ECOLOGICAL STATUS OF *AFZELIA AFRICANA* (SM), *BRACHYSTEGIA EURYCOMA* (HARMS), AND *MILICIA EXCELSA* (WELW.) C.C. BERG IN ABIA STATE, NIGERIA.

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ABSTRACT
This study investigated the occurrence, abundance and distribution of three indigenous tree species *(Afzelia africana, Brachystegia eurycoma,* and *Milicia excelsa)* of Abia State, located in the humid tropical forest region of Nigeria. It is a part of project aimed at estimating carbon storage in selected indigenous tree species in the State. The species population were evaluated from data collected by enumeration of the three species within randomly selected 100m x 100m sample plots in two selected forest reserves and two local communities in the three agricultural zones of the State respectively. Data collected were subjected to descriptive statistics of mean, frequencies and percentages using Statistical Packages for Social Sciences (SPSS 17). Although the populations of the species in Abia State are poor, *B. eurycoma* is the most abundant of the three species in the State forest reserves (1.556±0.616 ha^{-1}) and unreserved forests (1.167±0.786 ha^{-1}). It is followed by *M. excelsa* (0.944±0.725 ha^{-1} and 1.111±0.676 ha^{-1} correspondingly) while *A. africana* is the least abundant (0.722±0.669 ha^{-1} and 0.389±0.502 ha^{-1} correspondingly). Map of distribution of the species shows a generally poor species occurrences in the various zones of the State indicating unsustainable forest conservation and management practices. However, *B. eurycoma* is more abundant than *M. excelsa* and *A. africana,* and this may be associated with its popularity and usefulness in the study area as a food condiment. Adoption of community-based forest management strategy and incorporation of carbon storage objectives into forest management policy of the State is recommended.

Key words: Indigenous tree species, abundance, sustainable forest management

INTRODUCTION
Tropical deforestation robs the earth of its biological richness, and undermines long-range ecological security as well as local and global economic potential. Nigeria has one of the highest rate of deforestation in the world (FAO, 2010). At the present high rate of deforestation of natural forest, many Nigerian tree species are in serious danger of extinction (Mbakwe, 1986; Umeh, 1992; Okojie, 1997; Meregini, 2005; Akachuku, 2006; Borokini *et al.*, 2012). Consequently, Nigeria is among countries highly vulnerable to climate change impacts (IPCC, 2007). The effects of global warming have touched all six geo-political zones of the country (Akingbade, 2009) and every sector of the nation's development (FME, 2011). Many States of the Federation experienced severe flood disaster in 2012 which was attributed to global warming and climate change, as predicted (Nzegbule, 2008). In view of the foregoing, the management of the nation's forest has remained a major concern. The problems included lack of adequate knowledge of the ecology and silvicultural requirements of the diverse tree species as well as the narrow objective of forest management. Of the 560 species of trees present in forest reserves in Nigeria for instance, only 60 species are considered commercially important with attention restricted to about 35 of them (Nwoboshi, 1982). Consequently, as many as 58 (10.4%) of the tree species are listed as endangered (FORMECU, 1999; Borokini *et al.*, 2012).

Forests are managed for a variety of objectives including direct extraction of raw material, out-door recreation, conservation, hunting and aesthetics. However, emerging management practices include managing forest lands for biodiversity, carbon storage and air quality enhancement, all of which is intentional for environmental conservation. Indeed, in the context of global change and sustainable development, forest management activities play a key role through mitigation of climate change (IPCC, 2007). It is in the light of the foregoing that data on tree species of any area is essential towards the assessment of their potential for carbon storage and trade under the United Nation's REDD initiative amongst other management objectives.

Species abundance, sometimes referred to as species richness, is an expression of the number of the species in an area. It is the total number of individuals, or biomass, of a species present in a specified area (Okpiliya, 2013). Though it could be simply a measure of the number of species encountered in a sample, it is more usefully expressed as the species per unit area (Spellenberge, 1991). Species abundance in an ecosystem and how abundance changes in time and space are amongst the fundamental concerns of ecology not as an end in itself but as a tool to understand the ecology of population (Okpiliya, 2013). Amongst other things, the analysis of species abundance and other aspects of biodiversity help scientists to figure out what is going on within specific ecosystem. This study is an investigation of the abundance of *Afzelia africana, Brachystegia eurycoma,* and *Milicia excelsa* in Abia State, Nigeria. The species are important for production of high quality timber and other raw materials used by various

industries. They are also used as human medicine, edible fruits (as food condiments and soup thickeners), forage for livestock, and browse plant for wild animals. They also sequester large amounts of carbon in their biomass, reducing atmospheric carbon dioxide (CO_2) and mitigating climate change. Information on their ecology is essential for sustainable management and conservation of species in Abia State and Nigeria.

