

SUSTAINABILITY, POPULATION AND STRUCTURE OF WOODY SPECIES COMPOSITION OF TARABA STATE FORESTS

Abstract

Sustainability, population and structure of woody species composition of Taraba state forests were studied for future management strategies that allow a more sustainable use of woody species and a better conservation of forest ecosystems. The objectives of the study were to study the woody species dominance, important value index and population structure in different ecological zones of Taraba State forests. Data were obtained through woody species survey and the study area was stratified into three ecological zones and two protected areas. Five plots each measuring 50×50 m were sampled in each protected area and two protected areas were also sampled from each ecological zone. A total of 30 plots and 6 protected areas were sampled and all the woody species that occurred in the plots were also sampled. Data were analyzed using descriptive and inferential statistics such as Tables, percentages, frequency, ANOVA and LSD. A total of 3760 individual woody stands from 60, 34 and 32 species in Montane Forest, Southern and Northern Guinea Savanna respectively were recorded. *Strombosia postulate*, *Pleiocarpa pycnantha*, *Pericopsis laxiflora*, *Hymenocardia acida* and *Ziziphus mauritiana* were the dominance species while their corresponding rarest species were *Goria sp*, *Azelia africana*, *Elaeis guineensis*, *Combretum tomentosum* and *Ficus sur*. *Strombosia postulate* and *Pleiocarpa pycnantha* were the dominant woody species with high important value indices in Montane forest zone as opposed to *Pericopsis laxiflora* and *Ziziphus mauritiana* which dominated the Southern and Northern Guinea savanna respectively. The rarest species of *Goria sp*, *Azelia africana*, *Elaeis guineensis*, *Combretum tomentosum* and *Ficus sur* in the study area could be connected to its usefulness as fodder species. The population structure of woody species was found to be very low in the middle diameter classes. The diameter class distribution resembles interrupted “U” shape indicating the removal of merchantable trees. There were no significant differences ($p>0.05$) among the protected areas and ecological zones due to the low dominance and important value indices. This needs appropriate management techniques to improve forest composition and structure in the study area for sustainability.

Key Words: Sustainability; Population structure; Forests; Important value index; Ecological zones.

1. INTROSPECTION

Woody species composition and structure in an area depend on climatic and adaphic factors, these factors have recently been overwhelmed by anthropogenic factors especially in the tropics. Tropical forests are the richest biological communities on earth and have been recognized to harbor a significant proportion of global biodiversity [1]. These forest ecosystems which constitute a major woody species play critical roles in providing goods and services necessary for the well-being of both humans and animals at a range of scale from local to global [2]; [3]. The composition and structure of the tropical forests, which are home to around half of the terrestrial plant and animal species, are being destroyed at rates unprecedented in ecological history [3]; [4]; [5] resulting to the extinctions of many species. [6] and [7] estimated that Nigeria harbours 5,103 plant species; out of which 8.5% are threatened and 0.4% is endangered. The current estimates suggest that over 500 tree species are threatened with extinction [8].

Taraba State is one of the few States in Nigeria that possess a unique characteristic of natural forests. Many of the woody species found in these forests are characterized by short and irregular-shaped with many under growths including grasses that are burned annually. The woody plants and the environment in Taraba State have been used so much that the composition and structure of these species is gradually changing. The degradation of this environment continues and many ecosystems are increasingly vulnerable to collapse because of reduced habitat quality, unsustainable use and management of woody species which serves as the bedrock of the ecological communities. This necessitate the need to understand forest composition and structure [9] so that recommendations can be made for the restoration and future management [10]. The objectives of the study were to study the woody species dominance, important value index and population structure in different ecological zones of Taraba State forests.

2. MATERIALS AND METHODS

2.1 Study Area

Taraba State in Nigeria lies between latitudes $7^{\circ}00' 00''$ N and $9^{\circ} 58' 51''$ N and longitudes $9^{\circ} 52' 28''$ E and $12^{\circ} 39' 51''$ E. It occupies a total land mass of approximately 54, 473 km² (Figure 1). The State is bordered on the northwest by Gombe State, west by Plateau and Nassarawa States and by Adamawa State in the northeast. It also shares its southwest boundary with Benue State. An international boundary on the east separates Taraba State from the republic of Cameroon [11]. The state is made up of three (3) major ecological zones which include Southern

guinea savanna located in the south western part of the State, Northern guinea savanna in the northeast and Montane Forest in the southeast ([12].

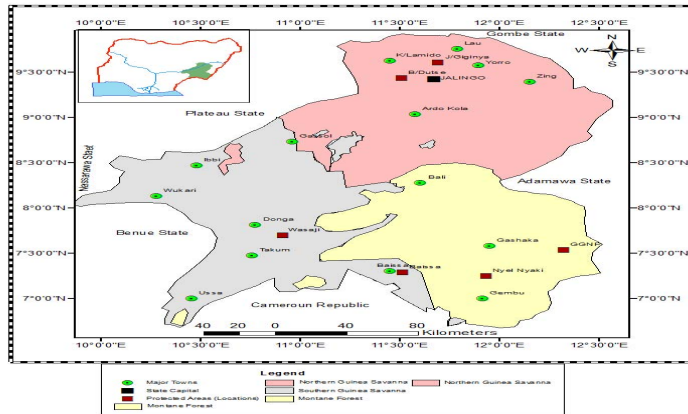


Figure 1. Map of Taraba State Showing the Major Ecological Zones and the Study Area
Source: G I S MAUTECH Yola, 2017

