VEGETATION COMPOSITION, REGENERATION AND ANTHROPOGENIC DISTURBANCES IN WESTERN MAU FOREST, KENYA

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DECLARATIONS

Declaration by the student

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DEDICATIONS

I dedicate this work to my parents Mr. and Mrs. Samuel Chepkwony, sisters and brothers for their support and encouragement.

ABSTRACT

Western Mau Forest is located at an altitude of 2,000 and 2,600 m and between the latitudes 0^0 10’ 46” S to 0^0 17’ 42” S and longitudes of 35^0 27’ 05” E to 35^0 39’ 42” E. It was originally 22,712 ha, but has been subjected to human encroachment such that it is now 21,676 ha. Tree harvesting was banned and any human population moved out of the gazetted forest land in 1987. A study was carried out between 2011 and 2012 on vegetation composition, regeneration and anthropogenic disturbances in the forest. The study sites were divided into three zones; forest, transition and grassland zones. Belt transects of 500 m long and 2 m wide were used in the forest zone; plots of 30 m long and 5 m wide were used in both in transition zone and grasslands. The forest zone transects were subdivided into 50 m by 2 m subplots, transition and grassland zone transects were subdivided into 5 m by 5 m subplots. In all subplots, a 1 m by 1 m quadrat was placed at the centre. Data were collected on occurrence of herb, fern, liana, shrub, seedling, sapling (DBH 1-9.9 cm) and tree (DBH $\geq$ 10 cm) species. The data were used to calculate abundance, diversity, importance value index, and regeneration. The data were analyzed using analysis of variance and chi-square statistic. Shannon-Weiner index was used to quantify species diversity. Two hundred and twenty three (223) vascular plant species belonging to eighty three (83) families were identified. The Asteraceae had the highest number of species (18) followed by Fabaceae (17). Forty (41) families had a single species each. There were more plant species in the transition zone than forest and grassland zone. The forest was dominated by seedlings and saplings (DBH $\leq$ 3 cm); the diameter size distribution was reverse J-shaped, indicating that the forest has a good regeneration potential. Species diversity was significantly higher in the forest (3.5 to 4.5) than transition zone (2.0 to 3.5) or grassland (1.5 to 3.0). There was a significant human disturbance and this affected the species composition, diversity and forest regeneration.

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LIST OF ABBREVIATIONS/ ACRONYMS

ANOVA:	Analysis of Variance
BA:	Basal Area
DBH:	Diameter at Breast Height
DRSRS:	Department of Resource Surveys and Remote Sensing
FAO:	Food and Agriculture Organization
KEFRI:	Kenya Forestry Research Institute
KFS:	Kenya Forest Service
KIFCON:	Kenya Indigenous Forest Conservation Network
KFWG:	Kenya Forests Working Group
IVI:	Important Value Index
MEA:	Millennium Ecosystem Assessment
RD:	Relative Dominance
RF:	Relative Frequency
UNDESA:	United Nations Department of Economic and Social Affairs
UNEP:	United Nations Environment Programme

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Conservation of natural vegetation is currently one of the leading agenda for a number of world conservation organizations, authorities and interest groups (UNDESA, 2004). The concern over vegetation conservation generally stems from the anthropogenic activities that lead to depletion of forest resources (Ramirez *et al*., 2001; Reyers, 2004). The major mechanisms of forest degradation, habitat change and biodiversity loss include forest conversion to farmland, exploitation through selective or clear harvesting and charcoal production, seasonally set forest fires, over-grazing and hunting of native herbivores. The disturbances created by these activities influence the vegetation dynamics and tree density at local and regional scales (Hubell *et al*., 1999), affect plant community structure (Sumina, 1994) and determine the size class distribution of species (Luoga *et al.*, 2004; Canham, 2005). In the face of these problems, ecologists and conservation biologists have proposed the protection of forest vegetation using different strategies that range from strict protection in the national parks to suitable management and other integrated conservation and development programs (Borgerhoff and Coppolillo, 2005).

Sustainable forest management has been the main focus of the worldwide forestry sector over the last few decades. It aims to ensure that the goods and services derived from the forest resources meet present day needs without compromising the ability of the future generations to satisfy their own requirements (Hitimana, 2000). The roles and functions of forest vegetation include; soil and water conservation, production of wood and non-wood products, carbon sequestration, socio-cultural (sites for rites and traditional ceremonies), moral and scientific education (offer of research opportunities and moral obligation to conserve existing species) (Hitimana, 2000). Moreover, sustainable forest management aims at balancing social, economic and environmental objectives. However, only about 6% of the total forest area in developing countries is managed properly (FAO, 2001). This is very low when compared with about 89% of the total forest area in developed countries, which is subjected to either formal or informal forest management (Girma, 2005). In developing countries, destruction of vegetation in most forests has been attributed to inappropriate land use practices generally driven by rapid human population growth and inequitable wealth distribution in the society (Sanchez *et al*., 2009).

Vegetation succession, traditionally referred to as the directional change in plant species composition over widely variable temporal and spatial scales (Taylor *et al*., 2009), is an important factor in forest ecosystem dynamics. Regeneration patterns give insights into the future stand composition and diversity (Mackey and Currie, 2001). Regeneration of any species is confined to a particular range of habitat conditions and the extent of those conditions is a major determinant of its geographic distribution (Pokhriyal, *et al*., 2010). According to Dhaulkhandi *et al*. (2008), the density values of seedlings and saplings are considered as regeneration potential of the species. The regeneration of existing tree populations in an area can be impeded by a lack of recruitment due to several causes, such as the scarce production and dispersion of seeds, high mortality of seedlings, severity of drought, overgrazing by domestic and wild herbivores (Comez *et al*., 2003).

The Mau complex is the most extensive block of montane forests in Kenya covering about 400,000 ha (Wass, 1995). It consists of South-West Mau, Eastern Mau, Ol'donyo Purro, Transmara, Maasai Mau, Southern Mau and Western Mau blocks. The Mau Forest ecosystem supports the world famous Maasai Mara Ecosystem by providing ecosystems services through the Mara River (UNEP 2009a). According to Kenya Forests Working Group report (KFWG, 2001), the Mau Forest Complex has decreased in area by approximately 9% (340 km^2) between the year 1964 (452,007 ha) and 2000 (421,790 ha). The changes in total area and other forest properties are pronounced in Western Mau portion of the forest where River Sondu and Nyando headwaters are located. Some 1,036 hectares, representing 5% of the forest area (22,712 ha), were excised for human settlement in 2001. In the year 2005 the total remaining forest cover of Mau Forest Complex was down to 403,775 ha (UNEP 2009a).

Western Mau Forest, provides critical ecological services to the country, in terms of water source; river flow regulation; flood mitigation; recharging groundwater; reduction of soil erosion and siltation; conservation of plant biodiversity and micro-climate regulation. Through these ecological services, the Western Mau Forest supports major economic sectors in Central Rift and Western Kenya; including energy, tourism, agriculture and industries (Beentje, 1994). In addition, the Western Mau Forest is the source of water supply to several urban centers and supports the livelihoods of thousands of people living in the rural areas. It is the home of indigenous ethnic group in Kenya, the Ogiek (DRSRS and KWFG, 2006). Rivers Sondu and Nyando drain from the forest and flow into Lake Victoria which is the major source of livelihoods to surrounding communities.

In spite of multiple uses, values and functions associated with the forest it has been a subject of encroachment and unregulated resource extraction. Baldyga *et al.*, (2007) detailed the effects of land use on forest cover in East Mau forest block showing that the forest area has been reducing at the expense of farmlands and grasslands since 1986. Similar destruction has been noted for other natural forests throughout the world such that many of them might disappear before some of the species are properly studied, catalogued, used or domesticated (Hitimana, 2000). Other consequences include soil erosion and reduced capacity for watershed protection with possible flooding, and reduced capacity for carbon sequestration. This could lead to instability of ecosystems and reduced availability of various forest products and services (Alemu and Bluffstone, 2007).

The causes of forest destruction includes; abiotic factors (global warming, disease epidemics), limited understanding and appreciation of the value of natural forests, resulting from insufficient information about the forest systems themselves, their component and how they interact (Chomitz and Kumari, 1998). Other cause is weak institutional capacity for forest law enforcement and governance, associated with inadequate staff, low morale and poor equipment for forest guards and inadequate training and knowledge on forest legislation, and governments' inability to monitor illegal logging activities within the forest areas (Yatich *et al.*, (2007). Ecological studies aimed at providing accurate and reliable information about forest components and processes with an emphasis on human influence and its significance in forest management and conservation need to be studied and practised.

1.2 Statement of the problem

After many years of disturbance, the capacity of Western Mau forest to regenerate and regain its pre-disturbance species composition is not known. Most of the forest ecosystems in Kenya including Western Mau do not have detailed and reliable database on the floristic composition especially on the non-woody species. Thus, the little knowledge on the above information of such forests limits their potential utilization, making prospective plant biodiversity conservation difficult. The ecology of the plant species has not been widely studied; hence baseline information on forest components needed for sustainable management of this forest is insufficient.

1.3 Justification of the study

The availability of accurate data on forest components in Western Mau Forest is an essential requirement for its management and planning within the context of sustainable development. Botanical assessments such as floristic composition and abundance studies are essential in view of their value in understanding the extent of plant diversity in forest ecosystem after its disturbance. Knowledge of floristic composition is also essential in study of plant diversity and identifying threatened and economic species. There is need to study the forest regeneration in order to evaluate if the forest is in the process of regaining stability following anthropogenic disturbance. The lack of such basic information is one of the factors that have hampered the conservation, management and rational utilization of the forest resources in Western Mau Forest. Thus, database on floristic composition, regeneration and impact of human activities of this forest is important and this study provided primary information that constituted the foundation for rehabilitation practice, allowing appropriate management decisions.

1.4 Objectives

1.4.1 Main objective

The objective of the study was to determine the status of the vegetation of Western Mau Forest.

1.4.2 Specific objectives

1. To determine plant species composition, abundance and diversity in Western Mau Forest.
2. To assess the extent of forest regeneration in Western Mau Forest.
3. To determine the level of human activities in the forest.

CHAPTER TWO

LITERATURE REVIEW

2.1 Plant species composition and diversity in forest habitats

A study of forest species composition includes the identification of all taxa represented in it. For trees, parameters derived from the primary record include density, basal area, frequency, species richness, evenness, and importance values and sometimes similarity co-efficient between different sample units or communities. Taxonomic groups such as species and families are important components in biodiversity conservation programmes. For example, important conservation sites for biodiversity are reviewed to include centers of endemism, high species and habitat diversity (Kent and Coker, 1992).

Species diversity is one of the most important indices used for evaluating the sustainability of forest communities (Smith, 1996). Diversity and equitability of species in a given vegetation community is used to interpret the relative variation among and within the community and help to explain the underlying reasons for such a difference (Kent and Coker, 1992). Species diversity is described on the basis of two factors; the total number of species in the community (species richness) and relative abundance of species (species evenness) within the sample or community. These two components of species diversity may be examined separately or used together to calculate some forms of indices. A common measure of species diversity is the Shannon-Weiner diversity index that is frequently used in ecological studies (Kent and Coker, 1992; Manuel and Molles, 2007).

There are three different kinds of species diversity, alpha (α), beta (β) and gamma (γ) (Whittaker, 1975). Alpha diversity refers to the number of species within a sample area or community. Beta diversity describes the differences in species composition between two adjacent areas or communities. It is a measure of the rate and extent of changes in species along a gradient from one habitat to another (Crawley, 1998; Burley, 2001).

Beta diversity is low when the overlap between the species composition of the two areas is high and is highest when the areas have no species in common at all. Beta diversity is sometimes called habitat diversity because it represents differences in species composition between very different areas or environments and the rapidity of change of those habitats (Crawley, 1998; Burley, 2001).

Gamma diversity describes regional differences in species composition; for example, the differences in species composition between comparable habitats on two adjacent mountain ranges and is influenced by the alpha and beta diversity (Kent and Coker, 1992; Crawley, 1998; Burley, 2001). Species diversity and species evenness are often calculated using Shannon-Weiner diversity index (H'), which naturally varies between 1.5 and 3.5 and rarely, exceeds 4.5 (Kent and Coker, 1992). The Shannon-Weiner diversity index is the most appropriate and the most widely used index for combining species richness and evenness (Krebs, 1999).

Importance value index indicates the structural importance of a species within a stand of mixed species (Curtis and McIntosh, 1951). It is calculated by summing up the relative percentages of basal area, density and frequency, each weighted equally for each species, relative to the same dimensions for the entire stand (Kathiresan, 2006). The Importance Value Index (IVI), gives a realistic figure of dominance from the structural point of view (Curtis and McIntosh, 1951). It is used for comparison of ecological significance of species in which high Importance Value Index (IVI) indicates that the species sociological structure in the community is high (Lamretcht, 1989). Moreover, species with the greatest importance value are the most dominant in plant vegetation (Simon and Girma, 2004). Identification of species with the highest species importance values and of the dominants upon which others depend on their survival within any forest ecosystem is an important step towards proper ecological understanding of natural forests. This will lead to development of sound management and conservation strategies, with respect to regeneration programs.

2.2 Forest Regeneration

Forest regeneration is the act of renewing tree cover by establishing young trees naturally or artificially after the previous stand or forest has been removed. Natural forest is a complex community, composed of trees of many sizes, seedlings, saplings and varied undergrowth. Regeneration is affected by several factors; the most important ones of which include availability of viable seeds, light, water, and soil (Silva, 1989). Both natural and artificial disturbances in a forest can cause tree death or injury, which in turn creates openings in the forest cover known as canopy gaps (Yamamoto, 2000). These gaps are often filled with other trees and this replacement phenomenon is termed gap dynamics (Brokaw and Busing, 2000).

Forest gaps develop or are maintained by several causes. The smallest openings are formed by the death of individual trees. Other natural factors such as landslides, earthquakes and strong winds also cause forest gaps. Man causes the formation of gaps by forest harvesting. Different gap sizes create heterogeneous light environment in the understory and this provides opportunities for niche differentiation in modes of production. This may contribute to the diversity of plants in tropical forests (Veblen, 1989).

Regeneration processes in gaps depend on a range of biological factors, such as the life history, physiology and behavior of regenerating species; the colonizing ability of species (Lawes *et al*., 2007). However, regeneration also heavily depends on physical gap characteristics such as gap size (Li *et al.*, 2005; Lima and Moura, 2008). Other subtle characteristics of canopy gaps influence postgap regeneration (Sapkota *et al.,* 2009), including gap shape; the height and diameter of the surrounding trees, gap age, the number, causes and sizes of tree fall, gap canopy height and the surrounding stand structure (Gagnon *et al.,* 2004). Collectively, these characteristics are commonly termed as 'gap regimes' (Gagnon *et al*., 2004; Yamamoto, 2000). The impact of gap regimes on plant population dynamics is of high interest to ecologists and must be taken into account when considering population dynamics within forest gaps (Naaf and Wulf, 2007).

The amount of light, water and nutrients available to regenerating species are determined by gap characteristics. Light has been recognized as one of the most important plant growth factors. Tree species are divided into light demanders or pioneer and shade-tolerant or climax species. Light demanders are species that need complete light exposure for germination, survival and growth (Severino, 1999). They cannot regenerate under their own shade and produce large quantities of seeds which are generally small and efficiently dispersed by wind or animals (Silva, 1989). They also readily colonize forest openings and usually have a short life span. Shade-tolerant species on the other hand can germinate and grow in the dense shade of the canopy. Their seeds are large with abundant food reserves, able to survive the suppression period, and become established as long as a gap eventually occurs (Whitemore, 1998). Furthermore, gap characteristics often act as sources of within-gap heterogeneity, influencing the availability of suitable micro-sites in which species can successfully establish and grow (Lima and Moura, 2008).

Regeneration is a central process of forest ecosystem dynamics (Grubb, 1977), and sustainable forest restoration is only possible if adequate information on regeneration of species is available. Unfortunately, in tropical forests this has been difficult to obtain because of propagation difficulties of many hardwood tree species (Boot and Gullison, 1995) and inadequate knowledge of their ecological requirements (Engel and Poggiani, 1992). Consequently, it has been difficult to identify suitable tree species (early or late pioneers) for active restoration that could accelerate succession in degraded tropical forest systems (MacDonald *et al*., 2003; Bussmann 2004). The recovery process of an ecosystem such as Western Mau forest is mainly determined by post-disturbance regeneration and succession patterns. It takes 60 to 80 years and even longer for a tropical ecosystem to recover and regain its pre-disturbance structure (Plumptre, 1996). In

Kakamega tropical rainforest, Fashing *et al.*, (2004) observed that over 60 years after disturbances of 1940s, the forest was still recovering.

It is important to understand succession mechanisms that include those factors and causes such as time, type of disturbances and species life history traits, which interact to drive succession pathways (Taylor *et al.*, 2009). Understanding these gives insights on the capacity of the ecosystem to regenerate naturally and forms basis upon which ecosystem restoration and human interventions can be undertaken.

2.3 Human activities in the forest

The primary contemporary drivers of tropical forest biodiversity loss include direct effects of human activities such as habitat destruction and fragmentation, introduction of invasive species and over-exploitation, as well as indirect effects of human activities such as climate change (MEA, 2005). Tropical forest lands and forest resources are being subjected to increasing direct and indirect pressures due to accelerated growth of human populations coupled with increased (per capita) demand for goods and services from these lands and resources (FAO, 1985). Degradation of natural forests is widely acknowledged to be a serious problem that causes rural poverty, destruction of water catchments, loss of bio-diversity and increases carbon emissions (FAO, 2005). Degraded landscapes are expanding in the tropics as forests are converted to unsustainable pasture or cultivation enterprises (Bussmann, 2004). Land-use change is thought to have the greatest impact on biodiversity in tropical forests. Forest clearance destroys the habitat and generally causes a decline in forest species abundance and diversity, particularly for species that are restricted in range (Lawton, 1998; Barlow, 2007).

