WOODY SPECIES COMPARISONS BETWEEN CONSERVED AND COMMUNAL SITES AND WOODY PLANT USE BY LOCAL COMMUNITIES: A CASE STUDY OF ESELENKEI AND KIMANA GROUP RANCHES IN SOUTHERN KAJIADO, KENYA

BY

SUZANNE TAPAPUL LEKOYIET

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATES STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULLFILMEMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

IN

DRYLAND BIODIVERSITY

July, 2006

Addis Ababa University

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

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A Thesis Presented to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment of the Degree of Master's in Dryland Biodiversity

Approved By Examining Board:

Name	**Signature**
Chairman, Department Graduate Committee	_____
Dr. Zemede Asfaw	_____
Prof. Zerihun Woldu	_____
Prof. Sebsebe Demisse	_____
Dr. Teshome Selomesse	_____

Dedicated to my family and friends for their love and support.

May the Almighty God bless you all abundantly.

ACKNOWLEDGEMENTS

The Research Programme on Sustainable Utilization of Dryland Biodiversity, SIDA/SAREC, Sweden funded this study. Additional financial support was received from The African Wildlife Foundation (AWF): Kilimanjaro Heartland, Kenya. The assistance is greatly appreciated. Many thanks to Ms. Rose Mayienda of GIS section, AWF for her tireless efforts in updating maps in this document despite her busy schedule.

It is my pleasure to acknowledge the permission granted to carry out fieldwork in Kimana and Eselenkei Group Ranches from the respective Group Ranch members. My sincere gratitude to the management of Eselenkei Conservancy, Porini Ecotourism, and Kimana community wildlife sanctuary, the African Safari Club (ASC), for their hospitality and relentlessly availing rangers to accompany me during data collection in the conservancies.

I gratefully acknowledge the comments received from my advisors, Prof. Zerihun Woldu (Addis Ababa University, Ethiopia), Dr. Zemede Asfaw (Addis Ababa University, Ethiopia) and Prof. James L. Kiyiapi (Moi University, Kenya). My everlasting gratitude goes to my colleagues, friends and family for their unconditional love, support and encouragement throughout the period of study.

It would not be possible to list down names of all individuals whom I had the privilege to work with. For you all, your contribution to this write-up is deeply treasured.

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ABSTRACT

A study that combined vegetation analysis with ethnobotanical approach was undertaken in Eselenkei and Kimana Group Ranches, in southern Kajiado, Kenya. The study particularly looked at the impact of setting aside conservation areas on woody species in traditionally pastoral rangelands. Systematic sampling was carried out to compare woody species diversity, density, regeneration. Quantitative ethnobotanical methods based on semi-structured interviews, paired comparisons of threatening activities to woody species and researcher's observations were also employed. These were to evaluate local community attitudes to conservation areas, their woody plant use and single out one most threatening activity to the existence of woody species in the two Group Ranches. Shannon-Wiener diversity index (H') of woody species was 1.078 and 1.758 in Eselenkei and 1.290 and 1.116 in Kimana in conserved and communal sites respectively and did not differ significantly in both cases ($P>0.05$). Mean woody species density in Eselenkei was 290.52 stems/ha and 280.17stems/ha in conserved and communal sites respectively. In Kimana, the mean woody density was 67.19 stems/ha and 107.82 stems/ha in *Acacia xanthophloea* woodland and 97 stems/ha and 57 stems/ha in *Acacia tortilis* woodland in conserved and communal sites respectively. There were no significant differences in mean densities in both study areas in conserved and communal sites ($P>0.005$). More seedlings and saplings were recorded in conserved areas than at communal areas in both sites, though the differences were not significant ($P>0.05$). Fifty two percent of respondents in both sites were positive towards the conservation area within their Group Ranches. Men were more positive towards the conservation area in both sites compared to women. Knowledge distribution of local plant use was not significantly different between gender but the elderly were more knowledgeable than the youth ($P<0.05$). Charcoal production in Kimana, and fencing and construction at Eselenkei were identified as the most threatening activities to woody species. Continuous monitoring of woody species within conserved and communal areas can help detect changes and associated threats. Community members should equally participate in natural resource management plans to develop effective conservation and sustainable utilization of woody species. Conservation of the natural resource base needs to target on the entire ecosystem, as revealed by multiple uses of various woody species by the local community.

1.0 INTRODUCTION

It has become a conservation slogan in Africa that the survival of the continent's natural resources, will depend on the goodwill of local communities. It is argued that the support of communities for wildlife can be enhanced through community-based wildlife management (CBWM), a process in which local people participate in, and benefit from, the conservation and management of wildlife on their land (Kiss, 1990; IIED, 1994; McNeely, 1995).

In the past, under communal landholdings, wildlife coexisted freely with people outside the protected areas (Western, 1989). Within East Africa, changes in land policies, high human population growth rates, and rapid changes in people's expectations over the past few decades have resulted in the expansion of cultivation, growth in the number of permanent settlements, urbanisation and diversification of land-use activities around conservation areas (Ellis *et al*., 1999). In Kenya, over 70% of wildlife lives outside protected areas (Western and Pearl, 1989). Although the importance of protected areas like Amboseli, Chyulu and Tsavo West as wildlife conservation areas is appreciated, most wildlife occurs outside these national parks, where the land is shared with Maasai and their livestock (Seno and Shaw, 2002).

As part of its wildlife management strategy, the government of Kenya is encouraging the establishment of tourist facilities (conservation areas) on Group Ranches adjacent to parks. Community ecotourism-based wildlife conservation areas are not only expanding wildlife ranges outside neighbouring protected areas, but also act as dispersal areas while bringing economic and employment benefits to the community. This helps reduce insularization of protected areas and keep critical wildlife corridors and migration routes open (Western and Ssemakula, 1981). The Maasai in Amboseli Group Ranches area have started to appreciate wildlife as they begin to gain direct benefits from community wildlife sanctuaries and concession areas (Okello, 2005).

Strong links (ecological, economic, and cultural), however, exist between the areas that have been set aside as conservation areas and the adjacent communal areas (Wells, 1996). Human land uses outside conservation areas greatly influence wildlife concentration, dispersal (Okello, 2005), and consequently, habitat quantity and quality within the conservation areas (Guy, 1989). Changes in land tenure experienced in the Amboseli-Tsavo Group Ranches, (from communal to individual landholdings), has facilitated a market-oriented economy, which tends to promote expansion of crop agriculture and sedentarization around conservation areas (Galaty, 1994). Consequences of these changes include declining ecological, economic and social integrity of rangelands due to fragmentation of landscapes, diminishing wildlife migratory corridors, heavy dependence on woody resources, cultural and economic diversification due to immigration (Gichohi *et al*., 1996).

1.1 PROBLEM STATEMENT AND JUSTIFICATION

An assumption that underlies the current conservation mainstream is that human land-use practices necessarily lead to land degradation and to a decline in biological diversity. Conservation initiatives largely focus on the establishment of conservation areas, within which human resource use is minimized. Natural resources within these areas are 'protected' from human exploitation. Consequently, unprotected areas with heavy human pressures are expected to be degraded leading to diminishing biological diversity and, as a result, are typically ignored by conservation agencies. However, some human land-use practices can enhance biodiversity, both within and outside conserved areas (Western, 1989; Homewood and Rodgers, 1991).

Community conservation initiatives in the Amboseli have been driven by the need to have local communities benefiting from the presence of wild animals in their area. Sustainable utilization of woody resources within areas adjacent to conservation areas is vital for the well-being of the ecosystem and the society. Changes in population dynamics, and land policies within ranches have resulted in individuals exploiting natural resource base further, at the expense of conservation. Most conservation areas form "ecological islands" because they are surrounded by human settlements, which may

exacerbate wildlife impact on woody plants. Many studies have focused on human-wildlife interaction and land uses in the Amboseli ecosystem (Western, 1989; Sindiga, 1995; Esikuri, 1998; Seno and Shaw, 2002; Okello, *et al*., 2003; Worden *et al*., 2003; Okello, 2005) leaving the performance of Community Based Conservation (CBC) areas in relation to woody vegetation resources understudied. There is a need, therefore, to link community conservation to the improvement of vegetation resources.

Against this background, a study on the ecological impact of setting aside conservation areas on woody species diversity, densities and recruitment potential on conserved sites and its adjacent communal areas in the Amboseli Ecosystem was undertaken. This study aimed at providing measures of success or failure of community conservation areas in protecting these natural resources from human exploitation. In addition, the attitude of local communities towards the setting aside of the conservation areas within Group Ranches, local use of woody species in this pastoral community, and activities considered as most threatening to the existence of woody species were investigated.

1.2 OBJECTIVES

1.2.1 General Objective

To assess differences in woody species diversity, density and regeneration potential in community conservation areas compared to adjacent communal areas in Eselenkei and Kimana conservation areas; and local community plant use and attitudes towards the conservation area.

1.2.2 Specific Objectives

i. Compare woody species diversity within and outside the conservation area in Eselenkei and Kimana Group Ranches
ii. Compare woody species density within and outside the conservation area, and assess trends in density in relation to distance from the conservation boundary towards and away from the conservation areas in Eselenkei and Kimana Group Ranches

iii. Compare the regeneration potential of woody species in conserved and adjacent communal areas in Eselenkei and Kimana Group Ranches

iv. Assess the attitude of local people towards the setting aside of the conservation area with respect to accessibility of natural resources in Eselenkei and Kimana Group Ranches

v. Assess community knowledge distribution on woody species utilization in Eselenkei and Kimana Group Ranches

vi. Identify an activity considered as most threatening to the existence of woody species in Eselenkei and Kimana Group Ranches

2.0 LITERATURE REVIEW

2.1 PLANT DIVERSITY

Plant diversity denotes the variety of life forms, the ecological roles they perform and the genetic diversity they contain (FAO, 1989). Conservation of plant diversity, at the levels of ecosystems, landscapes, species, populations, individuals and genes, is essential to sustain the health and vitality of ecosystems, thereby safeguarding their productive, protective, social and environmental functions.

Species diversity has been identified as one of the key indices of sustainable land use practices, and considerable resources are expended to identify and implement strategies that will reverse the current declines in biodiversity at local, regional and international scales (Shackelton, 2000). Species diversity is a function of the number of species present and evenness with which the individuals are distributed among these species (Margalef, 1958; Pielou, 1966). Species evenness is usually defined as the ratio of observed diversity to maximum diversity, the latter being said to occur when the species in a collection are equally abundant (Margalef, 1958; Pielou, 1966).

Species richness refers to the number of species present, without any particular regard for the exact area or number of individuals examined. However, it is useful to distinguish between ***numerical*** species richness (the number of species present in a collection containing a specified number of individuals) and ***areal*** species richness or species density (the number of species present in a given area or volume of the environment) (Simpson, 1964),

2.1.1 Processes that Affect Species Diversity

Processes driving species diversity have been the focus of studies in diverse ecosystems, and many important determinants have been delineated (e.g. MacArthur and Wilson, 1967; Gillon, 1972; Huston, 1994; Grace, 1999). Petraitis ***et al.*** (1989) determined that factors most important under conditions of community equilibrium as (i) resource availability, which operates by controlling population sizes; (ii) resource heterogeneity, which affects niche specialization; and (iii) species interactions, which alter competitive

relationships, and thus coexistence. Equally important are processes that inhibit equilibrial conditions, such as fires and other disturbances (Petraitis *et al*., 1989), life-history differences in seed dispersal (Hurt and Pacala, 1995), and influences of regional species pools (Schluter and Ricklefs, 1993). It is apparent that species diversity potentially depends on many factors, and diversity patterns likely arise from spatial gradients and temporal variability in multiple controlling variables (Gillson, 2004).

2.2 DENSITY OF WOODY SPECIES IN RANGELANDS

According to Frost *et al*., (1986) savanna vegetation consists of a herbaceous layer dominated by grasses, and a tree / shrub layer of variable density (Frost *et a*l., 1986). Skarpe, (1992) reported factors influencing tree/shrub densities as climate, soil type, rainfall variability, nutrient availability, plant interactions and disturbance by fire and herbivory which operate over a range of spatial and temporal scales. According to Gillson (2004), savanna vegetation is heterogeneous over time and space, and tree/shrub densities are constrained by a hierarchy of processes whose influence is apparent at different spatial scales.

Plants interact with one another at the micro-scale and these interactions are likely to vary over time because of the patchy and unpredictable availability of resources in the savanna environment (Gillson, 2004). Trees may compete with grasses for water in times of low rainfall, but this relationship may become facilitative rather than competitive if water availability increases (Knoop and Walker, 1985; Gillson, 2004). Similarly, disturbance such as trampling by animals and selective browsing affects individual plants (Levin, 1992). Gillson (2004) noted that, at micro scales, tree/shrub density is constrained by the availability of germination micro-sites, interactions between plants (competition and facilitation) and disturbances like trampling or selective herbivory.

At the local scale, woody plant density may be determined by spatially more extensive disturbances that influence patterns of tree recruitment (Gillson, 2004). Bond *et al.* (2000) suggests that recruitment of savanna tree populations is infrequent and occurs over limited spatial extent, because of frequent disturbance by fire and herbivores leading tree

cover decline over time. Furthermore, intense fires are more likely in senescent tree stands, because dead wood facilitates the spread of fire into the tree canopy (Young and Lindsay, 1988). Biotic factors (e.g. senescence) can thus act as a predisposing factor for disturbance by fire and transition to a grassland phase. Variations in water availability and disturbance affect woody density at local and micro scales (Coughenour and Ellis, 1993; Gillson, 2004). Infrequent recruitment events generate even-aged stands of trees which senesce at similar rates (Young and Lindsay, 1988); patches of vegetation thus undergo phase changes in which rapid recruitment events cause transition from grassland to wooded phases.

2.2.1 Factors Affecting Woody Species Density in Rangelands

2.2.1.1 Impacts of Elephants and other large Herbivorous Mammals

In African savannas, large herbivorous mammals such as elephants, giraffes, and various antelopes, are known to kill and damage woody plants via browsing, uprooting, and trampling (Dublin *et al*., 1990; Mwalyosi, 1990; Ruess and Halter, 1990). African elephants (*Loxodonta africana* Blumenbach) have major ecological effects on savanna dynamics, playing significant roles in nutrient cycling, seed dispersal, and the provision of space for new germinants (Lewis, 1987; Owen-Smith, 1988). The effect of elephants on plants depends on the plant's biology, elephant selectivity, and combined effect with other stresses (Field and Ross, 1976). Impacts can occur because of, (i) elephant tracks which compact the soil, (ii) mud wallowing depressions, (iii) debarking of trees which leads to eventual death, (iv) stripping stems and breaking of branches, and (v) uprooting of trees (Jachmann and Croes, 1991). In African savannas, due to human-livestock-wildlife interaction, the degree to which herbivory regulates woody plant dynamics is more related to human activities that influence herbivore distribution and abundance.

Evidence shows that food is the primary factor determining elephant movement, distribution and use of space (Laws *et al*., 1975; Owen-Smith, 1988). Field and Ross (1976) found out that elephant impacts could be exacerbated by drought conditions when elephants tend to increase the percentage of browse in their diet. The capacity of savanna areas to support elephant populations is influenced by elephant population density and

human land use activities (Leuthold and Sale, 1973). Most conservation areas in Africa form "ecological islands" (Martin and Taylor, 1983) because they are surrounded by human settlements. It is argued that the present spatial restriction of elephant populations by fenced nature reserves or external human pressures exacerbates their impact on woody plants (Laws, 1970). As elephants experience human-caused habitat reduction, elimination of migration routes and disturbance (including poaching), previously wide-ranging populations may become confined ("compressed") within reserves (Laws *et al.*, 1975; Jachmann and Bell, 1984).

High elephant densities alter the compositional, structural and possibly functional diversity of ecosystems (Dublin *et al.*, 1990; Cumming *et al.*, 1997). Elephant utilization can alter the vertical structure of the woody plant community, commonly manifested as reduced tree density and increased shrub density (Leuthold 1977; Guy 1989). Loss of canopy trees may imperil the woody plant population in the absence of recruits (Barnes 1983; Ruess and Halter, 1990), or be followed by a transition to bushland (i.e., shrub-dominated vegetation) due to the prevention of tree recruitment by herbivory and fire (Leuthold 1977; Jachmann and Bell, 1985).

2.2.1.2 Fire

Fire is an essential tool in pastoral lands to reduce weeds and pests and to inhibit the regrowth of woody species (Hugh and Lambin, 2000). Frequent uncontrolled fires modify the nutrient balance of soils (Crutzen and Andreae, 1990). Empirical data reveal that ecosystems affected by recurrent burning are characterized by soils of low nutrient status (Hugh and Lambin, 2000). Frequent fires cause disturbance to the landscapes and result in a partial or complete destruction of vegetation cover. This modifies community composition, hydrological processes at the soil surface and rates of soil erosion (Vogl, 1974). Frequent fires remove species that are less tolerant to fires hence reducing species diversity of an area (Goldammer, 1990). Fire intensity, frequency and magnitude may change the physiognomy of plants, reducing number of indispensable plant species (Petraitis, *et al.*, 1989). Fire may result in canopy gaps, which suppress seed germination

of some plant species, not favoured by canopy gaps and stimulate germination of other species that are favoured by canopy gaps (Goldammer, 1990).

