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Research Paper

Tree species composition and regeneration potential of Onigambari Forest Reserve, Oyo State

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Natural regeneration status and other related parameters, such as stem densities of woody plant and size-class distribution of high forest species were studied in Onigambari forest reserve Oyo state. Data were collected along the Point Centre Quadrants (PCQ) of the plot-less method of Cortam and Curtis (1956) 10 m apart. At each PCQ along the transect, the points were divided into four quadrants where wildlings were enumerated to species levels, the nearest woody plant in each quadrant was measured for girth at breast height for the calculation of size-classes, while the distance of the plant to the centre point was recorded for calculations of stem densities. The high forest was found to be dominated by members of the families of Apocynaceae, Papilionidaceae, Euphorbiaceae, Rubiaceae, Meliaceae and Sterculiaceae. The regeneration potential of this area was poor, dominated by *Angylocalyx oligophllus*, *Sphenocentrum jollyanum*, *Psychotria spp*, *Strombosia pustulata*. Therefore, there is need to apply Sivilcultural treatment that will enhance growth and survival of both dominant and rare species.

Key words: Regeneration potential, Onigambari, Point Centre Quadrants (PCQ), trees species.

INTRODUCTION

Tropical rain forest

Tropical forests are often referred to as one of the most species diverse terrestrial ecosystems, and generate a variety of natural resources to help sustain the livelihood of local communities (Nirmal *et al.*, 2011).Trees form the major structural and functional basis of tropical forest ecosystems and can serve as robust indicators of changes and stresses at the landscape scale. In terms of tree composition and species diversity, tropical rain forests are Earth‟s most complex ecosystems (Humphrey, 2015). Trees are often the most conspicuous plant life form in a typical tropical rainforest. The rainforest act as main repository of the genetic diversity of both flora and fauna.

Nigerian land, which covers a total area of 92.4 million hectares, has 9.7 million hectares, about 10% of the country, as forest reserves. Out of which, only a small part of this forest is lowland rainforest. Even in the late 1990s it was estimated that only 1.19 million hectares of lowland rainforest remained in the country, and about 288 000 hectares of which was in official forest reserves

(ITTO, 2011).The degradation, fragmentation and conversion of the forests to other forms of land uses in Nigeria, are currently progressing at alarming rates. Between 1990 and 2000, Nigeria lost about 2.7% of its natural forests to deforestation which increased to about 18.56% (about 2.06 million ha) between 2000 and 2010 (Humphrey, 2015). A cumulative 47.5% of Nigeria's natural forests were lost to deforestation between 1990 and 2010 (FRA, 2010).

There are growing concerns for developing new global, regional and national programmes for conserving and managing forest biodiversity (Aigbe *et al.,* 2014). Species diversity and stand density measures have been widely used as indicators of ecosystem status, and they play critical roles in studies dealing with the assessment of human impact on ecological systems (Aigbe *et al.,* 2014). Knowledge of stand density in forest management is an essential apparatus to check crowdedness and competition of trees in a forest stand. The need to provide adequate quantitative and qualitative ecological data to guide forest owners and managers in fashioning out realistic and effective management strategies is imperative.

Species composition

Early ecological studies in Nigeria rain forest described the forest structure, species composition an aspect of the forest functioning in relation to site factors on several forest reserves of southern Nigeria (Hopkin, 1966). These studies were mostly non respective over several years and little knowledge available with regard to the behaviour of the individual tree species in the studied plot with the passage of time. The Silvicultural treatment called tropical shelter wood system (TSS) given to the most forest in Nigeria between 1950 and 1960, coupled with massive exploitation during this period had major effect on the structure of Nigeria rainforest (Oguntala, 1981).

Generally, competition is intense among the tree in the forest that only a small proportion of pole- size seedling under the shade actually grow into big trees. These are some of the problem which led to gradual change in Nigeria's forestry policy and the trend towards growing trees in commercial plantation. The dynamic nature of the forest canopies provides many different regeneration niches to which different species have become specialized. There are two contrasting ecological species groups. These are climate species and pioneer species. The key features are that climate species can germinate or establish seedling below a canopy whereas, pioneer species required full light. In all tropical rainforest, there are fewer pioneers than climate species and they mostly belong to few families, for trees, Euphorbiaceae, Malvaceae and Urticeae (Whitmore, 1998). The purpose of this work therefore is to provides baseline and impact data on species composition and regeneration potential in Onigambari Forest Reserve, Nigeria.