MATERIALS AND METHOD

Study Area

Abia State, one of the States of the Southeast Geopolitical Zone of Nigeria, is located between longitude 04^{o} 45^{1} and 06^{o} 17^{1} North, and latitude 07^{o} 00^{1} and 08^{o} 10^{1} East, within the lowland rainforest area of Nigeria. It has a land mass of about 5,833.77 square kilometres, with ambient temperature range of between 20^{o}C and 36^{0}C, and characterized by rainy season and dry season (Abia State Government, 2005). The dry dust–laden north easterly winds, which blows across the country brings the dry season (November to March) while the rainy period is from April to October, during which period the moisture–laden South-westerly winds blow, bringing with it the rains (Onyemaobi, 2010; Peter *et al.*, 2017). The State is comprised of 17 local government areas (LGA) and shares boundaries with Imo State on the West, Anambra and Enugu State on the North and North-east directions respectively, the Cross River and Akwa Ibom State in the East and South–east ends, while Rivers State is at the Southern part of the State (Onyemaobi, 2010, Abia State Government, 2005). The 2006 national population census placed the population of Abia State at 2,833,999 people, made up of 1,434,193 males and 1,399,806 females (NBS, 2008). It has a population density of 580 per square km, a growth rate of 2.83%, and a male to female ratio of 49:51 (Abia State Government, 2005).

Agriculture is the major occupation of the people especially in the rural area involving over 70% of the population. Arable crops such as yam, cassava, maize, cocoyam and peas are cultivated in addition to permanent crops like oil palm, coconut, cocoa, rubber and Oranges. The State also boast of a number of industries including the Aba Textile Mills Plc Aba, International Glass Industries Plc (IGI), Golden Guinea Breweries, Umuahia, etc. The industrial activities and impact of Aba (one of the largest city in the State) small-scale artisans has earned it the name, Japan of Africa (Abia State Government, 2005). For ease of agricultural administration, as well as for advancement of scientific research in agriculture and socio-economic development, Abia State is divided into three (3) agricultural/Senatorial Zones of Abia South, Abia Central, and Abia North (Abia State Government, 2005) (Fig. 3.1).

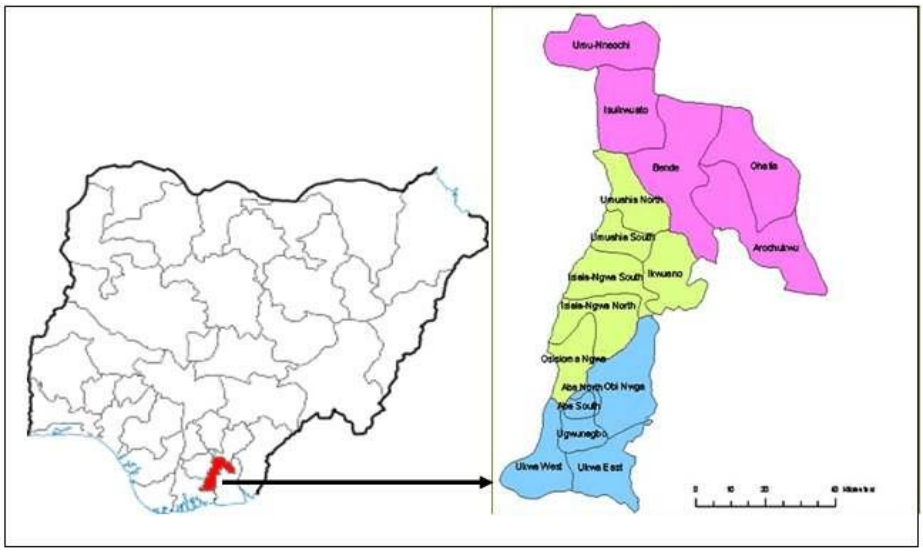

Fig. 3.1 Map showing the location of Abia State in Nigeria and the Three

Ecological survey of the three indigenous tree species in Abia State

Experimental approaches used to assess the abundance of the species and to evaluate people's perception of forest and forest management in the State include quadrat survey and use of structured questionnaire.