2.2.1.3 Settlement and Land Use

i. Settlement

The Maasai are pastoral people of Nilotic origin who moved southwards into Kenya's central rangelands in the seventeenth century (Berntsen, 1979). The Maasai of Amboseli have wet and dry-season settlement areas locally known as '***bomas***' (Western, 1973). In the Amboseli, as elsewhere in Maasailand, ***bomas*** are clustered in favoured localities, where soil and drainage conditions are suitable (Western and Dunne, 1979). As these settlements expand, trading centres, schools, dispensaries and cattle dips are established, and eventually these areas may become small townships. Reid and Ellis (1995) documented overuse of resources near villages and towns in Turkana, where human and livestock densities are relatively high. Years of observation have led to a conclusion that, pastoralist and their livestock, through overuse of communal vegetative resources (Hardin, 1968); often have negatively affected arid ecosystems (Pratt and Gwynne, 1977) especially at close proximity to their settlement areas.

ii. Agriculture

The widespread destruction of woodlands due to agriculture and other human activity (Huntley, 1982) throughout the savannas makes the biodiversity losses within parks even more troubling. In Kenya, the privately owned land outside the core-conserved areas has allowed the landowners to respond to market opportunities for agriculture at the expense of wildlife habitats (Homewood ***et al.*** 2001; Ottichilo ***et al.*** 2001). In some areas, the values and norms of agriculturalists (adopted either by former pastoralists or with the influx of newcomers) are coming to dominate the land-use decisions in higher potential rangelands or areas with key resources within dry rangelands (Campbell ***et al***., 2000). Campbell and Lusch, (2003) found out that agro-pastoralists and agriculturalists (both small-scale and large-scale farming enterprises) at the base of Mt. Kilimanjaro, are converting precious swamplands and riverbanks into crops for local and national markets.

iii. Grazing

According to Hobbs and Huenneke, (1992), imposition of grazing animals (or different herbivores) on a system previously ungrazed or of lower level of grazing will constitute a disturbance. The same applies to the removal of grazing from a system with a long grazing history. Species diversity will be affected by the direction of change in grazing regime (Milchunas *et al*., 1990). Grazing have minimal impact on plant diversity in conservation areas than on rangelands because the plants have coevolved with the wildlife, but containment of wildlife within small reserves may have exacerbated grazing impacts (O'Connor and Wiseman, 2004). Milchunas *et al*. (1990) have reported maximum species diversity under intermediate levels of grazing.

2.3 NATURAL REGENERATION

Natural regeneration refers to the natural process by which plants replace or re-establish themselves, usually from an abundant production of seeds (Malcolm, 1999). Seedlings represent the final stage in the process of regeneration from seed. Various environmental factors such as soil moisture, temperature, micro-scale disturbance, canopy cover (light condition) and deep leaf layers (Hobbs and Huenneke, 1992; Gerhardt, 1996; Nagamatsu *et al*., 2002) affect tree seedling dynamics. According to Negamatsu *et al*. (2002), biotic factors such as herbivores, fungal infection and inter-species competition affect seedling survival.

Mass recruitment of savanna trees occurs at infrequent intervals, when conditions are favourable, generating even-aged stands of trees, which grow and senesce at similar rates (Young and Lindsay, 1988). The spatial distribution of recruits is, therefore, important in the understanding of natural regeneration dynamics (Condit *et al*., 2000).

2.4 WOODY PLANT USE AND COMMUNITY KNOWLEDGE TRANSFER

In ecological theory, a keystone species is a species that controls the environment and determines which other species can survive in its presence. Casual observance might lead to placing humans into this domineering role though current ecological thinking does not

consider humans as a keystone species, but as a major external disturbance factor to a "natural system" (Farina, 2000).

Pastoral people possess extensive knowledge gained and fine tuned over time. This is reflected in their life styles and the extent of their dependence on woody species (Weber and Hoskins, 1983). The wide variety of plant species used for an equally wide array of uses is characteristic in pastoral communities. Such diverse use is a strategy to risk avoidance (Reid and Ellis, 1995). According to Lykke *et al*. (2004) the Fulani people of the Sahel highly value goods and services provided by woody plants and a thorough knowledge of uses and dynamics of woody species is common.

Most of Kenya is covered by arid and semi-arid rangelands that are generally characterized by low human population compared to the high potential areas (Republic of Kenya, 1999). Wamalwa (1991) noted that for decades, pastoral communities living in these rangelands had insignificant impact on locally available tree and shrub resources, but this is changing rapidly. Present increase in population densities, unemployment and extreme poverty in rangelands are placing enormous pressures on indigenous woodlands (Gichohi *et al*., 1996). The Maasai of Group Ranches depend on woody resources for primary medical care, provision of energy in the form of wood fuel, and for fencing and construction of homesteads (Kiringe and Okello, 2005).

2.4.1 Medicinal Plants

Plants have provided humans with a storehouse of various drugs for practically all ailments (Sindiga *et al.*, 1995). It is estimated that 70% of Kenya's rural population use a combination of traditional and modern medicine while 20% use traditional forms only (Sayer, 2000). Marshall (1998) reported that the traditional knowledge of medicinal plants is most often passed down within families and communities from generation to generation. Sindiga *et al.* (1995) found out that this high dependence on traditional medicine revolves around its ability to meet four criteria of "accessibility, availability, acceptability and dependability". Modern health facilities in Kenya are spatially inequitable and favour urban areas where only about 15% of the country's 25 million

population lives (Sindiga *et al.*, 1995). The inability to reach modern health facilities result to heavy reliance on medicinal plants in Kenya; even in urban areas where supplements to western forms of medicine are available (Sindiga *et al.*, 1995). According to Marshall (1998), depletion and loss or degradation of the natural habitats creates a conservation challenge and represents a serious threat to the healthcare system of many people in the country.

2.4.2 Fuelwood Provision

Fuelwood as a source of energy for heating and cooking is a common use of plant resources in many rural communities throughout Kenya. While reliance on wood for fuel has declined in the developed world over the past century, it is still the principle source of fuel for many developing nations like Kenya (Cunningham and Saigo, 1999). Urban dependence on firewood and charcoal is often presumed to be a major cause of deforestation in African savanna woodlands (Moyo *et al.*, 1993; Chidumayo, 1997). With such a high level of dependence on fuelwood, the increasing human populations in many developing countries are creating a deficit of this important resource. In eastern Africa, it is estimated that the demand for firewood is ten times the sustainable yield (Cunningham and Saigo, 1999).

Most rural communities in Kenya, including the Maasai, use wood fuel to provide for daily energy needs such as cooking and home heating (Musoga, 1988; Mugabe and Clark, 1998). Leach and Mearns (1988) found out that, due to the need to have access to sufficient quantities of woody resources to meet their daily demand, the Maasai move their homesteads to areas where energy needs can be guaranteed. A twist of events has been reported by Herlocker (1999) of cases of charcoal burning among the Maasai, in the recent past as an economic alternative to their declining pastoral lifestyle.

2.4.3 Fencing and Construction

Were and Wanjala (1986) found out that traditional pastoral communities of Kenya utilize various trees and shrub species as a source of construction materials. Fencing and housing is an important activity for traditional Maasai who have wet and dry season *bomas* as the activity primarily use trees and shrubs (Were and Wanjala, 1986). The

main species of plants used in construction are Acacia trees (ICRAF, 1992). *Acacia senegal* is used for posts, poles and tools, *Acacia mellifera* for live fencing, *Acacia xanthophloea* for poles and fencing and *Acacia nilotica* for shelterbelts and live fences (ICRAF, 1992). The Maasai use thorny species like *Acacia mellifera, Acacia tortilis* and *Balanites glabra*, to fence off homesteads, as predator deterrent and for construction of livestock sheds (Kiringe and Okello, 2005).

2.5 NATURAL RESOURCE ACCESSIBILITY WITHIN CONSERVED AREAS BY LOCAL COMMUNITIES

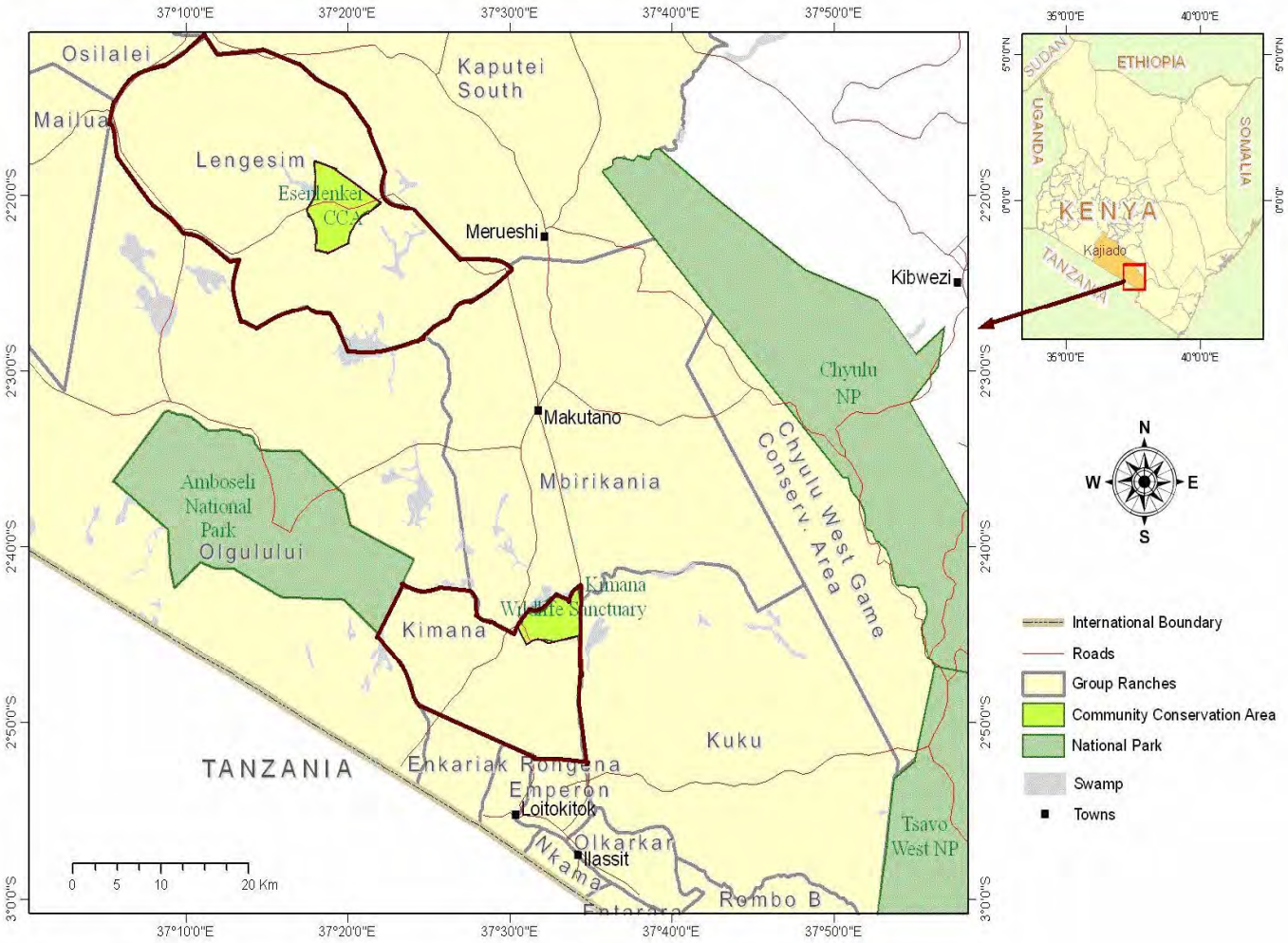
Pastoral people make best use of the vegetation both in time and space through a transhumant system of wet and dry season grazing combined with setting aside specific dry season grazing reserves (Barrow, 1996). Once an area is set aside for wildlife conservation, the pastoral community encounter restriction of access to resources from lands that they have utilized over a long time (Okello *et al*., 2003; Rutten, 2004). Okello *et al*., (2003) reported in a survey among members of the neighbouring Kuku Group Ranch that 'unfortunately, many community wildlife sanctuaries are based on the model of a National Park (IUCN category II) nested within a lived- in landscape with similar characteristics to a protected landscape (IUCN category V). Under this model, the establishment of protected areas involve the exclusion of human beings except for ecotourism activities and research (Okello *et al*., 2003).

This 'imitation' of a national park does not conform to the realities and needs of the communities. It alienates the communities from resources they had conserved and depended upon (e.g. for food, medicine, construction materials, etc.) before its designation as a conservation area (Sindiga, 1995; Rutten, 2004). Change factors including increase in population pressure, changes in economic activities and decline in resource availability can mean that the interests of local people are no longer compatible with conservation goals (Miller *et al.,* 1995).

3.0 METHODOLOGY

3.1 STUDY AREA DESCRIPTION

The study was conducted in Eselenkei and Kimana Group Ranches in southeastern part of Kajiado district (Fig. 1). Kajiado District is located at the southern end of the Rift Valley Province. The Republic of Tanzania borders it to the southwest; and is situated between longitudes 36˚5' and 37˚55' East and between latitude 1˚10' and 3˚10' south.

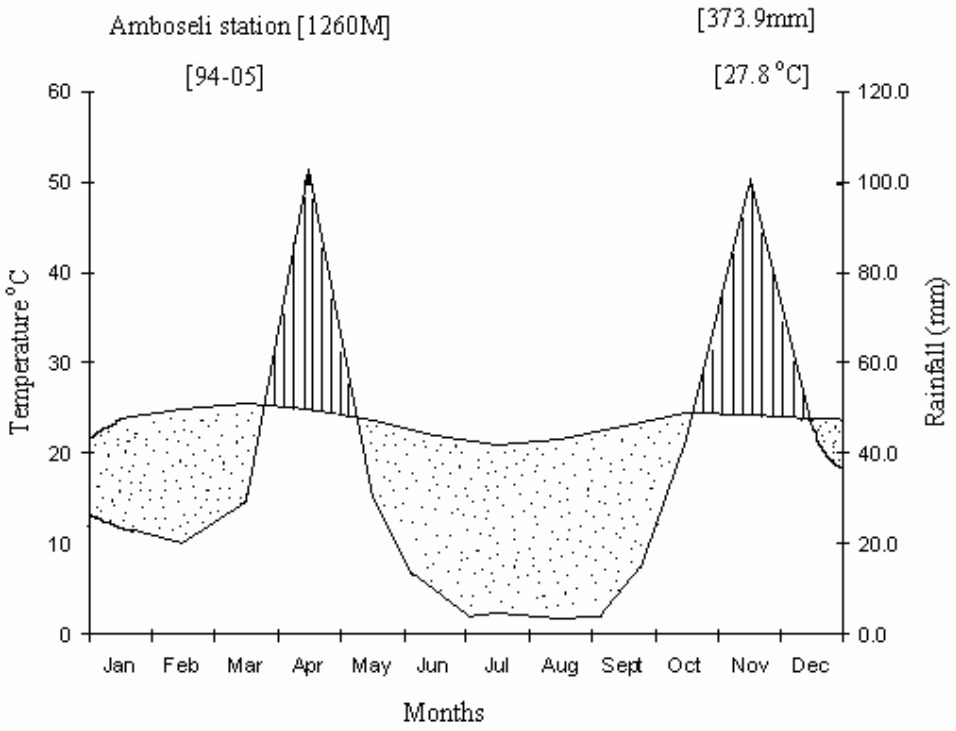


(**Source:** Field GPS data, AWF Spatial Analysis Laboratory, 2005)

Figure 1: A Map of Eselenkei and Kimana Group Ranches and the conservation areas

3.1.1 Climate and Geology

The District has a bimodal rainfall pattern occurring during November-January and March-May with mean annual rainfall of 350-mm. Temperatures range from 35˚C in February/March to 12˚C in July (Altmann *et al*., 2002). The climatic characteristics of the study areas are depicted in the clima diagram of the Amboseli basin constructed based on data obtained from the Meteorological Department of Kenya, Dagoreti (Fig. 2).



(**Data source**: Meteorological Department, Kenya 1994-2005)

Figure 2: Climadiagram for the Amboseli Basin

The geology of Eselenkei and Kimana Group Ranches is of lacustrine ash deposits, olivine gneisses, and volcanic ash mixtures. The soil types that occur here are brown calcareous clay-loams, black clays, ash and pumice and lava boulders (Kajiado District Atlas, 1990). The areas are within Agro-climatic zones V and VI (Sombroek *et al*., 1980), with the latter dominating the landscape. Zone V is rated as land with marginal to medium potential for agriculture. Livestock ranching and wildlife conservation are the major land use activities in this zone. Zone VI is classified as land with marginal

agricultural potential with extensive pastoralism and wildlife conservation being the major favourable land use activities.

3.1.2 Land Tenure System in Kajiado District

Land tenure system highly determines the use and access to land and its resources. Land tenure is an important and integral component of conservation and management of land resources and the environment in general (Ogolla and Mugabe, 1996). The Group Ranch scheme (GRS) launched in Kenya in the late 1960s was perceived as an enlightened approach to modernizing the Maasai pastoralists (Kimani and Pickard, 1998). The pivotal feature of the Group Ranch scheme was the conversion of communal land tenure system with fixed and legally recognized boundaries (Swift and Lane, 1988; Sperling and Galaty, 1990). This change was expected to encourage the Maasai to limit their livestock numbers to match the Group Ranch resources. Pasha (1986) and Munei (1991) reported that the Kenyan Government considered Group Ranches a failure since the Maasai did not reduce the number of livestock within the ranch boundaries. They continued exploiting Group Ranch land along traditional lines (Rutten, 1992). This initiated Group Ranch subdivision from the mid 1980s (Rutten, 1992; Kimani and Pickard, 1998). The existing type of land tenure system for Eselenkei and Kimana Group Ranches dictates sources of livelihoods for group ranch members.

