TREES SPECIES DIVERSITY AND ABUNDANCE AT BC 32/4 IN SAKPONBA FOREST RESERVE, EDO STATE, NIGERIA.

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ABSTRACT
Tropical rain forest is the most species diversity rich terrestrial ecosystem and its continuous existence depends on proper management of the various species present in it. The main objective of this study was to assesstree species diversity and their abundancein BC32/4 Sakpoba Forest Reserve Edo state Nigeria. This was with the view of providing necessary information and recommending suitable management practice for the forest reserve. Four blocks were sampled using systematic sampling technique. Each block consisting of 16 samples of which 6samples were randomly selected for the study and 6 sub plots laid for both adult and juvenile trees. In the 24 sample plots laid, 613 adult trees and 985 juvenile trees were encountered. The Shannon Wiener diversity index (H), Shannon equitability index (EH) for the species evenness and mechanical index® for the species richness of the study area were 3.54, 0.55 and 1.66 respectively. The values showed the abundance and distribution of species in the area.This information shows that sustainable harvesting can be done in the study area.This would ensure sustainable production of timber and other forest goods from the forest reserve. However, because of the high complexity, richness and biological diversity of the community in the reserve, areas not suitable for wood production were recommended for biodiversity conservation.

Keywords: Adult trees, Juvenile trees, Species evenness, Species richness and biodiversity

INTRODUCTION

The tropical rainforests are major reserves of wood resources for meeting the growing demand for wood. They are of greater attraction to timber contractors due to the availability of wide variety of species and tree sizes not obtainable in plantation (Akinsanmi and Akindele,2002). Based on their fundamental contributions to environmental stability and socio-economic development of mankind, the sustainability of tropical rainforest resources is of prime importance. Akindele (2001) pointed out that there is a growing concern in ensuring the sustainability of forest estate so that the benefits from it can be available in perpetuity. The sustainability of the benefits from the forest estate depends entirely on the sustainable management of the resources. According to Gower *et al*., (2003), the development of viable tropical forest management system and procedures for preserving the forest and utilizing it on a sustainable basis will require much better ecological and physiological information of the dominant tree species. Adequate information on quantity, quality and the potential ability of the resources to replenish themselves are indispensable for a sustainable forest management. It thus implies that the continuous existence of many indigenous timber species depends on the sustainable management of the remaining areas of our rainforest (Olajide and Akinyemi, 2007). Akindele*et al*., (2001) stated that in order to ensure the sustainability of timber resources and their benefits, adequate planning is required in the use of the timber resources and that planning itself requires knowledge of the extent of growing stock in the forest. In Nigeria the tropical rainforests accounts for over 80% of the timber produced both for export and internal consumption (Bada,1984; FORMECU,1997; Olajide,2004). Thus adequate information on the quantity and quality of the resources are indispensable for a sustainable forest management. Sustainable exploitation of natural resources holds the key to the conservation of the world's biological diversity (Poore,1989; Mcneely*et al*.,1990). This study, therefore involves the assessment of Sakponba forest reserve in the rainforest ecological zone of Edo state Nigeria for species diversity and abundance with a view to providing information that would enhance the sustainable management of forest resources in the state.

MATERIALS AND METHODS

The study was carried out at BC32/4 in Sakponba Forest Reserve (a secondary natural rainforest) in Edo state Nigeria. The area is located between latitude 6°32'N and longitude 5°58'E. It covers an area of about 32km^2 with 179 compartments (Edo State Ministry of Environment). The vegetation of the area is the West African lowland evergreen tropical rainforest, sometimes called lowland rainforest or tropical moist forest biome. The area has an annual rainfall from 2078mm to 4,000mm per annum and mean of minimum and maximum annual temperature of 27°C and 32°C respectively, while the relative humidity ranges from 70% to 80%. (Edo State Ministry of Environment).This study involved the inventory of trending species in the study area. It required demarcation of sampling plots and measurement of tree dimension with the use of the following instruments; **Hand Compass:** lt was used to determine the bearing and to direct the course of the demarcation line. **100-Feet (30m) Linnen Tape:** lt was used to measure the length of the demarcated

lines. **Ranging Poles:** For ranging out the demarcation lines and for marking the four corners of each sample plots for simple identification of the boundaries. **Girthing/Diameter Tape:** Used to measure diameter at the base and diameter at the breast height of the adult trees in each sample plot. **Relaskop:** It was used to measure the diameter at the middle and top and total height. **Tangent Stick:** It was used to measure the diameter of tree with high buttresses. **Global Positioning System (GPS):** lt was used to locate the position of the cluster. The Systematic sampling techniques was adopted for data collections. This method involved four (4) blocks in the forest reserve. Each block consisted of 200m×200m. Every block consists of sixteen (16) sample plots of 50m×50m. Six (6) sample plots were randomly selected in each block. Each block therefore comprisedsix (6) sample plots with a total of (1½ha) hectares. Implying that an area of $60,000m^2$ (6ha) was assessed for the adult trees. Timber trees species of all the sample plot were identified, measured, marked and enumerated.

