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Tree Diversity and Abundance in a Rainforest Reserve in Cross River State, Nigeria.

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Abstract
Tree species diversity and abundance in Ukpon River Forest Reserve, a tropical rainforest in Cross River State, Nigeria, were studied. The objective was to obtain quantitative information on the diversity and abundance of trees in the reserve. Using systematic cluster sampling technique, 16 sample plots of 50m x 50m were laid and trees ≥ 10cm dbh were enumerated. A total of 1,534 trees, belonging to 79 species, 77 genera and 28 families were encountered. *Strombosia* spp. (237) was the most abundant, with a relative abundance value of 15.45%. The Shannon-Wiener diversity index (H'), the Shannon's equitability index (EH) for species evenness and Menhinick's index (R) for species richness of the study area were 3.53, 0.81 and 2.02, respectively. The results conformed to the generally high ecological complexity reported of tropical natural forests. Being stocked with abundant and diverse tree species, which are valuable resources with high potential economic values in addition to their invaluable ecological benefits, it is recommended that the forest reserve should be conserved through sustainable forest management.

Keywords: Trees, Species, Families, Diversity, Abundance, Tropical Rainforest Reserve, Sustainable Management.

Introduction

Trees are perennial woody plants of reasonable heights; usually well above 10m tall, with single self-supporting trunks free of branches for some distance above the ground. They are classified as higher plants. Their big sizes and longevity make them outstanding in their environment and give them a greater capability of maintaining and protecting the environment against degradation. In fact, the Chinese adage that "when the last tree dies the last man will follow" is very apt (Adetula, 2002), considering the importance of the products and services provided by trees to mankind and his environment. This is evident by virtually non-human endurance or non-permanent habitation of the polar regions, deserts and mountain tops, where there are no trees (Adeyoju, 2001). Trees provide man with substantial benefits which include wood, food, medicine and essential ecological services. They possess a biological property, which can provide a stable above-ground biomass structure that helps sustain land-based production systems (Nasayao, 1999).

In a typical tropical rainforest ecosystem, trees are the most conspicuous plant life-form. They provide the forest framework and the necessary under-canopy microclimate for the growth of many kinds of plants, such as climbers, epiphytes, strangling plants, parasites and saprophytes (Whitemore, 1998; Olajide *et al*., 2008). Furthermore, the species, population and sizes of trees present in a forest community have often been used as the basis for the assessment of the quality of many tracts of tropical rainforest (Olajide & Udofia, 2008). Generally, the rainforest ecosystem is usually viewed as a crop of merchantable timber trees (Panayotou & Ashton, 1992), and is commonly exploited for its timber resources (Olajide *et al*., 2008); when the desired timber resources are depleted, it is considered degraded and sometimes valueless and may even be converted to other forms of land-uses.

Tropical rainforests are repositories of many and varied resources of social, economic and environmental values. Unfortunately, they are fast disappearing and mankind is losing their invaluable, indispensable and innumerable goods and services. Their disappearance will translate to a permanent loss of enormous resources of immeasurable economic and ecological values (Olajide & Akinyemi, 2007; Olajide *et al*., 2008) because many of their valuable resources have no substitutes and can neither be replaced nor revived within few years. According to Taylor (2004), in 1950 about 15% of the earth's land surface was covered by tropical rainforest ecosystem, but today more than half of this ecosystem has fallen victim to fire and the chainsaw, and the rate of destruction is still accelerating. Presently, many of the remaining areas of tropical rainforest ecosystem are severely threatened, fragmented and even degraded due mainly to unsustainable harvesting of their rich timber resources, indiscriminate bush burning and conversion of some portions of this ecosystem to other forms of land-uses, such as agriculture, mining, industries and urban development. The remaining areas of tropical rainforest ecosystem in Nigeria need to be managed sustainably to ensure the conservation and sustainable utilization of their resources. To check the ugly trend of unsustainable forest harvesting in Nigeria a sound forest management system that could ensure their sustainability must be designed for the remaining forest estates. Also, showing evidence that a tract of tropical rainforest worth as much as, if not more than the other forms of land-uses they are often converted to, could help to reduce the rate at which these resource-rich, highly productive and complex ecosystems are converted to these other forms of land-uses. However, both sustainable forest management planning and land-use decision making involving a forest area require relevant information, which necessarily include quantitative data on species composition of the affected forest area. Data on species composition provide information on species diversity and their abundance. Therefore, the objective of this study was to assess tree species diversity and abundance in Ukpon River Forest Reserve in Cross River State, Nigeria, with the view to gathering quantitative information that would enhance sustainable management of the forest.

