RESEARCH ARTICLE

POPULATION FREQUENCY, DENSITY, ABUNDANCE AND DIVERSITY OF TREE SPECIES IN TEN COMMUNAL FORESTS OF NORTHERN CROSS RIVER STATE, NIGERIA

*Akwaji Patrick Ishoro and Edu Esther Aja

Department of Botany, University of Calabar, Calabar, Cross River State, Nigeria

ABSTRACT

Due to the high rate of deforestation and degradation activities carried out by local people on forest ecosystem, this study assessed the tree species population frequency, density, abundance and diversity in ten communalforests (two each) of the five Local Government Areas (Ogoja, Yala, Bekwarra, Obudu and Obanliku) of Northern Cross River State, Nigeria using the modified Whittaker method. The study was carried out from (November, 2015 – May, 2016). In each site a 30 × 90 m plot was laid out in a spoke design and tree species present on the plots were recorded. Survey results revealed a total of 143 trees belonging to 45 families in the study area. The relative frequency and abundance of the tree species under study varied across the study sites. The highest percentage frequency of the tree species was 24% while the lowest was 6%. The highest population density recorded for the tree species was 2 stem/ha while the lowest was 0.1666 stem/ha. Abundance results show that the species were mostly low in their distribution with abundance of $(1.00 \leq AB \leq 2.99)$ except in Bechevie and Sankwala forest where there were occasional $(3.00 \leq AB \leq 3.33)$. Results from the study area show that Sankwala (8.18) had the highest species richness index while Omulako (4.63) had the lowest. Sankwala forest had the highest diversity index value of 2.12 while Omulako (1.21) had the lowest. This study shows that majority of the trees were low in their distribution and are declining in the study area. Appropriate decisions and measures in sustainable forest management are strongly recommended so that the forests would continue to provide goods and services for communities around the forests.

INTRODUCTION

According to Gillespie *et al.,* (2004) the tropical rainforest has been identified as the most biologically diverse terrestrial ecosystem on earth while Whitmore (1998), described a typical tropical forest as a complex community whose structure is provided by trees of many sizes and that upon the structure of trees and within the microclimate of the canopy of the trees, grow a range of other kinds of plants such as climbers, epiphytes, strangling plants, parasites and saprophytes. Panayotou and Ashton (1992) and Ikojo *et al.,* (2005) reported that a tract of rainforest is often viewed as a crop of timber trees suitable for sale rather than an interdependent high diversity ecosystem of potential multiple values. Thus, the tropical rainforests are mostly exploited for their timber resources. Muul (1993) stated that the tropical rainforest ecosystem is a symbol of abundance and nourishment of livelihood of millions of people extending back beyond memory or record and that this is because many of the timber

trees in the tropical rainforests produces a variety of highly valuable non-timber products like edible and medicinal fruits, seeds, nuts and oils. Also, a considerable number of trees produce industrial materials like latex, tannin, gum exudates, dyes and resin. The timber trees producing economically valuable non-timber products have been christened 'timber plus trees'. Furthermore, Ford Foundation (1998) stated that non-timber forest products are a particularly important part of multiple use strategies because they increase the range of income generating options of forest dependent communities, while avoiding some of the ecological costs of timber cutting. Presently, the need to protect what is left of the tropical rainforest has become imperative considering the high rate of forest destruction, degradation and fragmentation threatening the survival of both plant and animal species in Nigeria. As efforts are geared towards preventing the wanton destruction of the tropical rainforest and ensuring the conservation of its rich biodiversity, it is essential to provide sufficient quantitative and qualitative ecological data on tree species that produce different products. Such data will provide the needed information for fashioning out realistic and effectual conservation strategies. The ecological data that is needed

Corresponding author: Akwaji Patrick Ishoro
Department of Botany, University of Calabar, Calabar, Cross River State, Nigeria

include species composition, abundance of each species, stem diameter distribution and abundance of regeneration of each species. This study therefore assessed the population frequency, density, abundance and diversity of tree species that produce valuable timber and non-timber products in ten communal forests (two each) in the five Local Government areas (Ogoja, Yala, Bekwarra, Obudu and Obanliku) in Northern Cross River State, Nigeria with the aim of providing the required ecological data for effective management of the forests.

MATERIALS AND METHODS

Study area

The study was carried out in Northern Cross River State covering five Local Government Areas: Ogoja, Obudu, Yala, Bekwarra, and Obanliku. Two forest communities in each Local Government Area were chosen for the study (Figure 1). It was carried out from (November, 2015 – May, 2016). The area falls within the Southern Forest/Guinea savannah agro ecological zone of Nigeria, situated in the Northern Cross River State, it lies between latitudes 5˚ - 92′ and 7˚03′N of the Equator and Longitudes 8˚38′ and 9˚70′ East of the Greenwich meridian. The topography is generally low lying, ranging from below 80-140m (on the average) above sea level with three soil types namely, clay, loam and sandy. It covers a total landmass of 972km^2(375 sq mi). The areas have a muggy tropical climate of 1250-1300mm rainfall and an average yearly temperature of 30˚C (NIMET, 2015). Subsistence agriculture, basically farming of yams, cassava, palm oil and palm wine among others is the major source of sustenance (NIMET, 2015).

population has a known and equal opportunity of being counted) and the modified Whittaker design (Herrick *et al.,* 2005). To obtain tree species richness, three 10m × 30m plots were marked out in a spoke design. Within each of these plots, a 2m × 5m subplot and four 0.5 × 2m subplots were set. Beginning with the least subplots, the subplots and plots were searched and the tree species found captured. This was supplemented by the use of quadrats in areas of difficult terrains. The survey consisted of listing all free stationed trees of at least 10cm or above in diameter (dbh) in each study site. Tree species in this study were identified using the works of Hutchinson and Dalziel (1968-1972) and certified by a plant taxonomist of the Cross River State Forestry Commission, Calabar, Cross River State, Nigeria.

Data Analysis

Data collated from the field were analysed to obtain tree species Percentage frequency (%), Density and Abundance and using the methods of Sharma (2009).

The percentage frequency of the species was calculated as:

$$Frequency\ (\%) = \frac{Number\ of\ plots\ in\ which\ species\ is\ recorded \times 100}{Sum\ of\ all\ frequencies}$$

The relative density of the population was computed as:

$$Density = \frac{Number\ of\ individuals\ of\ a\ species \times 100}{Total\ areas\ sampled}$$
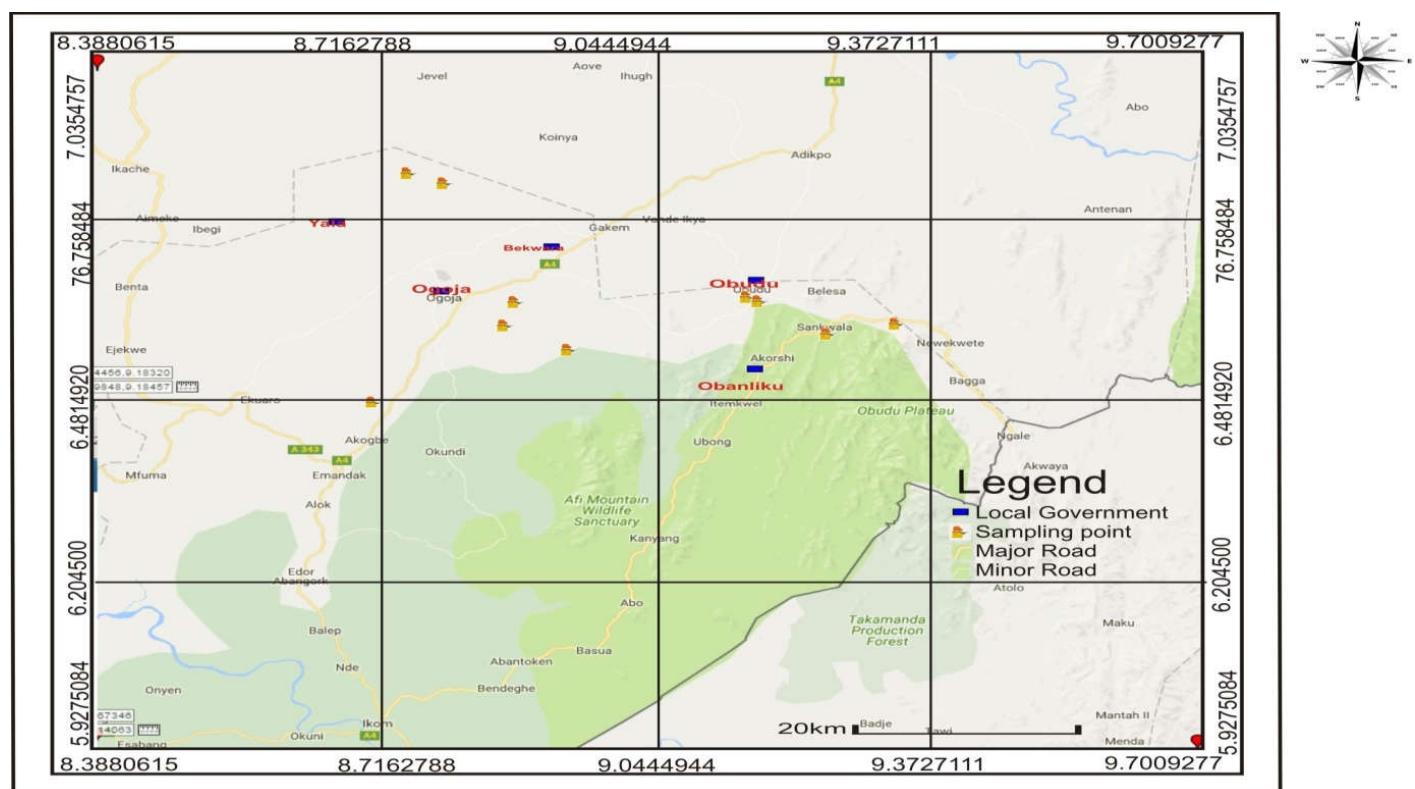

Fig. 1. GIS map of Northern Cross River State showing the study sites

Vegetation Assessment

The study was carried out using Systematic Sampling Method (a type of chance sampling where each element in the

The species abundance (Pi) was calculated as:

$$Abundance = \frac{Ni \times 100}{Sum\ of\ all\ individuals\ recorded}$$

Where; Ni is the sum or proportion of each individual species in the sample.

The different tree species recorded in this study were scored according to their Abundance (AB): abundant (AB $\geq$ 5.00); frequent (4.00 $\leq$ AB $\leq$ 4.99); occasional (3.00 $\leq$ AB $\leq$ 3.99); rare (1.00 $\leq$ AB $\leq$ 2.99) and threatened/endangered (0.00 $\leq$ AB $\leq$ 1.00) (Sharma, 2009). The measure of number of species occurring in a sample plot is known as species richness. The broader the sample, the more species we would expect to record, tree species richness in this study was recorded using the method of Stolhlgren *et al.* (1995), Bull *et al.* (1998) and Herrick *et al.* (2005) and calculated using Menhinick Index based on the proportion of the number of taxa to the 'square root of sample size' as given below:

$$D_{mn} = \frac{s}{\sqrt{N}} \text{(Tuomisto, 2010)}$$

Where,
D_{mn} in this case is the Menhinick Index
S = number of species
N = 'square root of the number of individuals in the sample plot'

Data obtained from relative abundance were used to compute the Shannon – Weiner's Diversity index (*H*) as ascribed by Jayaraman (1999) for forest areas. The Shannon – Weiner's diversity indices is given by the equation:

$$H = \sum pi \ln pi \text{ (Petchay and Gaston, 2002)}$$

Where H = Shannon's index, In = lnPi = Natural logarithm of the corresponding relative abundance (Pi) of the species, Pi = the proportion of individuals found in the ith species.

