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Woody Species Composition, Tree Diversity and Regeneration Status of Londiani Forest, Kenya

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Abstract: Tropical forests provide habitats for diverse flora and fauna. In addition, they are essential in regulating the climate while at the same time millions of people depend on them for their livelihoods. As seen by rising political commitment and worldwide promises to reduce rates of deforestation and boost restoration of degraded forest ecosystems, forests are becoming more widely acknowledged for their role as a nature-based solution to many sustainable development concerns. Understanding tropical forest dynamics and their conservation have so become more important. This study analyzed, the forest stand structure, tree species composition, abundance and diversity and the regeneration status of Londiani Forest.   Londiani Forest is divided into three blocks, namely Kedowa, Chebewor and Londiani and from each of these blocks belt transects 25 m wide and 1 km long were established 100 m from the edge of the forest to reduce edge effects. At every 200 m along the transect, 25 m × 25 m quadrats were set up in which, an inventory of all tree species was done. For tree species that could not be identified in the field, the local name was provided by para-taxonomists who participated in the data collection and the species name was later identified with the help of a taxonomist or a manual of woody tree species of Londiani Forest. The diameter at breast height (DBH) was measured at 1.3 m from the ground using a diameter tape. Tree height was measured using a Suunto angular clinometer. A nested quadrat 5 m x 5 m quadrat within the 25 m x 25 m quadrat was used to sample saplings while a 1 m x 1 m quadrat was used for sampling seedlings. Regeneration status was assessed using the number of seedlings and saplings. Stumps of trees cut were counted including identifying tree species from which the tree stump was derived. Data from the quadrats were entered into Microsoft Excel. Total stem density, species density, basal area, species basal area, relative density and species diversity were determined. A total of 1,308 individual trees belonging to 34 different species from 24 families were recorded. Kedowa had the highest (27) species richness followed by Chebewor (19) then Londiani (14). There was a statistically significant difference in species richness among the three forest blocks (p<0.05). There were no statistically significant differences in the mean DBH (F=0.560; p=0.729) and height class distribution (F= 0.821, p=.558) among the three forest blocks. There was a statistically significant difference in stem density (F=12.22; p=0.005) and woody species diversity (F=0.32; p=0.001) within the three forests blocks. There was no statistically significant difference in the basal area distribution within the three forest blocks p>0.005. The similarity index ranged from 0.34 to 0.47. In all the forest blocks, there was evidence of seedlings and saplings indicating that there was regeneration. Results clearly show that while the Londiani Forest shows variation in characteristics, there is clear evidence that it is regenerating.

Keywords: species composition; tree diversity; regeneration; forest management

1. Introduction

Tropical forests contain diverse ecosystems and provide a home for people, flora and faunal species. Forests provide habitats for 80 per cent of amphibian species, 75 per cent of bird species and 68 per cent of mammal species. About 60 per cent of all vascular plants are found in tropical forests.

Additionally, they are essential in regulating the climate through oxygen production and carbon storage, and provide livelihoods for millions of people (Bennet, 2004; Bharucha & Pretty, 2010; Blackman & Veit, 2018).   Consequently, understanding the dynamics of tropical forests and their conservation has gained prominence. Forests are increasingly recognized for their role as a nature-based solution to many sustainable development challenges, as manifested in increased political will and global commitments to reduce rates of deforestation and enhance restoration of degraded forest ecosystems (Beatty *et al.*, 2018; Bastin *et al.*, 2019). Most of the terrestrial biodiversity is contained in tropical forests. Consequently, the conservation of global biodiversity is dependent on how we interact with and use the world's tropical forests.

Deforestation and forest degradation remain the biggest challenges in forest conservation (Zhu *et al.*, 2004; Agrawal *et al.*, 2008). These two processes contribute significantly to the current loss of biodiversity. Over the last 30 years, it is estimated that some 420 million hectares of forest have been lost through conversion to other land uses (Chomba *et al.*, 2014). Agricultural expansion and urbanization are currently the main drivers of deforestation, forest fragmentation and the accompanying loss of forest biodiversity (Chan *et al.,* 2007). Large-scale commercial agriculture and local subsistence agriculture account for most tropical deforestation. The resilience of human food systems and their capacity to adapt to future change depend on the biodiversity that include; dry land shrub and tree species that are key in combating desertification, forest insects, bats and bird species that are useful in crop pollination, trees with extensive root systems which mitigate soil erosion, and mangrove species that provide resilience against flooding and erosion in coastal areas (Ahenkan *et al.,* 2011; Barros *et al.,* 2019). With climate change exacerbating the risks to food systems, the role of forests in capturing and storing carbon and mitigating climate change is of ever-increasing importance for the agricultural sector (CBD 2010b; Ding *et al.,* 2016).

