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RESEARCH ARTICLE

YIELD AND REGENERATION POTENTIAL OF TROPICAL RAINFOREST ECOSYSTEM IN ONDO AND EKITI STATES, NIGERIA

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ABSTRACT

Tree yield and regeneration potential were investigated in natural forest ecosystem in the southwestern region of Nigeria. Three forest reserves were selected for data collection. The three forest reserves are Akure Forest Reserve in Akure South Local Government Area, Eda Forest Reserve in Ekiti State and Idanre Forest Reserve in Idanre Local Government Area of Ondo State. Four equal size (25 × 25m) sample plots were centrally located in each of the selected forest reserves by adopting systematic line transect method. All trees with Dbh greater than or equal to 10cm encountered in each of the plots were identified. Quadrants of 5 × 5m size were laid inside the 25 × 25m plots that were laid. Akure forest reserve had the highest volume per hectare (172.96m^3), this was followed by Eda forest reserve (136.52m^3) and Idanre forest reserve (111.88m^3). Idanre forest had the highest regeneration potential (2.49%), followed by Akure forest reserve (2.38%) then Eda forest reserve (1.56%). A Regeneration potential of 2.14 was obtained when the forest were pooled together. It was concluded that the forest should continued to be managed and preserved from biotic and abiotic factors that could hinder regeneration in the natural forest ecosystem. This will help conserve biodiversity and provide all the other services required in perpetuity.

INTRODUCTION

The regeneration potential of a species or species group is the capacity of its various sources of reproduction to capture new growing space when it becomes available. At any given time the regeneration potential of a stand depends on the presence of one or more sources of reproduction, including sources arising from seed (either from the current seed crop or seeds stored in the forest floor) or advanced reproduction (seedlings, seedling-sprouts, root suckers, and stump sprouts (Nyland, 1996). It is possible to predict the regenerative potential of many species before harvesting a particular stand, based upon their occurrence either as advance-growth seedlings of sufficient size and vigor, or as overstory trees that will produce stump sprouts after cutting. The conditions required for the initial establishment and early growth of the desired species largely determine what regeneration method should be used (Boyer, 1979). According to Parthasarathy and Karthikeyan (1997), a species with less than ten individual per hectare is considered as a rare and endangered species. However, it is possible that the adult individual or regeneration of these species were present in the area but did fall in any of the sample plots. A tree species with less than 1.0 regeneration potential index is doomed as a rare species (Parthasarathy and Karthikeyan, 1997; FORMECU, 1999).

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They have very low potentialities to perpetuate or maintain their populations in that community. Their continued existence in that community is therefore threatened because of their low natural abilities to replace their adult populations in that community. Species with regeneration potential index of zero (0.00) are considered most threatened. Forest inventory data, silvicultural treatments and further population inventories is necessary to ensure adequate regeneration before logging begins. Loftis (1989) attributes successful regeneration of hardwoods to initial floristic composition and vital ecological attributes. Successful regeneration and reforestation depends on the accurate evaluation of site conditions created by harvesting, e.g. the success of natural regeneration by commercial tree species is strongly influenced by the intensity of harvesting. Specific forest resources information on wood volumes and growth is needed at the forest management unit level in order to determine sustainable yields of wood production. When creating a forest plantation, steps should be taken to improve the speed and efficiency of native forest regeneration. Information for economic appraisal and stand treatment like choice of species or spacing can equally be obtained from volume equation and biomass equation.

METHODOLOGY

Study Area: This study was carried out in Akure, Idanre and Eda forest reserve. Akure and Idanre forest reserves are located in Ondo state while Eda forest reserve is under the management of the Department of Forestry, Ekiti State, Nigeria.

The three forest reserves are located in the Southwest of Nigeria. The tropical climate is marked by dry and rainy seasons. Akure and Eda forest reserves are gentle undulating while Idanre forest reserve is sloping. Akure forest reserve is well drained when compared with Eda and Idanre forest reserves due to the presence of Owena river, which flows North to South across the forest reserve into Atlantic ocean about 160km away.

Data collection: Systematic sampling design (systematic line transect) was employed for the laying of plots. Transect was laid in each of the study sites. Sample plot of 25 X 25m in size was laid in alternate along each transect at 300m interval and thus summing up to 4 sample plots per 1000m transect. All living trees with Dbh ≥10cm were identified and their DBH were measured in every plot. All computed values were extrapolated for a hectare. Sample plot of 5m × 5m were laid inside 25m × 25m plot size at the edge and all living trees with DBH ≤10cm (juvenile or regeneration species) were identified and their DBH were measured in every plot.

Tree growth Variables: The diameter at the breast height (DBH), diameter at the top (Dt), diameter at the middle (Dm) diameter at the base (Db) and the total height of the trees were measured to estimate the basal area and volume per hectare.

Data Analysis

Basal Area Calculation: The basal area of all trees in the sample plots in the three study sites was calculated using the formula:

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

Where BA = Basal area (m^2), D = Diameter at breast height (cm) and π = Pie (3.142).