RESULTS

Composition of tree species

A total of 143 tree speciesbelonging to 45 families were recorded in the study area (Table 1). The majority of the species (28) were of the family Fabaceae, followed by Euphorbiaceae (12), Anonaceae (10), Moraceae (9 species), Meliaceae (7), Combretaceae, Sapotaceae and Sterculiaceae (6 species each), Anacardiaceae, Apocynaceae, Irvingiaceae and Myristicaceae (4 species each), Bombacaceae, Clusiaceae, Arecaceae and Ebenaceae (3 species each), Burseraceae, Lecythiadaceae, Olacaceae, Caesalpinaceae and Verbanaceae (2 species each), Bignoniaceae, Boriginacea, Ericaceae, Flacourtiaceae, Guttiferae, Juglandaceae, Liliaceae, Melastomataceae, Merantaceae, Meliaceae, Mimosaceae, Moringaceae, Ochnaceae, Palmae (Arecaceae), Papilionaceae, Proteaceae, Rabiaceae, Rhamnaceae, Rubiaceae, Sapindaceae and Ulmaceae had one (1) specie each.

Percentage frequency, density and abundance of tree species

A total of 32 trees were encountered in Gbogbu forest based on the sampled plots (Table 2), 31 in Omulako forest (Table 3), 56 in Aragban forest (Table 4), 57 in Abeya forest (Table 5), 62 in Aguomoh forest (Table 6), 58 in Ukpah forest (Table 7), 62 in Alege forest (Table 8), 61 in Beteh forest (Table 9), 83 in Bechevie forest (Table 10) and 93 species in Sankwala forest (Table 11).

Table 1. Tree species composition of the study area

S/N	Family	Species
1.	Anacardiaceae	*Anacardium occidentale*
2.	Anacardiaceae	*Pseudopondias microcarpa*
3.	Anarcadiaceae	*Antrocaryon micrasta*
4.	Anarcadiaceae	*Lannea welwitschi*
5.	Annocaceae	*Dennittia tripetala*
6.	Annonaceae	*Xylopia africana*
7.	Annonaceae	*Xylopia spp.*
8.	Annonaceae	*Monodora myristica*
9.	Annonaceae	*Anonidium mannii*
10.	Annonaceae	*Cleistopholis patens*
11.	Annonaceae	*Polyceratocarpus parvifllorus*
12.	Annonaceae	*Polyalthia suaveolens*
13.	Annonaceae	*Uvariopsis dioica*
14.	Annonaceae	*Annona senegalensis*
15.	Apocynaceae	*Funtumia elastica*
16.	Apocynaceae	*Hunteria umbellata*
17.	Apocynaceae	*Rauwolfia vomitora*
18.	Apocynaceae	*Alstonia boonei*
19.	Araliaceae	*Cussonia barteri*
20.	Arecaceae	*Cocos nucifera*
21.	Arecaceae	*Hyphaena thebaica*
22.	Bignoniaceae	*Newbouldia leavis*
23.	Bombacaceae	*Ceiba pentandra*
24.	Bombacaceae	*Bombax costatum*
25.	Bombacaceae	*Bombax brevicuspe*
26.	Boraginaceae	*Cordia millenii*
27.	Buseraceae	*Canarium schweinfurthii*
28.	Buseraceae	*Dacryodes edulis*
29.	Caesalpinioideae	*Parinari kerstingii*
30.	Clusiaceae	*Symphonia globulifera*
31.	Clusiaceae	*Allanblackia floribunda*
32.	Clusiaceae	*Pentadesma butyraceae*
33.	Combietaceae	*Anogeissus leiocarpus*
34.	Combietaceae	*Terminalia macroptera*
35.	Combretaceae	*Terminalia superb*
36.	Combretaceae	*Terminalia ivorensis*
37.	Combretaceae	*Combretum spp.*
38.	Combretaceae	*Terminalia aviceniodes*
39.	Ebenaceae	*Diospyros spp.*
40.	Ebenaceae	*Diospyros dendo*
41.	Ebenaceae	*Diospyros mesipiliformes*
42.	Ericaceae	*Eriboma oblonga*
43.	Euphobiaceae	*Hymenocardia acida*
44.	Euphorbiaceae	*Klainedoxa gabonensis*
45.	Euphorbiaceae	*Uapaca acuminata*
46.	Euphorbiaceae	*Uapaca spp.*
47.	Euphorbiaceae	*Anthonotha macrophylla*
48.	Euphorbiaceae	*Alchornea cordifolia*
49.	Euphorbiaceae	*Hevea brasilliensis*
50.	Euphorbiaceae	*Maesobotyra bateri*
51.	Euphorbiaceae	*Ricinodendron heudoelotii*
52.	Euphorbiaceae	*Tetrorchidium didymostemon*
53.	Euphorbiaceae	*Amphimas pterocarpoides*
54.	Euphorbiaceae	*Alchornia laxiflora*
55.	Fabaceae	*Calpocalyx winkleri*
56.	Fabaceae	*Prosopis Africana*
57.	Fabaceae	*Gliricidia sepium*
58.	Fabaceae	*Berlinia grandiflora*
59.	Fabaceae	*Berlinia spp.*
60.	Fabaceae	*Cyliodiscus gabunensis*
61.	Fabaceae	*Guibourtia spp.*
62.	Fabaceae	*Erythrinia senegalensis*
63.	Fabaceae	*Isoberlina doka*
64.	Fabaceae	*Afzelia bipidensis*
65.	Fabaceae	*Afzelia africana*
66.	Fabaceae	*Afzelia spp.*
67.	Fabaceae	*Pterocarpus erinaceous*
68.	Fabaceae	*Parkia biglobosa*
69.	Fabaceae	*Pentaclethra macrophylla*
70.	Fabaceae	*Albizia ferruginea*
71.	Fabaceae	*Daniella ogea*
72.	Fabaceae	*Tetrapleura tetraptera*
73.	Fabaceae	*Albizia zygia*
74.	Fabaceae	*Albizia lebbeck*
75.	Fabaceae	*Albizia spp.*
76.	Fabaceae	*Angylocalyx zenkeri*

77.	Fabaceae	*Dialum guineense*
78.	Fabaceae	*Brachystegia nigerica*
79.	Fabaceae	*Piptandeniastrum africanum*
80.	Fabaceae	*Pterocarpus osun*
81.	Fabaceae	*Pterocarpus milbraedii*
82.	Fabaceae	*Afzelia africana*
83.	Flacourtiaceae	*Oncoba spinosa*
84.	Guttiferae	*Garcinia kola*
85.	Irvingiaceae	*Irvingia wombulu*
86.	Irvingiaceae	*Irvingia gabonensis*
87.	Irvingiaceae	*Irvingia grandiflora*
88.	Irvingiaceae	*Irvingia spp.*
89.	Juglandaceae	*Juglans nigra*
90.	Lecythidaceae	*Combretodendron spp.*
91.	Leccythiadaceae	*Combretodendron macrocarpum*
92.	Liliaceae	*Albuca nigritans*
93.	Melastomataceae	*Memocylon blakeoides*
94.	Meliaceae	*Khaya ivorensis*
95.	Meliaceae	*Guarea cedrata*
96.	Meliaceae	*Khaya grandifoliata*
97.	Meliaceae	*Khaya senegalensis*
98.	Meliaceae	*Trichilia lanata*
99.	Meliaceae	*Carapa procera*
100.	Meliaceae	*Cedrella spp.*
101.	Caesalpinaceae	*Detarium senegalense*
102.	Miliaceae	*Milicia excelsa*
103.	Mimosaceae	*Acacia gourmaensis*
104.	Moraceae	*Treculia obovoidea*
105.	Moraceae	*Treculia africana*
106.	Moraceae	*Ficus capensis*
107.	Moraceae	*Antians welwitschii*
108.	Moraceae	*Bosqueia angolensis*
109.	Moraceae	*Musanga cecropioides*
110.	Moraceae	*Myrianthus arboreus*
111.	Moraceae	*Ficus exasperata*
112.	Moraceae	*Ficus mucuso*
113.	Moringaceae	*Moringa olefeira*
114.	Myristicaceae	*Staudtia stipitata*
115.	Myristicaceae	*Coelocaryon preusii*
116.	Myristicaceae	*Pycanthus angolensis*
117.	Myristicaceae	*Pycanthus spp.*
118.	Ochnaceae	*Lophira alata*
119.	Olacaceae	*Strombosia postulata*
120.	Olacaceae	*Ximenia americana*
121.	Palmae (Arecacea)	*Elaeis guinensis*
122.	Papilionaceae	*Baphia nitida*
123.	Proteaceae	*Protea elliotii*
124.	Rabiaceae	*Hymenostegia afzelia*
125.	Rhamnaceae	*Maesopsis eminii*
126.	Rubiaceae	*Nauclea latifolia*
127.	Rutaceae	*Fagara macrophylla*
128.	Sapindaceae	*Blighia sapida*
129.	Sapotaceae	*Chrysophylum albidum*
130.	Sapotaceae	*Chrysophyllum spp.*
131.	Sapotaceae	*Gambeya albida*
132.	Sapotaceae	*Vitellaria paradoxa*
133.	Sapotaceae	*Baillenolla toxisperma*
134.	Sapotaceae	*Aningeria robusta*
135.	Sterculiaceae	*Cola nitida*
136.	Sterculiaceae	*Cola millenii*
137.	Steculiaceae	*Mansonia altissima*
138.	Sterculiaceae	*Sterculia oblonga*
139.	Sterculiaceae	*Triplochiton scleroxylon*
140.	Sterculiaceae	*Cola acuminata*
141.	Ulmaceae	*Celtis zenkeri*
142.	Verbanaceae	*Vitex doniana*
143.	Verbanaceae	*Vitex spp.*

Results show that species proportion varied with sampled plots. Sankwala (93) had the highest proportion of species followed by Bechevie forest (83).Omulako (31) and Gbogbu (32) had the least proportion of tree species. Table 2 shows the population frequency, density and abundance of tree species in Gbogbu forest. Results show that *Prosopis africana* and *Vitellaria paradoxa* had the highest population frequency (24%) followed by *Afzelia spp.* and *Ceiba pentandra* with 18% each. Some other species, including *Pentaclethra macrophylla* and *Parkia biglobosa* had a population frequency of 12% each

while the lowest population frequency of 6% occurred in 19 species. *Prosopis africana* had the loftiest density of 1.3333 stem/ha of the total population, followed by *Vitellaria paradoxa (*1 stem/ha), *Afzelia spp.* and *Ceiba pentandra* (0.8333 stem/ha). *Parkia biglobosa* had a population density of 0.6666 stem/ha while *Pentaclethra macrophylla* and some species such as *Uapaca spp* and *Vitex spp.* had a population density of 0.5 stem/ha each while the lowest population density of 0.1666 stem/ha occurred in 13 species. Results of abundance ratio (AR) of each tree species showed that the species were rare (1.00–2.99) except in some few cases where the species were occasional (3.00 and 3.30) in the study area (Table 2 - 11).