Apart from destroying the habitat, forest clearance can fragment a forest, leaving areas of forest that are too small for some species to persist, or too far apart for animal species to move between (Fahrig, 2003), resulting in a long process of decay in residual diversity from the remaining habitat (Krauss, 2010). Edge effects on fragments also affect species richness and composition (Ewers and Didham, 2006). Over-exploitation of a particular species or group of species can result in that species, or group of species, being driven to local or even global extinction. The most well-known examples of over-exploitation of tropical forest species involve tropical hardwoods for timber (Asner *et al*., 2005). A less well-known example is that of Chamaedorea palms (xaté) in Central America, whose leaves are harvested for the floricultural industry (Bridgewater *et al*., 2006).

The loss of one species has been shown to have widespread knock on effects on many other species (Montaya *et al.,* 2006). This may lead to secondary or co-extinctions (Koh *et al.,* 2004), but may also, in the short-term, benefit other species, if their competitors are lost. Species interact both directly and indirectly, and the indirect interactions can be highly unpredictable (Montoya *et al.,* 2006). Consequently the loss of one species can result in the decrease, extinction or increase of apparently invasive species.

Invasive species are native or non-native plant species that grows aggressively and displaces other plants. Invasive species can cause extinctions or alter abiotic environments (Bradshaw *et al.,* 2009). Much of the evidence for the detrimental effects of invasive species is based on correlations between invasive species dominance and native species decline in degraded habitats (Didham *et al.,* 2005). In these cases, invasive species could be driving the native species loss or could simply be taking advantage of habitat modification or another ecosystem change that is itself driving the native species loss (MacDougall and Turkington, 2005).

Depending on the severity of the disturbance, the size of disturbances and rotation periods, the post-disturbance forest structure and species composition may change because they influence the successional trajectory (Svensson *et al.,* 2009). The size and degree of disturbance of deforested areas can determine the routes along which abandoned areas will become structured forests (Mesquita *et al*., 2001). Frelich and Reich (1999), defined moderate severity disturbances as the one that kills most of the overstory or most of the understory, leaving either canopy layer or seedling/seedbank layer intact (for example, logging, surface fire or patch crown fire). Where disturbance virtually removes all mother trees and part of the seedbank, recovery may take over hundred years (Graaf *et al.,* 1999) or over a thousand years (Wardle *et al.,* 1999) if the entire seedbank has been removed and soil structure changed. The intensity of soil disturbance profoundly influences the magnitude and direction of vegetation change (Halpern, 1998). Frelich and Reich (1999) indicated that disturbances may lead to an individualistic successional pathway over time rather than any sort of stable cycle, in which case, human intervention may be needed to aid in restoration (Graaf, 1986). In such situations, there is an urgent need for tools that can provide an integrated assessment of human impact on forest plant diversity and that can support decision making related to forest use.

Although a number of studies on the vegetation of Kenyan forest and mountain regions of East Africa have been undertaken since 1885 (Muchoki, 2001), information on the vegetation composition and regeneration following anthropogenic disturbances in Kenyan forets is still scanty. Comprehesive studies available on the species composition in Kenya indicate that Mt. Kenya forest has the richest biological diversity with species composition compared to other forests (Ndung'u, 2007).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area

3.1.1 Location and size

The study was carried out in Western Mau Forest block which is the fifth largest block of Mau Complex in the south Rift region in Kericho County (Figure 1). It is located at an altitude between 2000 and 2600 m above sea level; and between latitudes 0^0 10’ 46’’ S to 0^0 17’ 42” S and longitudes of 35^0 27’ 05’’ E to 35^0 39’ 42” E (Jackson and McCarter, 1994). It is managed by Kenya Forest Service and covers about 22,712 hectares of indigenous forest.

3.1.2 Climate and soil

The rainfall pattern is bimodal in distribution, peaking in the months of April and August, and ranges from 1000 to 2000 mm per year with the rain days ranging from 120 to 200 per year. Mean annual temperatures range from 12^0C to 16^0C, with greatest diurnal variation during the dry season. July is the coldest month. The potential evapotranspiration ranges from 1400 to 1800 mm per annum (Jackson and McCarter, 1994). The soils are well drained mollic andosols derived from tertiary volcanic parent material with inclusions of cambisols (Jaetzold and Schmidt, 1983).

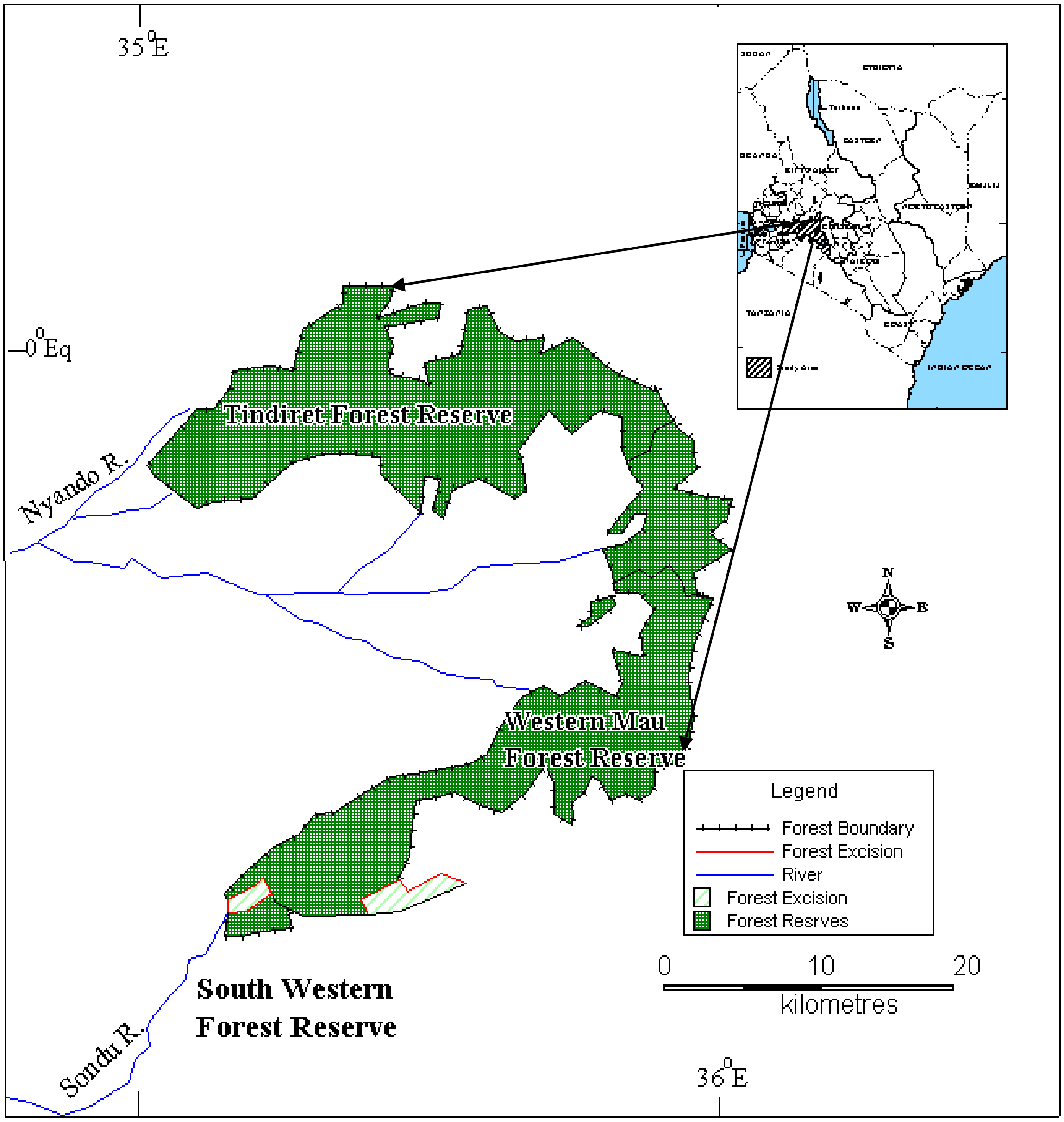

Figure 1: Western Mau Forest, Kenya (Source: author)

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3.2 Selection of study sites

A reconnaissance survey was carried with a view to locating the assemblages in the forest. The forest was then divided into three sites; Site 1 (Masaita and Mt. Blackett blocks), Site 2 (Kerisoi and Londiani blocks), Site 3 (Kedowa and Kericho blocks) (Figure 2). Stratified sampling method was used in each site, where the study site was subdivided into relatively homogenous parts of grassland, transition and forest zones. The area dominated by grasses and forbs was termed as grassland zone. The area consisting of shrubs and few seedlings, saplings and adult trees was termed as transition zone, while the area dominated by closed canopy of trees (≥ 20 m high) was termed as forest zone. Each zone was sampled independently.

3.3 Sampling procedures

3.3.1 Forest zone sampling

The belt transect method was used in the forest zone. A total of 24 belt transects were randomly laid out in the forest zone in the three sites (8 transects per site) using a table of random numbers.

The belt transects measured 2 m wide and 500 m long were set to confirm with the standard suggested by Kent and Coker (1992). Each transect was subdivided into ten subplots of 2 m wide and 50 m long and in each subplot a 1 m by 1 m quadrat was set at the center. All non-herbaceous plant species in the subplots were identified by scientific name and counted. The count of each individual species was used to calculate the density and relative density of the species.

The relative density was calculated as follows;

—……………..………………………..…………………... [Equation 1]

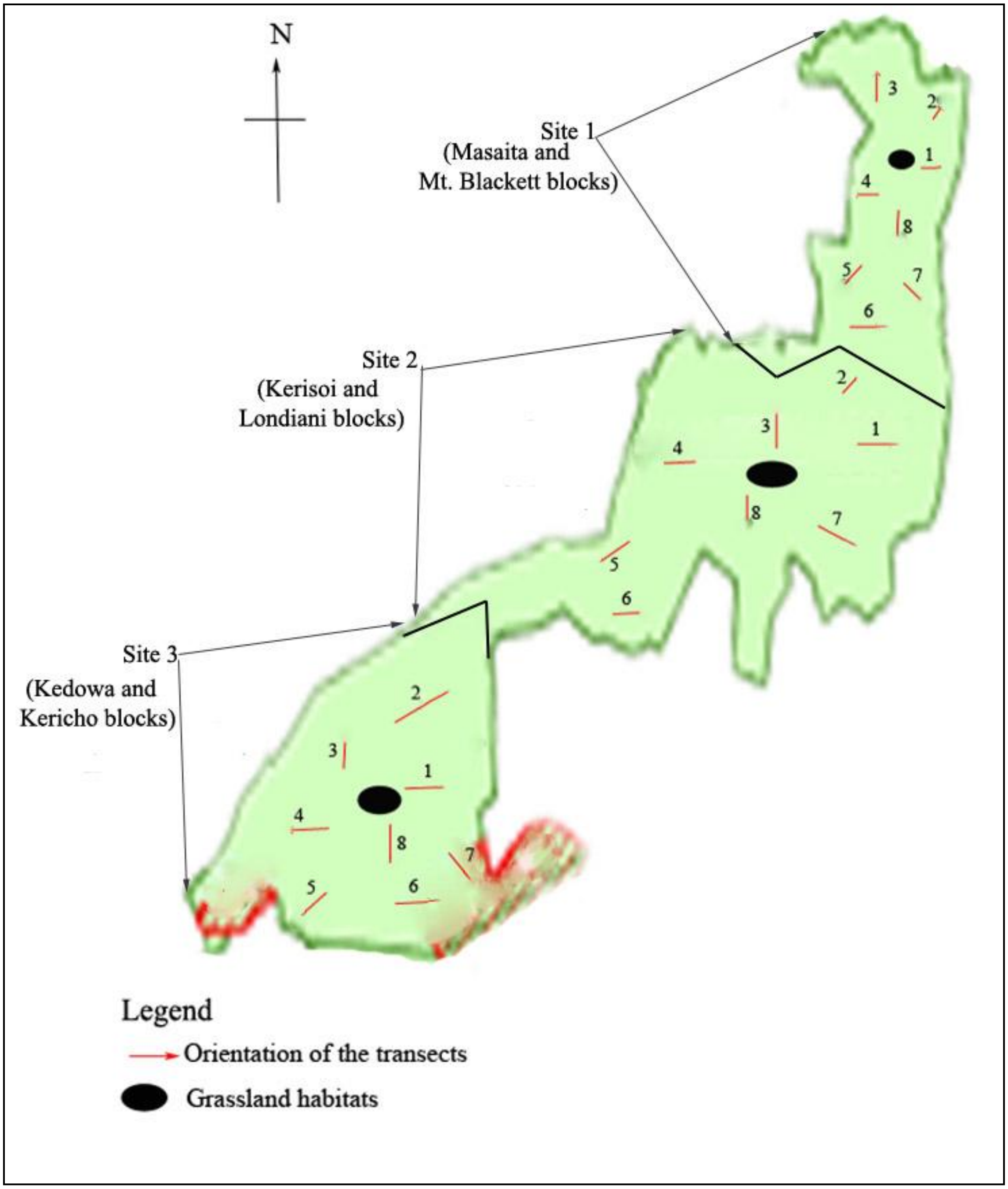

Figure 2: Position of transects in Western Mau Forest used in the study

Where; D = Density of a species

Tn = the total number of individuals of species n, counted.

s = Unit ground surface area (ha)

Relative density was calculated as follows;

…………..……………… [Equation 2]

Where; $\%R_d$ = Percentage of relative density

The frequency of each species was determined from the subplots and was calculated as;

……………….... [Equation 3]

Where: F = Frequency of a species

The relative frequency of each species was calculated as;

……………………... [Equation 4]

Where $\%R_f$ = Relative frequency percentage of a species

The diameter at breast height (DBH) for mature trees and saplings were measured at 1.45 m above ground level (Mueller and Ellenberge, 1974) for all the species encountered in the subplots using a diameter tape. In case of coppicing trees each stem was assessed separately. The basal area of the trees and saplings were calculated using the DBH values.

Basal area was calculated as;

………………………...…………………….……. [Equation 5]

Where: BA = Basal area of a species in m^2 per hectare

d = diameter at breast height in metres

$\pi = 3.14$

The basal area was used to calculate relative dominance for the species as follows;

— ……………………..………..……. [Equation 6]

Where; $\%R_{do}$ = relative dominance percentage of a species

Tba = total basal area of the species

Tbc = total basal area of all species

In every quadrat within each subplot, ferns and herbs were identified and the percent cover for all ferns estimated and recorded. The percent cover was used to calculate the abundance of the species.

3.3.2 Sampling within the transition and grassland zone

In the transition and grassland zone, plots were selected randomly using the table of random numbers. Thirty (30) plots in the transition zone (10 plots per site) and eighteen (18) plots in grassland zone (6 plots per site) of 5 m wide and 30 m long were established. The plots were then subdivided into six 5 m by 5 m subplots; each having 1 m by 1 m quadrat positioned at the centre. All non-herbaceous plant species within each subplot were identified by scientific name, counted and recorded. The count of each species was used to calculate the density and relative density of each species using equation 1 and 2 respectively. Frequency was obtained from sampling of subplots and was calculated as the number of subplots containing a given species divided by the total number of subplots laid out (Equation 3). Relative frequency of species was determined using Equation 4. The Diameter at breast height (DBH) for mature trees and saplings was measured at 1.45 m above ground for all the species. The basal area of the trees and saplings were calculated using the DBH values (Equation 5). The basal area was used to calculate relative dominance for the species using equation 6. In every quadrat within each subplot all ferns and herbs were identified by scientific names and percent cover estimated and recorded. The percent cover was used to calculate the abundance of species.

Importance Values Index (IVI) of a species was calculated from the sum of relative dominance, relative density and relative frequency a formula described by Kent and Coker (1992) and Morais and Scheuber (1997).

The importance value was thus calculated as follows;

$IVI = R_{do} + R_f + R_d$ .... [Equation 7]

Where: IVI = Importance Value Index

R_{do} = Relative dominance

R_f = Relative frequency

R_d = Relative density

3.3.3 Assessment of plant species composition and diversity

All the plant species from the forest, transition and grassland community were identified to the species level. Nomenclature followed Agnew and Agnew (1994) and Beentje (1994). All unidentified species were submitted to the East African Herbarium for identification and voucher specimens were deposited there. Unstructured sampling was used to record additional species not represented in the sample plots.

The total number of individual species in the various forest sites was used to calculate Shannon-Weiner diversity index using the standard equation described by Pielou (1975) and Magurran (1988).

$$H' = -\sum_{i=1}^{s} P_i (LnP_i)$$ ……………………………………………..…………… [Equation 8]

Where; H' = Shannon-Weiner diversity index

s = number of species

P_i = the proportion of individuals or the abundance of the i^{th} species expressed as the proportion of the total individuals.

Ln = log $base_n$

3.3.4 Assessment of regeneration

Regeneration and recruitment trends were determined by taking measurements on diameter at breast height (DBH) of mature trees, saplings and the count of seedlings along the belt transect from the forest community and plots from grassland community. They were categories as;

1. Seedlings (height < 1.3 m)
2. Saplings (DBH 1 – 9.9 cm and height > 1.3 m)
3. Mature trees, diameter classes (DBH >10 cm)

The DBH for mature trees and saplings was measured using a diameter tape. Frequencies and relative frequencies, densities and relative densities of seedlings, saplings and mature trees were calculated and regeneration and recruitment trends inferred. The count of seedlings, saplings and mature trees were used to calculate density.

