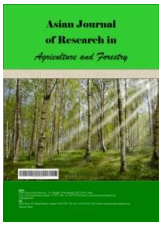

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Assessment of Species Diversity and Forest Regeneration Potentiality in Buruku Forest Reserve, Kaduna State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author AIS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RAS and SM managed the analyses of the study. Author GLL managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Species diversity and forest regeneration potentiality in Buruku Forest Reserve was assessed. Four (4) plots (A–D) of 60 m x 60 m were laid in each plot. Point centred quadrant method of sampling was used. Transect were selected on pure random basis where data were collected on species diversity and families, density of woody stem, diameter class distribution, regeneration potentials and relative frequency. 21 families with a total of 135 species were obtained on the species diversity at Buruku Forest Reserve. The densities of woody plant varied between 434.03 - 771.60 per hectare in plots A, B, C and D. While the highest number of trees in diameter-class distribution were apportioned to 10 – 19 cm class interval in plots A, B, C and D respectively. Diameter class 50 cm and above had the lowest number of trees allocated to it. The regeneration potential of the diversified species was very poor, which has a great implication for regeneration and conservation of the various species encountered. Although *Isoberlinia doka Craib & Stapf.* had the highest regeneration potential from each of the examined plots followed closely by

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Acacia senegal, Parkia biglobosa and *Terminalia avicennoides Gull & Peer.* Important woody plants of economic importance, like *Triplochiton scleroxylon K. Schum* had zero regeneration potential. However, it is recommended that Buruku Forest Reserve Should be regenerated artificially (through enrichment planting, re-afforestation programme and so on) to increase the plant diversity in the forest and regeneration potentials of the species for sustainability of the forest reserve.

Keywords: Conservation; woody plant; enrichment planting; point centred; sustainability.

1. INTRODUCTION

There is necessity to conserve the forest resources because of their economic importance. Several direct as well as indirect benefits are available in the forest such as timber and non-timber products. Apart from timber products in the forest, plant foods such as leaves, seed nuts, fruits, tubers and roots stand as source of food income generation [1]. Also, species of economic importance such as medicinal and aesthetic values can be kept in perpetuity in a well preserved forest. The forests of Nigeria comprises of swamp forest, tropical rainforests and secondary forest regrowth. The lowland tropical rainforest was described by as a complicated mosaic of communities of different status and floristic composition. Structurally, the forests consist of three layers – the tree layer, the shrub layer and the undergrowth. Many of the emergent species in the forest grow slowly and require fair amount of overhead shade in their early life in order to survive and thrive [2,3]. But it is now recognized that many of them grow very rapidly in full light conditions [4].

The emergent species exist for a long period in a state of suppressed regrowth under shade of the canopy until a gap occurs which allows them to grow up. Forestry growth cycle consists of a mosaic gap-phase, build up phase and mature phase forests as explained by [5]. At present most of the preserved forest areas are being vandalized and valuable species illegally removed. The only mean by which Forest Reserved Areas can sustain themselves of these valuable species, is through an effective regeneration programmes [6] indicated that 350,000 ha of forest and natural vegetation were lost in Nigeria. It led to problems such as desertification, soil erosion, declining soil fertility; flooding and extinction of important flora and fauna species [7,8]. Forests are dynamic. Seedlings germinate, grow, and compete with each other and with large trees. Some survive for hundreds of years. Changes will happen which will be predominant in the future forest depends not only on climate and soils but also on management decisions made today. Changes in forest composition will affect the quality and variety of forest resources available to future generations and wildlife [9]. Sustainable management of forest ecosystem is set as a goal by most nations [10,2] and maintaining biological diversity is one important component of this [11].

Biological diversity conservation strategies that include a variety of individual management strategies for specific species are neither feasible nor effective [12,13,14]. As an alternative, 'coarse-filter' management strategies focus on maintenance of broad patterns of forest age and composition under the assumption that this will provide the necessary habitat to support a wider variety of native species [15,16]. Native species are assumed to be adapted to the natural disturbance regime of their environment; thus, management that stimulates the natural disturbance regime has become a popular approach to maintaining species diversity as well as ecological integrity [17,18]. With this approach, natural processes are to be protected, which include forest regeneration after disturbance such as fire or logging [19]. A central component of biodiversity conservation in managed forest landscape is successful regeneration of natural tree species mixes after logging [20]. This often proves to be a substantial challenge. Site preparation and planning of tree seedlings have been widely adopted as strategies to ensure rapid and successful post harvest regeneration. These require a substantial silvicultural and financial investment, however, and are not always successful in meeting legal regeneration standards let alone achieving a natural species mix. Although natural regeneration can be much less expansive and lead to more natural species mixes, its success depends on availability of seed sources, regeneration micro sites and micro environmental and biotic conditions favoring establishment and early survival of tree seedlings [21,22].

