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Assessment of trees species diversity in Gongoshi grazing reserve Mayo-belwa local government area of Adamawa state, Nigeria

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Abstract
This research is entitled on this research Assessment of tree species diversity in Gongoshi grazing reserve Mayo-Belwa Local Government Area of Adamawa State, Nigeria. Data were collected from three plot in Gongoshi game reserve. Parameters evaluated includes, data to examine and identify the woody species diversity in the two forest reserves, frequency, DBH and height of the species, their abundance and distribution within the ecological zone *Hymenocardia acita* having 11 frequency Plot A, *Ficus capensis* having one frequency in Plot B reserve while in Plot C *Detarium microcarpum* having 9 frequency and *Ceiba pentandra* having 1 frequency. Diversity indices and importance value index (IVI) of the species were determined using relevant formulae. Student t-test and Shannon-weiner diversity index. Results from Plot A shows that Adansonia digitata has highest frequency, Basal Area, Relative dominance and IVI with values of 4,0.85, 14.81, 62.66 respectively. Plot B indicated that *Vitellania paradoxa* has values at 2, 0.21, 13.33 and 54.52 respectively while Plot C values were 3, 0.21, 12.50 and 40.05 for Adansonia digitata which recorded highest. Results obtained from totaling frequency, Basal Area, relative dominance, and important value index of Plot A were highest with values 27, 2.59, 100 and 300 followed by Plot C and B respectively. T-test indicated that there was no significant difference in all the variables when paired with one another with 13 degree of freedom. The highest species diversity indices were found in Plot A. these shows that Plot A has good management practice and protection than other Plots i.e. B and C which are in danger to sustainability. Endangered trees species from Plot B and C become low in quantity and genetic quality which will leads to extinction. There should be increase in protection and management practice.

Keywords: Woody species diversity, forest reserve, plots and parameters

Introduction
Forest provides significant economic and ecological benefits in an area. They play important role in protecting soil in water resources and provides a wide range of product and services for the population (Thomas, 2006) [12]. The total number of plant, their types and appearance within the environment make up the vegetation of the area. Thus, vegetation means the plant cover of an area (Thomas, 2006) [12]. Forest are therefore important sources of fuel (firewood and charcoal), timber from the trunk of woody plant is still world's cheapest structural material for building and construction processes (Thomas, 2006) [12]. Species diversity is measured through a combination of species richness (the number of species present) and species evenness (the abundance of each species). Species richness and evenness can be combined into a single indicator, and in ecology the Shannon Index is commonly used, Maliyat and Datt (2010) [9]. Species diversity can be calculated at any many scales, whether for a forest management unit, the whole forest area, regionally, or even nationally. One needs to know the area of the forest and area occupied by each species. This information can be gotten from forest survey and inventory data. Generally the larger the forest area the more species are present, we need to consider this when comparing forests Maliyat and Datt (2010) [9]. Increasing forest tree species diversity is an important component in building our resilience to climate change and to reducing the risk from pests or pathogens damage. Measuring species diversity allows us to: identify forests with lower/higher species Diversity compare the diversity of different potential management approaches track the change in diversity over time FAO (2005) [7]. Forest are also imperative in watershed management and amelioration of unfriendly environment e.g. sand dunes fixation, reduction of soil erosion and desertification control. They also provide food material, raw materials for industries, fodder for animals, recreation opportunities, shelter for wild animals etc. forest also serve as an effective tool in carbon dioxide sequestration and also release oxygen from its