METHODOLOGY

Onigambari forest reserve

The Onigambari Forest Reserve was declared from Ibadan Forest Reserve by a resolution of the Ibadan city council passed in September 1899 (Ajibode, 2002). A month later, the Mamu portion was added and to the government by deed of gift. Both sections were consolidated to form Gambari Forest Reserve 1953 making a total area of 125.62 km^2 (Ajibode, 2002). Hence tree like Teak (*Tectonia grandis*), Mahogany (*Khaya ivorences*), and other Agricultural crops like Cocoa (*Theobroma cacao*), Cassava (*Manihot esculata*) with exotic trees and crops are cultivated. The inhabitants of the area are predominantly farmers with relatively low number of hunters. Some of the forestry practice includes.

(i) Planting of trees for both timber and fuel wood production.

(ii) Collection and sales of non-wood products such as leaves and bark for herbs, rattan (cane) etc.

The noticeable surrounding areas are Idi Ayunre, Adebayo, Ibusogboro and Mamu. These areas are along the same equatorial belt with the study area. Onigambari area which was bounded up with the following villages; Aba-Igbagbo, gbale-asun, Ajibodu, Lagunju, Akintola, Okeseyi, Akinogbun, Amosun, Olonde ige, Olaya, Onipede. The distance between these areas is about 200 m to 500 m and altitude if 147 m depends on the undulating nature of the areas with a total number of people of 600 as at 1996 (Salawu,2002). Gambari Forest Reserve is located between latitude 7° 26N and longitude 3°54E. The plot lies within Onigambari Forest Reserve about 17 km South-east of Ibadan on the Idi-Ayunre-Ijebu-Ode road, Oyo state. It was laid about 2 km away from the nearest road well obscured by some forest fallows in the neighborhood.

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Location

Onigambari Forest Reserve is located between latitude $7°26^1$N and longitude $3°5^1$E. The plot lies within Gambari Forest Reserve about 17k m south-east of Ibadan on the Idi-Ayunre-Ijebu-Ode road, Oyo State. It was laid about 2k m away from the nearest road well obscured by some forest fallows in the neighbourhood (Figure 1).