3.3.5 Assessment of human activities

Human activities were determined by recording the following anthropogenic disturbances signs in the grassland, transition and grassland zone; footpath, charcoal burning, tree cutting, fire, grazing, and debarking using methods described by Silori, (2001) and Silori and Mishra (2001). The intensity of these human activities was determined by use of Likerts scores ranging from 1-5 where 1 represented least disturbance while 5 represented high disturbance (Likert, 1932). The scores were summed up and overall disturbance index calculated using the formula;

$$Disturbance\ Index = \frac{Disturbance\ score}{Total\ \max imum\ score} \times 100 \quad \text{……………………..…...… [Equation 9]}$$

Total maximum score was obtained by multiplying the number of disturbances with maximum score.

3.4 Data analyses

All statistical analyses were performed using STATISTICA 6.0 (StatSoft, 2001). Normality and homoscedasticity of data distribution was checked by means of the skewness and kurtosis (Zar, 2001). Differences in plant species composition was analyzed using a Chi-Square test. The mean abundance of plants species were calculated for each site. Differences in the mean plant species abundance among the sites was analyzed using one-way analysis of variance (ANOVA), and plant abundance among sites in different zones was analyzed by two-way ANOVA. All statistical analyses were done at 95% level of confidence.

CHAPTER FOUR

RESULTS

4.1 Plant species composition, abundance and diversity in Western Mau Forest

4.1.1 Plant species composition

A total of 223 vascular plant species belonging to 83 families were identified and documented from the study area (Appendix 1). The number of species per family differed significantly in the forest (χ^2 = 154.618, df = 82, P < 0.05). The major families were Asteraceae with 18 species, Fabaceae with 16 species, Euphorbiaceae with 11 species and Rubiaceae with 10 species. Some 41 Families were represented by a single species each (Appendix 1).

A checklist of the overall non-herbaceous plant species identified at the three sites of Western Mau Forest and their percent occurrence in 528, 0.01 ha sub-plots is shown in Table 1. There was a total of 124 species belonging to 57 families in the Western Mau Forest. The number of species per family differed significantly in the forest (χ^2 = 111.355, df = 56, P < 0.05) between transects. The major families were Fabaceae with 12 species, Asteraceae with 8 species and Euphorbiaceae with 8 species. Some 33 families were represented by only a single species each.

Table 1: Checklist of non-herbaceous plant species in the three sites of Western Mau Forest and their percent occurrence (in parenthesis)

Family	Species (percent composition)
Acanthaceae	*Acanthus eminens* C.B. Clarke (5.9), *Hypoestes forskahlii* (Vahl) R.Br. (2.1), *Justicia flava* (Forssk.) Vahl. (0.2)
Anacardiaceae	*Rhus natalensis* Berhn (4.0), *Rhus vulgaris* Meikle (0.3)
Apocynaceae	*Tabernaemontana stapfiana* Britten (12.9)
Araliaceae	*Cussonia holstii* Engl. (0.2), *Polyscias fulva* (Hiern) Harms (2.5)
Asclepediaceae	*Periploca linearifolia* Dil & A.Rich. (6.4)
Asteraceae	*Ageratum conzoides* L. (12.3), *Borthriocline fusca* (S.Moore) M. Gilbert (18.6), *Helichrysum odoratissimun* (L.) Less (0.2), *Launaea comuta* (Olive & Hiern) C. Jeffrey (0.3), *Solanecio mannii* (Hook.f.) C. Jeffrey (0.8), *Spilanthes mauritianum* (A.Rich.ex Pers) DC (8.3), *Tagetes minuta* L. (0.3), *Vernonia lasiopus* O. Hoffm. (20.9)
Boraginaceae	*Cordia abyssinica* R. Br. (0.2), *Ehretia cymosa* Thonn. (3.5)
Campanulaceae	*Lobellia gibberoa* Hemsl (5.3)
Canellaceae	*Warbugia ugandensis* Sprague (0.8)
Cannbaceae	*Celtis africana* N.L.Burm. (10.5)
Celastracace	*Catha edulis* (Vahl) Forssk.ex Endl. (1.8), *Hippocratea africana* (Willd.) Loes. (13.2), *Maytenus leterophyla* N. Robson (17.8), *Maytenus senegalensis* (Thunb) Blacklock (1.0), *Maytenus undata* Lam. (1.0)
Clusiaceae	*Garcinia buchanii* Baker (0.3)
Commelinaceae	*Commelina benghalensis* Forssk. (0.2)
Compositae	*Tarconanthus camphorates* L. (1.0)
Convolvulaceae	*Ipomoea hildebrandtii* Vatke (12.6)
Cucurbitaceae	*Lagenaria abyssinica* (Hook f.) C.Jeffry (0.2), *Momordica foetida* Schumach (1.3), *Zehneria scabra* (L.f.) Sond (15.4)
Cupressaceae	*Cupressus lusitanica* Mill (7.6), *Juniperus procera* Hochst ex Engl (1.4)
Dracaenaceae	*Dracaena steudneri* Engl. (5.6)
Ebenaceae	*Diospyros abyssinica* (Hiern) F.White (6.7), *Euclea divinorum* Hiern (9.4)
Euphorbiaceae	*Clutia abyssinica* Jaub. & Spach. (0.6), *Croton macrostachyus* Hochst.ex Delile (9.9), *Drypetes gerrardii* Hutch (0.3), *Erythrococca bongensis* Pax (0.2), *Macaranga kilimandscharica* Pax (1.9), *Neoboutonia macrocalyx* Pax (9.2), *Ricinus communis* L. (0.2), *Suregada procera* Croizat (6.2)
Fabaceae	*Acacia abyssinica* Hochst.ex Benth (1.1), *Acacia lahai* Benth. (1.4), *Albizia gummifera* (J.F. Gmel.) C.A. Sm. (19.4), *Caesalpinia decapelata* (Roth) Alston (3.5), *Crotalaria agatiflora* Schweinf. (0.2), *Crotalaria mauensis* Baker.f. (1.1), *Indigofera volkensii* Taub. (1.9), *Pterolobium stellatum* (Forssk.) Brenan (0.6), *Rhynchosia usambarensis* Taub. (8.6), *Senna didymobotrya* (Fresen.) Irwin & Barneby (1.0), *Senna Spp*. Mill (0.5), *Sesbania sesban* (L.) Mett (0.3)
Flacourtiaceae	*Dovyalis abyssinica* (A.Rich) Warb. (0.5), *Dovyalis macrocalyx* (Oliv.) Warb. (9.9), *Trimeria grandiflora* Wild. (5.7)
Hamammelidaceae	*Trichocladus ellipticus* Eckl & Zeyh. (13.5)
Hypoxidaceae	*Hypoxis obtuse* Burch. (3.2)

Table 1…cont.

Family	**Species (percent composition)**
Lamiaceae	*Leonotis mollissima* Gurke. (6.4), *Leucas grandis* Vatke (1.0), *Satureja biflora*(D.Don) Benth (0.3)
Malvaceae	*Abutilon longicuspe* Hochst ex A. Rich (3.2), *Dombeya torrid* (J.F. Gmel.) Bamps (2.5), *Grewia similes* K.Schum (0.2), *Hibiscus ludwigii* Eckle. & Zeyh. (0.5), *Sida ovate* Forsk (0.3)
Meliaceae	*Ekerbergia capensis* Sparrm. (1.8)
Meliantheceae	*Bersama abyssinica* Verdc (2.2)
Menispermaceae	*Cissampelos Pereira* L. (0.2)
Monimiaceae	*Xymalos monospora* (Harv.) Baill.ex Warb. (2.1)
Moraceae	*Ficus capensis* Hiern (0.5)
Myrsinaceae	*Rapanea melanophloes* (L.) Mez (0.2)
Myrtaceae	*Syzygium guineense* (Willd). DC. (5.7)
Ochnaceae	*Ochna ovate* F. Hoffm. (0.3)
Oleacae	*Fraxinus pennsylvanica* Marshall (25.5), *Olea capensis* L. (4.8)
Orchidaceae	*Orchid spp.* (0.2)
Passifloraceae	*Passina passiflora* L. (2.1)
Piperaceae	*Piper capense* L.f. (9.1)
Pittosporaceae	*Pittosporum viridiflorum* Sims. (0.2)
Poaceae	*Digitaria horizontalis* Henrard (20.9), *Oplismenus buminanii* P. Beauv. (0.3)
Podocarpaceae	*Podocarpus latifolius* (Thunb.) R.Br.ex Mirb. (3.2)
Polygonaceae	*Rumex usambarensis* Dammer (0.2)
Proteaceae	*Grevillea robusta* A.Cunn.ex R.Br. (1.0)
Ranunculaceae	*Clematis brachiata* Thumb. (4.9)
Rhamnaceae	*Scutia myrtina* (Burmf.) Kurz (14.0)
Rhizophoraceae	*Cassipourea malosana* (Bak)Alston (4.0)
Rosaceae	*Haggenia abyssinica* (Bruce) J.F. Gmel (0.3), *Prunus africana* (Hook f.) Kalkman (3.5), *Rubus steudneri* Schweinf. (18.5)
Rubiaceae	*Coffea eugenoides* S. Moore (11.0), *Psydrax schimperiana* (A. Rich.) Bridson (10.2), *Vangueria madagascariensis* J. F. Gmelin (8.6)
Rutaceae	*Clausena anisata* (Willd.) Hook. f. ex Benth. (0.2), *Teclea nobilis* Delile (10.0), *Toddalia asiatica* (L) Ram (5.1), *Zanthoxyllum gillettii* (De Wild.) P.G. Waterman (3.5)
Salicaceae	*Casearia battiscombei* R.E.Fr. (0.8)
Salvadoraceae	*Salvadora persica* L. (0.3)
Sapindaceae	*Allophylus abyssinicus* P. Beauv. (1.0)
Smilacaceae	*Smilax anceps* Willd. (0.3)
Solanaceae	*Physalis peruviana* L. (2.4), *Solanum mauritianum* Scop. (5.3), *Solanum terminale* Forssk. (0.2)
Tiliaceae	*Sparmannia ricinocarpa* (Eckl. & Zeyh.) Kuntze (4.0), *Triumfetta macrophylla* K.Schum (0.3), *Triumfetta rhomboidea* Jacq. (2.7)
Verbanaceae	*Clerodendrum johnstonii* Oliv. (14.3), *Lantana trifolia* L. (2.9), *Lippia javanica* (Burm.f.) Spreng (10.5), *Verbena bonariensis* Bitter (4.8)
Vitaceae	*Cyphostema orondo* (Gil & M.Brandt) Desc. (9.6), *Rhoicissus tridentate* (L.f.) Wild & R.B.Drumm. (5.3)

Results for the herbaceous plant species composition found at the three sites of Western Mau Forest in 528, one (1) m^2 quadrats are shown in Table 2. There were a total of 19 families of herbaceous plant species with a total of 33 species. There was a significant difference in the number of plant species per family (χ^2 = 27.471, df = 18, P = 0.045). The family Asteraceae had the highest number of species (8) followed by Poaceae at 3, while 12 families had a single species.

Table 2: Checklist of herbaceous plant species in the three sites of Western Mau Forest and their families

Family	Species
Acanthaceae	*Hypoestes forskahlii* (Vahl) R.Br., *Justicia flava* (Forssk.) Vahl.
Amaranthaceae	*Cyathula polycephala* Bak.
Amaranthaceae	*Achyrantes aspera* L.
Asteraceae	*Bidens pilosa* L., *Carduus keniensis* R.E.Fr., *Crassocephalum montousum* (S.Moore) Milne-Redh, *Crassocephalum vitellinum* (Benth.) S. Moore, *Erigeron floribudus* (Kunth.) Sch. Bip., *Taraxacum officinale* F.H. Wigg, *Vernonia auricurifela* Hiern, *Vernonia galamensis* (Cass.) Less
Balsaminaceae	*Impatiens niamniamensis* Gilg.
Commelinaceae	*Commelina benghalenis* Forssk
Crassulaceae	*Kalanchoe densiflora* Rofle
Cyperaceae	*Cyperus alternifolius* Schwein, *Cyperus difformis* L., *Kyllinga bulbosa* P. Beauv.
Fabaceae	*Glycine wightii* (Wight & Arn), *Rhynchosia usambarensis* Taub.
Mackinlayaceae	*Centella asiatica* (L.) Urban
Malvaceae	*Hibiscus ludwigii* Eckle. & Zeyh., *Sida ovate* Forssk
Menispermaceae	*Cissampelos Pereira* L.
Oxalidaceae	*Oxalis obliquifolia* Steud.ex A. Rich.
Poaceae	*Digitaria horizontals* Henrard, Verdc, *Oplismenus buminanii* P. Beauv., *Panicum laxum* Sw.
Polygonaceae	*Rumex usambarensis* Dammer
Pteridaceae	*Pteris catoptera* Kze.
Rosaceae	*Alchemilla fischeri* Engl.
Solanaceae	*Solanum terminale* Forssk., *Solanum nigrum* L.
Urticaceae	*Urtica massaica* Mildbr.

Occurrence of non-herbaceous plant species in the grassland zone at the three sites of Western Mau Forest is shown in Table 3. There was a significant difference in the species composition among the three sites in the grassland zone ($\chi^2 = 121.522$, df = 58, $P < 0.05$). Site 3 was dominated by lianas (4 species) and saplings (4 species) than other sites. However, there was a uniform distribution of shrubs in the three sites (9 species in Site 2 and 10 species in Site 1 and Site 3). Plants species common in the three sites were *Lippia javanica* and *Vernonia lasiopus.*

Table 3: Non-herbaceous plant form and species composition in the grassland zone Western Mau Forest

Plant form	Plant species	Site 1	2	3
Seedlings	*Prunus Africana* (Hook f.) Kalkman	-	-	+
Lianas	*Clutia abyssinica* Jaub. & Spach.	-	-	+
	Cyphostema orondo (Gil & M.Brandt) Desc.	-	+	-
	Ipomoea grandtii Vatke	+	-	+
	Rubus steudneri Schweinf.	+	-	+
	Zehneria scabra (L.f.) Sond	-	-	+
Saplings	*Albizia gummifera* J.F. Gmel.) C.A. Sm.	-	-	+
	Croton macrostachyus Hochst.ex Delile	-	-	+
	Dovyalis macrocalyx (Oliv.) Warb.	-	-	+
	Neoboutonia macrocalyx Pax	-	-	+
	Vangueria madagascariensis J. F. Gmelin	-	+	-
Shrub	*Ageratum conyzoides* L.	+	+	+
	Cissampelos Pereira L.	-	-	+
	Clerodendrum johnstonii Oliv.	-	+	+
	Euclea divinorum Hiern	+	-	-
	Hibiscus ludwigii Eckle. & Zeyh.	+	-	-
	Hypoestes forskahlii (Vahl) R.Br.	-	-	+
	Indigofera volkensii Taub.	-	+	-
	Launaea cornuta (Olive & Hiern) C. Jeffrey	-	+	-
	Leonotis mollissima Gurke	+	-	-
	Leucas grandis Vatke	-	-	+
	Lippia javanica (Burm.f.) Spreng	+	+	+
	Lobellia gibberoa Hemsl	-	-	+
	Maytenus leterophylla N. Robson	+	+	-
	Rhus natalensis Berhn	+	-	-
	Senna didymobotrya (Fresen.) Irwin & Barneby	+	-	+
	Solanum mauritianum Scop.	-	-	+
	Solanum sessilistellatum Bitter	-	+	-
	Verbena bonariensis Bitter	+	+	-
	Vernonia lasiopus O. Hoffm.	+	+	+

+ = present - = absent

The occurrence of non-herbaceous plant species in forest zone at the three sites of Western Mau Forest is shown in Table 4. There was a significant difference in the species composition among the three sites in the forest zone (χ^2 = 2569.596, df = 359, P < 0.05). Trees and saplings were more dominant in Site 1, seedlings dominated in Site 3, and shrubs and palms were more dominant in Site 2. The plants species common in the three sites were: seedlings (*Albizia gummifera, Diospyros abyssinica* and *Prunus africana*), lianas (*Coffea eugenoides, Cyphostema orondo, Ipomoea hildebrandtii, Physalis peruviana, Rubus steudneri, Scutia myrtina* and *Zehneria scabra*), saplings (*Albizia gummifera, Cassipourea malosana, Croton macrostachyus, Diospyros abyssinica* and *Syzygium guineense*), shrubs (*Acanthus eminens, Clerodendrum johnstonii, Dovyalis macrocalyx, Leonotis mollissima, Spilanthes mauritiana* and *Vernonia lasiopus*), palms (*Dracaena steudneri*), trees (*Albizia gummifera, Cassipourea malosana, Croton macrostachyus, Diospyros abyssinica, Dombeya torrida, Maytenus senegalensis* and *Polyscias fulva*).

Table 4: Non-herbaceous plant form and species composition in the forest zone of Western Mau Forest

Plant form	Plant species	Site 1	Site2	Site 3
Tree	*Acacia abyssinica* Hochst.ex Benth	+	-	+
	Acacia lahai Benth.	+	-	-
	Albizia gummifera (J.F. Gmel.) C.A. Sm.	+	+	+
	Allophylus abyssinicus P. Beauv.	-	-	+
	Bersama abyssinica Verdc	+	-	-
	Casearia battiscombei R.E.Fr.	-	-	+
	Cassipourea malosana (Bak)Alston	+	+	+
	Catha edulis (Vahl) Forssk.ex Endl.	+	+	-
	Celtis Africana N.L.Burm.	+	+	-
	Clematis brachiata Thumb.	-	-	+
	Croton macrostachyus Hochst.ex Delile	+	+	+
	Cupressus lusitanica Mill	+	+	-
	Cussonia holstii Engl.	-	+	-
	Diospyros abyssinica (Hiern) F.White	+	+	+
	Dombeya torrida (J.F. Gmel.) Bamps	+	+	+
	Drypetes gerrardii Hutch	-	+	-
	Ehretia cymosa Thonn.	+	+	-
	Ekerbergia capensis Sparrm.	+	+	-

Table 4…cont.