3.1.3 Vegetation Cover Types of the Amboseli Basin

According to (Shiflet, 1994), rangeland cover types are based on the plurality of canopy cover by dominant species. Dominance types and cover types remain broadly used because they provide a simple, efficient approach for inventory and mapping in rangelands. Amboseli Basin, which integrates the two Group Ranches, has a variety of habitats that are able to support a high diversity and density of wildlife. Namely; the seasonal lake, alkaline plains, *Acacia xanthophloea* woodlands, *Acacia tortilis* woodlands, swamp edge vegetation, swamps and bushlands (Esikuri, 1998). According to Western (1983), open grassland, bushland and woodland vegetation types dominate the area. A brief description of the cover types in Amboseli Basin is provided in Table 1.

Table 1: Brief Description of Cover Types in Amboseli Basin, Kenya

Cover Type	Description
Riverine vegetation and swamps	Support vegetation with *Acacia xanthophloea*, reeds and other hydrophytes the dominant grass being *Cynodon dactylon.* Rivers are seasonal and the area covered is small but critical during dry seasons.
Bushland	Generally contain more trees and bushes than other habitats in the basin. *Acacia-Commiphora* combination forms good browse while the understory provides grassy forage. Acacia trees are found in varying densities.
Forested woodland	*Acacia xanthophloea* and *Acacia tortilis* are the dominant features of the woodlands. These species are associated with a high ground water-table and are common around swamps and springs
Shrubland	Shrub savanna with dense layer of shrubs. Balanites shrubs with dense mats of tall grasses dominate this cover type.
Wooded grassland	Grassland savanna with scattered trees. Grasses dominate this cover type. However, various woody species are widely found in this cover type

Source: Esikuri (1998).

3.1.4 Eselenkei Group Ranch

Eselenkei Group Ranch with an area of 74,794 ha, has a population of about 10, 000 Maasai (Ogutu, 2002). It falls under agro-climatic zone V classified as semi-arid (Sombroek *et al*., 1980) and is characterized by low and erratic bimodal annual rainfall. The low and unpredictable rainfall and lack of good aquifers make water resources a constraint to development in this area (Potter, 1989). Maasai traditional pastoralism remains the only adapted form of livelihood (Southgate and Hume, 1996). A mixture of livestock is raised, with the East African zebu being popular (Ogutu, 2002). The soil types include sandy loam and black cotton soils that are susceptible to erosion (Ogutu, 2002). Vegetation resources are scanty, being retarded by overgrazing and the harsh physical conditions.

3.1.4.1 Eselenkei Land Tenure

According to Ntiati (2002) there has not been any consent for the sub division of land in Eselenkei Group Ranch, land is owned communally. Under the communal land tenure system, all members have equal rights to use resources on their land (Okowa-Bennun and Mwangi, 1996). In this system, the management of land is vested in elected officials.

3.1.4.2 Fauna

Eselenkei conservation area covers an area of 5,000ha. It was previously used by Group Ranch members as a dry-season grazing area until 1997, when the area was set aside as a wildlife sanctuary. This area is a wet season dispersal area for wild animals from Amboseli and is important for wildebeest calving. Other wildlife species found in this area include Eland, Buffalo, Zebra, gazelles, Leopard, Lion, jackals and Hyena. The area is also best known for its diversity in birds (Rutten, 2004).

3.1.5 Kimana Group Ranch

The Kimana Group Ranch was incorporated in 1972, stretches over an area of 25,120 ha, and is located at the base of the northern foothills of Mount Kilimanjaro. The variability in topography, richness of soils and availability of permanent water leads to a diverse array of habitats, ranging from grasslands to riverine woodlands, which in turn leads to an abundant and diverse wildlife population. Being a swampy area well endowed with natural springs, the Kimana Group Ranch offers opportunities for livestock keepers, agriculturalists and game animals.

3.1.5.1 Land Tenure in Kimana Group Ranch

Unlike Eselenkei Group Ranch, Kimana Group Ranch has been subdivided (Ntiati, 2002) and titles allocated to individuals resulting to small parcels of land. Subdivision of Kimana Group Ranch has had major consequences for natural resource management and indeed the viability of the pastoralist lifestyle. Individuals may practice, or at least not prevent, detrimental activities deriving short-term gains, such as uncontrolled charcoal production and clearing of marginal land for cultivation. Land privatization brought about sedentarization and ownership shift to outsiders through selling of land. Kimani and Pickard (1998) recorded that in some ranches in 1996, over 50% of plots created at

original subdivision were purchased by non-Maasai, and that Maasai holdings are less than half of their original size.

3.1.5.2 Fauna

Kimana Group Ranch is a wet season dispersal area for Amboseli National Park fauna and has been inhabited by game for a long time. Kimana Community Wildlife Sanctuary was established in 1996 and covers an approximate area of 2,575ha in the northeastern region of Group Ranch (Fig. 1). The sanctuary encompasses a swamp derived from the subterranean waters from Mt. Kilimanjaro. Historically, the swamps were used by Maasai pastoralists for dry-season and grazing and source of water. The area is an important migration corridor for wildlife between Tsavo National Park and Amboseli National Park especially elephants (Western and Ssemakula, 1981). Other species common in the area are: Buffalo, Eland, Elephant, Giraffe, Gerenuk, Grant's gazelle, Hippopotamus, Hartbeest, Impala, Thomson's gazelle, Waterbuck, Warthog, Wildebeest and Zebra (Worden, *et al*., 2003).

3.2 DATA COLLECTION

3.2.1 Stand Selection and Plot Design

Ground reconnaissance was conducted to develop a method for stand and plot selection. The local community assisted in the identification of boundaries of the two conservation areas which were mapped using a Garmin global positioning system (GPS 12) receiver. Selection of stands (contiguous areas of vegetation that are reasonably uniform in physiognomy and floristic composition) was preferentially done. Systematic sampling was undertaken within the two wildlife sanctuaries and adjacent communal sites.

3.2.1.1 Site Selection in Eselenkei and Kimana Ranches

i. Eselenkei conservation area and adjacent communal areas

Eselenkei conservation area has an indistinct mixed stands of species cutting across to the communal land. River Eselenkei, which acts as a boundary to the conservation site greatly, influenced the vegetation of the area in the conservation area and its adjacent site. Areas along the river were avoided, and instead, plot measurements were carried out

along the continuous stand of mixed *Acacia-Commiphora* bushland on the extreme upper zone (Fig. 3) towards Oloosinkiran hill.

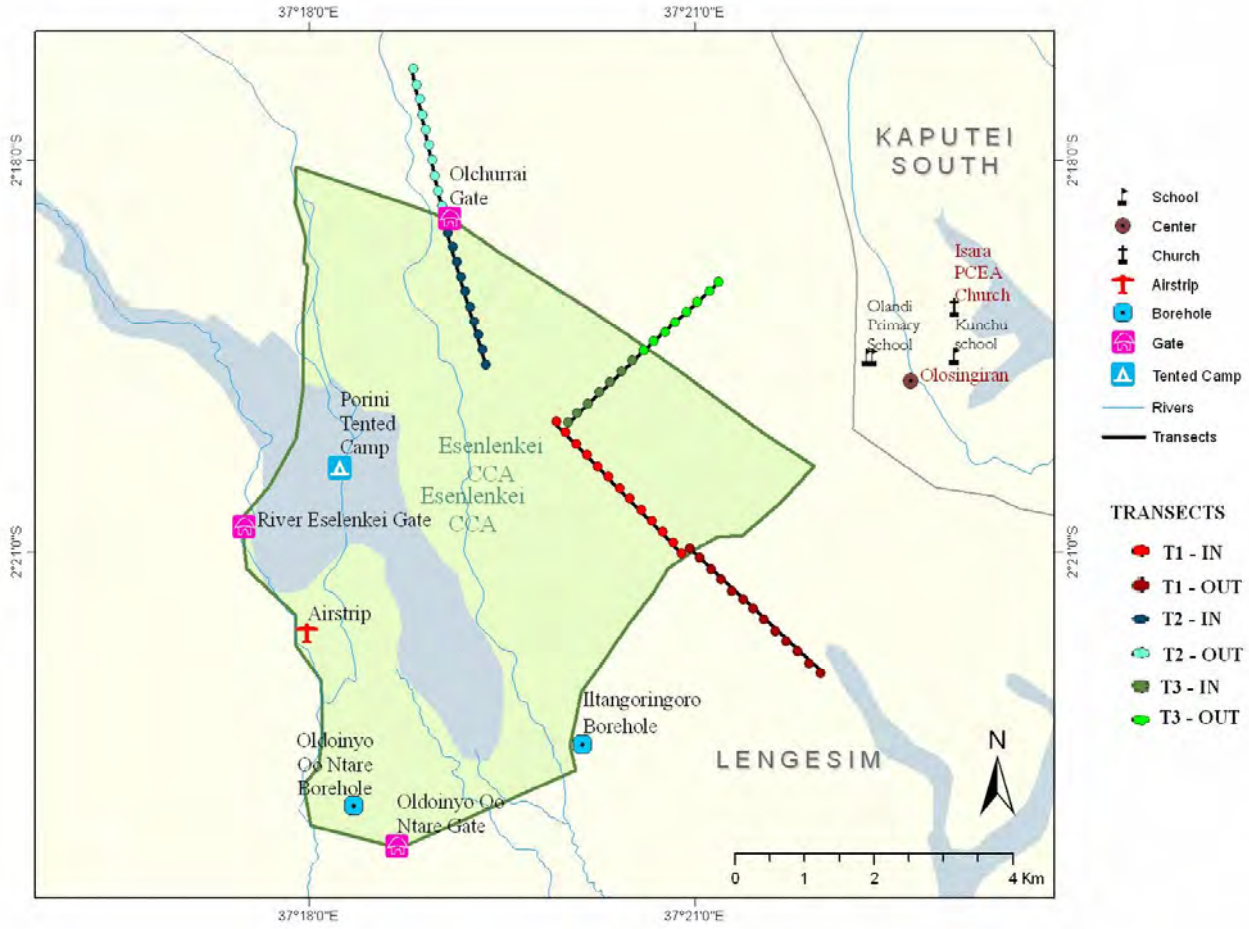


Figure 3: Map of Eselenkei conservation area showing transect, and plot location towards conserved and adjacent communal areas based on field GPS data

Transects were spaced at 1km interval and their orientation randomly picked. Transect 1 (**T1**) was randomly selected from the three possible transects along the 3 km bushland stretch from Oloosinkiran hill towards Iltangoringoro borehole. Transect 2 and 3 (**T2**) and (**T3**) were selected from eight along the Olchurrai gate -Oloosinkiran hill. Corresponding number of plots in each transect were established at an interval of 200m from the conservation area boundary towards the sanctuary and communal sites respectively.

Transect 1 (**T1**) had a total of 24 plots, transect 2 (**T2**) 20 plots and transect 3 (**T3**) 14 plots (Fig. 3).

ii. Kimana conservation area and adjacent communal areas

Cover types identified in Kimana site were *Acacia xanthophloea* woodland and *Acacia tortilis* woodland. Boundaries of these cover types were marked using a GPS receiver within the sanctuary and the adjacent sites (Fig.4).

There was no adjoining *Acacia xanthophloea* woodland on communal land since agriculture dominates on communal site in Mbirikani Group Ranch. An exception was made and comparative sites sampled outside the sanctuary along Kikarankot River at Esampu site. Thirteen plots were established at an interval of 200m interval, in the N50˚E direction towards the swamp, while eight were placed along Kikarankot River at Esampu site (Fig. 4).

In *Acacia tortilis* woodland, eight parallel transects placed at 500m interval from the sanctuary to the adjacent sites. Two transects (T1 and T2) were randomly picked from these. Plots were established at an interval of 100m; in N50˚E direction from the boundary towards the sanctuary and S230˚W towards settlements. Transect 1 (**T1**) had a total of 24 plots and transect 2 (**T2**) 26 plots (Fig. 4).

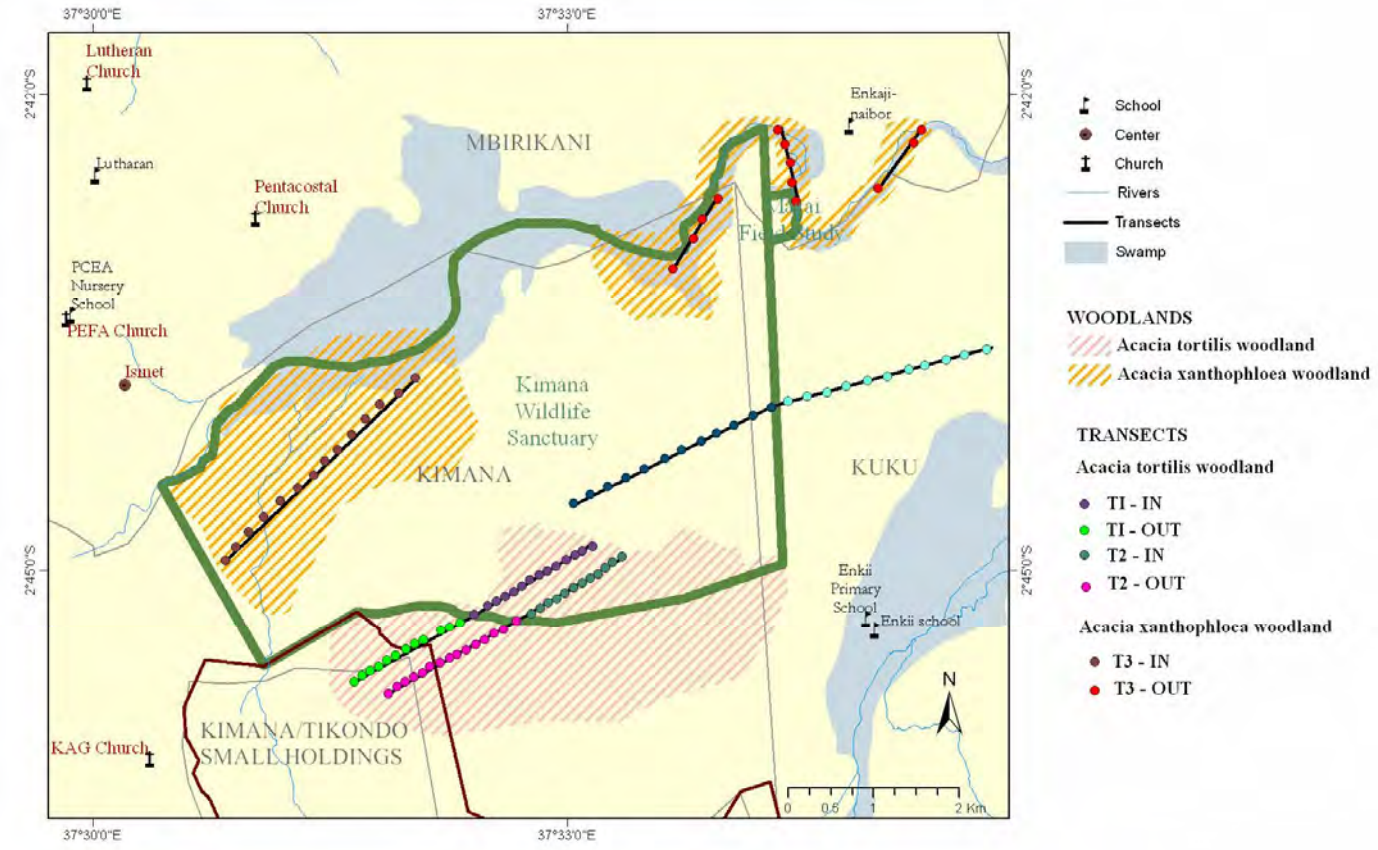


Figure 4: Map of Kimana conservation area, showing identified cover type, transect and plot location towards conserved and adjacent communal areas based on field GPS data

3.2.1.2 Plot Design and Measurements

All initial plots from the sanctuary boundary were placed at 200m away from the start point to avoid the edge effect. GPS was used to measure distances between plots and bearings. GPS readings for plot location were recorded and used to generate Fig. 3 and 4, for future monitoring. A nested plot of 20m x 20m for tree measurements, 5m x 5m for shrubs and 5m x 2m for seedlings was set up. All woody plants (trees, shrubs) in the plot were recorded, with their scientific names and vernacular names. A shrub was taken to be a multi-stemmed woody plant. Trees and shrubs are here grouped together as many savanna woody species can adopt either single or multi-stemmed growth forms,

depending on grazing pressure which can influence the degree of branching (ICRAF, 1992). A tape measure was used to measure diameter at breast height (DBH) 1.3m or diameter at stump height (DSH) 0.30m height above ground, where the structure of the vegetation was predominantly forked. Tree/shrub height for a few selected trees and shrubs within the plot were measured, by either using a calibrated pole or Suunto to represent the vertical stratification. Regeneration was recorded as seedling (≤1.0 m high) and sapling (>1.0 m high and ≤ 4.9 cm dbh).

Plant voucher specimens of plants were collected, identified and deposited at the National Museums of Kenya in Nairobi (Appendix 2). The identification of the voucher specimen was based on three methods: visual identification based on experience in the field, by comparisons with already identified specimens and lastly, by using taxonomical keys in the Flora of Tropical East Africa (FTEA).

3.2.2 Ethnobotanical Data Collection

Data were obtained from three main sources: interviewing Group Ranch members, undertaking paired comparisons of activities and personal observations.