DATA ANALYSIS

All the tree species recorded in the field enumeration were scored in their respective families according to the documentation of Keay (1989), while their trade /local names were identified using Etukudo (2000,2003). The tree diameter was classified into nine (9) size classes. The population structure of the trees was therefore determined accordingly, first by assigning all the individual adult tree species in each sample plot to their appropriate diameter classes/species using their respective diameter measurements. The adult individuals of each species from all the sample plots were pooled together according to diameter classes. Equation 1 was used to obtain the number of each tree species represented in the respective size classes.

$N=n_1+n_2+\ldots+n_{24}$… Equation1

Where;

N = Total number of individuals of each species in the representative size-classes

n_1-n_{24} =Numbers of individual of each species in sample plot 1-24

The numbers of adult individuals of each species in the respective size-classes were then added together, using equation 2, to obtain the total number of each species represented in the sample.

$S= N_1+N_2+ \ldots +N_9$ …. (2)

Where;

S = Sum total of adult individuals of each species represented in the sample

N_1-N_9 = Number of adult individuals of each species in the respective size classes. Similarly, the sum total of trees in each size class wasobtained by adding together the number of trees of all species represented in each size class using equation 3

T=N ………………………… (3)

Where;

T = The total trees in each size class

N = The number of trees of the various species represented in each size class.

The average number of adult trees per hectare in each size class was determined by dividing the total number of adult trees in the respective size classes by 6 (the number of hectares sampled). This is presented in equation 4

$AN= \frac{TN}{6}$ …………. (4)

Where;

AN = Average number of adult trees per hectare in each size class

TN = The total number of trees in each class size

Basal area estimation

The basal area of each tree was calculated using equation 5

$BA= \pi D^2/4$……….……… (5)

Where;

BA= Basal area(m^2)

Π= constant (3.142)

D= Diameter at breast height

The basal area of the individual trees in all the sample plots were properly sorted out into their respective diameter classes using the diameter measurement of the trees. The area in each size class were summed together using equation 6 to obtain the basal area for each class in all the sample plots.

$B=\sum b$…………………….….(6)

Where;

B= The basal area of all trees in each size class at the sample plot level.

∑ b= Summation of basal area of individual trees in each size class

The total basal area of trees in each size class from all sample plots were further summed together and divided by 4 (the number of hectares enumerated), using equation 7 to obtain the average basal area of trees per hectares for each size class. The data so obtained showed the distribution of basal area among the various size classes.

$AB= \sum B/4$ ………………(7)

Where;

AB= Average basal area of the trees per hectare in each size class

∑B= Summation of the basal areas of trees in each size class in the respective sample plot.

The population density and productivity of the study area were obtained by adding together the average number of trees, basal area per hectare from all the size classes (equations 8 and 9).

$TAN = AN_1 + AN_2 + \ldots\ldots + AN_9$ …. (8)

Where;
TAN = Total average number of trees per hectare
AN_1 — AN_9 = The average number of trees per hectare, for size classes 1-9
$TAB = AB_1 + AB_2 + \ldots\ldots + AB_9$….. (9)

Where;
TAB= Total average basal area of trees per hectare
AB1 – AB9 = The average basal area of trees per hectare for size classes 1-9
The tree species richness index of the area was determined using Menhinick's index formulas (Menhinick, 1964; Ogbeibu, 2005). This formula is given as:
$R = S/\sqrt{n}$ …….... (10)

Where;
R = Species richness index
S = Number of species
N = total number of individual plants
The trees species diversity index was calculated using the Shannon-Weiner diversity index (Kent and Coke, 1992). The formula is given as:
$H' = \sum_{i=1}^{s} - pi \ln (Pi)$ …..…..…. (11)

Where;
H = Shannon-Wiener diversity index
S = Total number of tree species in the community
Pi = the proportion of S made up of the ith species
In = Natural logarithm
The species evenness index of the area was determined using Shannon's equitability (Eh)(Kent and Coker, 1992; Ogbeibu, 2005).
The formula is given by:
$E_H = \frac{HI}{H_{max}} = \sum^{s}i=1 \; Pi \ln(Pi)/ins$ …… (12)

Where;
E_H = Shannon's equitability of species evenness.
H_I = Observed diversity, which is given by the value of Shannon- Wiener diversity index
H_{max} = Maximum diversity, which is given by the natural logarithm of the total number of tree species.