Plant form	Plant species	Site 1	Site 2	Site 3
Tree	*Erythrococca bongensis* Pax	+	-	-
	Euclea divinorum Hiern	+	+	-
	Ficus capensis Hiern	+	-	-
	Fraxinus pennsylvanica Marshall	+	-	-
	Grevillea robusta A.Cunn.ex R.Br.	+	-	-
	Haggenia abyssinica (Bruce) J.F. Gmel	-	-	+
	Juniperus procera Hochst ex Engl	+	-	-
	Macaranga kilimandscharica Pax	-	-	+
	Maytenus senegalensis (Thunb) Blacklock	+	+	+
	Maytenus undata Lam.	+	-	-
	Neoboutonia macrocalyx Pax	-	-	+
	Ochna ovata F. Hoffm.	-	+	-
	Olea capensis L.	+	+	-
	Podocarpus latifolius (Thunb.) R.Br.ex Mirb.	+	+	-
	Polyscias fulva(Hiern) Harms	+	+	+
	Prunus africana (Hook f.) Kalkman	+	-	+
	Psydrax schimperiana (A. Rich.) Bridson	-	-	+
	Rumex usambarensis Dammer	+	-	-
	Suregada procera Croizat	-	-	+
	Syzygium guineense (Willd). DC.	-	+	+
	Tabaenamontana stapfiana Britten	-	-	+
	Tarconanthus camphoratus L.	+	+	-
	Teclea nobilis Delile	+	+	-
	Trichocladus ellipticus Eckl & Zeyh.	+	+	-
	Trimeria grandiflora Wild.	+	+	-
	Vangueria madagascariensis J. F. Gmelin	+	+	-
	Warbugia ugandensis Sprague	-	-	+
	Xymalos monospora (Harv.) Baill.ex Warb.	-	-	+
	Zanthoxyllum gillettii (De Wild.)P.G.	-	-	+
Seedlings	*Acacia lahai* Benth.	-	-	-
	Albizia gummifera (J.F. Gmel.) C.A. Sm.	+	+	+
	Allophylus abyssinicus P. Beauv.	+	-	+
	Bersama abyssinica Verdc	-	-	+
	Cassipourea malosana (Bak)Alston	-	+	-
	Catha edulis (Vahl) Forssk.ex Endl.	+	+	-
	Celtis africana N.L.Burm.	+	+	-
	Croton macrostachyus Hochst.ex Delile	-	+	+
	Cupressus lusitanica Mill	+	+	-
	Diospyros abyssinica (Hiern) F.White	+	+	+
	Dombeya torrida (J.F. Gmel.) Bamps	+	-	+
	Ekerbergia capensis Sparrm.	-	-	+
	Euclea divinorum Hiern	+	-	-
	Fraxinus pennsylvanica Marshall	+	-	-
	Grevillea robusta A.Cunn.ex R.Br.	+	-	-
	Macaranga kilimandscharica Pax	-	-	+
	Maytenus senegalensis (Thunb) Blacklock	-	-	+
	Neoboutonia macrocalyx Pax	-	-	+
	Olea capensis L.	+	+	-
	Pittosporum viridiflorum Sims.	-	-	+
	Podocarpus latifolius (Thunb.) R.Br.ex Mirb.	+	+	-
	Polyscias fulva (Hiern) Harms	-	-	+
	Prunus africana (Hook f.) Kalkman	+	+	+
	Psydrax schimperiana (A. Rich.) Bridson	-	-	+
	Salvadora persica L.	-	-	+
	Suregada procera Croizat	-	-	+
	Syzygium guineense (Willd). DC.	-	-	+
	Tabaenamontana stapfiana Britten	-	-	+

Table 4…cont.

Plant form	Plant species	Site 1	Site 2	Site 3
Seedlings	*Teclea nobilis* Delile	+	+	-
	Trichocladus ellipticus Eckl & Zeyh.	+	+	-
	Trimeria grandiflora Willd.	+	+	-
	Vangueria madagascariensis J. F. Gmelin	+	+	-
	Warbugia ugandensis Sprague	-	-	+
	Xymalos monospora (Harv.) Baill.ex Warb.	-	-	+
	Zanthoxyllum gillettii (De Wild.)P.G.	-	-	+
Lianas	*Clausena anisata* (Willd.) Hook. f. ex Benth.	+	-	-
	Clutia abyssinica Jaub. & Spach.	-	-	+
	Coffea eugenoides S. Moore	+	+	+
	Cyphostema orondo (Gil & M.Brandt) Desc.	+	+	+
	Hippocratea africana (Willd.) Loes.	+	+	-
	Ipomoea grandtii Vatke	-	+	+
	Lagenaria abyssinica (Hook f.) C.Jeffry	-	-	+
	Passina passiflora L.	+	-	+
	Periploca linearifolia Dil & A.Rich.	+	+	+
	Physalis peruviana L.	+	+	+
	Pterolobium stellatum (Forssk.) Brenan	+	+	-
	Rhoicissus tridentate (L.f.) Wild &	-	-	+
	Rhynchosia usambarensis Taub.	+	+	-
	Rubus steudneri Schweinf.	+	+	+
	Scutia myrtina (Burmf.) Kurz	+	+	+
	Smilax anceps Willd.	-	-	+
	Toddalia asiatica (L) Ram	+	-	-
	Zehneria scabra (L.f.) Sond	+	+	+
Saplings	*Acacia abyssinica* Hochst.ex Benth	-	-	+
	Acacia lahai Benth.	+	-	-
	Albizia gummifera (J.F. Gmel.) C.A. Sm.	+	+	+
	Allophylus abyssinicus P. Beauv.	+	-	-
	Bersama abyssinica Verdc	+	+	-
	Casearia battiscombei R.E.Fr.	-	-	+
	Cassipourea malosana (Bak)Alston	+	+	+
	Catha edulis (Vahl) Forssk.ex Endl.	+	+	-
	Celtis africana N.L.Burm.	+	+	-
	Clematis brachiata Thumb.	-	-	+
	Croton macrostachyus Hochst.ex Delile	+	+	+
	Cupressus lusitanica Mill	+	-	-
	Diospyros abyssinica (Hiern) F.White	+	+	+
	Dombeya torrida (J.F. Gmel.) Bamps	+	-	+
	Dovyalis macrocalyx (Oliv.) Warb.	+	+	-
	Ehretia cymosa Thonn.	-	+	+
	Ekerbergia capensis Sparrm.	+	+	-
	Euclea divinorum Hiern	+	-	-
	Fraxinus pennsylvanica Marshall	+	-	-
	Grevillea robusta A.Cunn.ex R.Br.	+	+	-
	Juniperus procera Hochst ex Engl	+	-	-
	Macaranga kilimandscharica Pax	-	-	+
	Maytenus senegalensis (Thunb) Blacklock	-	+	-
	Maytenus undata Lam.	+	-	-
	Neoboutonia macrocalyx Pax	-	-	+
	Olea capensis L.	+	-	-
	Podocarpus latifolius (Thunb.) R.Br.ex Mirb.	-	+	-
	Polyscias fulva(Hiern) Harms	-	-	+
	Prunus africana (Hook f.) Kalkman	+	-	+
	Psydrax schimperiana (A. Rich.) Bridson	-	-	+
	Rapanea melanophloes (L.) Mez	-	+	-
	Salvadora persica L.	-	-	+

Table 4…cont.

Plant form	Plant species	Site 1	Site 2	Site 3
Saplings	*Suregada procera* Croizat	-	-	+
	Syzygium guineense (Willd). DC.	+	+	+
	Tabaenamontana stapfiana Britten	-	-	+
	Teclea nobilis Delile	+	+	-
	Trichocladus ellipticus Eckl & Zeyh.	+	+	-
	Trimeria grandiflora Wild.	+	+	-
	Vanqueria madagascariensis J. F. Gmelin	+	+	-
	Warbugia ugandensis Sprague	-	-	+
	Xymalos monospora (Harv.) Baill.ex Warb.	-	-	+
	Zanthoxyllum gillettii (De Wild.) P.G.	-	-	+
Shrub	*Abutilon longicuspe* Hochst ex A. Rich	+	+	-
	Acanthus eminens C.B. Clarke	+	+	+
	Ageratum conyzoides L.	+	+	-
	Borthriocline fusca (S.Moore) M. Gilbert	+	+	-
	Clematis brachiata Thumb.	-	-	+
	Clerodendrum johnstonii Oliv.	+	+	+
	Crotalaria mauensis Baker.f.	+	+	-
	Dovyalis abyssinica (A.Rich) Warb.	-	+	-
	Dovyalis macrocalyx (Oliv.) Warb.	+	+	+
	Euclea divinorum Hiern	+	-	-
	Grewia similis K.Schum	+	-	-
	Helichrysum odoratissimun (L.) Less	-	+	-
	Hibiscus ludwigii Eckle. & Zeyh.	-	+	-
	Hypoestes forskahlii (Vahl) R.Br.	-	+	-
	Indigofera volkensii Taub.	+	+	-
	Ipomoea grandtii Vatke	-	+	+
	Lantana trifolia L.	+	-	-
	Launaea cornuta (Olive & Hiern) C. Jeffrey	-	+	-
	Leonotis mollissima Gurke.	+	+	+
	Lippia javanica (Burm.f.) Spreng	+	+	-
	Lobellia gibberoa Hemsl	-	-	+
	Maytenus leterophyla N. Robson	+	+	-
	Momordica foetida Schumach	-	-	+
	Piper capense L.f.	-	-	+
	Rhus natalensis Berhn	+	-	-
	Satureja biflora (D.Don) Benth	-	+	-
	Senna didymobotrya Irwin & Barneby	+	-	-
	Sesbania sesban (L.) Mett	-	+	+
	Solanecio manii (Hook.f.) C. Jeffrey	-	-	+
	Solanum mauritianum Scop.	-	-	+
	Solanum terminale Forssk.	+	-	-
	Sparmannia ricinocarpa (Eckl. & Zeyh.)	-	+	+
	Spilanthes mauritiana (A.Rich.ex Pers) DC	+	+	+
	Tagetes minuta L.	-	+	-
	Triumfetta rhomboidea Jacq.	-	-	+
	Verbena bonariensis Bitter	+	+	-
	Vernonia lasiopus O. Hoffm.	+	+	+
Palms	*Dracaena steudneri* Engl.	+	+	+

+ = present - = absent

The occurrence of non-herbaceous plant species in transition zone at the three sites of Western Mau Forest is shown in Table 5. There was a significant difference in the species composition among the three sites in the transition zone ($\chi^2 = 551.716$, df = 144, $P < 0.05$). Trees, seedlings, lianas, shrubs and palms were more dominant in Site 3 than other sites. Plants species common in the three sites were; seedling (*Albizia gummifera*), shrub (*Ageratum conyzoides*, *Dovyalis macrocalyx* and *Vernonia lasiopus*).

Table 5: Non-herbaceous plant form and species composition in the transition zone of Western Mau Forest

Plant form	Plant species	Site 1	Site 2	Site 3
Tree	*Allophylus abyssinicus* P. Beauv.	-	-	+
	Cordia abyssinica R. Br.	-	+	-
	Croton macrostachyus Hochst.ex Delile	-	+	+
	Cupressus lusitanica Mill	+	-	-
	Fraxinus pennsylvanica Marshall	+	-	-
	Neoboutonia macrocalyx Pax	-	-	+
	Solanum giganteum Jacq.	-	-	+
	Syzygium guineense (Willd). DC.	-	-	+
	Tarconanthus camphoratus L.	+	-	-
Seedlings	*Acacia lahai* Benth.	+	-	-
	Albizia gummifera (J.F. Gmel.) C.A. Sm.	+	+	+
	Bersama abyssinica Verdc	-	-	+
	Croton macrostachyus Hochst.ex Delile	-	-	+
	Cupressus lusitanica Mill	+	-	-
	Dovyalis macrocalyx (Oliv.) Warb.	-	-	+
	Ehretia cymosa Thonn.	-	-	+
	Prunus africana (Hook f.) Kalkman	-	-	+
	Psydrax schimperiana (A. Rich.) Bridson	-	-	+
	Syzygium guineense (Willd). DC.	-	-	+
Lianas	*Coffea eugenoides* S. Moore	-	-	+
	Cyphostema orondo (Gil & M.Brandt)	-	-	+
	Ipomoea hildebrandtii Vatke	+	-	+
	Momordica foetida Schumach	-	-	+
	Periproca lineafolia Dil & A.Rich.	+	-	-
	Physalis peruviana L.	-	+	-
	Rhoicissus tridentate (L.f.) Wild &	-	-	+
	Rhynchosia usambarensis Taub.	-	-	+
	Rubus steudneri Schweinf.	+	-	+
	Scutia myrtina (Burmf.) Kurz	-	-	+
	Zehneria scabra (L.f.) Sond	+	-	+
Saplings	*Acacia lahai* Benth.	+	-	-
	Albizia gummifera (J.F. Gmel.) C.A. Sm.	+	-	+
	Allophylus abyssinicus P. Beauv.	-	-	+
	Croton macrostachyus Hochst.ex Delile	-	-	+
	Cupressus lusitanica Mill	+	-	-
	Euclea divinorum Hiern	+	-	-
	Fraxinus pennsylvanica Marshall	+	-	-

Table 5…cont.

Plant form	Plant species	Site 1	Site 2	Site 3
Saplings	*Maytenus leterophyla* N. Robson	-	+	-
	Neoboutonia macrocalyx Pax	-	-	+
	Olea capensis L.	+	+	-
	Prunus africana (Hook f.) Kalkman	-	-	+
	Psydrax schimperiana (A. Rich.) Bridson	-	-	+
	Syzygium guineense (Willd). DC.	-	-	+
	Trimeria grandiflora Wild.	+	-	-
	Vangueria madagascariensis J. F. Gmelin	-	+	-
	Zanthoxyllum gillettii (De Wild.)P.G. Waterman	-	-	+
Shrub	*Ageratum conyzoides* L.	+	+	+
	Borthriocline fusca (S.Moore) M. Gilbert	+	+	-
	Clerodendrum johnstonii Oliv.	-	+	+
	Dovyalis abyssinica (A.Rich) Warb.	-	-	+
	Dovyalis macrocalyx (Oliv.) Warb.	+	+	+
	Hibiscus ludwigii Eckle. & Zeyh.	-	-	+
	Hypoestes forskahlii (Vahl) R.Br.	-	-	+
	Indigofera volkensii Taub.	+	+	-
	Lantana trifolia L.	+	-	-
	Leonotis mollissima Gurke.	+	-	+
	Leucas grandis Vatke	-	-	+
	Lippia javanica (Burm.f.) Spreng	+	+	-
	Lobellia gibberoa Hemsl	-	-	+
	Maytenus leterophyla N. Robson	+	+	-
	Orchid spp.	+	-	-
	Piper capense L.f.	-	-	+
	Rhus natalensis Berhn	+	-	-
	Rhus vulgaris Meikle	+	-	-
	Solanecio mannii (Hook.f.) C. Jeffrey	-	-	+
	Solanum mauritianum Scop.	-	-	+
	Solanum terminale Forssk.	-	-	+
	Sparmannia ricinocarpa (Eckl. & Zeyh.) Kuntze	-	+	+
	Spilanthes mauritiana (A.Rich.ex Pers) DC	+	-	+
	Tagetes minuta L.	-	-	+
	Triumfetta rhomboidea Jacq.	-	-	+
	Verbena bonariensis Bitter	+	+	-
	Vernonia lasiopus O. Hoffm.	+	+	+

+ = present - = absent

4.1.2 Plant species abundance

The abundance of non-herbaceous plant forms in Western Mau Forest is shown in Figure 3. There was a significant difference in the plant forms encountered during sampling ($\chi^2 = 1259.589$, df = 4, P < 0.05). The most abundant plant form was shrubs followed by seedlings and saplings whilst palms were the least in species composition.

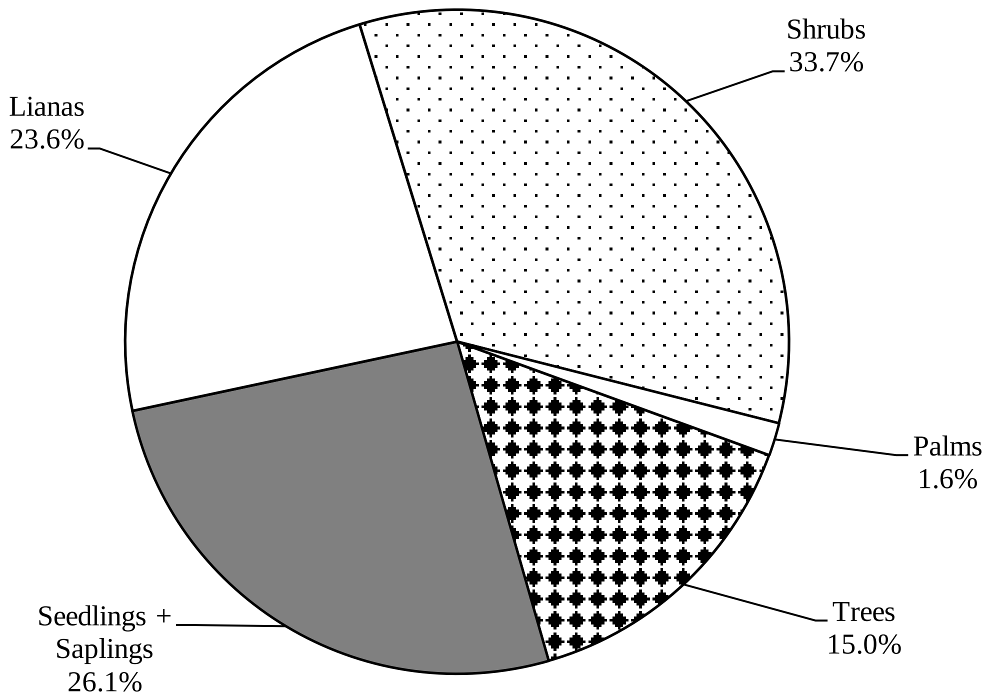

Figure 3: Abundance of non-herbaceous plant forms in Western Mau Forest

The overall abundance of non-herbaceous plant species among sites and at different sampling zones is presented in Figure 4. There was a significant difference in plant species abundance among sites and zones ($F = 4.909$, $df = 8$, $P < 0.05$). In Site 1, the highest species abundance was recorded for the forest, whilst in Site 3 the transition zone had the highest plant species abundance. On the other hand, Site 2 had no significant differences in the plant species abundance among sampling sites and zones.