3.2.2.1 Semi-Structured Interviews

Semi structured interviews as described by Martin (1995) and Cotton (1996) was used to obtain both qualitative and quantitative data from the community (Appendix 1). Relative distances from the conservation areas were used to identify settlement areas to be interviewed. The assumption is that, community members tend to utilise resources in their close proximity and, to avoid sampling Group Ranch members settled more closely to the national parks than the conservation areas. A list of all active settlement (***bomas*** with occupants) at close proximity to the conservation area was complied. I used the term 'boma' to remain consistent with other academic studies of Maasai pastoralism (Rutten, 1992; Homewood and Rodgers, 1991). Households to be interviewed were randomly selected from the list of ***bomas*** from each settlement area. Following Cotton (1996), equitable representation of gender and age differences were taken into consideration. Age sets were equated to four age categories as follows: Less than 20 years, 20-40 years, 40-60 years and more than 60 years of age. Ninety-six informants (48

respondents from each site) were interviewed from Eselenkei and Kimana Group Ranches. Twenty-three and twenty-five females were interviewed from Eselenkei and Kimana areas respectively.

3.2.2.2 Paired Comparisons

Paired comparisons as described by Martin (1995) was used to establish threats to indigenous useful plants as perceived by the respondents, based on discussions with participants, local guides, available literature and general observations. The total number of pairs was determined by the formula $n\ (n-1)/2$ where ***n*** stands for the number of items to be categorized. Four selected activities per Group Ranch were identified and the impact of each ranked in a pair wise approach. Fire outbreak, elephant damage, fencing and construction and charcoal production were selected for ranking at Eselenkei area. Charcoal production, agricultural expansion, fencing and construction and elephant damage were activities selected to be ranked by informants at Kimana Group Ranch (Appendix 1). Based on the degree of threat, the most destructive activity, as perceived by the local community were determined.

3.2.2.3 Researcher's Observations

This was applied for the whole period of study, with the researcher taking field notes, photographs, counts and measurements of various aspects related to the subject of the study. This is a useful tool for crosschecking information obtained from informal discussions and interviews.

3.3 DATA ANALYSIS

3.3.1 Ecological Data Analysis

Both descriptive and inferential statistics were used to analyze data collected. EXCEL spreadsheets were used for summarizing data. MINITAB Release 12.22, SPSS 10.0.5, Instat Graph Pad version 3.0, Sigma Plot data graphing software were used for data analysis.

The regeneration/ recruitment potential of the two sites was evaluated based on the average number of recruits in the area classified either as seedlings or saplings. The regeneration/ recruitment significance was tested by unpaired-t test in the case of *Acacia-Commiphora* bushland and Mann-Whitney test for the *Acacia xanthophloea* and *Acacia tortilis* woodlands. Variations in mean heights of woody species found both within the conserved areas and adjacent communal land was tested by T-tests and Mann-Whitney tests in Eselenkei and Kimana areas.

Importance Value Index (IVI) was used to compare ecological significance of woody species in Eselenkei and Kimana areas. Importance value index is the sum of relative density, relative frequency and relative basal area (ha^{-1}). The importance value index is useful for comparisons of ecologically significant species (Lamprecht, 1989) (for instance, the role played by a given species in nutrient recycling, influence to the under canopy growth). It represents the relative dominance of a tree species (Barker ***et al.***, 2001). Relative importance of woody species is calculated using the Importance Value Index (IVI) of Curtis and McIntosh (1951).

IVI = Relative density + Relative frequency + Relative dominance

Relative density = Number of stems per ha of the i^{th} species / Total number of stems pre Ha of all species x 100

Relative frequency = Frequency of i^{th} species / Total frequency of all species x 100

Relative dominance = Sum basal area of i^{th} species / total basal area of all species x 100

Population structure reflected in diameter class sizes was analysed for diameter size distribution. Descriptive statistics was used to analyse variation in woody species population structures within conserved and communal sites in Eselenkei and Kimana sites.

Shannon diversity index (Shannon and Weaver, 1949) was used to quantify species richness and diversity within and outside the conservation area. The Shannon–Wiener index takes into account species richness and proportional abundance to calculate a single

diversity measure. This is, in fact, a measure of evenness of species abundances in a sample with more even samples gaining a higher value. The Shannon diversity index (H') is calculated with the formula:

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

Where:

S = number of species

pi = proportion of individuals belonging to species *i*

H' = Shannon-Wiener index

ln = natural log (i.e. base 2.718).

For t-test comparisons, $pi (\ln pi)^2$ was calculated.

3.3.2 Ethnobotanical Data Analysis

Information collected through semi-structured interview was coded and descriptive statistics performed. Data collected through paired comparison was analyzed by total counts per activity and clustering done using MINITAB 12.12. Cluster analysis was used to classify respondents based on their insight on activities considered as threats to the existence of woody species in their area.

Use values were assigned to woody species use categories. Use-value was used to estimate local people's use-preferences directly from the number of informants mentioning a species during free-listing interviews (Philips and Gentry, 1993; Martin, 1995). During free listing exercise, informants might be tempted to mention abundant, eye-catching and easily accessible species as well as species providing goods at the season of investigation, and in that way abundance, conspicuousness, availability and season of investigation may influence informant consensus (Lykke *et al*., 2004) and use value assessment.

Use value is estimated using the formula:

$$UV_{is} = \sum u_{is}/n_{is}$$

UV_{is}= use value of a species ***s*** for informant ***i***

u_{is} = the number of uses mentioned in each event by informant ***i***

n_{is} = the number of events for species ***s*** with informant ***i***

According to Phillips and Gentry (1993), an event is defined as the process of asking one informant on one day about the uses he/she knows for one species. The overall estimate of use-value for each species is computed as:

$\mathbf{UV} = \sum \mathbf{UV_{is}} / \mathbf{n_s}$

Where $\mathbf{n_s}$ = the number of informants interviewed for species **s**

Use values were assigned to five broad categories: medicinal, shelter and construction, fuelwood (charcoal and firewood), fencing and others. The five broad use categories used here are similar to those used by Kiringe and Okello (2005), in their study of Kuku group ranch, with an addition of 'others' category for woody plants listed for cultural/ceremonial purposes. Kruskal-Wallis and T-tests were used to analyse community knowledge distribution in gender and age-set respondents across the species and use categories. Kruskal-Wallis and Dunn's tests were used to test the differences in responses between female and male across use categories.

4.0 RESULTS

4.1. FLORISTIC COMPOSITION AND STRUCTURAL PATTERNS

A total of 30 woody species belonging to 10 families were recorded in the two study sites. Eighteen woody species were recorded in Eselenkei site (*Acacia-Commiphora* bushland) belonging to 7 families; whereas 23 woody species belonging to 10 families were recorded in Kimana site (Appendix 2).

In Eselenkei study site, 16 and 17 woody species were recorded in the *Acacia-Commiphora* bushland on conserved and communal sites respectively (Appendix 3). In Kimana site, 5 and 6 woody species were recorded in the *Acacia xanthophloea* woodland in the conserved and communal sites respectively while 10 and 9 woody species were recorded in the *Acacia tortilis* woodland in the conserved and communal sites respectively.

4.1.1 Woody Species Diversity

In Eselenkei conservation area, within the *Acacia-Commiphora* bushland, a lower woody species diversity and evenness was recorded in the conserved area compared to the communal area though unpaired t-tests did not reveal significant difference ($t=0.19$, $df=17$, $P=0.85$).

In Kimana site, a higher woody species diversity and evenness was recorded in the *Acacia xanthophloea* woodland sampled within the conservation area compared to the communal area. Woody species diversity and evenness was lower in *Acacia tortilis* woodland at conserved area compared to the communal site, though unpaired t-tests revealed the difference not to be significant ($t=0.80$, $df=13$, $P=0.44$). Pooled values for woody species diversity for Kimana area showed higher species diversity within the conserved area compared to the communal site, though Mann Whitney test revealed no significant differences ($U'=55.00$, $P=0.62$)

Shannon diversity indices of woody species in Eselenkei and Kimana conservation areas are shown in Table 2.

Table 2: Shannon's Diversity Index (H') and evenness (H'/Hmax) for conserved and communal sites at Eselenkei and Kimana sites

Site/Stand	Conserved		Communal	
	H'	Evenness	H'	Evenness
Eselenkei Area				
Acacia-Commiphora bushland	1.078	0.554	1.758	0.708
Kimana Area				
Acacia xanthophloea	0.783	0.713	0.181	0.130
Acacia tortilis woodland	0.640	0.291	0.764	0.426
Kimana Pooled	*1.290*	*0.519*	*1.116*	*0.536*

4.1.2. Importance Value Index

Woody species in the two areas had different importance values indices. In Eselenkei, *Commiphora schimperi* had the highest IVI value (155.61) within the *Acacia Commiphora* bushland. In Kimana, *Acacia tortilis* had the highest IVI value (107.86) within the *Acacia tortilis* woodland. Importance value index, for all woody species with IVI values $\geq$ 5 for Eselenkei and Kimana sites are presented in Fig. 5 and Fig. 6 respectively.

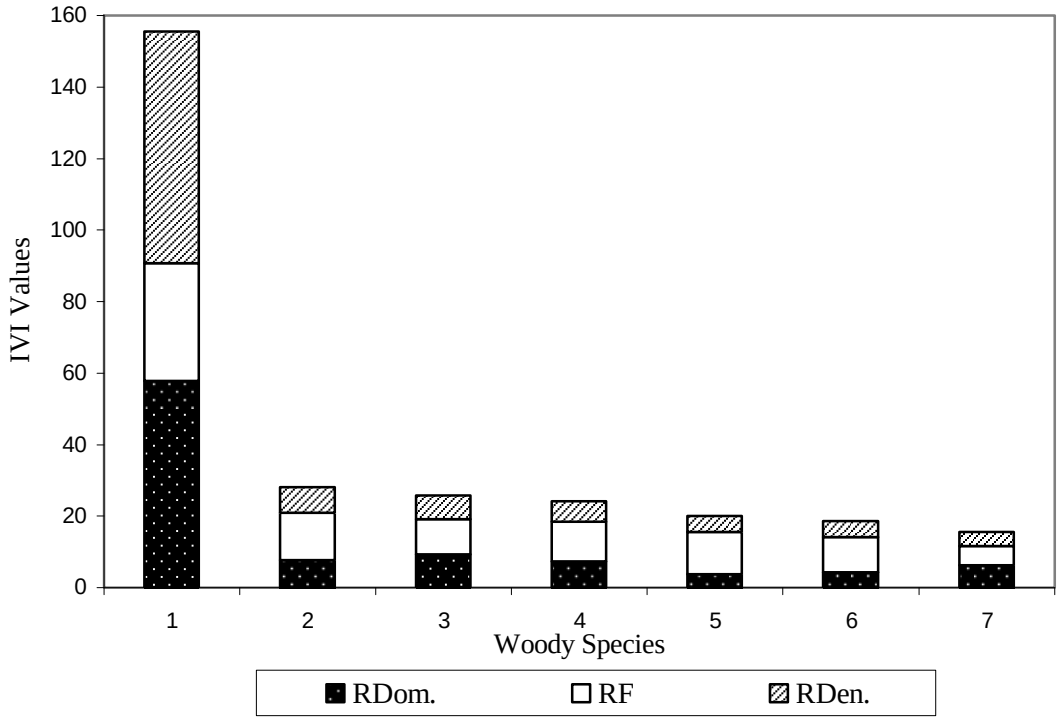


Figure 5: Relative dominance (RDom.), Relative frequency (RF) and Relative density (RD) of woody species with IVI $\geq$ 5 in Eselenkei Site: **1**; *Commiphora schimperi* **2**; *Commiphora africana* **3**; *Acacia mellifera* **4**; *Acacia tortilis* **5**; *Commiphora holtziana* **6**; *Acacia ancistroclada* **7**; *Balanites glabra*

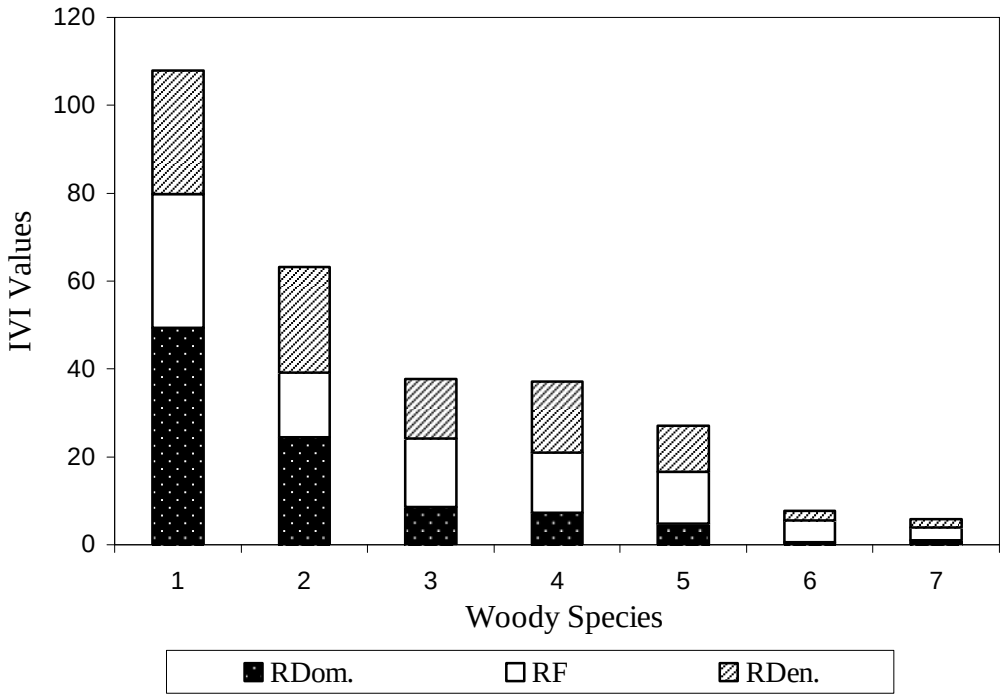


Figure 6: Relative dominance (RDom.), Relative frequency (RF) and Relative density (RD) of the woody species with IVI ≥ 5 in Kimana: **1***; Acacia tortilis* **2***; Acacia xanthophloea* **3***; Salvadora persica* **4***; Balanites glabra* **5***; Maerua edulis* **6***; Lycium europaeum* **7***; Balanites aegyptiaca*

4.1.3 Vertical Structure

Except for *Acacia tortilis* in Eselenkei and *Acacia xanthophloea* in Kimana; other woody species heights revealed no significant differences between conserved and communal sites tested either by t-tests or Mann-Whitney tests ($P>0.05$). Woody species mean heights comparisons within the conserved and adjacent communal sites are presented in Table 3.

Table 3: Mean height (m) for woody plants in conserved and communal areas at Eselenkei and Kimana study sites

Site/Stand	Conserved	Communal	
	Mean Height (±SE)	Mean Height (±SE)	Significance
Eselenkei: *Acacia-Commiphora* bushland			
Acacia ancistroclada	4.80±0.19	5.22±0.31	P= 0.2042
Acacia mellifera	4.22±0.33	4.53±0.30	P=0.4980
Acacia tortilis	3.90±0.45	6.42±0.39	**P=0.0051
Commiphora africana	4.87±0.23	4.92±0.12	P= 0.8994
Commiphora holtziana	3.04±0.24	3.61±0.35	P=0.2398
Commiphora schimperi	4.03±0.042	4.12±0.07	P= 0.7064
Kimana:			
Acacia xanthophloea woodland:			
Acacia xanthophloea	7.94 ± 0.63	16.83± 0.71	**P< 0.0001
Acacia tortilis woodland:			
Acacia tortilis	5.82 ± 0.75	7.17 ± 0.51	P = 0.1574
Maerua edulis	3.29 ± 0.67	3.71 ± 0.44	P= 0.1828
Salvadora persica	5.96 ± 0.54	5.39 ± 0.47	P = 0.4306
Balanites glabra	3.14 ± 0.23	3.52 ± 0.19	P= 0.2454

* - significant difference (P<0.05)

Acacia-Commiphora bushland at Eselenkei site

Acacia xanthophloea woodland, Kimana site

Acacia tortilis woodland, Kimana site

4.1.4 Population Structures of Woody Species

Population structures for *Commiphora schimperi* within the *Acacia-Commiphora* bushland in Eselenkei site; *Acacia xanthophloea* and *Acacia tortilis* in their respective woodlands in Kimana are shown in Fig. 7. The selection of these three woody species is based on their IVI > 50 obtained.

