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WOODY SPECIES DIVERSITY, RICHNESS AND POPULATION STRUCTURE OF ENCLOSED AREAS, NORTH GONDAR, ETHIOPIA

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Woody species; diversity; population structure; basal area; Importance value index; Regeneration

A B S T R A C T
This study investigated the species diversity, richness and vegetation structure analysis of Wogello natural forest. For Vegetation data collection, systematic sampling designs were used. A total of 42 quadrants/plots were taken. The result indicated that a total of 20 woody species belongs to 12 families were identified. Based on families, Fabaceae was the dominant family by consists of four species (20%), followed by Apocynaceae two (10%), Oleaceae two (10%) and the rest families share 60% from a total family of the study area. The total basal area was 28.97.3 m2 ha-1. Number of individuals with (DBH) ⩾ 2.5cm and height ⩾ 2 m were 1022 trees ha-1 and for the regeneration it was (6093 individuals ha-1). The overall diameter and height frequency distribution of woody species showed an inverse J- shape. The population structure of the study area was determined by selecting five species based on their Importance Value Index (IVI). The result indicated that three population structure distribution. Inverse J-shaped, Bell shaped and Broken inversed J-shaped

1. Introduction

Ethiopian land was covered by dense forestry and the high land are endowed with diversity and vegetation dynamics such as clearing forest for cultivation, overgrazing and exploitation with our replacement have reduced the forestry area which is estimated to be 2-3% at present (ICRAF,1998) and the rate of deforestation is estimated to be 200,000 ha/yr (FAO *et.al.*, 1998 and subsequently, large are of the forest estimate of 1-2 billion m3/yr (FAO,1981) resulting massive deforestation and trees have been subjected to repeated man made damage , natural disaster and some study indicated that the species growing around stream, and rivers have already vanished. North Gondar is well known composing natural forest resources mainly for ecological restoration providing direct use value of fuelwood for a couple of decades. Many farmers now days use community forest in the enclosed area sometimes they use the enclosed area for livestock feed and other service function.

Ecological restoration by plantation and enclosure are the only option of reversing land degradation which is observed in the high land of Ethiopia which was practiced as a common activity for the last three decades by involving the community tree planting. Some studies indicated that most farmers interest rely on planting and managing woody species around their home for fuelwood and pole production and many enclosed are in such area did not tell us about species distribution and abundance. simply farmers look after the area for long period until the area recovered very well and regenerate it, which species provide natural regeneration and soil seed bank for seedling emergence ultimately better ecological succession by

improving the ecological balance of the area

Based on the above facts, the local farmers utilise the current forest resources especially on the enclosed and degraded area while still it lacks information about tree diversity and use value. Thus, current climate change and deforestation rate threatening the vast potential of forest resources in the last decade especially trees providing multifunction are disappearing gradually. This implies that not only future ecological risk analysis the area faces but also other economic challenges will also be observed. Therefore, this paper aims on determining woody species composition and diversity of the study area as well as analyze the woody vegetation structure.

2. Materials and Methods

2.1. Study site description

This research was conducted in wogello natural forest, North Gondar administration zone of Amhara Regional state, Ethiopia. It is one of the most degraded areas in the state (Wassie et al., 2010). It is around 30 Km far away from Zonal capital and around 694 Km North of Addis Ababa. Wogello Forest consists of both plantation and natural forest

2.2. Sampling and Sampling Design

Different field equipments were used during fieldwork. For tree (Diameter and height) measurements such as Caliper, meter tapes, hypsometer. To avoid confusion, chalk was used to mark trees. GPS, compass with 360-degree scale (suunto), and tally sheet were used. A reconnaissance survey was conducted to collect basic information such as site condition and area of the forest to determine the sampling size. A systematic sampling method were used in homogenous vegetation stands along an altitudinal gradient (Lamprecht, 1989). All woody plants (Trees and shrubs), which have a diameters ≥ 2 cm and ≥ 2m height were measured. Diameter measurements were done at breast Height (DBH). Three sample sites were established in three different forest states based on altitude differences. Each forest site consists of 14 quadrants measuring 10 x 10 m =100 m^2 based on (Gering et al., 2003) were taken. A total of 42 quadrants were taken for Wogelo Natural Forest. Sample plots established at 50 m interval along a serious of transects and distance between transects were 30 m and within each plot were 30m. The diameter was determined by using calipers, but for those trees which has big diameter, measurement was done using tape meter. For regeneration, Trees which have < 2 cm or height < 2m are counted in each compartment. Tree height was measured using a suunto-clinometer. Altitude and longitude of each sample plots were measured using GPS (Geographical Position System) (Fisaha et al., 2013; Kebede et al., 2013).

2.3. Data collection

All Woody species in each quadrant were recorded. The plant specimen with their local name collected and identification were performed in the National Herbarium, Addis Ababa University. Identification of woody species was performed by referring the publication volume of flora and Ethiopian and Eritrea (Edwards et al., 1997; Bekele, 2007). Seedlings of each tree species were counted to estimate the regeneration status of Wogello Natural Forest.