Materials and Methods

Study Area

The study was conducted in Ukpon River Forest Reserve, which is located in Cross River State, Nigeria, between latitudes 5°41' and 5°57'N and longitudes 8°13' and 8°31'E. The forest Reserve is a secondary natural rainforest. It covers an area of about 31,380 hectares (Dunn *et al*., 1994). The vegetation of the area is the West African lowland evergreen tropical rainforest. Like any other tropical rainforest, the forest reserve has a complex structure, which is stratified both vertically and horizontally. The area has annual rainfall of 2,500mm – 4,000mm per annum, minimum and maximum annual temperature means of 24°C and 30°C respectively and relative humidity range of 70% - 80%. The soil type is clay-loam, mixed with gravels in most parts. The topography is undulating, having many hills and valleys, with many rivulets, which empty into the Ukpon River. Fig.1 is the map of the study area.

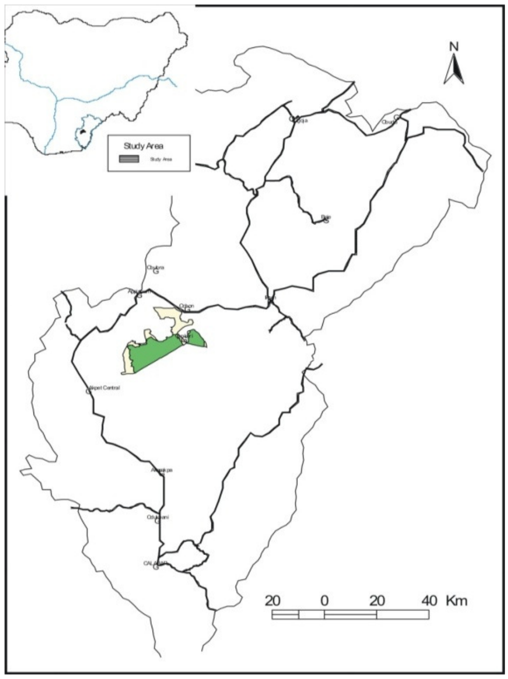

Fig. 1: Location of Ukpon River Forest Reserve in Cross River State with map of Nigeria showing Cross River State inset
Source: Cross River State Forestry Commission (1991)

Data Collection

Data collection started with a reconnaissance survey of the forest reserve, which involved a careful study of the forest reserve maps, followed by proper ground-truthing. 16 Sample plots of 50m x 50m were laid using the systematic cluster sampling technique. Two clusters were laid in the forest, each consisting of a base-line measuring 1,000m (1km) long, with 200m x 200m tract at each end and each tract consisted of 4 sample plots (FORMECU, 1997; Abayomi, 2001; Akindele *et al*., 2001). The two tracts in each cluster were, therefore, separated by a distance of 600m, while the two base-lines were separated by a distance of 1,000 (1km). A total of 4ha was assessed. All tree species with diameters at breast (dbh) of 10cm and above present in the sample plots were identified, enumerated and recorded in the field enumeration forms.

Data Analysis

All the tree species enumerated in the study were sorted into their respective families according to the documentation of Keay (1989). The tree species richness index of the area was determined using Menhinick's Index Formula (Menhinick, 1964; Ogbeibu, 2005).