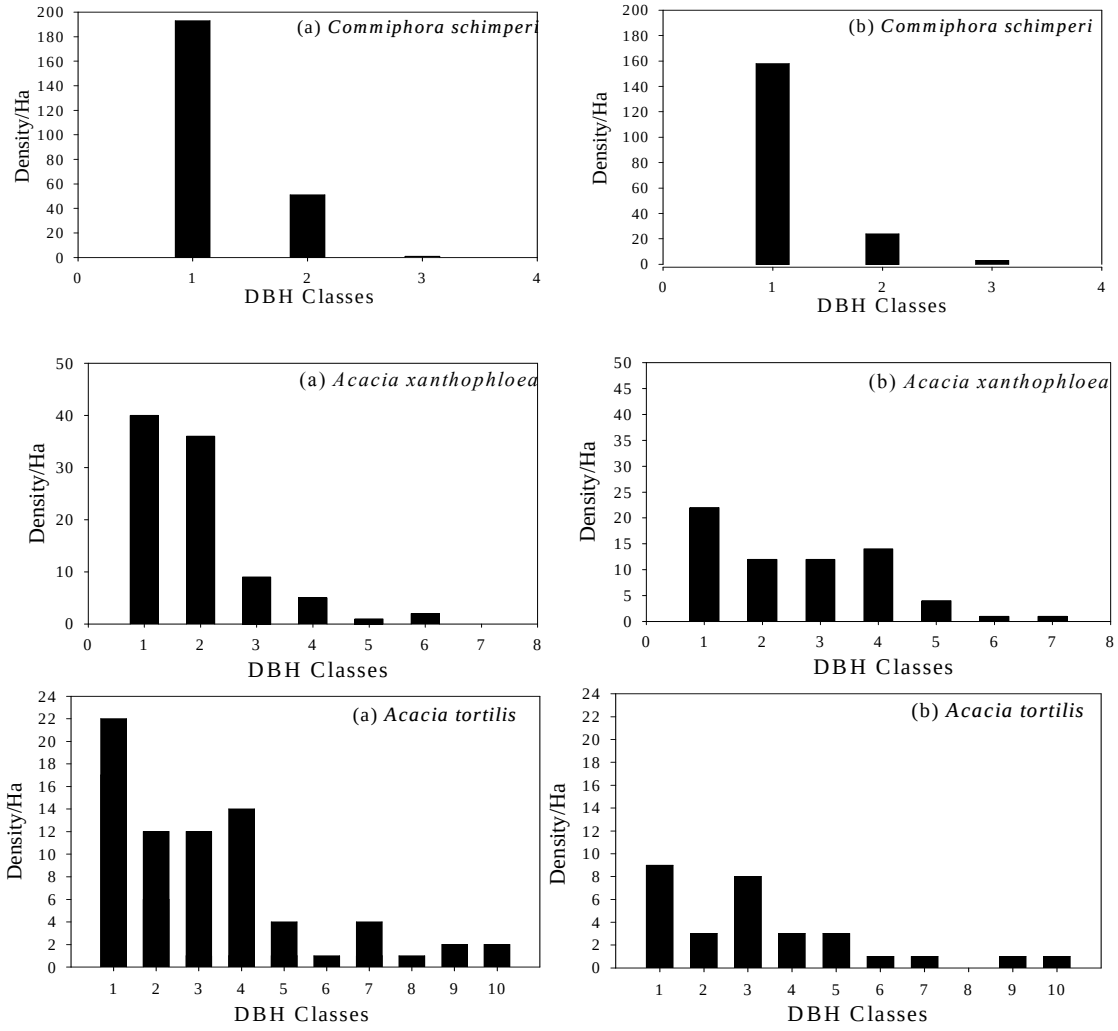


Figure 7: Population structure comparisons of woody species with IVI>50 between conserved (**a**) and communal (**b**) areas in Eselenkei (*Commiphora schimperi*) and Kimana (*Acacia xanthophloea* and *Acacia tortilis*) sites. Diameter at Breast Height (DBH) Classes (in cm) represented is as follows: **1**= >4.9-9.9, **2**=10.0-14.9, **3**=15.0-19.9, **4**=20.0–24.9, **5**=25.0–29.9, **6**=30.0–34.5, **7**=35.0–39.9, **8**=40.0–45.9, **9**=45.0–49.9 and **10**≥50.0

In Eselenkei site, *Commiphora schimperi* had an inverted J-shaped distribution and the density decreased with increasing diameter in conserved and communal sites, which indicates a good regeneration and recruitment potential. In Kimana, *Acacia xanthophloea* and *Acacia tortilis* had inverted J-shaped distribution both at conserved and communal sites. Regeneration and recruitment potential for the three woody species was noted to be better and higher within the conserved areas compared to its adjoining communal areas.

4.1.5 Natural Regeneration

In Eselenkei, t-tests comparing the number of seedlings in conserved and communal sites revealed significant differences (t=2.4, df=56, P=0.019) whereas no differences were detected in saplings (t=0.87, df=56, P=0.39) between the two adjacent areas.

In Kimana, Mann-Whitney tests performed for seedlings and saplings in conserved and communal sites within the *Acacia xanthophloea* and *Acacia tortilis* woodlands revealed no significant differences (P>0.05). The number of seedlings and saplings per hectare in Eselenkei and Kimana are shown in Table 4 within and outside the two conservation areas.

Table 4: Woody species regeneration (mean density seedlings/ha and saplings/ha) in conserved and communal areas at Eselenkei and Kimana sites.

SITE	**SEEDLINGS**		**SAPLINGS**	
	Conserved (No./ha ±SE)	Communal (No./ha ±SE)	Conserved (No./ha ±SE)	Communal (No./ha ±SE)
Eselenkei				
Acacia-Commiphora bushland	979±87.56	703±73.36	1462±155.95	1297±109.60
Kimana				
Acacia xanthophloea woodland	1600± 837.90	850 ± 420.00	262± 141.34	475± 176.00
Acacia tortilis woodland	1075±199.30	763±123.90	281.8± 66.67	245± 55.49

i. Eselenkei site

Acacia-Commiphora bushland: A total of 17 and 16 woody species were recorded either as seedlings or saplings on conserved and communal areas respectively. Saplings and seedlings were grouped into three broad categories; the commiphoras, acacias and others. Seedling percentages for Commiphora spp was 65% and 47%; Acacia spp was 10% and 21% and the others had 25% and 32% of the total number in conserved and communal sites respectively. Sapling percentages for Commiphora spp 56% and 36%, Acacia spp were 15% and 19% and the others had 29% and 45% of the total number on conserved and communal sites respectively.

ii. Kimana site

Acacia xanthophloea woodland: A total of 5 woody species were recorded either as seedlings or saplings on conserved site compared to 6 found within the communal area. Percentages of seedling within the conserved area were 20% *Acacia xanthophloea*, 30% *Acacia robusta*, 43% *Azima Tetracantha* and 7% others of the total number. Percentages of seedlings on communal area were *Acacia xanthophloea* 75%, *Azima tetracantha* 19%, others 6%. Saplings percentages on conserved site was 52% *Acacia xanthophloea*, 29% *Azima Tetracantha*, and 19% *Tabernaemontana stapfiana* of the total number. Saplings percentages on communal site were 42% *Acacia xanthophloea*, 55% *Azima tetracantha* and others 3% of the total on communal land.

Acacia tortilis woodland: A total of 9 woody species were recorded either as seedlings or saplings on conserved site compared to 7 within the communal site. Seedling percentages for *Maerua edulis* was 56%, *Acacia tortilis* 35%, *Azima tetracantha* 2% and *Balanites glabra* 7% of the total number on conserved areas. Seedling percentages for *Maerua edulis* was 52%, *Acacia tortilis* 37%, *Azima tetracantha* 7% and *Balanites glabra* 7% and 4% of the total number on communal sites. Sapling percentages were *Maerua edulis* 29% and 83%, *Acacia tortilis* 53% and 13%, *Balanites glabra* 18% and 2% of the total on conserved and communal sites respectively, and 2% of *Azima tetracantha* on communal site.

4.1.6 Woody Species Density

Woody species densities within and outside the conservation areas varied within stands as shown in Fig. 8. In Eselenkei area, the *Acacia-Commiphora* bushland density within the conservation area was 290.52 ± 25.25 stems/ha, while it was 280.17 ±28.49 stems/ha in the communal area. There was a slight decrease in density of woody species within the communal area but was not considered significant (t=0.27 df =56, P=0.79).

In Kimana sanctuary, the mean density of woody species in the *Acacia xanthophloea* woodland was 67.19 ± 16.86 stems/ha within the conservation area and 107.82 ±18.44 stems/ha on communal sites. Unpaired t-test revealed no significant difference in woody species densities between the two sites (t =1.626, df =14, P=0.13). In the *Acacia tortilis* woodland, the mean density of woody species within the sanctuary was 97 ± 16.54 stems/ha whereas it was 57 ± 12.46 stems/ha on communal land. Note the decline in woody density on communal site, though Mann-Whitney tests revealed no significant differences (U'=400 n=25, P=0.09).

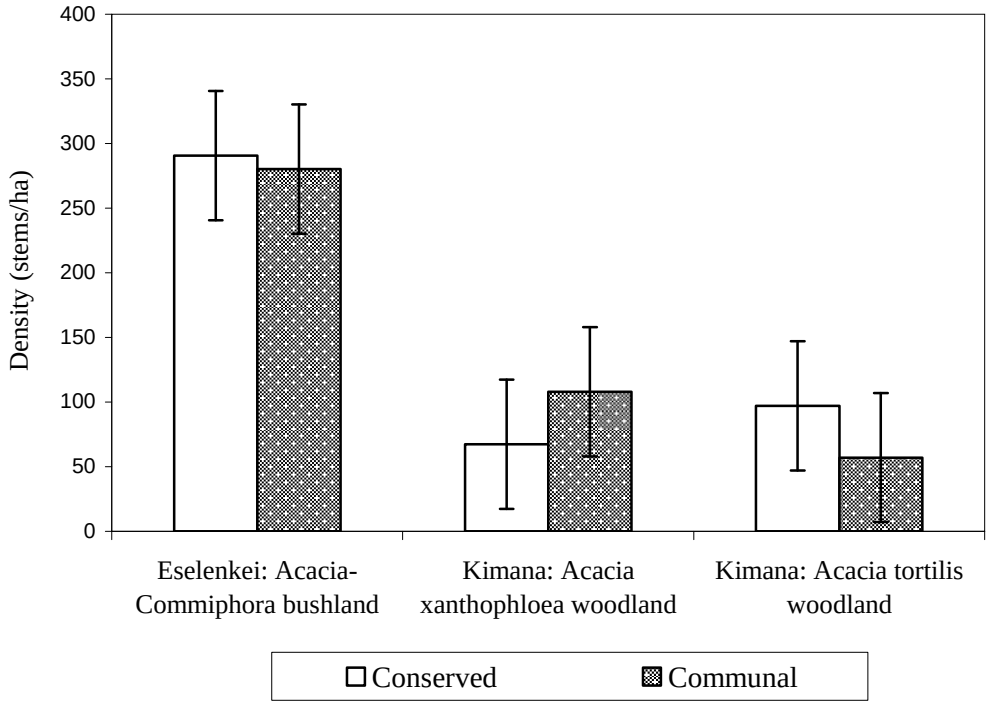


Figure 8: Mean woody species density at conserved and communal areas at Eselenkei and Kimana sites

4.1.6.1 Woody Species Density Trends

Changes in densities with increasing distance from the conservation area boundary resulted in both positive and negative relationships (Table 5) and scatter plots with simple regression lines (Fig. 9) shows the general trend in Eselenkei and Kimana. There was a significant ($P<0.05$) decrease in density of woody species towards the communal and conserved area at Eselenkei site, within the *Acacia-Commiphora* woodland.

In Kimana, the *Acacia xanthophloea* woodland was not analyzed since plot placements were not adjacent to each other (refer to Fig. 4). The *Acacia tortilis* woodland, which comprised the totality of species in Appendix 3, did not reveal significant differences ($P>0.05$) in woody species density increment towards the conserved and communal areas (Table 5 (c) and (d)). On further analysis of this woodland, *Acacia tortilis* species was specifically selected for density analysis with respect to distance from the boundary. The focus on this single species within this woodland revealed a decline in densities considered significant ($P<0.05$) towards and away from the conservation area.

Table 5: Pearson correlation coefficients of woody species densities in conserved and communal sites at Eselenkei and Kimana sites. (*n*) Represents averaged number of plots that were equidistant from the conservation area boundary.

Study area	**Stand**	**Pearson coefficient**	**n**	**Sig.**
Eselenkei(a)	*Acacia-Commiphora* bushland (Conserved)	-0.70	12	P=0.011**
(b)	*Acacia-Commiphora* bushland (Communal)	-0.69	12	P=0.012**
Kimana (c)	*Acacia tortilis* woodland (Conserved)	+0.54	13	P=0.059 ns
(d)	*Acacia tortilis* woodland (Communal)	+0.50	13	P=0.082 ns
Kimana (e)	*Acacia tortilis* (Conserved)	-0. 78	11	P=0.005**
(f)	*Acacia tortilis* (Communal)	-0.88	11	P=0004**

**: significantly different

ns: not significant

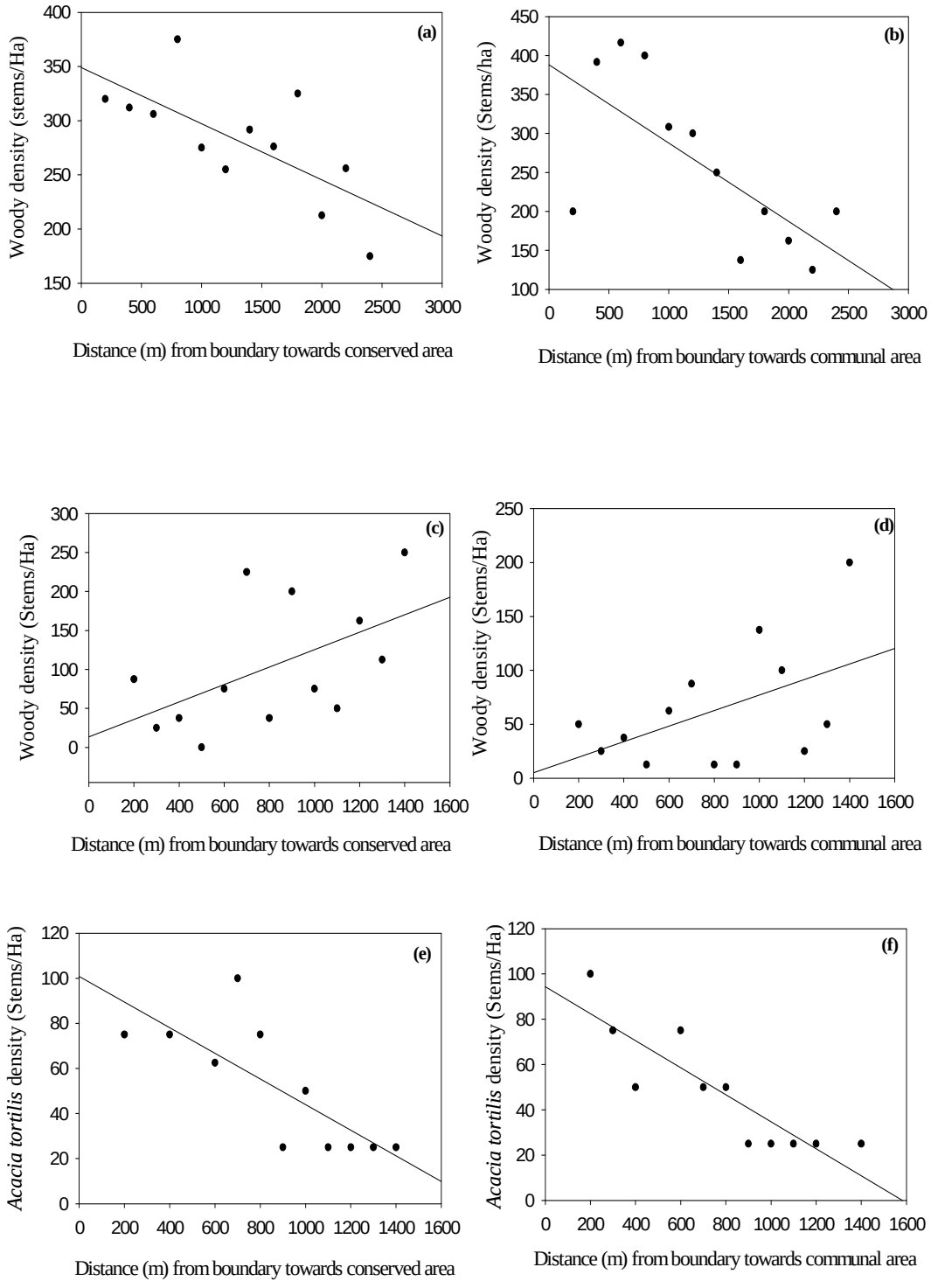


Figure 9: Scatter plots of the relationship between distance from the conservation area boundary towards the core of the conservation and communal areas in both study sites.

4.2 PEOPLE AND CONSERVATION AREAS

4.2.1 Local Community Attitude towards Conservation Areas

In Eselenkei Group Ranch, 52% of the total respondents favoured the presence of the conservation area, while 40% were against the conservation area. A further 8% were indifferent to the presence of the conservation area. Only 36% of the women interviewed were for the conservation area while 64% were either against or indifferent to the conservation area.

In Kimana Group Ranch, 52% were positive towards the conservation site, 44% did not want the conservation site while 4% were indifferent to the presence of the conservation area in the Group Ranch. Only 32% of women interviewed were positive towards the conservation area while 68% were either against or indifferent to the presence of a conservation area in the Group Ranch.