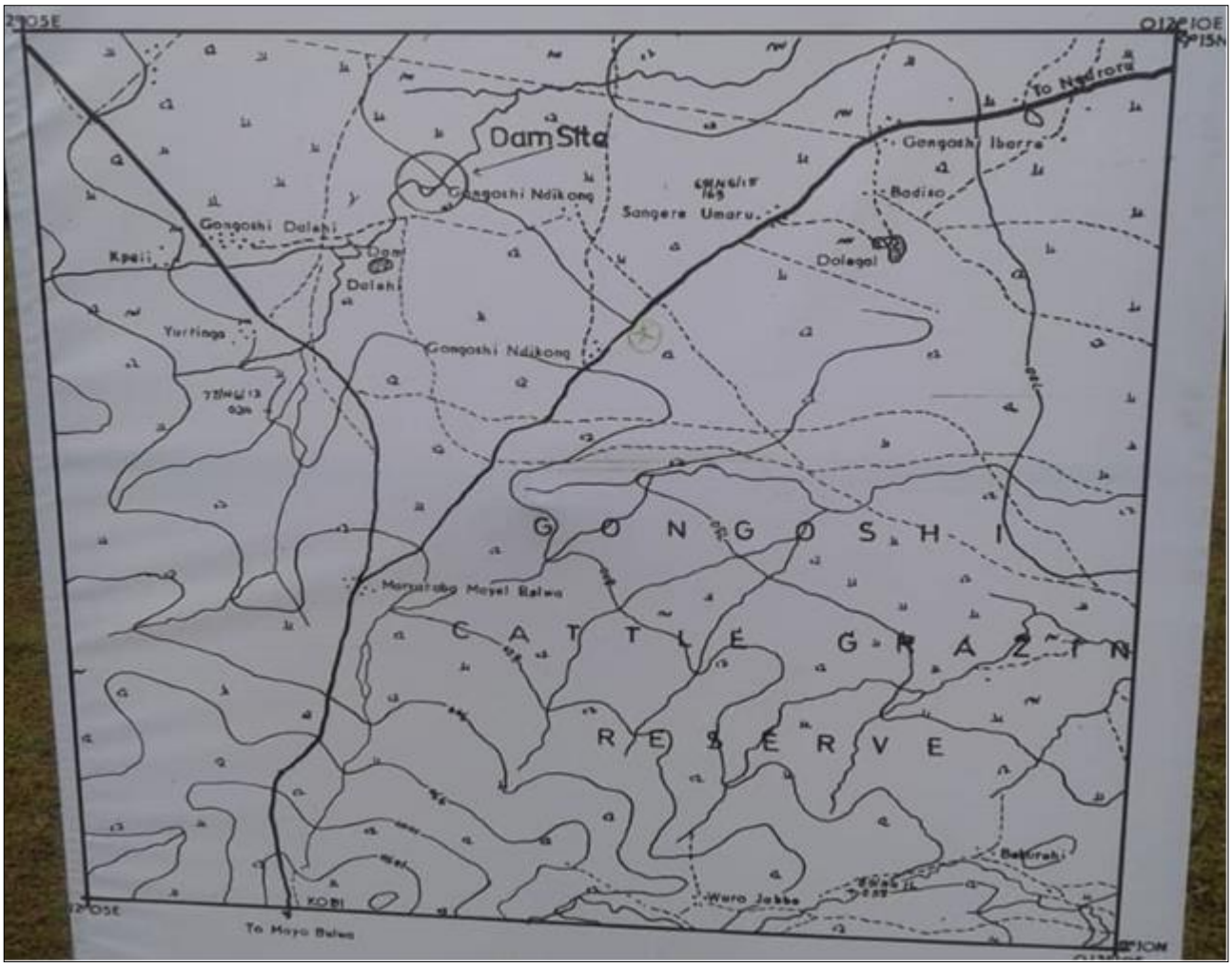
photosynthesis processes which help in maintenance of climate Akosim *et al*, (1999) [1].

Deforestation is one of the drivers of biodiversity loss as well as threat to the existence of the global biological lungs (Salami, 2006) [15]. According to Food and Agriculture Organization (FAOs) and Forest Resource Assessment (2005), each year about 13 million hectares of the world's forest are lost through deforestation or selective logging. The ten most affected countries with the largest net forest lost per year between 2000 and 2005 are; Brazil, Indonesia, Sudan, Myanmar, Zambia, Tazania, Nigeria, Venezuela, DR Congo and Zimbabwe. 37 countries loss 1% or more of their forest each year, while 20 countries gain more than 1% per year between 2000 and 2005 due to the natural expansion of existing forests and afforestation of new lands Food and Agriculture Organization (FAO, 2005) [7]. In Nigeria, population growth together with urbanization and industrialization have put more pressure on the decreasing forest resources which increases demand on renewable natural resources and often resulted to over exploitation (Mainly as food, fuel, fodder, illegal logging, overgrazing etc.) and non-replacement of the natural vegetation Isah, (2005) [8]. Forest reserves where therefore created in order to bind the forest resources through protection and conservation for the use of present generation as well as generation and posterity. The overall objectives of forest reserves in Nigeria includes: production of goods and services, conservation for the future, protection of flora and fauna, gene pool conservation and research purpose. Other objectives as are recreation purposes, environmental protection and production of timber and non-timber products Bello, (2013) [2].