Results of tree species abundance (Appendix II) show that *Acacia gourmaensis*, *Albizia spp.*, *Anthonotha macrophylla*, *Coelocaryon preusii*, *Daniella ogea*, *Juglans nigra*, *Parkia biglobosa*, *Prosopis africana*, *Symphonia globulifera* and *Xylopia spp.* had the highest abundance ratio of 2.00 followed by *Pentaclethra macrophylla*, *Uapaca spp.*, *Vitex spp.* and *Vitellaria paradoxa* (1.50) while the least abundance ratio was 1.00 in most species. Results of population frequency, density and abundance of tree species in Omulako forest (Table 3) shows that *Prosopis africana* had the highest frequency (24%) followed by *Parkia biglobosa* and *Acacia gourmaensis* with 18% each. *Pentaclethra macrophylla* and some species had 12% while the lowest was 6% in some species. *Prosopis africana* had the loftiest density of 1.3333 stem/ha and was preceded by *Acacia gourmaensis* and *Parkia biglobosa* with 0.8333 stem/ha each. *Juglans nigra* had a population density of 0.5 stem/ha while the lowest population density of 0.1666 stem/ha occurred in 8 species.

Acacia gourmaensis, *Pentaclethra macrophylla* and some species had the highest abundance ratio (2.00) while that of *Parkia biglobosa* was (1.66). The least abundance ratio was (1.00). Results of population frequency, density and abundance of tree species in Aragban forest (Table 4) shows that *Juglans nigra* and *Prosopis africana* had the highest frequency of (24%) each followed by *Alstonia boonei*, *Ceiba pentandra*, *Chrysophyllum albidum*, *Parkia biglobosa* and some species with 18% each while *Pentaclethra macrophylla* had 12%. The lowest frequency was 6% in some species such as *Uapaca spp.*, *Terminalia ivorensis*, *Maesopsis eminii* and *Guarea cedrata*. *Prosopis africana* had the loftiest density of 1.3333 stem/ha and was preceded by *Ceiba pentandra* with 1.1666 stem/ha. *Parkia biglobosa*, *Pentaclethra macrophylla*, *Xylopia aethiopica*, *Tetrapleura tetraptera*, *Pterocarpus milbraedii* and *Anthonotha macrophylla* had population density of 0.8333 stem/ha each. *Antrocaryon micrasta*, *Alstonia boonei*, *Anacardium occidentale* and few other species had 0.5 stem/ha while the lowest population density of 0.1666 stem/ha occurred in 7 species.

Anthonotha macrophylla, *Pentaclethra macrophylla* and *Pterocarpus millbraedii* had the highest abundance ratio (2.50) followed by *Ceiba pentandra* (2.40) while *Parkia biglobosa* had (1.66). Some species had (2.00) while the least abundance ratio was (1.00). Results of population frequency, density and abundance of tree species in Abeya forest (Table 5) shows that *Ceiba pentandra*, *Pentaclethra macrophylla*, *Prosopis africana* and *Vitellaria paradoxa* had the highest population frequency of (24%) each followed by *Parkia biglobosa*, *Moringa olefeira* and *Tetrapleura tetraptera* with 18% each. The least population frequency was 6% in most species.

Table 2. Population frequency, density and abundance ratio (AR) of tree species identified in GbogbuForest, Gabu, Yala Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Acacia gourmaensis*	4	2	6	12	0.6666	2.00
2.	*Afzelia spp.*	5	3	6	18	0.8333	1.66
3.	*Albizia ferruginea*	2	1	6	6	0.3333	2.00
4.	*Alstonia boonei*	1	1	6	6	0.1666	1.00
5.	*Anthonotha macrophylla*	2	1	6	6	0.3333	2.00
6.	*Berlinia spp.*	1	1	6	6	0.1666	1.00
7.	*Calpocalyx winkleri*	1	1	6	6	0.1666	1.00
8.	*Carapa procera*	1	1	6	6	0.1666	1.00
9.	*Ceiba pentandra*	5	3	6	18	0.8333	1.66
10.	*Coelocaryon preusii*	2	1	6	6	0.3333	2.00
11.	*Cola spp.*	1	1	6	6	0.1666	1.00
12.	*Daniella ogea*	2	1	6	6	0.3333	2.00
13.	*Diospyros spp.*	1	1	6	6	0.1666	1.00
14.	*Eriboma oblonga*	1	1	6	6	0.1666	1.00
15.	*Irvingia spp.*	1	1	6	6	0.1666	1.00
16.	*Juglans nigra*	2	1	6	6	0.3333	2.00
17.	*Khaya spp.*	1	1	6	6	0.1666	1.00
18.	*Klainedoxa gabonensis*	1	1	6	6	0.1666	1.00
19.	*Parinari kerstingii*	1	1	6	6	0.1666	1.00
20.	*Parkia biglobosa*	4	2	6	12	0.6666	2.00
21.	*Prosopis africana*	8	4	6	24	1.3333	2.00
22.	*Pycanthus angolensis*	1	1	6	6	0.1666	1.00
23.	*Staudtia spp.*	1	1	6	6	0.1666	1.00
24.	*Staudtia stipitata*	1	1	6	6	0.1666	1.00
25.	*Strombosia postulata*	2	2	6	12	0.3333	1.00
26.	*Symphonia globulifera*	4	2	6	12	0.6666	2.00
27.	*Treculia obovoidea*	2	2	6	12	0.3333	1.00
28.	*Trichilia lanata*	2	2	6	12	0.3333	1.00
29.	*Uapaca spp.*	3	2	6	12	0.5	1.50
30.	*Vitellaria paradoxa*	6	4	6	24	1	1.50
31.	*Vitex spp.*	3	2	6	12	0.5	1.50
32.	*Xylopia spp.*	4	2	6	12	0.6666	2.00

Table 3. Population frequency, density and abundance ratio (AR) of tree species identified in Omulako Forest, Aliforkpa, Yala Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Acacia gourmaensis*	6	3	6	18	1	2.00
2.	*Afzelia spp.*	4	2	6	12	0.6666	2.00
3.	*Alstonia boonei*	2	1	6	6	0.3333	2.00
4.	*Annona senegalensis*	2	2	6	12	0.3333	1.00
5.	*Anthonotha macrophylla*	2	1	6	6	0.3333	2.00
6.	*Berlinia spp.*	1	1	6	6	0.1666	1.00
7.	*Calpocalyx winkleri*	1	1	6	6	0.3333	1.00
8.	*Carapa procera*	3	2	6	12	0.5	1.50
9.	*Ceiba pentandra*	4	2	6	12	0.6666	2.00
10.	*Coelocaryon preusii*	1	1	6	6	0.1666	1.00
11.	*Cola acuminata*	2	2	6	12	0.3333	1.00
12.	*Combretum spp.*	2	1	6	6	0.3333	2.00
13.	*Diospyros spp.*	1	1	6	6	0.1666	1.00
14.	*Eriboma oblonga*	2	2	6	12	0.3333	1.00
15.	*Gambeya albida*	4	2	6	12	0.6666	2.00
16.	*Irvingia spp.*	1	1	6	6	0.1666	1.00
17.	*Juglans nigra*	3	2	6	12	0.5	1.50
18.	*Khaya spp.*	1	1	6	6	0.1666	1.00
19.	*Klainedoxa gabonensis*	1	1	6	6	0.1666	1.00
20.	*Oncoba spinosa*	1	1	6	6	0.1666	1.00
21.	*Parkia biglobosa*	5	3	6	18	0.8333	1.66
22.	*Pentaclethra macrophylla*	4	2	6	12	0.6666	2.00
23.	*Prosopis africana*	8	4	6	24	1.3333	2.00
24.	*Pterocarpus osun*	1	1	6	6	0.1666	1.00
25.	*Pycanthus angolensis*	2	1	6	6	0.3333	2.00
26.	*Staudtia stipitata*	2	1	6	6	0.3333	2.00
27.	*Terminalia macroptera*	4	2	6	12	0.6666	2.00
28.	*Treculia obovoidea*	1	1	6	6	0.1666	1.00
29.	*Uapaca spp.*	2	2	6	12	0.3333	1.00
30.	*Vitex spp.*	2	1	6	6	0.3333	2.00
31.	*Xylopia africana*	4	2	6	12	0.6666	2.00

Table. 4. Population frequency, density and abundance ratio (AR) of tree species identified in Aragban Forest, Mbube, Ogoja Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Alchornea laxiflora*	2	2	6	12	0.3333	1.00
3.	*Anacardium occidentale*	3	2	6	12	0.5	1.50
4.	*Anogeissus leiocarpus*	1	1	6	6	0.1666	1.00
5.	*Anthonotha macrophylla*	5	2	6	12	0.8333	2.50
6.	*Antians welwitschii*	2	2	6	12	0.3333	1.00
7.	*Antrocaryon micrasta*	3	2	6	12	0.5	1.50
8.	*Baillenolla toxisperma*	3	2	6	12	0.5	1.50
9.	*Blighia sapida*	1	1	6	6	0.1666	1.00
10.	*Bombax costatum*	4	2	6	12	0.6666	2.00
11.	*Cederella spp.*	2	2	6	12	0.3333	1.00
12.	*Ceiba pentandra*	7	3	6	18	1.1666	2.40
13.	*Chrysophyllum albidum*	3	3	6	18	0.5	1.00
14.	*Cocos nucifera*	4	3	6	18	0.6666	1.33
15.	*Cola nitida*	3	3	6	18	0.5	1.00
16.	*Combretodendron macrocarpum*	1	2	6	12	0.1666	0.50
17.	*Dacryodes edulis*	4	3	6	18	0.6666	1.33
18.	*Dennittia tripetala*	2	1	6	6	0.3333	2.00
19.	*Elaeis guinensis*	4	2	6	12	0.6666	2.00
20.	*Erythrina senegalensis*	4	3	6	18	0.6666	1.33
21.	*Fagara macrophylla*	2	1	6	6	0.3333	2.00
22.	*Ficus capensis*	2	2	6	12	0.3333	1.00
23.	*Ficus mucuso*	2	1	6	6	0.3333	2.00
24.	*Gambeya albida*	3	2	6	12	0.5	1.50
25.	*Garcinia kola*	4	2	6	12	0.6666	2.00
26.	*Guarea cedrata*	2	1	6	6	0.3333	2.00
27.	*Hunteria umbellata*	2	1	6	6	0.3333	2.00
28.	*Irvingia grandifolia*	3	2	6	12	0.5	1.50
29.	*Juglans nigra*	6	4	6	24	1	1.50
30.	*Khaya grandifoliola*	4	3	6	18	0.6666	1.33
31.	*Khaya senegalensis*	2	2	6	12	0.3333	1.00
32.	*Klainedoxa gabonensis*	2	1	6	6	0.3333	2.00
33.	*Maesopsis eminii*	1	1	6	6	0.1666	1.00
34.	*Mansonia altissima*	3	2	6	12	0.5	1.50
35.	*Memocylon blakeoides*	2	1	6	6	0.3333	2.00
36.	*Milicia excelsa*	3	2	6	12	0.5	1.50
37.	*Monodora myristisca*	4	2	6	12	0.6666	2.00
38.	*Moringa olefeira*	4	3	6	18	0.6666	1.33
39.	*Myrianthus arboreus*	2	2	6	12	0.3333	1.00
40.	*Parkia biglobosa*	5	3	6	18	0.8333	1.66
41.	*Pentaclethra macrophylla*	5	2	6	12	0.8333	2.50
42.	*Pentadesma butyracea*	3	2	6	12	0.5	1.50
43.	*Prosopis africana*	8	4	6	24	1.3333	2.00
44.	*Pterocarpus millbraedii*	5	2	6	12	0.8333	2.50
45.	*Pterocarpus spp.*	4	2	6	12	0.6666	2.00
46.	*Pycanthus angolensis*	6	3	6	18	1	2.00
47.	*Staudtia stipitata*	3	3	6	18	0.5	1.00
48.	*Sterculia oblonga*	4	2	6	12	0.3333	2.00
49.	*Terminalia ivorensis*	1	1	6	6	0.1666	1.00
50.	*Terminalia superb*	4	2	6	12	0.6666	2.00
51.	*Tetrapleura tetraptera*	5	3	6	18	0.8333	1.66
52.	*Treculia africana*	6	3	6	18	1	2.00
53.	*Uapaca spp.*	1	1	6	6	0.1666	1.00
54.	*Vitellaria paradoxa*	6	3	6	18	1	2.00
55.	*Vitex spp.*	4	3	6	18	0.6666	1.33
56.	*Xylopia aethiopica*	5	3	6	18	0.8333	1.66