RESULTS AND DISCUSSION

The species and their diversity as represented in the sampled area are summarized in Tables 1 and 2.*Caesalpinioideae* and *Olacaceae* were the most widely represented families, each represented by five adult trees in the sampled area per hectare. Table 3 on the other hand shows that only 8.5% of the trees belonged to the non-exploitable diameter size classes (1-3) while 91.5% belonged to the exploitatable diameter size classes (4-9). The distribution of the adult trees favoured the higher diameter classes as more adult individuals were recorded in size classes 4-9 than in size classes 1-3.

The number of tree species and families recorded in the study indicated that the forest is diverse and rich in the tropical hardwood tree species. The results also showed species evenness at a high level. Tables 1 and 2 revealed that each tree species had less than 20% dominance and that the nine top populated species which had above 20 individuals per hectare were distributed among different families. The species with dominance were *Gossweillrodendronbalsamiferum,Funtumiaelastica, Hylodendrongabunense, Pentaclethramacrophylla,Cordiamillenii sp., Drypeteschevolieri,Strombosiapostulata*and *Albiziaidiantifolia*.Comparing the results of the present study with those of some previous studies in other natural forests in Nigeria, some interesting observations that would enhance the appreciation of the results are possible and evident. In terms of species occurrence, the present study recorded about 102 adult trees per hectare belonging to 79 tree species in lkpon forest Reserve. Etigale (2010) recorded about 385 adult trees per hectare belonging to 79 tree species in lkpon forest Reserve. He recorded more number of trees per hectare and also more species diversity than the present study. Again the results of the present study are generally lower than those obtained by Abayomi (2001), who recorded 179 trees per hectare belonging to 68 species from three natural forest reserves in Cross River state and Adekunle*et al.*,(2002) who also recorded 364 trees per hectare drawn from 31 species inOmo forest reserve. Despite the slight variation, the results of this study generally corroborates the findings of Abayomi (2001), Adekunle*et al*., (2002) and Etigale (2010) on the biological diversity of the tree communities of natural rainforest ecosystem in Nigeria. The richness index of about 1.66 (Table 4) obtained in this study compared favourably with the richness index of about 2.02 obtained by Etigale (2010) for a relatively undisturbed forest area of Ukpon river in Cross River state. It is assumed that the higher the species richness index, the more stable and less disturbed the community is (Nzegbule and Onwuka, 2000). A species richness index of 1.66 therefore revealed that the tree species community in the area was relatively stable and undisturbed. TheSchannon Weiner diversity index (H^1) of about 3.53 was obtained for Ukpon river forest by Etigale (2010) but was higher than the values of 3.31 and 3.12 obtained for Queen's forest and Oluwa forest reserves, Ondo state respectively by Onyekwelu*et al*., (2005). Similarly, the Schannon's equitability index (EH) of 0.55 (Table 4) obtained for this study area was lower than those calculated for Ukpon River forest (0.81), Queen's forest (0.66) and Oluwaforesr (0.60). This indicated that the trees in the study area were less evenly distributed among the occurring species than those in Ukpon River forest,

Queen's forest and Oluwa forest. Since the evenness index is constrained between 0 and 1.0(Ogbeibu,2005), the value of 0.55 indicated 55% evenness in distribution, which is fairly high. This implies that the majority of the occurring species accounted for 81% of the tree population in the community. This means that the community was not dominated by few members. The results of the richness, evenness and diversity of tree species in the reserve thus conformed with the generally high ecological complexity reported for tropical natural forest by Ogbeibu (2005).