Materials and Methods

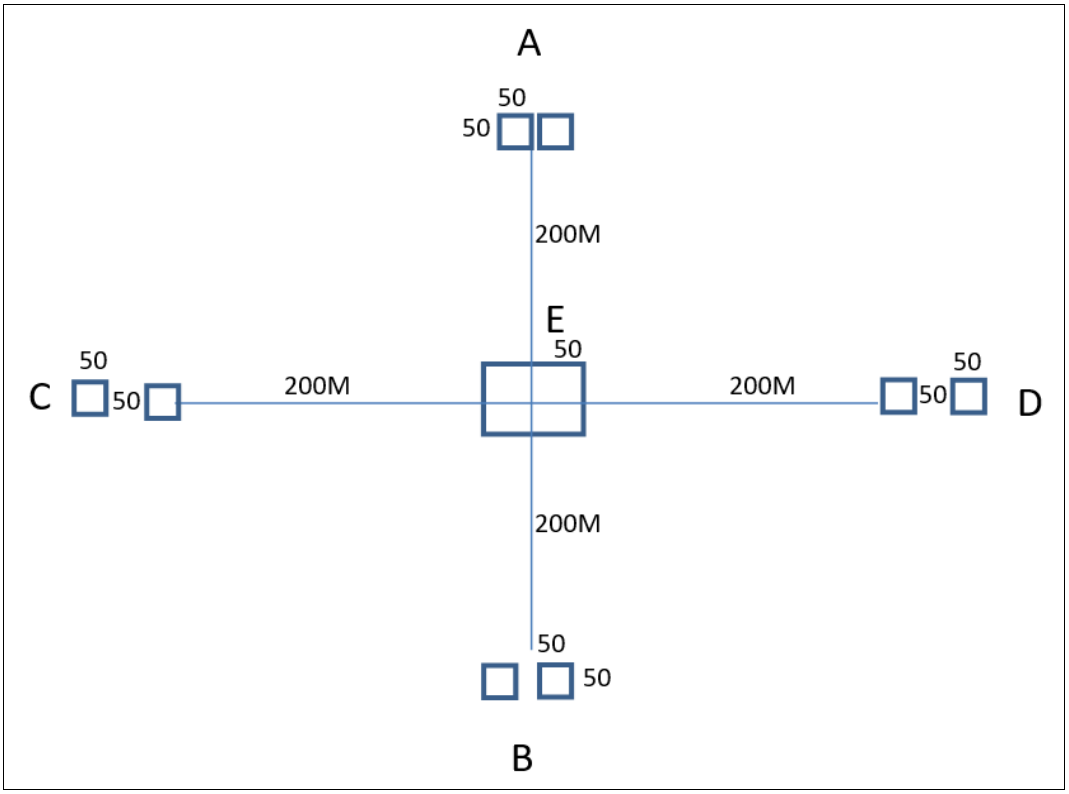
Location of Gongoshi Grazing Reserve

Gongoshi grazing reserve is located at Mayo-belwa local government area of Adamawa State at latitude 8^0 33' – 9^0 12' N, Longtitude 11^0 4' – 12^0 11' E. The total land area of Mayo-Belwa is about 1,702.45km^2 from Yola the headquarters of Adamawa State. The temperature is 33.5^{0}C maximum and 20.7^{0}C. It has an average rainfall of 1,022mm. Its major settlements are Mayo-Belwa, Mayo-farang and Tola, with a population of about 216,405. Its bordered by Ganye to the south, Jada to the southeast, Fufore to the northeast, Demsa to the north and Taraba to the west Durrani, (2005) [6].



***Source**:* Department of Agric Mayo-belwa Local Government Area

Fig 1: Map of Gongoshi Grazing Reserve



Data were collected through selected points where tree diversity is in abundance in the reserve. A number of 10quadrate of 50x50m^2 was laid along the transects in the reserve whereby the grazing was divided in North, South, East, West and the equator , two quadrants of 50x50m^2 were laid in each and 200m interval between the equator to each pole in the reserve.

