

Research Article

Woody Species Diversity, Structure, and Regeneration Status of Yemrehane Kirstos Church Forest of Lasta Woreda, North Wollo Zone, Amhara Region, Ethiopia

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This study is aimed at generating data on woody species diversity, structure, and regeneration status of some species and was conducted in Yemrehane Kirstos Church Forest of Lasta Woreda, North Wollo Zone, Amhara Region, Ethiopia. Six transect lines were laid following altitudinal gradient. Quadrats of size 20 m × 20 m (400m²) were used to collect data that were established systematically at every 100 m interval along the transect lines. Data on woody species was collected from a total of 34 sampling quadrats of 400m². To collect data on seedlings and saplings, five subplots of 1 m × 1m (1m²) size located at the four corners and centre of the main plot were used. Species diversity was determined using the Shannon-Wiener index (H'). A total of 39 woody species belonging to 38 genera and 29 families were identified in Yemrehane Kirstos Church Forest. The overall Shannon-Wiener diversity index (H') and evenness values for the entire forest were 2.88 and 0.79, respectively. The six most abundant woody species in their order of highest density were *Juniperus procera*, *Olea europaea* subsp. *cuspidata*, *Maytenus arbutifolia*, *Osyris quadripartita*, *Calpurnia aurea*, and *Debregeasia saeneb*. The densities for mature woody species, saplings, and seedlings were 506.6, 514.7, and 415.4 individuals ha⁻¹, respectively. The basal area of the forest is 72 m² ha⁻¹. The population structure and regeneration status of the forest indicated that there have been high forest degradation and severe anthropogenic disturbances in the area and, therefore, conservation of species, ecosystem restoration, and sustainable use of the forest genetic resources are recommended as a result of this study.

1. Introduction

1.1. Background and Justification. Loss of forest cover and biodiversity due to anthropogenic activities is a growing concern in many parts of the world [1, 2]. Africa's forest cover is estimated to be 650 million ha, constituting 17 percent of the world's forests including a number of global biodiversity hotspots [3]. Ethiopia is regarded as one of the most important countries in Africa with respect to biological resources (flora and fauna) [4]. The major challenge facing Ethiopia is environmental degradation manifested in the degradation of land and water resources as well as loss of biodiversity [5]. Deforestation is one of the major factors contributing to land degradation by exposing the soil to various agents of erosion. Rapid human population

growth, poverty, forest clearing, overgrazing, and lack of proper policy framework are some of the major factors that contribute to the loss of forest resources in Ethiopia [6]. In general topography, soil, climate, and geographical locations of a region influence the vegetation diversity of the forest ecosystem [7]. Lack of integration of the local people living around the conservation areas into the conservation efforts is the major constraint to the overall conservation effort in Ethiopia [8]. However, the current government of Ethiopia has started to protect forests through participatory forest management. Therefore, as a strategy for development interventions, initiation of forest management through local community participation would essentially be contributing to the reduction of forest degradation in Ethiopia [9, 10]. However, availability of accurate data on forest resources