2.2 Data Collection and Analysis

The study site was stratified into three ecological zones namely; Northern Guinea Savanna (NGS), Southern Guinea Savanna (SGS) and Montane Forest (MF). Two protected areas were randomly selected from each of the ecological zones. A grid of plots that cover the entire survey protected areas was generated first, all the plots were given a sequential number and the sampled plots were randomly selected from the grids. 5 plots measuring 50m×50m were randomly sampled from each protected area and a total of 30 plots and 6 protected areas were sampled in the study. The number of individuals of each woody species occurring within a sample plot was counted and recorded. Woody species identification was done first directly on the field using the field identification guides developed by Keller, [13] for tropical ecosystems.

In cases where identification was not possible, tree species specimens were taken to experts for later identification. In addition, Tree diameter at breast height (DBH) was measured using diameter measuring tape and ranging poles. DBH of all trees above 1.3m from the ground was measured. In cases where a tree bole branched at breast height or below, the diameter was measured separately for the branches and averaged as one DBH and in cases where tree boles buttressed, DBH measurement was taken from the point just above the buttresses.

Data were analyzed on SPSS version 20 software using the statistical tools. The number of species i.e. species composition was determined by summing up the number of species identified directly in the field from each plot and the quantitative analysis was made using data from density, abundance, frequency of distribution of each species in the study sites. Species density was determined by counting the number of individuals in the sample plots and converting the count into hectare basis.

$$i. \text{ Density of a species} = \frac{\text{Total number of individuals of a species}}{\text{Sample size in hectares}}$$

$$ii. \text{ Relative density} = \frac{\text{Density of individual species}}{\text{Total density of all species}} \times 100$$

$$iii. \text{ Relative dominance} = \frac{\text{Total basal area for a species}}{\text{Total basal area of all species}} \times 100$$

$$iv. \text{ Relative frequency} = \frac{\text{Frequency of individual species}}{\text{Sum of all frequencies}} \times 100$$

$$v. \text{ Basal area} = \pi(\text{Diameter})^2 / 4.$$

$$vi. \text{ The Importance Value Index (IVI)} = (R_{\text{dominance}} + R_{\text{Density}} + R_{\text{Frequency}}) / 3$$

Where R = Relative

The population structure of all the individuals of each species encountered in each protected area was grouped into diameter classes to analyze the woody species structure. This was assessed through Bar charts and diameter curve constructed by using the density of individuals of each species (Y-axis) categorized into eight diameter classes (X-axis) as it was used by Neelo, [3]. That is 1 = < 11 cm; 2 = 11 - 20 cm; 3 = 21 - 30 cm; 4 = 31 - 40 cm; 5 = 41 - 50 cm; 6 = 51 - 60 cm; 7 = 61 - 70 cm; 8 = > 70 cm. Based on this profile, the population structures of woody species was determined.

Data collected was also subjected to two – way analysis of variance (ANOVA) using basal area on SPSS version 20 software to test for the significant difference among the protected areas and ecological zones. Frequencies and percentages were generated by SPSS and presented in tables or figures.

3. RESULTS

3.1 Woody Species Composition

Results of woody species composition in the study area shown in Figure 2 was described in terms of its frequency, dominance, relative density, basal area and relative dominance (Appendix I). A total of 3760 individual woody plants were identified and enumerated in the study area. 60 species representing 57 genera and 30 families were found in Montane Forest (MF), while 34 and 32 species belonging to 31 and 27 genera, 25 and 21 families were encountered in Southern Guinea Savanna (SGS) and Northern Guinea Savanna (NGS) respectively (Figure 2). A total of 55 woody species found in MF were not found in SGS and NGS. Only 7 and 1 species were common to SGS and NGS respectively. *Ficus sur* species was common to MF, SGS and NGS (Appendix I).

Basal area provides the measure of the relative importance of the species. Species with largest contribution in dominance value through higher basal area were considered as the most important species in the study area. Analysis of species' important value index (Appendix I) in MF revealed that *Strombosia postulate* and *Pleiocarpa pycnantha* species were the most important species in Gashaka Gumti and Nyel Nyaki protected areas respectively. In SGS, *Pericopsis laxiflora* and *Hymenocardia acida* were among the abundant species in Wasaji and Baissa forest reserves respectively while *Ziziphus mauritiana* in Jen Giginya and *Hymenocardia acida* in Bakin Dutse were recorded in NGS. *Ziziphus mauritiana* was found to have the highest important value index (42.97) in the study area. *Mangifera indica*, *Gordia sp*, *Azelaia africana*, *Elaeis guineensis*, *Combretum tomentosum* and *Ficus sur* stood out as the rarest species due to their low IVI in the Gashaka Gumti, Nyel Nyaki, Wasaji, Baissa, Jen Giginya and Bakin Dutse protected areas respectively (Appendix I).

