable for successful conservation (Gibson and Marks 1995). This is because revenues generated from wildlife can create positive incentives for their management practices (Child 2000), whereas conflict between wildlife and people can prevent or erode local support for conservation (Gadd 2005). From my findings in this study, it is evident that the different land practitioners within Laikipia experience different levels of costs and benefits from co-existing with baboons. People within the commercial-tourism and pastoralism-tourism land use systems were the highest percentage of people in any given land use system to derive "Materialistic" benefits from baboons. Conversely, agropastoralism-tourism (100%), farmers (71%), and agropastoralists (60%) offered the highest percentages of people within a given land use system to evidently experience the highest overall costs from baboons. They were therefore more likely to harbor strong values of "Resentment" towards baboons. Unsurprisingly, these were all people who practiced farming irrespective of other complementary land use practice(s).

Wildlife-based benefits encourage tolerance (Gadd 2005). Wildlife-based employment and development projects aspire to provide both local private and communal owners with a sense of ownership over wildlife (Gibson and Marks, 1995). Thus, it appears that tourism, complemented with other land use practices in Laikipia, has the potential to foster tolerance towards wildlife in general and baboons in particular, except in the agropastoralism-tourism land use systems. The fact that all agropastoralist-tourism systems incur the highest reports of costs from co-existing with baboons indicates that the

benefits accrued from tourism do not offset these costs. The evidence from the agropastoralist-tourism land use system in Laikipia suggests that farming and tourism are incompatible practices vis-a-vis baboon co-existence. This is because the very resource (wildlife) that has the potential to provide economic benefits to this particular community is in conflict with their agricultural practices (because of crop raiding) as well as their pastoralism activities (because of livestock predation).

Concerns about both crop raiding and livestock predation caused by baboons are the main reasons why pastoralists who practice farming and tourism, in particular, harbor distinct "Resentment" values towards baboons in Laikipia. It is possible that channeling more direct (e.g., economic) and indirect benefits (e.g., school bursaries) accrued from wildlife should be channeled towards those who practice agropastoralism and also agropastoralism-tourism. This could be a viable option for fostering more tolerance and reduce "Resentment" values "towards wildlife. It is evident that those who practice agropastoralism-tourism claim to incur higher costs from baboons and from other wildlife, ironically because their conservation efforts most likely promote higher wildlife densities in the land next to where they cultivate. Ecotourism in pastoralist land use systems is only undertaken on communal lands, which are all equitably co-owned by group members who inhabit them (Polonet Kinyaga *pers comm*.). These pastoralist communal ranches are formed by a group of interacting pastoralists living in a common location under the same laws and regulation. They share a commitment to manage wildlife in order to foster wildlife through ecotourism such as, through, the construction of eco-lodges. These enterprises provide a wide range of employment opportunities,

camping, wildlife viewing, camel safaris, commercial selling of beadwork curios, and traditional artifacts (Moinde, unpub data). Both commercial ranchers and pastoralists who practice tourism combine their efforts to market their tourism endeavors both locally and internationally (see www.laikipiatourism.com).

Indirect benefits accrued from wildlife (i.e., constructions of schools, health dispensaries) that benefit the community at large was not identified by the communal pastoralists in the questionnaires. However, when interviewing people from Koija Ranch in the semi-structured phase of the research, many respondents were proud to inform me that Koija was the first ranch in Laikipia to educate children through university education bursaries accrued from wildlife. People also proudly pointed out the indirect benefits they had attained from wildlife, such as the best-equipped modern secondary school and health dispensary. Yet no one listed these indirect benefits during the questionnaire phase.

Agropastoralists, like other pastoralists (i.e., pastoralism, agropastoralism-tourism) and commercial ranchers alike, whose livelihood depends on the survival of their livestock, were more concerned about wildlife-borne diseases, such as foot and mouth disease in Laikipia (Georgiadis et al. 2007b).   In addition, lions, leopards, cheetahs, and hyenas, prey on livestock, while elephants and baboons raid crops. In other words, pastoralists have to contend only with diseases transmitted from wildlife to their livestock while farmers only have to contend with crop raiding from wildlife.

Agropastoralist claimed to incur more of these costs from wildlife, that is, livestock predation, crop raiding and wildlife-livestock transmitted diseases.

If wildlife in general is to be at least tolerated in Laikipia by those who perceive the largest costs of living with baboons and other wildlife, in this case farmers and agropastoralists (i.e., agropastoralist and agropastoralism-tourism), there is a need to redirect both direct and indirect benefits in a manner that offsets the evidently higher costs for these three particular land use practitioners. More importantly, baboons were found to be resented the most by farmers and all agropastoralists, irrespective of tourism practices. Aside from the economic benefits accrued from tourism, there is also clearly a need to emphasize the positive existential benefits that people expressed towards baboons, which generated the prominent value orientation "Interest-Attraction" and the less expressed "Mutualism" value orientation.

Living a long time in an area appears to be a mechanism for gaining experience and knowledge from interacting with wildlife. Ongoing wildlife environment educational programs coordinated by both Laikipia Wildlife Forum and the KWS for the public should be formulated to enhance the positive aspects of baboons that were revealed during my study. Similar to "baboon tourism" projects, the direct experience of "walking with baboons" could prove the most effective in influencing people's values towards baboons. For example, Hill (2005) argues that human attitudes towards nonhuman primates are a function of past contact between the two, while other studies demonstrate that both direct and indirect interactions with wildlife affect cognitive and emotional dispositions towards wildlife species (Saberwal et al., 1994). My study further supported

the rationale that reports of direct and indirect interaction influence beliefs and emotions (e.g., worries, joy) that influence how people perceive baboons.

The strength of applying WVO is that it is particularly useful for capturing trends in people's opinions about wildlife and their (reported) interactions with wildlife. Such information can guide conservation and management policies for mitigating conflict continual co-existence of humans and wildlife. However, this approach also has its weaknesses. For example, important nuances in values are lost in meaning because different opinions or statements are lumped to derive a particular value orientation towards wildlife. Hence, the cause of a reported particular interaction may not be clearly depicted in relation to a specific orientation.

This becomes more complicated when one recognizes that value orientations are not mutually exclusive. For example, in this study I found it difficult to differentiate the cause of the value orientation "fear". Respondents would express fear of a particular animal whether it cause physical harm/death or because it would traditionally bring honor and respect if killed (e.g. lion). These two expressions of fear could potentially produce two different outcomes of reported interactions with wildlife. One would cause respect and reverence, and the other avoidance and aggression. In this sense, the underlying cause of a particular interaction can be lost or misinterpreted, which could potentially mislead management strategies. It is important, therefore, to emphasize the nuances in meaning first, before categorizing value orientations as a means to avoid misinterpretation or human-wildlife interactions.

Some adaptive ecological perspectives on human-baboon interactions in Laikipia from a cost benefit analysis

The cost and benefit analysis of human-baboon interaction can also be viewed from the perspective of evolutionary ecology. For example in this study, the reported nature of human-baboon interactions across different land use practices in Laikipia can be viewed as synergistic components of a single ecosystem (sensu Fath and Patterson 1998). In line with the WVO theoretical perspective that mutualistic relationships have increasingly come to be recognized as common and stable interactions (i.e., Dugatkin 1997; Agrawal 2002), Ringel et al. (1996) argue that mutualistic relationships occur both within and between species in almost every ecosystem (reviewed in Dugatkin 1997). Fath and Patten (1998) go on to argue that human-primate interactions can be viewed as an exchange of resources between species –as *transactions*. "A transaction is defined as the direct, observable transfer of conservative resources between two organisms and the 'relation' is the direct and indirect consequence of these transfers" (Fath and Pattern 1998: 128).

These transactions also vary in the degree of dependence and directionality they manifest (Fath and Pattern 1998), as defined within different wildlife value orientations. For example, *facultative* relationships are not intentional or essential, and occur casually, while *obligate* relationships confer mutual survival – *mutualism*. Conversely, when only one side benefits from the transaction, it is *commensal* (Allaby 1998). Wildlife can pose different transactions on people depending upon the different land use systems. For

example, *commensal* transactions occur between the Il'Polei community in North-eastern Laikipia region where the community directly or indirectly benefits from baboon tourism relative to the surrounding communities that practice subsistence farming. Baboon tolerance in these neighboring communities is low (e.g., relative to Il Polei community) because baboons crop raid their *shambas*. In this case, the baboons are the beneficiaries of this *commensal* transaction. Concurrently, the killing of baboons around agricultural land use systems is considered to be relatively more common. It is here where "Resentment" values are most intense. Thus, baboons are likely to incur increased costs due to higher mortality rates relative to other land use systems.

An example of *obligate* interactions is when baboons were reported to emit distinct alarm calls near herders and their livestock. This behavior forewarns the humans of potential attacks from predators (e.g., lions, leopards) and consequently improves vigilance-based protection of their herds.   It is also possible that the presence of livestock within baboon home ranges reduces the risk of predation on baboons. The pressure to be preyed upon is reduced by the mere presence of livestock all over the landscape. Hence an *obligate* transaction exists where herders benefit from baboon alarm calls.

Baboons were reported by pastoralist communities to have facultative interactions with their livestock. Baboons drop pods from taller *Acacia* trees that livestock would otherwise not be able to access as food.   Such a reported indirect interaction between human domesticants and baboons is *facultative*, whereby the baboons incur no costs and *both* the baboon and livestock benefit, is called by-product mutualism (Burton and Caroll 1998). By-product mutualism differs from commensalism in that the former interaction

benefits both species while the later only benefits one of the species. Similarly, by-product mutualism has been observed between mantled howler monkey (*Alloutta palliatta*) and domesticants in Guatemala (Burton and Carroll 1998). By-product mutualism extends to the categories of cooperative behavior because an animal may perform a habitual beneficial behavior "for itself", such as eating, which incidentally is profitable to another (Brown 1983).

Thus, in this study I identified land users, particularly those from the majority of people found in pastoralist communities in Laikipia, whose positive value orientations and consequent reported interactions with baboons were rarely based on economic incentives relative to other wildlife species. This was despite pastoralist community-based conservation projects, which had in the past and still continue to run "baboon tourism" endeavors in communal pastoralist group ranches. The pastoralist communities, in particular the Maasai, were very aware of other indirect mutual benefits, such, as alarm calls emitting by baboons to warn of potential danger. Relative to traditional evaluations of people attitudes towards wildlife, the WVO approach can thus provide a more comprehensive perspective that will afford insights into social, ecological, economic, and also the potential evolutionary forces that characterize the nature of human relationships with baboons and other wildlife.

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Table 5.1: Summary of respondents socio-demographic information (N=242).

