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Woody plant species composition, structure, and regeneration status of ruruki forest of Liban Jawi District, West Shewa Zone, Oromia Regional State, Ethiopia

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Abstract

The study was conducted to assess the woody plant species composition, population structure, and regeneration status of Ruruki Forest. A total of 30 sample plots, each 20 m × 20 m, were established using a systematic sampling method. A sub-plot of 5 m × 5 m was used to count saplings and seedlings. To describe the vegetation structure of the study forest we computed DBH and height size frequency distributions of individuals and species importance value indexes (IVI).A total of 70 woody species which categorized into 64 genera, and 45 families were identified of which 57.14% were trees, while shrubs and lianas cover37.14%and5.7%, respectively. The total density of woody species recorded was 868.33 individuals / ha. The highest IVI index was recorded for *Syzygium guineense* species, indicating the species is ecologically important. The results of height showed that there was a greater predominance of small-sized individuals of woody species than large-sized woody species for the study forest. The general pattern of the DBH class distribution of the forest showed an irregular distribution, which implies there was some selective cutting of individual woody species for different purposes. The overall regeneration status of the forest was found to be fair. Generally, the result obtained from this study shows that there is disturbances and selective cutting of trees in the forest. Hence, there is a need for full participation in sustainable forest management to control selective cutting and to apply the best forest management practices, such as reforestation and afforestation.

Keywords Biological diversity, Species composition, Regeneration status, Structure

Introduction

Forests provide numerous ecological advantages, including biodiversity conservation and climate regulation [1]. It plays an important role in providing key ecosystem services to local populations, including energy, food security, and the development of the agricultural sector and GDP [2]. Yet, the world's forest resources continue to decline at a worrisome rate for many reasons as time goes on. In Ethiopia, the depletion of forest resources across various regions is occurring more rapidly because of multiple influencing factors [3].

Ethiopia's woodland areas have faced significant degradation and deforestation as a consequence of expanding agricultural land, urban growth, fuel wood consumption, lumber operations, and excessive grazing, leading to a substantial decline in forest biodiversity and ecosystem functions [4]. For thousands of

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years, ongoing deforestation and resulting land degradation have posed significant challenges, primarily driven by agricultural growth, excessive grazing, and unsustainable harvesting of timber products [5]. In addition to deforestation, logging and timber extraction are responsible for over 52% of forest degradation, followed by fuel wood collection and charcoal production at 31%, uncontrolled fires at 9%, and live stock grazing at 7% in tropical ecosystems [6].

A study indicates that, in Ethiopia, land degradation has affected around 23% of the total land area during the past three decades [7]. The exploitation of woody plant species as a result of human usage poses a serious danger to biodiversity globally. Changes in plant diversity, particularly those that result in loss of vegetation complexity, have an impact on soil's ability to restore nutrients. Today, forest degradation is increasing in many regions, and the world suffers from global warming, which is driven by climate change. According to a study conducted by [8] and [9], trees such as *Podocarpus falcatus, Croton macrostachyus, Olea europaea,* and *Acacia abyssinica* have severely declined in population throughout the forests of Ethiopia, which might result in significant environmental and economic consequences.

Furthermore, understanding the composition, structure, and regeneration status of woody species in forest ecosystems is essential for monitoring forest resources, conserving threatened species, and identifying their ecological importance and status [10].

Therefore, assessing the condition of a specific forest and determining appropriate management strategies are essential for its long-term sustainability. Understanding the regeneration status of the forest is crucial for forest management, as it indicates both the current condition of the forest and potential future changes [11]. Here, conservationandmanagementpracticeshaveasignificantimpactontheforest'sabilityto regenerates [11]. Better forest regeneration leads to higher species richness and variety, both of which are essential for biological diversity [12].

In general, research into vegetation composition, species diversity, and vegetation structure analysis is critical for providing information on forest species richness and diversity. Studying the composition, structure, and regeneration of woody species provides insights for forest management and helps to understand forest ecology and ecosystem services [13]. Never the less, insufficient data exists regarding the present condition of the Ruruki Forest, which is essential for formulating efficient management and conservation plans. This includes the diversity of woody plant species, flora composition, structure, and regeneration status of the forest. Consequently, in order to offer baseline data for the development of sustainable forest management approaches, this investigation is being done to assess the species composition, structure, and regeneration state of woody plants in Ruruki Forest.

Materials and methods

Study area description

The study was carried out at Ruruki Natural Forest in Liban Jawi district, West Shewa Zone, Oromia National Regional State, Ethiopia, which is situated approximately 169 km west of Addis Abeba, 55 km west of Ambo town, and 7 km from the district center (Babicha). It is located at 8055′30"to 90 0′0"N and 37,029′0"to 37,033′0"E (Fig. 1). The forest's elevation spans between 2398 and 2474 m above sea level (Liban Jawi district agricultural office, unpublished).