Data and information are key to sustainable management of forests (Wenger, 2013; Dau *et al.,* 2015). Such information is obtained mainly through forest inventories. Forest inventories are crucial in forest management because, they provide the data for planning, monitoring, evaluation, research, growth and yield, biodiversity, and timber sale (Monserud, 2013; Zerihun & Yemir 2013). An inventory of tree species that provides information on diversity and abundance helps in identifying species of special concern that may be heavily impacted by forest deforestation and degradation (Mendoza & Prabhu, 2000).

Tropical rainforest biodiversity is threatened by intense anthropogenic pressure that includes, deforestation, habitat degradation and fragmentation, exploitation, invasive species, pollution, and global climate change (Marengo 2020; Lawrence & Vandecar, 2015). Besides, synergies among these drivers have had a major negative impact on biodiversity (Kissinger *et al.,* 2012). These threats may alter the stand structure of the forest ecosystems (Krupnick, 2013; Fischer *et al.,* 2016). Tropical forest restoration which models the natural regeneration has been adopted as a strategy for restoring degraded forests (Aide, 2000). Regeneration is a central component of forest ecosystem dynamics and the restoration of degraded forest lands (Chadzon & Uriarte, 2016). The patterns of regeneration drive the structure and composition of the forest (Wangda, 2003; Mori and Takeda, 2004). These factors influence the species composition of tropical forests at different spatial scales (Peña-Claros *et al.,* 2012; Danková & Saniga 2013). One outcome is the enhancement of the stability, resilience and diversity of forest ecosystems (Liira *et al.,* 2011). Successful regeneration requires sufficient seedlings survival, which is a function of the prevailing microclimate of the site and the level of anthropogenic activities. The success of the different growth stages as well as the size-class distribution of a tree population is important in the recovery of the forest following disturbances (Chadzon 2003). Seedling densities in the forest understory are dynamic and rates may vary among species and in the gap and shade environments (Bazzaz 1991; Khumbongmayum *et al.*, 2006; Saikia & Khan, 2013; Strassburg 2019). Where regeneration is continuous, the size-class distribution of species cohorts will tend to exhibit a reverse J shape curve (Teketay, 2005). Understanding the knowledge of species composition and stand structure together with the regeneration patterns of the forest ecosystem is important in evaluating the sustainability, species diversity, conservation and management of the forest ecosystems (Kacholi, 2014). There are a number of studies that have determined patterns of tree

Data Collection

In each of the three forest blocks, belt transects 25 m wide and 1 km long were established 100 m from the edge into the forest. At every 200 m along the transect, 25 m × 25 m quadrats were set up. An inventory of all trees was made recording data on diameter at breast height (DBH), tree height, the species name and the number per plot in a data sheet. For tree species that could not be identified in the field, the local name was provided by para-taxonomists who participated in the data collection and the species name was later identified with the help of a taxonomist or a manual of woody tree species of the Londiani Forest (KFS, 2018). The tree species abundance was scaled to a hectare. The diameter at breast height (DBH) was measured at 1.3 m from the ground using a diameter tape. Tree height was measured using a Suunto angular clinometer. A nested quadrat 5 m x 5 m quadrat within the 25 m x 25 m quadrat was used to sample saplings while a 1 m x 1 m quadrat was used for sampling seedlings. All saplings and seedlings within the nested quadrat were identified and matched to the existing tree species. Regeneration status was assessed using the number of seedlings and saplings. Anthropogenic disturbances were assessed in each quadrat by counting tree stumps that were identified to species level and recording evidence of charcoal burning.

Data Analysis and Presentation

Data from the quadrats were entered into Microsoft Excel. The population structure of the tree species was analyzed across fifteen DBH classes with an interval of 10 cm apart and also across eleven Height classes with an interval of 5 m apart.   Total stem density, species density, basal area, species basal area, relative density, species diversity, evenness and richness were determined. Relative densities were extrapolated to per hectare.