Socio-demographic factors categories	Number	%*
Gender		
Males	169	70
Females	73	30
Age		
18 - 25 years	48	20
26 - 35 years	67	28
36 - 45 years	48	20
46 - 55 years	41	17
56 and older	38	16
Place of Birth		
In Laikipia	152	63
Out of Laikipia	90	37
Level of Education		
None	105	43
Primary	67	28
Secondary	44	18
Post- secondary	26	11
Religion		
Christian	182	75
Muslims	7	30
Traditionist	47	47
Atheist	6	6
Ethnicity		
Nilote	181	75
Bantu	36	15
European	15	6
Cushite	10	4
Land use System		
Pastorialism (PAST)	53	22
Commercial Ranching (COMR)	10	4
Farming (FARM)	24	10
Agropastorialism (AGRP)	63	26
Pastoralism + Tourism (PATO)	65	26
Commercial Ranching + Tourism (COTO)	11	5
Agropastorialism + Tourism (APTO)	16	7
Land Tenure		
Communal owned (COW)	105	43
Private owned (POW)	52	22
Occupied informally (OCC)	49	20
Occupied formally (FOC)	24	10
Unknown (N/A)	12	5

*Percentages are rounded to the nearest decimal

N/A – 12 respondents did not reveal there tenureship.   This category was not used for the Multinominal logistic regression analysis and therefore does not appear in any of the following tables.

Table 5.2: Multicolinearity Test – Pearson coefficient (*r*)

Socio-demographic Factors	Gender	Age	Birthplace	Education	Religion	Ethnicity	Land use system	Land tenure
AMBIVALENT	.048	.084	-.043	-.062	-.005	.089	.132	.031
Gender	-	-.078	.083	-0.285***	.039	-.085	-.053	0.170**
Age		-	0.133*	-0.207*	0.181**	0.15*	.069	.058
Birthplace			-	.084	-.094	.091	-.109	0.339***
Education				-	-.271	0.25**	0.175***	-0.113*
Religion					-	.091	-.049	-.069
Ethnicity						-	.112	-.050
Land use system							-	-0.161*
Land tenure								-
FEAR	0.115 *	-.037	.111	.097	-.044	-.009	.073	-.020
Gender	-	-.078	.083	-0.285***	.039	-.085	-.053	0.170**
Age		-	0.133*	-0.20**	0.181**	0.153***	.069	.058
Birthplace			-	.084	-.094	.091	-.109	0.339***
Education				-	-0.271***	0.254***	0.175**	-0.113*
Religion					-	.091	-.049	-.069
Ethnicity						-	.112	-.050
Land use system							-	-0.16`*
Land tenure								-
INTEREST- ATTRACTION	-0.153*	-0.156*	-.071	.146	-.042	-.053	-.007	-0.16*
Gender	-	-.078	.083	-0.285**	.039	-.085	-.053	0.170**
Age		-	0.133*	-0.207**	0.181**	0.15*	.069	.058
Birthplace			-	.084	-.094	.091	-.109	.339
Education				-	-0.271***	0.254*	0.175**	-0.113*
Religion					-	.091	-.049	-.069
Ethnicity						-	.112	-.050
Land use system							-	-0.16***

445

Land tenure								-
Socio-demographic factor	**Gender**	**Age**	**Birthplace**	**Education**	**Religion**	**Ethnicity**	**Land use**	**Tenure**
MUTUALISTIC	-.013	-.054	-.111	-.026	-.004	.028	-.037	0.141*
Gender	-	-.078	.083	-0.285***	.039	-.085	-.053	0.170***
Age		-	0.133*	-0.207*	0.181*	0.153*	.069	.058
Birthplace			-	.084	-.094	.091	-.109	0.339***
Education				-	-0.271***	0.254***	0.175**	-.113
Religion					-	.091	-.049	-.069
Ethnicity						-	.112	-.050
Land use system							-	-0.160*
Land tenure								-
RESENTMENT	.025	0.127*	-.070	-0.202**	.071	-.085	.005	-.057
Gender	-	-.078	.083	-.285	.039	-.085	-.053	.170
Age		-	0.133*	-0.207**	0.181**	0.153*	.069	.058
Birthplace			-	.084	-.094	.091	-.109	0.339***
Education				-	-0.271***	0.254***	0.175**	-.113
Religion					-	.091	-.049	-.069
Ethnicity						-	0.112*	-.050
Land use system							-	-.161
Land tenure								-
NEUTRAL	.067	.039	0.185*	.064	.017	0.122*	-.091	0.211**
Gender	-	-.078	.083	-0.285***	.039	-.085	-.053	0.170**
Age		-	0.133*	-0.207**	0.181**	0.153*	.069	.058
Birthplace			-	.084	-.094	.091	-.109	0.339*
Education				-	-0.271***	0.254***	0.175**	-.113
Religion					-	.091	-.049	-.069
Ethnicity						-	.112	-.050
Land use system							-	-0.161*

| Land tenure | | | | | | | | | - |

Table 5.3: Socio-demographics of respondent's within land use systems

Socio-demographics categories	Pastoralism (PAST)	Commercial ranching (COMR)	Farming (FARM)	Farming (FARM)	Agro-pastoralism (AGRP)	Pastoralism-tourism (PATO)	Commercial ranching-tourism (COTO)	Agro-pastoralism-tourism (APTO)	Overalll
GENDER									
Male	14% (34)	5% (11)	6% (14)	19% (45)	18% (44)	4% (10)	4%(10)	69% (168)
Female	7% (18)	0% (1)	4% (10)	7% (18)	8% (20)	0% (1)	3% (6)	31% (74)
TOTAL (N)	**52**	**12**	**24**	**63**	**64**	**11**	**16**	**242**
AGE CATEGO-RIES									
18-25 yrs	7% (16)	0% (0)	3% (0)	6%(0)	5%(0)	0%(0)	0% (1)	21% (50)
26-35 yrs	5%(11)	0%(1)	2% (5)	10% (25)	8% (20)	1% (3)	1% (2)	28% (67)
36-45 yrs	3% (8)	2% (5)	2% (4)	4% (9)	5% (12)	1% (2)	3% (7)	19% (47)
46-55 yrs	5% (11)	2% (4)	2% (4)	3% (6)	5% (12)	1% (3)	0% (1)	17% (41)
56^+ yrs	3% (6)	1% (2)	2% (5)	3% (8)	3% (8)	1% (3)	2% (5)	15% (37)
TOTAL (N)	**52**	**12**	**24**	**63**	**64**	**11**	**16**	**242**
BIRTH PLACE									
In Laikipia	14% (33)	3% (6)	4% (9)	16% (39)	21% (50)	1% (2)	5% (2)	63% (2)
Out of Laikipia	8% (19)	3% (6)	6% (9)	10% (24)	6% (14)	4% (9)	1% (3)	37% (89)
TOTAL (N)	**52**	**12**	**24**	**63**	**64**	**11**	**16**	**242**
EDUCAT-ION									

		Pastoralism (PAST)	Commercial ranching (COMR)	Farming (FARM)	Agro-pastoralism (AGRP)	Pastoralism-tourism (PATO)	Commercial ranching-tourism (COTO)	Agro-pastoralism-tourism (APTO)	Overall
	None	13% (32)	0% (0)	3% (8)	11% (27)	13% (31)	0% (0)	3% (7)	43% (105)
	Primary	5% (12)	0% (0)	5% (11)	10% (25)	7% (16)	0% (0)	1% (3)	28% (67)
	Secondary	2% (5)	3% (7)	2% (5)	3% (8)	5% (11)	2% (5)	1% (3)	18% (44)
	Post - Secondary	1% (3)	2% (5)	0% (0)	1% (3)	3% (6)	3% (6)	1% (3)	11% (26)
	TOTAL (N)	**52**	**12**	**24**	**63**	**64**	**11**	**16**	**242**
	Socio-demographics categories	**Pastoralism (PAST)**	**Commercial ranching (COMR)**	**Farming (FARM)**	**Agro-pastoralism (AGRP)**	**Pastoralism-tourism (PATO)**	**Commercial ranching-tourism (COTO)**	**Agro-pastoralism-tourism (APTO)**	**Overall**
RELIGION	Christian	13% (32)	5% (11)	10% (24)	19% (46)	21% (50)	3% (8)	5% (11)	75% (182)
	Muslim	1% (2)	0% (0)	0% (0)	2% (4)	0% (0)	0% (1)	0% (1)	3% (7)
	Traditionist	7% (17)	0% (0)	0% (0)	5% (12)	5% (13)	0% (0)	2% (5)	19% (47)
	Aethist	0% (1)	0% (1)	0% (0)	0% (1)	0% (1)	1% (2)	0% (0)	3% (6)
	TOTAL (N)	**52**	**12**	**24**	**63**	**64**	**11**	**16**	
ETHNI-CITY									
	Bantu	1% (3)	1% (3)	8% (19)	2% (5)	2% (4)	1% (2)	0% (0)	14% (36)
	Nilote	19 (45)	1% (2)	2% (5)	22% (54)	24% (59)	0% (0)	7% (16)	75% (181)
	Cushite	2% (4)	0% (0)	0% (0)	25 (4)	0% (1)	05 (1)	0% (0)	4% (10)
	European	0% (0)	3% (7)	0% (0)	0% (0)	0% (0)	3% (8)	0% (0)	6% (15)
	TOTAL (N)	**52**	**12**	**24**	**63**	**64**	**11**	**16**	**242**
TENURE									
	Communal owned	10 % (24)	0% (0)	0% (1)	9% (21)	21% (49)	0% (0)	4% (10)	46% (105)
	Private owned	2% (5)	4% (10)	6% (13)	4% (10)	2% (4)	4% (9)	0% (1)	23% (52)
	Occupied informally	6% (14)	0% (0)	2% (5)	8% (18)	3% (7)	0% (0)	2% (5)	21% (49)

Occupied formally	3% (6)	0% (0)	2% (5)	4% (10)	1% (3)	0% (0)	0% (0)	10% (24)
TOTAL (N)	**49**	**10**	**24**	**59**	**63**	**9**	**16**	**230**

Table 5.4: Wildlife mentioned by respondents in Laikipia District

No	Wildlife	Scientific name	Frequency	%
1	elephant	*Loxodonata africana*	223	16.4
2	common zebra	*Equus quagga*	153	11.3
3	baboon	*Papio hamadryas anubis*	142	10.5
4	Spotted hyena	*Crocuta crocuta*	100	7.4
5	lion	*Panthera leo*	86	6.3
6	giraffe	*Giraffa camelopardalis*	81	6.0
7	impala	*Aepyceros melampus*	81	6.0
8	gazelle	*Gazella sp.*	70	5.2
9	vervet monkey	*Chlorocebus pygerythrus*	68	5.0
10	leopard	*Panthera pardus*	61	4.5
11	eland	*Taurotragus oryx*	52	3.8
12	jackal	*Canis mesomelas.*	37	2.7
13	dik-dik	*Madoqua sp.*	28	2.1
14	wild dog	*Lycaon pictus*	23	1.7
15	cheetah	*Acinonyx jubatus*	20	1.5
16	warthog	*Phacochoerus africanus*	15	1.1
17	porcupine	*Hystrix africaeustralis*	14	1.0
18	hippo	*Hippopotamus amphibius*	13	1.0
19	kudu	*Tragelaphus*	11	.8
20	hare	*Lepus microtis*	9	.7
21	bush pig	*Potamochoerus larvatus*	9	.7
22	white rhinoceros	*Ceratotherium simum*	8	.6
23	grevy's zebra	*Equus grevyi*	7	.5
24	waterbuck	*Kobus ellipsiprymnus*	7	.5
25	ostrich	*Struthio camelus*	7	.5
26	antelope	-	6	.4
27	oryx	*Oryx beisa*	5	.4
28	Common duiker	*Sylvicapra sp.*	5	.4
29	tortoise	*Testudo sp.*	3	.2
30	squirrel	*Sciuridae sp.*	3	.2
31	gerenuk	*Litocranius walleri*	3	.2
32	aardvark	*Orycteropus afer*	3	.2
33	rock hyrax	*Procavia capensis*	2	.1
34	birds	-	1	.1
	Total		**1358**	**100.0**

