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RESEARCH ARTICLE

ASSESSMENT OF STRUCTURAL FRAMEWORK (TREE SPECIES DBH AND HEIGHT) OF SOME COMMUNAL FORESTS IN NORTHERN CROSS RIVER STATE, NIGERIA

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ABSTRACT

In view of the consequences of anthropogenic factors such as logging of forest trees for timber and other uses which leads to deforestation, fragmentation and degradation of forest ecosystem and eventually species extinction, this study assessed the structural framework of tree species using diameter at breast height (dbh) (cm) and height (m)in ten communal forests (two each) of the five Local Government Areas (Ogoja, Yala, Bekwarra, Obudu and Obanliku) of Northern Cross River State, Nigeria using the modified Whittaker design as well as diameter and height class intervals. The study was carried out from (November, 2015 – May, 2016). In each site a 30 × 90 m plot was laid out in a spoke design and tree species whose diameter at breast height (dbh) were (≥ 2.5 cm but ≤ 10 cm) for wildlings and 10 cm and above present on the plots were marked, identified, measured and counted. Results of diameter class size of the 352 tree species measured in the study area showed that there were more trees with average trunk size than wildlings (4.35%). Majority of the trees were in the diameter class of 30-39 cm (37.97%) and 20-29 cm (26.96%) with minimum and maximum height classes of 10-19 m (78.12%) and 20-29 m (8.81%). They were however no trees in the higher diameter class sizes of 70-79 cm, 80-89 cm, 90-99 cm and 100 cm and above. This study has therefore given baseline information on the structural framework of trees in these forests and the need for the different stakeholders to take appropriate decisions and measures in sustainable forest management.

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INTRODUCTION

Trees as a major structural and functional basis of tropical rainforest are perennial woody plants. Researcher like Huxley (1992) defined a tree as a woody plant that has many secondary branches supported by single main stem or trunk with clear apical dominance while according to Ghate (2007), it has a minimum height specification at maturity varying from 3 m to 6 m and a minimum of 10 cm trunk diameter (30 cm girth). According to Friis and Balslev (2005), compared with most other plants, trees are long-lived, some reaching several thousand years old and growing to up to 115 m (377ft) high and they are plant form that occurs in many different sets of species, genera, orders and families. They show a variety of growth forms, shapes, vegetative and reproductive characteristics, leading to their great range of diversity. Singh (2002), reported that trees apart from forming the major structural and functional basis of tropical rainforest, are vital as carbon sinks, water sheds, provide shades and homes for many life forms and above all act as a primary harvester of energy into the ecosystem.Huang *et al.*, (2003), reported that trees diversity is crucial to tropical forest biodiversity, because tree provide homes and resources to a wide variety of plant and animal species while Ndah*et al.*, (2012) reported that many tropical forests are undergoing severe anthropogenic modifications such as cutting down of forest for plantation establishment, poor farming techniques, poor hunting and trapping practices as well as over exploitation of non-timber forest products. FAO (2010) reported that Nigeria is among the ten countries with the highest annual net negative change rates from 2000-2005 degrading at the rate of 3.3%. And as the most populous country in Africa, Nigeria populace exerts intense pressures on biodiversity of the remaining forests. In Nigeria at large, anthropogenic factors such as logging of forest trees for timber and over exploitation of non-timber forest products has led to deforestation and degradation of most communal forest areas.

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This must not be unrelated with lack of strict conservation ethos, law enforcement, corruption and extreme poverty, leading to severe intrusion into or trespass and illegal exploitation of forest tree resources, which resulted to depletion in biodiversity of the existing forests, decreased productivity and tree species extinction. And as forest degradation is usually followedby species extinction, depletion in biodiversity and decline in primary productivity, it is imperative to deduce or ascertain habitat attributes or features of our remaining forest for absolute conservation and to be able to maintain a certain rate of the forest resources. In view of the consequences of anthropogenic factors such as logging of forest trees for timber and other uses which leads to deforestation, fragmentation and degradation of forest ecosystems and eventually species extinction, the aim of this study was to assess the diameter at breast height (dbh) and height of tree speciesin ten communal forest of Northern Cross River State, Nigeria. Assessment of tree species dbh and height will in no doubt give an insight into the structural framework of trees in these forests as well as the need for different stakeholders to take appropriate managerial measures in sustainable forest management.