Temperature and rainfall are the two most essential components of climate, and they have a significant impact on the environment. These two essential climate factors were gathered using data acquired by the National Meteorological Service Agency. In accordance with meteorological statistics, the average yearly temperature in the research area was around 18 °C. The usual monthly lowest and highest temperatures in the study area were 16 and 21 degrees Celsius, respectively. The hottest months were May and June, with a maximum temperature of 21 °C and 20 °C, respectively, while the coldest month was August, with a minimum temperature of 14 °C. The average annual rainfall was estimated to be 1300 mm (Ethiopia Meteorological Service Agency, unpublished).

The vegetation type in the area is dry, evergreen afromontane forests. The study site was dominated by *Syzygium guineense, Maytenus arbutifolia, Olinia rochetiana, Bersama abyssinica, Teclea nobilis, Croton macrostachyus,* and *Calpurnia aurea.* The forest covered an area of roughly 72 hectares. Human activity has affected this forest for various reasons, including the gathering of fuel wood, construction, agricultural land expansion, and the production of charcoal and timber. In that study forest, there are no significant altitudinal differences. The difference between lower and middle altitudes, as well as middle and upper altitudes, is less than fifty. This suggests that altitudinal range may have no impact on the composition, structure, and regeneration status of woody plant species in the forest.

Methods

Reconnaissance survey

In order to obtain pertinent data on the diversity of woody plant species, population structure, and the status of forest regeneration, a reconnaissance survey was carried out in October 2023. Following the prior research,

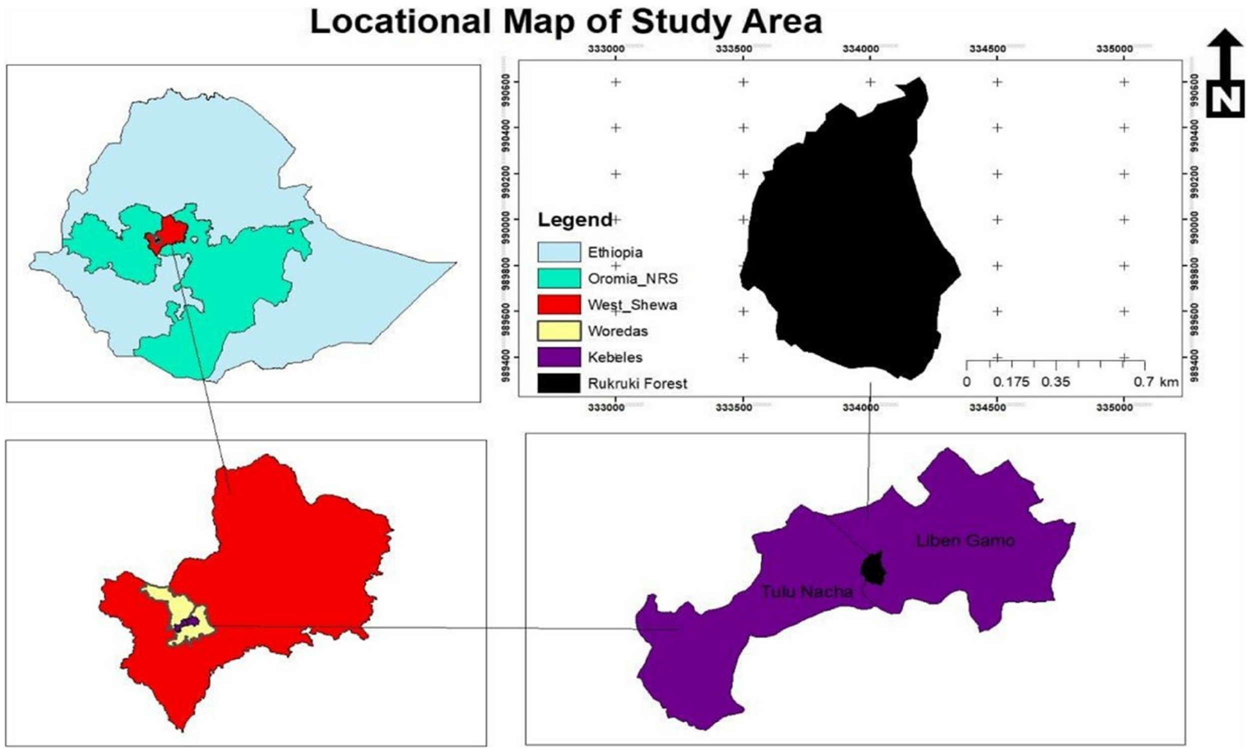

Fig. 1 Location map of the study area

the transect lines were established for the purpose of collecting data [14].

Sampling methods

Plots were established in order to collect data on woody species from the study site. A systematic sampling technique was utilized to collect data. Five transect lines were placed at 200-m intervals, and six plots were established at 100-m intervals along each transect line. A total of 30 sample plots were taken from the studied forest. A species accumulation curve was used to verify that the data sample for the entire plot was sufficient. Along each transect line, 20 m x 20 m sample plots were established in order to gather data on trees, shrubs, and lianas. For collecting seedlings and sapling data, five sub-plots of5 m x 5 m per plot, four at each corner and one at the midpoint of each main plot, were established [15–17]. To minimize the border effects on the forest's woody species, a 30 m border effect was left (Fig. 2).