1. Stem Density (trees/ha) = # trees sampled   x 10000 m²/ha

　　　　　　　　　　　　　　Plot area (m²)

Spp. Stem density (trees/ha) = # Sp. X sampled) x 10000 m²/ha

　　　　　　　　　　　　　　　Plot area (m²)

2. Total Basal Area (m²/ha) = ∑ (individual tree basal areas) x 10000 m²/ha

　　　　　　　　　　　　　　　　Plot area (m²)

Where: Individual tree basal area (m²) = π x (tree radius) ² x (1m²/10,000cm²)

Spp. Basal Area (m²/ha) = ∑ (Sp. X individual tree basal areas) x (10000 m²/ha).

　　　　　　　　　　　　　　　Plot area (m²)

3. Relative density = No. of trees of a species / Total no. of trees of all species

= ∑ (Sp. x individual tree basal areas)

　　(Plot area (m²) x (10000 m²/ha)

4. Species Diversity

Diversity was calculated using Shannon Diversity index as shown below

$H = -\Sigma\,[(pi)\times ln\,(pi)]$

Where Σ: A Greek symbol that means "sum" (ln) is Natural log, and (pi) is the proportion of the entire community made up of species i. (Roswell *et al.*, 2021)

5. Evenness

Hmax = ln(S) = Maximum diversity possible

E= Evenness = H/Hmax

S = number of species, = species richness

6. Jaccard Similarity Index

The Jaccard similarity index (Hancock, 2004) was determined using the formula shown below

$SJ = c\,/\,(a + b + c)$

Where *SJ* is the similarity index, *c* is the number of shared species between the two sites and *a* and *b* are the number of species unique to each site (Hancock, 2004).

7. The Importance Value Index (IVI), was used to determine the ecological importance of each tree species.

IVI = RD + RF + RDO

Where,

RD is Relative density,

RF is the relative frequency

RDO is relative dominance where:

RD = <u>Number of all individuals of a species</u> x 100
       Total number of all individuals

RF = <u>Number of plots where a species occurs</u> x100
     Total occurrences of all species in all plots

RDO = <u>Basal area of a species</u> x100
      Total basal area

The quantifiable data was tested for normality using Kolmogorov-Smirnov test and analyzed statistically using techniques for descriptive and inferential statistics through the aid of Predictive Analytics Software (PASW) version 25. Analysis of variance (ANOVA) was used to determine differences in the parameters among the three forest blocks.

3. Results

Forest Stand Structure and Composition of Londiani Forest

Woody species richness and (IVI)

A total of 1308 trees were sampled that represented thirty-four (N=34) woody tree species in 24 families. Trees' species richness ranged from 14 to 27 (Figure 2). The Kedowa Forest block had the highest species richness (n= 27, 45%) while the Londiani Forest block had the least (n= 14, 23.3%). There was a statistically significant difference in richness distribution among the three forest blocks p= 0.034. Indigenous tree species comprised 45.1% (n=591) of all the trees sampled while exotics comprised 54.9% (n=717). Kedowa Forest block accounted for 54.4% (n=235) of the indigenous trees and 45.6% (n=197) of the exotics, Chebewor Forest block accounted for 53.5% (n=231) of indigenous trees and 46.5% (n=201) of the exotics while Londiani Forest block accounted for 27.4% (n=118) of indigenous trees and 72.6% (n=312) of the exotics. The family *Cupressaceae* had the highest number of woody plants (32%; n= 421), followed by *Pinaceae* (15%; n= 196). The family with the least woody plants were *Proteaceae* and *Rhamnaceae* each representing 0.2% (n= 2). Analysis of importance value indices of woody species (IVI) for the three forest blocks ranged from 31.48% to 48.25%. Kedowa Forest block had the highest (IVI) of 48.25%, followed by the Londiani Forest block at 42.86% and then the Chebewor Forest block at 31.48%.
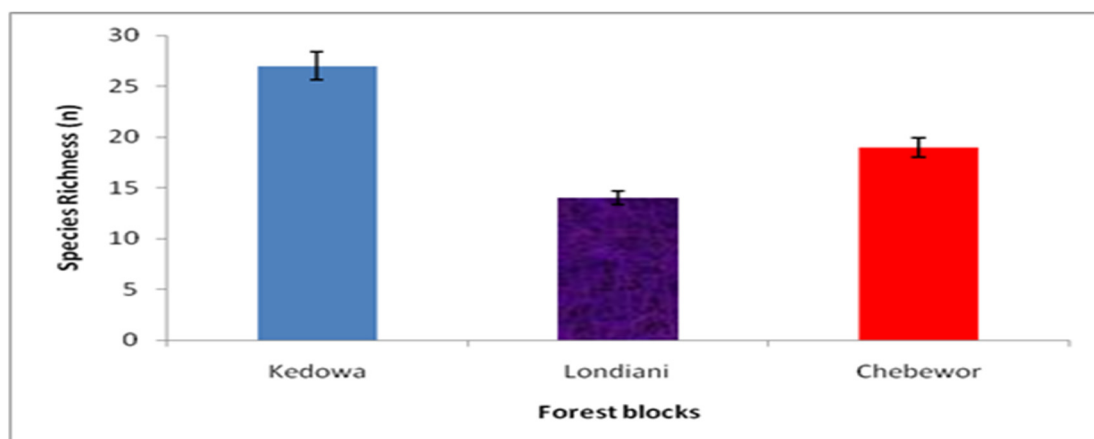

