STAND POPULATION ANALYSIS AND REGENERATION POTENTIALS OF TREE SPECIES IN FABACEAE FAMILY IN OBAN FOREST RESERVE, CROSS RIVER STATE, NIGERIA

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Abstract
There is a gross inadequate data, quantitative and qualitative scientific information on the population of many prominent timber tree species in Nigerian rainforest ecosystems and other protected tracts of rainforest to facilitate sustainable forest management. Thus, study on population ecology of timber tree species of Fabaceae family was carried out in Oban forest reserve in Cross River State, Nigeria using the combination of systematic and random sampling techniques for data collection on mature trees and regeneration. Data collected were subjected to descriptive statistical analysis and calculation of regeneration potential index of each tree species. Twenty two (22) tree species were encountered. The highest population density of 44 trees per/ha of mature trees was recorded for Berlinia grandiflora, while mature stands of Calpocalyx brevibracteatus and Lonchocarpu laxiflorus were not encountered. Most of the trees were of small stem diameters of 20 – 49cm. Berlinia confuse had the highest regeneration population density of 418 per/ha and highest regeneration potential index of 0.39, while the regeneration of Albizia adianthifolia, Berlinia congolensis and Brachystegia eurycoma were not encountered. It is recommended that timber exploitation should be restricted to the few species that have high populations of big diameter trees to forestall the extinction of most of the species from the forest reserve.

Keyword: *Tropical rainforest, Timber, Tree species, Fabaceae family, Population, Regeneration, Sustainable management*

Introduction

Wood, like food, is an indispensable need of man. It is a platitude that man cannot avoid encountering wood from cradle to grave. Aside being one of the major sources of energy (wood-fuel), wood is used for the production of many essential products, such as household and industrial furniture, plywood and veneer, fibre-board, paper of various grades, materials for packaging, lumber for building and construction work (Olajide and Udo, 2005; Molinos, 2013; Betti et al., 2016).

The world tropical rainforest (including Nigeria rainforest) is the source of about 40% of the world's wood consumption (ITTO, 2011; Agyeman, 2013; Betti et al., 2016). However, appreciable area of plantation forests exist, yet the rainforest is of great attraction to timber merchants due to their wide variety of tree species and sizes (Adekunle, 2006; Adekunle et al., 2010; Etigale et al., 2017). The tropical rainforest is the most biologically diverse ecosystem on the earth, and no other forms of forest can rival its richness in diversity of timber tree species (ITTO, 2011 and Newin, 2014).

The astronomical increase in human population has brought intense pressures on the tropical rainforest to meet the wood need for construction, housing, furniture, packaging and other purposes. Consequently, many tree species producing highly valued timbers have been over-exploited to the extent of being endangered and threatened with extinction (Betti et al., 2016 and Etigale et al., 2017). Unfortunately, most of the species cannot be cultivated in plantation on large-scale due to some silvicultural and ecological predicaments, such as quick loss of seed viability, general paucity of propagules and massive pest attacks (Olajide and Akpan-Ebe, 2006; Akpan-Ebe, 2015).

Among the trees' family in Nigerian rainforest that produce valuable timbers is Fabaceae family. The Fabaceae family was formerly called Leguminiosea with sub-families: Caesalpinioideae, Mimosoideae and Papilionoideae (Loupp et al., 2008). Many species in this family have been over-exploited for timber, and becoming rare. Among the well-known species in the family include Afzelia spp., Brachystegia spp., Gossweilerodenron balsamiferum, Hylodendron gabumense, Baphia nitida, Amphimas pterocarpoides and Pterocarpus spp.

Knowledge of the population density and distribution of stems by diameter class is important for the effective management of a given tree species, because it shows the structure of the population and helps in identifying deficiencies in regeneration capacity, and thus provide a basis for the adaptation of silvicultural interventions (Betti et al., 2016). Accordingly, sustainable management of the remaining tracts of tropical rainforest would be

an illusion without quantitative and qualitative ecological data bordering on population density of constituent tree species, stem-diameter distribution and population of regeneration.