Biotic Factors

Although evidence of past human influence is scanty, the

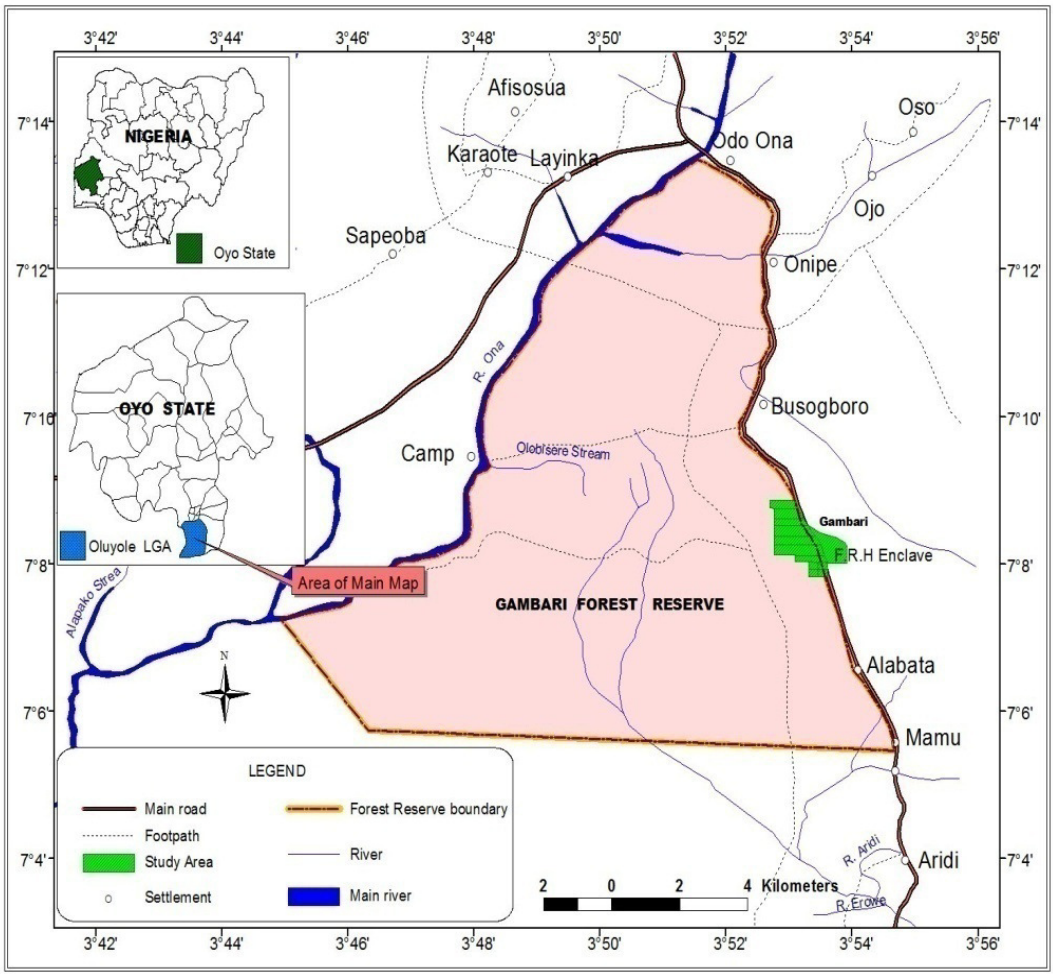

Figure 1. The map of Onigambari Forest Reserve.

presence of a few trees of *Elaeis guineensis* (palm) in the plot suggests that the forest was not a virgin forest, possibly a regrowth of a long abandoned farmland. It is also possible the plot must have been exploited long before. The plot was however the most relatively undisturbed forest in the reserve before it was demarcated a permanent sample plot (Oguntala, 1981). Exploitation and other forms of human disturbance are strictly prohibited in the plot.

Sampling technique

A reconnaissance survey of the reserve was carried out to establish the baseline. Subsequently, transects were cut perpendicular to the baseline. Randomly, five transects 1m x 1m were selected. The transect was pegged at 10 m intervals. Along each transect, important data were collected using Point Centre Quadrant (PCQ) of plot-less sampling method of Cortam and Curtis (1956) at 10 m apart (Figure 2).

Within each sampling quadrant, plant species were identified and listed. Those that could not be immediately identified with certainty were collected and taken for identification in herbarium. Wildlings within 1 m from the centre of quadrant laid to nearest woody tree species were identified and listed for the calculation of regeneration potential. The following parameter were taken from the assessment of nearest woody species-diameter at breast height (about 1.3 above the ground), the distance between the PCQ and tree species, canopy closure and height (Figure 2).

The concept of plot-less sampling overcomes many of the difficulties encountered in vegetation dominated by woody species. For example in forest or scrub vegetation, the establishment of sample stands, large enough to ensure that each contains an adequate number of individual plants for a realistic estimate of a vegetation parameter, becomes a major practical difficulty, particularly if these layers were dominated by brambles (*Rubusfruticosus*) or similar thorny species. There are several methods of plot-less sampling but all

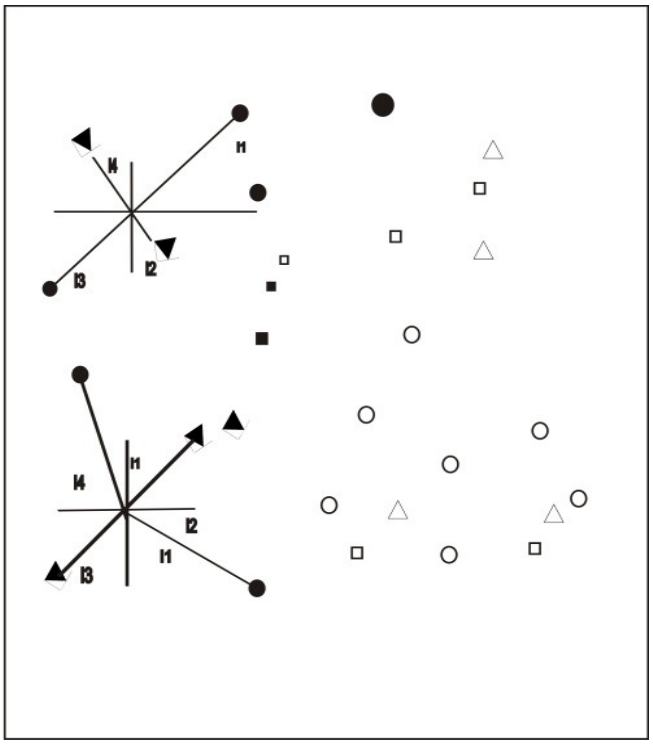

Figure 2. Point-centred Quarter Method (PCQ).

are based on the idea of measuring distance from randomly chosen points in the study area to certain individual plants, usually the nearest

RESULTS

Stem density

The distance measured between sample point (PCQ) and each woody stem was used to obtain the density of woody stem. It is expressed as density (D) = $\frac{100^2}{d^2}$ stem/ha.

