Journal of Agriculture and Ecology Research International

Volume 24, Issue 3, Page 20-26, 2023; Article no.JAERI.97059
ISSN: 2394-1073

Abundance and Regeneration Potentials of Trees Species at Ukpon River Forest Reserve, Cross River State, Nigeria

D. I. Omini [a], P. E. Esor [b], I. O. Iwara [b*], J. I. Ammonum [c] and S. I. Agera [c]

[a] Zero Handle Limited, Bristol, UK.
[b] Department of Forestry and Wildlife Management, Cross River University of Technology Calabar, Nigeria.
[c] Department of Forest Production and Products, College of Forestry and Fisheries, Joseph Sarwuan Tarka University, Makurdi Benue State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAERI/2023/v24i3528

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/97059

Original Research Article

Received: 04/01/2023
Accepted: 01/03/2023
Published: 17/03/2023

ABSTRACT

Tropical rainforest is continuously declining by timber exploitation, commercial and monoculture plantation. In This study, abundance and regeneration potentials of trees at Ukpon river forest reserve cross River State, Nigeria was assessed using Systematic line transects and purposive sampling techniques for plots demarcation and data collection. Data were analyzed using descriptive statistics such as tables, charts, frequencies and diversity indices were analyzed using 'R' soft wear. 65 tree species in 32 families and 10 genera. Meliaceae, (6) Caesalpiniceae and Moraceae (5) families each were the most abundant families individuals population.). The highest

[++] Lead Environmental Consultant;
**Corresponding author: E-mail: iwaraomini@ymail.com;*

relative frequency (2.256%) and (2.241%) were recorded in *Melicia excelsa*. Relative dominance (4.970%) was highest in *Bianella toxisperma*. IVI recorded the highest value (4.970%) in *Melicia excelsa* . The highest dbh and tree height were (80.5cm) and (68.3m). Shannon wiener index was (5.058), Margelef index (36. 097) and species richness (68). Regeneration potentials seedlings ranged between 0. 22% and 0.01%. However, it is necessary to understand the phenology of the forest reserve, to study whether seeds or fruits produced are adequate, physiological conditions to germinate and growth into wildlings for regeneration purpose.

Keywords: Abundant; regeneration; trees; species; Ukpon River.

1. INTRODUCTION

Tree species abundance and regeneration is very useful in understanding the forest stands, and structure for conservation work. The underlying shape of forest structure depends largely on the ecological characteristics of sites, species diversity and regeneration status of tree species. Tree species abundance and diversity are essential to the overall forests biodiversity, because trees provide resources like food, traditional medicine, timber, shade and habitats for other organism [1,2]. The degrees of decline of species in the second half of the 20th century becomes a universal or worldwide problem due to several anthropogenic factors [1]. In order to control or manage the increasing rate of anthropogenic activities of the forest estate, the provision and protection of biodiversity services is essential to describe the pattern of forest structure [3]. Many reasons have been suggested for variation in trees species diversity among forest reserves. Malhil et al. [4] and Lippok et al. [5], noted that, topography strongly influenced local endemism of plant species. Franscico et al, [6] Observed that disturbance affects diversity and regeneration, such as tree growth, tree mortality, understory development with respect to forest reserve and habitat heterogeneity. According to Pushpangadan [7], forests represent one of the dominant components of the vegetation in India (and also in Nigeria) and forests constitute an invaluable reserve of economically important species and genetic resources of many crop plants and their wild relatives. Sustainable conservation management requires a basic knowledge of the spatial and temporal ranges of key elements and the principal of environmental factors that govern their distribution and survival [8].

2. MATERIALS AND METHODS

2.1 Study Area

Okpon River forest reserve was Gazetted by Cross River State in 1930.The reserve occupied a land mass of 31,300 hectares of land, covering two Local Government Areas, Obubra and Yakurr respectively. The Reserve lies between Latitudes 5^0 . 40^1 ,5^0.50^1 and 6^0.00^1, 6^0 .10^1 North of the Equator and Longitude 8^0. 10^1 ,8^0. 20^1 and 8^0.30^1 , 8^0. 40^1 East of the Greenwich Meridian · The reserve is bounded in the North by Etung and Ikom LGA, South Baise, LGA, West Abi LGA to the East Eboyi State.