2.4. Data Analyses

Wogello Natural Forest species diversity and richness were calculated using the Shannon- Wiener diversity index (PEET, 1974; Gering et al., 2003)

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

Where,

H = Shannon diversity index,

Pi = the proportion of individuals or the abundance of the ith species expressed as a proportion of a total cover

K = the number of species,

ln = logbasen

Evenness or Equitability can be calculated based on (Peet, 1974)

Evenness = (D - Dmin) /(D max - D min) (2)

Evenness = (D/Dmax) (3)

Where, D = a heterogeneity value for the sampled population,
Dmin = the minimum values possible for the given species number and
Dmax = the maximum values possible for a given species number
But for this study purpose, the most common and widely used methods for Evenness were based on (Pielou, 1966) as follows
J= H'/H' max Where, (4)
J= Evenness,
H'= Shannon-Wiener diversity index and
H 'max = lns where s is the number of species
Simpson's Index (D)
According to (Gering et al., 2003), the value of Simpson's Index is always less than one and it is the chance that two similar species to be selected from the sample.
It is calculated as follow

$$1- \sum pi2 \quad (5)$$

Important Value Index (IVI)
All woody species population was examined by estimating Frequency, relative Frequency, density, relative density and Dominance (basal area). Important Value Index (IVI) measure to asses and compare the overall significant it considers several property of the species and those species which have a higher Importance Value Index shows the dominant tree in the study area and it calculated as follows based on (Lamprecht, 1989; Kent and Coker, 1992; Tauseef et al., 2012).
IVI = Relative density + relative dominance (basal area) + relative frequency (6)
But Relative density = Density of each species *100 (7)
Total Density
Relative dominance or basal area = basal area of each species *100 (8)
Total basal area
Relative frequency = Frequency of each species * 100 (9)
Total Frequency of species
Relative density defined as the number of all individuals of a species/ the total number of all individuals (DBH≥ 2 cm) times 100; whereas relative dominance (basal area) is defined as the basal area of the species /total basal area times 100 (DBH≥ 2 cm) and relative frequency is the number of plots, where a species occurs/the total occurrence of all species in all of the plots times 100. Basal area was calculated using the cross sectional area of a tree trunk measured at diameter at breast height (DBH, 1.3 m height) (Didita et al., 2010).
Basal area = Πd2/4 , Where, Π= 3.14, d= Diameter at breast height in cm
Software used
Analysis of data was carried out using quantitative methods. Species richness and diversity analysis were done using Shannon-Wiener diversity index and Simpson's Index. R version 3.2.1 software at a significant level of 5% was performed to analyze differences of species along altitudinal gradients and Diameter- Height curve. R version 3.2.1 software was used to draw histograms for diameter and height distribution of woody species. Excel 2007 was also performed to see the mean diameter and mean height of the stand.

3. Result

3.1. Stand diversity

3.1.1. Species area curve

Species area curve shows that the relationship between the area and the number of species found within that area. It is very important to determine the sufficiency of the sample plot (Gering et al., 2003).

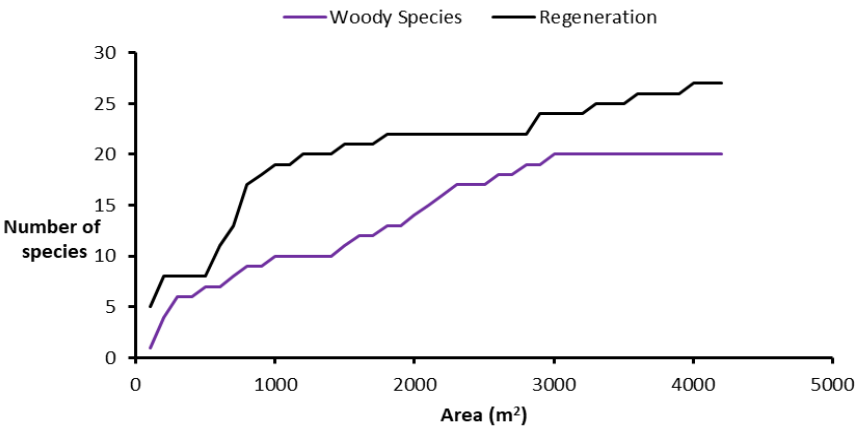

Fig 1. Species area curve of Wogello Natural Forest, North Gondar, Ethiopia

In the above graph, the pattern of curve increases the number of species with increasing areas up to 3000 m^2 for woody species (dbh $\geq$ 2.5 cm) and up to 2000 m^2 for regeneration) since species diversity will increase with the increasing of area (Rosenzweig, 1995). But after 3,000 m^2 the species area curve seems constant. Therefore, generally it can be concluded that sample plots were sufficient and it can give information about the composition, diversity and dominant tree species in the study area.