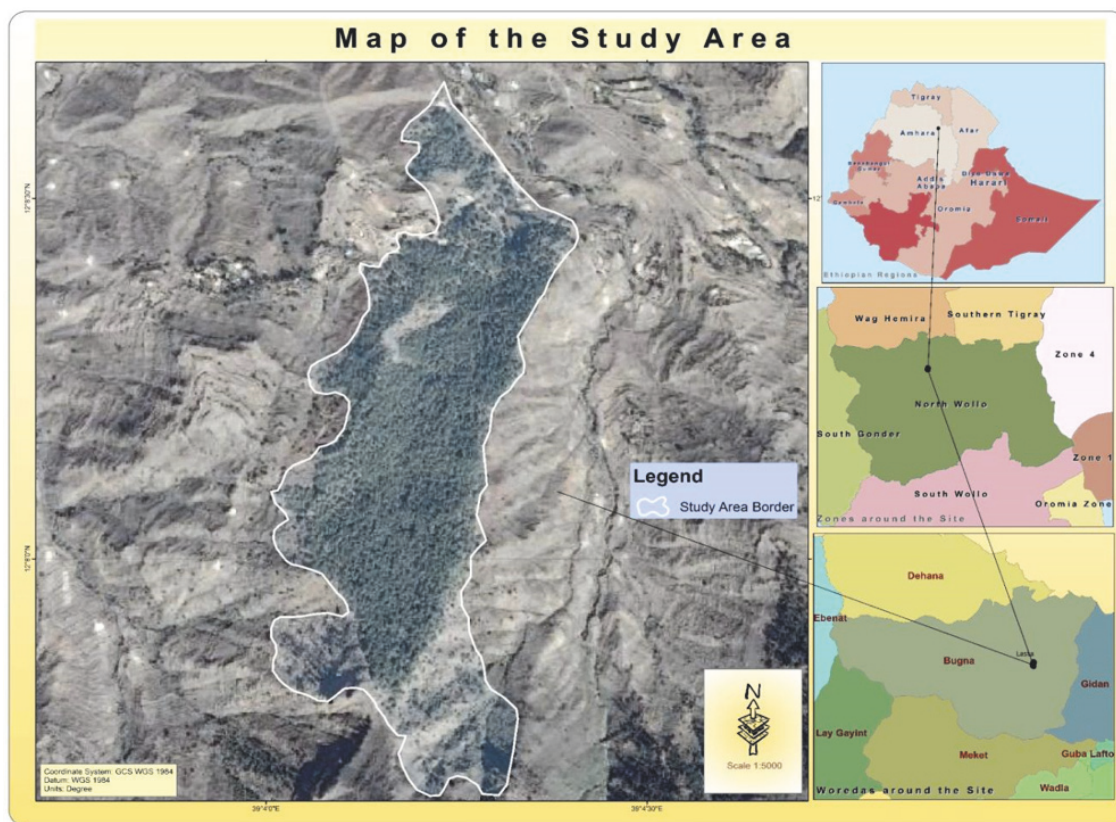


FIGURE 1: Location map of Yemrehane Kirstos Church Natural Forest.

is an essential requirement for management and planning within the context of sustainable development [11]. Likewise, as a conservation approach, scientific studies on floristic composition, vegetation structure, and regeneration status of a given forest patch are needed to determine the status of the forest and take appropriate conservation measures. Yemrehane Kirstos Church Forest, one of the most important and heritage priority areas, is currently not well managed and most of the forest area is degraded and converted to agricultural and grazing land [12]. The systematic investigation of forest vegetation for this area is lacking. Thus, the current work on floristic composition, diversity, structural analysis, and regeneration of the vegetation in the area is believed to contribute a lot to the effective conservation and management of this heritage forest. The major objective of this study was to determine floristic composition of woody species, regeneration status, and structure of woody species in Yemrehane Kirstos Church Forest.

2. Materials and Methods

2.1. Location and Description of the Study Area. The study was conducted in Yemrehane Kirstos Church Forest, Lasta Woreda, North Wollo Zone, Amhara National Regional State, characterized by a rugged mountain landscape, in the river valley of gorges and high clips of north Wollo, Lalibela, Ethiopia. It is located between $12^{\circ} 07' 39.9''$ – $12^{\circ} 08' 36.2''$ N

and $039^{\circ} 04' 00.8''$ – $039^{\circ} 04' 24.3''$ E (Figure 1) and extends over an altitudinal range from 2565 to 3135 m with the total area of 200ha [12]. The main types of soil in the area are loamy soil.

3. Sampling Design

Systematic sampling design was used to collect vegetation data from the study site. Appropriate transect lines and sampling quadrats were made based on the total area of the study site for vegetation data collection. Six transect lines were laid following the altitudinal gradient and quadrats of size $20\text{ m} \times 20\text{ m}$ (400m^2) were established systematically at every 100 m interval. To collect data on seedlings and saplings, five subquadrats of $1\text{ m} \times 1\text{ m}$ (1m^2) size located at the four corners and centre of the main quadrats were used.

3.1. Floristic Data Collection. All the woody plant species encountered in each sample quadrats were recorded and coded with vernacular and local names whenever possible. The plant species occurring outside sample quadrats but inside the forest were recorded only as present but not used in the subsequent vegetation data analyse. These species and the rest plant specimens were collected, pressed, dried, and brought to the National Herbarium of Ethiopia (ETH), Department of Plant Biology and Biodiversity Management,

TABLE 1: Density and relative density (RD) of woody species.