Woody vegetation data collection

Woody species data were gathered in each sampling plot within the forest stand using the procedures provided in the International Forestry Resources and Institutions (IFRI) Research Program at Indian University [18]. Each species was recorded using the local name and then later documented by scientific names with the support of professional foresters and botanists from Ambo University, as well as using reference sources like useful trees and shrubs of Ethiopia [19].

Trees and shrubs having a DBH >5 cm and a tree height >2 m were measured and noted in each 20 m× 20 m plot. In the case of multi-stem shrubs, the diameter and height of the dominant shoot were measured and recorded. Every seedling and sapling in every 5 m ×5 m sub-plot was counted and recorded. DBH of trees and shrubs was measured using a caliper, while clinometer was used for height measurement.

For that study, the trees include woody species that have a single erect stem (DBH >5 cm and height >2 m) and shrubs include woody species having multiple stems. Saplings include woody species with a diameter of 2.5–5 cm and height of 1–2 m, while seedlings refer to woody species that have referred to a collar diameter <2.5 cm and height <1 m, [20]. A physiographic variable such as altitude was recorded for each sampling plot using GPS.

Vegetation data analysis

Woody species composition

The entire composition of woody species within their respective genera and families was determined. The

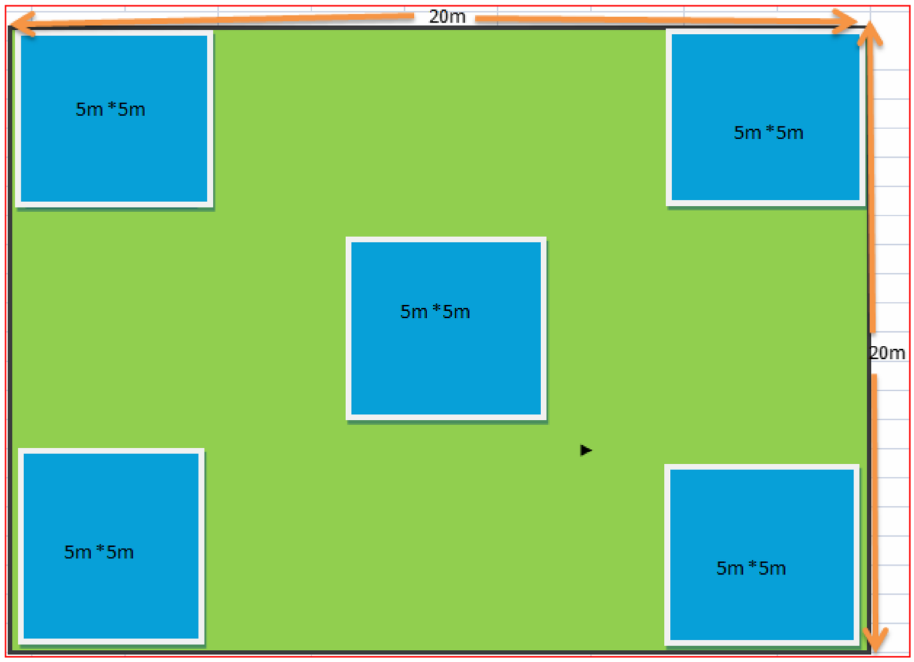

Fig. 2 Design of main plot and sub-plots for biomass collection

habits of the gathered woody species were also classified as trees, shrubs, and lianas. The data acquired was used to analyze the diversity of woody species using Microsoft Excel and SPSS software version 16.0. The woody species composition and variety of plant species in the forest were assessed using diversity indicators such as species richness, diversity, and evenness.

The Shannon–Wiener Diversity Index (H'), and Evenness or Equability Index (E) were used to estimate the diversity of woody species in natural forests.

Shannon–Wiener Diversity Index (H'): It is the best index used to measure woody species diversity because it accounts for both species richness and evenness. Moreover, the Shannon–Wiener Diversity Index is not influenced by sample size [21].

The Shannon–Wiener Diversity Index was calculated as:

$$\mathbf{H'} = -\sum_{\mathbf{i}}^{\mathbf{n}} (\mathbf{pi} * \mathbf{lnpi}) \quad (1)$$

Where H', is Shannon–Wiener Diversity Index S = is the number of species.

Pi = n/Nis the proportion of individuals found in the ith species n = number of individuals of a given species.

N = total number of individuals found.

Evenness (E): which is the ratio of observed diversity to maximum diversity [22] was calculated as:

$$E = \Sigma \text{ pi lnpi} / \ln S = H'/\ln S = H' / \text{Hmax} \quad (2)$$

E = is species evenness.

H' = is Shannon–Wiener Diversity Index.

S = is the number of species found when all sample plots are united.

Pi = is the proportion of total individuals in the i^{th} species.

LnS = is the natural logarithm of the total number of species.

Species richness (S): It was calculated by summing up the total number of woody plant species that identified in the sample plot. It was calculated by the below equation.

$$\mathbf{S} = \Sigma n \quad (3)$$

Where, *n*; is the number of species in a community.