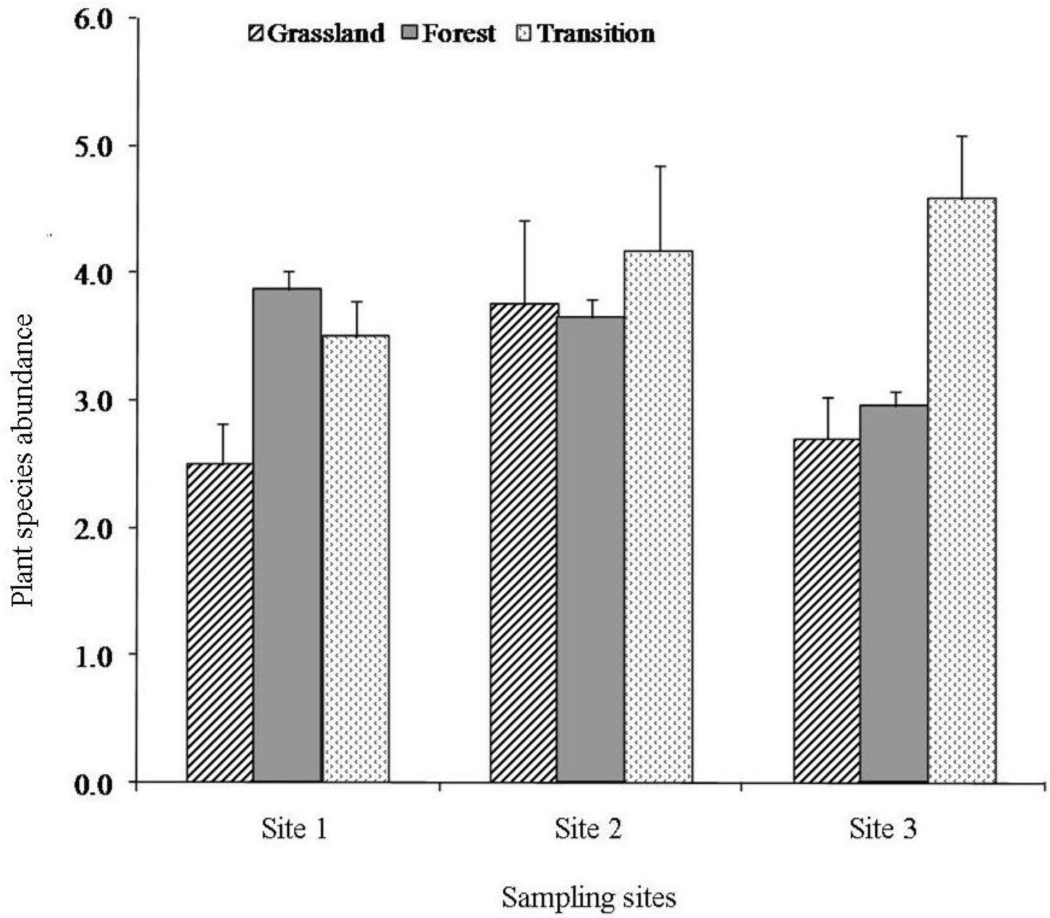

Figure 4: Overall plant abundance in the three sampling sites

Abundance of the non-herbaceous plant species at the grassland zone among the three sampling sites is provided in Table 6. There was no significant difference in plant species abundance among sampling sites ($F = 0.691$, $df = 43$, $P = 0.908$).

Table 6: Non-herbaceous plant species abundance in the grassland zone, from the three sampling sites in Western Mau Forest

Plant species	Site 1	Site 2	Site 3
Ageratum conyzoides L.	1.5 ± 0.3	3.5 ± 0.9	4.3 ± 0.6
Albizia gummifera (J.F. Gmel.) C.A. Sm.	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Cissampelos Pereira L.	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.0
Clerodendrum johnstonii Oliv.	0.0 ± 0.0	1.5 ± 0.5	0.5 ± 0.0

Clutia abyssinica Jaub. & Spach.	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.0
Croton macrostachyus Hochst.ex Delile	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Cyphostema orondo (Gil & M.Brandt)	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Dovyalis macrocalyx (Oliv.) Warb.	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 0.5
Euclea divinorum Hiern	3.0 ± 1.0	0.0 ± 0.0	0.0 ± 0.0
Hibiscus ludwigii Eckle. & Zeyh.	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Hypoestes forskahlii (Vahl) R.Br.	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 1.0
Indigofera volkensii Taub.	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Ipomoea hildebrandtii Vatke	1.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Launaea comuta (Olive & Hiern) C. Jeffrey	0.0 ± 0.0	5.0 ± 0.0	0.0 ± 0.0
Leonotis mollissima Gurke.	3.7 ± 0.8	8.0 ± 0.0	0.0 ± 0.0
Leucas grandis Vatke	0.0 ± 0.0	0.0 ± 0.0	6.0 ± 0.0
Lippia javanica (Burm.f.) Spreng	1.2 ± 0.2	3.0 ± 0.0	3.0 ± 2.0
Lobellia gibberoa Hemsl	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Maytenus leterophyla N. Robson	3.2 ± 0.8	8.0 ± 0.0	0.0 ± 0.0
Neoboutonia macrocalyx Pax	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Prunus africana (Hook f.) Kalkman	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Rhus natalensis Berhn	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Rubus steudneri Schweinf.	1.5 ± 0.5	0.0 ± 0.0	4.0 ± 0.0
Senna didymobotrya (Fresen.) Irwin &	1.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Solanum mauritianum Scop.	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.0
Solanum terminale Forssk.	0.0 ± 0.0	5.0 ± 0.0	0.0 ± 0.0
Vangueria madagascariensis J. F. Gmelin	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Verbena bonariensis Bitter	3.0 ± 0.0	6.0 ± 3.6	0.0 ± 0.0
Vernonia lasiopus O. Hoffm.	1.5 ± 0.5	2.7± 0.7	3.0 ± 0.0
Zehneria scabra (L.f.) Sond	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0

Abundance of the non-herbaceous plant species at the forest zone among the three sampling sites is presented in Table 7. There was a significant difference in plants species abundance among sampling sites ($F = 7.957$, $df = 206$, $P < 0.05$). The most abundant species in Site 1 were: *Hippocratea africana, Clerodendrum johnstonii, Lippia javanica, Rhynchosia usambarensis* and *Acanthus eminens. Acanthus eminens, Hippocratea africana, Satureia biflora* and *Borthriocline fusca* dominated in Site 2. On the other hand *Spilanthes mauritianum, Clematis brachiata, Piper capense, Clerodendrum johnstonii* and *Acanthus eminens* occurred more in Site 3.

Table 7: Non-herbaceous plant species abundance in the forest zone, from the three sampling sites in Western Mau Forest

Plant species	Site 1	Site 2	Site 3
Abutilon longicuspe Hochst ex A. Rich	3.0 ± 1.0	2.6 ± 0.5	0.0 ± 0.0
Acacia abyssinica Hochst.ex Benth	1.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.0
Acacia lahai Benth.	2.0 ± 0.2	0.0 ± 0.0	0.0 ± 0.0
Acanthus eminens C.B. Clarke	7.7 ± 1.3	12.1 ± 2.1	5.3 ± 0.8
Ageratum conyzoides L.	3.0 ± 0.7	2.8 ± 0.4	0.0 ± 0.0
Albizia gummifera (J.F. Gmel.) C.A. Sm.	4.4 ± 1.0	1.4 ± 0.1	1.7 ± 0.1
Allophylus abyssinicus P. Beauv.	2.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.0
Bersama abyssinica Verdc	2.2 ± 0.5	1.0 ± 0.0	1.5 ± 0.5
Borthriocline fusca(S.Moore) M. Gilbert	7.6 ± 1.3	14.0 ± 1.5	0.0 ± 0.0
Caesalpinasis decapelata (Roth) Alston	3.7 ± 0.8	3.0 ± 0.8	2.0 ± 0.0
Casearia battiscombei R.E.Fr.	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Cassipourea malosana(Bak)Alston	1.0 ± 0.0	1.7 ± 0.3	1.5 ± 0.5
Catha edulis (Vahl) Forssk.ex Endl.	1.1 ± 0.3	1.3 ± 0.3	0.0 ± 0.0
Celtis africana N.L.Burm.	1.8 ± 0.2	2.3 ± 0.3	0.0 ± 0.0
Clausena anisata (Willd.) Hook. f. ex Benth.	2.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Clematis brachiata Thumb.	0.0 ± 0.0	0.0 ± 0.0	9.8 ± 1.6
Clerodendrum johnstonii Oliv.	7.8 ± 2.0	6.4 ± 1.0	4.0 ± 0.6
Clutia abyssinica Jaub. & Spach.	0.0 ± 0.0	0.0 ± 0.0	2.7 ± 0.3
Coffea eugenoides S. Moore	3.0 ± 0.7	2.7 ± 0.4	2.4 ± 0.3
Crotalaria agatiflora Schweinf.	0.0 ± 0.0	2.0 ± 0.0	0.0 ± 0.0
Crotalaria mauensis Baker.f.	1.5 ± 0.3	2.7 ± 1.2	0.0 ± 0.0
Croton macrostachyus Hochst.ex Delile	1.7 ± 0.7	1.8 ± 0.4	1.2 ± 0.1
Cupressus lusitanica Mill	4.2 ± 0.8	4.6 ± 0.5	0.0 ± 0.0
Cussonia holstii Engl.	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Cyphostema orondo (Gil & M.Brandt) Desc.	1.5 ± 0.2	2.6 ± 0.5	2.0 ± 0.3
Digitaria horizontalis Henrard	0.0 ± 0.0	20.0 ± 0.0	0.0 ± 0.0
Diospyros abyssinica(Hiern) F.White	1.3 ± 0.2	2.1 ± 0.3	1.8 ± 0.8
Dombeya torrida (J.F. Gmel.) Bamps	2.4 ± 0.8	1.2 ± 0.2	3.0 ± 1.1
Dovyalis abyssinica (A.Rich) Warb.	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Dovyalis macrocalyx (Oliv.) Warb.	2.4 ± 0.2	3.2 ± 0.5	2.3 ± 0.3
Dracaena steudneri Engl.	2.6 ± 0.6	2.0 ± 0.0	2.2 ± 0.3
Drypetes gerrardii Hutch	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Ehretia cymosa Thonn.	1.4 ± 0.2	1.3 ± 1.2	1.0 ± 0.0
Ekerbergia capensis Sparrm.	1.0 ± 0.0	1.0 ± 0.0	1.5 ± 0.5
Erythrococca bongensis Pax	2.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Euclea divinorum Hiern	2.2 ± 0.4	1.0 ± 0.0	0.0 ± 0.0
Ficus capensis Hiern	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Fraxinus pennsylvanica Marshall	6.2 ± 0.4	0.0 ± 0.0	0.0 ± 0.0
Garcinia buchanii Baker	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 1.0
Grevillea robusta A.Cunn.ex R.Br.	2.0 ± 0.5	1.0 ± 0.0	0.0 ± 0.0
Grewia similes K.Schum	2.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0

Table 7…cont.

Plant species	**Site 1**	**Site 2**	**Site 3**
Hagenia abyssinica(Bruce) J.F. Gmel	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Helichrysum odoratissimun (L.) Less	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Hibiscus ludwigii Eckle. & Zeyh.	0.0 ± 0.0	6.0 ± 0.0	0.0 ± 0.0
Hippocratea africana (Willd.) Loes.	8.3 ± 1.0	8.6 ± 0.8	0.0 ± 0.0
Hypoestes forskahlii (Vahl) R.Br.	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Indigofera volkensii Taub.	2.2 ± 0.8	4.0 ± 1.4	0.0 ± 0.0
Ipomoea hildebrandtii Vatke	1.6 ± 0.4	2.8 ± 0.5	3.0 ± 0.3
Juniperus procera Hochst ex Engl	1.1± 0.1	0.0 ± 0.0	0.0 ± 0.0
Justicia flava (Forssk.) Vahl.	0.0 ± 0.0	3.0 ± 0.0	0.0 ± 0.0
Lagenaria abyssinica (Hook f.) C.Jeffry	0.0 ± 0.0	0.0 ± 0.0	4.0 ± 0.0
Lantana trifolia L.	2.5 ± 0.25	0.0 ± 0.0	0.0 ± 0.0
Launaea comuta(Olive & Hiern) C. Jeffrey	0.0 ± 0.0	4.0 ± 0.0	0.0 ± 0.0
Leonotis mollissima Gurke.	2.25 ± 0.6	3.0 ± 0.6	2.0 ± 0.0
Lippia javanica (Burm.f.) Spreng	10.3 ± 1.5	3.3 ± 0.6	0.0 ± 0.0
Lobellia gibberoa Hemsl	0.0 ± 0.0	0.0 ± 0.0	2.9 ± 0.3
Macaranga kilimandscharica Pax	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 0.2
Maytenus leterophyla N. Robson	5.3 ± 0.7	2.9 ± 0.3	0.0 ± 0.0
Maytenus senegalensis(Thunb) Blacklock	1.0 ± 0.0	1.0 ± 0.0	1.5 ± 0.5
Maytenus undata Lam.	1.5 ± 0.3	0.0 ± 0.0	0.0 ± 0.0
Momordica foetida Schumach	0.0 ± 0.0	0.0 ± 0.0	2.7 ± 0.5
Neoboutonia macrocalyx Pax	0.0 ± 0.0	0.0 ± 0.0	2.2 ± 0.3
Ochna ovata F. Hoffm.	0.0 ± 0.0	1.5 ± 0.5	0.0 ± 0.0
Olea capensis L.	1.3 ± 0.2	1.1 ± 0.1	0.0 ± 0.0
Passina passiflora L.	1.0 ± 0.0	0.0 ± 0.0	1.9 ± 0.2
Periproca lineafolia Dil & A.Rich.	2.7 ± 0.3	2.0 ± 0.4	2.0 ± 0.0
Physalis peruviana L.	2.5 ± 1.5	2.4 ± 0.5	1.0 ± 0.0
Piper capense L.f.	0.0 ± 0.0	0.0 ± 0.0	5.9 ± 0.7
Pittosporum viridiflorum Sims.	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.0
Podocarpus latifolius (Thunb.) R.Br.ex Mirb.	1.0 ± 0.0	1.3 ± 0.1	0.0 ± 0.0
Polyscias fulva (Hiern) Harms	1.0 ± 0.0	1.0 ± 0.0	1.2 ± 0.1
Prunus africana (Hook f.) Kalkman	1.3 ± 0.3	1.0 ± 0.0	1.8 ± 0.3
Psydrax schimperiana (A. Rich.) Bridson	0.0 ± 0.0	0.0 ± 0.0	1.9 ± 0.2
Pterolobium stellatum (Forssk.) Brenan	1.7 ± 0.7	3.0 ± 0.0	0.0 ± 0.0
Rapanea melanophloes (L.) Mez	0.0 ± 0.0	2.0 ± 0.0	0.0 ± 0.0
Rhoicissus tridentate (L.f.) Wild & R.B.Drumm.	0.0 ± 0.0	0.0 ± 0.0	2.3 ± 0.2
Rhus natalensis Berhn	1.5 ± 0.2	0.0 ± 0.0	0.0 ± 0.0
Rhynchosia usambarensis Taub.	8.2 ± 1.1	2.5 ± 0.3	0.0 ± 0.0
Ricinus communis L.	0.0 ± 0.0	2.0 ± 0.0	0.0 ± 0.0
Rubus steudneri Schweinf.	2.7 ± 0.3	1.8 ± 0.2	3.9 ± 0.5
Rumex usambarensis Dammer	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Salvadora persica L.	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Satureia biflora (D.Don) Benth	0.0 ± 0.0	10.0 ± 0.0	0.0 ± 0.0

Table 7…cont.