Figure 2. Woody trees species richness for the three forest blocks.

Diameter at Breast Height Distribution

The DBH ranged between 10 cm and 150 cm in Londiani Forest. The mean DBH for the Chebewor Forest block was 24.8 cm, for the Kedowa Forest block 32.4 cm and Londiani Forest block 34.2 cm (Figure 3).
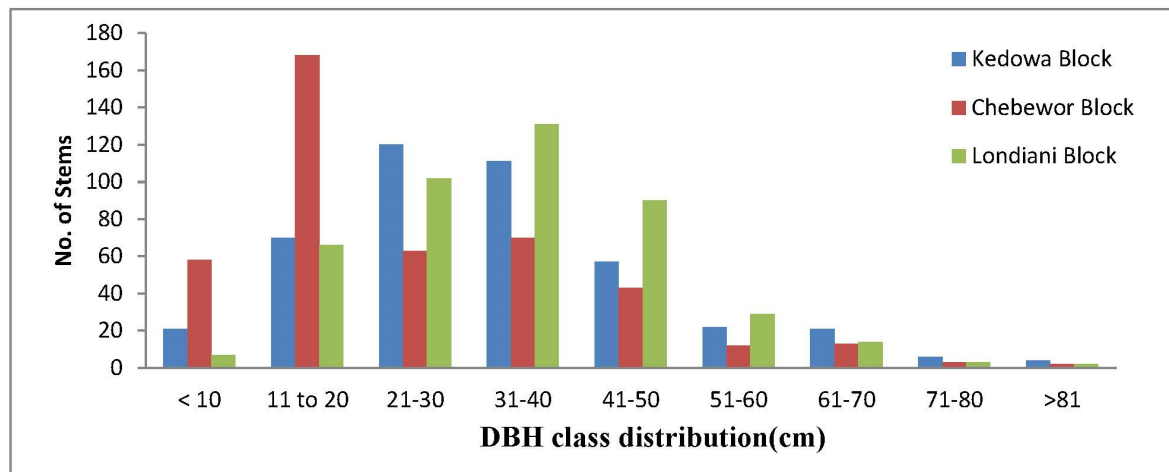
Figure 3. DBH distribution classes of the tree species recorded in Londiani Forest.

Kedowa and Londiani Forest blocks had more trees in the DBH range of (21-30cm), (31-40cm) and (41-50cm). Chebewor on the other hand had more trees in (11-20cm) DBH range. In all the forest blocks, there were trees in the DBH <10 cm which were mainly saplings. A total of (n=1,177(89.9%) trees out of (N=1,308) trees recorded from the entire forest recorded a small DBH below 50 cm showing that the forests consist of young still growing trees. Results of a one-way ANOVA found no statistically significant differences in the mean DBH distribution among the three forest blocks (F=0.560; p=0.729).

