

# Tree Species Composition, Structure and Importance Value Index (IVI) of Okwangwo Division, Cross River National Park, Nigeria

Ajayi S.<sup>1</sup>, Obi R. L.<sup>2</sup>

Department of Forestry and Wildlife Management, Cross River University of Technology (CRUTECH)  
Obubra Campus), P.M.B 102, Obubra, Cross River State, Nigeria

**Abstract:** Assessment of tree species composition and structure was carried out in Okwangwo division of Cross River National Park. Random sampling using quadrats was employed for the study. Each quadrat was 10m x 20m. A total of 25 quadrats were used from the selected plot of one hectare. Tree species and families were identified. Tree height measurement was carried out and used to identify the different layers of tree species in Okwangwo division of the Park. Four distinct layers were identified which include the emergent, the upper canopy, the under storey and the forest floor. A total of 114 different tree species and 37 families were identified. The family Leguminosae had the highest number of species (17). Tree species with 10cm DBH and above were measured and the data were used to calculate relative density (R.D), relative dominance (R.D), and relative frequency (RF). Their results were used to derive the Important Value Index (IVI) which determines the dominant tree species of the entire area under study. *Terminalia ivorensis* was the most dominant (13.08). The Cross River National Park should design programmes that will create awareness to people around and within the Park to see the need of conserving the flora and fauna species. Selective removal of dominant trees at emergent and upper storey is recommended to introduce sunlight to the forest floor so as to encourage the growth of young and valuable trees species.

**Keywords:** Tree species, composition, structure, relative dominance growth, importance value index

## 1. Introduction

Cross River National park is located between latitudes 5<sup>o</sup>, 05' and 6<sup>o</sup>, 29' N and longitude 8<sup>o</sup>, 15' and 9<sup>o</sup>, 30' E in South-Eastern corner of Nigeria in Cross River State (Cross River National Park, 2016;). The park is the largest area of undisturbed rainforest in the country and has been described as Amazon of Nigeria. It covers an area of about 4,000km<sup>2</sup>, most of which consist of primary moist tropical rainforest ecosystem in the south and central and montane mosaic in Obudu plateau. It lies in the guinea – Congolese rainforest region with closed canopy. The scattered emergent trees reach the height of about 40m to 70m (Nigeria National Park Service, 2016). The Cross River National Park has two distinct divisions; the Oban and Okwangwo.

The National Park, being a tropical rainforest ecosystem consist of broad leaved evergreen trees and many species of shrubs, herbs, climbers, lianas, and epiphytes naturally arranged in a multi-storey structures. The physiognomy of the Park is arranged naturally in four distinct strata (Adedire, 2002; Gower *et al.*, 2003 and Olajide, 2004). Trees are important to all living things including man. One of the fundamental concepts in community forest management is that trees have value; provide benefits and are desired by humans. People found great psychological, momentary, aesthetic and utilitarian values in trees. The benefits of trees which people enjoy include: aesthetic, recreation, shades, heat dissipation, reduction of pollutant, production of oxygen, reduction of erosion, increase properties value, provision of wildlife habitat and increase economic stability. Trees are essentially used for timbers, fire wood, building materials, traditional medicine, food and fodder and many others. Trees are major carbon sink and aid in balancing climate change and global warming issues.

Apart from plant species, the National Park ecosystem also houses many species of animals including mammals (vulnerable chimpanzee, Western gorilla, the endangered Selater's guenon, Preuss's monkey and drill, African forest Elephant and more common African buffalo), birds, reptiles, and insects. The number of insect species found in the canopy of the tropical rainforest was estimated in millions (Laura, 2003; Gower *et al.*, 2003; and Cunningham, 2004).

The Cross River National Park was established to protect a significant portion of the Okwangwo and Oban division forests respectively in Cross River State, Nigeria, which before now has suffered severe impacts for decades. This became crucial in view of the fact that the park is a hotspot characterized by species diversity and endemism (Conservation International, 2005; Edet, 2010). Thus, there is need to appraise the composition, families and structure of tree species to ascertain the present ecological status of trees which form an integral part of Wild animals' habitat of the park.

This research determined the composition, structure and Importance Value Index (IVI) of tree species in the Park. The results obtained from the research will aid research workers, scholars, Cross River State Forestry Commission, Cross River National Park and Nigeria as a whole in understanding the trees in Cross River National Park.

## 2. Materials and Methods

### The Study Area

This study was carried out at the Cross River National Park (Okwangwo division) in Boki Local Government Area of Cross River State, Nigeria. The Okwangwo division is centered on coordinates 6°17'00" N, 9°14'00"E/ 6.28333°N, 9.23333°E (Cross River National Park, 2016) – See Figure

1. The division is made up of the former Boshi, Okwangwo, and Boshi Extension Forest Reserves. Okwangwo division gazetted in 1991 has an area of about 1000km<sup>2</sup> at the altitude of 150 -1,700m above sea level. It lies South-west of Obudu plateau and immediately to East of Afi River Forest, separated from this reserved by the Mbe Mountain community forest. The division is bordered with Takamanda National Park in the Republic of Cameroon to the East. The terrain is rugged with rocky ridges and outcrops. The annual rainfall is about 3,000 to 3800mm (Agbor, 2003). Rainy season starts around late March or early April to November with a break in August. The dry season starts from late October or November and end in March. The mean monthly maximum temperature ranges from 22.2°C to 27.4°C (Edet, 2010). It is drained by Oyi, Bemi and Okon River tributaries of the Cross River.

The Takamanda Forest Reserve in the Republic of Cameroon shares a border with Okwangwo division to the east. The Park was created through a joint project with Wildlife Conservation Society and the Government of Cameroon, with the protection of the endanger Cross River gorilla, as a major objective. The Park also helps in conserving forest elephants, chimpanzees and drills (John, 2002). The ground is rugged with rocky ridges and outcrops. The highest point is the Sankwala Mountains in the north (1,700m) and in the Mbe Mountains in the southwest (1,000m). The annual rainfall may be as much as 3,000mm-3,800mm, mostly falling in the wet season between March and November. The division is drained by Oyi, Bemi and Okon rivers tributaries of Cross River. The soils in the highland and lowland areas are vulnerable to erosion and leaching when stripped of their plant cover.