-    Unspecified species

Table 5.5: Relative frequency of feelings and statements expressed about the 10 most frequently mentioned wildlife species

WVO	Feelings and statements about wildlife	N	%
RESENTMENT	Property	331	38
	Destructive	68	8
	Threat to livestock	70	8
	Concern/threat to property	5	1
	Crop raider	129	15
	Compete for grass with livestock	29	3
	Livestock predator	163	18
	Unattractive	2	0
	Sad	85	10
SUBTOTAL		882	100
SYMBOLISM	God's creatures	4	1
	Good luck	181	56
	Bad luck	141	43
SUBTOTAL		326	100
MATERIALISM	Tourist attraction	45	69
	Like livestock	17	26
	Source of food	3	5
SUBTOTAL		65	100
FEAR	Safety	291	51
	Threat humans	235	41
	Kill humans	47	8
	Brings diseases to animals	1	0
SUBTOTAL		574	100
NEUTRAL	Harmless	150	54
	Do not bother me	32	12
	Do not cause destruction	16	6
	No economic benefit	2	1
	No reason given	77	28
SUBTOTAL		277	100
INTEREST-ATTRACTION	Happy	302	31
	I like them	7	1
	Beautiful	121	12
	Interesting behavior	10	1
	Attraction	389	40
	Funny	4	0

	Clever or creative elusive	2	0
	Friendly	142	15
	SUBTOTAL	977	100
MUTUALISM	Have a right to be here	12	16
	respect	65	84
	SUBTOTAL	77	100
ENVIRONMENTALISM	Concern Rare and endangered	19	76
	Threat to wildlife	2	8
	Threat to the environment	4	16
	SUBTOTAL	25	100
	OVERALL TOTAL	**3203**	**100**

Table 5.6: WVO generated from people's about baboons

WVO	Respondents thought and feelings towards baboons	N	%
	Ambivalent	4	57
AMBIVALENT	Because it may kill and the way they live	1	14
	Crop raids by calculating like a human being	1	14
	Sometimes can fight back and sometimes interesting behavior	1	14
	SUBTOTAL	7	100
	Fear	23	92.0
FEAR	Threat to my life	1	4.0
	Seems like they want to fight with me	1	4.0
	SUBTOTAL	25	100.0
	Curiosity	86	85
	Because I want to know what attracts tourist	1	1
	Because of its way of living	1	1
	Because of its eating behavior	1	1
INTEREST-	Because they are funny sometimes they imitate a person	1	1
ATTRACTION	Interesting to watch their behavior, children - social interactions	1	1
	Happy	7	7
	Happy because I earn a living out of them	1	1
	Happy because they are friendly and can be easily tamed	1	1
	Interesting and intelligent animal	1	1
	SUBTOTAL	101	100
	Baboons behave and look like humans	2	10
	Because they play and interact to the human children	1	5
	Behave similar to humans	1	5
	Behaves and looks like a human being and very intelligent	1	5
	Humor and solidarity	1	5
MUTUALISTIC	I feel close to them because they behave like humans	1	5
	I like watching them because they behave like humans	1	5
	Interesting it's like a human being	2	10

	It imitates human behavior	2	10
	Its behavior resembles that of humans	2	10
	I would not do anything because it looks like a human being	2	10
	They are more like humans	2	10
	They are similar to human beings	2	10
	SUBTOTAL	20	100
	I feel nothing	15	48
	They do not bother me	7	23
	Feel nothing	1	3
	I don't derive any benefit from it	1	3
NEUTRAL	It is not destructive	1	3
	It's just like any other animal	1	3
WVO	**Respondents thought and feelings towards baboons**	**N**	**%**
	Nothing because they are rare	1	3
	Nothing much	1	3
	They don't bother me	1	3
	They are good because they don't bother my property	1	3
	They might kill my livestock	1	3
	SUBTOTAL	31	100
	Anger	84	76
	Because of crop raiding	1	1
	Because of the red backs ugly in shape	1	1
	Crop raid my *shamba**	5	5
	I don't like them	1	1
	It depends- when they are in the right place I don't bother	1	1
	It has led me to a great loss and a threat to my children	1	1
RESENTMENT	Kills (my) lambs and kids	8	7
	Not much destructive	2	2
	They destroy birds nest, insects die kill baby impala**	1	1

	They bring more problems than good	1	1
	They cause a lot of damage	2	2
	They raid crops, kill kids and lambs	1	1
	They are tricky	1	1
	Worry that I will have to chase them	1	1
	SUBTOTAL	**111**	**100**
	OVERALL TOTAL	**295**	**100**

*cultivated area (Swahili)

**also mutually inclusive with the "Environmentalism" concern for the environment as a result of baboons damage to aspects of the environment.

Table 5.7a: The Likelihood Ratio Tests indicating socio-demographic factors that influence respondent's WVOs towards baboons

Socio-demographic factors	Chi-Square	df	P value
Intercept	0.000 [a]	0	
Gender	3.577	5	0.612
Age	25.607	20	0.179
Birthplace	17.442	5	0.004
Education	25.503	15	0.044
Religion	16.306	15	0.362
Ethnicity	21.845	15	0.112
Land use system	36.738	30	0.185
Land tenure	37.067	15	0.001

[a]. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Table 5.7b: The differences within the socio-demographic categories that influenced respondents' value orientation towards baboons

Socio-demographics	Categories	WVO[a]				
		Ambivalence	Fear	Interest-Attraction	Mutualism	Resentment
		Estimate (SE)				
	Intercept	-29.617	-10.02 (5629.6)	-31.65 (2309.0)	-43.671	15.80 (1101.3)
GENDER						
	Male	-0.40 (1.1)	-1.36 (0.9)	0.02 (0.7)	-0.75 (1.1)	-0.17 (657.0)
	Female	0[b]	0[b]	0[b]	0[b]	0[b]
AGE						
	18-25 yrs	-0.84(1.5)	-2.1(1.5)	0.18 (1.2)	-1.364 (944.0)	-0.84 (1.1)
	26-35 yrs	-1.47 (1.1)	-0.78 1.4)	1.12 (1.1)	1.11 (730)	-0.64 (1.1)
	36-45 yrs	0.25(1.4)	-2.66 (1.6)	-0.23 (1.2)	-1.65 (996.0)	-0.41 (1.0)
	46-55 yrs	-1.49 (1.8)	-3.49 (1.9)	-0.01 (1.1.)	-2.47 (296.0)	-0.76 (1.0)
	$\geq$ 56 yrs	0[b]	0[b]	0[b]	0[b]	0[b]
BIRTH PLACE						
	In Laikipia	1.56 (1.04)	-1.40 (1.0)	0.72 (0.618)	3.22 (1.3)*	0.86 (0.6)
	Out of Laikipia	0[b]	0[b]	0[b]	0[b]	0[b]
EDUCATION						
	None	14.01 (905.6)	-1.34 (1.6)	-0.81 (1.20)	12.52 (973.7)	2.90 (1.5)
	Primary	12.89 (905.6)	-1.016 (1.5)	-0.74 (1.1)	12.83 (973.7)	2.34 (1.5)
	Secondary	16.00 (905.6)	1.450 (1.6)	0.47 (1.2)	15.9 (747.0)	3.82 (1.6)*
	Post-secondary	0[b]	0[b]	0[b]	0[b]	0[b]
RELIGION						
	Christian	16.55 (5573.8)	15.67 (3746.8)	17.43 (1919.6)	17.39 (915.0)	0.38 (1.3)
	Muslim	-4.47 (7264.6)	31.30 (11387.6)	13.99 (3229.2)	13.7 (802)	-2.20 (0.000)
	Traditionist	17.432 (5573.79)	15.19 (3746.8)	18.61 (1919.6)	18.6 (815)	0.96 (1.4)
	Atheist	0[b]	0[b]	0[b]	0[b]	0[b]
ETHNICITY						

Socio-demographics	Categories	Ambivalent	Fear	Interest-Attraction	Mutualism	Resentment
	Bantu	-25.37 (1626.8)	0.81 (4201.7)	14.84 (1283.4)	-1.04 (229)	-15.68 (1101.3)
	Nilote	-15.03 (1501.7)	-0.84 (4201.7)	12.97 (1283.4)	-2.59 (229.0)	-17.51 (1101.3)
				Estimate (SE)		
	Cushite	5.63 (1862.3)	-0.41 (11202.2)	30.91 (1691.1)	20.58 (849)	-0.30 (0.0)
	Europoean	0^b	0^b	0^b	0^b	0^b
LAND USE						
	PAST	-3.49 (2.0)	-1.98 (1.8)	1.33 (1.9)	14.24 (669.0)	-1.70 (1.5)
	COMR	-2.94 (1630.5)	-4.11 (2895.8)	0.60 (2.4)	-3.025 (571.0)	-17.80 (1101.3)
	FARM	-14.67 (707.0)	-3.18 (2.4)	1.30 (2.2)	13.56 (1507.7)	-1.79 (1.7)
	AGRP	-0.96 (1.8)	-1.750 (1.9)	1.48 (2.0)	14.81 (669.0)	-0.49 (1.6)
	PATO	-2.39 (1.8)	-1.71 (1.7)	1.97 (1.9)	15.20 (669.0)	-1.40 (1.5)
	COTO	-16.9 (2062.6)	-4.03 (4528.8)	16.14 (1283.4)	-1.93 (551.0)	-18.95 (1101.3)
	APTO	0^b	0^b	0^b	0^b	0^b
LAND TENURE						
	Communal owned	15.34 (1140.8)	1.67 (1.4)	1.06 (1.0)	-3.84 (2.1)	1.66 (0.993.0)
	Private owned	1.89 (1305.7)	-14.34 (681.5)	-0.90 (1.1)	-2.19 (2.1)	0.52 (993.0)
	Occupied informally	15.482 (1140.8)	-0.69 (1.2)	-0.73 (0.9)	-1.41 (320.0)	0.32 (861.0)
	Occupied formally	0^b	0^b	0^b	0^b	0^b

a. The reference category is: Neutral.

b. This parameter is set to zero because it is redundant as the reference category for the independent variable.

*indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$)

Table 5.8a: The Likelihood Ratio Tests indicating socio-demographic factors that influence respondent's opinion that the presence of baboons can cause sickness

Socio-demographic factors	Chi-Square	df	P value
Intercept	0.000[a]	0	
Gender	2.316	1	0.128
Age	6.295	4	0.178
Birthplace	0.661	1	0.416
Education	19.146	3	0.000
Religion	3.410	3	0.333
Ethnicity	13.585	3	0.004
Land use system	8.755	6	0.188
Land tenure	0.969	3	0.809

a. This reduced model is equivalent to the final model because omitting the effect does not increase the
b. degrees of freedom.