Plant species	**Site 1**	**Site 2**	**Site 3**
Scutia myrtina (Burmf.)Kurz	3.6 ± 0.4	3.4 ± 0.4	2.0 ± 0.3
Senna didymobotrya (Fresen.) Irwin & Barneby	4.3 ± 1.3	0.0 ± 0.0	0.0 ± 0.0
Senna Spp. Mill	0.0 ± 0.0	3.3 ± 1.2	0.0 ± 0.0
Sesbania sesban (L.) Mett	0.0 ± 0.0	1.0 ± 0.0	2.0 ± 0.0
Smilax anceps Willd.	0.0 ± 0.0	0.0 ± 0.0	2.5 ± 1.5
Solanecio mannii (Hook.f.) C. Jeffrey	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 0.5
Solanum mauritianum Scop.	0.0 ± 0.0	0.0 ± 0.0	3.8 ± 0.7
Solanum terminale Forssk.	6.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Sparmannia ricinocarpa (Eckl. & Zeyh.) Kuntze	0.0 ± 0.0	4.4 ± 0.9	2.0 ± 0.0
Spilanthes mauritianum (A.Rich.ex Pers) DC	4.5 ± 0.5	3.5 ± 1.5	9.5 ± 1.4
Suregada procera Croizat	0.0 ± 0.0	0.0 ± 0.0	1.8 ± 0.1
Syzygium guineense (Willd). DC.	3.0 ± 0.0	1.1 ± 0.1	1.3 ± 0.2
Tabaenamontana stapfiana Britten	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.1
Tagetes minuta L.	0.0 ± 0.0	3.0 ± 0.0	0.0 ± 0.0
Tarconanthus camphoratus L.	1.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Teclea nobilis Delile	1.7 ± 0.2	1.6 ± 0.1	0.0 ± 0.0
Toddalia asiatica (L) Ram	2.7 ± 0.27	0.0 ± 0.0	0.0 ± 0.0
Trichocladus ellipticus Eckl & Zeyh.	2.6 ± 0.2	2.5 ± 0.3	0.0 ± 0.0
Trimeria grandiflora Wild.	1.0 ± 0.0	1.8 ± 0.2	0.0 ± 0.0
Triumfetta macrophylla K.Schum	0.0 ± 0.0	1.5 ± 0.5	0.0 ± 0.0
Triumfetta rhomboidea Jacq.	0.0 ± 0.0	0.0 ± 0.0	3.9 ± 0.9
Vangueria madagascariensis J. F. Gmelin	1.3 ± 0.1	1.6 ± 0.2	0.0 ± 0.0
Verbena bonariensis Bitter	1.0 ± 0.0	2.7 ± 0.5	0.0 ± 0.0
Vernonia lasiopus O. Hoffm.	1.9 ± 0.3	5.1 ± 0.8	3.1 ± 0.4
Warbugia ugandensis Sprague	0.0 ± 0.0	0.0 ± 0.0	1.2 ± 0.2
Xymalos monospora (Harv.) Baill.ex Warb.	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 0.2
Zanthoxyllum gillettii (De Wild.)P.G. Waterman	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.1
Zehneria scabra (L.f.) Sond	3.4 ± 0.8	2.8 ± 0.3	2.4 ± 0.2

Abundance of the non-herbaceous plant species in the transition zone among the three sampling sites is provided in Table 8. There was a significant difference in plant species abundance among sampling sites ($F = 3.205$, $df = 84$, $P < 0.05$). *Ipomoea grandtii, Leonotis mollissima, Solanum sessilistellatum, Maytenus leterophyla* and *Lippia javanica* were found to be more dominant in Site 1, while *Borthriocline fusca* and *Lippia javanica* dominated in Site 2. *Spilanthes mauritianum, Tagetes minuta, Vernonia lasiopus, Leucas* *grandis, Hibiscus ludwigii* and *Rhynchosia usambarensis* occurred in higher abundance in Site 3.

Table 8: Non-herbaceous plant species abundance in the transition zone, from the three sampling sites in Western Mau Forest

Plant species	Site 1	Site 2	Site 3
Acacia lahai Benth.	2.0 ± 1.0	0.0 ± 0.0	0.0 ± 0.0
Ageratum conyzoides L.	2.8 ± 0.9	1.6 ± 0.3	2.0 ± 1.0
Albizia gummifera (J.F. Gmel.) C.A. Sm.	1.0 ± 0.0	1.0 ± 0.0	2.0 ± 0.0
Allophylus abyssinicus P. Beauv.	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 0.5
Bersama abyssinica Verdc	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Borthriocline fusca (S.Moore) M. Gilbert	6.3 ± 1.0	8.8 ± 1.8	0.0 ± 0.0
Clerodendrum johnstonii Oliv.	1.0 ± 0.0	2.2 ± 0.4	3.2 ± 0.5
Coffea eugenoides S. Moore	0.0 ± 0.0	0.0 ± 0.0	1.8 ± 0.5
Commelina benghalensis Forssk.	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Cordia abyssinica R. Br.	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Croton macrostachyus Hochst.ex Delile	0.0 ± 0.0	2.0 ± 0.0	1.5 ± 0.2
Cupressus lusitanica Mill	1.3 ± 0.3	0.0 ± 0.0	0.0 ± 0.0
Cyphostema orondo (Gil & M.Brandt) Desc.	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 0.5
Dovyalis abyssinica (A.Rich) Warb.	0.0 ± 0.0	0.0 ± 0.0	3.5 ± 0.5
Dovyalis macrocalyx (Oliv.) Warb.	2.0 ± 0.0	3.0 ± 0.0	2.0 ± 0.0
Ehretia cymosa Thonn.	0.0 ± 0.0	0.0 ± 0.0	3.0 ± 0.0
Euclea divinorum Hiern	3.4 ± 0.8	0.0 ± 0.0	0.0 ± 0.0
Fraxinus pennsylvanica Marshall	1.8 ± 0.4	0.0 ± 0.0	0.0 ± 0.0
Hibiscus ludwigii Eckle. & Zeyh.	0.0 ± 0.0	0.0 ± 0.0	8.0 ± 0.0
Hypoestes forskahlii (Vahl) R.Br.	0.0 ± 0.0	0.0 ± 0.0	3.4 ± 0.6
Hypoxis obtuse Burch.	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Indigofera volkensii Taub.	2.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Ipomoea hildebrandtii Vatke	6.0 ± 0.0	0.0 ± 0.0	2.5 ± 0.3
Lantana trifolia L.	1.5 ± 0.5	0.0 ± 0.0	0.0 ± 0.0
Leonotis mollissima Gurke.	4.0 ± 0.8	0.0 ± 0.0	3.0 ± 0.0
Leucas grandis Vatke	0.0 ± 0.0	0.0 ± 0.0	5.4 ± 1.8
Lippia javanica (Burm.f.) Spreng	6.2 ± 1.4	8.0 ± 3.2	0.0 ± 0.0
Lobellia gibberoa Hemsl	0.0 ± 0.0	0.0 ± 0.0	2.7 ± 0.5
Maytenus leterophyla N. Robson	5.9 ± 1.1	1.8 ± 0.5	0.0 ± 0.0
Momordica foetida Schumach	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Neoboutonia macrocalyx Pax	0.0 ± 0.0	0.0 ± 0.0	2.6 ± 0.6
Olea capensis L.	1.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Orchid spp.	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Periproca lineafolia Dil & A.Rich.	1.8 ± 0.2	0.0 ± 0.0	1.0 ± 0.0
Physalis peruviana L.	0.0 ± 0.0	2.0 ± 0.0	0.0 ± 0.0
Piper capense L.f.	0.0 ± 0.0	0.0 ± 0.0	2.5 ± 0.6
Prunus africana (Hook f.) Kalkman	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 0.3
Psydrax schimperiana (A. Rich.) Bridson	0.0 ± 0.0	0.0 ± 0.0	3.0 ± 1.0
Rhoicissus tridentate (L.f.) Wild & R.B.Drumm.	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0

Table 8…cont.

Plant species	**Site 1**	**Site 2**	**Site 3**
Rhus natalensis Berhn	1.3 ± 0.3	0.0 ± 0.0	0.0 ± 0.0
Rhus vulgaris Meikle	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Rhynchosia usambarensis Taub.	0.0 ± 0.0	0.0 ± 0.0	14.5 ± 0.0
Rubus steudneri Schweinf.	2.4 ± 0.3	0.0 ± 0.0	2.8 ± 0.4
Scutia myrtina (Burmf.) Kurz	1.0 ± 0.0	0.0 ± 0.0	2.5 ± 0.5
Solanecio mannii (Hook.f.) C. Jeffrey	0.0 ± 0.0	0.0 ± 0.0	1.7 ± 0.3
Solanum mauritianum Scop	0.0 ± 0.0	0.0 ± 0.0	3.0 ± 0.4
Solanum terminale Forssk.	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Sparmannia ricinocarpa (Eckl. & Zeyh.) Kuntze	0.0 ± 0.0	1.6 ± 0.2	2.0 ± 0.0
Spilanthes mauritianum(A.Rich.ex Pers) DC	0.0 ± 0.0	0.0 ± 0.0	17.5 ± 3.1
Syzygium guineense (Willd). DC.	0.0 ± 0.0	0.0 ± 0.0	1.1± 0.1
Tagetes minuta L.	0.0 ± 0.0	0.0 ± 0.0	12.0 ± 0.0
Tarconanthus camphoratus L.	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Trimeria grandiflora Wild.	1.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Triumfetta rhomboidea Jacq.	0.0 ± 0.0	0.0 ± 0.0	2.0 ± 1.0
Vangueria madagascariensis J. F. Gmelin	0.0 ± 0.0	1.0 ± 0.0	0.0 ± 0.0
Verbena bonariensis Bitter	1.8 ± 0.4	2.2 ± 0.5	0.0 ± 0.0
Vernonia lasiopus O. Hoffm.	1.6 ± 0.4	2.5 ± 0.6	4.6 ± 0.4.
Zanthoxyllum gillettii (De Wild.) P.G. Waterman	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.0
Zehneria scabra (L.f.) Sond	1.8 ± 0.3	0.0 ± 0.0	1.4 ± 0.2

Abundance of the herbaceous plant species at the grassland zone among the three sampling sites is presented in Table 9. There was a significant difference in plant species abundance among sampling sites ($F = 18.610$, $df = 42$, $P < 0.05$). The most abundant plant species in Site 1 included *Digitaria horizontalis, Kyllinga bulbosa, Kalanchoe densiflora, Panicum laxum* and *Justicia flava,* whilst the abundant species in Site 2 included *Carduus keniensis, Digitaria horizontalis, Kyllinga bulbosa* and *Justicia flava.* Site 3 was dominated by *Oplismenus buminanii, Digitaria horizontalis, Panicum laxum, Oxalis obliquifolia* and *Justicia flava*.

Table 9: Abundance of the herbaceous plant species at the grassland zone among the three sampling sites in Western Mau Forest

Plant species	Site 1	Site 2	Site 3
Alchemilla fischeri Engl.	2.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Carduus keniensis R.E.Fr.	3.5 ± 2.5	24.2 ± 4.7	0.0 ± 0.0
Centella asiatica (L.) Urban	0.0 ± 0.0	0.0 ± 0.0	1.3 ± 0.2
Crassocephalum montousum(S.Moore)Milne-Redh	2.0 ± 0.3	1.0 ± 0.0	2.9 ± 0.5
Crassocephalum vitellinum (Benth.) S. Moore	1.6 ± 0.2	0.0 ± 0.0	3.3 ± 0.8
Cyathula polycephala Bak.	3.0 ± 0.7	0.0 ± 0.0	0.0 ± 0.0
Cyperus difformis L.	4.0 ± 0.7	3.4 ± 0.7	3.0 ± 0.5
Digitaria horizontalis Henrard	12.3 ± 1.7	51.5 ± 5.1	7.6 ± 1.6
Glycine wyghtii (Wight & Arn) Verdc	1.8 ± 0.5	3.4 ± 0.5	1.6 ± 0.3
Hibiscus ludwigii Eckle. & Zeyh.	2.0 ± 0.0	2.6 ± 0.3	0.0 ± 0.0
Justicia flava (Forssk.) Vahl.	8.5 ± 1.4	6.6 ± 1.2	4.2 ± 0.6
Kalanchoe densiflora Rofle	4.9 ± 3.4	1.0 ± 0.0	5.3 ± 1.7
Kyllinga bulbosa P. Beauv.	7.4 ± 1.1	7.4 ± 1.0	1.0 ± 0.0
Oplismenus buminanii P. Beauv	3.1 ± 0.4	0.0 ± 0.0	14.3 ± 6.4
Oxalis obliquifolia L.	0.0 ± 0.0	0.0 ± 0.0	16.1 ± 1.8
Panicum laxum Sw.	11.8 ± 1.3	0.0 ± 0.0	42.4 ± 3.5
Solanum sessilistellatum Bitter	0.0 ± 0.0	0.0 ± 0.0	3.0 ± 0.8
Taraxacum officinale F.H. Wigg	3.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Vernonia auricurifela Hiern	0.0 ± 0.0	0.0 ± 0.0	3.0 ± 0.0
Vernonia galamensis (Cass.) Less	0.0 ± 0.0	0.0 ± 0.0	2.6 ± 0.5

Abundance of the herbaceous plant species at the forest zone among the three sampling sites is presented in Table 10. There was a significant difference in plant species abundance among sampling sites ($F = 3.698$, $df = 50$, $P < 0.05$). *Digitaria horizontalis, Hypoestes forskahlii*, *Kalanchoe densiflora*, *Panicum laxum* and *Justicia flava* occurred most in Site 1, whilst Site 2 was dominated by *Oplismenus buminanii*, *Digitaria horizontalis, Hypoestes forskahlii*, *Cyperus alternifolius* and *Justicia flava.* Site 3 was dominated by *Hypoestes forskahlii, Hibiscus ludwigii, Cyperus difformis, Urtica massaica, Impatiens niamensis* and *Pteris catoptera*.

Table 10: Abundance of the herbaceous plant species at the forest zone among the three sampling sites in Western Mau Forest

Plant species	Site 1	Site 2	Site 3
Achyrantes aspera L	0.0 ± 0.0	4.4 ± 1.8	5.4 ± 1.0
Alchemilla fischeri Engl.	2.0 ± 0.0	2.7 ± 0.3	3.2 ± 0.4
Bidens pilosa L.	0.0 ± 0.0	2.4 ± 0.2	0.0 ± 0.0
Commelina benghalensis Forssk.	0.0 ± 0.0	2.0 ± 0.4	3.5 ± 0.5
Crassocephalum montousum(S.Moore)Milne-Redh	0.0 ± 0.0	2.8 ± 0.8	0.0 ± 0.0
Crassocephalum vitellinum (Benth.) S. Moore	0.0 ± 0.0	2.5 ± 1.0	3.0 ± 0.0
Cyathula polycephala Bak.	0.0 ± 0.0	4.5 ± 1.5	3.5 ± 1.0
Cyperus alternifolius Schwein.	7.2 ± 0.9	6.8 ± 1.5	0.0 ± 0.0
Cyperus difformis L.	0.0 ± 0.0	2.8 ± 0.9	15.0 ± 0.0
Digitaria horizontalis Henrard	20.0 ± 0.0	21.2 ± 4.3	2.0 ± 0.6
Glycine wyghtii (Wight & Arn) Verdc	0.0 ± 0.0	2.4 ± 0.3	3.0 ± 0.0
Hibiscus ludwigii Eckle. & Zeyh.	0.0 ± 0.0	2.9 ± 07	20.0 ± 0.0
Hypoestes forskahlii (Vahl) R.Br.	16.3 ± 2.6	12.0 ± 3.7	14.4 ± 2.0
Impatiens niamniamensis Gilg.	0.0 ± 0.0	0.0 ± 0.0	14.3 ± 4.6
Justicia flava (Forssk.) Vahl.	19.4 ± 2.7	20.4 ± 3.0	11.5 ± 1.9
Kalanchoe densiflora Rofle	10.0 ± 0.0	3.0 ± 0.0	9.0 ± 6.0
Kyllinga bulbosa P. Beauv.	5.0 ± 0.0	4.6 ± 0.9	0.0 ± 0.0
Oplismenus buminanii P. Beauv.	6.3 ± 0.9	6.6 ± 1.0	12.9 ± 2.1
Oxalis obliquifolia L.	4.0 ± 1.0	2.0 ± 0.0	10.0 ± 2.5
Panicum laxum Sw.	12.2 ± 3.9	3.7 ± 1.0	5.2 ± 1.7
Pteris catoptera Kze.	0.0 ± 0.0	0.0 ± 0.0	22.5 ± 7.5
Sida ovata Forsk	0.0 ± 0.0	0.0 ± 0.0	5.0 ± 0.0
Solanum indicum L.	0.0 ± 0.0	0.0 ± 0.0	5.0 ± 0.0
Solanum sessilistellatum Bitter	0.0 ± 0.0	5.4 ± 1.4	10.0 ± 0.0
Urtica massaica Mildbr.	0.0 ± 0.0	0.0 ± 0.0	24.9 ± 2.8

Abundance of the herbaceous plant species at the transition zone among the three sampling sites is presented in Table 11. There was a significant difference in plant species abundance among sampling sites ($F = 13.991$, $df = 42$, $P < 0.05$). *Oplismenus buminanii, Digitaria horizontalis, Kyllinga bulbosa, Cyperus difformis, Panicum laxum* and *Justicia flava* dominated in Site 1, whilst Site 2 was dominated by *Osplismenus buminanii, Digitaria horizontalis, Kyllinga bulbosa, Justicia flava* and *Cyanthula* *polycephala. Osplismenus buminanii, Oxalis obliquifolia, Kalanchoe densiflora, Panicum laxum, Achyrantes aspera, Urtica massaica* occurred most in Site 3.