Species Name	Density ha ⁻¹	Relative density
<i>Juniperus procera</i>	119.65	38.35
<i>Olea europaea</i>	50.67	16.24
<i>Maytenus arbutifolia</i>	28.64	9.18
<i>Osyris quadripartita</i>	19.81	6.35
<i>Calpurnia aurea</i>	17.63	5.65
<i>Debregeasia saeneb</i>	13.23	4.24

Addis Ababa University, for taxonomic identification. Physiographic variables such as altitude, latitude, and longitude were recorded for each sampling quadrat using GPS. In each quadrat, trees and shrubs with DBH > 2.5 cm were measured and recorded for height and diameter at breast height (DBH) with clinometers and diameter tape, respectively. For trees and shrubs that are branched around the breast height, the circumference was measured separately and averaged. In each quadrat, the species list and number of seedlings and saplings were recorded to determine the regeneration status. The undergrowth of woody species with a height less than 1 m was considered as seedlings, height of greater than 2 m was considered as trees and shrubs, and 1-2 m was considered as sapling [14].

3.1.1. Diameter at Breast Height (DBH). DBH measurement was taken at about 1.3 m from the ground using a diameter tape. Trees and shrubs with DBH > 2.5 cm were measured and recorded for diameter at breast height (DBH). Trees/shrubs with multiple stems or fork below 1.3 m height were also treated as a single individual (Kent and Coker, 1992). For trees and shrubs that are branched around the breast height, the circumference was measured separately and averaged. Diameter class frequency distribution of selected tree species in the area was classified into ten classes: (1) 2.5-5cm, (2) 5.1-10cm, (3) 10.1-15cm, (4) 15.1-20cm, (5) 20.1-25cm, (6) 25.1-30cm, (7) 30.1-35cm, (8) 35.1-40cm, (9) 40.1-45cm, (10) >45cm.

3.1.2. Height. Height is a straightforward parameter used for direct measurement purposes. The total tree heights (to the top of the crown) were measured using Hypsometer. The tree heights were classified into different classes based on their height. Height class frequency distribution of trees and shrubs in the area was classified into five height classes: (1) <5m, (2) 5.1-10m, (3) 10.1-15m, (4) 15.1-20m, (5) >20m.

3.2. Data Analysis. The diameter at breast height (DBH), basal area, tree density, height, frequency, and important value index were used for description of vegetation structure.

That accounts both for species richness and evenness, and it is not affected by sample size (Kent and Coker, 1992).

Shannon diversity index [15] was calculated.

$$H' = -\sum_{i=1}^s p_i \ln p_i \quad (1)$$

Species richness was undertaken from all species encountered in each plot.

$$S = \frac{\text{number of species}}{\text{plot}} \quad (2)$$

Evenness of species was calculated by dividing H by Hmax (here Hmax = ln S).

$$E = \frac{H'}{H_{\max}} = \frac{H'}{\ln S} \quad (3)$$

3.3. Importance Value Index (IVI). Importance value index which combines data from three parameters (relative frequency, relative density, and relative abundance) is used to compare the ecological significance of species. The importance of value index (IVI) for each woody species was calculated using the formula indicated below [13].

$$\begin{aligned} \text{Importance Value} &= \text{Relative density} \\ &+ \text{Relative frequency} \\ &+ \text{Relative dominance.} \end{aligned} \quad (4)$$

3.4. Basal Area. It is the cross-sectional area of all of the stems in a stand at breast height (1.3 m above ground level). This basal area per unit area is used to explain the crowdedness of a stand of forests. It is expressed in square meter/hectare. Its area is also used to calculate the dominance of species. Basal area = $\Sigma (d/2)^2$, where D is diameter at breast height.

$$\begin{aligned} \text{Relative Dominance} &= \frac{\text{Dominance of Tree species}}{\text{Dominance of all species}} \\ &\times 100 \end{aligned} \quad (5)$$

where dominance is average basal area per tree times the number of tree species.

Woody species density is defined as the number of plants of a certain species per unit area.

$$\begin{aligned} \text{Density} &= \frac{\text{Total Number of all Trees}}{\text{Sample Size in Hectare}} \times 100 \\ \text{Relative Density} &= \frac{\text{Number of Individuals of Tree species}}{\text{Total Number of Individuals}} \times 100 \end{aligned} \quad (6)$$

3.5. Frequency. Frequency is defined as the probability or chance of finding a plant species in a given sample area or quadrat. It is calculated with the formula below.

$$\begin{aligned} \text{Frequency} &= \frac{\text{Number of Plots in which species occur}}{\text{Total number of plots}} \times 100 \end{aligned} \quad (7)$$

TABLE 2: Mean basal area (BA) in m² and relative dominance of woody species.