Table 5.8b: The differences within the socio-demographic categories that influenced peoples' opinions that baboons can cause sickness

Socio-demographics	Categories	Baboons causes sickness [a]	The presence of baboons does not cause sickness [a]
		B Estimates (SE)	
	Intercept	17.11 (6737.4)	36.1 (3620.3)
GENDER			
	Male	0.65 (0.5)	1.19 (0.4)**
	Female	0[b]	0[b]
AGE			
	18-25 yrs	-0.29 (0.8)	1.72 (0.7)*
	26-35 yrs	-1.83 (0.8)*	0.27 (0.6)
	36-45 yrs	-0.11 (0.7)	0.80 (0.7)
	46-55 yrs	-1.05 (0.8)	0.26 (0.7)
	≥ 56 yrs	0[b]	0[b]
BIRTH PLACE			
	Within Laikipia	0.39 (0.5)	0.60 (0.4)
	Out of Laikipia	0[b]	0[b]
EDUCATION			
	None	0.47 (1.0)	0.78 (0.8)
	Primary	2.03 (1.0)*	0.83 (0.8)
	Secondary	1.50 (1.0)	0.79 (0.8)
	Post-secondary	0[b]	0[b]
RELIGION			
	Christian	0.08 (0.6)	-18.80 (0.5)***
	Muslim	-17.71 (4592.7)	-18.92 (1.5)***
	Traditionist	0.05 (0.0)	-18.67 (0.0)
	Atheist	0[b]	0[b]
ETHNICITY			
	Bantu	-18.88 (6737.4)	-19.00 (3620.3)

	Nilote	-17.28 (6734.4)	-18.60 (3620.3)
	Cushites	-17.02 (6737.4)	-17.36 (3620.3)
	Europoean	0^b	0^b
LAND USE			
	PAST	0.51 (0.8)	0.43 (0.8)
	COMR	-17.49 (6620.2)	0.47 (1.6)
	FARM	-0.60 (1.3)	-0.33 (1.1)
	AGRP	-1.49 (0.9)	0.02 (0.83)
	PATO	-0.38 (0.8)	0.24 (0.8)
	COTO	-16.14 (6737.4)	-17.75 (3620.3)
	APTO	0^b	0^b
LAND TENURE			
	Communal owned	-1.13 (0.9)	-1.90 (0.7)*
	Private owned	-0.66 (1.0)	-0.95 (0.8)
	Occupied informally	-1.35 (0.9)	-1.044 (0.7)
	Occupied formally	0^b	0^b

[a]The reference category is: I don't know

[b] This parameter is set to zero because it is redundant as a reference category for each of the predictor variables for each of the models. *indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$

Table 5.9a: The Likelihood Ratio Tests indicating the influence of socio-demographic factors on peoples' reaction to baboons when they last saw them.

Socio-demographic factors	Chi-Square	df	P value
Intercept	0.000[a]	0	
Gender	5.398	2	0.067
Age	6.538	8	0.587
Birthplace	1.234	2	0.539
Education	17.974	6	0.006
Religion	11.711	6	0.069
Ethnicity	.490	6	0.998
Land use system	38.856	12	0.000
Land tenure	4.504	8	0.809

[a] This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Table 5.9b: socio-demographic categories that influenced peoples' reaction to baboons

Peoples' reaction to when baboons were last seen

Socio-demographics	Categories	*I did nothing*
	Intercept	104.71 (4731.4)
GENDER		
	Male	16.93 (1013.0)
	Female	0[b]
AGE	18-25 yrs	-1.70 (2203.4)
	26-35 yrs	-1.55 (2203.4)
	36-45 yrs	-27.48 (2203.4)
	46-55 yrs	12.43 (2203.4)
	$\geq$ 56 yrs	0[b]
BIRTH PLACE	Within Laikipia	-16.44 (1543.9)
	Out of Laikipia	0[b]
EDUCATION	None	-11.13 (1843.9)
	Primary	28.56 (2199.2)
	Secondary	-11.48 (1843.9)
	Post-secondary	0[b]
RELIGION	Christian	-16.82 (1.0)
	Muslim	0.73 (1.0)
	Traditionist	23.10 (1.0)
	Atheist	0[b]
ETHNICITY	Bantu	-14.31 (2372.0)
	Nilotes	-10.45 (2931.6)
	Cushites	-23.61 (8013.2)
	Europoean	0[b]
LAND USE	PAST	-17.45 (2974.7)
	COMR	-45.04 (2885.1)
	FARM	-16.94 (3585.5)
	AGRP	-44.53 (2734.4)
	PATO	-40.56 (2560.1)
	COTO	-58.15 (3546.7)
	APTO	0[b]
LAND TENURE	Communal owned	-7.87 (1334.7)
	Private owned	-3.89 (2728.5)
	Occupied informally	11.10 (0.7)*
	Occupied formally	0[b]

[a.] The reference category is: I watched (Interest)

b. This parameter is set to zero because it is redundant as a reference category for each of the predictor variables for each of the models. *indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$).

Table 5.9c: Peoples' reaction towards baboons when they last them (N = 232)

Reaction to seeing baboons	PAST	COMR	FARM	AGRP	PATO	COTO	APTO	Total
Nothing	81% (39)	83% (10)	36% (8)	63% (38)	78% (49)	91% (10)	31% (5)	69% (159)
I ran away	0% (0)	8% (1)	0% (0)	2% (1)	2% (1)	9% (1)	19% (7)	3% (7)
I tried to scare	17% (8)	0% (0)	64% (14)	32% (19)	17% (11)	0% (0)	50% (8)	26% (60)
I tried to kill	2% (1)	0% (0)	0% (0)	2% (1)	0% (0)	0% (0)	0% (0)	1% (2)
I watched	0%	8% (1)	0% (0)	2% (1)	3% (2)	0% (0)	0% (0)	1% (232)

Number of respondents is in parenthesis

Table 5.10a: The Likelihood Ratio Tests indicating socio-demographic factors that influenced people's reasons for their reaction when they last saw baboons

Socio-demographic factors	Chi-Square	df	p value
Intercept	0.000[a]	0	
Gender	3.488	7	0.837
Age	25.986	28	0.574
Birthplace	8.200	7	0.315
Education	26.106	21	0.202
Religion	285.585	21	0.000
Ethnicity	141.342	21	0.000
Land use system	75.720	42	0.001
Land tenure	21.832	28	0.789

[a] This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom
[b.] Unexpected singularities in the Hessian matrix are encountered. This indicates that either some predictor variables should be excluded or some categories merged.
[c.] The log-likelihood value cannot be further increased after maximum number of step-halving

Table 5.10b: The differences within the socio-demographic categories that influenced the reasons people responded to baboons when they last saw them

Socio-demographic	Categories	Reason for people's reaction to baboons when last seen [a]	
		The baboons were too far	*Don't bother me*
	Intercept	-17.12 (3034.9)	1.49 (2.5)
GENDER	Male	0.69 (0.6)	0.60 (0.5)
	Female	0[b]	0[b]
AGE			
	18-25 yrs	0.34 (0.9)	-0.61 (0.8)
	26-35 yrs	0.21 (0.8)	-0.38 (0.74)
	36-45 yrs	0.58 (0,9)	0.43 (0.8)
	46-55 yrs	0.63 (0,9)	-0.19 (0.8)
	$\geq$ 56 yrs	0[b]	0[b]
BIRTH PLACE			
	Within Laikipia	0.27 (0.6)	-0.170 (0.5)
	Out of Laikipia	0[b]	0[b]
EDUCATION			
	None	-1.08 (1.1)	-1.0 (1.0)
	Primary	-0.84 (1.2)	-0.45 (1.1)
	Secondary	-2.20 (1.1)*	-1.33 (0.1.0)
	Post-secondary	0[b]	0[b]
RELIGION			
	Christian	17.40 (3034.9)	0.02 (1.4)
	Muslim	30.76 (4074.4)	14.32 (2718.5)
	Traditionist	17.41 (3034.9)	-0.35 (1.4)
	Atheist	0[b]	0[b]
ETHNICITY			
	Bantu	-1.21 (2.0)	-0.36 (1.5)
	Nilote	-1.31 (2.2)	-1.15 (1.6)
	Cushite	12.36 (2479.1)	13.571

	Europoean	0[b]	0[b]
LAND USE			
	PAST	1.32 (1.1)	1.93 (1.0)*
	COMR	0.19 (2.3)	0.02 (1.7)
	FARM	3.66 (1.8)*	1.10 (1.7)
	AGRP	2.30 (.1.2)*	1.68 (1.0)
	PATO	1.2 (1.1)	2.18 (0.9)*
	COTO	2.61 (2.5)	0.52 (2.0)
	APTO	0[b]	0[b]
LAND TENURE			
	Communal owned	0.30 (1.0)	-0.47 (1.0)
	Private owned	-1.14 (1.2)	-0.10 (1.0)
	Occupied informally	-0.28 (1.0)	-0.13 (1.0)
	Occupied formally	0[b]	0[b]

[a] The reference category is "Other" b. This parameter is set to zero because it is redundant
*indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$)

Table 5.11a: The Likelihood Ratio Tests indicating socio-demographic factors that influenced people's use of preventative measures against baboons

Socio-demographic factors	Chi-Square	df	P value
Intercept	0.000[a]	0	
Gender	5.553	1	0.018
Age	1.049	4	0.902
Birthplace	.000	1	0.985
Education	4.755	3	0.191
Religion	3.244	3	0.355
Ethnicity	1.143	3	0.767
Land use system	9.788	6	0.134
Land tenure	2.625	3	0.453

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Table 5.11b: The differences within the socio-demographic categories that influenced peoples' use of preventative measures against baboons

Socio-demographic factors	categories	People who take preventative measures against baboons[a]
Intercept		4.02 (1.9)
GENDER	Male	-0.84 (0.4)*
	Female	0[b]
AGE		
	18-25 yrs	0.08 (0.6)
	26-35 yrs	-0.13 (0.5)
	36-45 yrs	-0.019 (0.52)
	46-55 yrs	0.35 (0.6)
	$\geq$ 56 yrs	0[b]
BIRTH PLACE		
	Within Laikipia	-0.01 (0.3)
	Out of Laikipia	0[b]
EDUCATION		
	None	-1.30 (0.7)
	Primary	-0.78 (0.7)
	Secondary	-0.44 (0.7)
	Post-secondary	0[b]
RELIGION		
	Christian	0.13 (1.1)
	Muslim	-2.27 (1.8)
	Traditionist	-0.06 (.1.1)
	Atheist	0[b]
ETHNICITY		
	Bantu	-1.30 (1.3)
	Nilote	-1.29 (1.4)
	Cushite	-0.82 (1.7)
	Europoean	0[b]
LAND USE		
	PAST	-1.46 (0.7)*

	COMR	-2.03 (1.4)
	FARM	-0.31 (1.0)
	AGRP	-0.81 (0.7)
	PATO	-1.37 (0.7)*
	COTO	-1.00 (1.7)
	APTO	0[b]
LAND TENURE		
	Communal owned	-0.22 (0.5)
	Private owned	0.17 (0.5)
	Occupied informally	-0.64 (.5)
	Occupied formally	0[b]

a. The reference category is: No

b. This parameter is set to zero because it is redundant. *indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$)