This paper, therefore, is a report of a study on population status and regeneration potentials of tree species in Fabaceae family in Oban forest reserve in tropical rainforest ecosystem of Cross River State, Nigeria. It is hoped that the information obtained would help the conservation of the tree species that are in the family in particular and sustainable management of the forest reserve in general.

Materials and Methods

Study Area

The study was carried out in Oban Forest Reserve, Cross River State, Nigeria. The forest reserve is a tropical rainforest, and one of the very few expanse tracts of rainforest remaining in Nigeria. The forest reserve covers an area of 245.48km^2. The area lies between latitudes 500' and 557'N, and longitudes 810' and 855'E. The annual rainfall of the area varies between 2,500mm and 3,500mm, mean minimum and maximum annual temperatures are 23C and 30C respectively. The average relative humidity is 85% at 12.00 hours (Offiong and Iwara, 2011). The soil is known to be formed from rocks of pre-Cambrian complex especially granite, gneisses and schist, and classified as Haptic nitsols (FAO and UNESCO, 1988; Offiong and Iwara, 2011). The forest reserve has been subjected to logging and therefore, is characterized by canopy gaps of varying sizes.

Data Collection

Systematic and random sampling techniques were used for data collection. The technique entailed the laying of one kilometer (1km) baseline across the main access route at 20m away from the border of the buffer zone of the forest reserve. Five points of 200m apart from one another were marked along the base-line, and thereafter three points were randomly selected for the laying of belt transects. Accordingly, three 1km belt transects were laid from the three randomly selected points on the base-line into the forest.

All trees having 20cm diameter at breast height (dbh) were deemed mature trees (Gilman, 2011). Accordingly, all mature trees within 10m away from both sides of each belt transect were identified, enumerated and measured for dbh. It, therefore, translated to an area of 20,000m^2 assessed around each belt transect, and gross total are of 60,000m^2 (6ha) enumerated for mature trees. Forty (40) 5m x 5m quadrats were randomly alternately laid on both sides of each belt transect, and subsequently enumerated for regeneration (<20cm dbh young trees) (Dike et al., 1997). Thus, a total area of 3,000m^2 (0.3ha) was enumerated for regeneration.

Data Analysis

The population density of mature individual tree species per hectare was determined from the population in the whole sampled area of 6ha. The population density of regeneration of each species in the total sampled area of 0.3ha was computed and extrapolated to density per hectare. The stem diameter distribution was analysed using descriptive statistics by classifying the stem diameters of all the trees into nine (9) classes as follows: 20-29cm (class 1), 30-39cm (class 2), 40-49cm (class 3), 50 – 59cm (class 4), 60 – 69cm (class 5), 70 – 79cm (class 6), 80-89cm (class 7), 90-99cm (class 8) and 100cm (class 9).

All the species virtually need similar microclimate within the rainforest for regeneration and growth, which imply competition among all the sibblings for survival (Dike, 1992; Akpan-Ebe, 2005; Agyeman, 2013). Accordingly, the natural regeneration potential index of each species was determined as follows:

$$R_p = \frac{t_i}{t_n}$$

Where,

R_p = Regeneration potential index

T_i = Population of regeneration of species i

T_n = Population of regeneration of all the species

Results

Twenty-two (22) species were encountered both at mature tree and regeneration categories (Table 1). The highest population density of 44 per/ha of mature trees was recorded for *Berlinia grandiflora*, while the mature individuals of *Calpocalyx brevibracteatus* and *Lonchocarpus laxiflorus* were not encountered (Table 1). The highest regeneration population density of 418 per/ha was obtained by *Berlinia confuse*, while the regeneration of *Albizia adianthifolia*, *Berlinia confuse* and *Brachystegia eurycoma* were not encountered (Table 1). The highest regeneration potential index of 3.39 was computed for *Berlinia confuse* (Table 3). Only *Baphia nitida*, *Berlinia confuse* and *Brachystegia kennedyi* were capable of sufficient natural regeneration (Table 3). All the species were mostly of small stem diameters of 20 – 49cm (Table 2). On the whole, stem diameter class 2 (30 – 39cm) had the highest tree frequency of 117, while class 8 (90 – 90cm) had the lowest of 11 (Fig. 1).