Height Distribution of Trees

The height of trees in Londiani Forest ranged from 1 m to 50 m. The mean height for the Chebewor Forest block was 16.9 m, the Kedowa Forest block had a mean height of 23.9 m and   the Londiani Forest block had a mean height of 25 m (Figure 4).
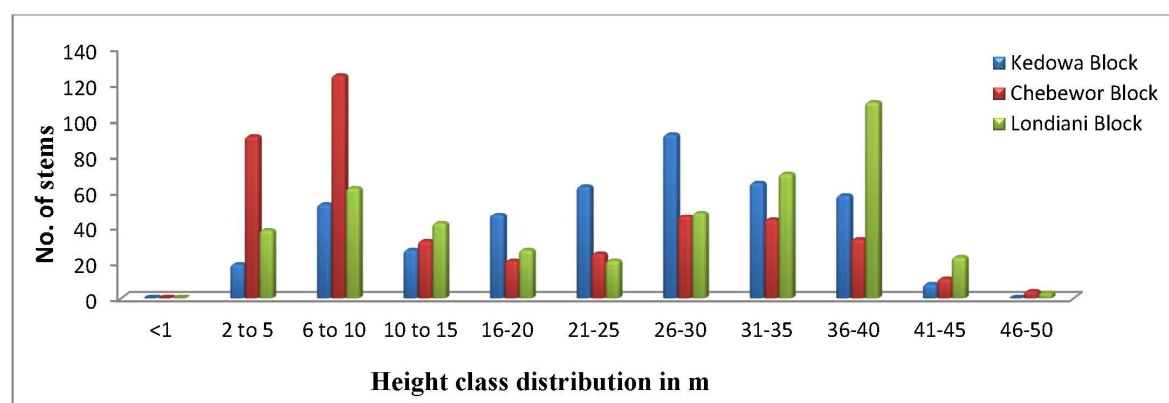
Figure 4. Height class distribution in metres of the three forest blocks.

The height of trees in the Kedowa Forest block ranged from 11 m to 45 m while the height of trees in Chebewor and Londiani Forest blocks ranged from 11 m to 50 m respectively.   One-way ANOVA analysis found no statistically significant difference in height distribution classes between the three forest blocks (F= 0.821, p=.558).

Density and Relative Density

The overall stem density in the Londiani forest varied from 0.33 stems/ha to 45.5 stems ha^{-1}. *Cupressus lusitanica* had the highest density of 45.5 stems ha^{-1}, followed by *Pinus patula* with a density of 32.7 stems ha^{-1} then *Eucalyptus globulus* and *Juniperus procera* were third in the row with a density of 24.7 stems ha^{-1} each *Grevillea robusta* had the least density of 0.33 stems ha^{-1}. There was a statistically significant difference in stem density between the three forest blocks (F=12.22; *p*=0.005).

Basal Area, Dominance and Relative Dominance

The total basal area for all species recorded in the entire forest was 122.6419 m^2. *Cupressus lusitanica* had the highest relative dominance of 33.684 m^2 and the species with the least relative dominance of 0.038 m^2 was *Grevillea robusta*. There was no statistically significant difference in basal area distribution within the three forest blocks (X^2 = 12.000 df = 9 p = .213). *Cupressus lusitanica* recorded the highest species basal area of 2.295m^2 ha^{-1}, followed by *Pinus patula* with 0.992m^2 ha^{-1}, *Juniperus procera* with 0.985m^2 ha^{-1}. The species recording the lowest species basal area was *Grevillea robusta* with 0.0026 m^2 ha^{-1}

Frequency and Relative frequency

Eucalyptus globulus had the highest frequency of 11 appearances and a relative frequency of 61.1%, followed by *Dombeya goetzenii* appearing 10 times with a relative frequency of 55.5%, *Juniperus procera* and *Olea africana* each had 8 frequency and a relative frequency of 44.4%, *Acacia nilotica*, *Cupressus lusitanica* and *Prunus africana* each had a frequency of 5 with a relative frequency of 27.7% (Figure 5). *Arundiana alpina, Brassica actinophylla, Croton macrostchyus, Grevillea robusta, Maesopsis eminii, Ocotea usambarensis* among others had the least frequencies of 1 and a relative frequency of 5.6%.
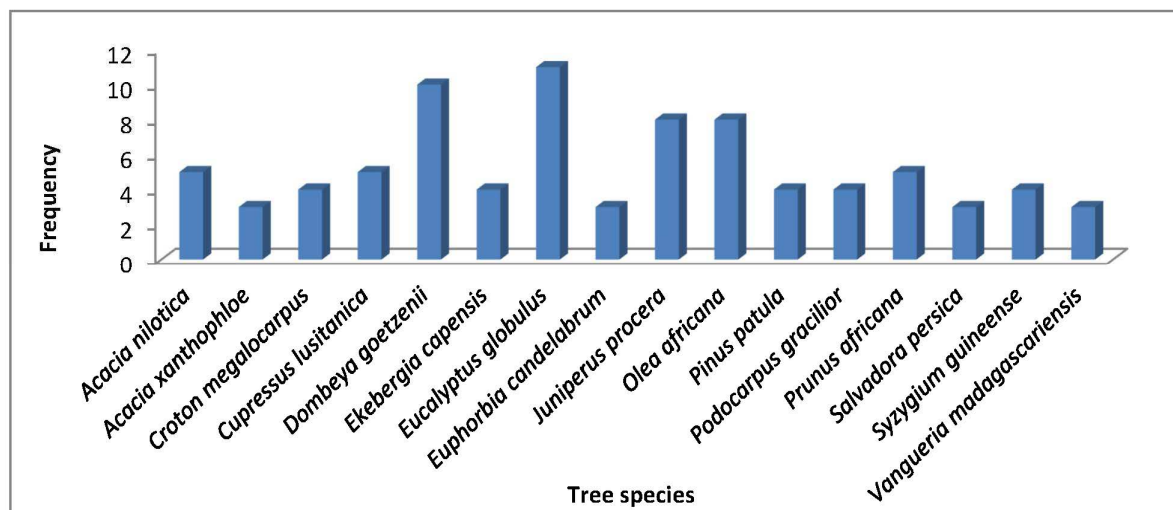
Figure 5. Tree species frequency distribution of Londiani Forest.