Table 5.12: Different preventative methods used against baboon used by different land users (N= 135)

Preventative methods	PAST	COMR	FARM	AGRP	PATO	COTO	APTO
Gun/rifle shotgun*	0% (0)	38% (3)	11% (2)	0% (0)	0% (0)	67% (6)	0% (0)
Throw stones at baboons	80% (16)	63% (5)	50% (9)	78% (29)	63% (19)	33% (3)	31% (4)
Thunder flashes	5% (1)	0% (0)	0% (0)	0% (0)	7% (2)	22% (2)	0% (0)
Chasing	80% (16)	50% (4)	94% (17)	78% (29)	83% (25)	44 (4)	1% (13)
Dogs	35% (7)	38 (3)	22 (4)	30 (11)	37 (11)	0% (0)	31 (4)
Other methods**	0% (0)	0% (0)	0% (0)	27% (2)	0% (0)	44% (4)	15 (2)

*Guns, rifles or shotguns used to scare baboon by shooting near them and not to harm them

**Other preventative methods employed people included erecting a fence by cutting down trees, or construction of an electric fence, planting cactus around a garden or shouting at baboon to scare them. respondents numbers are in parenthesis

Table 5.13a: The Likelihood Ratio Tests indicating socio-demographic factors that influenced respondents' opinion on the legality of killing baboons

Socio-demographic factors	Chi-Square	df	p value
Intercept	0.000[a]	0	
Gender	2.104	2	0.349
Age	5.996	8	0.648
Birthplace	1.763	2	0.414
Education	7.323	6	0.292
Religion	5.994	6	0.424
Ethnicity	8.606	6	0.197
Land use system	13.270	12	0.350
Land tenure	12.627	6	0.049

a. This reduced model is equivalent to the final model because omitting the effect
   does not increase the degrees of freedom.

Table 5.13b: The differences within the socio-demographic categories that influenced peoples' opinion on the legality of killing baboons in Laikipia

Socio-demographic factors		It is legal to kill a baboon [a]	It is illegal to kill a baboon [a]
Intercept		-0.23 (2450.1)	-4.94 (2450.1)
GENDER	Male	-1.00 (1.1)	-0.04 (0.9)
	Female	0[b]	0[b]
AGE			
	18-25 yrs	-0.80 (1.6)	0.13 (1.4)
	26-35 yrs	-0.46 (1.6)	1.14 (1.3)
	36-45 yrs	0.48 (1.6)	0.20 (1.1)
	46-55 yrs	0.46 (1.6)	0.79 (1.3)
	$\geq$ 56 yrs	0[b]	0[b]
BIRTH PLACE			
	Within Laikipia	1.0 (1.1)	0.14 (1.0)
	Out of Laikipia	0[b]	0[b]
EDUCATION			
	None	0.13 (1.7)	1.88 (1.4)
	Primary	-0.73 (1.7)	1.21 (1.4)
	Secondary	1.55 (1.6)	1.47 (1.5)
	Post-secondary	0[b]	0[b]
RELIGION			
	Christian	-16.78 (1.7)***	-14.72 (1.1)***
	Muslim	-17.43 (3331.9)	-3.30 (2830.3)
	Traditionist	-18.41 (1.4)***	-16.29 (0.0)
	Atheist	0[b]	0[b]
ETHNICITY			
	Bantu	14.78 (2450.1)	16.48 (2450.1)
	Nilote	16.55 (2450.1)	19.41 (2450.1)
	Cushite	15.44 (4135.8)	30.04 (3743.5)
	Europoean	0[b]	0[b]
LAND USE			

	PAST	-0.91 (1.9)	-0.68 (1.6)
	COMR	31.56 (2596.7)	16.31 (2450.1)
	FARM	17.86 (1329.0)	17.17 (1329.0)
	AGRP	1.57 (2.0)	0.77 (1.8)
	PATO	-0.20 (1.7)	-0.18 (1.9)
	COTO	49.41 (5541.3)	34.745 (5471.1)
	APTO	0^b	0^b
LAND TENURE			
	Communal owned	1.34 (1.6)	2.11 (1.4)
	Private owned	-14.18 (860.0)	2.04 (1.5)
	Occupied informally	2.44 (1.7)	2.41 (1.5)
	Occupied formally	0^b	0^b

a. Reference category is: I don't know.

b. This parameter is set to zero because it is redundant, *indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$

Table 5.13c: Peoples' opinion towards the legality of killing baboons across the land use systems (N = 206)

Response	PAST	COMR	FARM	AGRP	PATO	COTO	APTO	Total
Yes	5.1% (2)	45% (5)	13.6% (3)	12.5% (7)	7.8% (4)	45.5% (5)	12.5% (2)	13.6 % (28)
No	87.2% (34)	45.5 % (5)	22.7% (20)	82.1% (3)	86.3% (3)	54.5% (6)	81.3% (13)	81.6% (168)
I don't know	7.7% (3)	0.0 (0)	0.0 (0)	5.4% (3)	5.9% (3)	0.0% (0)	6.3% (1)	4.9% (10)
Total	18.9% (39)	5.3% (11)	10.7% (22)	27.2% (56)	24.8% (51)	5.3% (11)	7.8% (16)	100% (206)

Number of respondents are parenthesis

Table 5.14a: The Likelihood Ratio Tests indicating socio-demographic factors that influence the response to whether people still hunt baboons (242)

Socio-demographic factors	Chi-Square	df	p value
Intercept	0.000[a]	0	
Gender	1.522	2	0.467
Age	16.401	8	0.037
Birthplace	.939	2	0.625
Education	19.588	6	0.003
Religion	14.678	6	0.023
Ethnicity	3.290	6	0.772
Land use system	39.155	12	0.000
Land tenure	34.590	6	0.000

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom

Table 5.14b: The differences within the socio-demographic categories that influenced hunting of baboons

Socio-demographic factors	Categories	B Estimate (SE)
Intercept		138.49 (7530.5)
GENDER	Male	-27.43 (3246.1)
	Female	0[b]
AGE	18-25 yrs	22.00 (3253.3)
	26-35 yrs	66.56 (3900.0)
	36-45 yrs	-26.14 (4765.7)
	46-55 yrs	-24.16 (4707.4)
	$\geq$ 56 yrs	0[b]
BIRTH PLACE	Within Laikipia	-42.22 (3107.9)
	Out of Laikipia	0[b]
EDUCATION	None	-20.65 (2756.9)
	Primary	24.57 (627.2)
	Secondary	-133.41 (3353.7)
	Post-secondary	0[b]
RELIGION	Christian	137.19 (1757.2)
	Muslim	64.76 (10235.1)
	Traditionist	66.65 (1559.9)
	Atheist	0[b]
ETHNICITY	Bantu	-39.00 (6492.9)
	Nilotes	-49.15 (7291.4)
	Cushite	-108.90 (10955.4)
	Europoean	0[b]

LAND USE	PAST	-27.22 (2718.2)
	COMR	30.41 (3996.2)
	FARM	-86.02 95718.6)
	AGRP	0.33 (5219.6)
	PATO	-114.33 (3604.7)
	COTO	-101.32 (7375.3)
	APTO	0^b
LAND TENURE	Communal owned	84.60 (2914.9)
	Private owned	-25.76 (1160.1)
	Occupied informally	-80.88 (1.3)***
	Occupied formally	0^b

a. Reference category is: I don't know.

b. This parameter is set to zero because it is redundant

*indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$)

Table 5.14c: Response to whether people still hunt baboons (N = 174)

Response	PAST	COMR	FARM	AGRP	PATO	COTO	APTO	TOTAL
Yes	6.3% (2)	2.0% (2)	19% (2)	6.3% (3)	6.7% (3)	22.2% (2)	41.7% (5)	19.0% (19)
No	90.6% (29)	62.5% (5)	0.0% (0)	91.7% (44)	91.1% (41)	55.6% (5)	50.0% (6)	83.9% (146)
I don't know	3.1% (1)	12.5 (1)	10% (2)	2.1%) (1)	0.0% (0)	22.2% (2)	1.0.0% (1)	5.2% (9)
TOTAL	100.0% (32)	100.0% (8)	100.% (20)	100.0% (48)	100.0 (45)	100.0% (9)	100.0% (12)	100.0% (174)

Number of respondents in parenthesis

Table 5.15: Benefits people derive from baboons (N = 140)

Benefits received from baboons	PAST	COMR	FARM	AGRP	PATO	COTO	APTO	TOTAL
No benefits	68% (15)	43% (3)	100% (10)	81% (22)	8% (3)	0% (0)	50% (5)	41% (58)
Tourism	18% (4)	14% (1)	0% (0)	15% (4)	54% (20)	83% (5)	10% (1)	25% (35)
Security	14% (3)	0% (0)	0% (0)	7% (2)	21% (8)	0% (0)	20% (2)	11% (15)
Employments	5% (1)	14% (1)	0% (0)	4% (1)	16 % (6)	0% (0)	10% (1)	7% (10)
Important for the ecosystems*	0% (0)	29% (2)	0% (0)	0% (0)	8% (4)	33% (2)	0% (0)	6% (8)
Education bursaries & community projects	5% (1)	0% (0)	0% (0)	4% (1)	12% (6)	0% (0)	0% (0)	6% (8)
Research	5% (1)	0% (0)	0% (0)	0% (0)	3% (1)	0% (0)	0% (0)	1% (2)
Drop food from trees for livestock	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	0% (0)	20% (2)	1% (2)
It's a living creature	0% (0)	0% (0)	0% (0)	0% (0)	2.7%	0% (0)	0% (0)	1% (1)
Companionship	0% (0)	0% (0)	0% (0)	0% (0)	3% (1)	0% (0)	0% (0)	1% (1)
Total within land use systems (N)	25	7	10	30	50	7	11	140(100%)

Numbers are in parenthesis
*Includes those who said baboons are a source of food for leopards

Table 5.16: Costs of co-existing with baboons in Laikipia District

Costs	PAST	COMR	FARM	AGRP	PATO	COTO	APTO	TOTAL
Crop raiders	33% (11)	40% (2)	80% (16)	61% (27)	23% (9)	57% (4)	58% (7)	48% (76)
Kill livestock	52% (17)	20% (1)	5% (1)	39% (17)	72% (28)	14% (1)	67% (8)	46% (73)
Damage property	6% (2)	60% (3)	5% (1)	18% (8)	15% (6)	29% (2)	58% (7)	18% (29)
No cost	21% (7)	20% (1)	15% (3)	14% (6)	5% (2)	14% (1)	0% (0)	13% (20)
Diseases	9% (3)	20% (1)	0% (0)	2% (1)	3% (1)	0% (0)	8% (1)	4% (7)
Threat to humans	6% (2)	0% (0)	5% (1)	0% (0)	5% (2)	14% (1)	0% (0)	4% (6)
TOTAL (N)	33	5	20	44	39	7	12	160

Number of respondents in parenthesis

Table 5.17a: Socio-demographic factors that influenced the request for KWS
assistance to prevent baboons from property* (N = 137)