Size

The diameter and height of the woody plant in each quarter PCQ was measured at breast height to obtain size class as shown below:

Size-class 1= Plants between 0-10 cm in diameter

Size-class 2 = Plants between 11cm-30 cm in diameter

Size-class 3 = Plants between 31-60 cm in diameter

Size-class 4 = Plants between 61-90 cm in diameter

Size-class 5 = Plants greater than 90 cm in diameter

Wildling

Along each PCQ, wildling of individual species was assessed to get regeneration potential.

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

Relative frequency relative density and Relative Dominance

$$\text{Relative frequency of species} = \frac{\text{frequency of individual species} \times 100}{\text{Total density of all species}}$$

$$\text{Relative Dominance} = \frac{\text{Sum of basal area of individual species} \times 100}{\text{Sum of basal area of all species}}$$

Important value is the sum of relative frequency, density and dominance.

Basal area = $\frac{g^2}{4\pi}$ or $\frac{\pi d^2}{4}$

d = g/π

Where g is girth at breast height
d is a diameter at breast height
π = 3.142, 4 is a constant value.

There were thirty-three (33) families encountered in the sample plot during the study with fourteen (14) families having numbers greater than one (1) species while the rest have less than one (1) (Table 1).

Table 2 shows that out of 55 species encountered in the five transects sampled, 11 species had the highest regeneration potential range between 0.010 – 0.089 and relative frequencies range between 2.46% and 23.15% of the species of wildlings encountered. During the study, one genus came out clearly as abundant. This is *Angylocalyx* with relative frequency of 8.37%. Other abundant species are *Sphenocentrum, Psychotria stromobia and Baphia*. Equally important are species that are relatively low in occurrence. These include *Gnetis ferriginea, Pterocarpus osun, Pycanthus angolonsisi*. The occurrence of some species with high regeneration potential shows that those species are likely to be the future composition trees of the reserve while those that have low regeneration potentials are likely to be rare in the environment.

Table 3 shows the result of relative density, frequency, relative dominance and important value of woody species. Fifteen (15) species had relative density between1.14 to 16.16 and 16 species had relative density less than one (1).

Relative frequency

Six (6) species had relative frequency of five (5) and above and the rest had less than five.

Table 1. Composition of species and families.

Family	No of species	Name of Species	Habits
Acanthaceae	1	*Justicia flava*	Herb
Anacardiaceae	2	*Nothopondia staudtii*	Tree
		Sorindia spp	
Annonaceae	1	*Mondora tenuifolia*	Tree
Apocynaceae	7	*Alstonia booneii*	Tree
		Alafia barterii	
		Baissea axillaris	Climber
		Funtumia elastica	Tree
		Hedranthera barterii	
		Montandria guinensis	
		Tabernaemontana pachysiphon	Tree
Araceae	1	*Culcacia saxatillis*	Climber
Borginaceae	1	*Cordia millentii*	Tree
Caesalpinioideae	1	*Amphimas pterocarpoides*	Tree
Capparaceae	1	*Ritchea spp*	
Celastraceae	2	*Salacia erecta*	Climber
		Salacia pallescens	Climber
Combretaceae	1	*Combretum spp*	Climber
Connaraceae	2	*Agelaea spp*	Woody climber
		Gnetis ferruginea	Shrub
Ebenaceae	1	*Diosyros barterii*	Tree
Euphorbiaceae	5	*Drypetes gilgiana*	Tree
		Euphorbia spp	Herb
		Mallotus oppositifolius	Shrub
		Magarieteria discoides	Tree
		Ricinodendron heudelotic	Tree
Icacinaceae	1	*Icacinia trichantha*	Shrub
Lecythideceae	1	*Napoleona vogelii*	Tree
melastomataceae	1	*Memecylon afzelia*	Tree
Meliaceae	4	*Cedrela odorata*	Tree
		Guerea cedrata	Tree
		Khaya grandifoliola	Tree
		Trichillia prienriana	Shrub
Mensperamaceae	1	*Sphenocentrum jollyanum*	Shrub
Mimosoideae	2	*Albizi ferruguinea*	Tree
		Acacia taxacantha	Climber
Moraceae	3	*Antiaris africana*	Tree
		Treculia africana	Tree
		Trilepsium madagascariensis	`Fig like tree
Myristcaceae	1	*Pycnanthus angolenus*	Tree
Olacaceae	2	*Olaxsubsscorpoides*	Shrub
		Strombasis pustulata	Tree
Palmea	1	*Elaeis guineesis*	Palm
Panaceae	1	*Microdes muspuberula*	Shrub
Papilionoideae	5	*Angylocalyxoligophyllus*	Shrub
		Baphia nitida	Tree
		Baphia puberscens	Tree
		Dalbergia saxatillis	Climber
		Pterocarpus osun	Tree
Polygalaceae	1	*Carpolobia lutea*	Shrub
Rubiaceae	4	*Coffee afzelia*	Shrub
		Oxyanthus spp	Shrub
		Psychotriaspp	Shrub
		Chassalia kolly	Shrub
Rutaceae	1	*Fagara zanto*	
Sapindaceae	3	*Blighia unijugata*	Tree
		Deindollia pinnata	Shrub
		Lecanodiscus cupanioides	Tree
Sterculiaceae	4	*Cola gigantean*	Tree
		Cola millenii	Tree
		Triplichiton scleroxylon	Tree