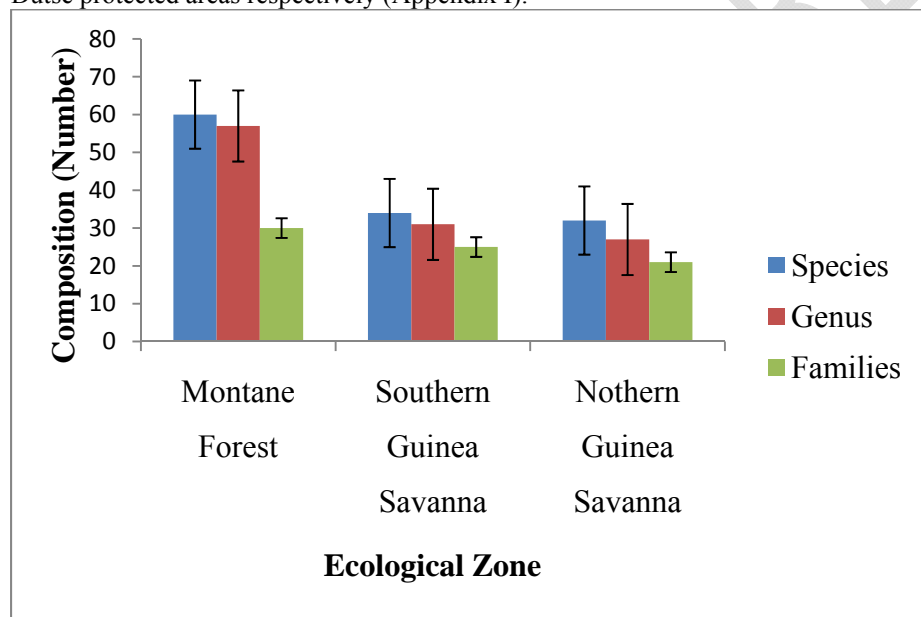


Figure 2: Woody Species Composition in the Study Area

3.2 Population Structure

Figure 3 shows the result of population structure of woody species in the study area which indicated that the number of individual woody species was high in the lower diameter classes. Most individuals, 59 (15.05%) in Gashaka, 387 (26.69%) in Ngel Nyaki, 145 (26.90%) in Wasaji, 140 (19.18%) in Baissa, 97 (26.87%) in Jen Giginya and 97 (27.43%) in Bakin Dutse were in the first diameter class ($1 = < 11$ cm) with a gradual decrease towards middle classes with many tree stands having branches at the breast height or below and a sharp rise in the highest diameter class. Ngel Nyaki had the highest number of individual woody stands in all the diameter classes. Consequently, the woody species recorded from the three ecological zones exhibited stable population structures composed of the highest density of individuals [446 (24.21%) in MF, 285 (22.46%) in SGS and 176 (27.12%) in NGS] at the lowest diameter class ($1 = < 11$ cm) followed by an abrupt drop in diameter class $2 = 11-20$ cm and little rise in diameter class $3 = 21-30$ cm in SGS and NGS. A gradual declining densities of individuals occurred in the increasing diameter classes with a sharp rise in the highest Diameter class giving it a “U” shape (Figure 4).