Socio-demographic factors	Chi-Square	df	P value
Intercept	0.000[a]	0	
Gender	0.113	1	0.736
Age	14.079	4	0.007
Birthplace	0.567	1	0.451
Education	9.506	3	0.023
Religion	0.032	2	0.984
Ethnicity	1.886	2	0.390
Land use system	9.644	6	0.140
Land tenure	4.369	3	0.224

*Property include cultivates crops
[a] This reduced model is equivalent to the final model because omitting the effect does not
increase the degrees of freedom
Table 5.17b: The differences within the socio-demographic categories that influenced peoples'
decisions to request help from KWS as an alternative measure to prevent baboons from their property

Socio-demographics	Categories	Request KWS for assistance to prevent baboons[a]
	Intercept	1.2 4 (2.7)
GENDER	Male	0.19 (0.6)
	Female	0[b]
AGE	18-25 yrs	0.44 ().9)
	26-35 yrs	-0.49 (0.9)
	36-45 yrs	2.06 (0.8)*
	46-55 yrs	1.12 (0.9)
	> 56 yrs	0[b]
BIRTH PLACE	Within Laikipia	0.40 (0.5)
	Out of Laikipia	0[b]
EDUCATION	None	-1.13 (1.0)
	Primary	0.84 (0.9)
	Secondary	0.4 (0.9)
	Post-secondary	0[b]
RELIGION	Christian	-0.24 (1.4)
	Muslim	-20.5 (0.0)
	Traditionist	-0.26 (1.5)
	Atheist	0[b]
ETHNICITY	Bantu	0.93 (1.9)
	Nilote	-0.40 (2.1)
	Cushite	0[b]
	Europoean	0[b]

LAND USE	PAST	-1.23 (1.0)
	COMR	-3.48 (2.1)
	FARM	-2.0 (1.5)
	AGRP	-0.19 (1.0)
	PATO	-1.73 (1.0)
	COTO	-2.42 (2.5)
	APTO	0^{b}
LAND TENURE	Communal owned	-1.71 (0.9)*
	Private owned	-1.19 (1.0)
	Occupied informally	-1.31 (0.8)
	Occupied formally	0^{b}

a. Reference category is: I don't know.

b. This parameter is set to zero because it is redundant, *indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$)

Table 5.17c: The percentage of people who requested assistance from KWS as an alternative

measure to prevent baboons from people's property (N = 137)

Response	PAST	COMR	FARM	AGRP	PATO	COTO	APTO	TOTAL
Yes	21.7% (5)	12.5% (1)	42.9% (9)	40.0% (14)	22.6% (7)	25% (2)	54.5% (6)	32.1% (44)
No	78.3% (18)	87.5% (7)	57.1% (12)	60% (21)	77.4% (24)	75% (6)	45.5% (5)	67.9% (93)
TOTAL	100% (23)	100% (8)	100% (21)	100% (35)	100% (31)	100% (8)	100% (11)	100% (137)

Number of respondents in parenthesis

Table 5.18a: Socio-demographic factors that influenced peoples' opinions of who owns the baboons they co-exist with.

Socio-demographic factors	Chi-Square	df	p value
Intercept	0.000[a]	0	
Gender	10.579	3	0.014
Age	10.210	12	0.598
Birthplace	4.345	3	0.227
Education	23.374	9	0.005
Religion	13.056	9	0.160
Ethnicity	4.889	9	0.844
Land use system	26.006	18	0.100
Land tenure	16.368	9	0.060

[a] This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom

Table 5.18b: The differences within the socio-demographic categories that influenced peoples' opinions of who owned baboons in their areas

Socio-demographic factors	Categories	Ownership of baboons[a]		
		Nobody owns the baboons	*The neighboring ranches*	*Kenya Wildlife Services*
Intercept		-17.74 (5211.3)	0.15 (5211.3)	0.30 (5211.4)
GENDER	Male	0.74 (0.6)	1.37 (0.6)*	1.42 (0.5)**
	Female	0[b]	0[b]	0[b]
AGE	18-25 yrs	2.39 (1.3)4	0.76 (0.9)	-0.27 (0.8)
	26-35 yrs	1.95 (1.3)	-0.08 (0.9)	-0.32 (0.70)
	36-45 yrs	2.44 (1.3)	0.25 (0.9)	0.12 (0.7)
	46-55 yrs	1.16 (1.4)	-0.28 (0.9)	-0.47 (0.7)
	≥ 56 yrs	0[b]	0[b]	0[b]
BIRTH PLACE	Within Laikipia	-0.75 (0.7)	-0.833 (0.6)	-1.05 (0.5)*
	Out of Laikipia	0[b]	0[b]	0[b]
EDUCATION	None	-1.84 (1.2)	-0.57 (1.2)	1.12 (1.2)
	Primary	-1.44 (1.2)	-1.13 (1.2)	1.75 (1.2)
	Secondary	0.74 (1.3)	0.69 (1.3)	1.77 (1.3)
	Post-secondary	0[b]	0[b]	0[b]
RELIGION	Christian	16.57 (0.74)***	0.03 (1.6)	-0.68 (1.5)
	Muslim	-4.30 (4711.3)	-0.32 (3.3)	-2.60 (3.0)
	Traditionist	17.10 (0.0)	-1.2 (1.7)	-1.28 (1.5)
	Atheist	0[b]	0[b]	0[b]
ETHNICITY	Bantu	-1.70 (5211.4)	-0.56 (5211.4)	-0.33 (5211.4)
	Nilote	-1.85 (52.11.363)	-1.70 (5211.3)	-0.38 (5211.4)

	Cushite	1.22 (5211.3)	-0.51 (5211.3)	0.53 (5211.4)
	Europoean	0[b]	0[b]	0[b]
LAND USE	PAST	1.32 (1.4)	-0.22 (1.1)	-0.65 (0.9)
	COMR	18.27 (5701.4)	15.91 (5701.4)	14.97 (5701.4)
	FARM	2.15 (1.8)	-0.69 (1.5)	-0.44 (1.3)
	AGRP	2.80 (1.5)	0.13 (1.2)	0.78 (1.0)
	PATO	0.43 (1.4)	-0.70 (1.1)	-1.54 (0.9)
	COTO	-0.34 (6345.2)	16.15 (2.0)****	16.30 (0.0)
	APTO	0[b]	0[b]	0[b]
LAND TENURE	Communal owned	0.82 (0.9)	1.68 (1.2)	1.361
	Private owned	-0.48 (1.2)	1.71 (1.4)	.985
	Occupied informally	1.2 (0.9)	2.76 (1.2)*	.747
	Occupied formally	0[b]	0[b]	0[b]

a. The reference category is: Kenyan Government.

b. This parameter is set to zero because it is redundant. *indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$)

Table 5.18c: The percentage of people opinions about who owned baboons in the area (N = 229)

Opinions on baboon ownership	PAST	COMR	FARM	AGRP	PATO	COTO	APTO	TOTAL
KWS	41% (21)	38% (3)	45% (10)	60% (35)	34% (22)	30% (3)	56% (9)	45% (103)
The government	22% (11)	0% (0)	18% (4)	10% (6)	33% (21)	0% (0)	19% (3)	20% (45)
The neighbors	20% (10)	25% (2)	18% (4)	12% (7)	19% (12)	70% (7)	19% (3)	20% (45)
Nobody	18% (9)	38% (3)	18% (4)	17% (10)	14% (9)	0% (0)	6% (1)	16% (36)
TOTAL (N)	**51**	**8**	**22**	**58**	**64**	**10**	**16**	**229**

Table 5.19: Summary on influence of the 7 socio-demographic factors on people's value towards baboons and their interaction with them

Model #	Response Variables	Gender	Age	Birth Place	Education	Religion	Ethnicity	Land use	Land Tenure
Model 1	**People's value towards baboons**			*	*				**
	Ambivalence								
	Fear								
	Interest-Attraction								
	Mutualism			*					
	Resentment				*				
Model 2	**The belief that baboons cause sickness**				**		*		
	Agreed		*		*				
	Disagreed	*	*			*			*
Model 3	**People's reaction to baboons when they last saw them**				*			*	
	I did nothing								*
Model 4	**Reason for people's reaction towards baboons**					***	***	**	
	Baboons were too far				*			*	
	Baboons did not bother me							*	
Model 5	**Use of preventative measures against baboons**	*							
	People who take preventative measures against baboons	*						*	
Model 6	**The legality of killing baboons**								*
	Opinion that it is legal to kill baboons					***			
	Opinion that it is illegal to kill baboons					***			
Model 7	**People's response to if hunting of baboons still occurs**		*		*	*		***	***
	Response that people still hunt baboons								***
Model 8	**Request for KWS as an alternative preventative measure against baboons**		*		*				
	People who requested for KWS								*
Model 9	**People's opinion on who owns baboons**	*			*				

Nobody owns the baboons							*	
The neighbors owns the baboons							*	*
Kenya wildlife service's own the baboons	*		*					

Grey shaded columns indicate overall influence of socio-demographic factors on people's values or interactions with baboons for each response (models), while white columns indicate their differences in opinions in respect to each of these values and interactions. *Indicates significance level, $p < 0.05$, ** $p < 0.001$, *** $p < 0.0001$)

Appendix 5.1: Categories within the 7 socio-demographic factors

Overall Demographics
Gender
Male
Female
Age
18 - 25 years
26 - 35 years
36 - 45 years
46 - 55 years
56 and older
Place of Birth
In Laikipia
Out of Laikipia
Level of Education
None
Primary
Secondary
Post- secondary
Religion
Christian
Muslim
Traditionist
Atheists
Ethnicity
Nilote
Bantu
European
Cushite
Land use
Pastoralism (PAST)
Commercial Ranching (COMR)
Farming (FARM)
Agro-pastoralism (AGRP)
Pastoralism -Tourism (PATO)
Commercial Ranching -Tourism (COTO)
Agro-pastoralism - Tourism (APTO)
Land Tenure
Communal owned (COW)
Private owned (POW)
Occupied informally (OCC)
Occupied formally (FOC)
Unknown (N/A)

Appendix 5.2: The fifteen communities interviewed within 4 ethnic groups and corresponding predominant livelihood.