Table 1. Contd.

		Sterculia rhizopetala	Tree
Ulimaceae	3	*Celtis wightil*	Tree
		Celtis zenkeri	Tree
		Holoptelia grandis	Tree
Tiliaceae	1	*Grewia spp*	Shrub
Violaceae	1	*Rinorea dentata*	Tree
		Lagateria spidetu	

Source: Field Survey, 2015.

Table 2. Regeneration potential and relative frequency of wildlings in the Onigambari Forest Ecosystem.

Species	Wilding No	Relative frequency	Regeneration Potential
Culcacia saxatilis	94	23.15	0.189
Angylocalyx oligophyllus	34	8.37	0.032
Sphencentrum jollyanum	27	6.65	0.026
Psychotria spp	26	6.40	0.025
Strombosia pustulata	24	5.91	0.023
Baphia pustulata	21	5.17	0.020
Microdesmus puberula	17	4.19	0.016
Cola millenii	12	2.96	0.011
Carpolobia lutea	11	2.17	0.010
Funtumia elastic	11	2.17	0.010
Trichilia preuriana	10	2.46	0.010
Alafia barterii	7	1.72	0.007
Coffea afzelia	7	1.72	0.007
Trilepsium madagascanensis	7	1.72	0.007
Tabernaemontana pachysiphon	6	1.48	0.006
Memeculo nafzelia	5	1.23	0.005
Antiaris Africana	5	1.23	0.005
Combretum spp	5	1.23	0.005
Icacinia trichantha	5	1.23	0.005
Montandra guineensis	5	1.23	0.005
Agelae spp	4	0.99	0.004
Baphia pubescens	4	0.99	0.004
Hedranthera barterii	4	0.99	0.004
Justicia flava	4	0.99	0.004
Salacia pallescens	4	0.99	0.004
Alstonia booneii	3	0.74	0.003
Celtis zenkeri	3	0.74	0.003
Cola gigantica	3	0.74	0.003
Drypetes gilgiana	3	0.74	0.003
Mallotu oppositifolius	3	0.74	0.003
Chassalia kolly	2	0.49	0.002
Deinbollia pinnata	2	0.49	0.002
Diosyros barterri	2	0.49	0.002
Napoleona vogellii	2	0.49	0.002
Olax subscorpoides	2	0.49	0.002
Salacia erecta	2	0.49	0.002
Sterculia rhizopetala	2	0.49	0.002
Acacia ataxacantha	1	0.25	0.001
Baissea axillaries	1	0.25	0.001
Blighia unijugata	1	0.25	0.001
Cedrela odorata	1	0.25	0.001
Celtis wightil	1	0.25	0.001
Dalbergia saxatilis	1	0.25	0.001
Euphorbia spp	1	0.25	0.001
Elaeis guineersis	1	0.25	0.001
Gnetis ferruginea	1	0.25	0.001

Table 2. Contd.