3.1.2. Woody species composition

Wogello natural forest woody species composition was assessed. For this study purpose, a total of 42 quadrants or sample plots were used and each sample plot contain an area of 100m2 (10 x 10 m). A total 20 woody species were identified. The total density of wogello natural forest was (1022 trees ha-1). Abundance, dominance, frequency and Important Value Index (IVI) of the study area were calculated. In Wogello natural forest, the species with the highest Importance Value Index (IVI) were *Allophylus abyssinics* (55) and followed by *Acacia Abyssinica* (38), *Euclea racemosa subsp. schimperi (*37), *Olea europeana (*29), *Terminalia brownii* (23) *and Carissa spinarum (*21) occupied the higher importance value index (IVI) and those species with higher IVI are considered as more significant than species with low IVI (Zegeye et al., 2005).

3.1.3. Tree species diversity

Diversity will be high if the species distributed evenly but only a few species dominate the area, the diversity will be low (Pielou, 1966). In Wogello natural forest 20 woody species and 12 families was recorded

SHANNON Index (H')

Wogello Natural Forest species diversity and richness were calculated using the Shannon- Wiener diversity index (See Equation 1) (PeeT, 1974; Gering et al., 2003) Whereas for Evenness or equitability calculation, the most common and widely used methods based on (Pielou, 1966) (See equation 4) and for Simpson's Index (See equation 5) (Gering et al., 2003). Shannon - Wiener diversity and evenness index woody species was 2.71 and 0.26 respectively which means woody diversity and evenness was high.

The Shannon diversity and Evenness index of Wogello natural forest was higher due to large number of rare species (Schemitt et al., 2010).

3.1.4. Basal Area

Total Woody species basal area was 28.97.3 m^2 ha^{-1}. More than 52 % of the basal area was shared by three species, *Allophylus abyssinics* 7.5 m^2 ha^{-1} (26 %), *Euclea racemosa subsp. schimperi 4.5* m^2 ha^{-1} (15 %), and *Croton macrostachyus* 3.2 m^2 ha^{-1} (11%). whereas the rest species share 13.7m^2 ha^{-1} (48 %) from a total basal area.

Based on families, *Fabaceae* was the dominant family by consists of 4 species (20%), followed by *Apocynaceae* 2 (10%), *Oleaceae* 2 (10%) and the rest families share 60% from a total family of the study area.

Table 1: The most common tree species ranked by their Importance Value Index of Wogello Natural Forest based on a complete enumeration of all Woody tree species with diameter at breast Height (dbh) at ≥ 2.5 cm in Wogello Forest, North Gondar.

RRank	Species	Abundance ($N\ ha^{-1}$)	Dominance ($m^2\ ha^{-1}$)	Frequency (%)	IVI
1	*Allophylus abyssinics*	169	7.6	21	55
2	*Acacia Abyssinica*	178	1.1	29	38
3	*Euclea racemosa subsp. schimperi*	116	4.5	18	37
4	*Olea europeana*	128	1.89	18	29
5	*Terminalia brownii*	64	2.7	13	23
6	*Carissa spinarum*	119	0.1	16	21
7	*Calpurnia aurea (Alt.) Benth*	57	2.2	12	20
8	*Croton macrostachyus*	36	3.2	6	18
9	*Dodonaea viscosa*	50	0.35	14	14
10	*Domeya torrida subsp. torrida (D. goetzenii)*	16	0.9	6	8
Others 11- 20		89	4.43		37
Total		**1022**	**28.97**		**300**

Table 2: Family of the dominant woody species of Wogello Natural Forest based on a complete enumeration of all Woody tree species with a diameter at breast Height (dbh) at ≥ 2.5 cm in Wogello Natural Forest, North Gondar, Ethiopia.

No	Family	No. of Species	No. of Individuals
1	*Fabaceae*	4	249
2	*Apocynaceae*	2	131
3	*Oleaceae*	2	135
4	*Sapindaceae*	2	298
5	*Sapindaceae*	2	219
6	*Euphorbiaceae*	2	50
7	*Anacardiaceae*	1	7
8	*Combretaceae*	1	64
9	*Sterculiaceae*	1	16
10	*verbenaceae*	1	2
	Others 11-12	2	125
	Total	**20**	**1296**

Table 3: Shannon Index and Simpson's Index, of Wogello Natural Forest, North Gondar, Ethiopia.