Woody species structure analysis in Ruruki forest

The structure of woody species is vital for identifying the existence of rare or threatened species for conservation and management planning [23]. Diameter at breast height (DBH), basal area (BA), relative density, evenness, frequency, and important value index (IVI) illustrate the vegetative structure of woody plant species [24] and [25]. Subsequently, the study forest in their woody plant structure was determined by computing the following variables:

Density, relative density, frequency, relative frequency, relative abundance, importance value index, basal area, DBH class distribution, and height class distribution.

Woody species density analysis

The density and relative density of woody species were determined using the equations provided below;

$$\text{Density} = \frac{\text{Number of individuals woody species}}{\text{Sum of all plot areas}} \quad (4)$$

$$\text{Relative density} = \frac{\text{Total number of individuals of species}}{\text{Total number of individuals of all species}} \times 100 \quad (5)$$

Woody species frequency

The frequency and relative frequency of the examined forest were determined using the following formula.

$$\mathbf{Frequency} = \frac{\text{Numberofquadrantsinwhichaspeciesoccur}}{\text{Totalnumberofquadrantssampledinthestudyarea}} \times 100 \quad (6)$$

$$\mathbf{Relative\ frequency} = \frac{\mathbf{FrquencyofSpecies}}{\mathbf{Frequencyofallspecies}} \times 100 \quad (7)$$

Dominance and relative dominance of Woody species analysis

The dominance of a species is often measured using the Basal Area (BA), which represents the total cross-sectional area of tree stems per unit area. Relative dominance expresses the dominance of a particular species as a proportion of the total dominance of all species in the area.

$$Dominance = \sum Basal\ Area\ of\ all\ individuals\ of\ a\ species\ per\ hectare \quad (8)$$

$$\text{Relative dominance} = \frac{\mathbf{BasalareaofSpecies}}{\mathbf{Totalbasalarea}} \times 100 \quad (9)$$

Importance Value Index (IVI) analysis

The Importance Value Index (IVI) for each woody species was computed using the following formula [26]:

$$\text{IVI} = \text{Relative density} + \text{Relative frequency} + \text{Relative Dominance} \quad (10)$$

Diameter class distribution analysis

The DBH classes of woody species of the forest were analyzed based on collected data.

Height class distribution analysis

The height classes of the study forest were analyzed based on the values of individual tree heights that were measured during data collection.

Basal area (BA) Analysis

Basal area of trees and shrubs with DBH ≥ 5 cm was calculated by the below formula:

$$\text{BA} = \frac{\pi di^2}{4} \quad (11)$$

where, d = diameter at breast height.

Regeneration data analysis

The regeneration status of sample species in the forest was analyzed by comparing seedlings with saplings and saplings with mature tree data [27]; [16] and [17] as the below categories:

i. Good regeneration; if occurred in seedling > sapling > mature tree;
ii. Fair regeneration; if occurred in seedlings > or ≤ saplings ≤ adults;
iii. Poor regeneration; if a species survives only in the sapling stage, but not as seedlings (saplings may be ≤ or ≥ adults)
iv. None; if a species is absent both in sapling and seedling stages, but present as mature.
v. V. New; if a species has no mature, but only sapling and/or seedling stages.

Results and discussions

Woody species composition and diversity of the study forest

A total of 70 woody species belonging to 64 genera and 45 families was recorded and identified from 30 plots in the study forest (appendix 1). Fabaceae was the dominant family, with 7 (10%) species, followed by Oleaceae, which has 5 (7.14%) species. Three families each had three (4.29%) species, nine families each had two (2.86%) species and 31 families each had one. In general, 14 families with 7, 5, 3, and 2 species

Table 1 List of Families, Species, and Genera of the Ruruki forest

Family	Species Number	Percentage	Genera Number	Percentage
Fabaceae	7	10	6	9.38
Oleaceae	5	7.14	3	4.69
Euphorbiaceae	3	4.29	3	4.69
Rosaceae	3	4.29	3	4.69
Asteraceae	3	4.29	2	3.13
Acanthaceae	2	2.86	2	3.13
Apocynaceae	2	2.86	2	3.13
Celastraceae	2	2.86	2	3.13
Flacourtiaceae	2	2.86	2	3.13
Myrsinaceae	2	2.86	2	3.13
Rutaceae	2	2.86	2	3.13
Sapindaceae	2	2.86	2	3.13
Anacardiaceae	2	2.86	1	1.56
Moraceae	2	2.86	1	1.56
Other	31	44.29	31	48.44
Total	**70**	**100**	**64**	**100**

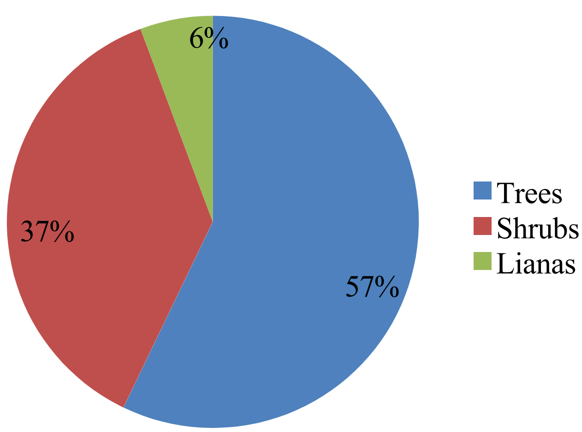

Fig. 3 Percentage composition of woody species of Ruruki forest

accounted for 55.71% of the total species, whereas 31 families with only one species accounted for 44.29% (Table 1 and appendix 2).