Table 1: Family Diversity, Adult and Juvenile Trees

S/N	Species Name	Number of Adult of Trees Sample	Number of Juvenile Trees
1	*Gossweilerodendronbalsomiferum*	32	41
2	*Homalumletestuii*	20	54
3	*Ficusexasperate*	3	12
4	*Millettiaaboensis*	6	12
5	*Funtumiaelastic*	28	75
6	*Synsepalumstipulatum*	2	4
7	*Piptadeniastrumafricanum*	20	16
8	*Pansinsytaliamacroceras*	17	45
9	*Enantachlorantha*	5	-
10	*Entandrophragmaangolense*	3	-
11	*Hylodendrongabunense*	27	29
12	*Omphalocarpumprocerum*	8	8
13	*Harunganamadagascariensis*	6	20
14	*Allanlackia floribunda*	13	16
15	*Sphenocentrumjollyanium*	7	8
16	*Guareacedrata*	20	49
17	*Anonidiummannii*	23	37
18	*Anthonothamacrophylla*	9	8
19	*Musangacecropioides*	17	16
20	*Khayaivorensis*	2	-
21	*Celtiszenkeri*	19	29
22	*Cylicodiscusgabunensis*	12	20
24	*Ricinodenchronheudelotii*	18	29
25	*Zanthoxyliumzanthoxyloides*	4	8
26	*Pentaclethramacrophylla*	22	50
27	*Dubosciaviridiflora*	8	-
28	*Cordiamillenii*	21	8
29	*Naucleachiderrichii*	15	8
30	*Sterculiaatragacantha*	15	25
31	*Trichiliaheudelotii*	18	29
32	*Maesopsiseminii*	12	29
33	*Drypeteschevalieri*	30	37
34	*Strombosiapostulate*	31	75
35	*Brenaniabrieyi*	8	12
36	*Hannoaklaineana*	15	8
37	*Trilepisiummadagascariense*	16	37
38	*Miliciaexcelsia*	20	8
39	*Pycnanthusangolensis*	17	4
40	*Rothmanniahispida*	19	50
41	*Albiziaidiemtifolia*	25	45
42	*Tabernaemontanapachysiphon, T.penduliflora*	-	8
43	Brenaniabrieyi	1	-
44	*Anoidiummannii*	-	4

Table 2: Number of individual adult trees species and their distribution into diameter class

		Diamental Class Size									
s/n	**Species name**	**20cm-29cm**	**30cm-39cm**	**40cm-49cm**	**50cm-59cm**	**60cm-69cm**	**80cm-89cm**	**90cm-99cm**	**100cm above**	**Total**	**Avg no/ha**
1	*Gossweilerodendronbalsomiferum*	0	0	0	0	2	10	13	6	32	5
2	*Homalumletestuii*	1	0	0	1	6	5	1	0	20	3
3	*Ficusexasperata*	0	0	0	0	0	1	0	1	3	1
4	*Millettiaaboensis*	0	0	0	0	1	2	1	0	6	1
5	*Funtumiaelastica*	1	0	0	7	10	5	1	1	28	5
6	*Synsepalumstipulatum*	0	0	0	1	0	0	0	0	2	<1
7	*Piptadeniastrumafricanum*	0	0	0	0	0	0	1	19	20	3
8	*Pansinsytaliamacroceras*	0	1	0	0	1	1	6	6	17	3
9	*Enantachlorantha*	0	0	0	0	0	2	3	0	5	1
10	*Entandrophragmaangolense*	0	0	0	0	0	0	0	3	3	1
11	*Hylodendrongabunense*	0	2	0	2	11	3	4	0	27	5
12	*Omphalocarpumprocerum*	1	0	0	0	0	1	2	1	8	1
13	*Harunganamadagascariensis*	0	0	0	0	1	1	0	1	6	1
14	*Allanlackia floribunda*	0	0	0	1	3	2	3	2	13	2
15	*Sphenocentrumjollyanium*	0	0	0	0	0	3	1	1	7	1
16	*Guareacedrata*	0	1	0	0	2	8	4	4	20	3
17	*Anonidiummannii*	0	0	0	5	4	3	4	3	23	4
18	*Anthonothamacrophylla*	0	0	1	1	0	4	3	0	9	2
19	*Musangacecropioides*	0	0	0	1	0	3	5	8	17	3
20	*Khayaivorensis*	0	0	0	0	0	0	1	1	2	<1
21	*Celtiszenkeri*	0	0	0	1	3	7	6	1	19	3
22	*Cylicodiscusgabunensis*	0	0	0	0	0	2	2	4	12	2
24	*Ricinodenchronheudelotii*	0	0	1	0	1	2	7	6	18	3
25	*Zanthoxyliumzanthoxyloides*	0	0	0	1	0	2	1	0	4	1
26	*Pentaclethramacrophylla*	0	0	0	2	4	5	2	2	22	4
27	*Dubosciaviridiflora*	0	0	0	1	2	1	2	0	8	1