Land use	No. of Trees/ha	No. of Species	Shannon Index (H')	Simpson's Index		Evenness (J)
				D	1-D	
Wogello Natural Forest, Ambober North Gondar	1022	20	2.71	0.06	0.94	26

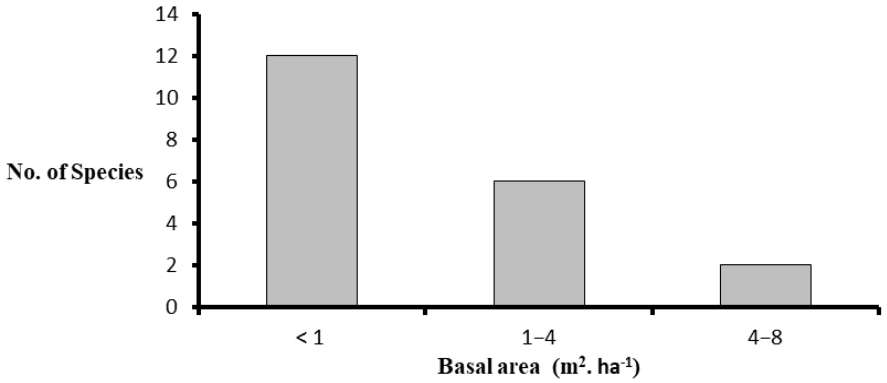

Fig. 2: Basal area and number of Woody species of wogello natural forest, North Gondar, Ethiopia.

3.2. Stand Structure

3.2.1. Diameter distribution and Stand height

Diameter distribution play a significant role in forest science and used to determine the optimum selective cutting, that improves the stand structure (Zheng and Zhou, 2010; Sheykholeslami et al, 2011). Both diameter and Height distribution of the study area showed that an inverted -J shaped which means that high number of individuals in the lower diameter class and very few numbers of individuals in the high diameter classes. On the other hand, the diameter of the trees increases with decreasing of the number of individuals. This is a general pattern of normal distribution (Didita et al., 2010). Based on result shown in the diameter frequency distribution graph, 85.5 % Diameter at breast height, DBH class 2 - 6.9 cm followed by 10.3 % DBH class 7 - 11.9 cm and the rest share only 4.5 % from a total diameter frequency distribution. This means that the study area were dominanted by low sized trees or shrubs species such as *Dodonia viscosa, Croton macrostachyus a*nd *Carissa spinarum.* Generally, this pattern of diameter distribution indicated that good regeneration status of the forest (Teketay, 1997). On the other hand, according to Gondar Zuria Agricultural office annual report, there was illegal cutting of tree for different purposes such as timber, construction and fuel wood. Therefore, this selective cutting of a forest leads to decrease in the number of trees in the higher diameter class (Zegeye et al., 2010; DWARD, 2013 unpub; Kebede et al., 2013).

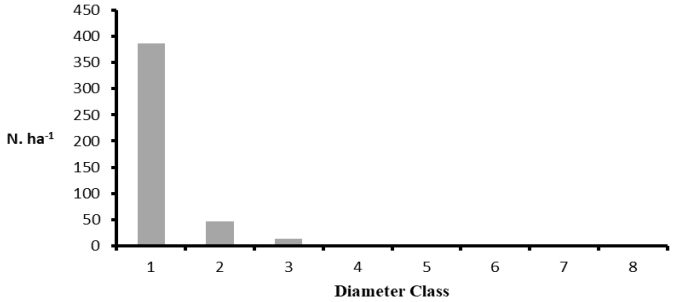

Fig.3 Diameter frequency distribution of Woody species of Wogello Natural Forest, Ambober, North

Gondar, Ethiopia. DBH classes (1= 2 - 6.9 cm; 2 = 7 - 11.9 cm; 3 = 12 - 16.9 cm; 4= 17 - 21.9 cm; 5 = 22-26.9 cm; 6 = 27 - 31.9 cm; 7 = 32 - 36.9 cm; 8 = 37- 41.9 cm;

Similar type of diameter distribution results was reported by (Yineger et al., 2008; Didita et al., 2010; Zegeye et al., 2011; Tadele et al., 2013; Tesfaye et al., 2013; Dibaba et al., 2014; Kebede et al., 2014).

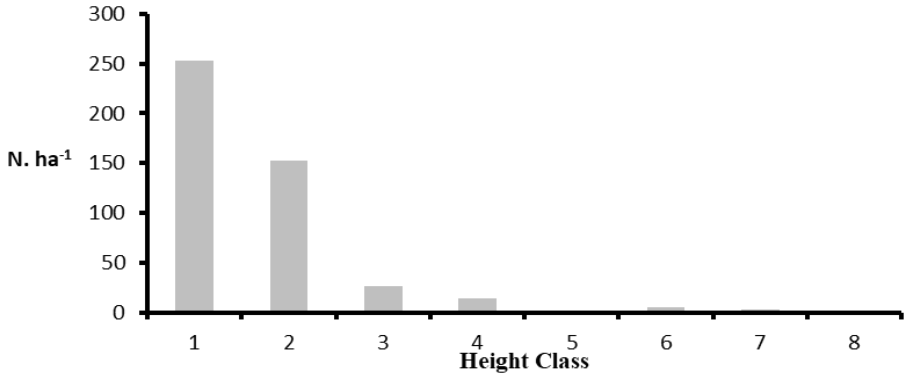

Fig.4 Height frequency distribution of Woody species of Wogello Natural Forest, Ambober, North Gondar, Ethiopia. Height classes (1= 2 - 4 m; 2 = 4 - 6 m; 3 = 6 - 8 m; 4= 8 - 10 m; 5 = 10 - 12 m; 6 = 12 - 14 m; 7 = 14 - 16 m; 8 = 16 - 18 m.