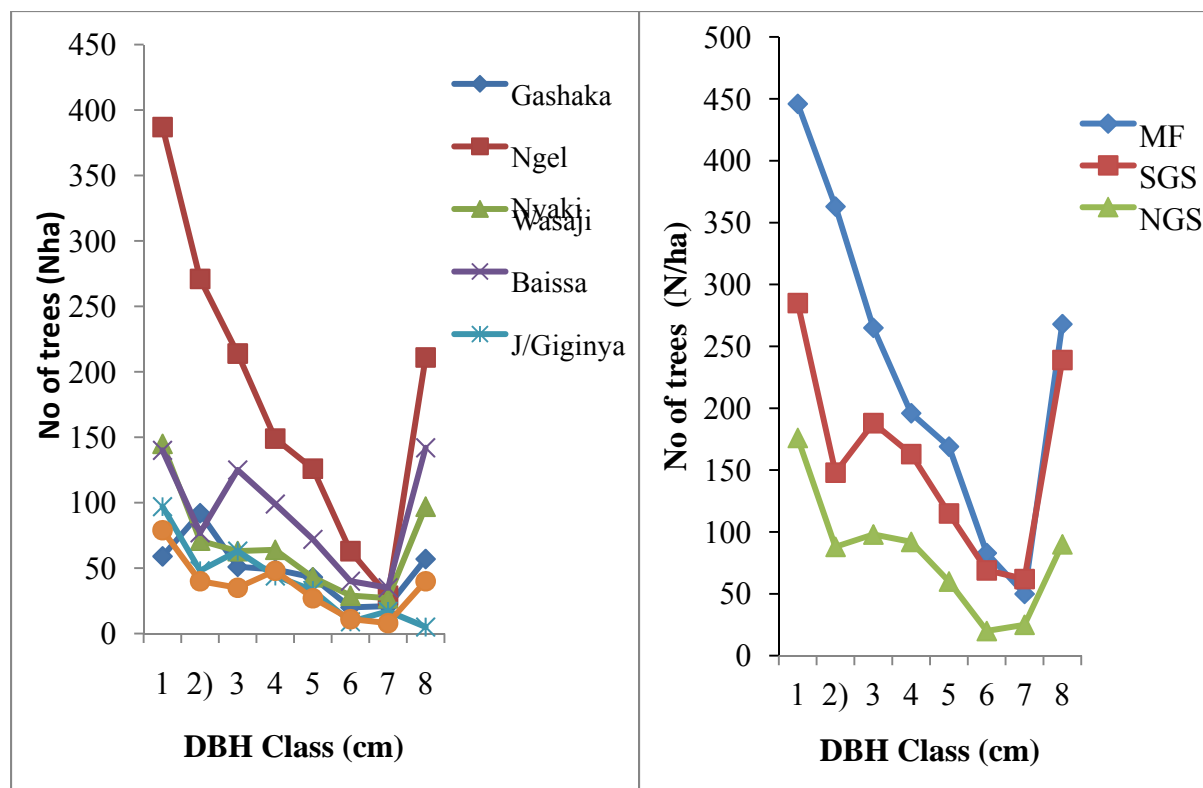


Figure 3: Diameter Curve Distribution at the various Protected Areas

[Diameter class (DBH): 1 = < 11 cm; 2 = 11 - 20 cm; 3 = 21 - 30 cm; 4 = 31 - 40 cm; 5 = 41 - 50 cm; 6 = 51 - 60 cm; 7 = 61 - 70 cm; 8 = > 70 cm].

Figure 4: Diameter Curve Distribution of the Ecological Zones in the Study Area

3.3 Diameter Distribution in all the Ecological Zones of the Study Area

The results of diameter curve distribution are shown in Figure 3 and 4. The results indicated that the diameter class distribution of the population structure produced an interrupted “U” shaped curve which seemed to show a pattern where species frequency distribution had the highest frequency in the lower diameter classes and a gradual decrease towards the middle diameter classes with a sharp rise in the highest class (8 = > 70 cm).

3.4 Comparison of Species Composition and Structure

Analysis of variance (ANOVA) result indicated that the F-calculated value (0.77) in woody species composition and structure was less than the F-tabulated value (4.23) at 0.05 level of significance among the protected areas of the study area. This means that there is no significant difference ($p > 0.05$) among the protected areas. Similarly, the ANOVA revealed that F-calculated value (0.88) was less than the F-tabulated value (3.37) at 0.05 level of significance among the three ecological zones of the study area which also implies that the woody species composition and structure among the ecological zones of the study area is not significantly different ($p > 0.05$).

4. DISCUSSION

The composition woody species from Montane forest zone was similar to the ones in our neighbouring Cameroon in Kalfou Forest Reserve where 28 families, 58 genera and 86 species were recorded [14]. In line with [15], which recorded 28 families, 54 genera and 75 species in non-cultivated plain of Moutourwa, Cameroon which shares boundary with the Montane forest ecological zone. A Large number of woody species occur in Ngel Nyaki forest reserve of Montane forest. However a modification of the species composition was observed in both the Southern and Northern guinea savanna having more similar species and different dominant species compared with the Montane forest, this could be attributed to differences in the climatic and edaphic conditions [3]; [16]; [17]; and difference of anthropogenic pressure [15] between Motane forest zone and the other two ecological zones.

Strombosia postulate and *Pleiocarpa pycnantha* were the dominant woody species with high important value indices in Montane forest zone as opposed to *Pericopsis laxiflora* and *Ziziphus mauritiana* which dominated the Southern and Northern guinea savanna respectively. These species indicate economic and ecological significant in these zones and this confirms the view of [18] that the important value index is an important parameter that indicates the economic and ecological significance of species in a given ecosystem. [15] identified *Ziziphus mauritiana* and *Parkia biglobosa* as one among the top sixteen most preferred and the most commercialized fruits producing species in Adamawa, Far-North and North Regions Cameroon and this is not exception in Nigeria, particularly Adamawa and Taraba States. Species with high important value indices are regarded as more important than those with low important value indices [19] and this is very important in conservation because those species with high important value indices need monitoring management only [20] while those with low important value indices are prioritized for conservation [21].

The rarest species of *Goria sp*, *Afzelia africana*, *Elaeis guineensis*, *Combretum tomentosum* and *Ficus sur* in the study area could be connected to its usefulness as fodder species. These species have also been found very useful for other purposes such as carving and firewood production, provision of tanning and dyeing materials, cultural and medicinal applications. *Combretum sp* is an important fodder species whose leaves are browsed by livestock. Its wood is very good for firewood, it produces good quality charcoal and various parts of the plant have been found to be of important medicinal value [22]. Identification of most valuable and threatened woody species and determination of their conservation status can provide a focus for future management strategies that allow a more sustainable use of plant resources and a better conservation of ecosystems [23]. IVI value of most woody species in the study fall below three (3) and according to [23], those woody species which have IVI value less than three are threaten and these need immediate conservation measures.

Woody species diameter class distribution is an important indicator of changes in population structure and species composition of a forest ecosystem. In this wise, the number of woody species in the study area was found to be very low in the middle diameter classes. This implies that the merchantable volume of woody species in the study area is adversely affected by the high degree of exploitation, farming and settlement. The lack of trees at the middle diameter classes of the study may be due to harvesting of such trees for sale in the urban areas as evidenced by numerous stumps in Wasaji, Jen Giginya and Bakin Dutse Forest Reserves, leading to the conversion of these forests to non-forest lands. [24] also reported the conversion of forest areas to non-forest land use like logged areas, arable land and urban use through diameter class distribution analysis. These findings agreed with [3] that the status of tree populations can be revealed by way of size class distribution analyses.