Dominance of Fabaceae has been documented from different floristic surveys done by numerous investigators at various times [28] and [29]. Fabaceae might have gotten the top dominant position probably due to having efficient pollination and successful seed dispersal mechanisms that might have adapted them to a wide range of ecological conditions in the past [29]. However, the variation in topography and environmental conditions like the amount of rainfall and temperature could be the causes of variation in dominance positions of plant taxa. Similarly, the results recorded from Ruruki Forest showed that the Fabaceae were the most dominant family.

Of the seventy woody species found in the research region, trees accounted for forty of the species; shrubs and liana accounted for twenty-six and four species, respectively (Fig. 3). This finding demonstrated that trees were adding more species to the total number of woody species found in Ruruki Forest. This indicates that trees were quite adaptive and can endure a variety of environmental conditions that impact woody species.

In Ruruki Forest, the woody plant communities had an evenness value of 0.83 and a Shannon Wiener diversity (H') of 3.42. This finding indicates that the investigated forest has high species richness, evenness, and Shannon Wiener diversity. Forests with the highest evenness values indicate that tree species within those forests are uniformly distributed throughout the sampled plots. The Shannon Weiner diversity value of the Ruruki forest was contrasted to other Ethiopian forests that had been previously examined. The resulting value was compared to the Shannon Weiner diversity of Woynwuha natural forest (H'= 3.24) and Wof-Washa forest (H'= 3.25), as reported in studies by [30] and [31], respectively. In this comparison, the Shannon–Wiener diversity of woody species in Ruruki Forest was higher than that reported from Woynwuha Natural Forest and Wof-Washa Forest.

Structure of woody species in Ruruki forest

Density of woody species in Ruruki forest

The overall density of woody species observed in the forest was 868.33 individuals per hectare (appendix 3). The ten most prominent woody species contributed a density of 535 individuals per hectare. *Syzygium guineense* was the major woody species contributing to the total density of woody species, with 86.67 individuals per hectare (Fig. 4). The studied forest had a greater overall density than Wofa Forest (698.8 individuals/ha) [31] and Boditi Forest (498 individuals/ha) [32]. However, it had a lower woody species density compared to Werganbula Forest (1,012.35 individuals/ha) [33] and Hugum burdian Forest (1,218 individuals/ha) [34].

Frequency of woody species in Ruruki forest

Among all woody species, *Croton macrostachyus* was the most commonly occurring species in all plots, with a frequency of 100%, followed by *Syzygium guineense* (90%) and *Olinia rochetiana* (90%). In Ethiopia, these species thrive in the *Kolla* and *Woyna Dega* agroclimatic zones across all regions, at altitudes ranging from 1,200 to 2,600 m above sea level [35]. In line with this, the altitude of Ruruki Forest ranged from 2,398 to 2,474 m above sea level, which might be favorable for these species.

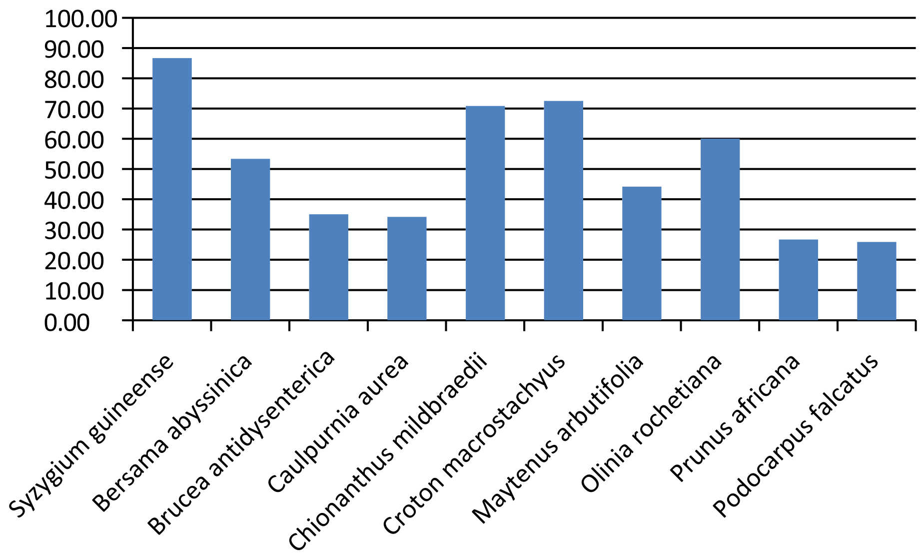

Fig. 4 Density of woody species in Ruruki Forest

Table 2 Dominance of Woody Species in Ruruki Forest

Scientific name	DO	RDO
Syzygium guineense	14.52	44.59
Ekebergia capensis	4.01	12.32
Olinia rochetiana	3.02	9.27
Croton macrostachyus	2.59	7.96
Prunus Africana	1.28	3.92
Chionanthus mildbraedii	1.02	3.12
Schefflera abyssinica	1.00	3.08
Vernonia auriculifera	0.66	2.02
Ficus sur Forssk	0.65	1.99
Teclea nobilis Del	0.53	1.63
Others	3.29	10.11
Total	**32.56**	**100.00**

According to [35], the number of frequency classes may potentially be a sign of uniformity in the composition of forests. The current investigation found that a comparatively small number of species were found in high frequency classes and a large percentage of species in lower frequency classes. Consequently, the outcome confirms that Ruruki Forest has a significant degree of species heterogeneity.