2.2 Sampling Techniques/ Procedure

Systematic and purposive sampling techniques was adopted to established transects and plots selection. (8) transects were laid for plants species enumeration. Transects were peg at 100m apart. 4 plots were laid along the transects alternately position at a distance of 250m interval. Within each plots, diameter at breast height (dbh at >10cm) 50m x50m of tree species were enumerated while subplots of 1mx 1m were laid within the Centre of the main plots for seedlings enumeration (< 10cm dbh) were identified and counted.

2.3 Data Collection

Tree species encountered were assigned as class based on (>10cm dbh) Diameters of tree species, while seedlings (< 10cm dbh) were measure using a venire caliper. Density, relative frequency, relative dominant and regeneration potentials index, IVI were all computed.

2.4 Data Analysis

Data collected were imputed into Microsoft word Excel package 2017 version. , Density, RF, RD, and RPI of tree seedlings and tree species were computed using Diversity indices. Statistical significance were accepted (P< 0.005%). Pearson Correlation analysis and regeneration potentials indices were all performed in ‘R’ soft wear.

Basal areas of all trees in the samples plots was calculated using the formula (eqn)..1,

$$BA = \frac{\pi D^2}{4} \quad (1)$$

Species Relative density (RD %): It was computed using the following equation

$$RD = \frac{ni \times 100}{N} \quad (2)$$

Where;

RD = Relative density of the species
ni = Number of individuals per species and
N = Total number of all individual tree of all species in the entire population.

Relative Dominance (%) was estimated using the following equation

$$RD_0 = \frac{\sum Ba_1 \times 100}{\sum Ba_n} \quad (3)$$

Where;

Ba_1 = Basal area of individual tree belonging to the ith species and
Ba_n = Stand basal area.

Shannon – wiener diversity index was calculated using equation

$$H = -\sum P_1 \ln (P_1)\ldots \quad (4)$$

Where; 1 = 1

H' = Shannon diversity index,
S = The total number of species in the community,
P_1 = Proportion S (species in the family) made *u* to the ith spp and
In = natural logarithm. Species Evenness:

Where;

H' = Evenness I Species in each plot will be determined by using

Shannon's equitability (EH), which was obtains using (equ 5).

$$E_H \; \frac{H}{H_{max}} = \sum P_1 \; \frac{\ln (P_1)}{_s \ln(S)} \quad (5)$$

Species Richness (d) was calculated using the Margalef index (d) (equ.6)

Species Richness (d) = S – 1/1Nn (2) (6)

Where;

S = Total number of spp,
N = Total numbers of individuals of all species.

Important Value Index:

IVI =RF+RD+RD (7)

Where;

RD = Relative density of the species;
RD_O = The relative dominance of species.

$$\text{Regeneration potentials} = \frac{\text{Number of Wildings of individuals species}}{\text{Density of the woody stem}} \quad (8)$$

3. RESULTS

Table 1. Maximum and minimum diameters were recorded as 80.5cm and 10.1cm. Mean dbh was 25.1cm, height was 28.6m standard deviation for dbh and height were 13.2cm and 14.1m. minimum and maximum height were 5.2m and 68.3m Table1.

Table 1. Diameter at breast height and tree growth at Okpon River forest reserve

	Dbh (cm)	Ht (m)
Minimum	10.1	5.2
Max	80.5	68.3
Mean	25.1	28.6
Standard deviation	13.2	14.1

68 tree species belonging to 34 families were recorded. Abundance species were, Meliaceae (6 tree / ha) followed by Caesalpiniceae and Moraceae (5 trees / ha) each. Relatives frequency was highest in *Melicia excelsa* 2.256%, followed by *Khaya irvorensis* 1.933%, *Ceiba pentadra* 1.826% .65 species recorded relative frequencies less than 0.001%. Relative density was highest in *Milicia excelsa* 2. 241% followed by *Khaya irvorensis* 2.028%. 66 tree species observed RD less than 0.001%. Table 2 *Melicia excelsa* obtained relative dominance 4.970% followed by *Biallonella toxisperma* 3.672. IVI was highest in *Melicia excelsa* 9.4675, followed by *Khaya irvorensis* 6.865% *Biallonella toxisperma 6.670% Ceiba pentadra* 6.865%. 64 tree species recorded IVI ranged from 0. 231% to 4. 758% Table 2.