#	Communities	N	%	Analytical ethnic categories	Prominent* Cultural Lifestyle
1	Kikuyu	28	12%	Bantu (N =36; 15%)	Farmers
2	Meru	7	3%		
3	Kamba	1	0.4%		
4	Nandi	1	0.4%	Nilotes (N = 181; 75%)	Agro-pastoralism
5	Pokot	13	5%		Pastoralism
6	Tugen	1	0.4%		
7	Masaai	105	43%		
8	Samburu	46	19%		
9	Turkana	15	6%		
10	Borana	3	1%	Cushite (N = 10; 1%)	
11	Rendile	3	1%		
12	Somali	2	1%		
13	Yaaku	2	1%		
14	European	15	5%	European (N = 15; 6%)	Commercial ranchers

*Ecotourism is not listed as a cultural lifestyle as it is a more recent adaptive land use practices used by commercial ranchers and pastoralist to complement their subsistence and economic livelihood

Appendix 5.3: Rationale for land tenure definitions

#	Land Tenure	Definition from respondents	Analytical tenure categories
1	Communal Ownership	Membership of group owned ranch through title deeds[a]	*Communal*
2	Private ownership	Purchased land with title deeds	*Private*
3	Private small hold ownership	Formerly large tracts of land subdivided into small plots (1–10 ha) and sold to people who were awarded title deeds[b]	
4	Private small hold rented	Private small hold land (1–10 ha) as described as above but rented to individual families.	*Formal occupation*
5	Government resettled	Former large tracts of land, in which inhabitants were resettled by the government	
6	Occupied	Opportunistic occupation of formerly abandoned land, most likely because it was not arable due to lack of adequate rainfall or water sources[c]	*Informal occupation*

[a]This typically included respondents who had claimed they were awarded title deeds from the Kenyan government on the basis that they inhabited ancestral land (Polonet Kinyaga, pers comm.).
[b]Georgiadis et al. 2007a
[c]Graham 2006

Appendix 5.4: Reasons for bad luck if you killed the following wildlife (Moinde unpub data)

QNO	Animal	Status	Reasons for bad luck if you killed the following wildlife	Categorized reasons
	Questions F8– which wildlife bring bad luck when you kill it?			
203	hare	Bad luck	Traditional belief it will bring bad luck if it comes near the homestead	Ancestral belief
209	hare	Bad luck	when it comes in the boma but not in the bush	Ancestral belief
237	hyena	Bad luck	will get bad luck when you kill it	Ancestral belief
231	porcupine	Bad luck	it was a belief from our forefathers	Ancestral belief
218	steenbok	Bad luck	because it is a customs or a believe	Ancestral belief
67	steenbok	Bad luck	heard from the ancestral	Ancestral belief
171	owl	Bad luck	believed that somebody will die	Cause death
215	Any animal that has just delivered	Bad luck	be cursed	Curse
94	Any animal that has just delivered	Bad luck	you will have stopped a new beginning of life	Curse
43	Any animal that has just delivered	Bad luck	brings a curse	Curse
238	owl	Bad luck	you will get a problem	Curse
233	rabbit	Bad luck	you will be cursed	Curse
220	tortoise	Bad luck	if you come across a tortoise on the road you will definitely have a bad luck	Curse
9	Any animal that has just delivered	Bad luck	because you have made it an orphan	Curse
210	zebra	Bad luck	it was believed to be if you spear on the black stirpe it brings bad lack	Curse
205	elephant	Bad luck	if you kill an elephant and remove its tusks it will be bad lick because it is a curse	Economic value
83	elephant	Bad luck	because our family believe to have relationship with livestock	Extended Family
108	zebra	Bad luck	it is forbidden in the bible	Forbidden by God
217	**baboons**	**Bad luck**	**because it is like a human being**	**Like Humans**
7	**baboons**	**Bad luck**	**it resembles humans and when killed it cries like a human**	**Like Humans**

			being	
100	**baboons**	**Bad luck**	**they are almost like humans and killing them will cause psychological issues**	**Like Humans**
216	**elephant**	**Bad luck**	**they have breast like humans**	**Like Humans**
228	**elephant**	**Bad luck**	**they look like a human being**	**Like Humans**
78	**baboons female**	**Bad luck**	**they are like human mothers**	**Like Humans**
189	rhino	Bad luck	Your livestock will die	materialist
94	any two fighting wild animals	Bad luck	you will make wild animals widow	Mutualism
67	wild dog	Bad luck	believed that they are circumcised boys	Mutualism
105	snake	Bad luck	because they are poisonous and should not be seen	Cause death
64	wild dog	Bad luck	they cause death	Cause death
217	frog	Bad luck	it resembles rain god because they croak when its about to rain	Spiritual/Symbolism
189	ostrich	Bad luck	your life will be short	Cause death
165	elephant	Bad luck	NC	
204	hare	Bad luck	NC	
82	lactating animal	Bad luck	NC	
150	lactating baboon	Bad luck	NC	
206	none	Bad luck	NC	
150	porcupine	Bad luck	NC	
150	python	Bad luck	NC	
152	Raven/eagle	Bad luck	NC	
215	when you kill an animal and don't eat it	Bad luck	NC	Materialism
158	wild dog	Bad luck	NC	

NC- No comment

Highlighted sections that are people's listed believes that bad luck would befall those who kill baboons, and to some extent elephants was due to "Mutualistic" values they have for specifically baboons and elephants

CHAPTER SIX

OVERALL CONCLUSION

My findings indicate that humans are key agents in reinforcing the selective pressures of ecological factors (i.e., food availability, predation) that potentially influence primate adaptive behavior and social evolution (Wrangham 1980; van Schaik 1989; Isbell 1991; Sterck et al. 1997). My findings confirm that anthropogenic impact on vegetation and predator presence can influence primate feeding and social behavior in a manner consistent with the adaptive socioecological model. Thus, I reiterate the importance of behavioral plasticity in baboons as an attribute of their success in varied human modified ecologies. This study also improves understanding of how (ancestral) humans may have influenced selective pressures that are predicted to have acted on primate social systems. Such an acknowledgement forces us to reexamine how we humans could, in fact, be coevolving in modified ecologies (both faunal and floral) that we construct to promote our very existence.

With respect to socioecological theory, food resources were the most important factor influencing baboon aggressive behaviors across the anthropogenic land use systems in this study. This result reiterates the importance of food availability as an integral selective pressure in the evolution of social behavior in primates. More recently, the validity of socioecological theories has been called into question by primatologists (Thierry 2008; Koenig and Borries 2009; Schülke and Ostner 2012). For example, Schülke and Ostner (2012) reviewed the literature pertaining to the extent,

strength, and mode of feeding competition as an influence on female social relationships, as predicted by the socioecological models. Others argue that phylogenetic inertia is the primary force that influences primate social evolution (Thierry 2008; Borries 2009). While it is well documented that parental care, mate guarding, sexual conflict, and phylogenetic inertia are key factors that contribute to the evolution of social systems (reviewed in Mitani et al. 2012), this study re-established the importance of food as a selective pressure in influencing primate social systems.

Further, complementary sociocultural-ecological enquiry on human-baboon relations also revealed that people's values towards baboons were not associated with land use practices, but rather with the duration of living closely with baboons, their level of education, and tenure. These factors, in particular, influence "Mutualistic" and Resentment" values towards baboons. The management implications of these data are that people's experiences and formal education are crucial aspects that must be incorporated to promote "Mutualistic" values or tolerance, especially where human-baboon conflict and "Resentment" is high. I argue that education and land tenure are the most important factors to incorporate into management practices that aim to foster people's tolerance for baboons in Laikipia. The approach of applying WVOs theory (Fulton et al. 1996; Ingelhart and Baker 2000; Manfredo and Dayer 2004) to management of wildlife in general, and baboons in particular, has merit.

Land use, on the other hand, was a prominent factor associated with people's reported direct interactions with baboons and their motivations underlying their encounters with them. A connection between the legality of killing baboons and the

patterns of hunting them is suggested by the influence of land use and other socio-demographic factors, such as, age, education, religion and land tenure on the belief that people still hunted baboons (in spite of legal prohibitions). This also demonstrates that land tenure is the only socio-ecological factor to influence *both* issues pertaining to the legality of killing baboons and hunting baboons. Specifically, people who indicated that hunting for baboons was still an ongoing activity in Laikipia were less likely to be those who occupied the land they lived on (i.e., were likely to be "squatters"). This result indicates that ownership of land, and its constituent resources, is crucial in determining the decision to eliminate baboons and possibly other wildlife. Thus, land tenure, and, to a lesser extent, land use, are crucial on matters pertaining to baboon survival in Laikipia.

Socioecological testing of baboon adaptive behavior in human modified ecologies

In this study, I found that differing composition and densities of livestock within two contrasting livestock management regimes (i.e., pastoralism and commercial ranching) influenced the dispersion, abundance, structure, and diversity of local vegetation. Contrasting human modified habitats can influence habitat heterogeneity at the landscape level, which had yet to be reported in Laikipia district. My findings provided useful insights on how variation in anthropogenic modification at the habitat level is important for promoting landscape heterogeneity across the district. Of importance to conservation management, Tews et al. (2004) reviewed empirical data from various sites and found a positive correlation between habitat heterogeneity and animal species diversity, suggesting that higher herbaceous diversity found on commercial ranches could be supporting increased faunal variety. Several studies have

reported that faunal diversity increases with habitat structural complexity (Leis et al. 2007; Uehara et al. 2009). The difference in land use systems in Laikipia thus appears to promote landscape heterogeneity which, in turn, has contributed to the highest diversity of wildlife species in any given place in East Africa. What is important for managers of wildlife and livestock alike is gaining a better understanding of how temporal patterns of resource variation are directly or indirectly influenced by land use changes. Such an understanding will provide managers with information that can sustain the high diversity of wildlife for which Laikipia is renowned.

The anthropogenic influences embodied by the contrasting habitats studied are currently moderate enough to allow baboons (and other wildlife species) to subsist and reproduce, but substantial enough to expose these primates to significantly different ecological settings. In particular, the overall longer feeding bouts and increased feeding rates observed in the baboons on the commercial ranch suggest that food resources within the commercial ranch were relatively patchier compared to those characterizing the pastoralist land. Of particular interest to this study is the contrary manner in which differing livestock regimes produce differences in woody food availability for baboons in the two land use systems. More specifically, increased gall production and thorn densities in *Acacia* trees occurred as compensatory defense mechanisms against herbivory by a higher density of livestock. Swollen thorns, combined with symbiotic ants, limited the ability to monopolize relatively more abundant *Acacia* food resources in the pastoralist land. Thus, the effective availability of woody food resources on the pastoralist land was more limited than in the commercial ranch despite their relatively higher abundance on the pastoralist land. The ability to monopolize clumped food

resources is an attribute of feeding behavior that is predicted to promote contest competition (Isbell 1998). The scenario on the pastoralist land, thus, appears to have promoted greater scramble competition in the baboons, relative to the commercial ranch. These findings suggest that anthropogenic impact of primate food resources has the potential to influence primate social behavior in a manner somewhat contrary to socioecological predictions.

Glades provided another clear example of how anthropogenic features can modify the distribution, abundance, and potential nutrient value of primate food resources, and thereby influence behavior in a fashion predicted by socioecological models. The spatial distribution and likely high nutrient content of grasses found in glades, relative to the surrounding grasses (Veblen 2006), has important socioecological implications for baboons in this study (Augustine 2003a; Veblen 2006). Access to the nutrient rich grasses found only within the confines of glades was especially contested for within the narrow window of opportunity dictated by rainfall. According to Wrangham (1980) and Janson (1985), if within-group contest competition is strong, then selection will favor traits that increase female access to high quality resources. Thus, the tendency to engage in aggressive interactions is likely to be enhanced. Contest competition is thought to occur when resources are scarce, defendable, and worth defending (ShÜlke and Ostner 2012). Food resources found within the context of glades fit the predicted profile that would evoke contest competition (van Schaik 1989, Isbell et al. 1998). This result further reiterates the importance of incorporating the influence of humans into socioecological theory.