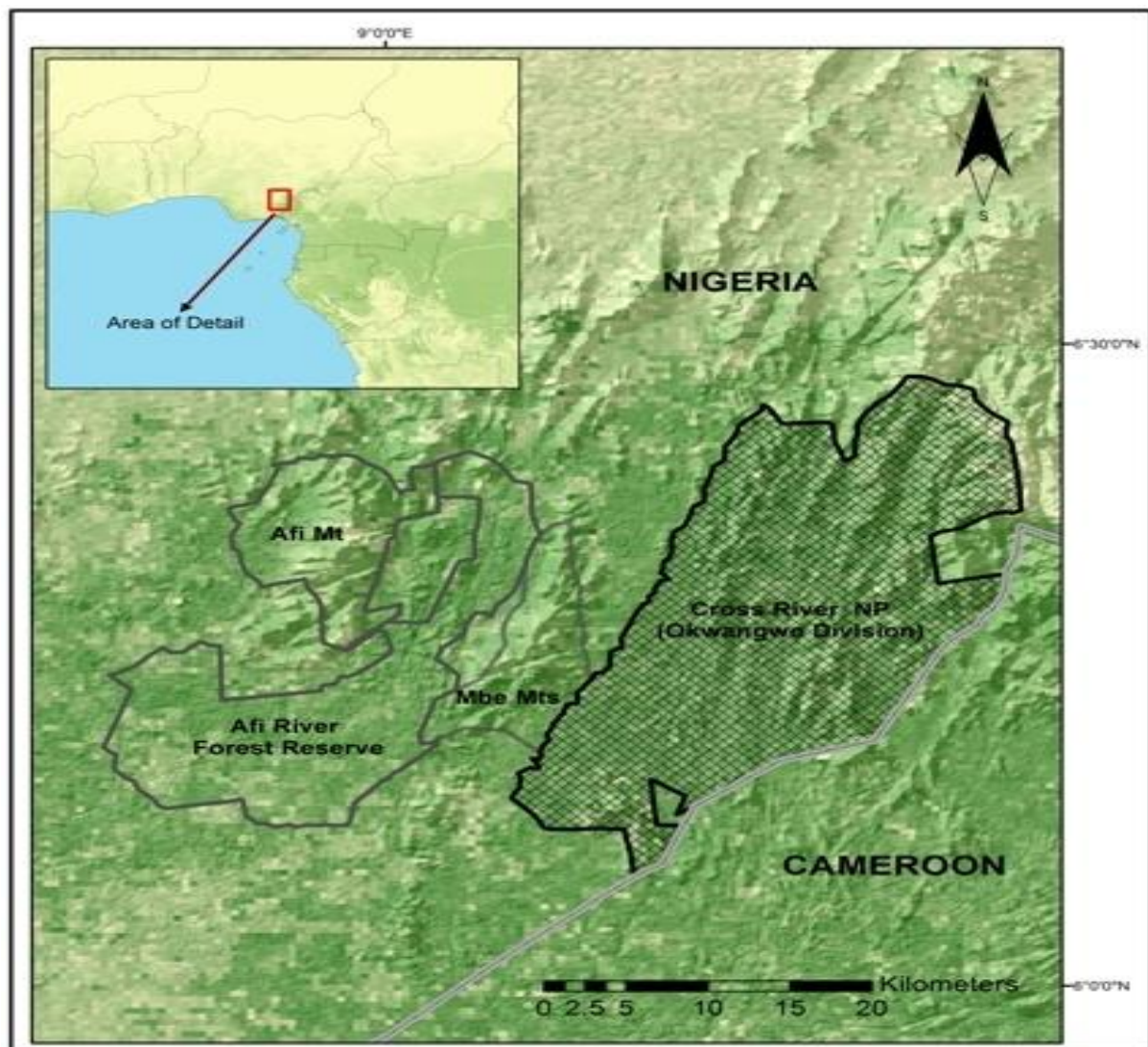


Figure 1: Cross River National Park (Okwangwo division)

#### Sampling technique

Random sampling using Quadrats as described by Bryant *et al* (2005) was employed to assess tree species composition in Cross River National Park (Okwangwo division) in May 2015. An area of one hectare (10,000m<sup>2</sup>) was sub-divided into ten (10) plots 10m×100m each using machetes, ranging poles, compass, and red flagging tape. Five plots were selected at random and five quadrats of 10m x 20m were laid

in each sample plot, giving a total of 25 plots for the entire area of study. From each plot, tree species were counted, recorded and separated into different families. Tree heights were measured using Nikon Forestry 550 Laser Rangefinder and classified according to range of height for different storeys. Generally, individual tree species belonging to the height measurements of 40m to 70m appear to have the highest height and are classified as the emergent layer. Tree

species with heights of 20m to 39m are classified as the upper canopy layer. While the trees with heights between 3m or 5m to 19m are classified as lower layer or under-storey. The fourth layer that is the forest floor, which in this research no measurements were taken and is made up of tree species with less than one meter (Newman, 2002).

**Data collection and Analysis**

Data collection included identification of tree species and classification into families. A botanist with the Park assisted in tree identification. Diameters at breast height ( $\geq 10\text{cm}$  dbh), and tree total height were also measured for all trees in each quadrat.