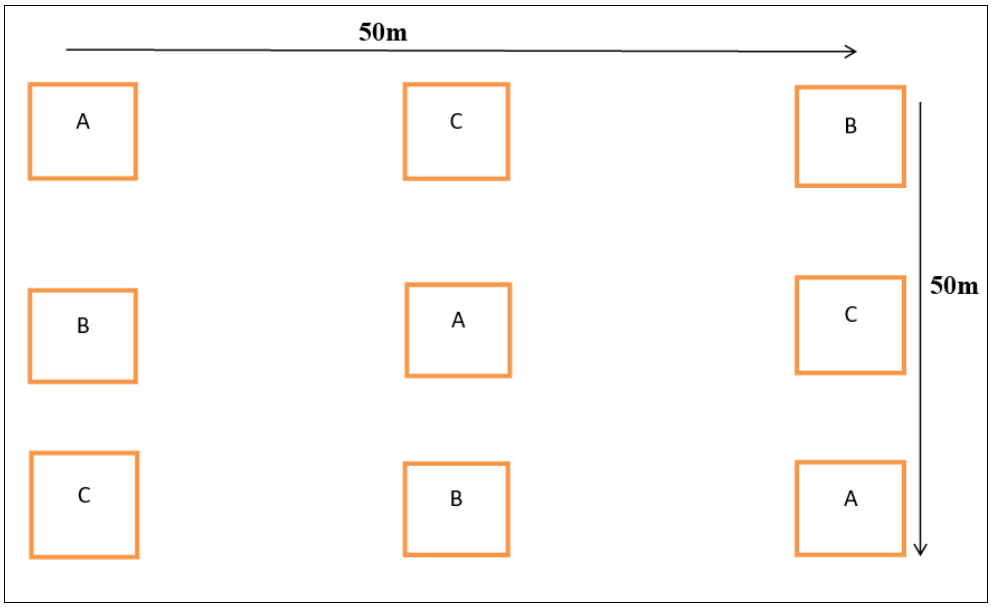
The following variables were identified.

1. Checklist of tree species
2. Identification of the tree species in each sample plots
3. Species frequency

Results were presented in table and chats for frequency

Sampling Techniques and Study Design

The sampling techniques that stratified random sampling while the experimental design was Randomized Completely Block Design (RCBD).



Data Analysis

1. Species relative frequency (FR) for each tree species was computed by the formulae;

$$\text{Relative frequency} = \frac{ni}{N} = \frac{ni}{\sum ini}$$

Where;

ni= Sampling Mean

N= the total Mean

Σini= the total number of Sampling Mean

2. Relative Dominance of species will be calculated usi ng the following formulae;

$$RDo = \left(\frac{\sum BA_i \ X \ 100}{\sum BA_n}\right)$$

Where;
RD = Species Relative Density
RDo = Relative Dominance
BA_i = Basal Area of the individual tree belonging to a particular species I,
BA_n = Standard basal area of all species

3. Shannon's Species Diversity Index
Charles (1989) [5] reported that one of the best methods of determining species diversity index is to use Shannon's formula of 1948 and that of Weaver and Shannon (1949). This is mathematically computed as follows:

$$H^i = \sum_{i=1}^{n} Piln\ (Pi)$$

Where;
H = Shannon diversity index
Σ = the total number of species in the community
P = the proportion of a species to the total number of plant in the community.
Ln = the natural logarithm

4. Species Richness will be calculated by the formula

$$d = \frac{S}{\sqrt{N}}$$

Where:
S = number of species in a collection
N = number of individual s collected

Species Evenness
Species evenness refers to how close in number species in an environment are. It is a measured of biodiversity which quantifies how equal the community is numerically (Mulder *et al*., 2004) [10]. According to them, it is obvious that the number of individual of each species in a community determines the evenness of the community composition. The evenness of a community can be represented by Pieliou's evenness index as reported by Mulder *et al* (2004) [10]; the model is state as follows:

H_{max}= In(*s*)

Where;
H = the number derived from the Shannon's Diversity Index
S = Total Number of the Species.