Woody Species Diversity and Evenness

The species diversity for the three forest blocks ranged from 0.792 to 0.864. Kedowa block had the highest Diversity H′= 0.864 followed by Chebewor Forest block with H′= 0.855 and finally, Londiani block which had the least diversity of H′= 0.792 (Table 1). There were significant statistical differences in woody species diversity among the three forest blocks (F=0.32; *p*=0.001). Chebewor Forest block had the highest evenness (1±0.32) while Londiani block had the lowest (0.41±0.04).

Table 1. Diversity and Evenness of tree species per Forest block in Londiani Forest.

Forest Block	Abundance	Richness	Diversity (H')	Evenness (H/Hmax)
Kedowa	76±0.033	6±0.5	1±0.14	0.57±0.1
Chebewor	71±0.4	7±0.01	1±0.64	1±0.32
Londiani	72±0.3	4±0.21	0.77±0.01	0.41±0.04

Similarity between Sites

Table 2 shows the Jaccard similarity indices among the three forest blocks. The similarity index ranged from 0.34 to 0.47. Kedowa and Chebewor forest blocks had a relatively higher similarity index of 0.47 which implied that the two vegetation types shared more woody species than between Londiani and Kedowa. This was followed by a lower similarity index between Londiani and Chebewor forest blocks.

Table 2. Jaccard's similarity Coefficient for the three forest blocks.

| Forest	Jaccard's Similarity Coefficient (S)		
	Kedowa	Chebewor	Londiani
Chebewor	0.47		
Londiani		0.35	
Kedowa			0.34

Regeneration Status of Londiani Forest

Londiani Forest recorded a total of (N=740) saplings and (N=832) seedlings. Kedowa Forest block recorded saplings abundance of (n=384) and seedlings (n=294), Chebewor had saplings abundance of (n=182) and seedlings (n=337) while Londiani block recorded saplings abundance of (n=174) and seedlings (n=198) (Figure 6).
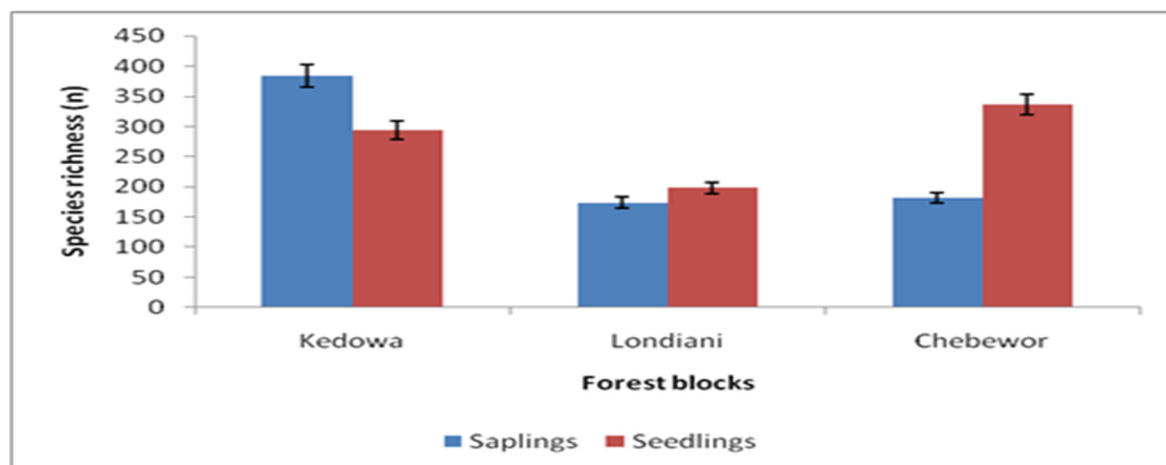
Figure 6. Species richness distribution for saplings and seedlings.