The high number of individual woody species in the lower diameter classes implies that the application of sustainable management principles may successful restore woody species in the middles diameter classes of the study area. The pattern is also an indicator of healthy regeneration status of woody species [3]; [25]; [19]; [26]; [27]; [28] that ensures sustainability in the study area. This finding agrees with those reported by [29] from Panama, they observed over 80% of individuals species in the smaller diameter classes. The factors that cause the abrupt rise in the highest diameter distribution class could be poor formation, species deformation, low quality production, pest and disease infections, old age of the individual species, adaphic and environmental factors among others. The interrupted “U” shaped diameter distribution curve is a characteristic of tropical forests in general, which should have a greater number of young individuals to ensure the replacement of trees with larger diameters [29] for sustainable management.

Similar trends were reported from studies in dry evergreen forests of Gedo, West Shewa Zone by [30], Dallo Mena Districk by [31] and TaraGedam forest at South Gonder by [19] as well as Kumuli Dry Evergreen Afromontane Forest in Yem District by [32], all in Ethiopia. Generally speaking, only few species with few matured individuals dominated the ecological zones of the study area in their composition, and structure while many of the species were very rare or low in their composition and structure. Such a result reflects adverse environmental situations and random distribution of available resources [33]; [34].

The poor composition and structure of woody species in the study area that does not show significant difference may be connected to the high number of species with lowest densities, dominance and important value indices recorded in the study area which is a clear indication that the major population of woody species in the study area were young as confirmed by the diameter curve distribution of the study. This development may be due to the disturbance history [35] of the study area. This confirms [36] that basal area significantly declines with decreasing patch size.

5. CONCLUSION

The knowledge of the composition and structural characteristics of woody species is highly necessary to the understanding of woody species and other forest resources for effective conservation. These have led to calls for urgent conservation attention as most of the species in the study area were found to possess low dominance and basal area values leading to low important value index. The Important value indices revealed the most ecologically

important woody species in the study area and those to be prioritized for conservation. The species having low important value indices need to be prioritized for conservation. The diameter class distribution pattern of woody individuals that showed an interrupted “U” shape is a reflection of more good regeneration profile in the study area; this needs appropriate management techniques to improve the nature of the forest population and structure in the study area.

6. RECOMMENDATIONS

There should be greater investment in research to improve the quality of information on woody species and to improve our understanding of woody species composition and structure for effective and sustainable management.

Recovery plans and blue prints for the restoration and afforestation of threatened species should be done as a matter of urgency through the use of traditional and in-situ means for optimal composition and forest structure. Rare and endangered species should be conserve using ex-situ strategy for proper care and attention

More protected areas and area exclosures should be established to protect the structural population of the larger lowest diameter distribution classes.

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APPENDIX I: Species Composition of each Protected Area According to Increasing Order of the Important Value Index

Species	Freq	RF	D	RD	BA	RDo	IVI
Gashaka							
<i>Mangifera indica</i>	1	0.255102	0.8	0.255102	0.005	0.101854	0.204019
<i>Vitex donianna</i>	1	0.255102	0.8	0.255102	0.2376	4.84009	1.783431
<i>Unknown Spp</i>	15	3.826531	12	3.826531	0.0882	1.7967	3.14992
<i>Elaeagnus guineensis</i>	21	5.357143	16.8	5.357143	0.0817	1.66429	4.126192
<i>Anogeissus leiocarpa</i>	18	4.591837	14.4	4.591837	0.3188	6.494194	5.225956
<i>Cola millenii</i>	32	8.163265	25.6	8.163265	0.0706	1.438175	5.921568
<i>Ancylotrypa anioena</i>	33	8.418367	26.4	8.418367	0.0822	1.674475	6.170403
<i>Tabernaemontana holstii</i>	30	7.653061	24	7.653061	0.2631	5.359544	6.888555
<i>Uvaria chamae</i>	11	2.806122	8.8	2.806122	0.8877	18.08311	7.898453
<i>Landolphia owariensis</i>	39	9.94898	31.2	9.94898	0.1895	3.860257	7.919405
<i>Cola gigantea</i>	18	4.591837	14.4	4.591837	0.8375	17.0605	8.748058
<i>Uapaca togoensis</i>	85	21.68367	68	21.68367	0.2419	4.927684	16.09834
<i>Strombosia postulate</i>	88	22.44898	70.4	22.44898	1.6053	32.70116	25.86637
Total	392	100.00000	313.6	99.99997	4.9091	100.00203	100.00065
Ngel Nyaki Forest Reserve							
<i>Gordia sp</i>	1	0.068966	0.8	0.068966	0.017674	0.095205	0.077712
<i>Leea guineensis</i>	2	0.137931	1.6	0.137931	0.002906	0.015656	0.097173
<i>Trilepisium madagascariensis</i>	3	0.206897	2.4	0.206897	0.010248	0.055205	0.156333
<i>Daslepis sp</i>	4	0.275862	3.2	0.275862	0.032402	0.174542	0.242089
<i>Beilshmeidia manii</i>	4	0.275862	3.2	0.275862	0.04931	0.265622	0.272449
<i>Santeria sp</i>	2	0.137931	1.6	0.137931	0.116922	0.629834	0.301899
<i>Tabernaemontana cantata</i>	5	0.344828	4	0.344828	0.091904	0.495066	0.394907
<i>Rauvolfia vomitoria</i>	3	0.206897	2.4	0.206897	0.165688	0.892529	0.435441
<i>Symphonia glubolifera</i>	1	0.068966	0.8	0.068966	0.301114	1.622038	0.586656
<i>Isolona capensis</i>	11	0.758621	8.8	0.758621	0.053614	0.288808	0.602016
<i>Polyscias fulva</i>	9	0.62069	7.2	0.62069	0.106749	0.575038	0.605472
<i>Ritchea albesea</i>	13	0.896552	10.4	0.896552	0.027825	0.149887	0.647663
<i>Xymalus monospor</i>	4	0.275862	3.2	0.275862	0.279874	1.507623	0.686449
<i>Macaranga monandra</i>	6	0.413793	4.8	0.413793	0.256138	1.379766	0.735784
<i>Allophylus Africana</i>	1	0.068966	0.8	0.068966	0.384895	2.073352	0.737094
<i>Schefferia abyssinica</i>	3	0.206897	2.4	0.206897	0.354339	1.908753	0.774182
<i>Psorospermum aurantiaca</i>	3	0.206897	2.4	0.206897	0.358947	1.933577	0.782457
<i>Eugenia gilgii</i>	16	1.103448	12.8	1.103448	0.032471	0.174913	0.793936
<i>Albizia gummifera</i>	14	0.965517	11.2	0.965517	0.087022	0.468771	0.799935
<i>Pychotria viridis</i>	9	0.62069	7.2	0.62069	0.228371	1.230189	0.823856
<i>Dislocloaxylum hexandrum</i>	11	0.758621	8.8	0.758621	0.189741	1.022097	0.846446
<i>Chrysophyllum albedum</i>	5	0.344828	4	0.344828	0.347081	1.869656	0.853104
<i>Croton macrotachyus</i>	1	0.068966	0.8	0.068966	0.490231	2.640773	0.926235