Results

Checklist and Comparison of Tree Species among the study sites
The various trees species as they occurred in the Plot A and Plot B study sites included *Annona senegalensis, Acacia Senegal, Adansonia digitata, Acacia seyal, Acacia nolitica, Adeniumobesum, Ficus platyphylla, Ficus sycomorus, Khaya senegalensis, Parkia bigobosa, Tamarindus indica, Vitellaria paradoxa, Vitex doniana, Piliostigma reticulatum, Faidherbia albida, Boscia senegalensis, Diospyros mespiliformis, Sterculia setigera, Ficus exasperate, Ziziphusspina Christi, Ziziphus mauritiana.* A total of 21 tree species were found belonging to 13 families. The SPP with highest number included *Adansonia digitata* which had 4 on Plot A, *Parkia biglobosa, Cacia senegal, Annona senegalensis, Adansonia digitata,* which had 3 of each species, *Acacia seyal, Tamarindus indica Ficu ssycomorus, Adenium obesum* and *Acacia Senegal, Vitellario paradoxa, Diospyros mespiliformis, Ziziphus spina christi, Ziziphus mauritiana, Sterculiase tigeva* which had 2 species on each of Plot A, B and C and other species contains 1and 0 species in each of the Plot A, B and C.

Table 1: Checklist of Tree Species in the Study Sites

S/N	Family	Species	English	Hausa Name	A	B	C
1.	Annonaceae	*Annona senegalensis*	African custardapple	Gwandandaji	-	+	+
2.	Fabaceae	*Acacia Senegal*	Gum arabic	Dakwara	+	+	+
3.	Malvaceae	*Adansonia digitata*	African baobab	Kuka	+	-	+
4.	Fabaceae	*Acacia seyal*	Shittimwood	Farar kaya	+	-	-
5.	Fabaceae	*Acacia nolitica*	Egyptian acacia	Bagaruwa	-	+	-
6.	Apocynaceae	*Adenium obesum*	Desert Rose	Kariya	-	-	+
7.	Moraceae	*Ficus platyphylla*	flake rubber tree	Gamji	+	-	-
8.	Moraceae	*Ficus sycomorus*	Figmulberry	Baure	-	-	+
9.	Meliaceae	*Khaya senegalensis*	African mahogany	Madaacii	-	+	-
10.	Fabaceae	*Parkia biglobosa*	African locust bean	Dorawa	+	+	+
11.	Fabaceae	*Tamarindus indica*	Tamarind	Tsamiya	+	+	+
12.	Sapotaceae	*Vitellaria paradoxa*	Shea tree	Kadanya	-	+	+
13.	Lamiaceae	*Vitex doniana*	Black plum	Dinya	+	-	-
14.	Fabaceae	*Piliostigma reticulatum*	Purple orchid tree	Kalgo	+	+	+
15.	Fabaceae	*Faidherbia albida*	Applering acacia	Gawo	-	-	+
16.	Capparaceae	*Boscia senegalensis*	Senegal boscia	Hanza	-	+	-
17.	Ebenaceae	*Diospyros mespiliformis*	Jackalberry	Kanya	+	+	-
18.	Malvaceae	*Sterculia setigera*	Karaya Gum Tree	Kukkuki	+	-	+
19.	Moraceae	*Ficus exasperate*	Sandpaper tree		-	-	+
20.	Rhamnaceae	*Ziziphus spina christi*	Christ's thorn jujube	Kurna	+	+	+
21	Rhamnaceae	*Ziziphus mauritiana*	Indian jujube	Magaryaa	+	-	+

***Source*:** Field Survey, 2022
Key:
+ = present,
- = Absent

Where;
A,B C represent locations where tree species diversity is highest.