The formula is given as :

$$R = \frac{S}{\sqrt{N}} \quad \ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

Where;

R = Species richness index

S = Number of species

N = Total number of individuals

The tree species diversity index was calculated using the Shannon-Wiener diversity index (Kent and Coker, 1992). The formula is given as:

$$H' = -\sum_{i=1}^{S} -p_i \; In(p_i) \quad \ldots.\ldots\ldots.(2)$$

Where;

H' = Shannon-Wiener diversity index

S = Total number of tree species in the community

P_i = 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 index (Kent and Coker, 1992; Ogbeibu, 2005). The formula is given as:

$$E_H = \frac{H'}{H_{max}} = \frac{\sum_{i=1}^{S} p_i \ln(p_i)}{lns} \quad \ldots\ldots\ldots\ldots(3)$$

Where;

E_H = Shannon's equitability index for species evenness.

H' = 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.

Species abundance in the sample and per hectare were determined using equations 4 and 5 respectively

$$n_i = \sum n \quad \ldots\ldots.\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$n_{ih} = \frac{\sum n}{4} \quad \ldots\ldots.\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where;

n_i = Total number of individuals of ith species represented in the sample.

n = number of individuals of ith species enumerated in the sample plots.

n_{ih} = number of individuals of ith species per hectare

Equation 6 was used to calculate the total abundance of the species encountered in the study.

$$N = \sum n_i \quad \ldots\ldots\ldots\ldots\ldots\ldots..(6)$$

Where;

N = Total number of individuals of all the tree species encountered.

n_i = number of individuals of ith species in the whole sample.

The relative abundance of each species was determined using equation 7 (Ogbeibu, 2005)

$$RA = \frac{n_i}{N} \times \frac{100}{1} \ldots\ldots\ldots\ldots\ldots.(7)$$

Where;

RA = Relative abundance of ith species.

n_i and N are explained in equation 6 above.

Results

A total of 1,534 trees, belonging to 79 species, 77 genera and 28 families were encountered. The three most abundant species were *Strombosia* spp. (237), *Treculia obovoidea* (165) and *Calpocalyx winkleri* (86), with estimated values of 59, 41 and 22 trees per hectare, respectively, and relative abundance values of 15.45%, 10.76% and 5.61%, respectively (Table 1). Other tree species with abundance of 10 stems/ha and above were *Diospyros* spp. (19 stems/ha), *Carapa procera* (18 stems/ha), *Klainedoxa gabonensis* (17 stems/ha), *Uapaca* spp. (13 stems/ha), *Xylopia* spp. (13 stems/ha), *Cola* spp. (11 stems/ha), *Staudtia stipitata* (11 stems/ha) and *Berlinia* spp. (10 stems/ha). The least represented were *Alstonia boonei*, *Alstonia congensis*, *Anonidium mannii*, *Aubrevillea kerstingii*, *Bombax buonopozense*, *Bridelia* spp. *Ceiba pentandra, Dialium guineense*, *Garcinia* spp., *Holoptelea grandis, Khaya* spp., *Nauclea diderrichii*, *Nesogordonia papaverifera*, *Petersianthus macrocarpus* and *Terminalia superba*, each having only one individual in the sample (Table 1).

The most widely represented families were *Caesalpinioideae* and *Mimosoideae*. While *Caesalpinioideae* was represented by nine species from eight genera, *Mimosoideae* was represented by eight species belonging to eight genera (Table 2). These were followed by *Annonaceae*, *Euphorbiaceae* and *Meliaceae* families, each represented by six species belonging to six genera, while the *Sterculiaceae* and *Moraceae* families were represented by five species from five genera each (Table 2). The other families encountered in the study area were represented by less than five species and genera. However, *Olacaceae* family, represented by only two species and two genera, was the most abundant, with 243 individuals encountered and followed by *Moraceae* family, with 204 individuals (Table 2). The *Mimosoideae* and *Ceasalpinioideae* families had 122 and 110 individuals, respectively, while the remaining families had less than 100 individuals (Table 2). The Shannon-Wiener diversity index (H') of the tree species, Shannon's equitability index (EH) for species evenness and Menhinick's index for species richness of the study were 3.53, 0.81 and 2.02 respectively (Table 3).