In Kedowa Forest block *Cupressus lusitanica* accounted for most of the saplings (33.4%; n=128) while *Vangueria madagascariensis* (0.5%; n=2) had the least number of saplings. Likewise, *Cupressus lusitanica* had the highest number of seedlings (66.7%; n=198), followed by *Croton megalocarpus* (4.4%; n=13) and, *Eucalyptus globulus* (4%; n=12). *Pinus patula* did not record any seedlings since the trees were still young and had not reached maturity stage where they can produce seeds which would later become seedlings.

In Chebewor Forest block, *Juniperus procera* had the highest numbers of saplings (34.6%; n=63), followed by *Eucalyptus globulus* with (21.4%; n=39), *Acacia mearnsii* (16.5%; n=30), *Rhus natalensis* (5.5%; n=10). *Cupressus lusitanica, Anthocleista vogelii, Grevillea robusta, Podocarpus falcatus, Salvadora persica, Tamarindus indica* and *Vangueria madagascariensis* had zero saplings. *Juniperus procera* had the

most seedlings (45.4%; n=153), followed by *Eucalyptus globulus* at (23.7%; n=80). The rest of the species had no seedlings.

In the Londiani Forest block the saplings ranged from 0-121. *Acacia xanthophloe* had the most saplings (69.5%; n=121), *Juniperus procera* (10.3%; n=18), *Eucalyptus globulus* (1.3%; n=2). The rest of the tree species had no saplings. *Acacia xanthophloe* had the most seedlings (n=130; 65.7%) *Juniperus procera* (n=29; 14.7%) seedlings, and *Dombeya goetzenii* (n=2; 1.01%). The rest of the species had no seedlings.

Abundance, Richness and Diversity of saplings and seedlings in Londiani Forest

Londiani Forest recorded a total of (740) saplings and (832) seedlings (Table 1). There was no statistically significant difference *p*= .082 in abundance distribution of saplings and seedlings *p*= .238 within the three forest blocks. Table 3

Table 3. Saplings and Seedlings distribution data for the three forest blocks.

Forest Blocks	Abundance		Richness		Diversity H′	
	Saplings	Seedlings	Saplings	Seedlings	Saplings	Seedlings
Kedowa	384	294	17	22	2.01	1.62
Chebewor	182	337	12	9	2.89	2.58
Londiani	174	198	8	7	1.64	1.78

4. Discussion

Forest Stand Structure and Species Composition

The results of this study revealed that the three forest blocks of Londiani Forest recorded a total of 34 different species. Other studies done in the same area like by the Kenya Forest Service (KFS) in 2018 (GoK, 2018) reported a total of 27 species while Mutiso *et al.,* (2011) identified 38 plant species. The species composition recorded in Londiani Forest was comparable to those of another dry Afromontane forest of Ethiopia (36 species) (Girma and Mosandl, 2012) and Mopane woodland in northern Botswana (35 species) (Teketay *et al.,* 2018). However, it was lower than tropical forests (55 species) of Kenya (Mutiso *et al.,* 2015). The different species within such ecosystems according to Getaneh *et al.,* (2019), helps to fulfill critical ecological functions which encompass provision of habitats for other plants and wild animals, as well as economic functions. The high number of species recorded in Londiani Forest could be attributed to the past and present disturbances mostly occasioned as a result of anthropogenic activities and well as natural causes. These factors stimulate the establishment of varied species (Kinyanjui, 2013). There were ongoing disturbances observed in the study site which further affects forest diversity. Livestock were grazing freely and unsupervised, charcoal burning was witnessed ongoing in Chebewor and Kedowa blocks at the remaining indigenous portion of the forest. These disturbances have led to decline in climax economic important species. Similarly, Sapkota *et al.,* (2010) noted species diversity reduction in response to disturbances.