Results from table 2 shows that tree species status in Plot A, B and C indicated that *Adonsonia digitata* is the highest in Plot A with frequency of 4 followed by Acacia Senegal and *Pakia biglobosa* having frequency of 3 also *Annona senegalensis, Acacia nolitica, Adenium obesum, Ficus sycomorus, Khaya senegalensis, Vitellaria paradoxa, Faidherbia albida, Boscia senegalensi and Ficus exasperate were absent in* plot A. Plot B results shows that *Khaya senejalensis, Annona Senegalensis, Vitellaria paradoxa and Boscia senegenlensis* has frequency of 2 respectively while *Acacia Senegal, Acacia nolitica, Parkia biglobosa, Tamarindus indica, Pihostigma reticulafum, Diospyros mespiliformis and Ziziphus spina christi* has 1 Frequency which is the lowest also Plot B has tree species absent which include *Adansonia digitata, Acacia seyal, Adeniumobesum, Ficus sycomorus, Vitex doniana, Faidherbia albida, Sterculia setigera, Ficus exasperate and Ziziphus mauritiana*. Plot C result shows *Annona senegalensis* and *Adonsonia digitata* has the highest frequency of 3. While the lowest frequency of 1 these include *Piliostigma reticulatum, Faidherbia albida, Sterculia setigera, ficus exasperate, Ziziphus spinachristi* and *Ziziphus mauritiana* species also *Acacia seyal, Acacia nolitica, Ficus platyphylla, Khaya senegalensis, Vitex doniana, Boscia senegalensis and Diospyros mespiliformis*

Table 2: Checklist of Tree Species Status on Plot A, B and C

S/N	Family	Species	English	Hausa Name	A	B	C
1.	Annonaceae	*Annona senegalensis*	African custardapple	Gwandandaji	0	2	3
2.	Fabaceae	*Acacia Senegal*	Gum arabic	Dakwara	3	1	2
3.	Malvaceae	*Adansonia digitata*	African baobab	Kuka	4	0	3
4.	Fabaceae	*Acacia seyal*	Shittimwood	Farar kaya	2	0	0
5.	Fabaceae	*Acacia nolitica*	Egyptian acacia	Bagaruwa	0	1	0
6.	Apocynaceae	*Adenium obesum*	Desert Rose	Kariya	0	0	2
7.	Moraceae	*Ficus platyphylla*	flake rubber tree	Gamji	2	0	0
8.	Moraceae	*Ficus sycomorus*	Figmulberry	Baure	0	0	2
9.	Meliaceae	*Khaya senegalensis*	African mahogany	Madaacii	0	2	0
10.	Fabaceae	*Parkia biglobosa*	African locust bean	Dorawa	3	1	2
11.	Fabaceae	*Tamarindus indica*	Tamarind	Tsamiya	2	1	2
12.	Sapotaceae	*Vitellaria paradoxa*	Shea tree	Kadanya	0	2	2
13.	Lamiaceae	*Vitex doniana*	Black plum	Dinya	2	0	0
14.	Fabaceae	*Piliostigma reticulatum*	Purple orchid tree	Kalgo	1	1	1
15.	Fabaceae	*Faidherbia albida*	Applering acacia	Gawo	0	0	1
16.	Capparaceae	*Boscia senegalensis*	Senegal boscia	Hanza	0	2	0
17.	Ebenaceae	*Diospyros mespiliformis*	Jackalberry	Kanya	2	1	0
18.	Malvaceae	*Sterculia setigera*	Karaya Gum Tree	Kukkuki	2	0	1
19.	Moraceae	*Ficus exasperata*	Sandpaper tree		0	0	1
20.	Rhamnaceae	*Ziziphus spina christi*	Christ's thorn jujube	Kurna	2	1	1
21.	Rhamnaceae	*Ziziphus mauritiana*	Indian jujube	Magaryaa	2	0	1

***Source*:** Field Survey, 2022

Table 3 results shows that *Adonsonia digitata* how the highest frequency of 4 while *piliostigma retriculatum* is the least with 1 frequency. Basal area is highest in *Adonsoniadigitata* with 0.85m while the lowest results was obtained in Acacia senegal, Acacia Seya, *Ziziphus spinachristi*and *Ziziphus mauritiana* with 0.01 respectively. Relative dominance was highest in *Adonsonia digitata* having 14.81 while lowest RD is found in *Piliostigma reticulatum* having 3.70. Important value index results highest in *Adonsonia digitata* with 62.66 and lowest in *Piliostigma reticulatum* with 8.46 in Plot A.