Dominance of woody species in Ruruki forest

The total analyzed dominance result for Ruruki Forest was approximately 32 m2/ha for woody species with DBH >5 cm. Dominance is a measure of the relative importance of species within the forest. Species with higher dominance can be considered the most important species in the study forest. In this study, dominance analysis across individual species revealed a high level of domination by a few woody species. *Syzygium guineense species* was the dominant species followed by *Ekebergia capensis (*Table 2 Overall, the dominance values for Ruruki Forest were higher than those recorded for Yemrehane Kirstos Church Forest [35].

Importance Value Index (IVI) of woody species

The Ruruki Forest's important value index was examined in order to compare the ecological significance of various woody species. According to [36], the leading dominant species in the designated vegetation are those with the highest important value index. In the forest, species with higher IVI were more prevalent than those with lower IVI, with fewer of each [37].As a result of the IVI obtained from the forest, the dominant and ecologically important woody species were *Syzygium guineense*, *Croton macrostachyus*, *Olinia rochetiana*, *Ekebergia capensis*, and *Chionanthus mildbraedii* due to their higher importance value index relative to the other woody species in the study area.

Among those dominating woody species, *Syzygium guineense* was the most ecologically important woody species, followed by *Croton macrostachyus* and *Olinia rochetiana* in the Ruruki forest (Table 3 and Fig. 5).

Diameter class distribution

The diameter class distributions of woody species in the study area were analyzed and classified into twelve DBH classes. The DBH class distribution of all individuals of

Table 3 Important value index of woody species in Ruruki Forest

Scientific name	Relative Density	Relative Frequency	Relative Dominance	IVI
Syzygiumguineense	9.98	4.86	44.59	59.44
Croton macrostachyus	8.35	5.41	7.96	21.72
Oliniarochetiana	6.91	4.86	9.27	21.04
Ekebergiacapensis	1.82	1.98	12.32	16.13
Chionanthusmildbraedii	8.16	4.68	3.12	15.96
Bersamaabyssinica	6.14	4.68	1.35	12.18
Maytenusarbutifolia	5.09	4.32	1.11	10.52
Prunus Africana	3.07	2.34	3.92	9.33
Bruceaantidysenterica	4.03	4.50	0.09	8.62
Others	46.45	62.34	16.27	125.06
Total	**100.00**	**100.00**	**100.00**	**300.00**

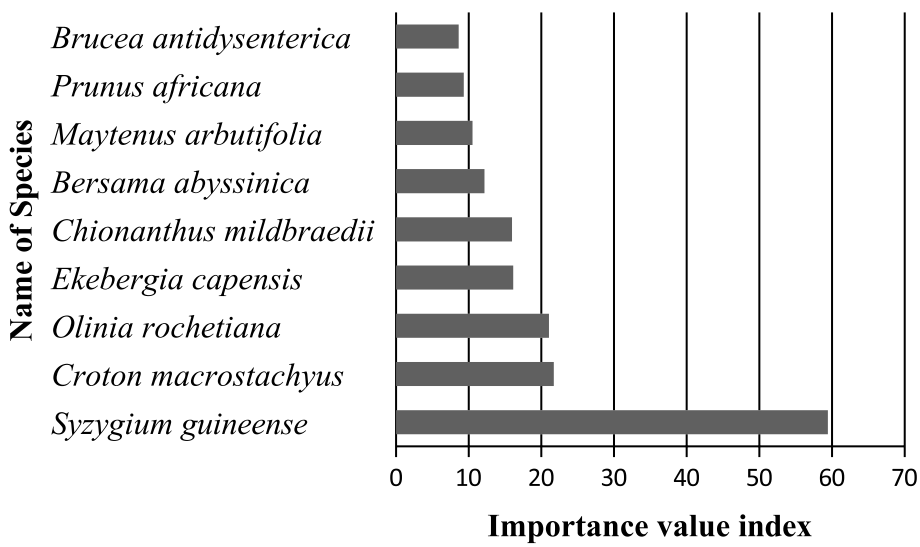

Fig. 5 Important value index of woody species in Ruruki Forest

each species counted in the samples was grouped into twelve [12] diameter classes with 6 cm intervals. Accordingly, < 6 cm, 7–12 cm, 13–18 cm, 19–25 cm, 26–31 cm, 32–37 cm, 37–42 cm, 43–48 cm, 49–54 cm, 55–60 cm, 61–66 cm and > 66 cm were the DBH classes (Fig. 6).