Table 1: Population Density of Mature Trees and Regeneration of Species in Fabaceae Family in Oban Forest Reserve, Cross River State, Nigeria

S/N	Species	Mean population of mature stand (per/ha)	Population of regeneration (per/ha)
1.	*Afzelia africana*	3	22
2.	*Albizia adianthofolia*	0.17	Xx
3.	*Albizia zygia*	1	27
4.	*Amphima pterocarpoide*	2	20
5.	*Baphia nitida*	5	160
6.	*Barlinia confuse*	8	418
7.	*Berlinia congolensis*	1	xx
8.	*Berlinia grandiflora*	44	12
9.	*Brachystegia eurycoma*	5	xx
10.	*Brachystegia kennedyi*	4	157
11.	*Brachystegia nigerica*	0.17	xx
12.	*Calpocalyx brevibracteatus*	x	25
13.	*Cylicodiscus gabunensis*	1	10
14.	*Distemonanthus benthamianus*	2	28
15.	*Erythrophelum ivorensis*	2	7
16.	*Gossweilerodendron balsamiforum*	1	10
17.	*Hylodendran gabunense*	1	10
18.	*Lonchocarpus laxiflorus*	xx	12
19.	*Parkia bicolor*	1	15
20.	*Pentaclethra macrophylla*	2	43
21.	*Piptademastrum africanum*	2	45
22.	*Pterocarpus osun*	2	50

x Mature stand not encountered
xx Regeneration not encountered

Table 2: Stem-diameter frequency distribution of tree species in Fabaceae family in Oban Forest Reserve, Cross River State, Nigeria.

Species	Diameter Classes									Total
	1	2	3	4	5	6	7	8	9	
Afzelia africana	4	2	3	1	2	1	2	1	1	17
Albizia adianthifolia				1						1
Albizia zygia	2	1								3
Amphimas pterocapoides	4	3					2		1	10
Baphia nitida	9	9	8	2						28
Berlinia confuse	10	13	10	5	4	2		1		45
Berlinia congolensis	3	1								4
Berlinia grandiflora	53	63	55	34	12	12	9	7	23	268
Brachystegia eurycoma	4	5	7	5	3	4			3	31
Brachystegia kennedyi	5	4	9	1		1	1	2		23
Brachystegia nigerica		1								1
Calpocalyx brevibracteatus										0
Cylicodiscus gabunensis	1		1	5						7
Distemonanthus benthamianus	2	3	3	1	1	1				11
Erythrophyleum ivorensis			3		1				6	10
Gossweilerodendron balsamiferum		1					1		1	3
Hylodendron gabunense	1	1	1		1					4
Lonchocarpus laxiflorus										0
Parkia bicolor		2	3		1	1				7
Pentaclethra macrophylla	2	6	4	1						13
Piptadeniastrum africanum	6		3		3				1	13
Pterocarpus osun	2	2	3	1		1			2	11

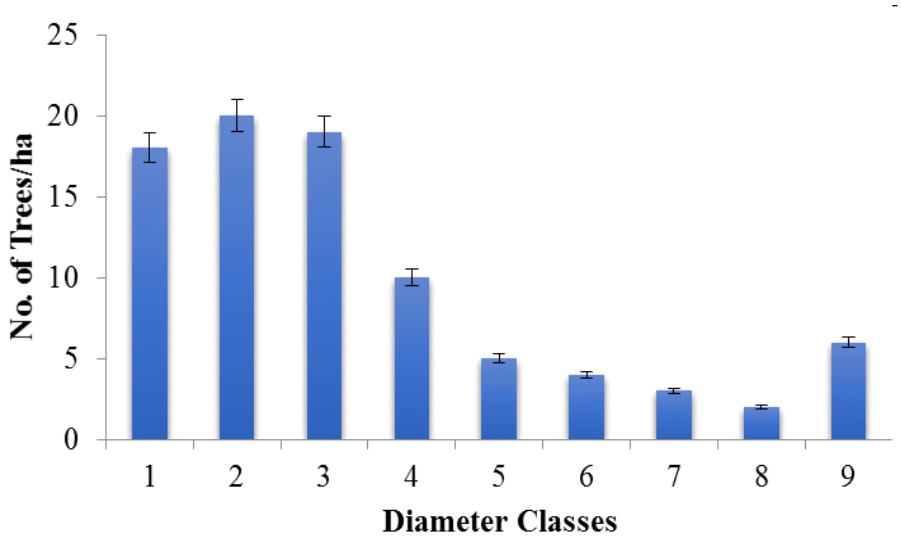

Figure 1: Diameter distribution of trees/ha of all the tree species in Fabaceae family in Oban Forest Reserve, Cross River State, Nigeria.