3.2.2. Species Population structure

Investigation of diameter at breast height (DBH) and Height distribution gives evidence for the regeneration status of the natural forest (Senbeta and Teketay, 2001). The diameter and height distribution of all individuals showed an inverted J-shape distribution (Fig 4&5). However, this pattern cannot indicate the general trend of a given species. Therefore, Analysis each species will give more information and used for conservation measures. Based on this, five species were selected based on their Importance Value Index (IVI) to determine the population structure of the study area. *Allophylus abyssinics, Acacia Abyssinica Euclea racemosa subsp. schimperi, Olea europeana* and *Terminalia brownii* Species with highest basal area lead to high relative dominance which contributed to the highest Importance Value Index (IVI).

Inverse J- Shape*: Acacia Abyssinica, Euclea racemosa subsp. schimperi and Terminalia brownii* classified under Inverse J- shape. This indicated that high number of individuals in the lower height class.

Bell- Shape*:* Species such as *Allophylus abyssinics and Olea europeana* shows a Bell-shape height distribution. This showed that high number of individuals in the middle class and gradually decreases in both sides of lower and higher height classes.

3.3. Natural regeneration

3.3.1. Abundance and frequency of natural regeneration

Seedling with diameter at breast height (DBH) < 2.5 cm and height < 2 m were counted and considered as a seedling (regeneration). The result indicated that 6092 ha^{-1} consists of 22 species were found. Number of individual (density) of wogello natural forest (5397 individuals. ha^{-1}) was higher compared with woody density of Biyo-Kelala (1746 and 2215 individuals. ha^{-1} enclosure and open area respectively) (Mengistu et al., 2004) and Gedo Dry Evergreen Montane forest (1068 individuals. ha^{-1}) (Kebede et al., 2014). et al., 2013).