Grewia spp	1	0.25	0.001
Lecanodiscus cupanioides	1	0.25	0.001
Mondora tenuifolia	1	0.25	0.001
Oxyanthus angolensis	1	0.25	0.001
Pycnatha angolensis	1	0.25	0.001
Rinoera dentate	1	0.25	0.001
Ritchea spp	1	0.25	0.001
Sorinda spp	1	0.25	0.001
Pterocarpus osun	1	0.25	0.001
Total	406		

Source: Field Survey, 2015.

Table 3. Relative density, frequency and dominance in Onigambari Forest Reserve.

Species	Frequency	Relative Density	Relative frequency	Relative dominance	Important value
Funtumia elastic	13	16.16	16.25	1.04	33.45
Trilepsium madagascariensis	10	12.36	12.50	1.42	26.27
Strombosia pustulata	8	10.46	10.00	0.67	21.13
Cola millenii	5	6.65	6.25	0.72	13.62
Triplochittonscleroxylon	3	3.80	3.75	3.56	11.11
Sterculia rhizopetala	4	1.28	5.00	1.28	11.03
Pycnathus angolensis	4	1.14	5.00	1.14	10.89
Tabernaemontana pachysiphon	3	3.80	3.75	0.76	8.31
Holoptelia grandis	2	2.85	2.50	2.33	7.68
Trichilia prieuriana	2	1.82	2.50	1.82	7.17
Albizia ferruginea	1	0.95	1.25	4.74	6.94
Khaya grandifolia	2	2.85	2.50	0.93	6.28
Lecanodiscu scupanioides	2	2.85	2.50	0.66	6.01
Pterocarpus osun	2	2.85	2.50	0.55	5.90
Celtis zenkeri	2	2.85	2.50	0.55	5.90
Drypetes gilgiana	2	2.85	2.50	0.46	5.81
Amphimaspterocarpoides	1	0.95	1.25	3.22	5.42
Cordia millenii	1	0.95	1.25	2.37	4.57
Alstonia booneii	1	0.95	1.25	1.69	3.89
Lagateria spidetu	1	0.95	1.25	1.69	3.89
Guareacedrela	1	0.95	1.25	1.69	3.89
Margarieteria discoides	1	0.95	1.25	1.52	3.72
Fagara zanto	1	0.95	1.25	1.52	3.72
Ricinodendron leudelotii	1	0.95	1.25	1.52	3.72
Cedrala odorata	1	0.95	1.25	1.35	3.55
Microdesmis puberula	1	0.95	1.25	0.85	3.05
Cola gigantean	1	0.95	1.25	0.73	2.93
Antiaris Africana	1	0.95	1.25	0.51	2.71
Treculia Africana	1	0.95	1.25	0.51	2.71
Napoleinav ogellii	1	0.95	1.25	0.17	2.37
Nothospondia staudtii	1	0.95	1.25	0.17	2.37
Total	80				

Source: Field Survey, 2015.

Table 4. The size class (diameter at breast height) distribution of tree species.

Dbh (cm) class size interval	0-10	11-30	31-60	61-90	>90
No. of trees	25	32	18	5	0

Relative dominance

Seventeen (17) species had relative dominance greater than 1 and 14 had less than 1.

The species that had the highest input value range between 10.89 and 33.45 were (7) species and rest (24) had less than 10. Table 4 and Figure 3 show the classes between 0-10 cm diameter at breast heights (DBH) and between 11 and 30 (DBH) had the highest occurrences of 25 and 32 respectively while species that fall under size