Prosopis africana and *Vitellaria paradoxa* had the highest density of 1.3333 stem/ha each and was preceded by *Pentaclethra macrophylla* and *Ceiba pentandra* with a population density of 1.1666 stem/ha each. *Moringa olefeira*, *Parkia biglobosa*, *Tetrapleura tetraptera* and *Xylopia spp*. had 1 stem/ha each while the lowest population density of 0.1666 stem/ha occurred in 10 species. *Milicia excelsa* had the highest abundance ratio (2.50) followed by *Albizia zygia*, *Parkia biglobosa* and some species with (2.00) while *Pentaclethra macrophylla* had abundance of (1.75). The least abundance ratio was (1.00). Results of population frequency, density and abundance of tree species in Aguomoh forest (Table 6) shows that *Anthonotha macrophylla*, *Ceiba pentandra*, *Milicia excelsa*, *Prosopis africana* and *Xylopia aethiopica* had the highest population frequency of (24%) each preceded by *Afzelia africana*, *Bombax costatum*, *Chrysophyllum spp.*, *Ficus mucuso*, *Parkia biglobosa* and *Pentaclethra macrophylla* with 18% each. The least population frequency was 6%. *Prosopis africana* and *Anthonotha macrophylla* had the loftiest density of 1.1666 stem/ha each followed by *Afzelia africana*, *Ceiba pentandra*, *Chrysophyllum spp.*, *Milicia excelsa*, *Parkia biglobosa*, *Vitellaria paradoxa* and *Xylopia aethiopica* with 1 stem/ha each. *Cedrella sp.*, *Lophira alata*, *Mansonia altissima* and *Newbouldia laevis* had a population density of 0.5 stem/ha each. *Pentaclethra macrophylla* and some species had the lowest population density of 0.1666 stem/ha. *Parkia biglobosa* and some species had the highest abundance ratio of (2.00) followed by *Prosopis africana* (1.75) while *Pentaclethra macrophylla* had (1.33). The least abundance ratio was (1.00).

Table. 5. Population frequency, density and abundance ratio (AR) of tree species identified in Abeya Forest, Winniba-Ekajuk, Ogoja Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Albizia zygia*	2	1	6	12	0.3333	2.00
2.	*Anacardium occidentale*	3	2	6	12	0.5	1.50
3.	*Anthonotha macrophylla*	2	1	6	6	0.3333	1.50
4.	*Antrocaryon micrasta*	1	1	6	6	0.1666	1.00
5.	*Berlinia spp.*	3	2	6	12	0.5	1.50
6.	*Bombax brevicuspe*	2	1	6	6	0.3333	2.00
7.	*Bombax costatum*	3	2	6	12	0.5	1.50
8.	*Brachystegia nigerica*	1	1	6	6	0.1666	1.00
9.	*Calpocalyx winkleri*	3	2	6	12	0.5	1.50
10.	*Carapa procera*	2	1	6	6	0.3333	2.00
11.	*Ceiba pentandra*	7	4	6	24	1.1666	1.75
12.	*Chrysophylum spp.*	4	2	6	12	0.6666	2.00
13.	*Cleistopholis patens*	3	2	6	12	0.5	1.50
14.	*Cocos nucifera*	2	1	6	6	0.3333	2.00
15.	*Coelocaryon preusii*	1	1	6	6	0.1666	1.00
16.	*Cola nitida*	2	2	6	12	0.3333	1.00
17.	*Cordia millenii*	1	1	6	6	0.1666	1.00
18.	*Cyliocodiscus gabonensis*	2	2	6	12	0.3333	1.00
19.	*Daniella ogea*	4	2	6	12	0.6666	2.00
20.	*Diospyros mesipiliformes*	2	1	6	6	0.3333	2.00
21.	*Diospyros spp.*	3	2	6	12	0.5	1.50
22.	*Elaeis guinensis*	4	2	6	12	0.6666	2.00
23.	*Ficus capensis*	2	1	6	6	0.3333	2.00
24.	*Ficus mucuso*	3	2	6	12	0.5	1.50
25.	*Funtumia elastica*	2	1	6	6	0.3333	2.00
26.	*Garcinia kola*	3	2	6	12	0.5	1.50
27.	*Gliricidia sepium*	1	1	6	6	0.1666	1.00
28.	*Guibourtia spp.*	1	1	6	6	0.1666	2.00
29.	*Hunteria umbellata*	2	2	6	12	0.3333	1.00
30.	*Irvingia gabonensis*	2	1	6	6	0.3333	2.00
31.	*Irvingia grandifolia*	3	2	6	12	0.5	1.50
32.	*Juglans nigra*	4	2	6	12	0.6666	2.00
33.	*Khaya grandifolia*	2	1	6	6	0.3333	2.00
34.	*Khaya ivorensis*	4	2	6	12	0.6666	2.00
35.	*Klainedoxa gabonensis*	1	1	6	6	0.1666	1.00
36.	*Lannea welwitschi*	1	1	6	6	0.1666	1.00
37.	*Lophira alata*	1	1	6	6	0.1666	1.00
38.	*Maesobotyra bateri*	4	2	6	12	0.6666	2.00
39.	*Mansonia altissima*	4	2	6	12	0.6666	2.00
40.	*Milicia excelsa*	5	2	6	12	0.8333	2.50
41.	*Moringa oleifeira*	6	3	6	18	1	2.00
42.	*Parkia biglobosa*	6	3	6	18	1	2.00
43.	*Pentaclethra macrophylla*	7	4	6	24	1.1666	1.75
44.	*Polyalthia suaveolens*	2	1	6	6	0.3333	2.00
45.	*Polyceratocarpus parvifllorus*	2	1	6	6	0.3333	2.00
46.	*Prosopis africana*	8	4	6	24	1.3333	2.00
47.	*Pycanthus angloensis*	2	1	6	6	0.3333	2.00
48.	*Ricinodendron heudoelotii*	2	1	6	6	0.3333	2.00
49.	*Strombosia postulata*	2	1	6	6	0.3333	2.00
50.	*Symphonia globulifera*	3	2	6	12	0.5	1.50
51.	*Tetrapleura tetraptera*	6	3	6	18	1	2.00
52.	*Detarium senegalense*	2	1	6	6	0.3333	2.00
53.	*Treculia africana*	4	2	6	12	0.6666	2.00
54.	*Uvariopsis dioica*	3	2	6	12	0.5	1.50
55.	*Vitellaria paradoxa*	8	4	6	24	1.3333	2.00
56.	*Vitex doniana*	2	1	6	6	0.3333	2.00
57.	*Xylopia spp.*	6	3	6	18	1	2.00

Table 6. Population frequency, density and abundance ratio (AR) of tree species identified in Aguomoh forest, Afrike, Bekwarra Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Afzelia africana*	6	3	6	18	1	2.00
2.	*Afzelia spp.*	1	1	6	6	0.1666	1.00
3.	*Albizia zygia*	4	2	6	12	0.6666	2.00
4.	*Alchornea cordifolia*	2	2	6	12	0.3333	1.00
5.	*Alstonia boonei*	2	1	6	6	0.3333	2.00
6.	*Anogeissus leiocarpus*	2	2	6	12	0.3333	1.00
7.	*Anthonotha macrophylla*	7	4	6	24	1.1666	1.75
8.	*Antrocaryon micrasta*	1	1	6	6	0.1666	1.00
9.	*Baillenolla toxisperma*	1	1	6	6	0.1666	1.00
10.	*Berlinia grandiflora*	1	1	6	6	0.1666	1.00

11.	*Bombax costatum*	4	3	6	18	0.6666	1.33
12.	*Carapa procera*	2	2	6	12	0.3333	1.00
13.	*Cedrella spp.*	3	2	6	12	0.5	1.50
14.	*Ceiba pentandra*	6	4	6	24	1	1.50
15.	*Chrysophyllum spp.*	6	3	6	18	1	2.00
16.	*Chrysophylum albidum*	4	2	6	12	0.6666	2.00
17.	*Cleistopholis patens*	2	2	6	12	0.3333	1.00
18.	*Cocos nucifera*	2	1	6	6	0.3333	2.00
19.	*Coelocaryon preusii*	1	1	6	6	0.1666	1.00
20.	*Cola millenii*	1	1	6	6	0.1666	1.00
21.	*Cola nitida*	1	1	6	6	0.1666	1.00
22.	*Dennittia tripetala*	1	1	6	6	0.1666	1.00
23.	*Elaeis guinensis*	4	2	6	12	0.6666	2.00
24.	*Eriboma oblonga*	1	1	6	6	0.1666	1.00
25.	*Ficus capensis*	2	2	6	12	0.3333	1.00
26.	*Ficus exasperata*	4	3	6	18	0.6666	1.33
27.	*Funtumia elastica*	2	1	6	6	0. 3333	2.00
28.	*Gambeya albida*	1	1	6	6	0.1666	1.00
29.	*Garcinia kola*	2	1	6	6	0.3333	2.00
30.	*Gliricidia sepium*	1	1	6	6	0.1666	1.00
31.	*Hunteria umbellata*	1	1	6	6	0.1666	1.00
32.	*Irvingia gabonensis*	4	2	6	12	0.6666	2.00
33.	*Irvingia spp.*	2	1	6	6	0.3333	2.00
34.	*Juglans nigra*	2	1	6	6	0.3333	2.00
35.	*Lannea welwitschi*	1	1	6	6	0.1666	1.00
36.	*Lophira alata*	3	2	6	12	0.5	1.50
37.	*Mansonia altissima*	3	2	6	12	0.5	1.50
38.	*Milicia excelsa*	6	4	6	24	1	1.50
40.	*Moringa olefeira*	4	2	6	12	0.6666	2.00
41.	*Newbouldia laevis*	3	2	6	12	0.5	1.50
42.	*Parkia biglobosa*	6	3	6	18	1	2.00
43.	*Pentaclethra macrophylla*	4	3	6	18	0.6666	1.33
44.	*Polyalthia suaveolens*	1	1	6	6	0.1666	1.00
45.	*Polyceratocarpus parvifllorus*	1	1	6	6	0.1666	1.00
46.	*Prosopis africana*	7	4	6	24	1.1666	1.75
47.	*Pterocarpus erinaceous*	1	1	6	6	0.1666	1.00
48.	*Pycanthus spp.*	3	2	6	12	0.5	1.50
49.	*Rauwolfia vomitora*	1	1	6	6	0.1666	1.00
50.	*Strombosia postulata*	1	1	6	6	0.1666	1.00
51.	*Symphonia globulifera*	2	1	6	6	0.3333	2.00
52.	*Terminalia macroptera*	4	2	6	12	0.6666	2.00
53.	*Terminalia superb*	1	1	6	6	0.1666	1.00
54.	*Tetrapleura tetraptera*	2	2	6	12	0.3333	1.00
55.	*Thaumatococus daniella*	1	1	6	6	0.1666	1.00
56.	*Treculia africana*	1	1	6	16	0.1666	1.00
57.	*Treculia obovoidea*	1	1	6	6	0.1666	1.00
58.	*Uapaca spp.*	2	1	6	6	0.3333	2.00
59.	*Uvariopsis dioica*	1	1	6	6	0.1666	1.00
60.	*Vitellaria paradoxa*	6	3	6	18	1	2.00
61.	*Xylopia aethiopica*	6	4	6	24	1	1.50
62.	*Xylopia africana*	1	1	6	6	0.1666	1.00