Table 3: Tree Status in Plot A

Species	Freq	BA	RD	Rdo	RF	IVI	PilnPi
Acacia senegal	3	0.01	11.11	0.32	11.11	22.55	0.24
Adansonia digitata	4	0.85	14.81	33.03	14.81	62.66	0.28
Acacia seyal	2	0.01	7.41	0.47	7.41	15.29	0.19
Ficus platyphylla	2	0.18	7.41	6.99	7.41	21.81	0.19
Parkia biglobosa	3	0.44	11.11	17.11	11.11	39.34	0.24
Tamarindus indica	2	0.39	7.41	15.00	7.41	29.81	0.19
Vitex doniana	2	0.26	7.41	10.17	7.41	24.98	0.19
Piliostigmareticulatum	1	0.03	3.70	1.06	3.70	8.46	0.12
Diospyros mespiliformis	2	0.14	7.41	5.37	7.41	20.18	0.19
Sterculia setigera	2	0.25	7.41	9.81	7.41	24.62	0.19
Ziziphus spina christi	2	0.01	7.41	0.27	7.41	15.08	0.19
Ziziphus mauritiana	2	0.01	7.41	0.40	7.41	15.22	0.19
	27	2.59	100.00	100.00	100.00	300.00	2.44

Source: Field Survey, 2022

Results from Plot B on the tree status, frequency shows highest in *Annona senegalensis, Khaya senegalensis, Vitellaria paradoxa, and Boscia senegalensis* with 2 frequency while *Acacia Senegal, Acacia nilotica, Parkia biglobosa, Tamarindus indica, Piliostigma reticulatum, Diospyros mespiliformis* and *Ziziphus spinachristi* all having 1 frequency respectively. Basal area is highest in *Vitellaria paradoxa* and lowest in Annona senegalensis, *Acacia nilotica* and *piliostigmareticulatum* with 0.01m. Relative dominance is observed to be highest in species of *Annona senegalensis, VItellaria paradoxa* and *Boscia senegalensis* with 13.33 respectively while lowest results was obtained in *Acacia senegal, Acacia nilotica, Parkia biglobosa, Tamarindus indica, Piliostigma reticulatum, Diospyros mespiliformis* and *Ziziphus Spina Christi* with 6.67. Results of important value index is highest in *Vitellaria paradoxa* with 54.52 and lowest in *Ziziphus Spinachristi* and *Acacia Senegal* with 13.63 and 13.74 respectively.

Table 4: Tree Status of Plot B

Species	Freq	BA	RD	Rdo	RF	IVI	PilnPi
Annona senegalensis	2	0.01	13.33	0.98	13.33	27.65	0.27
Acacia senegal	1	0.00	6.67	0.41	6.67	13.74	0.18
Acacia nolitica	1	0.01	6.67	0.69	6.67	14.02	0.18
Khaya senegalensis	2	0.17	13.33	21.96	13.33	48.62	0.27
Parkia biglobosa	1	0.08	6.67	10.26	6.67	23.60	0.18
Tamarindus indica	1	0.08	6.67	10.94	6.67	24.27	0.18
Vitellaria paradoxa	2	0.21	13.33	27.86	13.33	54.52	0.27
Piliostigmareticulatum	1	0.01	6.67	1.87	6.67	15.20	0.18
Boscia senegalensis	2	0.14	13.33	18.27	13.33	44.93	0.27
Diospyros mespiliformis	1	0.05	6.67	6.48	6.67	19.81	0.18
Ziziphus spina christi	1	0.00	6.67	0.30	6.67	13.63	0.18
Total	15	0.76	100.00	100.00	100.00	300.00	2.34

***Source*:** Field Survey, 2022

Table 5 tree status of Plot C frequency is highest in *Annona senegalensis* and *Adansonia digitata* having 3 while *piliostigma reticulatum, Faidherbia albida, sterculia setigera, ficus exasperate, Ziziphus spinachristi* and *Ziziphus Mauritiana* having only 1 tree species frequency. Basal area is highest in *Parkia biglobosa* with 0.28 and lowest in *Piliostigma reticulatum* with 0.01m. Relative dominance results shows that *Annona senegalensis* and *Adansonia digitata* has 12.50 each while lowest results is found in *Piliostigma reticulatum, Faidherbia albida, Sterculia setigera, Ficus exasperate, Ziziphus spinachristi* and *ZIziphus mauritiana* having 1 relative dominance respectively. Important value index is highest in *Adansonia digitata* with 40.05 and lowest in *Ziziphus spinachristi* and *Ziziphus mauritiana* with 8.41 and 8.42 respectively in Plot C.