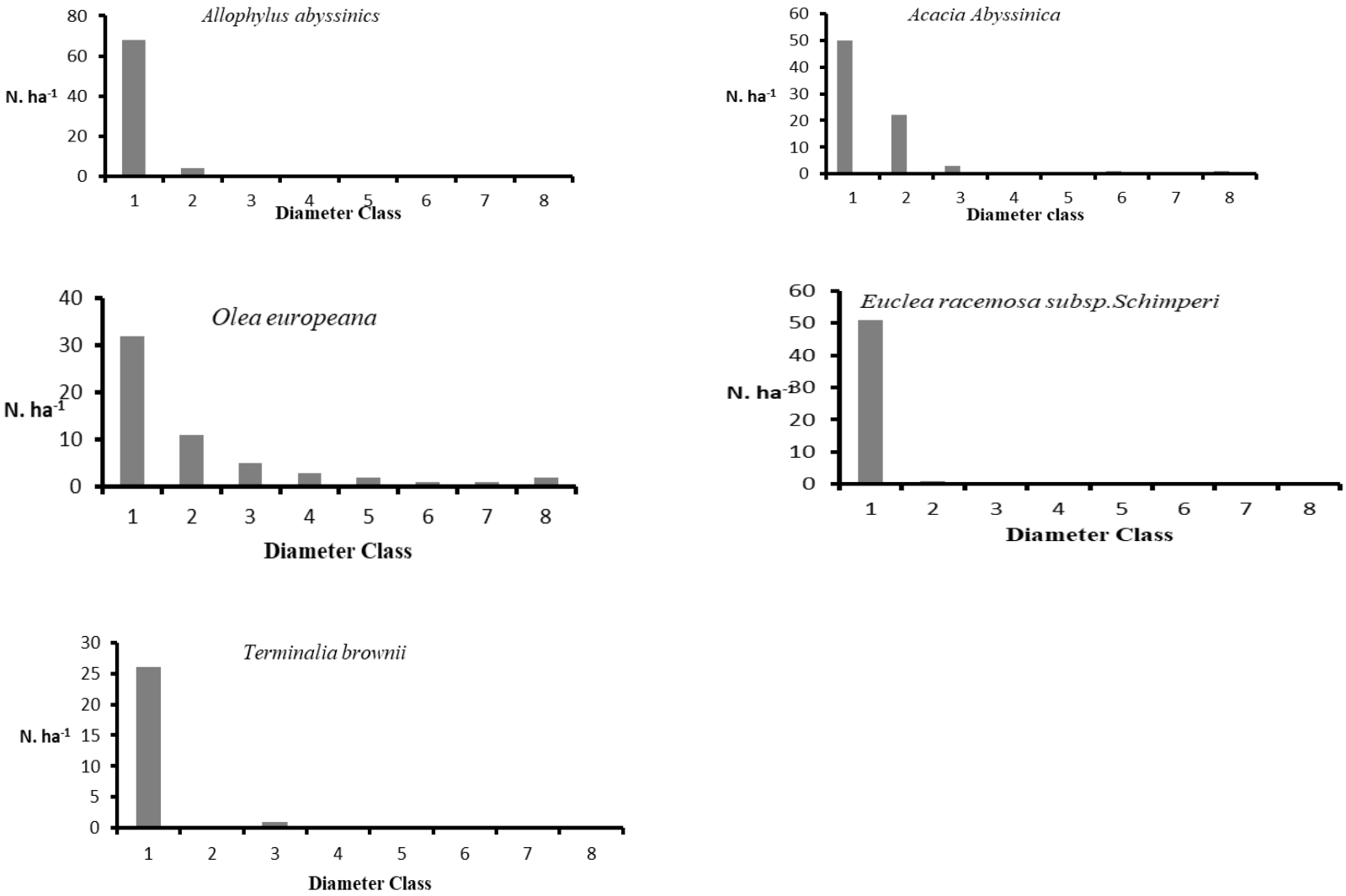

Fig.5 Species population structure of selected five woody species based on diameter frequency distribution DBH classes (1= 2 - 6.9 cm; 2 = 7 - 11.9 cm; 3 = 12 - 16.9 cm; 4= 17 - 21.9 cm; 5 = 22- 26.9 cm; 6 = 27 - 31.9 cm; 7 = 32 - 36.9 cm; 8 = 37- 41.9 cm;

Height distributions of the selected five species also performed. The species population structure based on height classified into two distribution patterns.