Table 11: Abundance of the herbaceous plant species at the transition zone among the three sampling sites in Western Mau Forest

Plant species	Site 1	Site 2	Site 3
Achyrantes aspera L	0.0 ± 0.0	0.0 ± 0.0	11.0 ± 4.8
Alchemilla fischeri Engl.	2.3 ± 0.3	5.0 ± 0.0	6.2 ± 1.6
Bidens pilosa L.	0.0 ± 0.0	5.0 ± 0.0	0.0 ± 0.0
Commelina benghalensis Forssk.	2.0 ± 0.8	0.0 ± 0.0	6.3 ± 1.8
Crassocephalum montousum (Benth.) S. Moore	1.8 ± 0.2	2.0 ± 0.0	2.0 ± 0.3
Crassocephalum vitellinum (Benth.) S. Moore	2.0 ± 0.4	0.0 ± 0.0	0.0 ± 0.0
Cyathula polycephala Bak.	0.0 ± 0.0	5.9 ± 2.4	3.7 ± 0.7
Cyperus alternifolius Schwein.	5.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Cyperus difformis L.	5.1 ± 1.3	4.6 ± 0.5	4.8 ± 1.2
Digitaria horizontalis Henrard	8.6 ± 1.1	26.0 ± 2.2	6.3 ± 1.4
Glycine wyghtii(Wight & Arn) Verdc	1.8 ± 0.3	3.3 ± 0.4	3.3 ± 0.8
Hibiscus ludwigii Eckle. & Zeyh.	0.0 ± 0.0	4.2 ± 0.5	0.0 ± 0.0
Hypoestes forskahlii (Vahl) R.Br.	0.0 ± 0.0	0.0 ± 0.0	5.9 ± 0.9
Justicia flava (Forssk.) Vahl.	11.5 ± 1.3	11.6 ± 4.8	9.6 ± 1.3
Kalanchoe densiflora Rofle	4.5 ± 0.7	3.3 ± 0.9	10.6 ± 2.4
Kyllinga bulbosa P. Beauv.	7.5 ± 0.9	6.2 ± 0.7	3.5 ± 1.5
Oplismenus buminanii P. Beauv.	5.1 ± 1.6	10.7 ± 1.5	19.4 ± 3.6
Oxalis obliquifolia L.	3.5 ± 0.9	0.0 ± 0.0	15.1 ± 1.4
Panicum laxum Sw.	10.9 ± 1.3	0.0 ± 0.0	35.7 ± 3.1
Solanum sessilistellatum Bitter	0.0 ± 0.0	0.0 ± 0.0	3.5 ± 1.5
Urtica massaica Mildbr.	0.0 ± 0.0	0.0 ± 0.0	20.0 ± 0.0
Vernonia galamensis (Cass.) Less	0.0 ± 0.0	0.0 ± 0.0	3.3 ± 0.9

4.1.3 Species diversity

Species diversity in the three sampling sites among the sampling zones is provided in Table 12. The highest species diversity occurred at the forest zone in Site 1 (H' = 4.05), Site 2 (H' = 3.98) and Site 3 (H' = 3.90) with the lowest species diversity occurring in the grassland zone at Site 1 (H' = 1.77).

Table 12: Shannon-Weiner Diversity index for plant species in the Western Mau Forest

Sites	Zones	Shannon-Weiner Diversity indices
Site 1	Grassland	1.77
	Forest	4.05
	Transition	3.10
Site 2	Grassland	2.29
	Forest	3.98
	Transition	2.47
Site 3	Grassland	2.62
	Forest	3.90
	Transition	3.30

4.1.4 Importance value index

The importance value index of trees in Western Mau Forest is shown in Table 13. Species with the highest Importance value indices included; *Fraxinus pennsylvanica*, *Trichocladus ellipticus, Euclea divinorum, Albizia gummifera* and *Tabaenamontana stapfiana*. *Oplismenus buminanii, Cussonia holstii,* and *Salvadora persica* had the lowest importance value index.

Table 13: Importance value index of trees in Western Mau Forest

Species	Dominance	Frequency	Density	Importance value index
Fraxinus pennsylvanica Marshall	27.472	27.3	20.23	75.003
Trichocladus ellipticus Eckl & Zeyh.	10.657	9.9	5.33	25.885
Euclea divinorum Hiern	12.176	7.1	4.86	24.137
Albizia gummifera (J.F. Gmel.) C.A. Sm.	3.292	5.5	7.71	16.501
Tabaenamontana stapfiana Britten	3.590	4.3	3.88	11.769
Cupressus lusitanica Mill	3.522	4.3	2.63	10.449
Neoboutonia macrocalyx Pax	2.778	3.3	2.63	8.705
Teclea nobilis Delile	2.726	3.3	2.48	8.506
Croton macrostachyus Hochst.ex Delile	3.336	3.0	2.01	8.349
Suregada procera Croizat	3.634	2.6	1.72	7.953
Celtis Africana N.L.Burm.	1.802	2.7	3.34	7.841
Clematis brachiata Thumb.	0.194	0.2	7.44	7.833
Psydrax schimperiana (A. Rich.) Bridson	2.055	2.2	2.75	7.005
Vangueria madagascariensis J. F. Gmelin	1.594	2.8	1.84	6.235
Diospyros abyssinica (Hiern) F.White	1.884	2.4	1.74	6.027

Trimeria grandiflora Wild.	1.199	1.9	1.23	4.327
Olea capensis L.	1.586	1.3	0.79	3.672
Dombeya torrida (J.F. Gmel.) Bamps	1.579	1.1	0.86	3.538
Cassipourea malosana (Bak)Alston	1.214	1.4	0.91	3.522
Syzygium guineense (Willd). DC.	1.132	1.3	0.91	3.340
Ehretia cymosa Thonn.	1.065	1.2	0.69	2.952
Zanthoxyllum gillettii (De Wild.) P.G.	1.288	0.9	0.54	2.728
Podocarpus latifolius (Thunb.) R.Br.	0.946	0.9	0.61	2.460
Bersama abyssinica Verdc	0.760	0.8	0.52	2.076
Xymalos monospora (Harv.) Baill.	0.730	0.8	0.49	2.021
Polyscias fulva (Hiern) Harms	0.946	0.5	0.44	1.888
Macaranga kilimandscharica Pax	0.752	0.5	0.44	1.694
Acacia abyssinica Hochst.ex Benth	0.707	0.5	0.39	1.600
Prunus africana (Hook f.) Kalkman	0.350	0.5	0.69	1.537
Acacia lahai Benth.	0.499	0.6	0.34	1.443
Olea capensis L.	0.566	0.5	0.34	1.410
Grevillea robusta A.Cunn.ex R.Br.	0.410	0.4	0.27	1.080
Catha edulis (Vahl) Forssk.ex Endl.	0.283	0.4	0.32	1.002
Juniperus procera Hochst ex Engl	0.350	0.4	0.25	0.996
Ekerbergia capensis Sparrm.	0.283	0.4	0.29	0.978
Maytenus undata Lam.	0.216	0.4	0.22	0.837
Warbugia ugandensis Sprague	0.328	0.2	0.15	0.675
Maytenus senegalensis (Thunb) Blacklock	0.231	0.2	0.17	0.603
Casearia battiscombei R.E.Fr.	0.253	0.2	0.12	0.576
Allophylus abyssinicus P. Beauv.	0.171	0.2	0.20	0.567
Tarconanthus camphoratus L.	0.112	0.3	0.12	0.535
Ochna ovata F. Hoffm.	0.201	0.1	0.07	0.375
Ficus capensis Hiern	0.134	0.1	0.07	0.308
Drypetes gerrardii Hutch	0.134	0.1	0.05	0.283
Erythrococca bongensis Pax	0.127	0.1	0.05	0.276
Hagenia abyssinica (Bruce) J.F. Gmel	0.127	0.1	0.05	0.276
Rapanea melanophloes (L.) Mez	0.015	0.1	0.05	0.164
Cussonia holstii Engl.	0.067	0	0.02	0.092
Salvadora persica L.	0.007	0	0.05	0.056

4.2 Forest Regeneration

The diameter at breast height of the forest is shown in Figure 5. There was a significant difference in the diameter at breast height in the three sites ($P < 0.05$). Diameter at breast height was dominated by trees of < 3 cm and decreased thereafter in the forest. The diameter distribution followed the reverse J-curve.

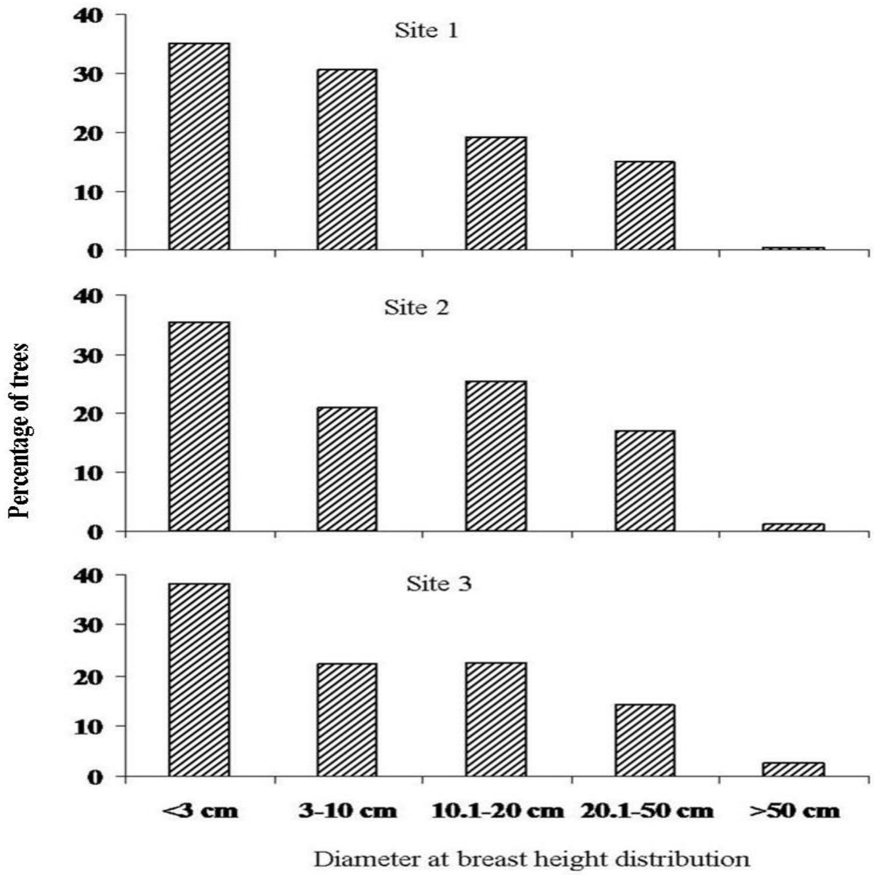

Figure 5: Diameter at Breast Height (DBH) of trees in the forest of Western Mau

4.3 Human activities in Western Mau Forest

The various types of human activities in the forest habitats are presented in Table 14. The most common form of disturbance was grazing, followed by footpaths and tree cutting. The event that had the least disturbance in the forest was charcoal burning. Site 3 was the most disturbed in the forest zone followed by Site 2, whilst Site 1 was the least disturbed. Site 3 was the most disturbed site in the transition zone whilst Site 1 and 2 had the same disturbance index. Site 3 was the most disturbed site in the grassland zone followed by Site 2, whilst Site 1 was the least disturbed. Photos' showing various human activities in the forest is shown in Appendix 2.

Table 14: Scores of the various types of human activity in Western Mau Forest

	Site 1			Site 2			Site 3			Disturbance intensity	Disturbance index
	Grassland	Forest	Transition	Grassland	Forest	Transition	Grassland	Forest	Transition		
Charcoal making	0	0	0	0	0	0	0	3	0	**3**	**10**
Tree cutting	0	4	2	0	4	0	0	5	4	**19**	**63.33**
Footpath	1	3	1	3	1	1	5	1	5	**21**	**70.00**
Fire	0	1	0	0	0	0	0	1	0	**2**	**6.67**
Grazing	4	0	2	3	2	4	5	4	5	**29**	**96.67**
Debarking	0	2	0	0	4	0	0	5	0	**11**	**36.67**
Disturbance intensity	**5**	**10**	**5**	**6**	**11**	**5**	**11**	**20**	**14**		
Disturbance index	**16.67**	**33.33**	**16.67**	**20.00**	**36.67**	**16.67**	**36.67**	**66.67**	**46.67**		

CHAPTER FIVE

DISCUSSION

5.1 Species composition, abundance and diversity

In this study the species composition of Western Mau Forest was determined and it was established that there were 223 vascular plant species. The high number of species could be due to disturbance in the forest. Forest disturbance has been observed to stimulate establishment of varied species (Hobbs and Huenneke, 1992; Rogers, 1996; Franklin *et al*., 2002). It could also possibly indicate that the forest has an ideal habitat for floral growth and reproduction. This is because of high humidity witnessed in the forest during sampling; vegetative growth is more likely to be encouraged (Odum, 2008). This compares well with studies that have been done in other forests like Mt. Elgon Forest (Hitimana, 2000), Kakamega forest (Habwe, 2005) and Nabkoi forest (Wanjohi, 2010) which have over 200 plant species. Asteraceae was the most dominant plant family in the forest. Similar number was recorded in Nabkoi forest by Wanjohi (2010). The presence of Asteraceae in the forest can be attributed to their successful wind and animal modes of dispersal (Fransen *et al*., 2006; Wanjohi, 2010). Members of the Asteraceae are typical indicators of disturbance (Umberto, *et al* 2010).

Most plant families in Western Mau Forest were represented by a single genera and by a single species each indicating poor diversity at family and genus levels. Similar results were recorded by Nthuni (1999) in South Nandi, Hitimana (2000) in Mt. Elgon and Wanjohi (2010) in Nabkoi forests. The low number of species observed per family is a common feature in East African forests (Dale and Greenway, 1961; Lind and Morrison, 1974).

Shrubs were the most abundant followed by seedlings and saplings whilst palms were the least in species composition. The high number of shrubs, seedlings and saplings can be attributed to the combined effects of human disturbance. There was high number of non herbaceous species (124) than herbaceous species (33). The low count of the herbaceous species could be due to the intense grazing in the Western Mau Forest. High levels of disturbance are likely to reduce vegetation growth and reproduction (Hitimana, 2000). Most of the herbaceous plants were found growing under large trees most probably because they are tolerant to shade.

Plant species abundance and composition differed substantially among the zones in the Western Mau Forest. The species composition of the different functional groups was fairly well-separated among zones, mainly because several species were strictly associated with the different ecological zones. This supports previous findings that after establishment, species form distinct combinations, depending on the suitability of small-scale environmental conditions (Myster, 2004). The results also showed that there were significant differences in sapling richness and abundance between the grassland, transition zone and forest zone. However, species richness and abundance of adult trees were high in the transition zone and forest zone, suggesting that previously disturbed areas transitioned towards forest type structure and composition. The transition zone and forest zone had higher plant species dominance than the grassland zone, probably due to more intense grazing pressure in the grassland zone which benefited growth and reproduction in transition and forest zone over grassland zone (Ostertag and Verville 2002).

Muniz-Castro *et al.,* (2006) reported that sapling density decreased gradually with increasing distance from potential seed sources in a forest. A similar pattern in Western Mau Forest was observed, although a direct distinction between the effects of distance to the seed source and disturbances could not be drawn. The distance to the seed source compares with the degree of disturbance, which could explain most of the variation in species richness, abundance and composition among the grassland, transition and forest zone. Only a few of the seedlings and saplings species colonizing the transition zone occurred in the forest zone as adult trees, suggesting that colonization of the site is a function of both neighbour vegetation and long distance dispersal.

The highest species diversity occurred in the forest zone followed by the transition zone whilst grassland had the lowest species diversity. The differences in the species diversity in Western Mau Forest can be attributed to differences in intensity of human activities. In the grassland zone there was intense grazing which may have led to loss of some species. Plant diversity is enhanced through periodic disturbance of plant communities (Rogers and Ryel, 2008).

Fraxinus pennsylvanica, Trichocladus ellipticus, Euclea divinorum, Albizia gummifera and *Tabaenamontana stapfiana* had the highest importance value index. This group of plant species had a very strong recruitment pattern as evidenced by their high density. *Fraxinus pennsylvanica* had the highest importance value index than other species and this indicates that the species sociological structure in the forest is high (Lamretcht, 1989). *Trichocladus ellipticus* is a colonizer that effectively invades disturbed forest ecosystems (Henderson, 2001). It has a strong proliferation capacity, effectively regenerating through root suckers. This strategy gives it a competitive ability over other plant species by ensuring enough regeneration propagules. Availability of propagules of potential colonists may influence successional trajectory, leading to competitive displacement of indigenous species by superior competitors (Dovciak *et al*., 2005).

5.2 Forest Regeneration

Regeneration of any species is confined to a particular range of habitat conditions and the extent of those conditions is a major determinant of its geographic distribution. The population structure of a species in a forest can convey its regeneration behavior. Knowledge on regeneration can contribute significantly to planning, conservation and decision making in forest resource management (Pokhriyal *et al.*, 2010).

The study showed gradual increase in species richness and abundance of tree seedlings, saplings and adult trees from the grassland zone towards the forest zone. This could indicate recovery in degraded natural forest (Duarte *et al.*, 2006). The analysis showed that, there were high species frequency values in the lower DBH classes and progressively decreased to higher DBH class in all the three sites. The pattern had more individuals at seedling stage and decreasing number of individual successively at sapling and adult stages. This exhibited reverse J-shape curves but not perfectly in Site 2 and Site

3, typical of uneven-aged mixed forests. The reverse J-shape pattern signifies that the forest has a good regeneration potential (Meyer, 1952).

There was a higher density of trees at lower diameter classes compared to larger diameter classes. These results are similar to many previously reported findings. Sherma and Kumar (1992) and Geldenhuys and Murray (1993) reported that logging reduced the density of larger diameter class trees. This could result from slow recruitment of the residual trees in the lower diameter classes into higher ones after logging, because indigenous trees grow slowly (Kigomo, 1987; KFMP, 1994). Uncontrolled and continuous exploitation of the forest trees for timber and fuelwood by the surrounding settlements could also cause slow recovery of the forest. Extensive logging in the forest could therefore be increasing the diameter distributions in favour of the tree species with lower diameter at breast height (DBH) (Campos, 2001). In agreement with the present study, Wanjohi (2010) also reported that the standing basal area of several species of trees in Nabkoi forest correlated significantly with general tree cutting. Similar observation was also recorded in Bonga- broad leaved Afromontane forest in Ethiopia (Dorero, 1998) and Mt. Elgon (Hitimana, 2000).