Quadrat Survey Approach

This involved field survey in two forest reserves and two communities selected from each agro-ecological zone of the State for the study (Table 3.1) (Fig. 3.2). The communities were selected based on the extent of natural forest cover, following a reconnaissance survey of the sub-zones. Three (3) replicates 100m x 100m sample plots were marked out in each of the two forest reserves and two communities in each of the agro-ecological zones of the State. Saplings and trees of the three tree species (*Brachystegia eurycoma (Achi), Afzelia africana (Akparata), Milicia excelsa (Oji)*) of at least 1.3m height (Nigerian REDD+

Program, 2016) were enumerated and recorded (Plate 3.1 - 3.9).

Table 3.1 Selected Forest Reserves andFree Forest Areas of the Ecological Survey

	Abia South	Abia Central	Abia North
Forest Reserves	1. Obeaku 2. Ohanbele	1. Nkalunta FR 2. Umuahia- Ibeku	1. Ukpom-Bende 2. Acharra-Ihie
Free-Forest Communities	1. Akwete 2. Ikpe(oko-ikpe)	1. Umuosu – Ubakala 2. Itunta	1. Bende 2. Abiah

Data collected from the study were analysed using descriptive statistics of means and frequencies and used in comparing the abundance of the species between the agro-ecological zones of the State. The results were presented using tables and charts.

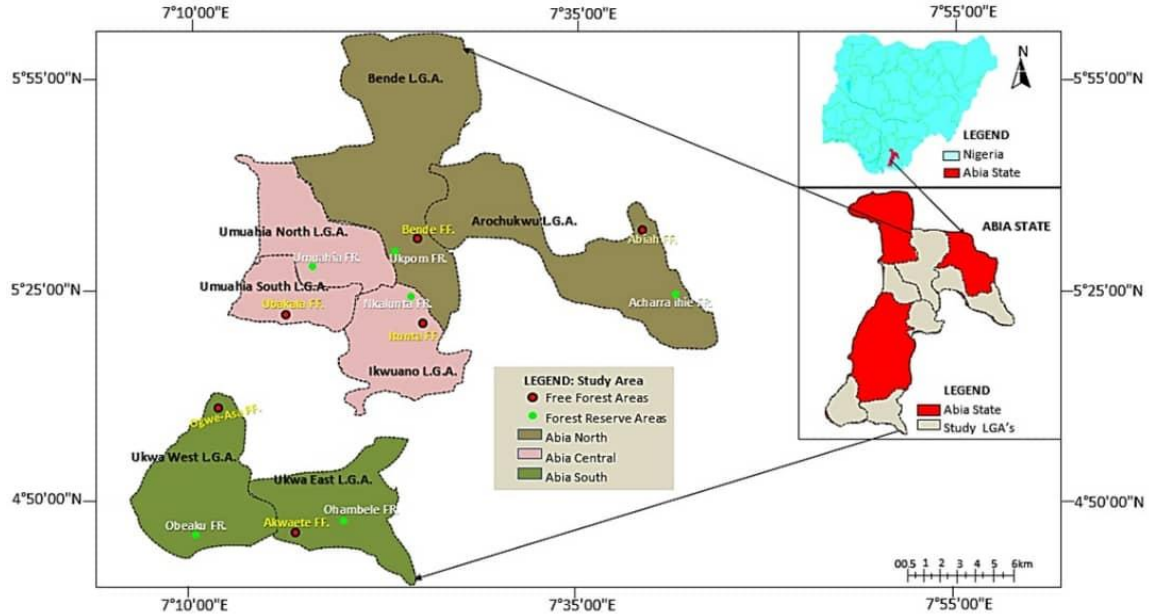

Fig. 3.2Map of Abia State showing selected forest reserves and free forest areas in each agricultural zone.