Results of population frequency, density and abundance of tree species in Ukpah forest (Table 7) shows that *Ceiba pentandra*, *Prosopis africana* and *Vitex spp*. had the highest frequency of (24%) each followed by *Parkia biglobosa*, *Pentaclethra macrophylla* and *Vitellaria paradoxa* with 18% each.

The least population frequency was observed in species such as *Vitex spp.*, *Uvariopsis dioica* and *Treculia obovoideae* which had a population frequency of 6% each. *Ceiba pentandra*, *Parkia biglobosa*, *Prosopis africana*, *Vitellaria paradoxa* and *Vitex doniana* had the highest density of 1 stem/ha and was preceded by *Pentaclethra macrophylla* with 0.8333 stem/ha. *Anthonotha macrophylla* and *Cedrella spp.* had a population density of 0.5 stem/ha while the lowest population density of 0.1666 stem/ha occurred in 20 species. *Parkia biglobosa*, *Anona senegalensis*, *Cocos nucifera*, *Elaeis guinensis* and some species had the highest abundance ratio of (2.00) followed by *Pentaclethra macrophylla* (1.66). *Anthonotha macrophylla*, *Cedrella spp*. and *Ceiba pentandra* had abundance ratio of (1.50) while the least was (1.00).

Results of population frequency, density and abundance of tree species in Alege forest (Table 8) shows that *Prosopis africana* had the highest frequency(24%) followed by *Albizia lebbeck*, *Albizia zygia*, *Angylocalyx zenkeri*, *Ceiba pentandra*, *Garcinia kola*, *Parkia biglobosa* and *Pentaclethra macrophylla* with 18% each. The lowest frequency was 6%. *Pentaclethra macrophylla* and *Prosopis africana* had the loftiestdensity of 1 stem/ha and was preceded by *Tetrapleura tetraptera* with 0.8333 stem/ha and *Parkia biglobosa* with a population density of 0.6666 stem/ha. *Albuca nigritans*, *Alstonia boonei*, *Anacardium occidentale*, *Berlinia grandiflora*, *Pterocarpus osun* and *Pycanthus angolensis* had a population density of 0.5 stem/ha each while the lowest population density of 0.1666 stem/ha occurred in 18 species. *Baphia nitida*, *Brachystegia nigerica*, *Carapa procera*, *Pentaclethra macrophylla* and some species had the highest abundance ratio of (2.00) followed by *Albizia zygia* (1.60) and *Parkia biglobosa* with (1.30) while the least abundance ratio was (1.00).

Table 7. Population frequency, density and abundance ratio (AR) of tree species identified in Ukpah Forest, Bekwarra Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	frequency	Density	AR
1.	*Afzelia spp.*	1	1	6	6	0.1666	1.00
2.	*Albizia lebbeck*	2	2	6	12	0.3333	1.00
3.	*Albizia zygia*	2	2	6	12	0.3333	1.00
4.	*Annona senegalensis*	2	1	6	6	0.3333	2.00
5.	*Anthonotha macrophylla*	3	2	6	12	0.5	1.50
6.	*Antrocaryon micrasta*	1	1	6	6	0.1666	1.00
7.	*Baillenolla toxisperma*	1	1	6	6	0.1666	1.00
8.	*Berlinia grandiflora*	1	1	6	6	0.1666	1.00
9.	*Bombax costatum*	1	1	6	6	0.1666	1.00
10.	*Carapa procera*	1	1	6	6	0.1666	1.00
11.	*Cedrella spp.*	3	2	6	12	0.5	1.50
12.	*Ceiba pentandra*	6	4	6	24	1	1.50
13.	*Chrysophyllum spp.*	1	1	6	6	0.1666	1.00
14.	*Cleistopholis patens*	2	2	6	12	0.3333	1.00
15.	*Cocos nucifera*	2	1	6	12	0.3333	2.00
16.	*Coelocaryon preusii*	1	1	6	6	0.1666	1.00
17.	*Cola millenii*	2	2	6	12	0.3333	1.00
18.	*Combretodendron spp.*	2	2	6	12	0.3333	1.00
19.	*Cussonia barteri*	1	1	6	6	0.1666	1.00
20.	*Elaeis guinensis*	4	2	6	12	0.6666	2.00
21.	*Eriboma oblonga*	1	1	6	6	0.1666	1.00
22.	*Ficus capensis*	2	2	6	12	0.3333	1.00
23.	*Funtumia elastica*	1	1	6	6	0.1666	1.00
24.	*Gambeya albida*	2	1	6	6	0.3333	2.00
25.	*Garcinia kola*	2	2	6	12	0.3333	1.00
26.	*Guarea cedrata*	1	1	6	6	0.1666	1.00
27.	*Guibourtia spp.*	1	1	6	6	0.1666	1.00
28.	*Hunteria umbellata*	2	2	6	12	0.3333	1.00
29.	*Irvingia gabonensis*	1	1	6	6	0.1666	1.00
30.	*Irvingia spp.*	2	2	6	12	0.3333	1.00
31.	*Juglans nigra*	4	2	6	12	0.6666	2.00
32.	*Lannea welwitschi*	2	2	6	12	0.3333	1.00
33.	*Lophira alata*	4	2	6	12	0.6666	2.00
34.	*Mansonia altissima*	2	2	6	12	0.3333	1.00
35.	*Milicia excelsa*	1	1	6	6	0.1666	1.00
36.	*Monodora myristica*	1	1	6	6	0.1666	1.00
37.	*Moringa olefeira*	4	2	6	12	0.6666	2.00
38.	*Newbouldia leavis*	1	1	6	6	0.1666	1.00
39.	*Oncoba spinosa*	1	1	6	6	0.1666	1.00
40.	*Parkia biglobosa*	6	3	6	18	1	2.00
41.	*Pentaclethra macrophylla*	5	3	6	18	0.8333	1.66
42.	*Polyalthia suaveolens*	1	1	6	6	0.1666	1.00
43.	*Polyceratocarpus parvifllorus*	1	1	6	6	0.1666	1.00
44.	*Prosopis africana*	6	4	6	24	1	1.50
45.	*Pycanthus angolensis*	4	2	6	12	0.6666	2.00
46.	*Rauwolfia vomitora*	1	1	6	6	0.1666	1.00
47.	*Strombosia spp.*	1	1	6	6	0.1666	1.00
48.	*Symphonia globulifera*	2	2	6	12	0.3333	1.00
49.	*Terminalia macroptera*	1	1	6	6	0.1666	1.00
50.	*Terminalia aviceniodes*	2	2	6	12	0.3333	1.00
51.	*Tetrapleura tetraptera*	4	2	6	12	0.6666	2.00
52.	*Treculia africana*	4	2	6	12	0.6666	2.00
53.	*Treculia obovoidea*	2	1	6	6	0.3333	2.00
54.	*Uvariopsis dioica*	1	1	6	6	0.1666	1.00
55.	*Vitellaria paradoxa*	6	3	6	18	1	2.00
56.	*Vitex doniana*	6	4	6	24	1	1.50
57.	*Vitex spp.*	1	1	6	6	0.1666	1.00
58.	*Xylopia africana*	2	2	6	12	0.3333	1.00

Results of population frequency, density and abundance of tree species in Beteh forest (Table 9) shows that *Prosopis africana* had the highest frequency (30%) followed by *Vitellaria paradoxa* with 24%. *Parkia biglobosa* and *Pentaclethra macrophylla* had frequency of 18% each while the least population frequency was 6% in some species.

Prosopis africana had the loftiest density of 1.6666 stem/ha and was preceded by *Vitellaria paradoxa* with 1 stem/ha and *Parkia biglobosa* and *Pentaclethra macrophylla* with population density of 0.8333 stem/ha each. *Elaeis guinensis*, *Ficus capensis*, *Hevea brasilliensis*, *Memocylon blakeoides* and *Polyalthia suaveolens* had a population density of 0.5

Table 8. Population frequency, density and abundance ratio (AR) of tree species identified in Alege Forest, Obudu Local Government Area, Cross River State