Trees identified were listed and classified. Diameters at breast height and other data generated from this study were used to calculate the Basal Area, Frequency, Relative Frequency, Relative Density, Relative Dominance and Importance Value Index (IVI) using:

*Frequency*

$$= \frac{\text{No. of quadrats in which species occurred} \times 100}{\text{Total no. of quadrats studied}}$$

*Relative Frequency (R. F) =*

$$\frac{\text{Frequency of occurrence of species} \times 100}{\text{Total frequency of occurrence of all species}}$$

*Relative Density (R. Den) =*

$$\frac{\text{No. of individuals of the species} \times 100}{\text{Total no. of individuals in all species}}$$

*Relative Dominance (R. D) =*  $\frac{\text{Total basal area of a species} \times 100}{\text{Total basal area of all species}}$

Basal area =  $\frac{\pi D^2}{4}$  where D = dbh

Important Value Index (IVI) = R. D + R. F + R. D (Panwar and Bhardwaj, 2012)

**3. Results and Discussion**

**Tree species composition and forest structure**

Table 1 shows the list of tree species encountered by families and height under different storeys. The Cross River National Park being typical high forests, a wide range of different tree species were encountered. Species composition showed a total of two hundred and fifty (250) individual trees distributed among one hundred and fourteen (114) different tree species and thirty seven (37) families (Table 1).

The families had different tree species. Family Leguminosae show dominance over others with high number of tree species encountered (17).

The families that followed the Leguminosae are the Euphorbiaceae, Meliceae, and Sterculiaceae which had eight tree species in each family. The next families to these are the Apocynaceae and Rubiaceae with six tree species in each family. Closely to these families are the Anacardiaceae, and Moraceae having five tree species each. Other families such as Guttiferae, Mimosoidae, Ebenaceae, Bombacaceae, Buseraceae, Combretaceae, Irvingiaceae, Loganiaceae, Mimosaceae, Ochnaceae, Pandaceae, Polygalaceae, Palmae, Papilionoidae, Rosaceae, Rutaceae, Tiliaceae, Ulmaceae and the Verbenaceae family which had tree species ranging from one to four, as a result of low species diversity had poor species composition distribution in the study area. The result of this research is similar to the findings of Oguntala (1981) which states that although there are usually several tree species in the tropical rainforest ecosystem, some may have only one representative per hectare. Also, Ojo et.al, (1999), noted that in a tropical rainforest the smaller trees dominate the larger size trees.

The height measurements indicated different tree heights which were used to classify the various layers in the ecosystem. There exist four (4) different layers in Cross River National Park (Okwangwo division). The first (1<sup>st</sup>) layer is the emergent with 16 species and heights ranging from 40m to 70m. Some of the species in this category are *Baillonella toxiosperma* 50m, *Anthocleista vogelii* 60m, *Terminalia superb* 60m, and *Ceiba pentandra* 70m. The second (2<sup>nd</sup>) layer is the upper canopy with range of trees height from 20m to 39m. There are 60 species identified in this storey. The third (3<sup>rd</sup>) layer is the under-storey with height of 3m to 19m.

Thirty eight (38) species were identify in this storey and some of them include *Sorindela mildbraedii* 12m, *Funtumia Africana* 12m, *Canarium schweinfurthii* 18m, *Grosseria vignei* 20m, *Maesobotrya staudtia* 12m, *Rhcinodendron heudelotii* 15m, *Compostylus ovalis* 12m, *Garcinia mannii* 18m, *Daniela ogea* 14m, *Pterocarpus erinaceous* 18m, *Pterocarpus mildbraedii* 18m, *Tetrapleura tetraptera* 18m, *Anthocleista djlensis* 15m, *Myriathus arboreus* 18m, *Treculia obvoidae* 12m, *Tectea afzeli* 18m, *Chrysophyllum albidum* 12m, *Cola accumulata* 15m, *Cola pachycarpa* 18m, *Leptobychia pallid* 15m, and *Glypheae brevica* 12m. No species was found in the fourth layer (Bourgeron, 1983 and King, 2011).

**Table 1: Tree species composition and height measurements in Okwangwo division of Cross River National Park**

S/N	Family	Species present	No of species by family	Tree height(m)			
				Emergent 40-70m	Upper 20-39m	Lower 5-19m	Forest flour < 1m
1	ANNACARDIACEAE	<i>Antrocaryon klaineinum</i>	5		25m		
		<i>Antrocaryon micraster</i>		45m			
		<i>Pseudospondias microcarpa</i>			20m		
		<i>Sorindela mildbraedii</i>				12m	
		<i>Spondias mombin</i>			20		
2	ANISOPHHYLIACEAE	<i>Poga oleosa</i>	1	40m			
3	ANNONACEAE	<i>Monodora myristica</i>	4		35m		
		<i>Enantia calorantha</i>				15	