Plate 3.1 Conducting a survey of *A. africana, B. eurycoma* and *M. excelsa* in Ukpom-Bende Forest Reserve

Plate 3.2Conducting a survey of *A. africana, B. eurycoma* and *M. excelsa* Umuahia-Ibeku Forest Reserve

Plate 3.3Conducting survey of *A. africana, B. eurycoma* and *M. excelsa* at Obeaku Forest Reserve

Plate 3.4 Conducting a survey of *A. africana, B. eurycoma* and *M. excelsa* at Ogwe-Asa Community free forest area

Plate 3.5Conducting a survey of *A. africana, B. eurycoma* and *M. excelsa* at Acharra-Ihie Forest Reserve

Plate 3.6A Standing *Milicia excelsa* at Ubakala free forest area

Plate 3.7 A Standing *B. eurycoma* tree at Umuahia-Ibeku Forest Researve

Plate 3.8A standing *A. africana* tree at Oke-Ikpe Free Forest

Plate 3.9 A standing *M. excelsa* at Itunta Free Forest Area

RESULT AND DISCUSSION

Abundance of *A. africana, B. eurycoma* and *M. excelsa* in Free Forest Areas (ha^{-1})

All three species were present in the three agro-ecological zones of Abia State at varying densities (Fig. 4.1) either naturally regeneration or planted by the people. The finding supports Okunomo and Egwo (2010) that the people of Nigeria have been planting for thousands of years for food, shelter, ceremonial or religious purpose. FAO (2010) stated that more than half (57%) of global forests naturally regenerated and show clearly visible indications of human activity. However, the population of the three species in all three zones of the State is low. Abia South and Abia Central had the least density of *A. african* (0.033 ±0.47ha^{-1}) while Abia North has highest density of *A. africana* (0.50 ±0.50ha^{-1}). Abia central recorded highest density of *B. eurycoma* (1.667±0.817ha^{-1}) and *M. excelsa* (1.50±0.50ha^{-1}) in all three zones followed by Abia North (1.00±b 0.5 ha^{-1}) while least density value of 0.833±753ha^{-1} was recorded in Abia South for the two species. Considering that these species were once reported as abundant in the southern part of Nigeria (Keay, 1989b; Hawthorne and Jongkind, 2006; Amusa, 2011), the findings indicated high rate of deforestation in the State, withno consideration to environmental services such as carbon sequestration provided by the species. The findings disagree with Okunomo and Egho (2010) that adequate emphasis is being given to tree planting due mainly to the climate change being experienced all over the world currently.It corroborated Appiah (2013) who reported that excessive timber exploitation and forest clearance for agriculture have depleted tree populations and that

currently, Iroko occur at less than one tree per ha in Abia State. The lower population of the species in Abia South may be connected with its ecological proximity with the Mangrove swamp in the south of Nigeria since the species are rainforest and savanna species (Keay e*t al*., 1964). It could also be due to unpopularity, poor knowledge and use, of the species in the subzone compared to other subzones.Thus, the findings will support Lillesø *et al.* (2001) who noted that the limited of knowledge of the usefulness of species could be a factor affecting species conservation status in the area. People will modify the forest in favourof those species known as useful to them, and as such,lesser known species may be easily cut down for other land use purposes because of the lack of knowledge of their usefulness. FAO (2010) reported that people have modified the characteristics and species composition of forests for thousands of years to suit their needs, and that more than half (57%) of global forests show clearly visible indications of human activity. Nwoboshi (1982) reported that of the 560 species of trees present in reserves in Nigeria, only 60 species are considered commercially important with attention restricted to about 35 of them. The poor knowledge of the usefulness of the species may have played roles in placing the species in the IUCN (2004) list of endangered tree species. People usually express concerns over excessive exploitation of the well-known commercially important species (Ihenyen *et al*., 2009) but seem to ignore the fact that the under exploitation of the lesser known species due to limited knowledge of their usefulness also expose them to the threat of extinction.

Overall, the least Abundant in the communities of the State is *A. africana*. The result supported findings that the species is not popular amongst residents in the study area as most of the people do not know the plant. It supported reports that poor knowledge of the usefulness of species could be a factor in species conservation, and that one way to protect forest is to value their environmental services (Minang, 2010; FAO, 2010).