28	*Cordiamillenii*	0	0	1	1	0	4	7	7	21	4
29	*Naucleachiderrichii*	0	0	0	0	2	5	4	1	15	3
30	*Sterculiaatragacantha*	0	0	0	0	3	6	2	2	15	3
31	*Trichiliaheudelotii*	0	0	2	1	0	6	1	2	18	3
32	*Maesopsiseminii*	0	0	0	0	1	7	1	0	12	2
33	*Drypeteschevalieri*	3	1	1	2	6	4	2	2	30	5
34	*Strombosiapustulate*	0	0	0	0	8	10	4	1	31	5
35	*Brenaniabrieyi*	0	0	0	1	1	1	3	1	8	1
36	*Hannoaklaineana*	0	0	0	0	0	5	0	3	15	3
37	*Trilepisiummadagascariense*	0	1	0	2	1	8	0	2	16	3
38	*Miliciaexcelsia*	0	0	0	0	0	0	3	17	20	3
39	*Pycnanthusangolensis*	0	0	0	0	4	4	2	1	17	3
40	*Rothmanniahispida*	0	0	0	0	6	2	4	1	19	3
41	*Albiziaidiemtifolia*	0	0	0	0	1	11	4	1	25	4
	Total	6	6	6	31	84	146	110	111	613	
	Estimation no/ha	1	1	1	5	14	24	18	19	102	

Table 3: Percentage of adult trees/ha in each size class

Size class Number	No of adult trees in study area	Estimated No of adult trees/ha	% of adult trees/ha
1	5	1	2.5
2	6	1	3.0
3	6	1	3.0
4	18	3	9.1
5	26	4	13.1
6	34	6	17.2
7	36	6	18.2
8	35	6	17.7
9	32	5	16.2
TOTAL	**198**	**33**	**100.0**

Table 4: Biodiversity Index for the Study area

Species Divisity Index

Species	number	pi	H
Synsepalumstipulatum	2	0.003	0.019
Khayaivorensis	2	0.003	0.019
Ficusexasperata	3	0.005	0.026
Entandrophragmaangolense	3	0.005	0.026
Pentaclethramacrophylla	4	0.007	0.033
Zanthoxyliumzanthoxyloides	4	0.007	0.033
Enantachlorantha	5	0.008	0.039
Millettiaaboensis	6	0.010	0.045
Harunganamadagascariensis	6	0.010	0.045
Sphenocentrumjollyanium	7	0.011	0.051
Omphalocarpumprocerum	8	0.013	0.057
Dubosciaviridiflora	8	0.013	0.057
Brenaniabrieyi	8	0.013	0.057
Anthonothamacrophylla	9	0.015	0.062
Cylicodiscusgabunensis	12	0.020	0.077
Maesopsiseminii	12	0.020	0.077
Allanlackia floribunda	13	0.021	0.082
Naucleachiderrichii	15	0.024	0.091
Sterculiaatragacantha	15	0.024	0.091
Hannoaklaineana	15	0.024	0.091
Trilepisiummadagascariense	16	0.026	0.095
Pansinsytaliamacroceras	17	0.028	0.099
Musangacecropioides	17	0.028	0.099
Pycnanthusangolensis	17	0.028	0.099
Ricinodenchronheudelotii	18	0.029	0.103
Pentaclethramacrophylla	18	0.029	0.103
Trichiliaheudelotii	18	0.029	0.103
Celtiszenkeri	19	0.031	0.108
Rothmanniahispida	19	0.031	0.108
Homalumletestuii	20	0.033	0.112
Piptadeniastrumafricanum	20	0.033	0.112
Guareacedrata	20	0.033	0.112
Miliciaexcelsia	20	0.033	0.112
Cordiamillenii	21	0.034	0.115
Anonidiummannii	23	0.037	0.123
Albiziaidiemtifolia	25	0.041	0.130
Hylodendrongabunense	27	0.044	0.137
Funtumiaelastica	28	0.046	0.141
Drypeteschevalieri	30	0.049	0.147
Strombosiapustulate	31	0.050	0.151
Gossweilerodendronbalsomiferum	32	0.052	0.154
Species Divisity Index (H^1)			*3.53847*
Species Richness Index			*1.65597*

Species Evenness Index(E_H)	*0.5513*

CONCLUSION

Many tropical countries are richly endowed with natural resources. These forests together constitute almost half of the world's forest area and contain an enormous quantity of renewable raw materials in a world of growing needs. The management of these important renewable natural resources to maintain and where possible increase their productivity on a permanent basis has become the most main pre-occupation and the most challenging task of tropical foresters. To succeed therefore, the forester needs to understand the type and composition of the forest to be managed as well as the conditions under which such forest perpetuate themselves hence this study on Sakponba forest reserve.

The number of tree species and family recorded and the richness, diversity and evenness indices obtained in the study demonstrated that the tree community in BC 32/4 Sakponba forest reserve, with particular reference to the sample area is complex, rich in biological diversity and constitutes a reliable gene pool for potential conservation purposes.

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