Table 1: Species, Families, Abundance, Relative Abundance and Diversity of Trees Encountered in Ukpon River Forest Reserve, Cross River State, Nigeria

Species	**Family**	**Abundance of each species**		**Relative Abundance (%)**	**P_i ln P_i**
		In the sample	**Per hectare**		
Afzelia bipindensis Harms	*Caesalpinioideae*	23	6	1.50	-0.063
Albizia zygia (DC) J. F. Macbr.	*Mimosoideae*	10	3	0.65	-0.033
Allanblackia floribunda Oliv.	*Guttiferae*	16	4	1.04	-0.048
Allophylus africanus P. Beauv.	*Sapindaceae*	13	3	0.85	-0.040
Alstonia boonei De Wild.	*Apocynaceae*	1	<1	0.07	-0.005
Alstonia congensis Engl.	*Apocynaceae*	1	<1	0.07	-0.005
Amphimas pterocarpoides Harms	*Papilionoideae*	6	2	0.39	-0.022
Anonidium mannii (Oliv.) Engl. & Diels	*Annonaceae*	1	<1	0.07	-0.005
Antiaris Africana Engl.	*Moraceae*	2	1	0.13	-0.009
Araliopsis soyauxii Engl.	*Rutaceae*	9	2	0.59	-0.030
Aubrevillea kerstingii (Harms) Peuegr.	*Mimosoideae*	1	<1	0.07	-0.005
Baillonella toxisperma Pierre	*Sapotaceae*	6	2	0.39	-0.022
Berlinia confuse Hoyle	*Caesalpinioideae*	38	10	2.48	-0.092
Blighia sapida Konig	*Sapindaceae*	20	5	1.30	-0.057
Bombax buonopozense P. Beauv.	*Bombacaceae*	1	<1	0.07	-0.005
Brachystegia eurycoma Harms	*Caesalpinioideae*	6	2	0.39	-0.022
Brachystegia nigerica Hoyle & A. P. D. Jones	*Caesalpinioideae*	10	3	0.65	-0.033
Bridelia spp. Willd.	*Euphorbiaceae*	1	<1	0.07	-0.005
Calpocalyx winkleri Harms	*Mimosoideae*	86	22	5.61	-0.162
Carapa procera DC	*Meliaceae*	73	18	4.76	-0.145
Ceiba pentandra (Linn.) Gaertn.	*Bombacaceae*	1	<1	0.07	-0.005
Celtis zenkeri Engl.	*Ulmaceae*	13	3	0.85	-0.040
Chrysophyllum albidum G. Don	*Sapotaceae*	24	6	1.56	-0.065
Cleistopholis patens (Benth.) Engl. & Diels	*Annonaceae*	3	1	0.20	-0.012
Coelocaryon preussii Warb	*Myristicaceae*	31	8	2.02	-0.079
Cola millenii K. Shum.	*Sterculiaceae*	43	11	2.80	-0.100
Coula edulis Bail.	*Olacaceae*	6	2	0.39	-0.022
Cylicodiscus gabunensis Harms	*Mimosoideae*	4	1	0.26	-0.016
*Dacryodes edulis (*G. Don) H. J. Lam	*Burseraceae*	14	4	0.91	-0.043
Daniellia ogea (Harms Rolfe ex Holl.	*Caesalpinioideae*	5	1	0.33	-0.019
Dialium guineense Willd.	*Caesalpinioideae*	1	<1	0.07	-0.005
Diospyros spp. Linn.	*Ebenaceae*	74	19	4.82	-0.146
Distemonanthus benthamianus Baill.	*Caesalpinioideae*	4	1	0.26	-0.016
Enantia chlorantha Oliv.	*Annonaceae*	3	1	0.20	-0.012
Eribroma oblonga (Mast.) Peire ex A. Chev	*Sterculiaceae*	21	5	1.37	-0.059
Erythrophleum suaveolens	*Caesalpinioideae*	2	1	0.13	-0.009