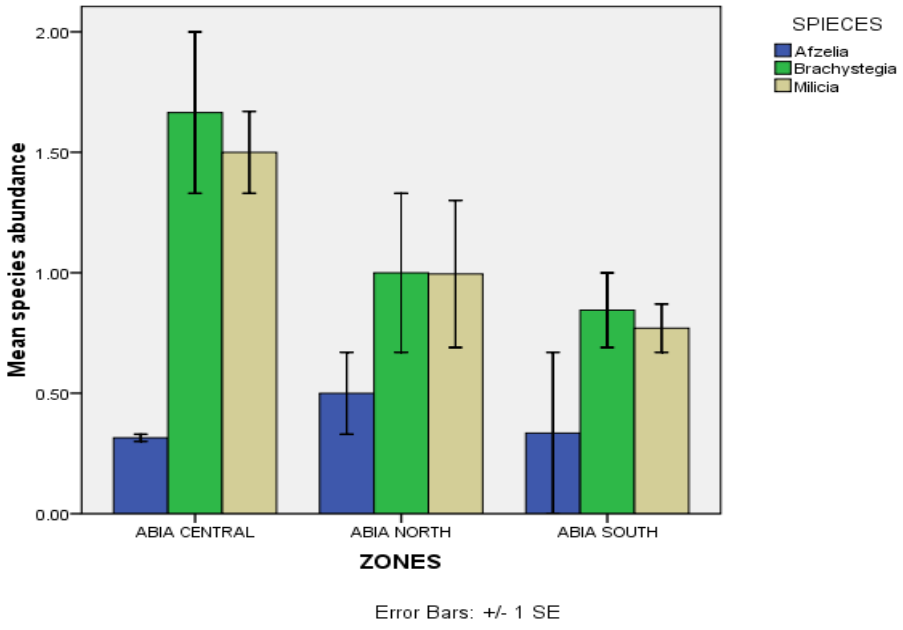

Fig. 1 Abundance of *A. africana, B. eurycoma* and *M. excelsa* in Free Forest Areas (ha^{-1})

Abundance of *A. africana, B. eurycoma* and *M. excelsa* in Forest Reserves (ha^{-1})

The three tree species were present at varying degrees in the forest reserves in all three agro ecological zones of the State (Fig. 4.2). There were more *B. eurycoma* in the forest reserves in all three zones of the State-Abia Central (1.835±0.753 ha^{-1}), Abia North (1.667±0.516ha^{-1}), and Abia South (1.167±0.408ha^{-1}), followed by *M. excelsa* in Abia Central (1.167±0.753ha^{-1}) and Abia North (1.167±0.753ha^{-1}), but by *A. africana* in Abia South (0.833±0.753ha^{-1}). The abundance of the species in the forest reserves in the State is poor considering that species were reported as highly abundant (Keay, 1989a), occurring at 2 to 3 trees per hectare (Nwoboshi, 1982). The findings supported reports of high rate of deforestation in Nigeria (Akachuku, 2006a; Nzegbule, 2008; FAO, 2010; Molinos, 2013), indicating unsustainable forest

management in the State. It agrees with Appiah (2013) that excessive timber exploitation and forest clearance have depleted tree populations. The scarcity of the species in Abia South compared to other zones may be associated with its geographical location at the fring of the Mangrove swamp ecosystem in the south-south zone of Nigeria. This will support Keay*et al*. (1964) that the species are rainforest and savanna species. It could also be that people of Abia South have culturally have less use of the species than people of Abia central and Abia North. Thus, the findings support Kjaer and Nathan (2000)conservation model of enhancing the use of valuable genetic resources, as a means of conserving them.