Table 5: Tree Status of Plot C

Species	Freq	BA	RD	Rdo	RF	IVI	PilnPi
Annona senegalensis	3	0.02	12.50	1.23	12.50	26.23	0.26
Acacia senegal	2	0.02	8.33	1.62	8.33	18.29	0.21
Adansonia digitata	3	0.21	12.50	15.05	12.50	40.05	0.26
Adenium obesum	2	0.00	8.33	0.20	8.33	16.87	0.21
Ficus sycomorus	2	0.16	8.33	11.55	8.33	28.22	0.21
Parkia biglobosa	2	0.28	8.33	19.50	8.33	36.17	0.21
Tamarindus indica	2	0.25	8.33	17.59	8.33	34.25	0.21
Vitellaria paradoxa	2	0.20	8.33	13.94	8.33	30.61	0.21
Piliostigma reticulatum	1	0.01	4.17	0.80	4.17	9.13	0.13
Faidherbia albida	1	0.09	4.17	6.12	4.17	14.45	0.13
Sterculia setigera	1	0.07	4.17	4.96	4.17	13.30	0.13
Ficus exasperata	1	0.10	4.17	7.28	4.17	15.61	0.13
Ziziphus spina christi	1	0.00	4.17	0.07	4.17	8.41	0.13
Ziziphus mauritiana	1	0.00	4.17	0.09	4.17	8.42	0.13
	24	1.43	100.00	100.00	100.00	300.00	2.56

Source: Field Survey, 2022

Discussion

Species diversity assessment is a way of indicting an ecosystem to understand have knowledge on dynamics and quality, disturbance factors are impacting on it (Kalema, 2010, Zimudzi and Chapano, 2016) [13, 14]. Gongoshi grazing reserve was selected for the study (Plot A, B and C). Results Obtained shows that the plots has a moderate tree species abundance and distribution, little difference between the two protected area which is a results of edaphic factor or anthropogenic factor causing impact on the site. Tree species observed from Plot A, Plot B and Plot C protected areas revealed twenty one (21) species belonging to thirteen (13) families.

Plot A has twelve(12) species which belongs to ten (10) families results, reported that frequency of species having from the study area.Total of 27 while Plot B has fifteen (15) species belong to Ten (10) families and Plot C has twenty four (24) species belong to (10) families, results obtained shows total frequency of 15 was recorded which is lower than Plot A. Theses may be as a results over exploitation,

due to none or little protection measure and it proximity to settlement of the local resource uses in Plot C in Gongoshi Grazing Reserve. It may also due to the paucity of conservation strategies, seed source and regeneration practice (Gonzales and Nakashizuka, 2010) and Bremer and Farley, 2010) [4].

The apparent similarly species diversity between Plot A, Plot B and C in Gongoshi Grazing Reserve in Mayo-Below Local Government Area did not show a significant difference (P>0.05), paired sample t-test of variables between the study location, this could be attributed to the close distance that guarantee the same climate and adhere factors as well as human disturbances. Many studies (Kalema, 2010) [13] have shown that climate and adaphic factors couple with human disturbance are the major determinants of species diversity in natural forest. The relative high frequency in Plot A are as a results of conservation measures. This study is in line with (Meer and Tella, 2018), whereby little differences was recorded in species abundance in the two protected areas.

Conclusion

From the findings of this study it can be concluded that Plot A, B, and C in Gongoshi grazing reserve in Mayo-Belwa LGA, Adamawa State, Nigeria contain a moderate diversity of tree species although some of the species that are characteristically indigenous to these vegetation's zone as revealed by previous studies were absent; probably because the indigenous trees species have been selectively logged by the inhabitants as preferred species for fuel wood. It is also evident from the findings in this study, that the stocks of the forests are been depleted by anthropogenic agents owing to their hostile effects which includes; fuel wood gatherers, farms, animal grazing, bush burning and logging. The degree to which Plot A, B and C are being exploited constitutes an extreme danger to sustainability. It is paramount to comment that once a forest tree is endangered, it entails that such a tree becomes low in quantity and genetic quality. If at the point of being endangered and something is not done quickly, extinction will set in.

Competing Interest

Authors have declared no competing interest

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