(Guill. & Perr.) Brenan					
Ficus exasperata Vahl	*Moraceae*	2	1	0.13	-0.009
Garcinia mannii Oliv.	*Guttiferae*	1	<1	0.07	-0.005
Guarea cedrata (A. Chev.) Pellegr.	*Meliaceae*	4	1	0.26	0.016
Hannoa klaineana Pierr & Engl.	*Simaroubaceae*	8	2	0.52	-0.027
Holoptelea grandis (Hutch.) Milbr.	*Ulmaceae*	1	<1	0.07	-0.005
Hylodendron gabunense Taub.	*Caesalpinioideae*	21	5	1.37	-0.059
Irvingia gabonensis (O'Rorke) Baill.	*Irvingiaceae*	27	7	1.76	-0.071
Khaya ivorensis A. Chev.	*Meliaceae*	1	<1	0.07	-0.005
Klainedoxa gabonensis Engl.	*Irvingiaceae*	67	17	4.37	-0.137
Lannea welwitschii (Hiem) Engl.	*Anacardiaceae*	15	4	0.98	-0.045
Macaranga barteri Muell. Arg.	*Euphorbiaceae*	6	2	0.39	-0.022
Mammea Africana Sabine	*Guttiferae*	18	5	1.17	-0.052
Margaritaria discoidea (Baill.) Webster	*Euphorbiaceae*	2	1	0.13	-0.009
Monodora tenuifolia Benth.	*Annonaceae*	11	3	0.72	-0.035
Musanga cecropioides R. Br. Ex Tedlie	*Moraceae*	9	2	0.59	-0.030
Nauclea diderrichii (De Wild. & Th. Dur.) Merrill	*Rubiaceae*	1	<1	0.07	-0.005
Nesogordonia papaverifera (A. Chev.) R. Capuron	*Sterculiaceae*	1	<1	0.07	-0.005
Panda oleosa Pierre	*Pandaceae*	9	2	0.59	-0.030
Parinari excelsa Sabine	*Chysopbalanaceae*	10	3	0.65	-0.033
Parkia bicolor A. Chev.	*Mimosoideae*	11	3	0.72	-0.035
Pausinystalia johimbe (K. Schum.) Pierre ex Beille	*Rubiaceae*	10	3	0.65	-0.033
Pentaclethra macrophylla Benth.	*Mimosoideae*	3	1	0.20	-0.012
Petersianthus macrocarpus (P. Beauv.) Liben	*Lecythidaceae*	1	<1	0.07	-0.005
Piptadeniastrum africanum Brean	*Mimosoideae*	7	2	0.46	-0.025
Psydrax spp. Gaertn.	*Rubiaceae*	15	4	0.98	-0.045
Pterocarpus soyauxii Taub.	*Papilionoideae*	23	6	1.50	-0.063
Pterygota macrocarpa K. Schum.	*Sterculiaceae*	2	1	0.13	-0.009
Pycnanthus angolensis (Nelw.) Warb.	*Myristicaceae*	24	6	1.56	-0.065
Ricinodendron heudelotii (Baill.) Heckel	*Euphorbiaceae*	6	2	0.39	-0.022
Staudtia stipitata Warb.	*Myristicaceae*	43	11	2.81	-0.100
Sterculia rhinopetala K. Schum.	*Sterculiaceae*	7	2	0.46	-0.025
Strombosia pustulata Oliv.	*Olacaceae*	237	59	15.45	-0.289
Symphonia globulifera Linn. f.	*Guttiferae*	24	6	1.56	-0.065
Tabernaemontana pachysiphon Stapf	*Apocynaceae*	3	1	0.20	-0.012
Terminalia superb Engl. &	*Combretaceae*	1	<1	0.07	-0.005