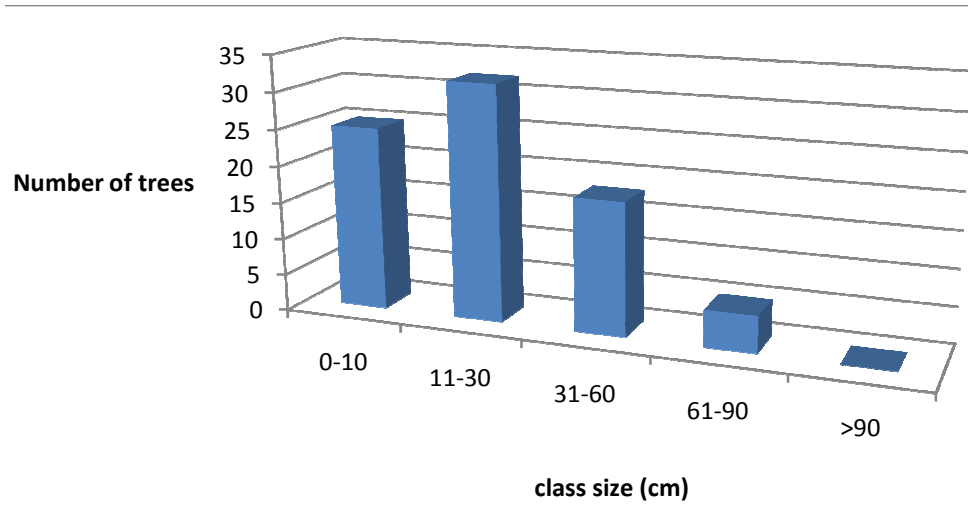

Figure 3. Bar chart showing class sizes distribution of tree species.

class 31-60 and 61-90 cm (DBH) had lesser number 18 and 5 respectively. However, size class 90 and above contain no species.

Discussion

Regeneration Potential

The regeneration potential of the diversified species was found to be poor. About 15 important economic species had regeneration potential of less than 0.002. This is going to have great effect on the conservation of such species. However, the species with high regeneration values were found to be universally distributed. Hence, the prospect of this reserve depends on their proper management. The structure of the forest in term of canopy closure has prime influence on the species composition of regeneration there in. From result, it was observed that canopy closure of an average of 50% had the highest number of wildlings. Although, different species established themselves better on different microsite. These are light demander and shade tolerant. The need for canopy to be silviculturally manipulated in a manner which reduces the site specific stress and the risk of damage, but at the same time, permit the trees to exploit fully the more favourable conditions during an average situation cannot be over stressed.

Floristic composition

From the study, some extent Onigambari is somewhat rich in species diversity. The reserve contains important species, dominated by family Apocynaceae. The dominant families had relatively high regeneration status. In term of size-class distribution (Figure 3), the number of trees recorded in each class was an indication of the reserve developing to climax vegetation. There are only two important species between 2.0 and 2.8 girth sizes. These are *Triplochiton scleroxylon* and *Albizia ferruginea.* Therefore, there is need for proper Silviculture method that would be consistence with nature conservation (Oguntala, 1981).

Classification according economic important of the species

During the study, tree species were classified according to Redhead (1971) classification as follows:

Class I: Species of major timber economic importance:
Cordia millenii, Guarea cedrela, Khaya grandifoliola, Triplochiton sclroxylon

Class II: Species of less timber importance:
Albizia ferruginea Antiaris africana
Holoptellia grandis, Amphimas pterocarpoides
Pterocarpus osun ,Celtis zenkeri
Pycnathus angolensis ,Cola gigantean

Class III: Species of possible timber:
Diospyrus spp
Fagara spp
Alstonia booneeii
Ricinodendron heudelotii

Others are tree species likely to be used for fuel wood, charcoal and industrial uses. It was observed that most of

the tree species in classes' I-III had few or no wildlings on the forest floor although; there are some species that do not regenerate from seedlings. Therefore, there is need for vegetative propagation of some of these species to enhance better regeneration. There are other benefits derivable from the various species encountered. This supports the observation (Adekunle, 2007) that Obanla Natural forest contains seven utility classes instead of eight classes followed by Redhead (1971) and modified by Fomecu (1999).

Conclusion and recommendations

The results of this study provide relevant quantitative data on flora richness of Onigambari. Forest reserve based on plot-less sampling technique for the area to serve the purpose, for which it was established, the regeneration status is very important. Since the regeneration potential of this reserve is poor there is need for Silviculture treatment that will enhance both the development and survival of the species therein. In same vein, the fear of losing endemic species to extinction necessitates adoption of effective conservation technique (In-situ and ex-situ). However, 'precautionary principle' should be applied when adopting ex-situ conservation strategies. This is necessary because the ecological functions of many wild species or population are still only partly known. In addition, the reserve was assumed to be secondary regrowth. Therefore, there is need for more protective measure so that any kind of exploitation is reduced to barest minimum. Also, there are some species that are non-timber forest products. These species are not always spared when clearing operation is being carried out. Therefore, there is need to conserve this undergrowth (because of their medicinal and economic importance) along with the key species.

Furthermore, government should continue to provide and increase the various alternatives available to reduce pressure on the demand for wood products and enrichment planting should be embarked upon by using viable seeds and vegetative parts collected from the parents/mature stands.

AUTHORS` DECLARATION

We declare that this study is an original research by our research team and we agree to publish it in the journal.

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