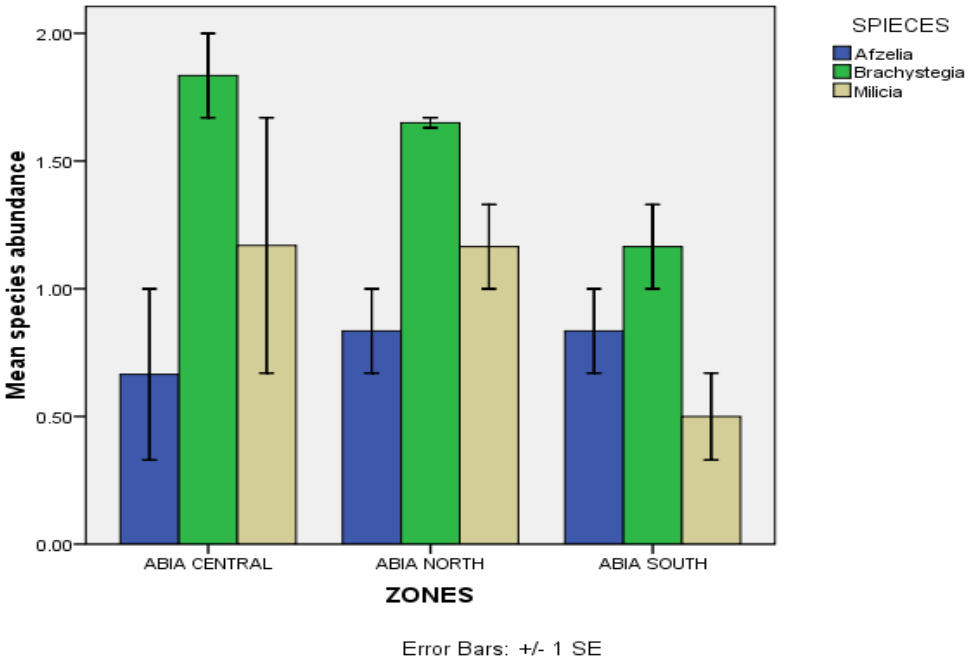

Fig. 2 Abundance of *A. africana, B. eurycoma* and *M. excels* in Forest Reserves (ha^{-1})

Abundance of *A. africana, B. eurycoma* and *M. excelsa* in Forest Reserves and Free Forest Areas (ha^{-1})

Comparison of the abundance of the three indigenous tree species in the forest reserves and free forest of Abia state (Fig. 4.3) shows that there are greater density of *A. africana* and *B. eurycoma* in the forest reserves (0.722±0.669 ha^{-1} and 1.556±0.616 ha^{-1} respectively) than in the free forest areas (0.389±0.502 ha^{-1}and 1.167±0.786ha^{-1} respectively) while the density of *M. excelsa* is higher in the free forest area (1.111±0.676 ha^{-1}) than in the forest reserves (0.944±0.725 ha^{-1}).*B. eurycoma* is the most abundant of the three species in both the forest reserves (1.556±0.616 ha^{-1}) and the free forest (1.167±0.786ha^{-1}) areas of the State while *A. africana* is the least abundant in the reserves (0.722±0.669 ha^{-1}) and the free forest (0.389±0.502ha^{-1}) respectively. The higher abundance of *B. eurycoma* relative to *A. africana* and *M. excelsa* could be attributed to the multiple benefits of the species to the people than the other species. The findings support reports that *B. eurycoma* is widely used traditionally in Eastern Nigeria for several purposes (Oyen, 2012; Igwe and Okwu, 2013). The result corresponded with our observation that *A. africana* is not popular amongst the people of the study area, and that most people do not even know about the use of the species as food condiment.

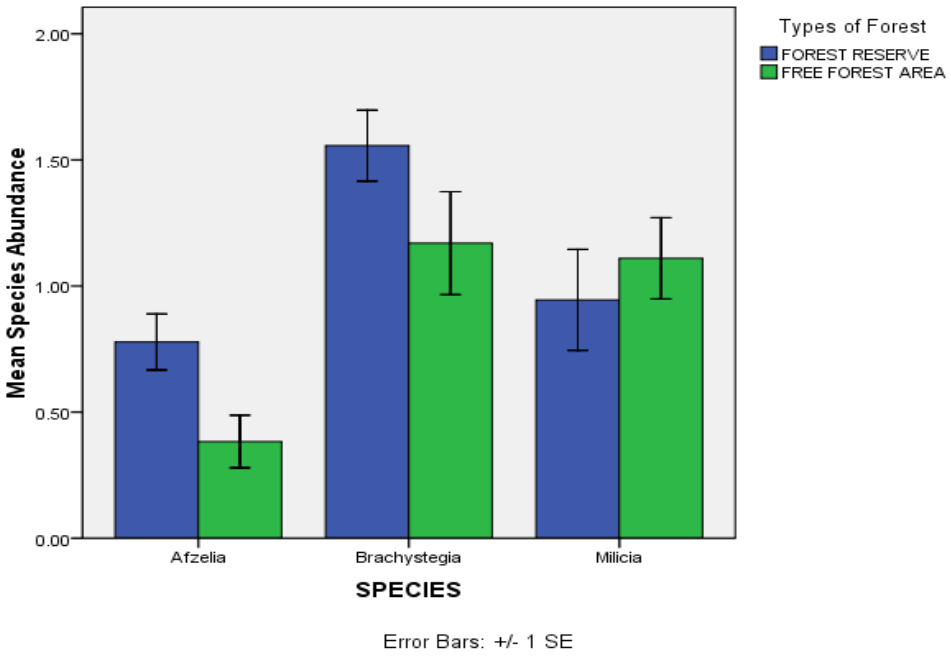

Fig. 4.3 Abundance of *A. africana, B. eurycoma* and *M. excelsa* in Forest Reserves and Free Forest Areas (ha^{-1})