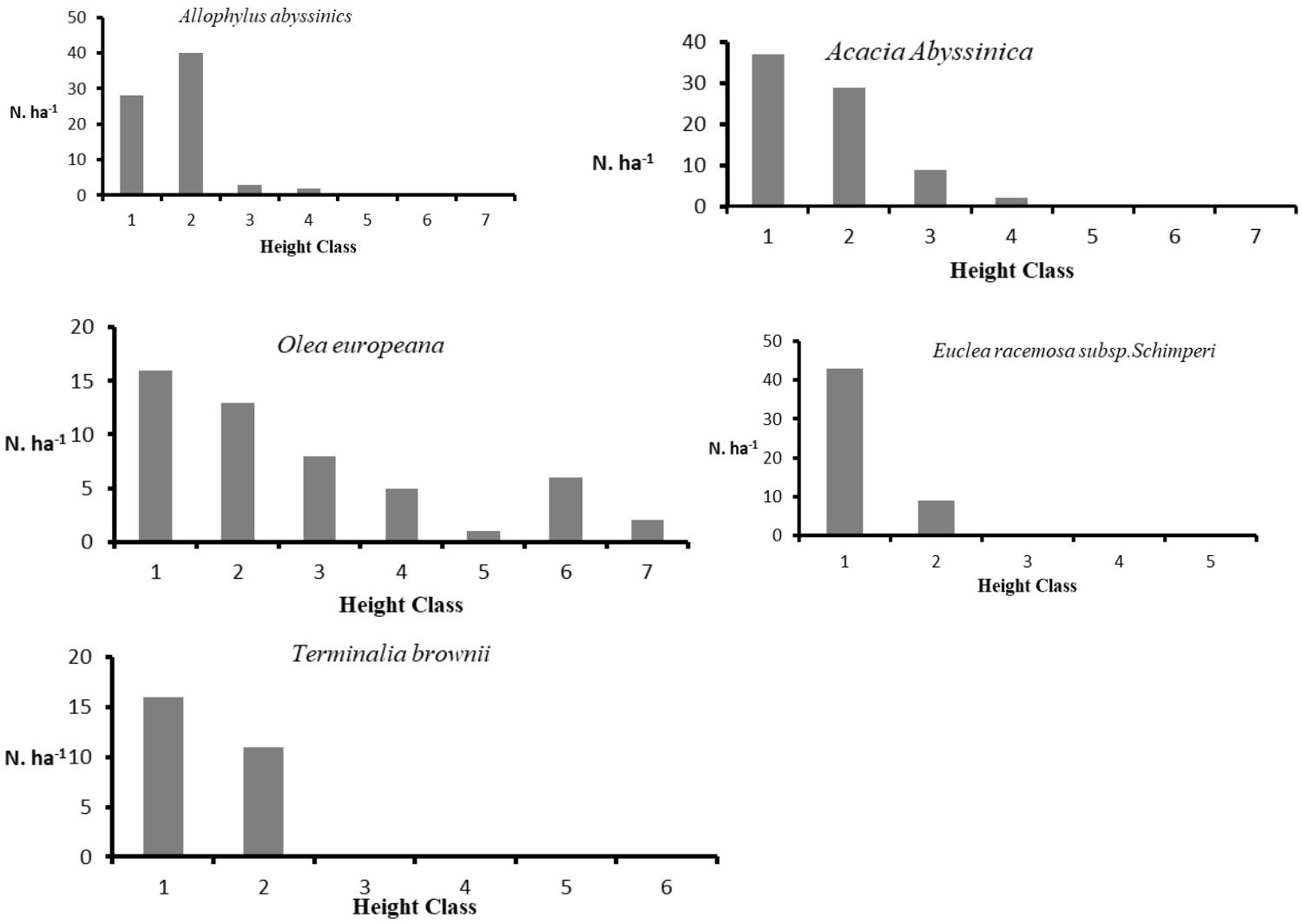

Fig 6. Species Population structure of selected five woody species based on Height frequency distribution of Wogello Natural Forest. Height classes (1= 2 - 4m; 2 = 4 - 6m; 3 = 6 - 8m; 4= 8 - 10m; 5 = 10- 12m; 6 = 12 - 14m; 7 = 14 - 16m)

Table 4 Abundance and Frequency of seedlings for the most abundant species of Wogello Natural Forest, Ambober, North Gondar (DBH < 2.5 cm and Height < 2 m)

No	Scientific name	Abundance (N. ha^{-1})	Frequency (%)
1	*Dodonaea viscosa*	2590	100
2	*Calpurnia aurea (Alt.) Benth*	1076	88
3	*Terminalia brownii*	474	59
4	*Euclea racemosa subsp. schimperi*	326	64
5	*Carissa spinarum*	307	74
6	*Clutia abyssinica Juab & Spach*	257	12
7	*Olea europeana*	236	45
8	*Pteroloblum stellautm (Forssk) Brenan*	174	50
9	*Acacia Abyssinica*	155	36
10	*Allophylus abyssinics*	117	33
11	*Senna multiglandulosa*	93	24
12	*Vernonia amygdalina*	86	14
13	*Premna schimpri*	71	36
14	*Jasminum grandiflormL*	64	24
15	*Maytenus arbutifolia*	31	7
16	*Acokanthera schimperi*	10	2
17	*Acacia abyssinica subsp. abyssinica*	10	7
18	*Rosa abyssinica*	5	5
19	*Domeya torrida subsp. torrida (D. goetzenii*	5	2
20	*Osyris quadripartite*	2	2
21	*Croton macrostachyus*	2	2
22	*Buddleia polystachya*	2	2
	Total	6092	

4. Discussion

4.1. Woody species composition

Wogello natural forest was higher than the remnant moist Afromontane forest of Wondo Genet (379 ha-1) (Kebede et al., 2013), Wof Washa Natural Forest (698 ha-1) (Fisaha et al., 2013), Boda Dry evergreen Montane Forest (682 ha-1) (Erenso et al., 2014) and Bale National Park, Boditi Forest (498 ha-1) (Yineger et al., 2008). The same finding also reported that *fabaceae* were the dominant family in the Dry Afromontane forest (Mengistu et al., 2004; Didita et al., 2010; Aynekulu et al., 2011; Burju et al., 2013; Tadele et al., 2013; Tesfaye et al., 2014).

4.2. Tree species diversity

It was rich in species composition because species richness indicates that the assets of species in the community (Peet, 1974). The result was similar to Zengena Forest (Tadele et al., 2013). The species richness was higher compared with other dry Afro-montane forests reported by (Abiyu et al., 2011), (15 woody species) and lower than (Lemenih et al., 2004) (33 woody species); (Senbebeta and Teketay, 2001) (42 woody species); (Girma and Mosandl, 2012) (36 woody species) at

Munessa-Shashemene Forest and (Teketay, 1997) (40 and 41 species) at Gera and Menagesha Forest respectively.

4.3. Basal Area

Generally, the basal area of Wogello natural forest was very low even when it compared to the mean basal area of tropical forest 35 m^2. ha^{-1} (Midgley and Niklas, 2004). But it was higher than Bale Mountain National park, Boditi Forest, 23 m^2. ha^{-1} (Yineger et al., 2008), wood land and Riverine vegetation of Sire Beggo in Golocha district (19.3 m^2. ha^{-1}) (Dibaba et al., 2014); Zengena Forest (22.3 m^2. ha^{-1}) (Tadele et al., 2013) and Hugumburda forest (9.23 m^2. ha^{-1}) (Ayenekulu, 2011). The basal area of Wogello Natural Forest (28.97 m^2. ha^{-1}) was less than that of Boda Dry Evergreen Montane Forest (114.6 m^2. ha^{-1}) (Erenso et al., 2014); Belete moist evergreen montane forest (103.5 m^2. ha^{-1}) (Gbrehiwot and Hundera, 2014); Tara Gedam and Abebaye Forest, 115.4 m^2. ha^{-1} and 49.5 m^2. ha^{-1} respectively (Zegeye et al., 2011).