The presence of tree species in different sites of the study area could be one criterion that can be used to identify species suitable for restoration (Bussmann, 2004). In this study, a group of tree species were identified to have relatively low association to any site, suggesting that these species are habitat-generalists with few requirements for specific environmental conditions that change during succession. Such species may be particularly suitable for restoration because they may germinate under diverse conditions and may persist for long periods during succession. The species that most clearly exhibited these characteristics in the study were *Croton macrostachyus, Albizia gummifera, Diospyros abyssinica, Syzygium guineense, Cassipourea malosana, Dombeya torrida, Polyscias fulva* and *Maytenus senegalensis.* These species may have a potential for restoration of degraded forests because they have the ability to establish as seedlings and survive as a mature tree in different sites of the Western Mau Forest.

5.3 Human activities

Although Western Mau Forest is under Kenya Forest Service (KFS), currently, the conservation status of the forest is at a very low ecological condition. Forest conservation has never been a concern for the local communities as the local people view the forest as a source of fuel wood, and a hindrance to cultivation. At the present, the largest proportion of this forest has been cleared for cultivation.

In this study, six factors were found to be key agents of disturbance within the forest ecosystem. They include; tree cutting, charcoal making, footpaths, fire, grazing and debarking. The expanding rural population in the area which utilizes plant material from the forest for construction, fuel and charcoal, threatens the forest. One of the major activities of the local people being livestock keeping, the forest provides grazing area to the local communities. Grazing is likely to influence soil and aboveground vegetation, which may significantly impede forest regeneration, particularly recovery of species composition. As an example, Haggar *et al.* (1997) and Posada *et al.* (2000) reported that severe reduction in regeneration of trees and shrubs in pastures were due to intensive browsing by livestock. Intensive grazing, trampling, and uprooting by both large and small domestic herbivores in these grass/forb areas may have perpetuated dominance by perennial grasses, such as *Panicum laxum, Kyllinga bulbosa*, and *Digitaria horizontalis* that are all abundant in the grasslands of Western Mau Forest.

The local inhabitants use the forest as a primary source of fuel. Previous studies showed that local inhabitants chiefly use *Olea africana* as a fuel wood, *Juniperus procera* and *Cupressus lusatanica* for construction purposes, *Podocarpus falcatus* for timber production, *Acacia abyssinica* for making charcoal and *Teclea nobilis* for making farming implements. Another and perhaps most destructive habit of local communities is their cutting of slabs of bark from *Juniperus procera* and *Podocarpus falcatus* for making traditional beehives.

The footpaths and animal trails were evidence of easy human access in the forest, and usually bring about the trampling of seedligs and soil thus affecting forest regeneration (Serna, 1986). Disturbance levels decreased with distance from villages, indicating that the pressures of illegal logging, harvesting and other human impact were closely connected to accessibility and transport cost.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Western Mau Forest has high species diversity, that is, 223 species of vascular plants belonging to 83 families were recognized. Asteraceae was found to be the most dominant family followed by Fabaceae, Euphorbiaceae and Rubiaceae. Species abundance and diversity varied among the zone types. The density of tree species in the forest decreased with increasing DBH, which implied the predominance of small sized individuals in the lower classes than in higher classes indicating good recruitment of the forest. There is a high rate of destruction because of the frequent visits of the people from nearby villages for fuel, fodder, wood for construction and other forest products. This has resulted in the depletion of the forest vegetation, thereby causing damage to plant diversity in the area.

6.2 Recommendations

1. The forest requires more strict protection if continuous forest regeneration are to be maintained. This may include involving the local people in efforts to conserve the forest.
2. Due to forest disturbances, there is need to educate the local people on conservation of forest resources.

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APPENDICES

Appendix I: Comprehensive plant check list for Western Mau Forest showing their families and growth forms.

Family	SPECIES NAME	Life form
Acanthaceae	*Acanthus eminens* C.B. Clarke	S
	Hypoestes forskahlii (Vahl) R.Br.	H/S
	Justicia diclipteroides Lindau	H
	Justicia flava (Forssk.) Vahl.	H
	Thurbegia alata Sims.	S
Amaranthaceae	*Achyrantes aspera* L.	H
	Alternanthera sessilis (L.) R.Br.ex DC.	H
	Amaranthus hibridus L.	H
	Cyathula polycephala Bak.	H
Amaryllidaceae	*Scadoxus multiflorus* (Martyn) Raf.	G
Anacardaceae	*Rhus natalensis* Berhn	S/T
	Rhus vulgaris Meikle	S
Apocynaceae	*Landolphia buchananii* (Hallier f.) Stapf	C
	Tabernaemontana stapfiana Britten	T
Araliaceae	*Cussonia holstii* Engl.	T
	Cussonia spicata Hunb	T
	Polyscias fulva (Hiern) Harms	T
	Polysciasis kikuyuensis Summerh.	T
	Schefflera abyssinica (Hochst. Ex A. Rich.)	T
	Schefflera volkensii (Engl.) Harms	T
Asclepiadiaceae	*Gomphocarpus kaesneri* Brown	C
	Periploca linearifolia Dil & A.Rich.	C
Asparagaceae	*Sansevieva trifasciata* Prain.	H
Aspleniaceae	*Asplenium adiantum-nigrum* L.	F
Asteraceae	*Ageratum conyzoides* L.	S
	Bidens pilosa L.	H
	Borthriocline fusca (S.Moore) M. Gilbert	S
	Carduus keniensis R.E.Fr.	H
	Crassocephalum montousum (S.Moore)Milne-Redh	H
	Crassocephalum vitellinum (Benth.) S. Moore	H
	Erigeron floribudus (Kunth.) Sch. Bip.	H
	Galinsoga paviflora Cav.Plate	H
	Gerbera viridifolia (DC.) Sch. Bip.	H
	Helichrysum odoratissimun (L.) Less	S/H
	Launaea cornuta (Olive & Hiern) C. Jeffrey	S
	Solanecio mannii (Hook.f.) C. Jeffrey	S
	Spilanthes mauritiana (A.Rich.ex Pers) DC	S
	Tagetes minuta L.	S
	Taraxacum officinale F.H. Wigg	H
	Vernonia auricurifela Hiern	H
	Vernonia galamensis (Cass.) Less	H
	Vernonia lasiopus O. Hoffm.	S
Balsaminaceae	*Impatiens niamniamensis* Gilg.	H/S
Boraginaceae	*Cordia abyssinica* R. Br.	T
	Cynoglossum coeruleum A.D.C.	H
	Cynoglossum coeruleum A.DC.	H
	Ehretia cymosa Thonn.	T

Appendix I…cont.

Family	SPECIES NAME	Life form
Campanulaceae	*Lobellia gibberoa* Hemsl	S
Canellaceae	*Warbugia ugandensis* Sprague	T
Cannbaceae	*Celtis africana* N.L.Burm.	T
Capparaceae	*Ritchea arbesii* L.	S/T
Caricaceae	*Carica papaya* L.	T
Celastracace	*Catha edulis* (Vahl) Forssk.ex Endl.	S/T
	Hippocratea africana (Willd.) Loes.	C
	Maytenus leterophylla N. Robson	S/T
	Maytenus senegalensis (Thunb) Blacklock	T
	Maytenus undata Lam.	T/S
Clusiaceae	*Garcinia buchananii* Baker	T
Commelinaceae	*Commelina africana* L.	H
	Commelina benghalenis Forssk.	H
Compositae	*Tarconanthus camphorates* L.	S/T
Convolvulaceae	*Ipomoea hildebrandtii* Vatke	C
Crassulaceae	*Kalanchoe densiflora* Rofle	H
Cucurbitaceae	*Cucurmis ficifolius* A. Rich.	C
	Laggenaria abyssinica (Hook f.) C.Jeffry	C
	Momordica foetida Schumach	S/C
	Zehneria scabra (L.f.) Sond	C
Cupressaceae	*Cupressus lusitanica* Mill	T
	Juniperus procera Hochst ex Engl	T
Cyatheaceae	*Cyathea humulis* Hier.in Engl.	F
	Cyathea manniana Hook.	F
Cyperaceae	*Cyperus alternifolius* Schwein.	Sedge
	Cyperus difformis L.	Sedge
	Kyllinga bulbosa P. Beauv.	Sedge
Dracaenaceae	*Dracaena steudneri* Engl.	P
Ebenaceae	*Diospyros abyssinica* (Hiern) F.White	T
	Euclea divinorum Hiern	S/T
Ericaceae	*Erica arborea* L.	T
Euphorbiaceae	*Acalypha sp.* L.	S
	Acalypha volkensii Pax	S
	Clutia abyssinica Jaub. & Spach.	C
	Croton macrostachyus Hochst.ex Delile	T
	Drypetes gerrardii Hutch	T
	Erythrococca bongensis Pax	T/S
	Macaranga kilimandscharica Pax	T
	Neoboutonia macrocalyx Pax	T
	Phyllanthus ovalifolius Forsk.	S/T
	Ricinus communis L.	H
	Suregada procera Croizat	T
Fabaceae	*Acacia abyssinica* Hochst.ex Benth	T
	Acacia lahai Benth.	T
	Albizia gummifera (J.F. Gmel.) C.A. Sm.	T
	Caesalpinia decapelata (Roth) Alston	S
	Calpurnea aurea (Ait.) Benth.	S
	Crotalaria agatiflora Schweinf.	S/H
	Crotalaria mauensis Baker.f.	S
	Glycine wightii (Wight & Arn) Verdc	H
	Indigofera homblei Bak.f. & Martin.	H
	Indigofera volkensii Taub.	S
	Pterolobium stellatum (Forssk.) Brenan	C

Appendix I…cont.

Family	SPECIES NAME	Life form
Fabaceae	*Rhynchosia usambarensis* Taub.	C
	Senna biflora (Vahl) H. S. Irwin and Barneby	S
	Senna didymobotrya (Fresen.) Irwin & Barneby	S
	Senna Spp. Mill	C
	Sesbania sesban (L.) Mett	S
Flacourtiaceae	*Dovyalis abyssinica* (A.Rich) Warb.	S
	Dovyalis macrocalyx (Oliv.) Warb.	T/S
	Flacortia indica (Burm F.) Merrill	T
	Trimeria grandiflora Wild.	S/T
Hamammelidaceae	*Trichoclados ellipticus* Eckl & Zeyh.	S/T
Hypericaceae	*Hypericum revolutum* Vahl	S
Hypoxidaceae	*Hypoxis obtuse* Burch.	H
Lamiaceae	*Leonotis mollissima* Gurke.	S
	Leucas grandis Vatke	H/S
	Ocimum forskolei Benth.	S
	Satureja biflora (D.Don) Benth	S
Loganiaceae	*Nuxia congesta* R. Br. Ex Fressen	T
	Strychnos usambarensis (Gilg)	T
Mackinlayaceae	*Centella asiatica* (L.) Urban	H
Maesaceae	*Maesa lanceolata* Forssk.	T
Malvaceae	*Abutilon longicuspe* Hochst ex A. Rich	S/H
	Abutilon mauritianum (Jacq.) Medic	S/H
	Dombeya torrid (J.F. Gmel.) Bamps	S/T
	Grewia similis K.Schum	S/C
	Hibiscus ludwigii Eckle. & Zeyh.	H/S
	Malva verticilata L.	H
	Sida ovate Forssk	H
Meliaceae	*Ekerbergia capensis* Sparrm.	T
	Trichilia emetica Vahl	T
Meliantheceae	*Bersama abyssinica* Verdc	T
Menispermaceae	*Cissampelos Pereira* L.	C
Monimiaceae	*Xymalos monospora* (Harv.) Baill.ex Warb.	T
Moraceae	*Ficus capensis* Hiern	T
	Ficus natalensis Hochst.	T
Myricaceae	*Morella salicifolia* (Hochst.ex A. Rich.) Verdc. &Poihill	T
Myrsinaceae	*Myrsine africana* L.	S/T
	Rapanea melanophloes (L.) Mez	T
Myrtaceae	*Syzgium guineense* (Willd). DC.	T
Ochnaceae	*Ochna holstii* Engl.	T
	Ochna ovata F. Hoffm.	S/T
Oleacae	*Fraxinus pennsylvanica* Marshall	T
	Olea capensis L.	T
	Olea europea africana (Mill.) P.S. Green	T
	Olea hochesterri Baker	T
Orchidaceae	*Orchid spp.*	S
Oxalidaceae	*Oxalis corniculata* L.	H
	Oxalis obliquifolia Steud.ex A. Rich.	H
Passifloraceae	*Passina passiflora* L.	C
Phyllanthaceae	*Bischovia japonica* L.	T
Pinaceae	*Pinus canariensis* C.Sm	T
	Pinus patula Schiede & Deppe	T
Piperaceae	*Piper capense* L.f.	S

Appendix I…cont.

Family	SPECIES NAME	Life form
Pittosporaceae	*Pittosporum viridiflorum* Sims.	T
Poaceae	*Cynodon dactilon* (L.) Pers.	G
	Digitaria horizontals Henrard	G
	Oplismenus buminanii P. Beauv.	G
	Panicum laxum Sw.	G
	Rhyntherytum repens L.	G
	Scleria verrucosa Willd	G
Podocarpaceae	*Podocarpus falcatus* (Thunb)	T
	Podocarpus latifolius (Thunb.) R.Br.ex Mirb.	T
Polygonaceae	*Polygonum pulchrum* BI.	S
	Rumex usambarensis Dammer	S
Portulaceae	*Talinum portuliciflium* (Forssk.) Asch.ex Scheweinf	S
Proteaceae	*Grevillea robusta* A.Cunn.ex R.Br.	T
Pteridaceae	*Pteris catoptera* Kze.	F
Ranunculacaea	*Clematis brachiata* Thumb.	C
	Thalictrum rynchocarpum Dillon ex.A. Rich.	H
Rhamnaceae	*Gouania longispicata* Engl.	S/C
	Rhamnus prinoides L'Herit	S/T
	Scutia myrtina (Burmf.) Kurz	C
Rhizophoraceae	*Cassipourea malossana* (Bak)Alston	T
Rosaceae	*Alchemilla fischeri* Engl.	H
	Cotoneaster pannosa Franch	T
	Haggenia abyssinica (Bruce) J.F. Gmel	T
	Prunus africana (Hook f.) Kalkman	T
	Rubus steudneri Schweinf.	C
Rubiaceae	*Anthospermum herbaceum* L.f.	H
	Coffea eugenioides S. Moore	S/C
	Galium aparine L.	H
	Galium scioanum Chiov.	C
	Heinsenia diervilleioides K. Schum.	T
	Keetia gueinzii (Sond.) Bridson	T
	Meyna tetraphylla(Schweinf.Ex Hiern) Robyns	T
	Psydrax schimperiana (A. Rich.) Bridson	T
	Rubia cordifolia L.	T
	Spermacoce princeae (K.Schum) Verdc.	H
	Vangueria madagascariensis J. F. Gmelin	S/T
Rutaceae	*Calodendrum capense* (L.f) Thunb.	T
	Clausena anisata (Willd.) Hook. f. ex Benth.	S/T/C
	Fagaropsis angolensis (Engl.) Dale	T
	Teclea nobilis Delile	T
	Teclea simplifolia (Engl.)	T
	Toddalia asiatica (L) Ram	C
	Zanthoxyllum gillettii (De Wild.) P.G. Waterman	T
Salicaceae	*Casearia battiscombei* R.E.Fr.	T
	Scolopia zeyheri (Nees) Harv.	T
Salvadoraceae	*Salvadora persica* L.	T
Santalaceae	*Osyris lanceolata* Hochst. & Steud	T
Sapindaceae	*Allophylus abyssinicus* P. Beauv.	T
	Dodonaea augustifolia L. f.	T
Sapotaceae	*Manilkara discolour*(Sond.)J.H.Hemsl	T
Smilacaceae	*Smilax anceps* Willd.	C
Solanaceae	*Physalis peruviana* L.	C

Appendix I…cont.

Family	SPECIES NAME	Life form
Solanaceae	*Solanum giganteum* Jacq.	T/S
	Solanum indicum L.	H
	Solanum mauritianum Scop.	S
	Solanum nigrum L.	H
	Solanum sessilistellatum Bitter	H
	Solanum terminale Forssk.	S
Sterculiaceae	*Dombeya goetzenii* K. Schum	T
Tiliaceae	*Grewia tenax* (Forssk.) Fiori	S
	Sparmannia ricinocarpa (Eckl. & Zeyh.) Kuntze	S/C
	Triumfetta macrophylla K.Schum	H/S
	Triumfetta rhomboidea Jacq.	S
Umbelliferae	*Haplociadium abyssinicum* L.	H
Urticaceae	*Urtica massaica* Mildbr.	H
Verbenaceae	*Clerodendrum johnstonii* Oliv.	S
	Lantana trifolia L.	S
	Lippia javanica (Burm.f.) Spreng	S
	Verbena bonariensis Bitter	S
Vitaceae	*Cyphostema orondo* (Gil & M.Brandt) Desc.	C
	Rhoicissus tridentate (L.f.) Wild & R.B.Drumm.	C

H= Herb. F= Fern. C= Climber. S= Shrub. P= Palm. T= Tree. Sedge.

Appendix II: Human activities in Western Mau Forest

a) **Maize plantation and human settlement in a section of Western Mau Forest** (Source: author)

b) Cattle grazing in the grassland zone of the forest (Source: author)

c) ***Juniperus procera*** **and** ***Cupressus lusatanica*** **poached by local wood loggers in the forest** (Source: author)