Table 2. Tree species composition and abundance

S/No	Species	Family	RF(%)	RD(%)	RDo(%)	IVI
1	*Antidesma laciniatum*	Euphorbiaceae	0.215	0.213	0.097	0.525
2	*Antrocaryon micraster*	Anacardiaceae	0.107	0.107	0.017	0.231
3	*Aubregrinia taiensis*	Mimosaceae	0.215	0.213	0.037	0.466
4	*Avicennia africana*	Avienniaceae	0.430	0.427	0.209	1.066
5	*Azadirachta indica*	Meliaceae	0.322	0.320	0.192	0.835
6	*Baillonella toxisperma*	Sapotaceae	1.504	1.494	3.672	6.670
7	*Balanites wilsoniana*	Balanitaceae	0.322	0.320	0.147	0.789
8	*Baphia maxima*	Papiloniaceae	0.537	0.534	0.200	1.271
9	*Baphia nitida*	Papiloniaceae	0.537	0.534	0.247	1.318
10	*Barteria fistulosa*	Passifloraceae	0.215	0.213	0.036	0.464
11	*Carpolobia lutea*	Apocynaceae	0.107	0.107	0.049	0.263
12	*Casearia barteri*	Salicaceae	0.107	0.107	0.053	0.267
13	*Cassipourea congoensis*	Rphizophoraceae	0.107	0.107	0.024	0.238
14	*Ceiba pentandra*	Bombaceae	1.826	1.814	2.635	6.275
15	*Dialium dinklagei*	Caesalpinaceae	0.107	0.107	0.132	0.346
16	*Dialium guineense*	Caesalpinaceae	1.611	1.708	1.439	4.758
17	*Dichaetanthera africana*	Melastomataceae	0.215	0.213	0.064	0.492
18	*Dichapetalum spp*	Melastomataceae	0.107	0.107	0.026	0.240
19	*Entandrophragma utile*	Meliaceae	0.537	0.534	0.774	1.845
20	*Eribroma oblonga*	Malvaceae	0.215	0.213	0.082	0.510
21	*Eriocoelum macrocarpum*	Sapindaceae	0.215	0.213	0.212	0.641
22	*Erythrina vogelii*	Caesalpinaceae	0.322	0.320	0.257	0.899
23	*Erythrophelum suaveolens*	Caesalpinaceae	0.107	0.107	0.090	0.304
24	*Erythroxylum mannii*	Erthroxylaceae	0.215	0.213	0.124	0.552
25	*Ficus capensis*	Moracaae	0.752	0.747	0.157	1.656
26	*Ficus congensis*	Moraceae	0.537	0.534	0.149	1.220
27	*Ficus exasperate*	Moraceae	1.182	1.174	0.431	2.786
28	*Ficus mucuso*	Moraceae	0.107	0.107	0.014	0.228
29	*Ficus vogeliana*	Moraceae	0.430	0.427	0.091	0.947
30	*Funtumia elastica*	Apocynaceae	1.826	1.814	0.789	4.430
31	*Garcinia kola*	Moraceae	1.074	1.067	0.359	2.501
32	*Garcinia livingstonei*	Moraceae	0.215	0.213	0.047	0.475
33	*Garcinia manii*	Apocynaceae	0.859	0.854	0.446	2.160
34	*Gilbertiodendron dewevrei*	Caesalpinaceae	0.215	0.213	0.180	0.608
35	*Gmelina arborea*	Verbenaceae	1.182	1.174	1.948	4.303
36	*Grewia coriacea*	Tillaceae	0.215	0.213	0.077	0.505
37	*Guarea glomerulata*	Meliaceae	0.430	0.427	0.172	1.028
38	*Hannoa klaineana*	Simaroubaceae	0.752	0.747	0.474	1.973
39	*Harungana madagascariensis*	Guttiferae	0.322	0.320	0.182	0.824
40	*Heinsia crinata*	Myristicaceae	0.107	0.107	0.019	0.233
41	*Hevea brasiliensis*	Euphorbiaceae	0.537	0.534	0.136	1.207
42	*Hexalobus crispiflorus*	Annonaceae	0.107	0.107	0.027	0.241
43	*Hymenostegia afzelia*	Caesalpinaceae	0.107	0.107	0.213	0.427
44	*Irvingia gabonensis*	Irvingiaceae	1.504	1.494	2.669	5.667
45	*Irvingia grandifolia*	Meliaceae	0.107	0.107	0.059	0.273
46	*Irvingia wombolu*	Irvingiaceae	0.859	0.854	1.320	3.033
47	*Khaya grandifoliola*	Meliaceae	0.967	0.961	1.142	3.069
48	*Khaya ivorensis*	Meliaceae	1.933	2.028	2.903	6.865
49	*Kigelia africana*	Bignoniaceae	0.107	0.107	0.016	0.230
50	*Klainedoxa gabonensis*	Irvingiaceae	0.322	0.320	0.873	1.515
51	*Lepidobotrys staudtii*	Linaceae	0.215	0.213	0.119	0.547
52	*Leptonychia pallida*	Sterculiaceae	0.215	0.213	0.041	0.469
53	*Lophira alata*	Ochnaceae	1.826	1.814	1.657	5.297