Diels					
Treculia obovoidea N. E. Br.	*Moraceae*	165	41	10.76	-0.240
Trichilia spp. P. Browne	*Meliaceae*	9	2	0.59	-0.030
Trilepisium madagascariense DC.	*Moraceae*	26	7	1.69	-0.069
Uapaca staudtii Pax	*Euphorbiaceae*	53	13	3.46	-0.116
Uvariodendron connivens (Benth.) R. E. Fries	*Annonaceae*	10	3	0.65	-0.033
Vitex oxycuspis Bak.	*Verbenaceae*	13	3	0.85	-0.040
Xylopia aethiopica (Dunal) A. Rich	*Annonaceae*	50	13	3.24	-0.112
Zanthoxylum zanthoxyloides (Lam.) Zepernick & Timler	*Rutaceae*	4	1	0.26	-0.016
Total		**1534**	**385**	**100.08**	**-3.527**

Table 2: The families and their diversities and abundances

Family	No. of genera	No. of species	No. of individual trees in sample
Anacardiaceae	1	1	15
Annonaceae	6	6	78
Apocynaceae	2	3	5
Bombacaceae	2	2	2
Burseraceae	1	1	14
Caesalpinioideae	8	9	110
Chysopbalanaceae	1	1	10
Combretaceae	1	1	1
Ebenaceae	1	1	74
Euphorbiaceae	5	5	68
Guttiferae	4	4	59
Irvingiaceae	2	2	94
Lecythidaceae	1	1	1
Meliaceae	4	4	87
Mimosoideae	7	7	122
Moraceae	5	5	204
Myristicaceae	3	3	98
Olacaceae	2	2	243
Pandaceae	1	1	9
Papilionoideae	2	2	29
Rubiaceae	3	3	26
Rutaceae	2	2	13
Sapindaceae	2	2	33
Sapotaceae	2	2	30
Simaroubaceae	1	1	8
Sterculiaceae	5	5	74
Ulmaceae	2	2	14
Verbenaceae	1	1	13
TOTAL	77	79	1,534

Table 3: Summary of biodiversity indices for the study area

Index	Value
Shannon-Weiner diversity index (H')	3.53
Shannon's equitability index (E_H)	0.81
Menhinick's index	2.02

Discussion

The number of tree species, genera and families encountered in this study indicated that the forest was rich and diverse in tropical hardwood tree species, which is a common characteristic of a typical tropical rainforest ecosystem. A forest that is rich in tree species composition is a valuable asset considering that trees have high potential economic values for livelihood and development, and also offer innumerable ecosystem services of immense benefits. In terms of climate change mitigation, trees in a forest are very important, as they hold a lot of carbon in their biomass. For instance, among all the forest species, trees have been identified, as principal sinks of CO_2 (Sukhdev, 2010; ITTO, 2011). They are described as "carbon storage experts", with almost 350 million years experience in sequestering carbon and unique in their ability to lock up large amounts of carbon in their wood, adding more carbon as they grow (DEC, 2016). Their big sizes afford them high capacities to capture and store up to 4.5-11kg of carbon per annum (Akbari, 2002) in their biomass and can store most of the sequestered carbons for hundreds of years, depending on their longevity.

The results also indicated a high level of species evenness. The evenness index of 0.8 (Table 3) was corroborated by the species relative abundance values of ≤ 15.45% (Table 1), showing that no single species dominated the population. The relative abundance of the species showed the percentage contribution of each species to the entire population, that is, the percentage of the population made up of each species. The most abundant species in this study, which had 10 and above individuals per hectare, were distributed among different families (Table 1). Also, there was no correlation between family diversity (number of species and genera per family) and family abundance (number of individuals per family) (Table 2).