Volume Estimation: The volume of individual trees was estimated using Newton's equation developed for trees volume estimation in the rainforests ecosystem.

$$V = \pi D^2_b + 4\pi D^2_m + \pi D^2_t \text{....................................} (2)$$

Where V = Volume of tree (m^3), H = Height, D^2b = Diameter at the base, D^2m = Diameter at the middle, D^2t = Diameter at the top, Π = Pie (3.142)

Regeneration Potential: Trees were categorized into adult (DBH > 10cm) and juvenile (DBH < 10cm). The total number of juvenile trees (regeneration) of each species in the sample was extrapolated using equation bellow to obtain the regeneration of each species per hectare.

$$R = H/A \times N \text{ - - - - -......- ..} (3)$$

Where;

R = the regeneration of each species per hectare
H = One hectare (10,000m^2) of the forest
N = Number of juvenile trees of each species that will be represented in the sample
A = the total area to be sampled for the juvenile trees (25m^2).

The number of adult trees of each species per hectare was estimated by dividing the total number of each species enumerated in all the sample plots by 4.

$$AN = TN/4 \text{ -} (4)$$

Where;

AN = Average number of adult trees of each species per hectare.

TN = the total number of adult trees of each species in the sample.

The regeneration potential index

The regeneration potential index of each species was estimated with the formula:

$$Rp = n_i / N \times r_i \text{ -} (5)$$

Where;

Rp = Natural regeneration potential index.
n_i = Number of adult individuals of species I per hectare.
r_i = Number of regeneration or juvenile of species I per hectare.
N = Total number of all adult trees.

The summary of tree growth variables of understory is presented in table 1. The highest mean Dbh was obtained in Eda forest reserve (7.30cm) while the highest mean height obtained was in Akure forest reserve (7.019m). Eda forest reserve had a basal area of 1.51 m^2 and this was the highest value recorded in the three forest reserves while the lowest (0.85 m^2) was obtained in Idanre forest reserve. Eda forest had the highest volume per hectare (24.28m^3) and the lowest was recorded in Idanre Forest Reserve (12.36m^3). The regeneration potential of trees in the forest reserves are presented in table 2, the highest regeneration potential of 2.49 was obtained in Idanre forest reserve, followed by 2.38 in Akure forest reserve and 1.56 in Eda forest reserve. When all the forest reserves were pooled, a regeneration potential of 2.14 was observed. Analysis of variance table for test of significance in stand growth variables is presented in table 3. There was significant difference ($P<0.05$) in the mean height but no significant difference ($P>0.05$) was observed in basal area, volumes and the regeneration potential of the tree growth variables.\

DISCUSSION

Species with little regeneration per hectare, but no adult individual were *Baphia nitida, Carpolobia lubia, Cola hispidia, Diospyrous chrasliflora, Ficus exasperate, Mallotus subulatus, and Quassia undulate.* This scarcity representation of some tree species in this study is typical of the tropical rainforest ecosystem as stated by Nwoboshi (1982) and Etukudo (2000).In terms of sustainable forest management, the natural regeneration of Idanre forest reserve with its high regeneration potential indices, offers enough potential to support sustained yield harvest without any need for artificial intervention. Artificial regeneration is useful where natural seedlings of the desired species are absent and difficult to obtain or where their performance is poor and unreliable, and there is need to correct any imbalance between regeneration and exploitation (Nwoboshi, 1982).

Table 1. Summary of Tree Growth Variables of Understory for the Selected Communities

	No of stem	Mean DBH(cm)	Mean Height(m)	BA/ha (m^2)	Vol./ha (m^3)
AKURE	22	6.79	7.02	4.44	16.84
EDA	13	7.30	6.80	6.04	24.28m^3
IDANRE	18	4.82	4.70	3.40	12.36m^3

Table 2. Summary of the Regeneration Potential for the Selected Communities

	Akure FR	Eda FR	Idanre FR	Total	Mean
No of spp	172.96m3	136.52m3	111.88m3	421.36	140.45
No/sample plot	117	125	81	323	108
No/ha	468	500	324	1292	431
No of Family	19	15	11	45	15
Mean Dbh (cm)	28.55	26.67	31.33	86.56	28.85
Mean height (m)	17.73	13.56	15.48	46.77	15.59
Basal Area/ha (m^2)	9.32	8.28	8.12	25.72	8.57
Volume/ha (m^3)	43.28	34.88	27.97	106.13	35.38
Regeneration Potential %	2.38	1.56	2.49	6.42	2.14