High demands for timber and increasing accessibility are leading to increased exploitation of these high elevation forests. They are characterized by slow growth rates of post-disturbance regeneration and established trees. Thus meeting objections for regeneration of natural species mixes and sustainability of fiber and other ecosystem components can prove challenging [23,24]. The only mean by which Forest Reserved Areas can sustain themselves of these valuable species, is through an effective regeneration programmes. Forest and natural vegetation lost in Nigeria every year due to antropogenic activities are of great concerned. It led to problems such as desertification, soil erosion, declining soil fertility, flooding and extinction of important flora and fauna species [7]. Hence, necessitate the need to study the natural regeneration potentials of forest reserved areas so that species of economic significance, including non-timber forest products (NTFPs) and aesthetic values, can be maintained in perpetuity. The objective of the study is to assess the species diversity and potentiality for forest regeneration in Buruku Forest Reserve.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Buruku Forest Reserve. Buruku is in Chikun Local Government Area. Chikun Local Government Area was carved out of Kachia Local Government Area in 1989. The local Government covers an area of about 45,659 km^2 with a projected population of 368,250 thousand of people according to the 2006 census figure [25]. Chikun Local Government lies between the latitude 10°37^{1}N and Longitude 7°15^{1}E [25]. It constitutes one of the twenty three (23) Local Government Areas of Kaduna State and is in the Northern Part of the State. The soil type in Buruku Forest Reserve is Sandy loam which severally eroded exposing ironstone on the surface [3].

2.2 Sampling Procedure

Four (4) sampling plots of 60 m x 60 m were laid in Permanent Protected Areas of Buruku Forest Reserve. Technique used was adopted from [26,1,24]. Point centred quadrant method of sampling was used in each of the selected plots. Transects were selected using systematic sampling method. The first one was selected on pure random basis. Along the direction of each transect, sampling points were taken at intervals of 5 m which helps in getting sufficient sampling points and possible overlapping and duplication of units of measurement were avoided. At each sampling point, the following parameters were assessed. Distance to four nearest woody plants, one in such quadrant.

i. Height of the tree

This is measured through the use of Haga altimeter.

ii. Diameter of each tree

This is measured through the use of diameter tape.

2.3 Analytical Tools

(i) Density: Densities of the woody stem in all the study plots were determined. The distance measured between sample points of each woody plant was used to obtain the density stem. The estimation was based on the formula;

$$D = \frac{10^4}{d^2} \text{ stem ha}^{-1}$$

Where d^2 = is the average distance in m^2 [26].

(ii) Diameter class distribution

Diameter class distribution was determined through the measurement of diameter of the woody stand in all the plots at DBH (1.37 m height).

(iii) Regeneration potentials:

$$\text{Regeneration potential} = \frac{\text{Number of wilding of individual species}}{\text{Density of the woody stem}}$$

(iv) Relative frequency:

$$\text{R.F} = \frac{\text{Number of individual of the species X 100}}{\text{Number of individual of all species}}$$

(v) Species abundance:

Species abundance, indicating the number of species contained in the number of individual plants.

3. RESULTS AND DISCUSSION

3.1 Species Diversity and Families

Members of the families in acceding order include *Fabaceae>Combretaceae,*

Sterculiaceae>Verbanaceae dominated the permanent protected area followed by members of *Annonaceae >Rhamnaceae> Anacardiaceae >Meliaceae* and to a lesser extent, some other families include *Sapotacea>Euphorbiaceae> Ochnaceae*and so on. The species that are most common in acceding order are *Isobanilia doka>Parkia biglobosa>Prosopis africana>Vitex doniana> Acacia senegal > Lawsonia inermis* (Table 1). This result is in agreement with the work of [3] that the first four (4) families dominated Buruku forest Reserve with high percentage spread.

3.2 Density

The density of the woody stem as indicated in Table 2, revealed that plot C in permanent protected area had 771.60 stem/ha which was the highest when compare to plot A, plot B and plot D with 657.46 stem/ha, 540.83 stem/ha and 434.03 stem/ha respectively.

3.3 Diameter Class Distribution

Diameter class distribution of woody stems assessed in plot A, B, C and D; however, the number of trees assessed for diameter was 70, 110, 80, and 80 respectively. The highest number of trees was apportioned to diameter class 10 – 19 cm for each of the plots A, B, C and D, that was 30 trees, 50 trees, 60 trees and 40 trees respectively, followed by diameter class 20 – 29 cm (Fig. 1). Diameter class 50 and above had the lowest number of trees allocated to it.