Accordingly, the highest number of woody species was recorded in the second DBH classes, followed by first and fourth classes, while the least were recorded in the tenth and ninth classes.

The pattern of diameter class distribution indicates overall tendencies in population dynamics and recruitment procedures for a certain species. The overall pattern of the DBH class distribution in the forest reveals an uneven distribution of species, implying selective removal of individual woody species for various purposes. As a result, the current finding implies that woody species with lower diameter class distributions in Ruruki forest have a high potential for reproduction and recruitment. Similar results were found from several Afromontane vegetations in Ethiopia [38] and [29].

Height class distribution

The height classes were classified as intervals with 3 m intervals, and nine height classes occurred. Those height classes were organized as 2–5 m, 5.1–8 m, 8.1–11 m, 11.1–14 m, 14.1–17 m, 17.1–20 m, 20.1–23 m, 23.1–26 m and > 26 m. The distribution of individuals in the different height classes was recorded in the second class distribution (Fig. 7). The results showed more woody

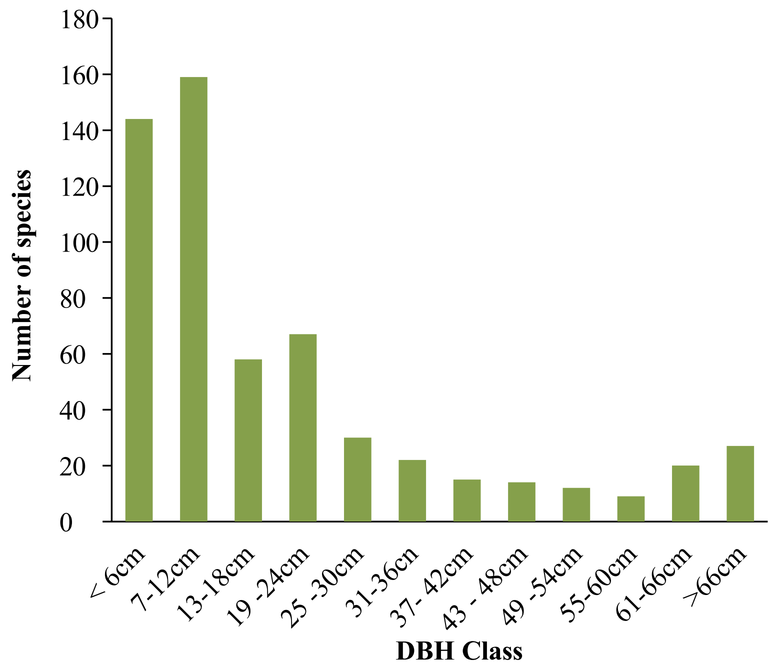

Fig. 6 Diameter (DBH) classes of woody plant species in study area

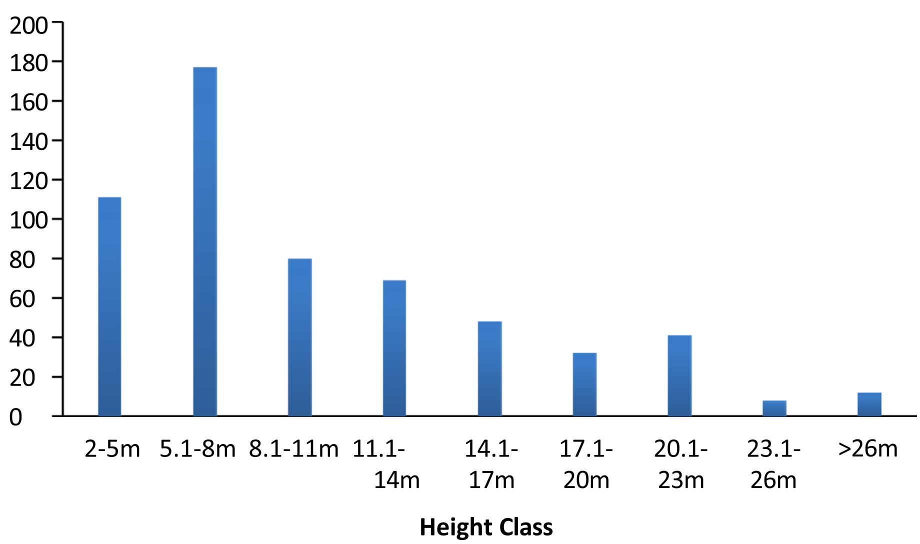

Fig. 7 Height classes' classification in study area

species in small-sized individuals than large-sized woody species. The least number of individuals were recorded in the eighth and ninth classes.

The distribution of tree species across height classes toward the lower classes revealed a predominance of small individual trees in the forest, suggesting characteristic features of the forest type [39].