Species Name	Mean basal area	Density	Dominance	Relative dominance	Rank
<i>Juniperus procera</i>	0.18	119.85	21.63	66.98	1
<i>Olea europaea</i>	0.08	50.74	4.09	12.66	2
<i>Clusia lanceolata</i>	0.06	10.2	3.1	9.6	3
<i>Acacia abyssinica</i>	0.11	7.35	0.78	2.41	4
<i>Hibiscus crassinervius</i>	0.01	0.9	0.55	1.7	5
<i>Dombeya torrida</i>	0.1	8.6	0.4	1.24	6

TABLE 3: Basal area comparison of Yemrehane Kirstos Church Forest with other forests.

Forest	Basal area	Author
Denkoro	45.00	Abate (2003)
Gelawdewos	52.00	Alemayehu (2003)
Debresena	45.00	Alemayehu (2003)
Dengolt	35.00	Alemayehu (2003)
Kimpe Lafa	114.40	[13]
Yemrehane Kirstos	72.00	Present study
Bibita	69.90	Denu [6]
Wof-Washa	64.32	Fisaha et al. [26]

The frequencies of the tree and shrub species in all thirty-four quadrats were computed.

$$\text{Relative Frequency} = \frac{\text{Frequency of Tree species}}{\text{Frequency of all Tree species}} \times 100 \quad (8)$$

4. Results and Discussion

4.1. Floristic Composition. A total of 39 woody species belonging to 38 genera and 29 families were identified in Yemrehane Kirstos Church Forest (Table 5). Of these species, 19 (50%) were trees, 5 (13%) shrubs, and 14 (36.8%) tree/shrubs. Fabaceae was the most dominant family (4 species) followed by Apocynaceae, Clusiaceae, and Cupressaceae with 2 (5.26%) species each represented by nineteen species. The remaining represented eleven families (42.08%) and each is represented by a single species.

4.2. Vegetation Structure

4.2.1. Density of Woody Species. The six most abundant woody species in their order of density in Yemrehane Kirstos Church Natural Forest were *Juniperus procera*, *Olea europaea*, *Maytenus arbutifolia*, *Osyris quadripartite*, *Calpurnia aurea*, and *Debregeasia saeneb* (Table 1).

4.2.2. Basal Area. The total basal area of Yemrehane Kirstos Church Natural Forest was about 72 m² ha⁻¹ for woody species that have DBH > 2.5 cm. Basal area provides the measure of the relative importance of the species rather than simple stem count [16]. Species with higher basal area could be considered as the most important species in the study vegetation. In this study, basal area analysis across individual

species revealed that there was high domination by very few or small woody species. This also indicates that species with the highest basal area do not necessarily have the highest density, indicating size difference between species [17]. The following species made the largest contribution to the basal area: *Juniperus procera*, *Olea europaea*, *Acacia abyssinica*, *Allophylus abyssinicus*, and *Dovyalis abyssinica*, respectively (Table 2).

In general, the basal area values for present forest were higher than most of the other studied forests in Ethiopia [12]. This suggests that the Yemrehane Kirstos Church Forests have better growth and potential to retain higher biomass (Table 3).

4.3. Frequency. Frequency is an indicator of homogeneity and heterogeneity of a given vegetation type [16]. The higher number of species in higher frequency classes and lower number of species in lower frequency classes show homogeneity in forest composition. And the low number of species in higher frequency classes shows heterogeneity of species. The present study revealed high percentage of species in lower frequency classes and relatively low percentage of number of species in high frequency classes. Thus, the result verifies the existence of high degree of floristic heterogeneity in Yemrehane Kirstos Church Forest [12]. The relative frequency revealed that *Juniperus procera* was the most frequent species with frequency of 94.12 followed by *Olea europaea*, *Maytenus arbutifolia*, *Osyris Quadripartite*, *Acacia abyssinica*, *Dodonaea viscosa*, *Allophylus abyssinicus*, *Calpurnia aurea*, *Rhus glutinosa*, and *Clusia abyssinica*.

4.4. Species Diversity and Evenness. Species diversity is a combination of the number of species and their relative abundance. The values of species diversity depend upon levels

TABLE 4: The list of most frequent and most IVI of ten trees species of the forest with their corresponding frequency, relative frequency, relative density, and relative dominance in Yemrehane Kirstos Church Forest.