The findings show that Kedowa block was rich in tree species compared to the other two blocks same sentiments were shared by KFS, (GoK, 2018). There were many indigenous tree species fully matured and with saplings and seedlings unlike Londiani block which had a small area with indigenous tree species same observations were recorded by Mutiso *et al.,* (2009). Chebewor block had above 50% of indigenous tree species but had faced numerous anthropogenic impacts. Efforts of restoration could be seen where many secondary planted indigenous tree species some matured while other plots were still young trees growing under Plantation Establishment for Livelihood Improvement Scheme (PELIS). The DBH for the forest ranged from 10 cm to 150 cm, an indication that the forest consists of young trees which are still growing. Translating to carbon sequestration potential implied the forest is actively sequestering carbon. The small DBH ranges in the trees sampled in the forest could also be an indication that bigger trees are being harvested for timber and charcoal leaving behind small ones.

Cupressus lusitanica was the most dominant species in Londiani Forest. It is a secondary exotic species planted under Plantation Establishment for Livelihood Improvement Scheme (PELIS) program to replace the indigenous trees after the forest experienced disturbances. Mutiso *et al.,* (2013) recorded *Cupressus lusitanica* as the most abundant exotic species in the Mau Forest Complex which Londiani Forest is part of.   Among the conifers introduced, *Cupressus lusitanica* and *Pinus patula* have adapted well to local growing conditions and are now the key species widely planted in commercial plantations (Joram *et al.,* 2023, Kuria *et al.,* 2019, Mbugua, 2005). The two conifer species *Cupressus lusitanica* and *Pinus patula* currently make up around 80% of the 186,000 ha state-owned forest plantation estate (Kuria *et al.,* 2019).   Additionally, because the species have existed in the Kenyan landscape for a considerable amount of time, their management regimes, silviculture, and other growth features are well recognized (Kuria *et al.,* 2019). This study also agrees with Henry *et al.,* (2011) and Agevi, (2020) who found out high abundance of these species on farms neighboring Kakamega tropical rainforest. The only indigenous conifer species, *Juniperus procera*, was recorded in Londiani Forest but had a very low abundance. The results of this study are consistent with those of Cheboiwo *et al.,* (2015), who discovered that *Juniperus procera* is a slow-growing conifer when compared to exotic conifers and that it grows naturally in Western rainforests and high-altitude montane forest types, such as the Kenya Mau Forest Complex. According to Cheboiwo *et al.,* (2015), it achieves a production of 33.73 m^3/ha/year for Mean Annual Increment (MAI).

Analysis of importance value indices of woody species (IVI) for the three forest blocks ranged from 31.48% to 48.25% indicating that some of the tree species are commonly found in the forests. Based on Jaccard similarity indices, it is very clear that the three forest blocks have very low similarity index less than 0.5. The important thing worth noting is that in all the three forest blocks there is a certain degree of species sharing especially between Chebewor and Kedowa block. This can be greatly attributed to endemism and neighborhood effects. Neighbor plant interaction is cited by Huang *et al.,* (2003) as a factor in post-disturbance plant forms. Conversely, the small variations in their topography and levels of disturbance might have contributed to the high similarity in Kedowa and Chebewor Forest blocks.

Population Structure and Regeneration Status of Londiani Forest

The population structure and regeneration status varied among the tree species because of poor forest management that has exposed the trees to illegal harvesting and hence the observed cut tree stumps in the three forest blocks. The variations of species richness of adult trees remained insignificant among the three forest blocks, but the abundance and diversity of species of adult tree species was much higher than saplings and seedlings. The overall numbers of seedlings and saplings varied among forests. Similar to the densities of adult tree species, a few species accounted for the number of species of seedlings and saplings. These findings are in agreement with those of Mutiso *et al.,* (2013) and Mutiso *et al.,* (2015) in studies done in Mau complex who asserted that ongoing disturbances on the sites have impacted negatively on the regeneration and recruitment processes. Such regeneration patterns promote mono-dominant forests with low redundancy (Gaaf, 1999).   The degrees of harvesting in the forests were the main source of variations in species composition between the adults and saplings and seedlings. Therefore, human interventions are required to reduce the effects of disturbances, maintain the integrity of the forests as well as enhance their composition and structure (Getaneh, *et al.,* 2019).

5. Conclusions

The objective of this study was to determine the Woody Species Composition, Tree diversity and Regeneration Status of Londiani Forest, Kenya. The findings revealed gains and losses in forest cover over the years. Physical observation revealed a low floristic composition in the Londiani Forest at mature, seedling, and sapling stages, indicating poor establishment and recruitment as a result of continuing disturbances, primarily anthropogenic. Anthropogenic factors stemming from population pressure and ineffective implementation of relevant forest laws, policies, and regulations were shown to be the main causes of forest cover reduction.

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