		<i>Xylopia Africana</i>			20m		
		<i>Xylopia staudtia</i>				10m	
4	APOCYNACEAE	<i>Alstonia boonei</i>	6	45m			
		<i>Funtumia elastic</i>				10m	
		<i>Funtumia Africana</i>				12m	
		<i>Rauvolfia yomitoria</i>				8m	
		<i>Rauvolfia manni</i>			24m		
		<i>Pleiocarpa tolbotii</i>			21m		
5	BIGNONIACEAE	<i>Newbouldia laevis</i>	1		20m		
6	BOMBACACEAE	<i>Bombax buonopozense</i>	2	40m			
		<i>Ceiba pentandra</i>		70m			
7	BUSERACEAE	<i>Canacium schweinfurthii</i>	2			18m	
		<i>Dacrodes edulis</i>			30m		
8	CONNARACEAE	<i>Cnetis ferrugiunea</i>	1			6m	
9	COMBRETACEAE	<i>Terminalia superb</i>	2	60m			
		<i>Terminalia ivorensis</i>		45m			
10	EBENACEAE	<i>Diospyras heudelotii</i>	3		20m		
		<i>Diospyras melocarpa</i>			30m		
		<i>Diospyras zenkerii</i>			20m		
11	EUHORBIACEAE	<i>Alchornia laxiflora</i>	8			6m	
		<i>Anthonota fragrans</i>			35m		
		<i>Cyrtogonne argentia</i>			30m		
		<i>Grosseria vignei</i>				20m	
		<i>Maesobotrya dusenii</i>		47m			
		<i>Maesobotrya staudtia</i>				12m	
		<i>Rhcinodendron heudelotii</i>				15m	
		<i>Uapaca accuminata</i>				10m	
12	FABACEAE	<i>Amphimas pterocarpoides</i>	4		30m		
		<i>Hymenostegia afzelii</i>			21		
		<i>Hylodendron gabonensis</i>			25m		
3	FLACOURTIACEAE	<i>Cylicodiscus gabonensis</i>			34m		
		<i>Compostylus ovalis</i>	2			12m	
		<i>Ophiobostyrs zenkerii</i>			30m		
14	GUTTIFERAE	<i>Garcina kola</i>	4		30m		
		<i>Garcina manni</i>				18m	
		<i>Harungana madagascariensis</i>			25m		
		<i>Mammea africanum</i>				6m	
15	HUMIRACEAE	<i>Sacoglotis gabonensis</i>	1		25m		
16	IRVINGIACEAE	<i>Irvingia gabonensis</i>	2	40			
		<i>Irvingia wombulu</i>			28m		
16	LEGUMINOSAE	<i>Afzelia bipidensis</i>	17			8m	
		<i>Albizia ferruginea</i>			35m		
		<i>Albizia lebbeck</i>			30m		
		<i>Albizia zygia</i>			29m		
		<i>Angylocalyx oligophyllus</i>			30m		
		<i>Brachystegia eurycoma</i>			32m		
		<i>Daniela ogea</i>				14m	
		<i>Dialum guineense</i>			21m		
		<i>Pentaclethra macrophylla</i>			20m		
		<i>Piptadeniistrum africanum</i>		40m			
		<i>Pterocarpus erinaceous</i>				16m	
		<i>Pterocarpus mildbraedii</i>				18m	
		<i>Pterocarpus osun</i>			20m		
		<i>Pterocarpus soyauxii</i>			25m		
		<i>Parkia bicolour</i>			20m		
		<i>Tetrapleura tetraptera</i>				12m	
		<i>Zenkerella citran</i>			23m		
17	LOGANIACEAE	<i>Anthocleista djonensis</i>	1			15m	
18	MELIACEAE	<i>Entandrophragma cylindricum</i>	8		30m		
		<i>Entandrophragma angolense</i>			30m		
		<i>Guarea glomerulata</i>				6m	
		<i>Khaya grandifolia</i>			26m		
		<i>Khaya ivorensis</i>			27m		
		<i>Lovea trichiloides</i>		40m			

		<i>Melicea excels</i>			23m		
		<i>Melicea zygia</i>			30m		
19	MIMOSACEAE	<i>Newtonia duparaquetiana</i>	1		20m		
20	MORACEAE	<i>Anthodeista vogelii</i>	6	60m			
		<i>Myriathus arboreus</i>				14m	
		<i>Bosquicia angolensis</i>				10m	
		<i>Treculia Africana</i>			30m		
		<i>Treculia obovoidea</i>				12m	
		<i>Treculia microcephalus</i>			25m		
22	OLACACEAE	<i>Strombosia grandifolia</i>	1		20m		
23	OCHNACEAE	<i>Lophira alata</i>	1	40m			
24	PANDACEAE	<i>Panda oleosa</i>	1		38m		
25	POLYGALACEAE	<i>Antiaris Africana</i>	1			18m	
26	PALMAE	<i>Elaeis guineensis</i>	1		30m		
27	PAPILIONOIDEAE	<i>Angyocalyx oligophyllus</i>	1			18m	
28	RUBIACEAE	<i>Naualea diderrichi</i>	6			12m	
		<i>Euelina longiflora</i>			33m		
		<i>Didymosalphinx parvoflora</i>		42m			
		<i>Hymenodictyon biafranum</i>			25m		
		<i>Massularia accuminata</i>			20m		
		<i>Mystragyna stipulosa</i>			25m		
29	ROSACEAE	<i>Parinari chrysphylla</i>	1		30m		
30	RUTACEAE	<i>Tectea afzeli</i>	1			18m	
31	SAPINDACEAE	<i>Blighia sapida</i>	2			8m	
		<i>Placodiscus tubiniatus</i>			21m		
32	SAPOTACEAE	<i>Bailonella taxisperma</i>	4	50m			
		<i>Chrysophyllum albidum</i>				12m	
		<i>Cola accumulate</i>				15m	
		<i>Omphalocarpum procera</i>			32m		
33	STERCULIACEAE	<i>Pterygota macrocarpa</i>	8		25m		
		<i>Cola lepidota</i>			37m		
		<i>Cola millenii</i>			21m		
		<i>Cola pachycarpa</i>				18m	
		<i>Cola rostrata</i>				8m	
		<i>Leptobychia pallid</i>				15m	
		<i>Sterculia tragacantha</i>				10m	
		<i>Triplochiton scleroxylon</i>		45m			
34	STYRACEAE	<i>Afrostryas lepidophyllus</i>	2		20m		
		<i>Glyphea breviea</i>				12m	
35	TILIACEAE	<i>Deplatsia dewevrei</i>	1		35m		
36	ULMACEAE	<i>Trema guineensis</i>	1		20m		
37	VERBENACEAE	<i>Vitex doniana</i>	1		39m		
	<b>Total</b>		<b>114</b>		<b>16</b>	<b>60</b>	<b>38</b>
							<b>0</b>

The results confirm that several tree species are in Cross River National Park ecosystem and some of the species have only one representative (table 1). Furthermore, trees with smaller sizes dominate more than those with larger sizes in the Park. Greater numbers of trees were encountered in the upper and lower layer than the emergent layer.

These findings also agree with Burgeron (1983) and King (2011) that the forest floors are usually made of seedlings, shrubs and herbs. Therefore, it will be appropriate if selective removal of trees at the emergent and upper storey is allowed to enable sunlight to reach the forest floor so as to encourage growth of tree seedlings at that level.