3.4 Regeneration Potentials

The regeneration potential of the diversified species as indicated in Table 3 is very poor. It therefore, has a great implication for regeneration and conservation of the various species encountered. *Isoberlinia doka* had the highest regeneration potential from each of the examined plots in Buruku Forest; followed by *Acacia senegal*, *Parkia biglobosa* and *Terminalia avicennoides*. However, most of the important woody plants of economic importance like *Triplochiton scleroxylon*, had zero regeneration potential. Regeneration potential of the most species is zero, owing to complete absent of mother trees which would have produced the wildlings within the assessed area. The results is in consonance with the works and observations of [1,24,3].

Table 1. Species diversity and families in Buruku Forest Reserve

S/No	Families	Number of species	Percentage (%) spread
1	*Fabaceae*	22	16.3
2	*Ebenaceae*	4	2.96
3	*Annonaceae*	6	4.44
4	*Anaccardiaceae*	5	3.70
5	*Combretaceae*	13	9.63
6	*Longaniaceae*	3	2.22
7	*Meliaceae*	5	3.70
8	*Rhamnaceae*	5	3.70
9	*Rubiaceae*	4	2.96
10	*Sapotaceae*	6	4.44
11	*Sterculiaceae*	8	5.93
12	*Verbanaceae*	5	3.70
13	*Papilioceae*	6	4.44
14	*Casalpiniaceae*	4	2.96
15	*Myristicaceae*	5	3.70
16	*Ochnaceae*	6	4.44
17	*Irvingiaceae*	8	5.93
18	*Chysobaniaceae*	4	2.93
19	*Euphorbiaceae*	6	4.44
20	*Lythraceae*	6	4.44
21	*Myrtaceae*	4	2.96
	Total	***135***	***100***

Table 2. Density of woody plants at various plots in Buruku Forest Reserve

S/N	Site	Stem (ha^{-1})
1	Plot C	771.60
2	Plot A	657.46
3	Plot B	540.83
4	Plot D	434.03

Table 3. Regeneration potential of species in Buruku Forest Reserve

S/N	Species	Plot A	Plot B	Plot C	Plot D
1	*Vitex doniana Linn.*	0.00	0.00	0.00	0.01
2	*Entada africana Gull & Perr.*	0.01	0.00	0.00	0.00
3	*Prosopis africana*	0.00	0.00	0.00	0.03
4	*Terminalia avicennoides Guill & Perr.*	0.04	0.02	0.01	0.02
5	*Triplochiton scleroxylone K. Schum.*	0.00	0.00	0.00	0.00
6	*Macaranga hurifolia*	0.00	0.00	0.00	0.00
7	*Isoberlinia doka Craib & Stapf.*	0.41	0.71	0.66	0.58
8	*Annona senegalensis Pers.*	0.00	0.05	0.00	0.00
9	*Pilostigma thornningii (schum)*	0.00	0.00	0.03	0.00
10	*Carissa adolia Linn.*	0.01	0.00	0.00	0.00
11	*Acacia senegal (Houtt)*	0.03	0.02	0.04	0.01
12	*Lophira lanceolata Banks ex Gaertn.*	0.01	0.00	0.00	0.00
13	*Combretum ghasalense Engl.& Diels*	0.01	0.00	0.01	0.00
14	*Parkia biglobosa (Jacq) Benth*	0.02	0.04	0.01	0.02
15	*Parinari curatellifolia Planch.*	0.00	0.02	0.00	0.00

Table 4. Relative frequency of species in Buruku Forest Reserve

S/N	Species	Plot A	Plot B	Plot C	Plot D
1	*Terminalia avecinnoides Guill & Perr.*	4.950	7.692	5.542	7.229
2	*Khaya senegalensis Ders.*	0.248	0.350	0.503	0.000
3	*Vitellaria paradoxa C.F. Gaertn*	0.743	1.049	1.259	1.807
4	*Pilostigma thonningii(schum)*	4.703	2.093	5.289	2.108
5	*Annona senegalensis Pers.*	6.931	3.497	7.557	0.000
6	*Acacia Senegal(Houtt)*	54.208	43.010	45.844	45.482
7	*Lannea barteri (Oliv)*	1.733	0.699	0.000	1.205
8	*Gardenia imperialis(K .Schum)*	1.238	3.846	0.000	3.012
9	*Carissa adolia Linn.*	4.703	1.748	5.289	2.410
10	*Sterculia setigera Del.*	1.238	5.944	0.000	5.422
11	*Isoberlinia doka Craib&Stapf.*	6.188	18.531	7.053	16.877
12	*Entada africana Gull & Perr.*	0.248	0.350	0.000	0.904
13	*Diospyros mespiloformis Hochst.*	0.248	0.000	0.000	0.604
14	*Prosopis africana (Gull & Perr) Taub*	0.248	0.000	0.000	0.000
15	*Combretum ghasalens Engl.& Diels*	0.248	1.049	0.000	0.000
16	*Anogeisus liocarpus (DC) Gull & Perr*	4.950	0.000	0.000	0.301
17	*Parkia biglobosa (Jacq) Benth*	3.465	0.000	0.00	0.000
18	*Triplochiton scleroxylon K.Schum.*	0.990	0.000	1.511	0.000
19	*Vitex doniana Linn*	0.990	0.000	1.511	1.506
20	*Strychnos spinosa Lam.*	0.495	0.000	1.007	0.000
21	*Tectona grandis L.f.*	1.238	0.000	0.000	1.807
22	*Macaranga hurifolia Beille.*	0.000	7.692	2.267	5.723
23	*Parinari curitellifolia Planch.*	0.000	0.350	0.000	0.904
24	*Lophira lanceolata Banks ex Gaertn*	0.000	0.350	1.763	0.000
25	*Lawsonia inermis L.*	0.000	0.350	5.542	0.000
26	*Psidium guajava L.*	0.000	0.350	0.503	1.205
27	*Irvingia gabonensis (Bail)*	0.000	1.049	1.763	1.506