Baboons in this study made apparent trade-offs by foraging more efficiently in the commercial ranch where predation risk was higher, while concurrently potentially decreasing vulnerability to predation by increasing individual vigilance, as predicted by socioecological theory (van Schaik 1989; Sterck et al. 1997; Isbell and Enstam 2002). The possibility of baboons maintaining proximity to humans as an antipredator strategy also arose in my study. I recommend follow up research to evaluate this possibility of baboons coexisting in close proximity to humans as an antipredator strategy. Fuentes (2006), for example, argues that differential interactions between humans and primates in shared human ecologies may, in fact create diverse social, demographic, and ecological conditions that that affect the occurrence of predators.

Sociocultural-ecological interactions with baboons to test Wildlife Value Orientation theories

I found that people's values towards baboons were influenced by only two socio-demographic factors: education and long-term residency in wildlife area. The value orientations that were influenced by these two socio-demographic factors were both on the extreme end of the human-baboon interaction spectrum, that is   "Resentment" (High intolerance") to "Mutualism" (High tolerance) relative to other values (i.e., "Ambivalence", "Interest-Attraction", "Fear", "Neutral"). In order to alleviate conflict and reduce the levels of "Resentment", management practices should focus on public education where literacy levels are low as means of increasing knowledge and awareness about baboons. This approach will serve to enhance people's positive

experiences with baboons, which is an important prerequisite for familiarizing and fostering the "Mutualistic" tendencies found among people in this study.

Both land use system and education were the only two socio-demographic factors to influence both the underlying motivations and the patterning of people's reported interactions with baboons. One implication for management purposes is that both people's land use practices and their level of education are important considerations for formulating policy addressing human-baboon relations in Laikipia.

For management purposes, it is crucial to note that education was one factor that influenced the majority of responses people provided in this study. Education was integral in influencing people's "Resentment" values as well as attitudes about health matters concerning baboons' reported interactions with baboons, hunting and management issues towards baboons, and opinions about baboon ownership. People's reported direct interactions with baboons were also prominently influenced by land use systems, and, to a lesser extent, by gender, ethnicity, and religious affiliations. Land tenure, however, was distinctly prominent in influencing attitudes about both the legality of killing baboons, knowledge of baboon hunting activities, and ownership of baboons. This implies that human tenure is an integral factor affecting the continued existence of baboons in Laikipia.

Decision making at the land use and land tenure level is key in the deliberation over informed management policies. Policy decisions in this respect should be directed towards educating local communities in a manner that facilitates human-wildlife coexistence as well as baboon survival. This can be attained through formal education

as well as through public awareness campaigns that aim to sensitize management decisions concerning, people's values and opinions about and interactions with baboons. This approach should also be tailored towards promoting knowledge of the costs and benefits to human coexistence with wildlife within each of the land use types. Current ongoing programs coordinated by both the KWS and LWF specifically aim to sensitize school-going children and local communities within Laikipia (Laikipia Wildlife Report 2011). In particular, I recommend that local primatologists working within Laikipia should contribute their findings on baboons and also coordinate local guided visits to baboons that have been specifically habituated for this purpose. Such an approach will not only inform the public, but it will also directly enhance their experiences with baboons and promote "Mutualistic" values that promote tolerance towards baboons where "Resentment" values are intense.

The link between the legality of killing baboons and the patterns of baboons hunting activity is still unclear. Land tenure was the only socio-ecological factor to influence *both* of these issues. My findings suggest that land tenure importantly affects people's sense of control, which seems to affect their opinions and actions in matters pertaining to killing baboons. In line with this claim, it is important to highlight that tenants of occupied land or "squatters" were less likely to admit knowing about the hunting of baboons than those who legally or formally occupied land. This result could be attributed to the fact that "squatters" were more afraid to admit continued incidences of baboon hunting because hunting of wildlife is illegal in Kenya. Alternatively, ownership of land may influence control in relation to management and utilization of resources, which includes baboons. It could be that the sense of entitlement among

"squatters", for example, was diminished relative to people who own their land. This indicates that property rights, or the sense of entitlement, that is typically reinforced by land ownership is crucial in determining decisions to eliminate baboons and possibly other wildlife. Although land tenure is crucial on matters pertaining to baboon survival in Laikipia, the role of land use systems should not be underestimated, as it directly associated with the knowledge of baboon hunting activities in Laikipia. Understanding the dynamics between these two factors (i.e., land use and tenure) is critical for management policy in this respect.

Local management of baboons in relation to the people's use of preventative measures against baboons was, surprisingly, influenced by gender only. Women, rather than men were more likely to employ various preventative tactics. This is because women are primarily the ones who tend to their *shambas* or farms and herd young sheep and goats that baboons may potentially prey upon. Moreover, where crop raiding was intense and individual preventative measures used against baboons were inadequate, people pursued the alternative measures of requesting the KWS to "shoot and kill" them on sight. Based on respondents' reports, these legal methods of eliminating baboons appeared to be more effective in temporarily reducing crop-raiding incidences than individual preventative methods. It was clear, however, that people in Laikipia felt that the KWS was an unreliable alternative to preventing baboons from exploiting their property. Those who farmed and also complemented this practice with pastoralism, as well as tourism, reported incurring the highest costs from baboons and, therefore, were more likely to take matters into their own hands (i.e., to kill baboons).

Land ownership or tenure promotes a feeling of greater control over wildlife and thereby enables people to manage, strategize, and optimize current land use practices for the perceivable future, such as the decisions of when to conserve or terminate wildlife. Studies have shown that people's sense of ownership provides local communities with incentives for the sustainable use of natural resources (Ribot and Peluso 2003; Norton-Griffiths 2007).   People's opinions about baboon ownership, however, apparently are not encompassed by notions of property rights in Laikipia. Most of the respondents were under the impression that baboons belonged to the KWS, rather than to the government on behalf of the citizens at large (?). Only commercial ranchers (regardless of their practice ecotourism) appeared to know the distinctive role between KWS and the government in relation to wildlife management issues, but they were also still unclear about baboon ownership. Thus, people's sense of ownership, in relation to the baboon, was unclear. Further studies need to be conducted to gauge if this is true of other local wildlife in general or if this pattern applies specifically to the baboon, and why.

My attempts to reconcile these different perspectives —socioecological, within baboons, and sociocultural-ecological, between humans and baboons, provides a more holistic approach to achieving insights on the adaptive significance of behaviors and on patterns of symbiosis between the two primate taxa.

Reconciling socioecological and WVO theories into primatological inquiry

Pastoralism is one of the most widespread land use practices in Africa and Asia. It has been going on for thousands of years while commercial ranching was introduced relatively more recently, i.e., only about two hundred years ago (Walker and Janssen 2002). The comparative approach I used in this study revealed how landscapes are transformed differently under pastoralism versus commercial ranching. Although the potential for indirect competition for terrestrial vegetation between primates and livestock has been recognized for a long time (Struhsaker 1973; Altmann 1974; Strum and Western 1982; Druker 1984), there are few quantitative data available regarding the influence of livestock grazing on primate social strategiesfeeding. The rationale for incorporating land use systems in my research is that pastoralism and commercial ranching are more recent anthropogenic phenomena that impose recent, but contrasting, anthropogenic changes to the habitat that can be used to examine behaviorally flexible responses to these ecological changes. The evidence in the archeological record, however, shows that humans have historically shaped habitats, resource availability, and the presence of predators (Sponsel et al. 2002, Riley 2006) throughout their evolutionary history suggesting a potential coevolutionary relationship between human and primates.

In this study, I provide evidence that a system of adaptive behavioral plasticity operates in response to differences in human modified ecologies. This approach is a means of testing the socioecological models and not an end in itself. Such an approach compels us to examine how humans have historically shaped habitats, resource availability, and the presence of predators throughout history. Underlying the use of anthropogenic influence to test socioecological models is an attempt to evaluate *Homo*

sapiens (and possibly some of its ancestors) as an important selective force on the evolution of baboons social behavior, beyond simply the effects of baboon predation and crop raiding (Strier 2006; Fuentes 2006).

Secondly, the findings from this study are an indication that the humans-primate interface needs be considered while designing primate behavioral field research. It seems very likely that patterns of primate behavior that we observe in the field today are more often than not a response to human modification of the habitat. Within this Anthropocene era, where man has left his mark virtually everywhere on the globe, it appears almost impossible to tease out which of the behaviors we see in primates today are inherent and which ones are not. Further, examining the behavioral flexibility of the olive baboon in contrasting human modified habitats may therefore help to clarify *how* members of the genera *Macaca* and *Chlorocebus* remain exceptionally resilient to anthropogenic disturbance, even to the point of thriving in such human sympatry (Richard et al. 1989; Hill 2005; Lee and Preston 2005; Fuentes 2006). However, identifying which behaviors are human-induced is a crucial first step. Doing so will help us to better understand *how* we humans and other primates have an apparent propensity to adapt to dynamic ecological changes, including possibly this dynamic Anthropocene era.

I provide evidence in this study that suggests that interactions between humans and the habitat may, in fact, create diverse social, demographic, and ecological conditions that influence primate social behavior in ways that are not only unexpected but even partly contrary to socioecological predictions. Many species from the genera *Papio* and *Macaca* manifest a pronounced social nature, cooperative behavior, have manual

dexterity, extreme agility, and dietary and behavioral flexibility (Hill 2005). These attributes have contributed to the baboon's successful interactions with humans in shared ecologies (Richard et al. 1989; Naughton-Treves et al. 1998; Burton and Caroll 2005; Kemnitz et al, 2002; Ocaido et al., 2004).

Consequently, there is a growing recognition of the relevance of long-term sympatry between human and nonhuman primates. Most socioecological investigations of primate groups and human populations do not incorporate this interspecific interactions (beyond predation or crop raiding), or the role of the anthropogenically impacted environments (Fuentes 2006). Current relationships between human and nonhuman primates, therefore, are generally assumed to be rooted in conflict over land use that is relatively recent and thus has limited evolutionary and long-term ecological significance. In this study, I found that human-primate coexistence in Laikipia can be mutualistic, commensal and competitive as a result of different socio-demographic factors. My attempt to integrate the human cultural-ecological contexts into socioecological enquiry improves our understanding of the diverse ways in which human cultural-ecological beliefs and practices shape human-primate symbiosis (e.g., commensalism, mutualism, conflict.. etc) (Biquand et al. 1992; Burton 2002; Lee and Priston 2005)

This study also contributes to the growing interdisciplinary field of ethnoprimatology. Applying different interdisciplinary approaches can be complicated, especially when different epistemologies are applied, one from an evolutionary perspective and the other from a socio-cultural perspective. An integrated synthesis that

places humans and primates (baboons) in shared social ecologies facilitates a better

understanding about human social evolution as well as human-nonhuman primate

coevolution. As Fuentes (2010) emphasizes,

> *"*Understanding the interactions of organisms within mutual ecologies—how they coproduce and coconstruct each other's niches in behavioral, ecological and physiological senses can help social scientists describe this moment in history, when humans have become major agents of environmental changes, in a time that has lately been dubbed the epoch of the Anthropocene (Crutzen and Stoermer 2000; Rose 2009). Such social–ecological approaches can make examinations of the Anthropocene just a little less anthropocentric (Kirksey and Helmreich 2010). Such work can also advance emerging investigations …….concerned with the integration, engagement and interface between humans and other kinds of living things (Kohn 2007)". (p. 601)

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