<i>Weakenia sp</i>	14	0.965517	11.2	0.965517	0.208797	1.124748	1.018594
<i>Campylospermum perexilis</i>	16	1.103448	12.8	1.103448	0.228846	1.232745	1.146547
<i>Millettia barteri</i>	11	0.758621	8.8	0.758621	0.380568	2.050041	1.189094
<i>Ceitis zenkeni</i>	8	0.551724	6.4	0.551724	0.465851	2.509444	1.204297
<i>Entandrophragma angolense</i>	4	0.275862	3.2	0.275862	0.594506	3.202483	1.251402
<i>Voacanga africana</i>	18	1.241379	14.4	1.241379	0.256797	1.383316	1.288692
<i>Unknown</i>	30	2.068966	24	2.068966	0.010248	0.055205	1.397712
<i>Pavetta crombosa</i>	1	0.068966	0.8	0.068966	0.7855	4.231331	1.456421
<i>Oxyanthus sp</i>	4	0.275862	3.2	0.275862	0.854329	4.602101	1.717942
<i>Ficus sur</i>	22	1.517241	17.6	1.517241	0.439187	2.365814	1.800099
<i>Diospyros camarunensis</i>	10	0.689655	8	0.689655	0.773725	4.167903	1.849071
<i>Clausena anissata</i>	39	2.689655	31.2	2.689655	0.031768	0.17113	1.850147
<i>Drypetes floribunda</i>	3	0.206897	2.4	0.206897	1.116091	6.012157	2.141983
<i>Carapa oriophylla</i>	28	1.931034	22.4	1.931034	0.497407	2.67943	2.1805
<i>Anthonatha noldeae</i>	42	2.896552	33.6	2.896552	0.350935	1.890418	2.561174
<i>Ficus lutea</i>	22	1.517241	17.6	1.517241	1.079784	5.81658	2.950354
<i>Sherubapsis sp</i>	6	0.413793	4.8	0.413793	1.803806	9.716743	3.514776
<i>Zanthoxylum zanthoxyloidea</i>	77	5.310345	61.6	5.310345	0.101638	0.547501	3.72273
<i>Newtonia buchananii</i>	45	3.103448	36	3.103448	1.092035	5.882575	4.029824
<i>Poutaria altissima</i>	12	0.827586	9.6	0.827586	2.165185	11.66342	4.43953
<i>Rothmania hispida</i>	88	6.068966	70.4	6.068966	0.324474	1.747876	4.628602
<i>Strombosia postulate</i>	94	6.482759	75.2	6.482759	0.293813	1.582709	4.849409
<i>Deinbolia pinnata</i>	122	8.413793	97.6	8.413793	0.128696	0.693258	5.840282
<i>Garcinia smithmanii</i>	157	10.82759	125.6	10.82759	0.182956	0.98555	7.546907
<i>Rytignia umbellatum</i>	221	15.24138	176.8	15.24138	0.256843	1.383563	10.62211
<i>Pleiocarpa pycnantha</i>	225	15.51724	180	15.51724	0.154669	0.83317	10.62255
Total	1392	96.00001	1160	100.00001	18.56392	100.00011	100.00004
Wasaji Forest Reserve							
<i>Azzeria africana</i>	1	0.185529	0.8	0.185529	0.020109	0.258934	0.209997
<i>Neocarya polyandra</i>	1	0.185529	0.8	0.185529	0.101801	1.310852	0.560637
<i>Maranthes polyandra</i>	5	0.927644	4	0.927644	0.025152	0.32387	0.726386
<i>Pilliosigma thorningii</i>	4	0.742115	3.2	0.742115	0.107083	1.378873	0.954368
<i>Bridelia ferruginea</i>	10	1.855288	8	1.855288	0.118508	1.52599	1.745522
<i>Strychnos innocua</i>	6	1.113173	4.8	1.113173	0.256335	3.300732	1.842359
<i>Nuclea latifolia</i>	9	1.669759	7.2	1.669759	0.207005	2.665535	2.001684
<i>Ficus sur</i>	6	1.113173	4.8	1.113173	0.316936	4.081069	2.102471
<i>Vetellaria paradoxa</i>	10	1.855288	8	1.855288	0.246795	3.177889	2.296155
<i>Syzigium guineense</i>	9	1.669759	7.2	1.669759	0.284953	3.66924	2.336253
<i>Khaya senegalensis</i>	6	1.113173	4.8	1.113173	0.391114	5.036229	2.420858
<i>Vitex donianna</i>	17	3.153989	13.6	3.153989	0.092201	1.187233	2.498404
<i>Pterocarpus erinaceus</i>	10	1.855288	8	1.855288	0.336885	4.337951	2.682842
<i>Crossopteryx febrifuga</i>	18	3.339518	14.4	3.339518	0.209035	2.691664	3.123566
<i>Lophira alata</i>	17	3.153989	13.6	3.153989	0.292654	3.768403	3.358794