Comparing the results of this study with those of some previous studies in other natural forests in Nigeria, some interesting observations, that would enhance a better appreciation of the results, were made. In terms of species occurrence, the present study recorded about 385 trees per hectare belonging to 79 species, 77 genera and 28 families, while in Bende Forest Reserve, Ogbannaya (2002) recorded about 319 trees per hectare, belonging to 109 species, 85 genera and 37 families, and in Akure Strict nature Reserve (SNR), Ondo State, Nigeria, Adekunle *et al.* (2010) recorded about 549 trees per hectare, belonging to 46 species and 21 families. While Ogbonnaya (2002) recorded less number of trees per hectare and more species diversity, Adekunle *et al.* (2010) recorded more number of trees per hectare, but less species diversity than the present study. However, the results of the present study are generally higher than those obtained by Abayomi (2001) – 179 trees/ha, 68 species and 59 genera from three natural Forest Reserves in Cross River State, Nigeria - and Adekunle *et al*. (2002) – 354 trees/ha, 31 species and 15 families from Omo Forest Reserve, Ondo State, Nigeria. Despite the slight differences, the results of this study generally corroborate the records of Abayomi (2001), Adekunle *et al*. (2002; 2010), Ogbonnaya (2002) and Olajide *et* al. (2008; 2015) on the biological diversity of the tree communities of natural rainforest ecosystems in different regions of Nigeria.

The richness index of about 2.02 (Table 3) obtained in this study compared favourably with the richness index of about 2.14 obtained by Nzegbule & Onwuka (2000) for a relatively undisturbed forest area of Ohiya Umuahia, Imo State, Nigeria. It is assumed that the higher the species richness index the more stable the ecosystem and faster ecological succession to reach climatic climax state (Nzegbule & Onwuka, 2000; Thompson, 2010; Agyeman, 2013). A species richness index of 2.02, therefore, indicated that the tree species community in the area was relatively stable and undisturbed. Actually, no visible signs of human disturbance were observed in the present study area. The only signs of disturbance observed were gaps created by natural phenomena, such as wind-throw and death of old trees. The Shannon-Wiener diversity index (H') of about 3.53 (Table 3) compared favourably with results of researches conducted in other tropical rainforest ecosystems in Nigeria. For example, it was higher than the values, 3.31 and 3.12, obtained for Queen's forest and Oluwa forest, respectively, by Onyekwelu *et al*. (2005) and the value (3.16) obtained for Akure Strict Nature Reserve (SNR) by Adekuble *et al*. (2010), but fell within the common range of values (3.34 – 3.66) reported for some tropical rainforest sites in Southern Nigeria (Adekunle, 2006; Adekunle & Olagoke, 2007). The result thus revealed that the tree community in the study area was highly diverse.

The Shannon's equitability index (EH) of 0.81 (Table 3) obtained in the current study was also higher than those calculated by Onyekwelu *et al*. (2005) for Queen's forest (0.66) and Oluwa forest (0.60), and compared favourably with the value (0.83) computed for Akure SNR by Adekunle *et al*. (2010). The higher the value of the evenness index, the more evenly distributed are the individuals among the occurring species. Since the evenness index is constrained between 0 and 1.0 (Ogbeibu, 2005), the value of 0.81 indicated 81% evenness in distribution, which was very high. This implied that majority of the occurring species accounted for 81% of the trees population in the community and that the community was not dominated by few member species.

Conclusion and Recommendations

The study revealed that Ukpon River Forest Reserve has abundant and diverse tropical hardwood tree species. These trees are valuable resources with high potential economic values for livelihood and development and also render invaluable environmental services. Therefore, there is need for this reserve to be conserved to ensure the availability of these resources and their benefits in perpetuity. It is therefore, recommended that the reserve should be managed in a sustainable manner that would ensure the conservation of its rich biodiversity.

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