4.2.2 Total Use Values of Woody Plants

Eselenkei Group Ranch: The local opinion of the community on usefulness across woody species was higher at this site and a total of 35 woody plant species were listed as useful (Appendix 4). Total use values by respondents in Eselenkei are presented in (Appendix 5(a)). Harvesting of woody species for ethnomedicinal purposes was the most commonly cited across the woody species by 35±5% respondents; followed by shelter 31±5% respondents; fencing 28±5% of respondents; fuelwood 24±5% respondents; and other uses (ritual and ceremonial purposes) by 1±1% respondents. Plant use categories (Fig. 10) were compared using ANOVA and the proportion of people identifying various uses did not differ from each other ($F=0.94$; df =3, 15; $P= 0.42$)

Kimana Group Ranch: The local community opinion on usefulness across species was generally low and 26 woody species were listed as useful (Appendix 4). Total use values, by respondents in Kimana are presented in (Appendix 5(b)). *Acacia mellifera, Acacia tortilis, Balanites glabra and Acacia ancistroclada* were mentioned across all use categories. Harvesting of woody species for fencing and fuel were the most commonly identified forms of use across woody species, with both categories having 13±5%

respondents while ethno medicinal purposes and building categories had 11±4% respondents. The other category (ritual and ceremonial) purposes was ignored by most respondents at both study sites (Fig. 10) and not considered for analysis. Plant use categories when compared using ANOVA revealed that the proportion of people identifying various uses did not differ from each other (F=0.06; df =3,104; P= 0.98)

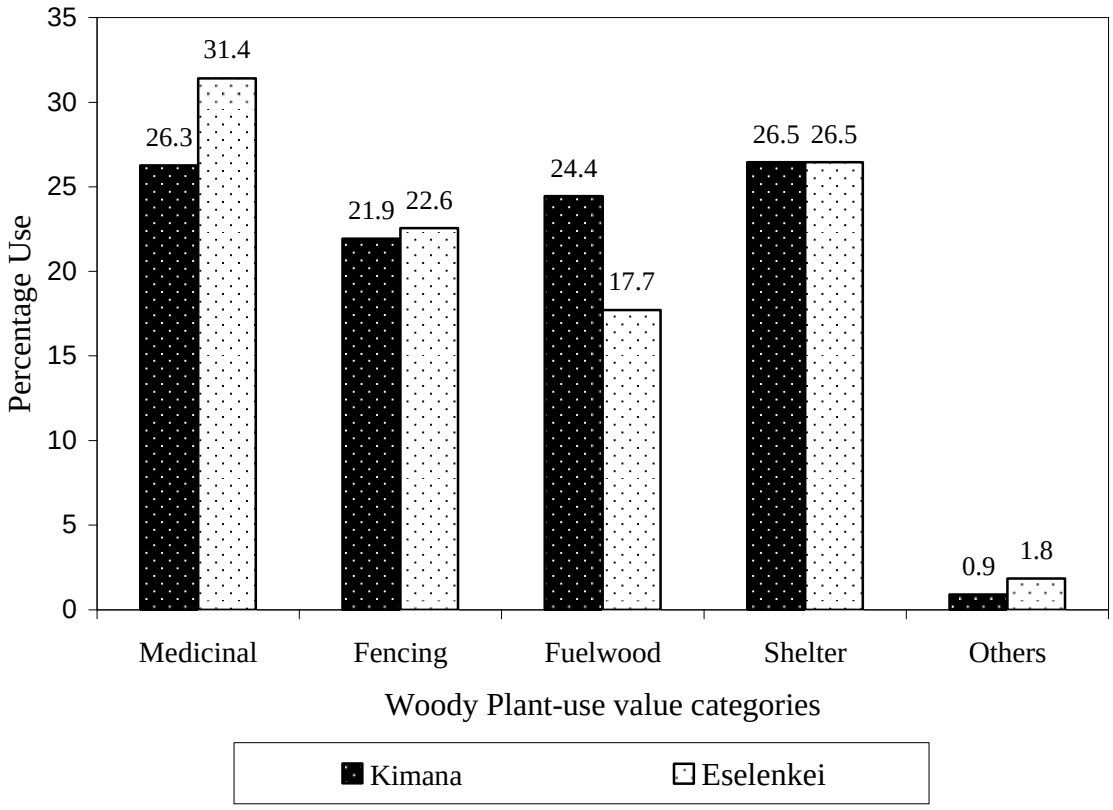


Figure 10: Percentage of Woody Plant- use value categories at Eselenkei and Kimana Group Ranches

4.2.2.1 Knowledge Distribution on Woody Species Use

i. Knowledge distribution on woody species between gender

Variation across use categories responses by female and male respondents was tested by Kruskal Wallis and did not reveal significant differences (W= 4.94, P=0.67) in Eselenkei site. In Kimana, Kruskal Wallis test did not reveal variation among the different use categories of plant mentioned by both female and male respondents (W=3.47, P=0.84).

ii. Knowledge distribution on woody species amongst age-set

Comparison of age set response to the four use categories was performed by Kruskal-Wallis and found to be significant in both Eselenkei (W=12.08, P= 0.0071) and Kimana (W = 11.80, P = 0.0081). Dunn's multiple comparison tests revealed differences in responses amongst the age group above 60 years of age and below 20 years at both Eselenkei and Kimana areas (P<0.05). Further differences in responses between the age group of 40-60 years and less than 20 years of age were revealed at Eselenkei site (P=<0.05) as shown in Table 6.

Table 6: Comparison of knowledge distribution on woody species amongst age sets across the use categories at Kimana and Eselenkei sites

Age-sets	Eselenkei Area		Kimana Area	
	P Values	Sig.	P Values	Sig.
>60 vs. 40-60	P>0.05	ns	P>0.05	ns
>60 vs. 20-40	P>0.05	ns	P>0.05	ns
>60 vs. <20	P<0.05	**	P< 0.05	**
40-60 vs. <20	P<0.05	**	P>0.05	ns
20-40 vs. <20	P>0.05	ns	P>0.05	ns

ns not significant

** significant

4.2.3 Threatening Activities to Woody Species

Individual responses for the four activities are presented in Appendix 6 and a summary of the totals amongst all respondents in the two study sites is presented in Table 7. Fencing and construction scored the highest value as a threat to woody species in Eselenkei Group Ranch, while charcoal production scored the highest value as a threat to woody species at Kimana Group Ranch.

Table 7: Paired comparison for the activities considered most threatening to woody species by respondents in Eselenkei and Kimana Group Ranches:

Eselenkei Group Ranch(n=48)			**Kimana Group Ranch (n=48)**		
Activity	**Total Score**	**Rank**	**Activity**	**Total Score**	**Rank**
Fencing and construction	**110**	1st	Charcoal production	**110**	1st
Fire incidences	**96**	2nd	Elephant damage	**81**	2nd
Elephant damage	**53**	3rd	Agricultural expansion	**72**	3rd
Charcoal production	**29**	4th	Fencing and construction	**24**	4th

There are clear differences amongst respondents' comments from the two Group Ranches on activities considered as threats to the woody species at their localities. Charcoal burning is least regarded as a threat in Eselenkei, while fencing and construction is not considered a threat at Kimana Group Ranch (Table 7).

4.2.3.1 Cluster analysis of respondents based on factors considered as threats to woody species

i. Eselenkei site

Four defined clusters were observed from paired ranking of the activities within Eselenkei Group Ranch (Fig. 11) with similarity level >72% between respondents. The first cluster, with 6 respondents, placed emphasis on fires, and equal weights were allocated on charcoal production and elephant damage, the least weight to fencing and construction. The second cluster, with 8 respondents, placed more weight on fencing and construction, fire outbreaks was second followed by charcoal production. The least activity cited was elephant damage to woody species. The third cluster, with 24 respondents, placed more weight on fire outbreaks in the area followed by fencing and construction. Elephant damage was mentioned within this cluster but the least disturbance was considered to be charcoal burning in the area. The fourth cluster, with 10 respondents, placed more weight on fencing and construction, followed by elephant damage, fires was the least threat and charcoal production was totally ignored by these respondents.

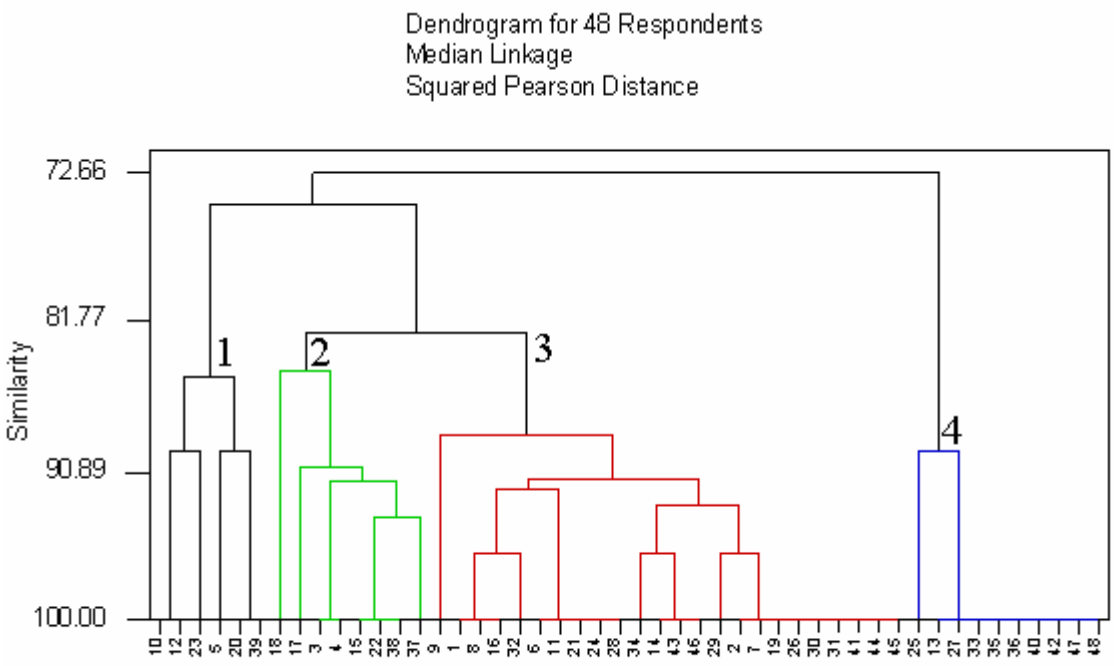


Figure 11: Results from a cluster analysis (CA) based on factors considered as threats to woody species at Eselenkei Group Ranch

ii. Kimana site

Four defined clusters were observed from paired ranking of activities within Kimana Group Ranch (Fig. 12) with similarity level >62% between respondents. The first cluster, with 8 respondents, categorized charcoal production in the area as the main threat, followed by elephant damage, fencing and construction and the least threat was considered agricultural activities in the area. The second cluster, with 4 people, identified the highest impact on woody species to be from agricultural activities, elephant damage, fencing and construction were equally ranked and they took no notice of charcoal burning as a threat. The third cluster, with 13 respondents, considered elephant damage as the most destructive incident to woody species, agricultural activities and charcoal production were ranked second, while fencing and construction were not considered as a threat.

The fourth cluster, with 23 respondents, identified charcoal production as the most threatening activity followed by agricultural activities in the area. Elephant damage was ranked third and least attention given to the amount of woody material used for fencing and construction.

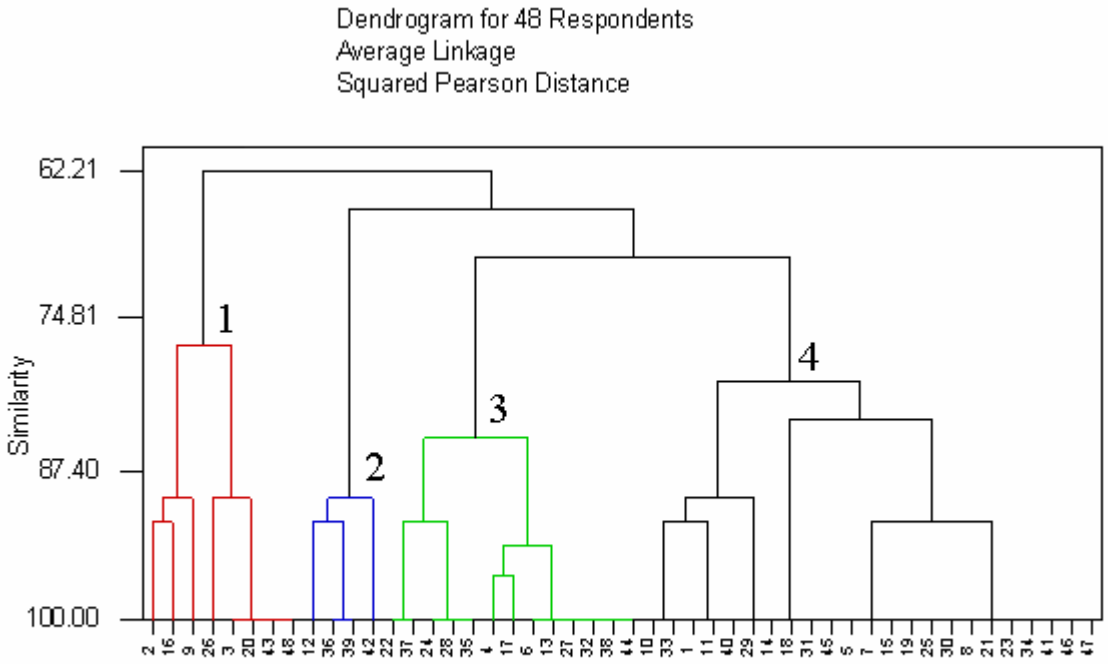


Figure 12: Results from a cluster analysis (CA) based on factors considered as threats to woody species at Kimana Group Ranch

5.0 DISCUSSION

5.1 FLORISTIC COMPOSITION AND STRUCTURAL PATTERN S

i. Eselenkei Floristic Description

The IVI distribution showed that the ecologically significant species at Eselenkei study site were *Commiphora schimperi, Commiphora africana, Acacia mellifera, Acacia tortilis, Commiphora holtziana, Acacia ancistroclada* and *Balanites glabra. Commiphora schimperi* is the most dominant within this bushland. Its population structure indicated a reversed J-shape indicative of good regeneration and recruitment potential at both the communal and conserved sites. Most individuals are 'clumped' in the first diameter class; no individuals were found to have a diameter of more than 20cm and the fact that there was no significant difference detected in mean heights recorded in this area supports the idea of evenness in this bushland (Plate 1).

Plate 1: Even aged stand of deciduous *Commiphoras* sampled at Eselenkei site

The evenness observed within the *Acacia-Commiphora* bushland could be attributed to periodic recruitment events (e.g. fires as stated by community members interviewed) in the area. Young and Lindsay, (1988) who attributed the growth of even-aged stands of trees which senescence at the same rate to periodic recruitment events in Amboseli,

Kenya support this. The significant differences observed in mean heights of *Acacia tortilis* at Eselenkei site was attributed to a higher number of the species recorded on communal site at Olchurrai gate (Fig. 3) where there were few Commiphora species. Woody species regeneration and recruitment potential were better within conserved areas compared to the communal area. This is due to reduced effect of trampling by livestock within the conservation area.

ii. Kimana Floristic Description

The IVI distribution showed that the ecologically significant species at Kimana sanctuary site were *Acacia tortilis, Acacia xanthophloea, Salvadora persica, Balanites glabra* and *Maerua edulis. Acacia xanthophloea* and *Acacia tortilis* had an inverted J-shaped distribution at the conserved and communal sites. Woody species recruitment into higher DBH classes was better within conserved areas compared to the communal area. The indiscriminate harvesting of woody species by the local community for various purposes on communal land has resulted in this trend. The general decline in density in the higher diameter classes is attributed to clearing for cultivation (Plate 3) and elephant damage in the case of *Acacia xanthophloea* and charcoal production (Plate 4) and elephant damage in the case of *Acacia tortilis.*

The reason for the relatively high mean heights measured for *Acacia xanthophloea* on communal site, was that sample plots were biased along Kikarankot River (refer to plot placement (Fig. 4) where there was greater frequency of extremely tall individuals recorded. This had the effect of pulling the mean disproportionately upwards and contributing to the significant results.

5.1.1 Woody Species Diversity

There was insignificant difference in woody species diversity at conserved and communal areas, contrary to the expectation that human pressure inevitably results in reduced biological diversity. This is not an unusual finding; similar studies have found a positive effect, or no effect, of greater intensity of human use in rural areas on species richness across a range of taxa relative to less impacted areas. For example, Dahlberg (1996), in comparing a communal area with an adjacent protected area in arid woodlands in

Botswana, found no difference in herbaceous species richness between the two land uses. Similarly, Vermeulen (1996) reported no difference in tree species richness between a communal area and a protected state forest in central Zimbabwe, even though there was a much lower woody basal area and density in the communal area. Cumming *et al.* (1997) found reduced species richness of trees, woodland birds, bats, ants and mantises in protected woodland areas with high elephant densities relative to adjacent unprotected areas with higher human impacts, but lower elephant densities.

5.1.2 Woody Species Density

Similar trends of woody species densities from either conservation area towards the core of the conservation or communal area could be indicative of comparable pressure exerted on woody species, or there existed differences in these sites prior to the setting aside of the conservation area. Factors that contribute to the decreasing trends in woody densities are settlement areas and elephant damage to woody species.

Patterns of settlements favoured localities where soil and drainage conditions are suitable (Western and Dunne, 1979) and this has resulted in upcoming nearby market centers like Kimana and Lenkism nearby conservation areas. The community usually tends to be more settled, and engage in cultivation on their individual land. Pastoralists whose range has become too restricted for traditional livestock grazing practices have increasingly turned to agriculture (Katampoi *et al*., 1990; Thompson and Homewood, 2002).

Population increases greatly augment the severity of human impacts on woody species. The existence of bomas and the disturbance zones around them as well as trampling and overgrazing due to livestock results in unintended effects on vegetation in proximity to human settlements in these Group Ranches. Although many human impacts on vegetation result from livestock, traditional Maasai also selectively utilize certain woody species for medicine, fuelwood and construction materials, a finding that is similar to that of Kiringe and Okello (2005). The utilization of plants for these purposes contributes to over-harvesting of certain woodland species. In addition, presence of glades (sites appearing as open grassland patches) reduced woody density in an area. Young *et al.* (1995)

hypothesized that glades originated from abandoned Maasai settlements that had persisted for decades.