Table 3: Regeneration potential indices of trees in fabaceae family in Oban Forest Reserve, Cross River State, Nigeria

S/N	Species	Regeneration Index
1.	*Afzelia africana*	0.021
2.	*Albizia adianthofolia*	0.00
3.	*Albizia zygia*	0.025
4.	*Amphima pterocarpoide*	0.019
5.	*Baphia nitida*	0.149*
6.	*Berlinia confuse*	0.39*
7.	*Berlinia congolensis*	0.00
8.	*Berlinia grandiflora*	0.011
9.	*Brachystegia eurycoma*	0.00
10.	*Brachystegia kennedy*	0.147*
11.	*Brachystegia nigerica*	0.00
12.	*Calpocalyx brevibracteatus*	0.023
13.	*Cylicodiscus gabunensis*	0.009
14.	*Distemonanthus benthamianus*	0.026
15.	*Erythrophelum ivorensis*	0.007
16.	*Gossweilerodendron balsamiforum*	0.009
17.	*Hylodendran gabunense*	0.09
18.	*Lonchocarpus laxiflorus*	0.011
19.	*Parkia bicolor*	0.014
20.	*Pentaclethra macrophylla*	0.04
21.	*Piptademastrum africanum*	0.042
22.	*Pterocarpus osun*	0.047

*Capable of sufficient natural regeneration.

Discussion

The majority of the tree species are fast becoming rare in the study forest as indicated by their population per/ha which is less than 10. It has been suggested that any tree species in the tropical rainforest ecosystem with a population per/ha less than 10 individuals is deemed rare (Parthasarathy and Karthikayan, 1997; Nath et al., 2005; Newin, 2014). The rarity status of most of the tree species can be attributed to their over-exploitation for timber. Similar observations on many commercial timber tree species occasioned by over-logging in many tracts of tropical rainforest had earlier been made (Agyeman, 2013; Newin, 2014; Betti et al., 2016; Annah and Olajide, 2016). The prevalence of the trees of small stem diameters (20 – 49cm) is indicative of the fact that the forest reserve is a secondary rainforest. In other words, the prevalence of small diameter trees can be attributed to verse exploitation of big-sized trees. Similar high prevalence of small-diameter trees including members of Fabaceae family, in some other disturbed rainforest reserves had been observed (Agyeman, 2013; Newin, 2014;

Onyekwelu et al., 2019). Aside Baphia nitida, Berlinia confuse and Brachystegia kennedyi that showed capable of sufficient natural regeneration potentials, all other species are not capable of adequate natural regeneration, because a tree species with regeneration potential index less than 0.10 is indicative of unsustainable natural regeneration (Parthasarathy and Kaythikeyan, 1997; Nath et al., 2005). The unsustainable natural regeneration of most of the species can be ascribed to the felling of many of their mothers' trees (seed bearing trees) in the course of timber harvesting. Also, the dearth of seeds of some of the species to bring about their regeneration might not be unconnected with the collection of the seeds of some species for food by human and consumption by wild animals, examples of such seeds are that of Brachystegia eurycoma, Barchystegia nigerica and Pentaclethra macrophylla, which are widely consumed food items in the rainforest region of Nigeria (Olajide et al., 2008; Udo et al., 2009; Olajide et al., 2015; Olajide and Etigale, 2017).

Conclusion

Consequent upon the prevalence of the small-diameter individuals of most of the tree species, timber exploitation should be restricted to the few species that have big-sized or big-diameters trees. Enrichment planting of the forest with the sturdy seedlings of the species, particularly those incapable of sustainable natural regeneration, to forestall their extinction from the forest reserve and enhance the timber richness of the forest reserve.

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