4.4. Stand Structure

4.4.1. Species Population structure

Wogello natural forest species population structures were classified into two population distribution patterns. Inverse J- Shape and Broken Inverse J- shape. illustrated in (Figure 6)

Inverse J- Shape: Allophylus abyssinics, Olea eurpoeana and Euclea racemosa subsp. schimperi, showed Inverse J- shaped distribution, which indicated a Good regeneration status (Teketay, 1997; Yineger et al., 2008; Didita et al., 2010). Inverse J-Shape characterized by its shade tolerant species (Sokpon and Biaou, 2001), which have a high number of seedling and sampling growth stage (Teketay, 2005). High number of individuals in the lower diameter class and gradual it decreases with the increasing of diameter classes. Similar result also reported by (Yineger et al., 2008) at Bale National Park, Dry Afromontane forest.

Broken Inverse J- shaped: - Acacia Abyssinica and Terminalia brownii showed broken Inverse J-shaped which indicated that high number individuals in the lowest diameter class and gradually decrease individuals in highest diameter class even miss individuals in classes (17-26.9) and (7-11.9) for both species respectively, which mean that poor regeneration.

5. Conclusion

A total 20 woody species and 12 families were identified. (1022 individuals /ha) with DBH ≥ 2.5 cm and Height ≥ 2 m. were encountered where as in the regeneration forest 22 species and 6093 individuals. ha^{-1} with DBH < 2.5 cm and Height < 2 m was found. Importance Value Index (IVI) of the study area was calculated and based on the result *Allophylus abyssinics* (55) and followed by *Acacia Abyssinica* (38), *Euclea racemosa subsp. schimperi (*37), *Olea europeana (*29), *Terminalia brownii* (23) *and Carissa spinarum (*21) occupied the higher importance value index (IVI) and those species with higher IVI are considered as more significant than species with low IVI (Zegeye et al., 2005). Based on families, based on families, Fabaceae was the dominant family by consists of 4 species (20%), followed by *Apocynaceae* 2 (10%), *Oleaceae* 2 (10%) and the rest families share 60% from a total family of the study area.

Total Woody species basal area was 28.97.3 m^2 ha^{-1}. Three species shared more than 52 % of the basal area, *Allophylus abyssinics 7.5* m^2 ha^{-1} (26 %), *Euclea racemosa subsp.schimperi 4.5* m^2. ha^{-1} (15 %), and *Croton macrostachyus* 3.2 m^2. ha^{-1} (11%). whereas the rest species share 13.7m^2. ha^{-1} (48 %) from a total basal area. Generally, the basal area of the study area was very low with compare to other forests. The diameter distribution of the study area shows that an inverse -J shaped which means that high number of individuals in the lower diameter class and very few numbers of individuals in the

high diameter classes. On the other hand, the diameter of the trees increases with decreasing of the number of individuals. Species with low Importance Value Index (IVI) such as *Jasminum grandiflormL., Buddleia polystachya, Premna schimpri and Acokanthera schimperi* needs high conservation efforts, Therefore, those rare species should be given big attention and conserve them with the collaboration of the community and government. Woody species basal area was relatively low with compared to another dry montane forest as the result of the low woody species density and illegal cutting of big trees for different purposes. So, some Gaps were created in the forest area. Therefore, it needs forest rehabilitation program through different mechanisms such as enrichment planting because tree planting enhances forest succession through nursing effect.

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Appendix: List of species and their IVI of wogello natural forest, Ambober, North Gondar, Ethiopia.

No.	local name	scientific name	Total number of trees/Ha	frequency	Dominance m2. ha	IVI
1	nech girar	*Acacia Abyssinica*	178	29	1.1	38.07
2	agam	*Carissa spinarum*	119	16	0.1	21.29
3	merenz	*Acokanthera schimperi*	12	3	0.63	5.09
4	woyera	*Olea europeana*	128	18	1.89	29.51
5	dedeho	*Euclea racemosa subsp.schimperi*	116	18	4.5	37.35
6	zegeta	*Calpurnia aurea (Alt.) Benth*	57	12	2.2	20.15
7	ketekita	*Dodonaea viscosa*	50	14	0.35	14.24
8	embes	*Allophylus abyssinics*	169	21	7.6	54.98
9	abalo	*Terminalia brownii*	64	13	2.7	23.14
10	wulekefa	*Domeya torrida subsp.torrida (D.goetzenii)*	16	6	0.9	8.16
11	checho	*Premna schimpri*	2	1	0.18	1.40
12	feyel fegi	*Clutia abyssinica Juab & Spach*	14	2	0.6	4.60
13	beshibesha	*Senna multiglandulosa*	12	4	0.7	5.92
14	bisana	*Croton macrostachyus*	36	6	3.2	18.06
15	misrech	*Clerodendrum myricoides (Hochst.) R,Br.*	7	1	0.23	2.06
16	grawa	*Vernonia amygdalina*	24	2	1.1	7.31
17	kamo	*Rhus glutinosa*	7	3	0.35	3.64
18	tembelel	*Jasminum grandiflormL.*	7	1	0.25	2.13
19	atakuar	Buddleia polystachya	2	1	0.08	1.05
20	kuara	*Erythrina abyssinica*	2	1	0.31	1.85
				172	28.97	300.0