S/N	Species	Total no. of individual	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Acacia gourmaensis*	2	2	6	12	0.3333	1.00
2.	*Albizia lebbeck*	4	3	6	18	0.6666	1.30
3.	*Albizia zygia*	5	3	6	18	0.8333	1.60
4.	*Albuca nigritans*	3	2	6	12	0.5	1.50
5.	*Alstonia boonei*	3	2	6	12	0.5	1.50
6.	*Amphimas pterocarpoides*	2	2	6	12	0.3333	1.00
7.	*Anacardium occidentale*	3	2	6	12	0.5	1.50
8.	*Angylocalyx zenkeri*	4	3	6	18	0.6666	1.33
9.	*Anthonotha macrophylla*	1	1	6	6	0.1666	1.00
10.	*Baillenolla toxisperma*	1	1	6	6	0.1666	1.00
11.	*Baphia nitida*	4	2	6	12	0.6666	2.00
12.	*Berlinia grandiflora*	3	2	6	12	0.5	1.50
13.	*Brachystegia nigerica*	2	1	6	6	0.3333	2.00
14.	*Calpocalyx winkleri*	1	1	6	6	0.1666	1.00
15.	*Carapa procera*	2	1	6	6	0.3333	2.00
16.	*Cedrella spp.*	2	1	6	6	0.3333	2.00
17.	*Ceiba pentandra*	4	3	6	18	0.6666	1.30
18.	*Chrysophylum albidum*	2	1	6	6	0.3333	2.00
19.	*Cleistopholis patens*	1	1	6	6	0.1666	1.00
20.	*Cola nitida*	1	1	6	6	0.1666	1.00
21.	*Cyliodiscus gabonensis*	1	1	6	6	0.1666	1.00
22.	*Daniella ogea*	1	1	6	6	0.1666	1.00
23.	*Dennittia tripetala*	2	2	6	12	0.3333	1.00
24.	*Diospyros dendo*	1	1	6	6	0.1666	1.00
25.	*Diospyros mesipiliformes*	1	1	6	6	0.1666	1.00
26.	*Elaeis guinensis*	2	2	6	12	0.3333	1.00
27.	*Ficus exasperata*	2	1	6	6	0.3333	2.00
28.	*Funtumia elastica*	2	2	6	12	0.3333	1.00
29.	*Garcinia kola*	4	3	6	18	0.6666	1.30
30.	*Guarea cedrata*	1	1	6	6	0.1666	1.00
31.	*Guibourtia spp.*	1	1	6	6	0.1666	1.00
32.	*Hevea brasilliensis*	1	1	6	6	0.1666	1.00
33.	*Hymenostegia afzelia*	2	2	6	12	0.3333	1.00
34.	*Irvingia grandifolia*	2	2	6	12	0.3333	1.00
35.	*Juglans nigra*	2	1	6	6	0.3333	2.00
36.	*Khaya ivorensis*	2	1	6	6	0.3333	2.00
37.	*Maesobotyra bateri*	2	1	6	6	0.3333	2.00
38.	*Mansonia altissima*	2	1	6	6	0.3333	2.00
39.	*Memocylon blakeoides*	1	1	6	6	0.1666	1.00
40.	*Milicia excelsa*	4	2	6	12	0.6666	2.00
41.	*Newbouldia leavis*	2	1	6	6	0.3333	2.00
42.	*Parinari kerstingii*	2	2	6	12	0.3333	1.00
43.	*Parkia biglobosa*	4	3	6	18	0.6666	1.30
44.	*Pentaclethra macrophylla*	6	3	6	18	1	2.00
45.	*Pentadesma butyraceae*	1	1	6	6	0.1666	1.00
46.	*Piptadeniastrum africanum*	2	1	6	6	0.6666	2.00
47.	*Polyalthia suaveolens*	2	1	6	6	0.3333	2.00
48.	*Prosopis africana*	6	4	6	24	1	1.50
49.	*Pterocarpus osun*	3	2	6	12	0.5	1.50
50.	*Pycanthus spp.*	3	2	6	12	0.5	1.50
51.	*Rauwolfia vomitora*	2	2	6	12	0.3333	1.00
52.	*Ricinodendron heudoelotii*	1	1	6	6	0.1666	1.00
53.	*Staudtia stipitata*	2	2	6	12	0.3333	1.00
54.	*Symphonia globulifera*	1	1	6	6	0.1666	1.00
55.	*Terminalia ivorensis*	2	2	6	12	0.3333	1.00
56.	*Tetrapleura tetraptera*	5	3	6	18	0.8333	1.60
57.	*Tetrorchidium didymostemon*	4	2	6	12	0.6666	2.00
58.	*Uapaca acuminata*	1	1	6	6	0.1666	1.00
59.	*Uvariopsis dioica*	1	1	6	6	0.1666	1.00
60.	*Vitellaria paradoxa*	4	2	6	12	0.6666	2.00
61.	*Vitex doniana*	3	2	6	12	0.5	1.50
62.	*Xylopia aethiopica*	4	2	6	12	0.6666	2.00

stem/ha each while the lowest population density of 0.1666 stem/ha occurred in 18 species. *Albizia lebbeck*, *Anogeissus leiocarpus*, *Anthonotha macrophylla* and some species had the highest abundance ratio (2.00) followed by *Parkia biglobosa* and *Pentaclethra macrophylla* with (1.60) each while the least was (1.00). Results of population frequency, density and abundance of tree species in Bechevie forest (Table 10) shows that *Prosopis africana* had the highest frequency (30%) followed by *Pentaclethra macrophylla* and *Vitellaria paradoxa* with 24% each.

Parkia biglobosa had a population frequency of 18% while the least was 6%. *Pentaclethra macrophylla* had the highest density of 2 stem/ha and was preceded by *Prosopis africana* with 1.6666 stem/ha and *Parkia biglobosa* with 1.3333 stem/ha. *Irvingia gradifolia*, *Tetrapleura tetraptera* and *Vitellaria paradoxa* had population density of 1 stem/ha each. *Carapa procera*, *Cola nitida*, *Diospyros mesipiliformes*, *Gambeya albida*, *Garcinia kola* and some species had a population density of 0.5 stem/ha while the lowest population density of 0.1666 stem/ha occurred in 24 species.

Table 9. Population frequency, density and abundance ratio (AR) of tree species identified in Beteh Forest, Obudu Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Albizia lebbeck*	2	1	6	6	0.3333	2.00
2.	*Albizia zygia*	2	2	6	12	0.3333	1.00
3.	*Alchornea cordifolia*	1	1	6	6	0.1666	1.00
4.	*Alstonia boonei*	2	2	6	12	0.3333	1.00
5.	*Amphimas pterocarpoides*	1	1	6	6	0.1666	1.00
6.	*Anacardium occidentale*	2	2	6	12	0.3333	1.00
7.	*Angylocalyx zenkeri*	1	1	6	6	0.1666	1.00
8.	*Annona senegalensis*	2	2	6	12	0.3333	1.00
9.	*Anogeissus leiocarpus*	2	1	6	6	0.3333	2.00
10.	*Anthonotha macrophylla*	4	2	6	12	0.6666	2.00
11.	*Baillenolla toxisperma*	1	1	6	6	0.1666	1.00
12.	*Baphia nitida*	2	2	6	12	0.3333	1.00
13.	*Berlinia grandiflora*	2	1	6	6	0.3333	2.00
14.	*Bosqueia angolensis*	1	1	6	6	0.1666	1.00
15.	*Calpocalyx winkleri*	2	1	6	6	0.3333	2.00
16.	*Carapa procera*	2	1	6	6	0.3333	2.00
17.	*Cedrella spp.*	2	2	6	12	0.3333	1.00
18.	*Chrysophylum spp.*	1	1	6	6	0.1666	1.00
19.	*Cleistopholis patens*	2	2	6	12	0.3333	1.00
20.	*Combretodendron macrocopum*	2	2	6	12	0.3333	1.00
21.	*Cussonia barteri*	1	1	6	6	0.1666	1.00
22.	*Cyliodiscus gabunensis*	1	1	6	6	0.1666	1.00
23.	*Daniella ogea*	1	1	6	6	0.1666	1.00
24.	*Diospyros dendo*	1	1	6	6	0.1666	1.00
25.	*Elaeis guinensis*	3	2	6	12	0.5	1.50
26.	*Ficus capensis*	3	2	6	12	0.5	1.50
27.	*Garcinia kola*	2	1	6	6	0.3333	2.00
28.	*Guarea cedrata*	2	2	6	12	0.3333	1.00
29.	*Guibourtia spp.*	1	1	6	6	0.1666	1.00
30.	*Hevea brasilliensis*	3	2	6	12	0.5	1.50
31.	*Hymenostegia afzelia*	1	1	6	6	0.1666	1.00
32.	*Irvingia grandiflolia*	2	1	6	6	0.3333	2.00
33.	*Irvingia wombulu*	2	2	6	12	0.3333	1.00
34.	*Juglans nigra*	2	2	6	12	0.3333	1.00
35.	*Maesobotyra bateri*	2	1	6	6	0.3333	2.00
36.	*Mansonia altissima*	2	2	6	12	0.3333	1.00
37.	*Memocylon blakeoides*	3	2	6	12	0.5	1.50
38.	*Milicia excelsa*	4	2	6	12	0.6666	2.00
39.	*Moringa olefeira*	4	2	6	12	0.6666	2.00
40.	*Nauclea latifolia*	1	1	6	6	0.1666	1.00
41.	*Newbouldia leavis*	2	1	6	6	0.3333	2.00
42.	*Oncoba spinosa*	2	2	6	12	0.3333	1.00
43.	*Parkia biglobosa*	5	3	6	18	0.8333	1.60
44.	*Pentaclethra macrophylla*	5	3	6	18	0.8333	1.60
45.	*Pentadesma butraceae*	1	1	6	6	0.1666	1.00
46.	*Piptandeniastrum africanum*	2	2	6	12	0.3333	1.00
47.	*Polyalthia suaveolens*	3	2	6	12	0.5	1.50
48.	*Prosopis africana*	10	5	6	30	1.6666	2.00
49.	*Pterocarpus erinaceous*	1	1	6	6	0.1666	1.00
50.	*Rauwolfia vomitora*	1	1	6	6	0.1666	1.00
51.	*Ricinodendron heudoelotii*	1	1	6	6	0.1666	1.00
52.	*Symphonia globulifera*	1	1	6	6	0.1666	1.00
53.	*Terminalia ivorensis*	2	2	6	12	0.3333	1.00
54.	*Terminalia macroptera*	1	1	6	6	0.1666	1.00
55.	*Tetrapleura tetraptera*	5	3	6	18	0.8333	1.60
58.	*Uvariopsis dioica*	1	1	6	6	0.3333	1.00
59.	*Vitellaria paradoxa*	6	4	6	24	1	1.50
60.	*Vitex doniana*	2	1	6	6	0.3333	2.00
61.	*Xylopia africana*	3	2	6	12	0.5	1.50

Pentaclethra macrophylla had the highest abundance ratio of (RD 3.00) followed by *Parkia biglobosa* with (2.66). Other species had abundance of (2.00) while the least was (1.00). Results of population frequency, density and abundance of tree species in Sankwala forest (Table 11) shows that *Alchornia cordifolia*, *Lophira alata*, *Tetrapleura tetraptera* and *Vitellaria paradoxa* had the highest frequency of 30% each followed by *Chrysophyllum spp.*, *Milicia excelsa*, *Moringa olefeira* and *Prosopis africana* with 24% each, *Parkia biglobosa* and *Pentaclethra macrophylla* had population frequency of 18% each while the lowest was 6%. *Lophira alata* had the loftiest density of 2 stem/ha and was preceded by *Pentaclethra macrophylla* with 1.6666 stem/ha. *Parkia biglobosa*, *Prosopis africana* and *Vitellaria paradoxa* had population density of 1.3333 stem/ha each while the least was 0.1666 stem/ha. *Alchornia cordifolia*, *Ceiba pentandra*, *Chrysophyllum spp.*, *Irvingia grandifolia*, *Milicia excelsa*, *Moringa olefeira* and *Tetrapleura tetraptera* had population density of 1 stem/ha each. *Pentaclethra macrophylla* had the highest abundance ratio (3.30) followed by *Parkia biglobosa* and *Vitellaria paradoxa* with abundance of (2.60) each. *Lophira alata* had abundance ratio (2.40) while the least abundance was (1.00) in some species. Results of population frequency, density and abundance therefore, shows that Sankwala forest had the highest population frequency, density and abundance of tree species followed by Bechevie forest while the least was Gbogbu and Omulako forests respectively.