#### Species dominance (Importance value Index)

Table 2 shows the DBH results of the tree species. The values were used to estimate the Importance Value Index (IVI) - Species dominance

**Species relative density:** The table indicates the density of each tree species encountered in the study site. *Irvingia gabonensis*, had relative density of (4.8%) and was the most abundant. It was closely followed by *Antrocaryon klaineanum*, *Dacryodes edulis*, and *Funtumia africana* with relative density of (4.0%), *Terminalia ivorensis* (3.6%), *Uapaca accuminata* (3.2%), *Hylodendron gabonensis*, *Brachystegia eurycoma*, *Pentaclethra macrophylla*, *Piptadeniastrium africanum*, and *Lophira alata* had density of (2.8%), *Bombax buonopozense*, *Dialum guineense* and *Pycnanthus angolensis* had relative density of (2.4%). Species such as *Funtumia elastica*, *Canarium schweinfurthii*, *Grosseria vignei*, *Maesobotrya staudtia*, *Pterocarpus osun*, *Tetrapleura tetraptera*, *Bailonella taxisperma*, *Chrysophyllum albidum* and *Deplatsia dewevrei* all had relative density of (2.0%). *Antrocaryon miscraster*, *Xylopia africana*, *Terminalia superb*, *Cyclicodiscus gabonensis*, *Melicia excelsa*, *Khaya ivorensis*,

*Treculia ovoidae*, *Elaeis guinensis*, and *sterculia stragacantha* all had relative density of (1.6%). Other species with relative density ranging from one percent (1%)

and below had low relative density. The total relative density of the study area is 136.6.

**Table 2:** Basal area, relative density, relative dominance, relative frequency and Importance value index (Species Dominance)

Tree species	No. of stems	Mean DBH (cm)	Basal area (m <sup>2</sup> )	Frequency	Relative density	Relative dominance	Relative frequency	Importance Value Index (IVI)
<i>Antrocaryon klaineianum</i>	10	19.0	0.2834	12	4.0	1.767	1.4778	7.2448
<i>Antrocaryon miscraster</i>	4	16.9	0.0897	4	1.6	0.5591	0.4926	2.6517
<i>Spondias mombin</i>	1	10.5	0.0086	4	0.4	0.0536	0.4926	0.9462
<i>Pseudospondias microcarpa</i>	2	11.4	0.0204	4	0.8	0.1272	0.4926	1.4198
<i>Poga oleosa</i>	3	28.4	0.1899	12	1.2	1.1837	1.4778	3.8615
<i>Monodora myristica</i>	1	12.5	0.0122	4	0.4	0.0760	0.4926	0.9686
<i>Sorindela mildbraedii</i>	3	14.0	0.0462	8	1.2	0.2879	0.9852	2.4731
<i>Enantia calorantha</i>	1	11.5	0.0104	4	0.4	0.0648	0.4926	0.9574
<i>Xylopia Africana</i>	4	12.5	0.0490	8	1.6	0.3054	0.9852	2.8906
<i>Alstonia boonei</i>	2	32.5	0.1658	8	1.8	1.0335	0.9852	3.8187
<i>Funtumia elastic</i>	5	16.6	0.1082	8	2.0	0.6745	0.9852	3.6597
<i>Rauvolfia manni</i>	3	13s.6	0.0436	8	1.2	0.2718	0.9852	2.457
<i>Pteiocarpa tolbotii</i>	1	25.0	0.0491	4	0.4	0.3061	0.4926	1.1987
<i>Newbouldia laevis</i>	3	11.6	0.0317	8	1.2	0.1976	0.9852	2.3828
<i>Bombax buonopozense</i>	6	52.9	1.1380	20	2.4	7.0937	2.4631	11.9568
<i>Dacryodes edulis</i>	10	13.8	0.1495	16	4.0	0.9319	1.9704	6.9023
<i>Canarium schweinfurthii</i>	5	24.5	0.2356	12	2.0	1.4686	1.4778	4.9464
<i>Cnetis ferruginea</i>	2	13.8	0.0299	4	0.8	0.1864	0.4926	1.479
<i>Ceiba pentandra</i>	3	50.0	0.5888	4	1.2	3.6703	0.4926	5.3629
<i>Terminalia superb</i>	4	36.7	0.4229	8	1.6	2.6361	0.9852	5.2213
<i>Diospyros heudeloti</i>	1	20.5	0.0329	4	0.4	0.2051	0.4926	1.0977
<i>Alchornia laxiflora</i>	3	10.3	0.0249	8	1.2	0.1552	0.9852	2.3404
<i>Terminalia ivorensis</i>	9	39.8	1.1191	20	3.6	6.9758	2.4631	13.0389
<i>Cyrtogonne argentia</i>	3	11.9	0.0333	4	0.4	0.1957	0.4926	1.0883
<i>Diospyros melocarpa</i>	2	21.9	0.7529	8	0.8	4.6932	0.9852	6.4784
<i>Diospyros zenkerii</i>	1	20.0	0.0314	4	0.4	0.1957	0.4926	1.0883
<i>Groseria vignei</i>	5	12.5	0.0613	8	2.0	0.3821	0.9852	3.3673
<i>Uapaca acuminate</i>	8	17.4	0.1901	12	3.2	1.1849	1.4778	5.8627
<i>Alstonia congensis</i>	1	30.0	0.0707	4	0.4	0.4407	0.4926	1.3333
<i>Funtumia Africana</i>	10	14.14	0.1569	16	4.0	0.9780	1.9704	6.9484
<i>Rauvolfia vomitoria</i>	2	11.2	0.0197	8	0.8	0.1228	0.9852	1.908
<i>Xylopia staudtia</i>	2	13.3	0.0278	4	0.8	0.1733	0.4926	1.4659
<i>Maesobotrya dusenii</i>	2	11.3	0.0200	8	0.8	0.1247	0.9852	1.9099
<i>Maesobotrya staudtia</i>	5	17.8	0.1244	8	2.0	0.7754	0.9852	3.7606
<i>Rhcinodendron heudelotii</i>	1	40.0	0.1256	4	0.4	0.7754	0.4926	1.668
<i>Pterocarpus Osun</i>	5	21.5	0.1814	16	2.0	1.1307	1.9704	5.1011
<i>Hymenostegia afzelii</i>	2	17.7	0.0492	4	0.8	0.3060	0.4926	1.5986
<i>Hylodendron gabonensis</i>	7	14.9	0.1219	12	2.8	0.7598	1.4778	5.0376
<i>Diallum guinense</i>	6	11.8	0.0656	12	2.4	0.4089	1.4778	4.2867
<i>Cyclicodiscus gabonensis</i>	4	33.2	0.3461	16	1.6	2.1574	1.9704	5.7278
<i>Amphimas pterocarpoides</i>	1	45.4	0.1618	4	0.4	1.0086	0.4926	1.9012
<i>Garcinia cola</i>	1	35.0	0.0962	4	0.4	0.5977	0.4926	1.4903
<i>Garcinia manni</i>	2	12.9	0.0261	8	0.8	0.1627	0.9852	1.9479
<i>Harungana madagascariensis</i>	1	20.0	0.0314	4	0.4	0.1957	0.4926	1.0883
<i>Mammea africanaum</i>	2	10.0	0.0157	4	0.8	0.0979	0.4926	1.3905
<i>Sacoglitis gabonensis</i>	2	16.3	0.0417	4	0.8	0.2599		1.0599
<i>Irvingia gabonensis</i>	12	26.6	0.6665	24	4.8	4.1546	2.9557	11.9103
<i>Anglylocalyx oligophyllus</i>	2	17.8	0.0497	4	0.8	0.3098	0.4926	1.6024
<i>Afzelia bipidensis</i>	3	13.5	0.0429	8	1.2	0.2674	0.9852	2.4526
<i>Irvingia wombulu</i>	2	17.8	0.0497	4	0.8	0.3098	0.4926	1.6024
<i>Albizia zygia</i>	1	12.0	0.0113	4	0.4	0.0704	0.4926	0.963
<i>Brachystegia eurycoma</i>	7	33.6	0.6204	8	2.8	3.8672	0.9852	7.6524
<i>Pentaclethra macrophylla</i>	7	18.3	0.1840	12	2.8	1.1469	1.4778	5.4247
<i>Daniellia ogea</i>	1	11.5	0.0104	4	0.4	0.0648	0.4926	0.9574
<i>Parkia bicolor</i>	8	18.7	0.2196	12	3.2	1.3689	1.4778	6.0467
<i>Albizia lebbeck</i>	2	11.3	0.0200	4	0.8	0.1247	0.4926	1.4173
<i>Piptadeniestrum africanum</i>	7	51.8	1.4744	8	2.8	9.1906	0.9852	12.9758
<i>Pterocarpus erinaceous</i>	1	20.0	0.0314	4	0.4	0.1957	0.4926	1.0883
<i>Tetrapeura tetraptera</i>	5	13.9	0.0758	12	2.0	0.4725	1.4778	3.9503