<i>Parkia biglobosa</i>	14	2.597403	11.2	2.597403	0.457391	5.889661	3.694822
<i>Lenea alata</i>	18	3.339518	14.4	3.339518	0.462031	5.949409	4.209481
<i>Hymenocardia acida</i>	30	5.565863	24	5.565863	0.180751	2.327471	4.486399
<i>Anonna senegalensis</i>	40	7.42115	32	7.42115	0.072341	0.931504	5.257935
<i>Ficus lutea</i>	25	4.638219	20	4.638219	0.614905	7.917913	5.73145
<i>Uapaca togoensis</i>	42	7.792208	33.6	7.792208	0.329908	4.248109	6.610841
<i>Daniellia oliveri</i>	24	4.45269	19.2	4.45269	0.866717	11.16041	6.688597
Unknown	32	5.93692	25.6	5.93692	0.639923	8.240063	6.704634
<i>Parinari excelsa</i>	56	10.38961	44.8	10.38961	0.278704	3.588769	8.122663
<i>Terminalia sp</i>	65	12.05937	52	12.05937	0.243449	3.134811	9.084516
<i>Pericopsis laxiflora</i>	64	11.87384	51.2	11.87384	0.613387	7.898366	10.54868
Total	539	100.00001	431.2	100.00001	7.766073	100.00095	100.31
Baissa Forest Reserve							
<i>Elaeis guineensis</i>	2	0.273973	1.6	0.273973	0.168568	1.831269	0.793071
<i>Malacantha alnifolia</i>	1	0.136986	0.8	0.136986	0.204309	2.219539	0.83117
<i>Mangifera indica</i>	6	0.821918	4.8	0.821918	0.1087	1.180881	0.941572
<i>Bridelia ferruginea</i>	8	1.09589	6.4	1.09589	0.097785	1.062302	1.084694
<i>Khaya senegalensis</i>	8	1.09589	6.4	1.09589	0.160134	1.739641	1.310474
<i>Ziziphus mauritiana</i>	10	1.369863	8	1.369863	0.136913	1.487373	1.409033
<i>Maranthes polyandra</i>	8	1.09589	6.4	1.09589	0.214353	2.32866	1.506814
<i>Pilliosigma thorningii</i>	11	1.506849	8.8	1.506849	0.193976	2.107286	1.706995
<i>Terminalia glancosens</i>	10	1.369863	8	1.369863	0.235862	2.562326	1.767351
<i>Ficus sur</i>	15	2.054795	12	2.054795	0.194469	2.112644	2.074078
<i>Crossopteryx febrifuga</i>	16	2.191781	12.8	2.191781	0.209557	2.276553	2.220038
<i>Terminalia sp</i>	11	1.506849	8.8	1.506849	0.412923	4.485856	2.499852
<i>Loteria alata</i>	22	3.013699	17.6	3.013699	0.153969	1.672664	2.566687
<i>Vitex donianna</i>	9	1.232877	7.2	1.232877	0.500416	5.436348	2.634034
<i>Vetellaria paradoxa</i>	4	0.547945	3.2	0.547945	0.676198	7.345982	2.813958
<i>Lannea acida</i>	22	3.013699	17.6	3.013699	0.269255	2.925096	2.984165
<i>Parkia biglobosa</i>	7	0.958904	5.6	0.958904	0.653873	7.103451	3.007086
<i>Parinari polyandra</i>	25	3.424658	20	3.424658	0.206555	2.243944	3.031086
<i>Jatropha carcass</i>	19	2.60274	15.2	2.60274	0.510745	5.548555	3.584678
<i>Nuclea latifolia</i>	58	7.945205	46.4	7.945205	0.185782	2.018268	5.96956
<i>Anogeissus leiocarpa</i>	52	7.123288	41.6	7.123288	0.373159	4.053876	6.100151
<i>Parinari excels</i>	75	10.27397	60	10.27397	0.258613	2.809482	7.785809
<i>Daniellia oliveri</i>	4	0.547945	3.2	0.547945	2.376786	25.82059	8.972161
<i>Uapaca togoensis</i>	105	14.38356	84	14.38356	0.266696	2.897294	10.55481
<i>Hymenocardia acida</i>	222	30.41096	177.6	30.41096	0.435491	4.731024	21.85098
<i>Combretum tomentosum</i>	2	0.554017	1.6	0.692521	0.004163	0.028153	0.424897
<i>Bridelia ferruginea</i>	1	0.277008	0.8	1.385042	0.009505	0.064274	0.575441
<i>Borassus aethiapum</i>	10	2.770083	8	0.34626	0.011518	0.077892	1.064745
<i>Diatarium senegalensis</i>	2	0.554017	1.6	1.731302	0.239931	1.622526	1.302615
<i>Parinari polyandra</i>	3	0.831025	2.4	3.462604	0.061505	0.415923	1.569851