The decline of *Acacia tortilis* species density towards the core of the conservation area could be explained by the impact of elephants on the woodland. According to Ruess and Halter (1990), the damage of mature trees by elephants has led to a decline in the proportion of mature trees in the Seronera Valley of Tanzania over the past two decades. Walpole *et al.* (2004) reported a decline in woody density within the Maasai Mara National Reserve (MMNR), and comparative research outside MMNR in the 1980s revealed that woody habitats were increasing in density (Lamprey, 1985; Sinclair, 1995). Walpole *et al.* (2004) attributed the situation in part because of a focus on conserving large mammalian diversity in protected areas rather than plant diversity. Maasai Mara National Reserve had become a refuge for large mammals that are becoming less common outside the reserve as human–wildlife competition for land and resources increases (Homewood *et al.*, 2001).

In Kimana sanctuary, woody species density within the *Acacia tortilis* woodland was noted to be positive, from the conservation area boundary towards the communal and core of the conservation. This could be explained by the fact that damage of elephants was observed primarily on large shrubs and thus, they had minimal effects on the rate of shrub density increase. These findings are consistent with the predictions of Dublin *et al.* (1990) that elephants are unlikely to switch shrub population growth rate from positive to negative unless fire reduces shrubs to low initial density.

5.2 WOODY SPECIES TRENDS AND ASSOCIATED THREATS

High similarity levels between respondents at both sites indicates the reliability of the information obtained and consensus between individuals within the community on activities perceived to be threatening to woody species in their respective Group Ranches.

i. Eselenkei Group Ranch

In Eselenkei area, though most respondents were concerned about the declining woody species trend, others believed that the woody species trend had increased in the past 30 years. Seventy seven percent of Eselenkei members noted a decline of woody vegetation in the area while 23% cited an increase in woody species within the Group Ranch in the last 30 years.

People attributed the loss of woody vegetation cover to the removal of economically important trees and shrubs for various purposes in the study area. However, a different viewpoint (from the few respondents) that needs to be investigated further is the possibility of bush encroachment and thickening in the area. This being a pastoral group, livestock grazing might have affected the structure, composition, quality and productivity of rangeland vegetation. Macharia and Ekaya (2005) reported an increase in woody species after overgrazing in the neighbouring Mashuru Division of Kajiado District.

Frequent pastoral movement dictates that higher quantities of woody plants be utilized for fencing and house construction. *Commiphoras* spp., which takes root easily when fresh stakes are driven in to the ground, was highly used for fencing purposes. This was highly supported by the many 'abandoned bomas' (Plate 2) encountered during the study period which coincided with the prolonged drought period in the area.

Plate 2: Abundant use of woody species for fencing and construction at an abandoned settlement 'boma' at Eselenkei Group Ranch

Fire incidences is considered a great influence, especially in the past, when large areas were deliberately set on fire to rejuvenate green grass for livestock, or occurred naturally due to the extensive drought experienced in the area (Macharia and Ekaya, 2005). The use of fire by this pastoral community supports findings by Hugh and Lambin, (2000) that the impact of fire on vegetation is mainly controlled by land use.

In the clustering of respondents, most of the respondents aged forty and above attributed the changes in woody species to fire outbreaks experienced in the area. This could be due to their long term observation of woody species trends and dynamics. They did not consider fencing and construction as a threat. A few women (in cluster 4) considered frequent movements due to extensive drought periods as a threat to woody species, and this could be due to their active role in construction of shelters for their families. Few respondents viewed charcoal burning as a threat which implies that incidences of charcoal production could not be totally disregarded in this Group Ranch. Ogutu (2002)

in his study of Eselenkei pointed out the importance of cultivation and charcoal production in areas next to Mashuru water pipeline for wildlife conservation.

ii. Kimana Group Ranch

Only 4% of the respondents at Kimana cited an increase in woody species in the area in the last 30 years, while 96% were concerned about the declining woody species in the area. A high consensus among respondents on the declining trend of woody species in the area could be attributed to either charcoal burning, elephant damage to woody species, cultivation or an interaction of all these activities in the area. Clearing of surrounding woodland for agriculture are evidence of degradation (Plate 3) ranked third as a threatening activity to woody species by the local community.

Plate 3: Remnants of *Acacia xanthophloea* along Kikarankot River as a result of agricultural expansion on communal land

Charcoal burning (Plate 4) has increased in Kimana and the neighbouring Group Ranches, especially for commercial purposes due to increased demand for this form of fuel in urban areas. Kiringe and Okello (2005) reported same findings for Kuku Group Ranch within the Amboseli ecosystem. Charcoal production has a greater impact on

valuable hardwood species, including Acacia, which results in the overall reduction of savanna biodiversity. Kiringe and Okello (2005) recorded that the most targeted key species in the neighbouring Kuku group ranch was *Acacia tortilis* as disclosed by 61% of respondents.

Plate 4: Burnt *Acacia tortilis* for charcoal production on privately owned land adjacent to Kimana conservation area

The impacts associated with elephants to woody species at Kimana site could be explained by several factors. Firstly, it could be due to the tendency for elephant population to experience an artificially high population due to more individuals being confined to a more reduced foraging area. This results when the usual dispersal routes of the elephant population are removed through such actions as farming and human settlements in the area as reported by Laws *et al.* (1975) and Jachmann and Bell (1984). Secondly, Field and Ross (1976) found that elephant impacts are exacerbated by drought conditions when elephants tend to increase the percentage of browse in their diet. Lastly, the presence of the riverine woodland could have increased the concentration of elephant

populations around the permanent water source (along the Kikarankot River) in the dry season that could lead to "damage epicenters" (Laws, 1970; Field and Ross, 1976).

In the clustering of respondents of Kimana Group Ranch, most respondents aged forty and above considered introduced activities such as charcoal burning and agriculture and the increased numbers of elephants in the area as the main threats to woody species. This reflects their reaction towards the society that is changing from purely pastoralism to diversified economic activities in the area. Cluster 3 comprised mainly of agro pastoralists who attributed the decline in woody species in the area to damages by elephants and did not place any weight on the amount of woody species utilized for fencing around the crop field is a threat to woody species though crop raids from the elephants could have highly influenced their response. This group reveals the influence of economic activities on the local community's perspective on threats to woody species. Kiringe and Okello (2005) found that changes from traditional pastoralism to agro pastoralism in Kuku Group Ranch resulted in increased woody species use for fencing of cultivated lands to minimise crop raids from wild animals.

5.3 PEOPLE AND CONSERVATION AREAS

5.3.1 Community Attitudes to Conservation Areas

Access to natural resources greatly influences the community opinion towards the conserved sites. Whereas 90% of Eselenkei members interviewed confirmed access to the conservation area for dry season grazing, only 6% of Kimana members confirmed likewise. This contrasts findings by Rutten (2004) that both Kimana and Eselenkei communities had lost access to their dry season area grazing. In a study conducted by Okello *et al.* (2003) for the proposed Kuku Group Ranch conservation area, less than 2% of Kuku community members wanted their land leased to foreign investors, fearing they might not allow them access to these natural resources. The results of that study showed that, 87.72% of the members desired to have access to dry season grazing; 52.67% to water and 47.37% firewood collection within the proposed conservation area (Okello *et al.*, 2003).

Of the 35% of Kimana agro-pastoralists interviewed, only 18% had a positive attitude towards the conservation area. The majority, 82% considered agriculture as the most beneficial activity. This is in agreement with Okello *et al*. (2003) who observed that most of the people in the neighborhood of Kuku Group Ranch believed that agriculture was more beneficial than wildlife conservation. The findings are similar to Gadd (2005) who found that pastoralists were more tolerant of elephants than agriculturalists. When people attempt to cultivate adjacent to or in the midst of elephant populations, conflict with elephants is inevitable (Gadd, 2005).

The number of females supporting the conservation area as a good intervention, at both sites, was less than that of their male counterparts. There could be two probable explanations: due to the Maasai cultural settings, women are usually left out in decision-making processes, a finding supported by Southgate and Hume (1996), and monetary issues are considered a male domain; and their daily activities entail increased chances of interacting with these animals. These complement findings by Hunter *et al.* (1990) and Gadd (2005) who interviewed women in Zambia and Laikipia District, Kenya respectively. Women said they were afraid to travel far from the village to gather food and other resources when large mammal populations were high.

5.3.2 Woody Plant Use by the Community

Eselenkei and Kimana Group Ranch members were highly dependant on woody species for their day-to-day activities as reflected in their knowledge of these plants. A thorough understanding of woody plants used for both human and livestock ailments was portrayed in both Group Ranches.

The number of listed woody plant species at Kimana did not differ much from the 24 identified in Kuku Group Ranch (Kiringe and Okello, 2005) probably due to the proximity of the two ranches and the similarity in cultural backgrounds. Sedentary way of life imminent in this community is reflected by less attention given to woody plant resources used for construction of homesteads. People preferred a few selected woody

species for construction and often collect quality construction materials that can resist termite attacks and endure for many years.

5.3.2.1 Community Knowledge on Woody Plant Use

In both Group Ranches, the knowledge difference observed between the young (<20) and old age (>60) could be due to cultural diversification. This is where the Maasai community have integrated modern education to the traditional means of knowledge transfer and have diversified their sources of livelihoods from purely pastoral to other activities that do not entirely require a thorough understanding of all woody plants.

Similarities in plant knowledge distribution could most probably be explained by, first, the relatively low floristic diversity in the area and secondly, the very broad and 'almost obvious' categories used for analysis and lastly, by the exclusion of herbaceous species in the study. A more detailed inquiry on medicine, specific concoction/preparation required might have revealed gender and age differences. These results partly harmonize with findings by Kristensen and Lykke (2003) in the evaluation of use and conservation preferences for woody savanna species among the Gourounsi people in south-central Burkina Faso who observed that local knowledge on selected woody species was similar between men and women, and between the young and old. Lykkei *et al.* (2005) also noted a similarity within age and gender respondents in the Sahel.

6.0 CONCLUSION

Woody species diversity, density and regeneration potential within the conservation area and adjacent communal sites did not show distinct differences at both sites. This depicts the fact that, either comparable pressure is exerted on woody species on either side, or there existed differences in these sites prior to the setting aside of the conservation area.

In both communities, a heavy reliance on woody species for primary medical care, provision of energy in the form of wood fuel, and for fencing and construction of their homesteads was noted. The present study illustrated how a large share of the woody species serves many functions in a local society. The local Maasai have a good knowledge of wild plant resources and vegetation dynamics because of their frequent and lifelong interaction with the local environment. Knowledge distribution on woody plant resources was consistent between genders. The fact that old age is a reference for information was clearly depicted at both study sites where information provided by elderly members of the community was much detailed than that obtained from the youth.

The concern of most ranch members is the decline in the overall tree and shrub cover, which is important in raising issues of potential over-utilization of tree and shrub resources. The potential depletion is due to a combination of factors like expansion of agriculture, increased human settlements, livestock overgrazing and an overall increased demand on plant resources for various uses. Other factors are frequent droughts in the recent past and damage of trees by elephants from the protected areas. A possibility of bush encroachment could not be ruled out completely at Eselenkei area.

Being a pastoral group, Eselenkei members associated their frequent movement in search of green pasture and livestock to high amounts of woody species utilization for fencing and construction. Kimana members are relatively settled with individuals engaging in various economic activities to substitute their declining pastoral life. Charcoal burning, especially for commercial purposes was considered a threat to woody species in this area. I infer that land tenure highly determines the trend of woody species exploitation by local

communities. An activity that Kimana individual Group Ranch members can freely undertake on their parcel of land is different from that at Eselenkei where land is under communal ownership with regulations to be adhered to.

Fifty two percent of Group Ranch members interviewed living at close proximity to the conservation area was optimistic towards the presence of a conservation area in their Group Ranch. The opinion for women at both sites was lower than that of men who are actively involved in the management of these areas. Community members' opinion on the presence of conservation areas within the Group Ranches was evidently influenced by their economic activity, natural resource accessibility and benefits thereof.

7.0 RECOMMENDATIONS

- Data obtained on woody species density, diversity and regeneration to be used as baseline information for future comparative monitoring within conservation areas and adjacent communal land so that changes taking place within the conservation area can be understood in a wider context.
- Involvement of all community members in natural resource management through environmental and conservation education needs to be encouraged. Emphasis should be placed on equal gender involvement in conservation activities and in the management of conservation areas.
- An approach to interview all Group Ranch members irrespective of their distance from the conservation area should be undertaken to obtain the overall Group Ranch members' perspective on conservation and the future of such initiatives in the area.
- Biodiversity conservation inside and outside protected areas should be integrated through alternative models that allow for conservation of resources as well as retain human presence and activities within these areas. This will guarantee sustainability of such areas.
- Action plans to restore sustainable utilization of plant resources on Group Ranches should be developed. There is need to develop an effective conservation and sustainable utilization of resources within and outside the conservation area.
- With the observed declining trends in woody species and use of multiple woody species by the community, conservation of the natural resource base needs to focus on the entire ecosystem instead of a few selected key species. In relation to this, further analysis of the woody species trends at Eselenkei and Kimana areas is recommended.
- Produce culturally and ecologically rational management strategies based on local people's profound knowledge and clear-cut opinions on plant use-preferences, general ecological conditions and vegetation dynamics.
- There is a need to explore further the effects of elephant disturbance on woody species and particularly their effects on spatial and temporal heterogeneity of habitats in community conservation areas in the Amboseli ecosystem.

8.0 REFERENCES

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9.0 APPENDICES

Appendix 1: Semi-Structured Interview Questions Administered In Kimana and Eselenkei Group Ranch Members

1. Gender classification F ☐ M ☐
2. Age-Set: <20 ☐ 20-40 ☐
   40-60 ☐ >60 ☐
3. Marital Status
4. Are you a member of the Group Ranch?
5. What are the primary activities (economic) you engage in within the Group Ranch?
   i. Pastoralism
   ii. Agro-pastoralism (Self-cultivating or Leasing?)
   iii. Agriculture
   iv. Any other
6. What trees and shrub plant species are commonly-utilized within the Group Ranch? State the various purposes to which they are put into
7. What is the general trend that you have noticed over the past 30 years in availability of woody plants within the Group Ranch? What could be the causes of the observed trend?
8. How do you feel about the setting aside of a conservation area within the Group Ranch?
9. Has the setting aside of the conservation area affected any natural-resource accessibility? In what sense
10. What activities are you allowed to carry out within the conservation area?
11. Would you support the continued existence of a conservation site in future?
12. Any additional comments/observations with respect to the existence of the conservation area within the ranch

II. PAIRED COMPARISONS

What activity do you consider most threatening to the availability of woody species within your Group Ranch?

i. Paired comparisons for four activities at Eselenkei Group Ranch fully randomized for the sequence of pairs and the order within each pair presented to each Eselenkei informant

Eselenkei Group Ranch	Number	Order	Activities
	6	4,3	Fire outbreaks, Fencing and construction
	1	2,1	Elephant damage, Charcoal production
	4	3,2	Fencing and construction, Elephant damage
	5	2,4	Elephant damage, Fire outbreaks
	2	1,3	Charcoal production, Fencing and construction
	3	1,4	Charcoal production, Fire outbreaks

ii. Paired comparisons for four activities at Kimana Group Ranch fully randomized for the sequence of pairs and the order within each pair presented to each Kimana informant

Kimana Group Ranch	Number	Order	Activities
	5	2,4	Elephant damage, Fencing and construction
	3	4,1	Fencing & construction, Agricultural expansion
	1	1,2	Agricultural expansion, Charcoal production
	4	3,2	Elephant damage, Charcoal production
	6	3,4	Elephant damage, Fencing and construction
	2	3,1	Elephant damage, Agricultural expansion

Appendix 2: Woody Species Recorded in Eselenkei and Kimana Conservation Areas and Adjacent Communal Sites.