<i>Zenkerella citran</i>	1	20.0	0.0314	4	0.4	0.1957	0.4926	1.0883
<i>Anthocleista djlouensis</i>	1	14.5	0.0165	4	0.4	0.1029	0.4926	0.9955
<i>Entandrophragma cylindricum</i>	2	27.5	0.1187	4	0.8	0.7399	0.4926	2.0325
<i>Guarea glumerula</i>	1	10.5	0.0087	4	0.4	0.0542	0.4926	0.9468
<i>Khaya grandifolia</i>	1	25.0	0.0491	4	0.4	0.3061	0.4926	1.1987
<i>Lovoa trichiloides</i>	3	23.5	0.1301	4	1.2	0.8109	0.4926	2.5035
<i>Pterocarpus mildbraedii</i>	1	11.5	0.0104	4	0.4	0.0648	0.4926	0.9574
<i>Melicia excels</i>	4	25.9	0.2106	12	1.6	1.3127	1.4778	4.3905
<i>Newbouldia duparaquetiana</i>	1	20.5	0.0329	4	0.4	0.2051	0.4926	1.0977
<i>Anthocleista vogelii</i>	3	11.0	0.0285	8	1.2	0.1776	0.9852	2.3628
<i>Pterocarpus Soyauxii</i>	1	30	0.0707	4	0.4	0.4407	0.4926	1.3333
<i>Entandrophragma angolensis</i>	1	20.0	0.0314	4	0.4	0.1957	0.4926	1.0883
<i>Khaya ivorensis</i>	4	36.1	0.4092	8	1.6	2.5507	0.9852	5.1359
<i>Melicia zygia</i>	1	40.5	0.1288	4	0.4	0.8029	0.4926	1.6955
<i>Myrianthus arboreus</i>	2	12.3	0.0237	8	0.8	0.1477	0.9852	1.9329
<i>Bosquicia angolensis</i>	1	11.5	0.0104	4	0.4	0.0648	0.4926	0.9574
<i>Treculia Africana</i>	5	17.0	0.1134	12	2.0	0.7069	1.4778	4.1847
<i>Pycnanthus angolensis</i>	6	23.5	0.2601	12	2.4	1.6213	1.4778	5.4991
<i>Lophira alata</i>	7	26.3	0.3801	12	2.8	2.3693	1.4778	6.6471
<i>Treculia obovoidea</i>	4	12.4	0.0483	4	1.6	0.3011	0.4926	2.3937
<i>Treculia microcephalus</i>	1	20.0	0.0314	4	0.4	0.1957	0.4926	1.0883
<i>Strombosia grandifolia</i>	1	35.5	0.0989	4	0.4	0.6165	0.4926	1.5091
<i>Pycnanthus microcephalus</i>	1	40.0	0.1256	4	0.4	0.7289	0.4926	1.6215
<i>Panda oleosa</i>	8	25.9	0.2106	16	3.2	1.3128	1.9704	6.4832
<i>Antiaris Africana</i>	6	13.4	0.0846	8	2.4	0.5273	0.9852	3.9125
<i>Elaeis guinensis</i>	4	19.3	0.1169	8	1.6	0.5720	0.9852	3.1572
<i>Nauclea diderichi</i>	1	10.5	0.0087	4	0.4	0.0542	0.4926	0.9468
<i>Didymosalphinx parvoflora</i>	1	35.0	0.0962	4	0.4	0.5997	0.4926	1.4923
<i>Hymenodictyon biafranum</i>	1	25.0	0.0491	4	0.4	0.3061	0.4926	0.7061
<i>Masularia acuminate</i>	1	21.5	0.0363	4	0.4	0.2263	0.4926	1.1189
<i>Mystragyna stipulosa</i>	1	18.5	0.0269	4	0.4	0.1677	0.4926	1.0603
<i>Cola lepidota</i>	1	10.0	0.0078	4	0.4	0.0486	0.4926	0.9412
<i>Parinari chrysophylla</i>	1	12.5	0.0123	4	0.4	0.0767	0.4926	0.9693
<i>Tectea afzeli</i>	1	10.0	0.0078	4	0.4	0.0486	0.4926	0.5812
<i>Cola gigantean</i>	3	10.3	0.0249	8	1.2	0.1552	0.9852	2.3404
<i>Cala pachycarpa</i>	3	10.9	0.0279	8	1.2	0.1739	0.9852	2.3591
<i>Zanthoxylum zanthoxyloides</i>	1	10.0	0.0078	4	0.4	0.0486	0.4926	0.9412
<i>Blighia sapida</i>	2	10.3	0.0167	4	0.4	0.1041	0.4926	0.9967
<i>Placodiscus tubiniatus</i>	1	25.7	0.0518	4	0.4	0.3229	0.4926	1.2155
<i>Baillonella toxisperma</i>	5	37.2	0.5432	8	2.0	3.3861	0.9852	6.3713
<i>Chrysophyllum albidum</i>	5	20.4	0.1633	8	2.0	1.0179	0.9852	4.0031
<i>Omphalocarpum procerum</i>	2	11.0	0.0189	8	0.8	0.1178	0.9852	1.903
<i>Cola millenii</i>	3	10.2	0.0245	8	1.2	0.1527	0.9852	2.3379
<i>Cola rostrata</i>	2	10.3	0.0249	8	0.8	0.1552	0.9852	1.9404
<i>Leptobychia pallid</i>	1	10.0	0.0078	4	0.4	0.0486	0.4926	0.9412
<i>Triplochiton scleroxylon</i>	1	65.8	0.3399	4	0.4	2.1187	0.4926	3.0113
<i>Afrostryax lepydophyllus</i>	2	16.3	0.0417	8	0.8	0.2599	0.9852	2.0451
<i>Gyphae brevae</i>	1	12.8	0.0129	4	0.4	0.0804	0.4926	0.973
<i>Deplatsia dewevrei</i>	5	17.28	0.1172	12	2.0	0.7306	1.4778	4.2084
<i>Vitex doniana</i>	1	30.8	0.0745	4	0.4	0.4644	0.4926	1.357
<i>Trema guinensis</i>	2	21.1	0.0746	8	0.8	0.4650	0.9852	2.2502
<i>Pterygota macrocarpa</i>	1	16.5	0.0214	4	0.4	0.1334	0.4926	1.026
<i>Sterculia tragacantha</i>	4	10.3	0.0167	8	1.6	0.1041	0.9852	2.6893
114	<b>250</b>		<b>16.0425</b>	<b>812</b>	<b>136.6</b>	<b>91.7422</b>		