Species Name	Frequency (%)	RF	RD	RDO	IVI	Rank
<i>Juniperus procera</i>	94.12	23.36	38.35	79.37	141.08	1
<i>Olea europaea</i>	70.59	17.52	16.24	15.00	48.76	2
<i>Maytenus arbutifolia</i>	41.18	10.22	9.18	0.29	19.69	3
<i>Osyris quadripartita</i>	26.47	6.57	6.35	0.30	13.22	4
<i>Acacia abyssinica</i>	23.53	5.84	2.35	2.86	11.05	5
<i>Dodonaea angustifolia</i>	23.53	5.84	4.24	0.04	10.12	6
<i>Allophylus abyssinicus</i>	20.59	5.11	3.29	0.70	9.62	7
<i>Calpurnia aurea</i>	14.71	3.65	5.65	0.30	9.10	8
<i>Rhus glutinosa</i>	14.71	3.65	1.88	0.01	5.54	9
<i>Clusia abyssinica</i>	8.82	2.19	1.18	0.01	3.38	10

of species richness and evenness [18]. Generally speaking, only few species were dominating the vegetation of the study area in their abundance while many of the species were very rare or low in their abundance.

Reports from other studies indicated that species richness and diversity tend to peak at an intermediate altitude and decline at the lower and upper elevations [19]. The result of the present study more or less agrees with this regarding species richness. Such a result reflects either adverse environmental situations or random distribution of available resource in the study area. The overall average Shannon-Wiener diversity index (H') and the average evenness values of Yemrehane Kirstos Church Forest were 2.88 and 0.79, respectively, which is higher than Hareenna Forest (2.60) [20]. According to [16], species area curve is a cumulative curve that relates the occurrence of species with the area sampled; curves that grow up and flattened at the end indicate that the numbers of plots taken are sufficient. Seven sample quadrats were taken randomly and decided the species area curves of the vegetation of Yemrehane Kirstos Church Forest. The result showed that species richness across quadrats was good and pattern of diversity curve raised up and flattened owing to the fairly enough number of quadrats observed.

4.5. Importance Value Index. IVI indicates the structural importance of a species within a stand of mixed species. And it is used for comparison of ecological significance of species in which high IVI value indicates that the species sociological structure in the community is high. It is crucial to compare the ecological significance of species [16]. It was also stated that species with the greatest importance value are the leading dominant of specified vegetation [21]. The top ten leading woody species with greatest importance value and dominance in Yemrehane Kirstos Church Forest were *Juniperus procera*, *Olea europaea*, *Maytenus arbutifolia*, *Osyris quadripartita*, *Acacia abyssinica*, *Dodonaea angustifolia*, *Calpurnia aurea*, *Allophylus abyssinicus*, *Rhus glutinosa*, and *Clusia abyssinica*, compared to other species of the area (Table 4).

4.6. Diameter Class of Woody Species. The general pattern of DBH class distribution of Yemrehane Kirstos Church Forest

showed an inverted bell-shaped distribution. This pattern of DBH classes indicates a good potential of reproduction and recruitment of the forest. Similar results were reported by [22, 23]. In this study, cumulative diameter class distribution of the population structure of the study area reflected an irregular shape, which seemed to be a bell-shaped distribution pattern, but a complete absence of individuals in some classes and a fair representation of individuals in other classes. Above sixty-five percent of the total density is restricted in the middle and higher diameter class (5-32cm), whereas the rest of density was found to be in the lower diameter classes (1-5 cm) (Figure 2). This indicated that there was drawing out of trees for various purposes by local dwellers (e.g., for fencing and fuel wood, by livestock trampling or browsing, or maybe by agricultural expansion) in the lower classes of trees in the area.

4.7. Height. In case of population height class distribution similar results were reported in Chilimo and Menagesha Forests of central plateau of Ethiopia [17], in Denker Forest [22], and in Menagesha Ameba Mariam Forest [24]. The higher number of large-sized individuals in the upper height class in the natural forest implies the presence of a good number of adult tree species for reproduction [25]. This argument holds true for Yemrehane Kirstos Church Forest. This is partly due to the absence of large scale timber exploitation. Therefore, the current study exhibited a condition of primary forest development of the Yemrehane Kirstos Church Forest. It is noteworthy that woody species with the highest DBH size were also recorded for the highest height (Figure 3). Although there is selective logging of tree species at certain height, Yemrehane Kirstos Church Forest exhibited individuals of all height classes.