Table 10. Frequency, density and abundance ratio (AR) of tree species identified in Bechevie Forest, Obanliku Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Acacia gourmaensis*	1	1	6	6	0.1666	1.00
2.	*Afzelia spp.*	2	2	6	12	0.3333	1.00
3.	*Albizia lebbeck*	2	2	6	12	0.3333	1.00
4.	*Albizia spp.*	1	1	6	6	0.1666	1.00
5.	*Albizia zygia*	1	1	6	6	0.1666	1.00
6.	*Albuca nigritans*	1	1	6	6	0.1666	1.00
7.	*Allanblackia floribunda*	2	2	6	12	0.3333	1.00
8.	*Alstonia boonei*	2	2	6	12	0.3333	1.00
9.	*Amphimas pterocarpoides*	4	2	6	12	0.6666	2.00
10.	*Anacardium occidentale*	4	2	6	12	0.6666	2.00
11.	*Angylocalyx zenkeri*	1	1	6	6	0.1666	1.00
12.	*Antians welwitschii*	1	1	6	6	0.1666	1.00
13.	*Baphia nitida*	1	1	6	6	0.1666	1.00
14.	*Berlinia grandiflora*	1	1	6	6	0.1666	1.00
15.	*Blighia sapida*	1	1	6	6	0.1666	1.00
16.	*Bombax brevicuspe*	2	2	6	12	0.3333	1.00
17.	*Bombax costatum*	2	2	6	12	0.3333	1.00
18.	*Bosqueia angolensis*	1	1	6	6	0.1666	1.00
19.	*Brachystegia nigerica*	1	1	6	6	0.1666	1.00
20.	*Carapa procera*	3	2	6	12	0.5	1.50
21.	*Cedrella spp.*	4	2	6	12	0.6666	2.00
22.	*Ceiba pentandra*	4	2	6	12	0.6666	2.00
23.	*Chrysophylum albidum*	2	2	6	12	0.3333	1.00
24.	*Cleistopholis patens*	1	1	6	6	0.1666	1.00
25.	*Cola nitida*	3	2	6	12	0.5	1.50
26.	*Combretum spp.*	1	1	6	6	0.1666	1.00
27.	*Cordia millenii*	2	2	6	12	0.3333	1.00
28.	*Cussonia barteri*	3	2	6	12	0.5	1.50
29.	*Cyliodiscus gabunensis*	2	2	6	12	0.3333	1.00
30.	*Daniella ogea*	1	1	6	6	0.1666	1.00
31.	*Diospyros mesipiliformes*	3	2	6	12	0.5	1.50
32.	*Elaeis guinensis*	2	1	6	6	0.3333	2.00
33.	*Fagara macrophylla*	2	2	6	12	0.3333	1.00
34.	*Ficus capensis*	1	1	6	6	0.1666	1.00
35.	*Ficus exasperata*	2	2	6	12	0.3333	1.00
36.	*Funtumia elastica*	2	2	6	12	0.3333	1.00
37.	*Gambeya albida*	3	2	6	12	0.5	1.50
38	*Garcinia kola*	3	2	6	12	0.5	1.5
39.	*Guarea cedrata*	2	2	6	12	0.3333	1.00
40.	*Guibourtia spp.*	2	2	6	12	0.3333	1.00
41.	*Hevea brasilliensis*	3	2	6	12	0.5	1.50
42.	*Hunteria umbellata*	4	2	6	12	0.6666	2.00
43.	*Hymenostegia afzelia*	2	1	6	6	0.3333	2.00
44.	*Irvingia gabonensis*	4	2	6	12	0.6666	2.00
45.	*Irvingia grandifolia*	6	3	6	18	1	2.00
46.	*Irvingia wombulu*	4	2	6	12	0.6666	2.00
47.	*Khaya grandifoliola*	2	2	6	12	0.3333	1.00
48.	*Khaya spp.*	2	2	6	12	0.3333	1.00
49.	*Klainedoxa gabonensis*	1	1	6	6	0.1666	1.00
50.	*Lannea welwitschi*	2	2	6	12	0.3333	1.00
51.	*Maesobotyra bateri*	1	1	6	6	0.1666	1.00
52.	*Maesopsis eminii*	1	1	6	6	0.1666	1.00
53.	*Memocylon blakeoides*	2	2	6	12	0.3333	1.00
54.	*Milicia excelsa*	4	3	6	18	0.3333	1.33
55.	*Moringa olefeira*	4	2	6	12	0.6666	2.00
56.	*Musanga cecropioides*	2	2	6	12	0.3333	1.00
57.	*Myrianthus arboreus*	1	1	6	6	0.1666	1.00
58.	*Nauclea latifolia*	2	2	6	12	0.3333	1.00
59.	*Oncoba spinosa*	2	1	6	12	0.3333	2.00
60.	*Parkia biglobosa*	8	3	6	18	1.3333	2.66
61.	*Pentaclethra macrophylla*	12	4	6	24	2	3.00
62.	*Pentadesma butyraceae*	1	1	6	6	0.1666	1.00
63.	*Piptadoniastrum africanum*	1	1	6	6	0.1666	1.00
64.	*Polyalthia suaveolens*	2	1	6	6	0.3333	2.00
65.	*Prosopis africana*	10	5	6	30	1.6666	2.00
66.	*Pterocarpus milbraedii*	2	1	6	6	0.3333	2.00
67.	*Pterocarpus osun*	1	1	6	6	0.1666	1.00
68.	*Pycanthus angolensis*	3	2	6	12	0.5	1.50
69.	*Rauwolfia vomitora*	2	2	6	12	0.3333	1.00
70.	*Ricinodendron heudoelotii*	2	1	6	6	0.3333	2.00
71.	*Staudtia stipitata*	2	2	6	12	0.3333	1.00
72	*Terminalia ivorensis*	2	2	6	12	0.3333	1.0
73	*Terminalia macroptera*	2	2	6	12	0.3333	1.00
74	*Tetrapleura tetraptera*	6	3	6	1	8	1.50
75.	*Tetrorchidium didymostemon*	2	1	6	6	0.3333	2.00
76.	*Thaumatococus daniella*	2	2	6	12	0.3333	1.00
77.	*Treculia africana*	2	2	6	12	0.3333	1.00
78.	*Trichilia lanata*	1	1	6	6	0.1666	1.00
79.	*Uapaca acuminata*	4	3	6	18	0.6666	1.33
80.	*Uvariopsis dioica*	2	2	6	12	0.3333	1.00
81.	*Vitellaria paradoxa*	6	4	6	24	1	1.50
82.	*Vitex spp.*	1	1	6	6	0.1666	1.00
83.	*Xylopia aethiopica*	2	2	6	12	0.3333	1.00

Table 11. Population frequency, density and abundance ratio (AR) of tree species identified in Sankwala Forest, Obanliku Local Government Area, Cross River State

S/N	Species	Total no. of individuals	Total no. of segments the species occurred	Total no. of segments	Frequency	Density	AR
1.	*Acacia gourmaensis*	4	2	6	12	0.6666	2.00
2.	*Afzelia africana*	2	2	6	12	0.3333	1.00
3.	*Afzelia spp.*	2	2	6	12	0.3333	1.00
4.	*Alchornea cordifolia*	6	5	6	30	1	1.20
5.	*Allanblackia floribunda*	4	2	6	12	0.6666	2.00
6.	*Alstonia boonei*	2	2	6	12	0.3333	1.00
7.	*Amphimas pterocarpoides*	2	2	6	12	0.3333	1.00
8.	*Anacardium occidentale*	2	2	6	12	0.3333	1.00
9.	*Angylocalyx zenkeri*	1	1	6	6	0.1666	1.00
10.	*Aningeria robusta*	2	2	6	12	0.3333	1.00
11.	*Annona senegalensis*	2	1	6	6	0.3333	2.00
13.	*Annonidium manii*	4	2	6	12	0.6666	2.00
12.	*Anogeissus leiocarpus*	1	1	6	6	0.1666	1.00
14.	*Antians welwitschii*	2	2	6	12	0.3333	1.00
15.	*Antrocaryon micrasta*	1	1	6	6	0.1666	1.00
16.	*Baphia nitida*	4	2	6	12	0.6666	2.00
17.	*Berlinia grandiflora*	3	2	6	12	0.5	1.50
18.	*Berlinia spp.*	1	1	6	6	0.1666	1.00
19.	*Blighia sapida*	3	2	6	12	0.5	1.50
20.	*Bombax brevicuspe*	2	1	6	6	0.3333	2.00
21.	*Bombax costatum*	2	2	6	12	0.3333	1.00
22.	*Bosqueia angolensis*	2	2	6	12	0.3333	1.00
23.	*Canarium schweinfurthii*	2	1	6	6	0.3333	2.00
24.	*Carapa procera*	2	2	6	12	0.3333	1.00
25.	*Cedrella spp.*	3	2	6	12	0.5	1.50
26.	*Ceiba pentandra*	6	3	6	18	1	2.00
27.	*Chrysophyllum spp.*	6	4	6	24	1	1.50
28.	*Cleistopholis patens*	2	2	6	12	0.3333	1.00
29.	*Cocos nucifera*	4	2	6	12	0.6666	2.00
30.	*Coelocaryon preusii*	1	1	6	6	0.1666	1.00
31.	*Cola acuminata*	3	2	6	12	0.5	1.50
32.	*Cola millenii*	4	2	6	12	0.6666	2.00
33.	*Cola nitida*	1	1	6	6	0.1666	1.00
34.	*Combretodendron spp.*	2	2	6	12	0.3333	1.00
35.	*Combretum spp.*	2	2	6	12	0.3333	1.00
36.	*Cordia millenii*	2	1	6	6	0.3333	2.00
37	*Cussonia barteri*	1	1	6	6	0.1666	1.00
38.	*Dacryodes edulis*	4	2	6	12	0.6666	2.00
39.	*Diospyros dendo*	2	2	6	12	0.3333	1.00
40.	*Diospyros mesipiliformes*	1	1	6	6	0.1666	1.00
41.	*Elaeis guinensis*	4	2	6	12	0.6666	2.00
42.	*Eriboma oblonga*	1	1	6	6	0.1666	1.00
43.	*Erythrinia senegalensis*	4	2	6	12	0.6666	2.00
44.	*Fagara macrophylla*	2	2	6	12	0.3333	1.00
45.	*Ficus capensis*	4	2	6	12	0.6666	2.00
46.	*Ficus exasperata*	4	3	6	12	0.6666	1.33
47.	*Ficus mucuso*	3	2	6	12	0.5	1.50
48.	*Funtumia elastica*	2	1	6	6	0.3333	2.00
49.	*Gambeya albida*	3	2	6	12	0.5	1.50
50.	*Garcinia kola*	4	2	6	12	0.6666	2.00
51.	*Gliricidia sepium*	1	1	6	6	0.1666	1.00
52.	*Guarea cedrata*	1	1	6	6	0.1666	1.00
53.	*Hevea brasilliensis*	4	2	6	12	0.6666	2.00
54.	*Hunteria umbellata*	2	2	6	12	0.3333	1.00
55.	*Hymenocardia acida*	2	2	6	12	0.3333	1.00
56.	*Hyphaena thebaica*	2	2	6	12	0.3333	1.00
57.	*Irvingia gabonensis*	4	2	6	12	0.6666	2.00
58.	*Irvingia grandifolia*	6	3	6	18	1	2.00
59.	*Irvingia wombulu*	4	2	6	12	0.6666	2.00
60.	*Isoberlina doka*	3	3	6	18	0.5	1.00
61.	*Juglans nigra*	2	2	6	12	0.3333	1.00
62.	*Lannea welwitschi*	2	2	6	12	0.3333	1.00
63.	*Lophira alata*	12	5	6	30	2	2.40
64.	*Maesopsis eminii*	4	2	6	12	0.6666	2.00
65.	*Memocylon blakeoides*	2	2	6	12	0.3333	1.00
66.	*Milicia excelsa*	6	4	6	24	1	1.50
67.	*Moringa olefeira*	6	4	6	24	1	1.50
68.	*Musanga cecropioides*	3	2	6	12	0.5	1.50
69.	*Myrianthus arboreus*	1	1	6	6	0.1666	1.00
70.	*Nauclea latifolia*	1	1	6	6	0.1666	1.00
71.	*Oncoba spinosa*	2	1	6	12	0.3333	2.00
72.	*Parinari kerstingii*	2	2	6	12	0.3333	1.00

Continue…………………………..