**Frequency distribution:** The frequency distribution of all species encountered for this study differs and depends on the tree species; some had high frequency while other had low frequency. The total frequency for all the tree species encountered in the study site is 812. *Irvingia gabonensis* had (24%) frequency distribution and is the most abundant. It was closely followed by *Bombax buonopozense* and *Terminalia ivorensis* with frequency distribution of (20%). *Dacryodes edulis*, *Funtumia Africana*, *Cyclicodiscus gabonensis*, *Pterocarpus osun* and *Panda oleosa* had frequency distribution of (16%). Tree species such as

*Antrocaryon klaineanum*, *Poga oleosa*, *Canarium schweinfurthii*, *Uapaca acuminate*, *Hylodendron gabonensis*, *Dialum guineensis*, *Pentaclethra macrophylla*, *Parkia bicolor*, *Tetrapleura tetraptera*, and *Melicia excelsa* all had frequency distribution of (12%). Other species listed had low frequency distribution between (4%) and (8%) respectively.

**Basal area:** The total study area for the plot was 16.0425m<sup>2</sup> for the trees with 10cm DBH and above, which covers relative small portion of the land area under study. Out of

the entire tree species encountered *Piptadeniestrums africanum* dominates with basal area of 1.474m<sup>2</sup>. Closely to this is *Bombax buonopozense* with basal area of 1.1380m<sup>2</sup> and *Terminalia ivorensis* had basal area of 1.1191m<sup>2</sup>. Other species list had low basal area.

Species dominance encountered in the study area was determined using Important Value Index (IVI). From table 2, *Terminalia ivorensis* had Important Value Index (IVI) of 13.0839 and is the most dominant for all the tree species encountered for this research. The next species is *Piptadeniestrums africanum*, with Important Value Index (IVI) of 12.9758. Closely to this is *Bombax buonopozense* with dominant value of 11.9568 and *Terminalia ivorensis* with dominant value of 11.9103. Species such as *Brachystegia eurycoma* had 7.6524, *Antrocaryon klaineianum* 7.2448, *Dacryodes edulis* 6.9023, *Diospyros melocarpa* 6.4784, *Lophira alata* 6.6471, *Parkia bicolor* 6.0467, *Funtumia africana* 6.9484, *Bailonella toxisperma* 6.3713, *Panda oleosa* and *Ceiba pentandra* 5.3629, *Terminalia superba* 5.2213, *Uapaca accuminata* 5.8627, *Pentaclethra macrophylla* 5.4247, *Khaya ivorensis* 5.1359 and *Pycnanthus angolensis* had 5.4991 Important Value Index (IVI). Other listed species had low Importance Value Index (IVI).