4.8. Regeneration Status of Yemrehane Kirstos Church Forest. A total of 1245 individuals, 696 seedlings and 549 saplings individuals, were counted from all quadrants. The following species were the largest contributors to the seedling and sapling counts: *Becium grandiflorum*, *Maytenus Juniperus procera*, and *Dodonaea angustifolia*. In general the distribution of seedlings as a whole is greater than that of saplings and mature trees, and that of saplings is less than mature

TABLE 5: List of woody species collected from Yemrehane Kirstos Church Natural Forest.

No	Local name	Scientific name	Family	Habitat
1	Yehabesha Tid	<i>Juniperus procera</i> L.	Cupressaceae	Tree and Shrub
2	Weyira	<i>Olea europaea</i>	Oleaceae	Tree and Shrub
3	Tikurgirar	<i>Acacia abyssinica</i> Hochst. ex Benth.	Fabaceae	Tree and Shrub
4	Emibis	<i>Allophylus abyssinicus</i> (Hochst.) Radlkofer	Sapindaceae	Tree and Shrub
5	Digta	<i>Calpurnia aurea</i> (Ait.) Benth.	Fabaceae	Tree and Shrub
6	Atat	<i>Maytenus arbutifolia</i> . (A. Rich.) Wilczek.	Celastraceae	Tree and Shrub
7	Fiyelefi	<i>Clutia lanceolata</i> Forssk.	Euphorbiaceae	Shrub
8	Kitkita	<i>Dodonaea angustifolia</i> L.f.	Sapindaceae	Shrub
9	Wanza	<i>Cordia africana</i> Lam.	Boraginaceae	Tree
10	Yedegamentese	<i>Becium grandiflorum</i> (Lam.) Pic.Serm.	Lamiaceae	Shrub
11	Talo	<i>Rhus glutinosa</i> A. Rich.	Anacardiaceae	Tree and Shrub
12	Keskese	<i>Lippia adoensis</i> Hochst. ex Walp.	Verbenaceae	Shrub
13	Emibacho	<i>Rumex nervosus</i> Vahl.	Polygonaceae	Shrub
14	Yewushaawut	<i>Solanum anguivi</i> Lam.	Solanaceae	Shrub
15	Tikurenchet	<i>Prunus africana</i> (Hook. f.) Kalkm.	Rosaceae	Shrub and Tree
16	Asikuar	<i>Nuxia congesta</i> R. Br. Ex Fresen.	Loganiaceae	Tree
17	Keret	<i>Osyris quadripartita</i> Dec.	Santalaceae	Tree and Shrub
18	Amfar	<i>Buddleja polystachya</i> Fresen.	Loganiaceae	
19	Wulikfa	<i>Dombeya torrida</i> (J. F. Gmel.) P. Bamps	Sterculiaceae	Tree and Shrub
20	Beles	<i>Ficus carica</i> L.	Moraceae	Tree
21	Semaytero	<i>Dovyalis abyssinica</i> (A. Rich.) Warb.	Flacourtiaceae	Tree
22	Yetotakula	<i>Galinierasaxifraga</i> (Hochst.) Bridson.	Rubiaceae	Tree
23	Duaduate	<i>Clutia abyssinica</i> Jaub. and Spach.	Fabaceae	Shrub
24	Kechem	<i>myrsine africana</i> L	Myrsinaceae	Shrub
25	Shinet	<i>Myricasalicifolia</i> A. Rich.	Myricaceae	Tree and Shrub
26	Kega	<i>Rosa abyssinica</i> Lindley	Rosaceae	Tree and Shrub
27	Weyinagift	<i>Pentasschimperia</i> (A. Rich.) Vatke	Rubiaceae	Shrub
28	Asita	<i>Erica arborea</i> L.	Ericaceae	Tree and Shrub
29	Kushele	<i>Echinops pappii</i> Chiov.	Asteraceae	Shrub
30	Azamir	<i>Bersama abyssinica</i> Fresen.	Melanthaceae	Shrub
31	Bisana	<i>Croton macrostachyus</i> Del.	Euphorbiaceae	Tree
32	Agam	<i>Carissa spinarum</i> L.	Apocynaceae	Shrub
33	Gesho	<i>Rhamnus prinoides</i> L'Herit.	Rhamnaceae	Shrub
34	Yeferenjitid	<i>Cupressus lusitanica</i> Miller	Cupressaceae	Tree and Shrub
35	Merez	<i>Acokanthera schimperi</i> (A. DC.) Schweinf.	Apocynaceae	Shrub
36	Yedegaamija	<i>Hypericum revolutum</i> Vahl	Guttiferae	Shrub
37	Tunjat	<i>Otostegia tomentosa</i> A. Rich.	Lamiaceae	Shrub
38	Derofes	<i>Debregeasia saeneb</i> (Forssk.) Hepper and Wood	Urticaceae	Shrub
39	Ticha chenger	<i>Hibiscus crassinervius</i> Hochst. ex A. Rich.	Malvaceae	Shrub