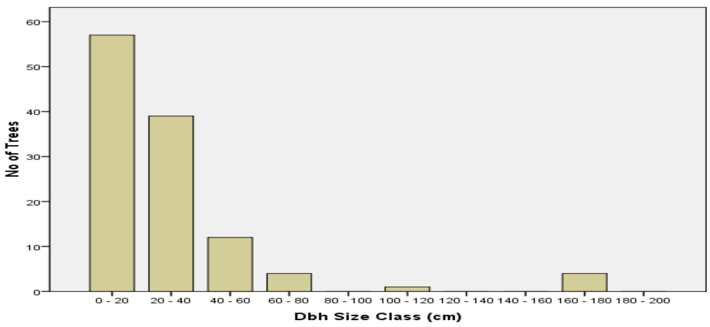
FR-Forest Reserve

Table 3.ANOVA table for test of Significance in Stand Growth Variable

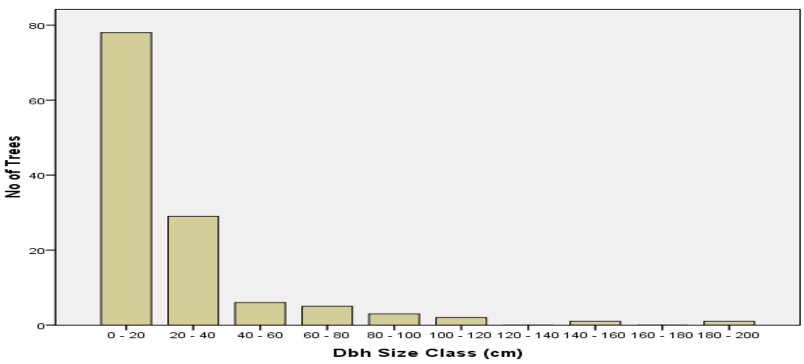
Variables		SS	Df	MS	F	Sig.
Mean DBH(cm)	Forest reserve	44.006	2	22.003	.841	.463ns
	treatment	235.471	9	26.163		
	Total	279.477	11			
Basal area(m^2)	Forest reserve	.214	2	.107	.152	.861ns
	treatment	6.319	9	.702		
	Total	6.534	11			
Mean height(m)	Forest reserve	34.726	2	17.363	14.946	.001*
	treatment	10.456	9	1.162		
	Total	45.182	11			
Volume(m^3)	Forest reserve	469.939	2	234.969	1.038	.393 ns
	treatment	2037.239	9	226.360		
	Total	2507.178	11			
Regeneration potential	Forest reserve	2.052	2	1.026	3.231	.088 ns
	treatment	2.858	9	.318		
	Total	4.911	11			

**-significant ns-non significant*

(a)Akure forest reserve



(b)Eda Forest Reserve



(c)Idanre Forest Reserve

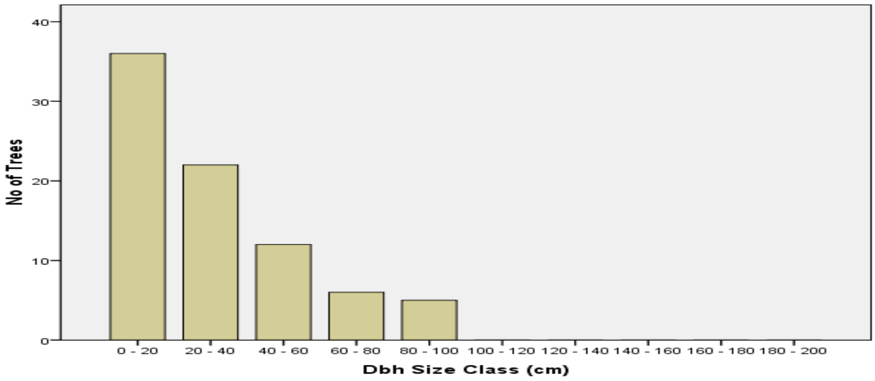


Figure 1(a-c). Diameter distribution of tree species in selected forest reserves in the south west Nigeria

On the other hand, both Akure and Eda forest reserves also offer enough potential to support sustained yield harvest. Iyagin and Adekunle (2017) asserted that the inverted J-curve, where the abundance decreases with increasing diameter, is an indication of good regeneration of the constituent species. The conformity of the population structure of trees in all the selected communities' forest with this reverse J-shaped structure as shown in figure 3 (a-c) clearly reflects the potential of these communities' forest to regenerate over a space of time. Although there was no sign of any recent exploitation of timber in Akure and Eda forest reserves, the scanty representation and low regeneration potentials of some tree species in the area which have non-timber values could be attributed to their over exploitation for non-timber uses.

Conclusion and Recommendation

This study investigated the yields and regeneration potential of tree species in some selected forest reserves in southwest, Nigeria. Results showed that Akure forest reserve had the highest number of families while the lowest was observed in Idanre forest reserve. Evidently, Idanre forest reserve has been under intense human disturbances. Most of the tree species in Akure forest reserve and Eda forest reserve are distributed in the highest diameter size class and the percentage of the merchantable trees ready for sawn-timber harvest are very high. Forest should be managed and preserved from biotic and abiotic factors that could hinder regeneration in the natural forest ecosystem. This will help to conserve biodiversity and provide all the other services required in perpetuity.

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