The presence of highly desired timber species for construction purposes such as; *Milicia excelsa*, *Entandrophragma species*, *Brachystegia eurycoma*, *Triplochiton scleroxylon*, *Lovoa trichiloides*, *Piptadeniestrums africanum*, *Daniellia ogea* and *Lophira alata* etc indicate adequate protection of flora in the Park.

#### 4. Conclusion and Recommendations

Tree assessment is the process of collecting information about the extent and conditions of the vegetation within a specific area. Quantitative assessment of the tree species was carried out using sampling of plot with Quadrats. Measurements of tree height were used to classify tree species into different structures. Families and tree species were identified in Okwangwo division of Cross River Natural Park.

A total of 250 tree species in 37 families were encountered in this study and tree measurements gave four different layers; emergent, the upper canopy, the under storey and the forest floor. The data collected from the measurements were used to calculate the relative density (R.D), relative dominance (R.D), relative frequency (R.F), Basal area and frequency. Results from relative density(RD), relative dominant (RD) and relative frequency (RF) were used to determine the dominant species using Important value Index (IVI), which show that *Terminalia ivorensis* was the most dominant with Important Value Index of 13.0839.

The diversity of tree species is unevenly distributed in the study area. Different tree species with different families were distributed heterogeneously with diverse height and sizes forming different storeys. The tree species composition and structure in this study will serve as management tool to managers of the Park in terms of determining appropriate silvicultural treatments such as selective harvesting of

certain storeys (emergent and upper storey) to allow growth of seedlings at forest floor level. It will also help the operators of the park to identify possible uses to which the trees can be put now or in the future.

Reliable information on the status and trends of Forest resources helps give decision makers the prospect necessary for orientation of forest policies and programs. Thus, tree assessment and structure in Cross River National Park serves as a valuable tool that will enable conservators and managers of National park to quantify tree species composition as well as providing information on structure which are essential for forest management and tree utilization.

Cross River National Park which is saddled with responsibilities of managing the resources of the park should design programmes that will create more awareness on the Park for the people to see the need to protect the flora and fauna species from being threatened.

Domestication of indigenous tree species should be encouraged for the reduction of poverty and for balance to be maintained in the ecosystem

There is problem of encroachment by people living in the buffer zone, support zone, and enclave Communities for harvesting of Non-timber forest products (NTFPs). Therefore, the government should encourage cultivation of edible and medicinal trees species around homes (home garden). This will reduce encroachment into the Park for tree species exploitation for economics and medicinal reasons.

#### References

- [1] Adedire, M.O (2002). Environment of tropical deforestation. *International Journal of Sustainable Development and World Ecology*, 9:33-40.
- [2] Agbor C.O, (2003). An ecological basis for management of Afi Mount Wildlife Sanctuary, Cross River State. *Unpublished Ph.D thesis*, Department of Wildlife and Fisheries management, University of Ibadan. Pp 119 -210.
- [3] Bourgeron, Patrick S. (1983). 'Spatial aspects of vegetation structure and function. *Ecosystems of the World* (4acd). Elsevier scientific. Pp.29-47.
- [4] Bryant, D.M; Ducey, M.J; and Innes J.C. et'al (2005). Forest Community Analysis and Quadrates Method. *Plant Ecology* 175(2): 193-203.
- [5] Cross River National Park (2016). Biodiversity conservation. [http://en.wikipedia.org/wiki/Cross\\_River\\_National\\_Park](http://en.wikipedia.org/wiki/Cross_River_National_Park)
- [6] Conservation international (2005). Biodiversity hotspots. CI facts. Internet communication available from URL <http://www.Fao.org/docreb/X0451E/cl/htm>.
- [7] Cunningham, W. P and M. A. Cunningham (2004). Principle of environmental science: enquiries and applications. 2<sup>nd</sup> Ed: New York, London: McGraw-Hill companies Inc.424.p.
- [8] Edet D. I. (2010). Biodiversity utilization pattern in Afi Mountain Wildlife Sanctuary, Cross River State, Nigeria. *Ph.D. Thesis*, University of Ibadan, Ibadan, Nigeria. 307 pp



- [9] Gower, S.T., J.J. Landberg and K.E. Bisbee (2003). Forest biomes of the World. In: Young R.A and Gies,R.L (Eds): introduction to ecosystem science and management. 3<sup>rd</sup> edition, John Wiley and Sons Inc, U.S.A.pp57-745.
- [10] John Terborgh (2002). Making Park work: Strategies for preserving tropical nature. Island press. Pp 65.
- [11] King, David a. and Clerk, Deborah A. (2011). "Algemetry of emergent tree species from sapling to above canopy adults in Coast Rican Rainforest." *Journal of Tropical Ecology*, 27 (6): 573-79.
- [12] Laura K. Marsh (2003). Primate fragments: Ecology and Conservation. Springer. Pp 350.
- [13] Newman, Arnold (2002). Tropical Rainforest: our most valuable and endangered habitat with blue print for survival into the third millennium (2 Ed).
- [14] Nigeria National Park Service (2016). Evolution of Parks in Nigeria. <http://nigeriaparkservices.org/?p=140>
- [15] Olajide, O. (2004). Growth performance of trees in Akure Forest Reserve, Ondo State Nigeria. *Phd Thesis*. University of Ibadan, Nigeria. 108p.
- [16] Oguntala, A.B. (1981). The dynamic of tree population in Cambari Forests Reserve, Nigeria. *Nigerian journal of Forestry* 11 (1): 5-9.
- [17] Ojo L.O; Adeola, A.O; and Okajie, J.A; eta'al (1999). Status of a Strict Nature Reserve in Akure Forest Reserve. *Journal of tropical forest resources* 15 (1): 1-9.
- [18] Panwar, P. and Bhardwaj S.D (2012). *Handbook of Practical Forestry*. Agrobios India 191p.