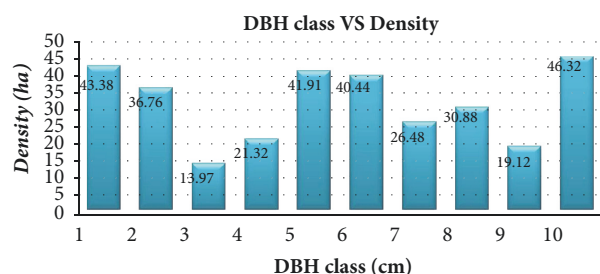


FIGURE 2: Cumulative diameter class frequency distribution of selected tree species DBH class: 1 = 2.5–5cm; 2 = 5.1–10cm; 3 = 10.1–15cm; 4 = 15.1–20cm; 5 = 20.1–25cm; 6 = 25.1–30cm; 7 = 30.1–35cm; 8 = 35.1–40cm; 9 = 40.1–45cm; 10 > 45cm.

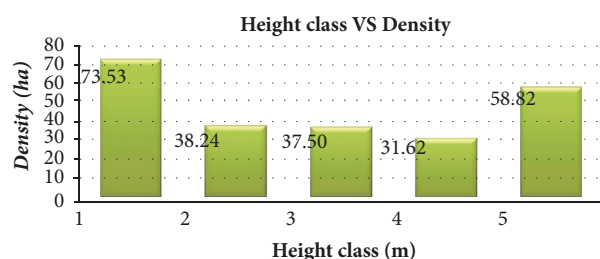


FIGURE 3: Cumulative height class frequency distribution of woody species: class 1 includes < 5 m; 2 = 5–10 m; 3 = 10–15 m; 4 = 15–20 m; and class 5 > =20 m).

trees. This ratio indicates that the number of seedlings and saplings being regenerated in the forest is about more than two times the mature trees of the forest. Analysis of seedlings and saplings of Yemrehane Kirstos Church Natural Forest indicated that the densities of seedlings and saplings of woody plants species of the forest were 415.4 and 514.7 ha⁻¹, respectively. Regeneration status of a forest is poor if number of seedlings and saplings are much less than mature individuals [13]. In this seedling and sapling assessment *Becium grandiflorum*, *Clusia lanceolata*, *Maytenus arbutifolia*, *Olea europaea*, and *Juniperus procera* were found with good recruitment status relative to other species. Generally, good regeneration was more observed for most bush/shrub species than trees.

5. Conclusion and Recommendation

The study provides useful information on the present condition of the woody species diversity, structure, and regeneration status of Yemrehane Kirstos Church Forest. The forest has a large number of woody species bound with a high diversity. The woody species of the Yemrehane Kirstos Church Forest were dominated by *Juniperus procera*, and the most economical and ecologically important woody species in the forest was *Acokanthera schimperi*. However, the renewal of species through the regeneration was not adequate; the vulnerability of young plants to disturbance has caused slower replacement into tree size class.

6. Recommendation

The Yemrehane Kirstos Church Forest is currently being exploited by the local people. This calls for the need of serious attention for conservation and management of this forest. Hence the following recommendations are made to meet these objectives:

- (i) Subsequent ecological studies are vital concerning species composition, diversity, and distribution of possible plant communities with respect to other environmental factors.
- (ii) Raising awareness among local communities of the value of forest resources and ecological consequences of deforestation.
- (iii) Creating mechanisms such as participatory forest management by which human impacts can be minimized, through discussion and consultation with the local communities.
- (iv) Based on the finding, the forest has to be managed for biological diversities found in the area and for carbon sequestration.
- (v) The present study was limited to diversity, structure of woody species, and regeneration status; thus, further studies on soil seed bank, seed physiology, herbaceous plants, and land use management system in the area are needed.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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