<i>Hyphaene thebaica</i>	4	1.108033	3.2	3.462604	0.026491	0.179144	1.583261
<i>Nuclea latifolia</i>	10	2.770083	8	1.038781	0.171019	1.156511	1.655125
<i>Azadirachta indica</i>	6	1.66205	4.8	3.462604	0.044211	0.298972	1.807875
<i>Sterculia setijera</i>	1	0.277008	0.8	4.501385	0.145239	0.982174	1.920189
<i>Unknown</i>	15	4.155125	12	1.731302	0.11782	0.796752	2.227726
<i>Lannea acida</i>	10	2.770083	8	3.462604	0.211606	1.430978	2.554555
<i>Pteleopsis suberosa</i>	23	6.371191	18.4	0.34626	0.144713	0.978617	2.565356
<i>Acacia kirkir</i>	22	6.094183	17.6	2.077562	0.050308	0.340204	2.837316
<i>Combretum molle</i>	29	8.033241	23.2	0.692521	0.127435	0.861776	3.195846
<i>Combretum lecardii</i>	2	0.554017	1.6	10.04155	0.081456	0.550846	3.715471
<i>Terminalia sp</i>	13	3.601108	10.4	5.193906	0.424919	2.873503	3.889506
<i>Prosopis africana</i>	23	6.371191	18.4	7.963989	1.075155	7.2707	7.20196
<i>Pilliosigma thorningii</i>	66	18.28255	52.8	7.963989	0.101922	0.689246	8.978594
<i>Parkia biglobosa</i>	10	2.770083	8	22.85319	0.280172	1.894655	9.172641
<i>Hymenocardia acida</i>	95	26.31579	76	1.385042	0.148307	1.002918	9.567916
<i>Entada Africana</i>	5	1.385042	4	32.89474	0.383481	2.593279	12.29102
<i>Ceiba pentandra</i>	4	1.108033	3.2	0.692521	10.55516	71.37891	24.39315
<i>Ziziphus mauritiana</i>	5	1.385042	4	125	0.371432	2.511794	42.96561
Total	1091	200	872.8	342.38228	23.99256	200.00065	247.460973
Bakin Dutse Forest Reserve							
<i>Ficus sur</i>	3	1.041667	2.4	1.043478	0.076796	1.281585	1.122243
<i>Bridelia scleroneura</i>	2	0.694444	1.6	0.695652	0.241384	4.028274	1.806124
<i>Parinari polyandra</i>	8	2.777778	6.4	2.782609	0.034375	0.573665	2.044684
<i>Bridelia ferruginea</i>	7	2.430556	5.6	2.434783	0.241384	4.028274	2.964538
<i>Parinari excels</i>	12	4.166667	9.6	4.173913	0.103719	1.730882	3.357154
<i>Pericopsis laxiflora</i>	15	5.208333	12	5.217391	0.088437	1.475858	3.967194
<i>Hyptis suaveolens</i>	3	1.041667	2.4	1.043478	0.705091	11.76672	4.617289
<i>Lonchocarpus laxiflorus</i>	3	1.041667	2.4	1.043478	0.827053	13.80205	5.295732
<i>Anonna senegalensis</i>	24	8.333333	19.2	8.347826	0.090768	1.514754	6.065304
<i>Khaya senegalensis</i>	27	9.375	21.6	9.391304	0.132889	2.217685	6.994663
<i>Acacia kirkir</i>	32	11.11111	25.6	11.13043	0.018518	0.309034	7.51686
<i>Daniellia oliveri</i>	11	3.819444	8.8	3.826087	1.035225	17.27607	8.3072
<i>Nuclea latifolia</i>	35	12.15278	28	12.17391	0.18314	3.05629	9.12766
<i>Hymenocardia acida</i>	65	22.56944	52	22.6087	0.199873	3.33554	16.17123
Total	247	85.76389	197.6	85.91304	3.9785	66.39668	79.35788