S/N	Scientific Name and Author	V/No.	Habit	Family	Eselenkei	Kimana
1.	*Acacia ancistroclada* Brenan	K6017	Tree	Fabaceae	x	
2.	*Acacia mellifera* (Vahl) Benth	K6009	Shrub	Fabaceae	x	x
3.	*Acacia nubica* Benth	K6018	Shrub	Fabaceae		x
4.	*Acacia robusta* Burch.	K6001	Tree	Fabaceae		x
5.	*Acacia senegal* Willd.	K6020	Tree	Fabaceae		x
6.	*Acacia tortilis* (Forssk) Hayne	K6005	Tree	Fabaceae	x	x
7.	*Acacia xanthophloea* (Benth.)	K6002	Tree	Fabaceae		x
8.	*Albizia anthelmintica* (Brongn.)	K6019	Tree	Fabaceae	x	x
9.	*Azima tetracantha* Lam.	K6008	Shrub	Salvadoraceae		x
10.	*Balanites aegyptiaca* (L.) Del	K6007	Shrub	Balanitaceae		x
11.	*Balanites glabra* Mildr. and Schlectr.	K6006	Shrub	Balanitaceae	x	x
12.	*Boscia angustifolia* A. Rich.	-	Shrub	Capparidaceae	x	x
13.	*Cadaba farinosa* Forssk	-	Shrub	Capparidaceae	x	x
14.	*Capparis tomentosa* Lam.	-	Shrub	Capparidaceae		x
15.	*Commiphora africana* (A. Rich.) Engl.	K6010	Small T	Burseraceae	x	x
16.	*Commiphora baluensis* Engl.	K6014	Tree	Burseraceae	x	x
17.	*Commiphora campestris* Engl.	K6016	Small T	Burseraceae	x	
18.	*Commiphora confusa* Vollesen	K6012	Small T	Burseraceae	x	
19.	*Commiphora holtziana* Engl.	K6013	Small T	Burseraceae	x	
20.	*Commiphora schimperi* Engl.	K6015	Small T	Burseraceae	x	
21.	*Cordia crenata* Roem. & Schult.	-	Shrub	Boraginaceae	x	
22.	*Cordia monoica* Bojer	-	Shrub	Boraginaceae		x
23.	*Croton dichogamous* Pax	K6011	Shrub	Euphorbiaceae		x
24.	*Grewia bicolor* Juss.	-	Shrub	Tiliaceae		x

S/N	Scientific Name and Author	V/No.	Habit	Family	Eselenkei	Kimana
25.	*Grewia tembensis* Fresen	-	Shrub	Tiliaceae	x	x
26.	*Grewia villosa* Willd.	-	Shrub	Tiliaceae	x	
27.	*Lycium europaeum* Merat ex Dun.	-	Shrub	Solanaceae	x	x
28.	*Maerua edulis* (Gilg & Benedict) DeWolf	-	Shrub	Capparidaceae	x	x
29.	*Salvadora persica* Linn.	K6004	Shrub	Salvadoraceae		x
30.	*Tabernaemontana stapfiana* Britten	K6003	Shrub	Apocynacea		x

x: woody species recorded at specific study sites

S – Shrub

T – Tree

Appendix 3: Woody Species Encountered in Conserved and Communal Sites

i. Eselenkei site

***Acacia-commiphora* bushland**	**Woody Species**	**Conserved**	**Communal**
	Acacia ancistroclada	x	x
	Acacia mellifera	x	x
	Acacia tortilis	x	x
	Albizia anthelmintica	x	x
	Balanites glabra	x	x
	Cadaba farinosa	x	
	Boscia angustifolia		x
	Commiphora africana	x	x
	Commiphora baluensis	x	x
	Commiphora campestris	x	x
	Commiphora confuse	x	x
	Commiphora holtziana	x	x
	Commiphora schimperi	x	x
	Cordia crenata	x	x
	Grewia tembensis	x	x
	Grewia villosa		x
	Lycium europaeum	x	x
	Maerua edulis	x	x

x: indicates woody species encountered at the site

For habit, voucher specimen number and family name, see Appendix 2

ii. Kimana site

Stand	Woody Species	Conserved	Communal
Acacia tortilis woodland	*Acacia nubica*		x
	Acacia mellifera	x	
	Acacia tortilis	x	x
	Azima tetracantha	x	x
	Balanites aegyptiaca	x	x
	Balanites glabra	x	x
	Capparis tomentosa	x	
	Cordia monoica	x	
	Cadaba farinosa		x
	Lycium europaeum	x	x
	Maerua edulis	x	x
	Salvadora persica	x	x
Acacia xanthophloea woodland	*Acacia robusta*	x	
	Acacia xanthophloea	x	x
	Azima tetracantha	x	x
	Balanites glabra		x
	Cordia monoica		x
	Lycium europaeum		x
	Salvadora persica	x	x
	Tabernaemontana stapfiana	x	

x: indicates woody species encountered at the site

For habit, voucher specimen number and family name, see Appendix 2

Appendix 4: List of useful plants by Respondents at Kimana and Eselenkei Group Ranches

	Maasai Name	Scientific Name	Family	Habit	Kimana	Eselenkei
1.	Olchurrai	*Acacia ancistroclada* Brenan	Fabaceae	Tree	x	x
2.	Olkigirri	*Acacia brevispica* Harms	Fabaceae	Tree	x	x
3.	Oluai	*Acacia drepanolobium* Harms ex Sjostedt	Fabaceae	Tree		x
4.	Oiti	*Acacia mellifera* Benth.	Fabaceae	Shrub	x	x
5.	Olkiloriti	*Acacia nilotica* (L.) Del.	Fabaceae	Tree		x
6.	Oldepe	*Acacia nubica* Benth.	Fabaceae	Shrub	x	x
7.	Olmumunyi	*Acacia robusta* Burch.	Fabaceae	Tree	x	x
8.	Enkiloilo	*Acacia senegal* Willd.	Fabaceae	Tree		x
9.	Oltiakaikart	*Acacia thomasii* Harms	Fabaceae	Shrub		x
10.	Oltepesi	*Acacia tortilis* (Forssk) Hayne	Fabaceae	Tree	x	x
11.	Elerai	*Acacia xanthophloea* Benth.	Fabaceae	Tree	x	x
12.	Olmisera	*Adansonia digitata* Linn.	Bombacaceae	Tree		x
13.	Olmugutan	*Albizia anthelmintica* Brongn.	Fabaceae	Tree	x	x
14.	Osukuroi	*Aloe secundiflora* Engl.	Aloaceae	Shrub	x	
15.	Olongututisho	*Azima tetracantha* Lam.	Salvadoraceae	Shrub	x	x
16.	Osaragi	*Balanites aegyptica* (L.) Del.	Balanitaceae	Shrub	x	x
17.	Olng'oswa	*Balanites glabra* Mildr. and Schlectr.	Balanitaceae	Shrub	x	x
18.	Oloirero	*Boscia angustifolia* Harv.	Capparidaceae	Shrub	x	x
19.	Olchilishili	*Commiphora africana* (A. Rich.) Engl.	Burseraceae	Small Tree		x
20.	Olbili	*Commiphora baluensis* Engl.	Burseraceae	Tree		x
21.	Ormame	*Commiphora campestris* Engl.	Burseraceae	Small Tree		x

	Maasai Name	Scientific Name	Family	Habit	Kimana	Eselenkei
22.	Enkonerei	*Commiphora confusa* Vollesen	Burseraceae	Small Tree		x
23.	Olkishili	*Commiphora holtziana* Engl.	Burseraceae	Small Tree		x
24.	Osilalei	*Commiphora schimperi* Engl.	Burseraceae	Small Tree	x	x
25.	Ormapitet	*Cordia crenata* Roem. & Schult.	Boraginaceae	Shrub	x	x
26.	Eseki	*Cordia monoica* Bojer	Boraginaceae	Shrub	x	x
27.	Oldorko	*Cordia sinensis* Lam.	Boraginaceae	Shrub		x
28.	Oloibor benek	*Croton dichogamus* Pax	Euphorbiaceae	Shrub	x	
29.	Oltangoringoroi	*Delonix elata* Gamble	Fabaceae	Tree		x
30.	Esiteti	*Grewia bicolor* Juss.	Tiliaceae	Shrub	x	x
31.	Eirri	*Grewia tembensis* Fresen.	Tiliaceae	Shrub	x	x
32.	Olmangulai	*Grewia villosa* Willd.	Tiliaceae	Shrub	x	x
33.	Olokii	*Lycium europaeum* Merat ex Dun.	Solanaceae	Shrub	x	x
34.	Enkamoloki	*Maerua edulis* (Gilg & Benedict) DeWolf	Capparidaceae	Shrub	x	x
35.	Oremit	*Salvadora persica* Linn.	Salvadoraceae	Shrub	x	x
36.	Olaisai	*Sericocomopsis hildebrandii*		Shrub	x	x
37.	Olkorrbobit	*Synadenium grantii* Hook.f.	Euphorbiaceae	Shrub	x	

x: indicates species listed as useful woody species in the specified Group Ranch

S - Shrub

T- Tree

Appendix 5: Plant Use Values sorted by the highest number of respondents' free-listing the same species

a) Eselenkei Group Ranch Members Plant use-values with (**R** = Respondents ≥5)

			Respondents	Use Values (UV) allocated to various categories					Total UV
S/N	**Maasai**	**Scientific Name**	**R (%)**	**Medicinal**	**Fencing**	**Fuelwood**	**Shelter**	**Others**	
1	Oiti	*Acacia mellifera*	**97.9**	0.87	1.00	1.00	0.94	0.00	**3.81**
2	Oltepesi	*Acacia tortilis*	**97.9**	0.68	0.72	0.94	0.91	0.00	**3.26**
3	Olng'oswa	*Balanites glabra*	**93.8**	0.98	0.67	0.91	0.84	0.00	**3.40**
4	Osilalei	*Commiphora schimperi*	**93.8**	0.13	0.98	0.16	0.04	0.00	**1.31**
5	Olchurrai	*Acacia ancistroclada*	**91.7**	1.00	0.91	0.98	0.95	0.00	**3.84**
6	Olchilishili	*Commiphora africana*	**89.6**	0.72	0.95	0.28	0.09	0.00	**2.05**
7	Olmangulai	*Grewia villosa*	**89.6**	0.93	0.00	0.02	0.88	0.00	**1.84**
8	Eirri	*Grewia tembensis*	**89.6**	0.88	0.00	0.00	0.93	0.00	**1.81**
9	Oremit	*Salvadora persica*	**87.5**	1.00	0.00	0.26	0.36	0.00	**1.62**
10	Olbili	*Commiphora baluensis*	**85.4**	0.68	1.00	0.46	0.07	0.00	**2.22**
11	Oldepe	*Acacia nubica*	**79.2**	0.92	0.42	0.63	0.76	0.00	**2.74**
12	Olmumunyi	*Acacia robusta*	**75.0**	0.64	0.33	0.28	0.64	0.03	**1.92**
13	Oloireroi	*Boscia angustifolia*	**75.0**	0.92	0.00	0.03	0.22	0.00	**1.17**
14	Elerai	*Acacia xanthophloea*	**70.8**	0.74	0.35	0.53	0.50	0.00	**2.12**
15	Esiteti	*Grewia bicolor*	**70.8**	0.29	0.00	0.12	0.79	0.03	**1.24**
16	Osaragi	*Balanites aegyptiaca*	**66.7**	0.03	0.81	0.81	0.66	0.00	**2.31**

Eselenkei continued..

			Respondents	Use Values (UV) allocated to various categories					Total UV
S/N	**Maasai**	**Scientific Name**	**R (%)**	**Medicinal**	**Fencing**	**Fuelwood**	**Shelter**	**Others**	
17	Oltiakaikart	*Acacia thomasii*	**66.7**	0.66	0.25	0.84	0.47	0.00	**2.22**
18	Emapitet	*Cordia creneta*	**66.7**	0.00	0.56	0.63	0.78	0.00	**1.97**
19	Olmugutan	*Albizia anthelmintica*	**66.7**	0.97	0.03	0.13	0.19	0.00	**1.31**
20	Oldorko	*Cordia sinensis*	**64.6**	0.03	0.39	0.81	0.97	0.00	**2.19**
21	Ormame	*Commiphora campestris*	**62.5**	0.97	0.77	0.03	0.07	0.00	**1.83**
22	Engamoloki	*Maerua edulis*	**62.5**	0.00	0.23	0.10	0.87	0.00	**1.20**
23	Eseki	*Cordia monoica*	**60.4**	0.21	0.14	0.41	0.59	0.52	**1.86**
24	Olokii	*Lycium europaeum*	**60.4**	0.17	1.00	0.28	0.10	0.00	**1.55**
25	Olkishili	*Commiphora holtziana*	**58.3**	0.14	0.93	0.07	0.07	0.00	**1.21**
26	Olkiloriti	*Acacia nilotica*	**54.2**	0.92	0.50	0.58	0.31	0.00	**2.31**
27	Oltangoringoroi	*Delonix elata*	**50.0**	0.04	0.50	0.21	0.83	0.00	**1.58**
28	Olaisai	*Sericocompsis hildebrandii*	**45.8**	0.85	0.00	0.04	0.12	0.00	**1.00**
29	Enkonerei	*Commiphora confusa*	**43.8**	0.48	1.00	0.14	0.00	0.00	**1.62**
30	Oluai	*Acacia drepanolobium*	**31.3**	0.93	0.20	0.40	0.53	0.00	**2.07**
31	Olongututisho	*Azima tetracantha*	**27.1**	0.69	0.31	0.00	0.00	0.00	**1.00**
32	Olkigirri	*Acacia brevispica*	**18.8**	0.22	0.00	0.22	1.00	0.00	**1.44**
33	Olairrudidiai	*Capparis tomentosa*	**10.4**	0.80	0.20	0.40	0.20	0.00	**1.60**

b) Kimana Group Ranch Members Plant use-values with (**R**= Respondents ≥5)

			Respondents	**Use Values (UV) allocated to various categories**					**Total UV**
	Maasai	**Scientific name**	**R (%)**	**Medicinal**	**Fencing**	**Fuelwood**	**Shelter**	**Others**	
1	Oiti	*Acacia mellifera*	**93.8**	0.44	1.00	0.98	0.98	0.00	**3.40**
2	Oltepesi	*Acacia tortilis*	**87.5**	0.14	0.88	0.95	0.36	0.00	**2.33**
3	Olng'oswa	*Balanites glabra*	**72.9**	0.94	0.86	0.97	0.71	0.00	**3.49**
4	Olchurrai	*Acacia ancistroclada*	**72.9**	0.94	0.80	0.89	0.80	0.00	**3.43**
5	Oremit	*Salvadora persica*	**27.1**	1.00	0.00	0.15	0.00	0.00	**1.15**
6	Olaisai	*Sericocompsis hildebrandii*	**22.9**	0.91	0.09	0.09	0.00	0.00	**1.09**
7	Oloibor benek	*Croton dichogamus*	**16.7**	1.00	0.25	0.25	1.00	0.00	**2.50**
8	Olmugutan	*Albizia anthelmintica*	**14.6**	1.00	0.29	0.14	0.14	0.00	**1.57**
9	Elerai	*Acacia xanthophloea*	**10.4**	1.00	0.60	1.00	0.00	0.00	**2.60**
10	Olokii	*Lycium europaeum*	**10.4**	0.20	1.00	0.40	0.20	0.00	**1.80**

Appendix 6: Paired Ranking of Different Activities Considered Threatening to the Existence of Woody Species in Kimana and Eselenkei Group Ranches.

ESELENKEI AREA					KIMANA AREA				
	Charcoal	Elephant	Fen & con	Fires		Agric	Charcoal	Elephant	Fen & con
R1	1	1	1	3	**R1**	1	3	1	1
R2	0	1	3	2	**R2**	1	2	1	2
R3	2	0	3	1	**R3**	0	3	2	1
R4	2	0	3	1	**R4**	1	2	2	0
R5	1	2	0	3	**R5**	1	3	2	0
R6	0	1	2	3	**R6**	1	2	3	0
R7	0	1	3	2	**R7**	1	3	2	0
R8	1	1	1	3	**R8**	2	3	1	0
R9	1	0	2	3	**R9**	0	2	1	3
R10	2	1	0	3	**R10**	2	3	0	1
R11	0	1	2	3	**R11**	1	3	1	1
R12	2	1	0	3	**R12**	2	1	2	1
R13	0	2	3	1	**R13**	1	2	3	0
R14	1	1	2	2	**R14**	3	2	1	0
R15	1	0	3	2	**R15**	1	3	2	0
R16	1	1	1	3	**R16**	0	2	2	2
R17	2	0	2	2	**R17**	2	2	2	0
R18	1	1	3	1	**R18**	3	2	1	0
R19	0	1	3	2	**R19**	1	3	2	0
R20	1	2	1	2	**R20**	0	3	2	1
R21	0	1	2	3	**R21**	2	3	1	0
R22	1	0	3	2	**R22**	3	1	2	0
R23	2	1	1	2	**R23**	2	3	1	0
R24	0	1	2	3	**R24**	2	1	3	0
R25	0	2	2	2	**R25**	1	3	2	0
R26	0	1	3	2	**R26**	0	2	3	1
R27	0	2	3	1	**R27**	1	2	3	0
R28	0	1	2	3	**R28**	2	1	3	0
R29	0	1	2	2	**R29**	1	3	0	2
R30	0	1	3	2	**R30**	1	3	2	0
R31	0	1	3	2	**R31**	3	2	1	0
R32	1	1	2	3	**R32**	1	2	3	0
R33	0	2	3	1	**R33**	2	3	0	1
R34	1	1	3	2	**R34**	2	3	1	0
R35	0	2	3	1	**R35**	2	1	3	0
R36	0	2	3	1	**R36**	3	1	1	1
R37	1	0	3	1	**R37**	3	1	2	0
R38	1	0	3	2	**R38**	1	2	3	0
R39	1	2	1	2	**R39**	3	1	1	1
R40	0	2	3	1	**R40**	1	3	1	1
R41	0	1	3	2	**R41**	2	3	1	0
R42	0	2	3	1	**R42**	2	1	1	2
R43	1	1	2	2	**R43**	0	3	2	1
R44	0	1	3	2	**R44**	1	2	3	0
R45	0	1	3	2	**R45**	3	2	1	0
R46	1	1	2	2	**R46**	2	3	1	0
R47	0	2	3	1	**R47**	2	3	1	0
R48	0	2	3	1	**R48**	0	3	2	1
Total score	**29**	**53**	**110**	**96**	**Total score**	**72**	**110**	**81**	**24**

DECLARATION

I, Suzanne Tapapul Lekoyiet, certify that although I may have drawn upon a range of sources cited in this work, the contents of this thesis is solely my original work and has not been submitted any where else for the same purpose.

Suzanne Tapapul Lekoyiet _____ _____

Name **Signature** **Date**