S/No	Species	Family	RF(%)	RD(%)	RDo(%)	IVI
54	*Lovoa trichilioides*	Meliaceae	1.504	1.601	1.902	5.006
55	*Milicia excels*	Moraceae	2.256	2.241	4.970	9.467
56	*Millettia macrophylla*	Papiloniaceae	0.215	0.213	0.075	0.503
57	*Mitragyna ledermannii*	Rubiaceae	0.107	0.107	0.181	0.396
58	*Moringa oleifera*	Moringarceae	0.430	0.427	0.705	1.562
59	*Randia longiflora*	Rubiaceae	0.430	0.427	0.186	1.043
60	*Raphia hookeri*	Arecaceae	0.215	0.213	0.109	0.537
61	*Rauvolfia vomitoria*	Apocynaceae	0.107	0.107	0.087	0.301
62	*Rhaptopetalum beguei*	Scytopetalaceae	0.107	0.107	0.019	0.234
63	*Ricinodendron heudelotii*	Euphorbiaceae	0.967	0.961	0.437	2.364
64	*Tectona grandis*	Verbenaceae	0.322	0.320	0.631	1.274
65	*Thecacoris leptobotrya*	Euphorbiaceae	0.107	0.107	0.119	0.333

Where RF=relative frequency; RD= relative density; RDo=relative dominance; IVI – importance value index

Table 3. Seedlings species composition, density and regeneration potentials index

S/N	SPP	Family	Density	NSP	RF	RD	RPI
1	*Accoa Pallescences*	Chysobalaria	1	1	6293	0.216	1.001
2	*Afromosia Chevalieri*	Rufaleae	5	5	1.466	1.08	0.005
3	*Afzelia africana*	Caesalpinacea	2	1	0.293	0.432	0.002
4	*Afzedua bipindensis*	Leguminosae	1	1	0.293	0.216	0.001
5	*Albizia lebbock*	Leguminosae	1	1	0.293	0.216	0.001
6	*Albizia gummfera*	Leguminosae	1	1	0.293	0.216	0.001
7	*Alchornea Laxifera*	Euphorbiaceae	2	2	0.587	0.432	0.002
8	*Alanblanka Floribunda*	Cluciaceae	3	3	0.88	0.648	0.003
9	*Astoma boonei*	Apocynaceae	5	4	1.173	1.08	0.005
10	*Alstonia congensis*	Apocynaceae	11	4	1.173	2.376	0.012
11	*Anonidum mannii*	Annonaceae	1	1	0.293	0.216	0.001
12	*Bailonella toxisperma*	Sapotaceae	9	7	2.053	1.944	0.01
13	*Baphia maxima*	Papiloniaceae	1	1	0.293	0.216	0.001
14	*Baphia nitida*	Papiloniaceae	2	1	0.293	0.216	0.002
15	*Brachystegia eurgcena*	Caesalpinaceae	21	14	4.106	4.536	0.022
16	*Ceiba panfadra*	Bombaceae	13	11	3.226	2.808	0.014
17	*Chnysophyllun albidum*	Sapotaceae	12	11	3.226	2.592	0.013
18	*Danyodes edulis*	Burseracae	13	13	3.812	2.808	0.014
19	*Entandrophrasman ang*	Meliaceae	8	5	1.566	1.728	0.009
20	*Ficus Congensis*	Moraceae	3	1	0.293	0.648	0.003
21	*Funtuma elastic*	Apocynaceae	7	3	0.88	1512	0.007
22	*Gmelina arborea*	Verberacea	6	6	1.76	1.296	0.006
23	*Iyunyia gatinearsis*	Irumgiaceae	10	10	2.933	2.16	0.011
24	*Khaya Ivorences*	Meliaceae	11	6	1.76	2.376	0.012
25	*Lophna alata*	Ochnaceae	8	8	2.346	1.728	0.009
26	*Lovoa trichillioides*	Meliacceae	10	6	1.76	2.16	0.011
27	*Magnetera indica*	Anacardiaceae	7	6	1.76	1.512	0.007
28	*Mansonia altissima*	Sterculiaceae	1	1	0.293	0.216	0.001
29	*Melicia excels*	Moraceae	11	9	2.639	2.376	0.012
30	*Mussanga ceropiodies*	Urticaceae	18	18	5.279	3.888	0.019
31	*Neudea didomichii*	Rubiaceae	6	6	1.76	1.296	0.006
32	*Oxystigma mannii*	Caesalpimaceae	4	1	0.293	0.864	0.004