Basal area of woody species

The basal area provides the measure of the relative importance of the species rather than the simple stem count [26]. The study forest yielded a total basal area of 32.5598 m^2(Table 4). *Syzygium guineense* supplied the most basal area to the overall basal area of the forest, with a recorded value of 14.5188 m^2 (44.59%), followed by *Olinia rochetiana* and *Ekerbergia capensis*, having recorded values of 4.0114 m^2 and 3.0175 m^2, respectively

Table 4 Basal area of woody species in studied forest

Scientific name	Basal Area/ha	Percentage
Syzygium guineense	14.5188	44.59
Ekebergia capensis	4.0114	12.32
Olinia rochetiana	3.0175	9.27
Croton macrostachyus	2.5926	7.96
Prunus Africana	1.2750	3.92
Chionanthus mildbraedii	1.0155	3.12
Schefflera abyssinica	1.0013	3.08
Vernonia auriculifera	0.6572	2.02
Ficus sur	0.6483	1.99
Tecle anobilis	0.5308	1.63
Others	3.2915	10.11
Total	32.5598	100.00

with an estimated value of 0.0022 m^2, *Maytenus arbutifolia* and *Asparagus africanus* donated the least basal area. According to [26] basal area has an impact on IVI, which is a metric used to compare the ecological significance of different species.

A high IVI value denotes a high degree of sociological organization within the species'forest. This basal area values for the current forest were generally higher than those of some other studied forests in Ethiopia, including 15.85 m^2 $ha^{-1}$for Yegof forest [40] and 22.3 m^2ha^{-1} for Zengena forest [41] and lower than 64 m^2 ha^{-1} for Wofwasha forest [31]. This suggests that the Ruruki forests have better growth and the potential to retain higher biomass.

Regeneration status of Ruruki forest

The composition and density of seedlings, saplings, and adult woody plant species were utilized to assess the forest's regeneration state [35]. According to [42], the distribution pattern where the density of the seedlings exceeded the total density of the saplings, and the total density of saplings is less than that of mature trees/shrubs, shows that the regeneration status of the studied vegetation is fair. As a result, the density of seedlings, saplings, and adults recorded in the forest were 258 (24.76%), 198 (19%), and 586 (56.24%) individuals/ha, respectively (Fig. 8). This result pattern of seedlings, saplings, and mature trees/shrubs indicates that the currently studied forest is in fair regeneration. The reproduction capability of seedling > sapling < mature tree is as shown (Fig. 8).

Conclusions and recommendations

Overall, Ruruki Forest was diversified by numerous woody plants species. For the purpose of the study, a total of 70 species of woody plants, classified into 64 genera and 45 families, were gathered. Of these 70 kinds of woody plants, trees accounted for 57.14%, while shrubs and lianas made up 37.14% and 5.71%, respectively. In the process of collecting data on woody plant species, it was discovered that there is no uniform distribution of all species across plots in terms of species kinds, height, and DBH. A single tree species (*Croton macrostachyus*) was found in all plots. The majority of species were categorized in the lower height classes. The overall pattern of the DBH class distribution in the studied forest was uneven. The regeneration status of the studied forest was classified as 'fair' regeneration conditions and requires some management.

Based on the findings, the following recommendations were forwarded;

Active engagement in forest management is necessary to uphold the benefits that forests offer. The community should be aware of the benefits of properly managed and preserved forests, as well as the problems that arise when these forests are degraded. The results showed that the forest is disturbed and that certain trees

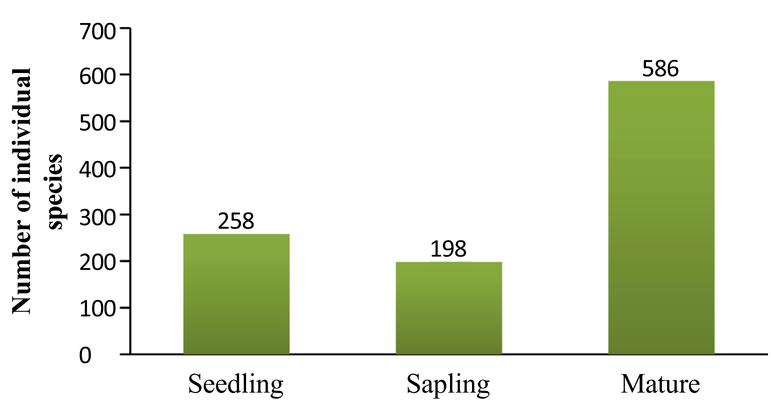

Fig. 8 Graph of regeneration status of the studied forest

are being selectively cut down. This necessitates regular monitoring for effective forest protection and management. Therefore, it is crucial for local and regional administrative bodies to oversee and monitor the forest, invite interested stakeholders including governmental, non-governmental, and private organizations to participate in forest management, implement forest policies, and engage in good forest management practices such as afforestation and reforestation, all of which are essential for the sustainable management of the forest.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12862-025-02375-x.

Additional file 1.

Permissions for collection

No research permit was required for this study. The studies comply with the current laws of Ethiopia. All procedures were approved by the all Health Research Ethics Review Committees (permit no HRERCs – 2020–005).

Authors' contributions

B.B. collected data and wrote the 1st draft Manuscript, T.R. supervised the data collection and S.M. Writing – review & editing, Conflict of interest.

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Data availability

All data supporting the findings of this study are available within the paper and its Supplementary Information.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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