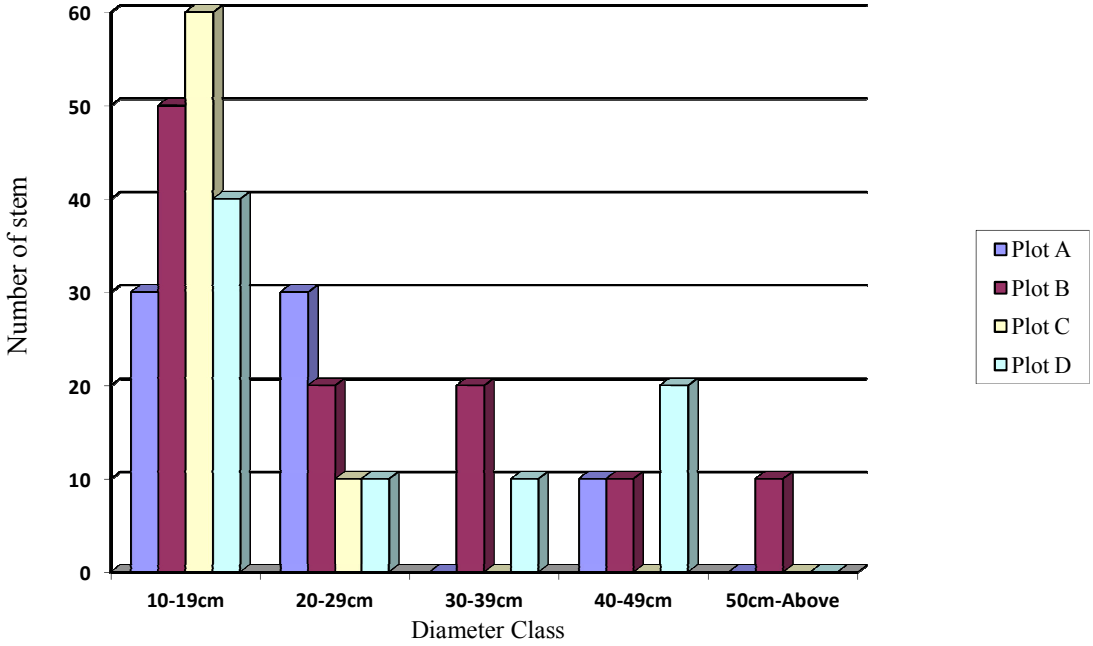

Fig. 1. Diameter class distribution of woody stem in plot A, B, C and D of Buruku Forest Reserve

3.5 Relative Frequency

In Table 4 plots A, B, C and D, about 21, 19, 16 and 18 species were observed. In plot A, *Acacia senegal* showed the greatest occurrence with relative frequency of 54.2%, the species had some spread in plot B, plot C and plot D with relative frequency of 43.0%, 45.8% and 45.5%. This was followed by *Isoberlinia doka* in plots B and plot D with relative frequency of 18.5% and 16.9% respectively. However, in plot C *Acacia senegal* was closely followed by *Annona senegalensis* with relative frequency of 7.56% respectively.

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Regeneration potentials of the diverse species in Buruku Forest Reserve are very poor. It was observed that most of the woody species were not regenerating themselves. Most of the species of economic importance had zero regeneration potentials. There were cases when mother trees of the wildlings observed were absent from the plots or the wildlings of woody species were absent. Therefore, this situation poses a great threat to conservation of the diverse species in the PPA of Buruku Forest Reserve.

4.2 Recommendation

Based on the findings, it is recommended that Buruku Forest Reserve Should be regenerated artificially (through enrichment planting, re-afforestation programme and so on) to increase the plant diversity in the forest and regeneration potentials of the species for sustainability of the forest reserve.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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