Distribution of *A. africana, B. eurycoma* and *M. excelsa* in Abia State

The map of the distribution of *A. africana, B. eurycoma* and *M. excelsa* in the three agro-ecological zones of the State (Fig. 4.4) shows that *B. eurycoma* is more abundant than the *M. excelsa* and *A. africana* in the ratio of 3:2:1 per hectare in Abia South, 5:4:2 in Abia central and 5:3:2 in Abia North. Based on findings from interviews and discussions in the field discussed earlier, the possible explanation for the poor ecological status of *A. africana* could be the greater cultural value, relevance and usefulness of *B. eurycoma* to the people than *A. africana*. *Milicia excelsa* on the other hand is well known for its usefulness as timber and supplies fodder for lives stock. The findings supported Kjaer and Nathan (2000) who have conceptualized the conservation model of enhancing the use of valuable genetic resources, as a means of conserving them (the 'use it or lose it' model). It also agrees with Lillesø *et al.* (2001) that planting valuable species or seed sources in forest areas or on farmland can both improve access to their products for rural people and raise their conservation status. This suggests that creating awareness of the environmental significance, including their relevance for carbon storage, in the public domain could enhance their value and conservation status.

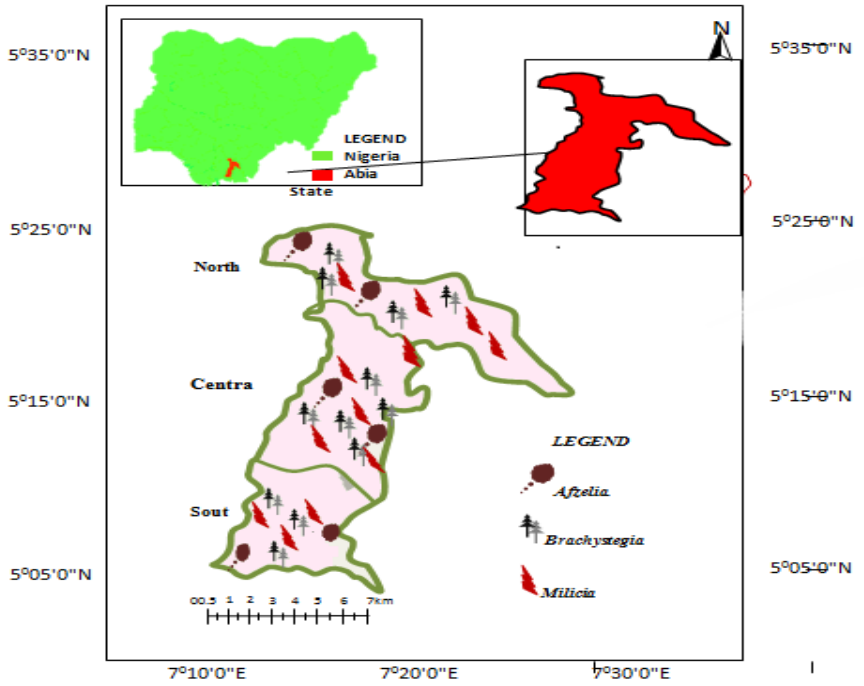

Fig. 4.4 Map showing distribution of *A. africana, B. eurycoma* and*M. excelsa* in Abia State.

CONCLUSION AND RECOMMENDATIONS

The population of the three tree species in both the forest reserves and free forest areas in Abia State were poor (less than $2ha^{-1}$). It highlights an urgent need for effective management and conservation of the State forest. There's also a poor knowledge of the tree species and their uses especially their usefulness and role in environmental protection. Thus, it demonstrated the absence of global best practice in natural resources management which integrates community participation, and this is unhelpful to goal of sustainable management of the forest, especially the indigenous tree species. The predominance of exotic species like *Gmelina arborea* and *Tectona grandis as* observed during the field survey indicated the characteristics and composition of the forest are being modified by the people to suit their perceived needs, based on the extent of their knowledge or ignorance of the importance and usefulness of the forest tree species. However, in the face of a global climate change regime, opportunities exist for the indigenous tropical tree species for modern uses such as for biomass production and carbon storage purposes. Thus enhancing the socio-economic benefits derivable from these species to the communities as well as their conservation status. Community based forest management could enhance awareness, adaptability and consequently the conservation status of the indigenous tree species and forest for sustainable development of the State.

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