73.	*Parkia biglobosa*	8	3	6	18	1.3333	2.60
76.	*Polyceratocarpus parvifllorus*	1	1	6	6	0.1666	1.00
77.	*Prosopis africana*	8	4	6	24	1.3333	2.00
78.	*Protea elliotii*	2	2	6	12	0.3333	1.00
79.	*Pseudopondias microcarpa*	1	1	6	6	0.1666	1.00
80.	*Pterocarpus milbraedii*	1	1	6	6	0.1666	1.00
81.	*Pycanthus angolensis*	2	1	6	6	0.3333	2.00
82.	*Staudtia stipitata*	2	1	6	6	0.3333	2.00
84.	*Terminalia aviceniodes*	2	2	6	12	0.3333	1.00
85.	*Terminalia ivorensis*	1	1	6	6	0.1666	1.00
86.	*Terminalia macroptera*	1	1	6	6	0.1666	1.00
87.	*Tetrapleura tetraptera*	6	5	6	30	1	1.20
88.	*Tetrorchidium didymostemon*	1	1	6	6	0.1666	1.00
89.	*Pentaclethra macrophylla*	10	3	6	18	1.6666	3.30
90.	*Trichilia lanata*	2	2	6	12	0.3333	1.00
91.	*Triplochiton scleroxylon*	2	1	6	6	0.3333	2.00
92.	*Vitellaria paradoxa*	8	5	6	30	1.3333	2.60
93.	*Ximenia americana*	2	2	6	12	0.3333	1.00

Table 12. Indices of tree species in the study area

Index	Gbogbu	Omulako	Aragban	Abeya	Aguomoh	Ukpah	Alege	Beteh	Bechevie	Sankwala
Taxa_S	32	31	56	57	62	58	62	61	83	93
Individual	45.5	47.7	87.5	97.5	87.6	75.16	87.7	81.3	110.23	131.8
Shannon_H	1.221	1.212	1.980	2.027	2.051	2.011	2.047	2.032	2.106	2.128
Evenness_e^H/	0.9523	0.9492	0.9548	0.967	0.9534	0.9506	0.9552	0.9525	0.9446	0.9393
Menhinick	4.749	4.633	5.987	5.874	6.838	6.69	6.727	6.765	8.096	8.188

Species richness (Menhinick Index)

Table 12 shows the results of tree species richness (using the Menhinick Index) of the study area. The overall species richness of tree species in the study area was 64.54. A summary of the tree species richness of the study area shows that Gbogbu, Omulako, Abeya, Aragban, Aguomoh, Ukpah, Alege, Beteh, Bechevie and Sankwala forests had a tree species richness of 4.74, 4.63, 5.87, 5.98, 6.83, 6.69, 6.72, 6.76, 8.09 and 8.18 respectively. Therefore, Sankwala forest had the highest tree species richness (8.18) followed by Bechevie forest (8.09) while the lowest was Omulako (4.63) and Gbogbu (4.74) forests respectively.

Species diversity (Shannon – Weiner's Index)

Shannon – Weiner's diversity index of tree species in the study area are also presented in Table 12. Results show that Sankwala forest had the highest Shannon Weiner's index of 2.13 followed by Bechevie forest with a diversity index of 2.11 while Gbogbu and Omulako forests had the lowest Shannon Weiner's indices of 1.22 and 1.21respectively. The Shannon – Weiner's diversity indices of 1.98, 2.03, 2.05, 2.01, 2.05 and 2.03 were recorded for tree species in Aragban, Abeya, Aguomoh, Ukpah, Alege and Beteh forest respectively.

DISCUSSION

The survey carried out in ten communities, two from each of the five Local Government Areas of Northern Cross River State (Ogoja, Yala, Bekwarra, Obudu and Obanliku) Nigeria, revealed a total of 143 trees belonging to 45 families (Table 1). The family Fabaceae (28) had the greater number of species. This was followed by Euphorbiaceae (12) species while some families such as Bombacaceae, Clusiaceae, and Ebenaceae etc had fewer species. The greater number of species in the family Fabaceae may be as a result of their fast germination ability associated and persistence of seeds in soils which have warranted species to effortlessly establish within different habitat. Ihenyen *et al.,* (2009) made similar reports that family Fabaceae had the greater number of eighteen species in an investigation in Ehor Forest Reserve, Edo State, Nigeria. Also,

Omorogbe (2004) gave an account of fourteen species from the Fabaceae family with the greatest diversity in Sakponba forest Reserve in Edo State, Nigeria. The Fabaceae family was preceded by Euphorbiaceae and Annonaceae with twelve and ten species respectively and distantly by the family Moraceae with nine species. Meliaceae had seven while Sapotaceae and Sterculiaceae had six species each. The families Anacardiaceae, Apocynaceae, Irvingiaceae and Myristicaceae had four species each while Bombaceae, Clusiaceae and Ebenaceae had three species each. The families Euphorbiaceae, Annonaceae, Apocynaceae and Meliaceae were delineated by Ojo (2004) as constituting 86% of the trees in Abeku axis of Omo forest Reserve in Ondo State, Nigeria. The occurrence of high number of species in these families may be as a result of their mechanism of seed dispersal such as explosive mechanism and wind dispersal, where they germinate when conditions are suitable. Ogunleye *et al.,* (2004) gave an account of the supremacy of Fabaceae and Meliaceae families in Olokemeji Forest Reserve due to facile wind dispersal which facilitated their spread. Soladoye *et al.,* (2005) also reported that dispersal medium played a major role in the establishment of species of Fabaceae and Euphorbiaceae on the Olabisi Onobanjo University permanent plot. However, less number of species noticed in some families may be as a result of poor germinability as seeds may require scarification or changes in thermal or light conditions to break dormancy or quiescence for germination to occur. Pausas and Austin (2001) reported such need on species richness in connection to the environment. Other limiting factors include lean light by canopy trees; destruction of undergrowth on the forest floor during tree logging, composition of nutrients and other anthropogenic factors (Egbe *et al.,* 2012). Result of population studies (Table 2-11) show that species proportion varied with sampled plots. Sankwala (93) had the highest proportion of species followed by Bechevie (83), while Omulako (31) and Gbogbu (32) were the least populated in species. The population frequency and abundance of the tree species varied across the study sites. The highest percentage frequency recorded for the tree species was 24%while the least was 6% indicating low distribution for the species in the study area. Nelson *et al.,* (2015) reported low percentage frequencies of 11, 12, 16 and 23% in some tree species in Ikot Efre Itak

community forest in Akwa Ibom State, Nigeria. The highest population densities recorded for the tree species in some study sites was 2 stem/ha while the least was 0.1666 stem/ha. Results of abundance of each tree species in the different sites/area studied shows that the species had the highest abundance rates of 2.66-3.33 while the lowest was 1.00. The population density and abundance of a tree species in a patch of rainforest is substantially affected by the atmospheric conditions inside the forest and the number of seeds capable of surviving generated by the tree in question (Aigbe and Omokhua, 2015). For example, a tree species that is not able to endure a shady environment would find it hard to rejuvenate in a rainforest with closed crown. Accordingly, the density and abundance of such a tree species would be lessen in the forest, while the old trees of same species would die. Christie and Armesto (2003) gave an account of very low population densities and abundance of a vast number of economically viable tree species triggered by death of viable seeds and poor micro-sites for rejuvenation.

Aigbe and Omokhua (2005) reported low population densities and abundance of tree species in Oban Forest Reserve in Cross River State, Nigeria due to anthropogenic factors. Similarly, the low population density and abundance of the tree species in the study sites may be due to the poor atmospheric conditions within the forests and anthropogenic factors. Furthermore, abundance or rarity of a tree species of economic significance in an area of rainforest is a role of the severity and pattern of overexploitation of the trees for timber and wood fuel (charcoal). This would also lead to overall paucity of seeds for rejuvenation, as large number of mother trees must have been cut down. Olajide (2004) confirmed a positive correlation between poor population density and abundance of some tree species and the death of their old mother trees. The species richness index (Table 12) evaluates the heterogeinity of species. It takes into account the overall number of a certain species in connection to the overall number of individuals inside the forest plot (Gebreselassen, 2011). The species richness index (Menhinick) obtained for the study area was 64.56 which indicates high species richness. Results of species richness show that Sankwala forest had the highest tree species richness of 8.18, this was followed by Bechevie forest with 8.09 while the lowest was recorded in Omulako and Gbogbu forests with 4.63 and 4.74 respectively.

The species richness results (Sankwala and Bechevie) obtained in this study is high compared to the values for some tropical forests such as 7.19 for Bwindi forest, 7.54 for Kasyohakitomi forest and 6.38 for Kibale, all of which are located in the Albertine rift, Uganda as reported by Eilu *et al.*,(2004). The low species richness of some of the study sites (Omulako and Gbogbu) agrees with the findings of Odebiyi *et al.*, (2004) in their study on population structure of economically viable tree species in Kwara State, Nigeria due to anthropogenic factors. Generally, species diversity is one of the most necessary or vital key used to assess an ecosystem. A rich ecosystem with greater species diversity has a lofty Shannon-Weiner (H) value whereas an ecosystem with low (H) will have a less species diversity (Deka *et al.*, 2012; Sobay and Rahman, 2011). Results of Shannon-Weiner's index (H) of tree species diversity in the study area (Table 12) show that Sankwala forest had the greater species diversity (2.12), this was followed by Bechevie forest with a value of 2.10 while the lowest (H) index values of 1.22 and 1.21 were recorded for Gbogbu and Omulako forests respectively.

The (H) index values of 2.12, 2.10, 1.22 and 1.21 obtained for Sankwala, Bechevie, Gbogbu and Omulako forest respectively is lower than that of 3.1 and 3.3 for different rainforest sites in South-western Nigeria (Adekunle, 2006) and that of 2.20 – 2.65 obtained for tropical forests of Kudarya in Western Ghats, India (Sundaranpandian *et al.,* 2000). Nevertheless, it should be well known that essential quantitative comparisons of species varieties between forest enviroments is dependent on plot size, sample size, environmental factors, as well as other site components. The low (H) index of the tree species in the study area could be as a result of the great economic value of the species to the people of the communities as most species produce consumable fruits and seeds on which the people depend for medicine, food, oil and timber. The products are normally sold in the rural and urban areas by the people who sell them to earn a living (Nath *et al.,* 2009; Udo *et al.,* 2009). The low (H) index value of the tree species also indicates that these tree species are low in their distribution; similar findings were reported by Olajide *et al.,* (2008) and Udo *et al.,* (2009).

Conclusion

This study revealed that the tree species were mostly low in their distribution and scantily populates the study area; this may be due to unrestrained exploitation and hence are declining. For the reason that these tree species are mostly depended on for timber (wood) and non-timber forest products in this area, it is crucial to make certain their sustainability. To make it possible to prevent the continuos decline of these valuable tree species; there is need for effective management of the forest by the indigenous communities so that the forest can keep on with providing goods and services necessary for these communities.

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