Results of Regeneration potentials index indicates that relative frequency was highest in *Mussanga cecropides* seedlings 5.279% followed by *Brachystegia eurycoma* 4.106%. Relative density was highest *in Brahystegia eurycoma* seedlings (4.536) followed by *Mussanga cecrpiodes* 3.888% respectively. *Brachystegia eurycoma* seedlings recorded the highest RPI 0.022%) followed by *Mussanga cecropiodes* seedlings (0.019). *Mussagan cecropiodes* seedlings was represented by 18 sampled plots with a density of 18%, followed by *Brachystegia eurycoma* seedlings represented by 14 sampled plots Table 3.

4. DISCUSSION

The results of this study recorded 68 tree species belonging to 34 families. *Caesalpinceae, Moraceae and Meliaceae* were the most abundance families. The area is rich in terms of tree species composition but lower when compared with 99 tree species belonging to 36 families recorded in Takamanda Rainforest of Southwest, Cameroon by [9]. In the same vain, it is lower than 118 tree species reported by Adeyemi et al, [10] for the Oban Division of the Cross River National Park in Nigeria. Comparing the results of this study to a similar study by Oluwatosin and Jimoh [11], in Onigambari forest reserve Ondo State, Nigeria, obtained a higher number of families (54) tree species, while, Muazu [12], reported four families in Kuyambana forest reserve, Zamfara State, Nigeria, even lower than the presence study of 34 families recorded in Okpon river forest reserve. He reported the dominance of *Caesalpinaceae, Mimosaceae* and *Combretaceae* families. This finding corroborated the works of Adekunle [13] who found that tropical rainforest ecosystems of Southwest Nigeria are dominated by some specific families such as the *Sterculiaceae, Meliaceae, Moraceae,.* In this present study, Okpon River Forest reserve were dominated by *Caesalpinceae, Meliacea and Moracea.*

Fabaceae, meliceae, and *caesalpiniaceae* have been consistently reported as dominant plant families in Nigeria tropical forest [13]. The effect of anthropogenic activities on growth and distribution of tree species may have played a role in the status of these species in the ecosystem, threatening the occurrence and development of certain species while favoring others. The *Caesalpinaceae, Meliacea, Moraceae and euhporbiacea* were observed to be the most prevalent families in this presence study. This may be due to their fast regeneration ability associated with symbiotic properties, which may have enabled the species to easily established within habitat types.

Regeneration potentials was highest in *Brachystegia eurycoma* (0.022%) Which is quite lower in value than (0.189%) *Culcacia saxatilis* species obtained in Onigambari forest reserve Oyo State, Nigeria by Salami et al. [14]. The differences in value could be attributed to the location and management practices adopted among the two forest reserve. Osamionayi et al. [15] recorded regeneration potential even higher that [14] in Strombosia postulate at Sakponda forest reserve Edo State, Nigeria. Probably these species were able to regenerate successfully in the area because of their ability to produce large quantities of viable seeds, withstand shading, suppression and compete favorable for growth resources in the micro climate under the close canopy.

5. CONCLUSION AND RECOMMENDATION

Assessment of tree species diversity and regeneration potential was documented in Okpon river forest reserve. *Caesalpiniaceae, Leguminosae, Meliaceae Apocynaceae* were the dominant families in the forest reserve. The density value of 21%, RF 5.279%, and RD 4.536% was indication that forest reserve is moderate and intake. The research has proven that, there is make differences in the vegetation species composition. Also, majority of the species occupying the forest reserve were found to have a lower importance value index as a poor representation amongst the samplings population of the forests. This could be achieve with the adoption and appropriate Silvicultural measures that can enhance the regeneration, survival and growth of the species with low representation to ensure its sustainability in the reserve.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/97059