MATERIALS AND METHODS

Study location: The study was carried out in Northern Cross River State covering five Local Government Areas: Ogoja, Obudu, Yala, Bekwarra, and Obanliku. Two forest communities in each Local Government Area were chosen for the study (Figure 1). It was carried out from (November, 2015 – May, 2016). The area falls within the Southern Forest/Guinea savannah agro ecological zone of Nigeria, situated in the Northern Cross River State, it lies between latitudes 5˚ - 92´and 7˚03´N of the Equator and Longitudes 8˚38´and 9˚70´East of the Greenwich meridian. The topography is generally low lying, ranging from below 80-140m (on the average) above sea level with three soil types namely, clay, loam and sandy. It covers a total landmass of 972km^2(375 sq mi). The areas have a muggy tropical climate of 1250-1300mm rainfall and an average yearly temperature of 30˚C (NIMET, 2015). Subsistence agriculture, basically farming of yams, cassava, palm oil and palm wine among others is the major source of sustenance (NIMET, 2015).

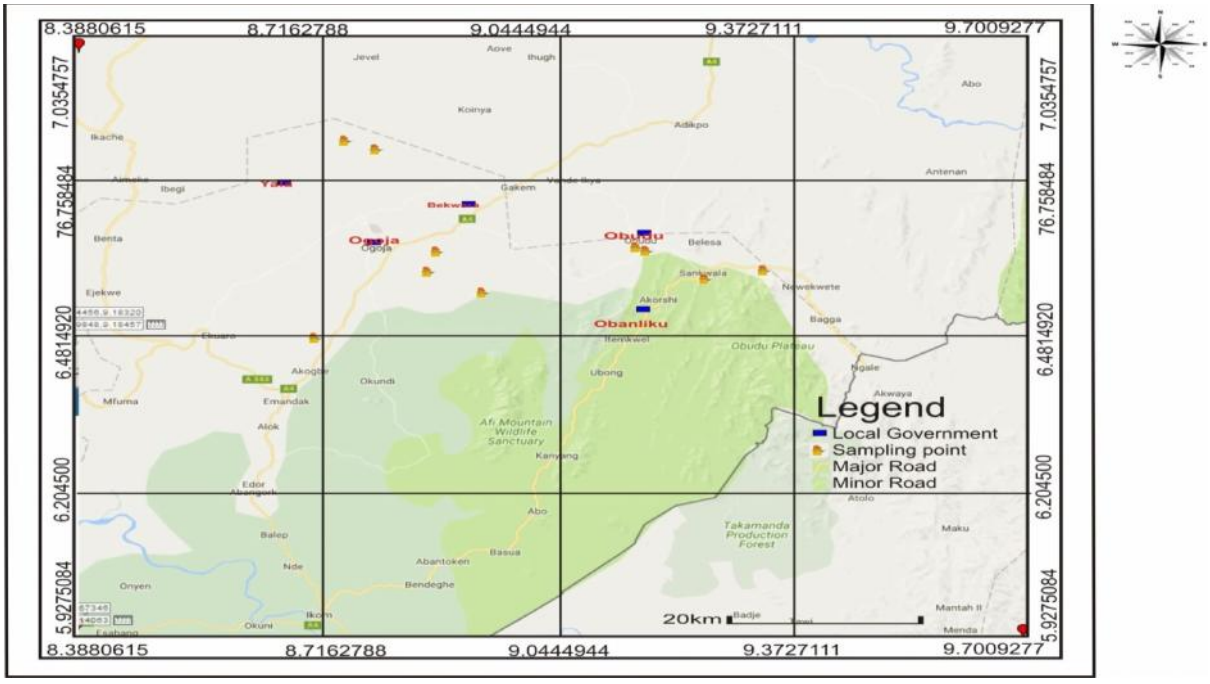

Fig. 1. GIS map of Northern Cross River State showing the study sites

Sampling method and design: The study was carried out using Systematic Sampling Method (a type of chance sampling where each element in the population has a known and equal opportunity of being counted) and the Modified Whittaker design (Herrick *et al.*, 2005). To obtain tree species richness, three 10m × 30m plots were marked out in a spoke design. Within each of these plots, a 2m × 5m subplot and four 0.5 × 2m subplots were set. Beginning with the least subplots, the subplots and plots were searched and the tree species found captured. This was supplemented by the use of quadrats in areas of difficult terrains. The survey consisted of listing all free stationed trees of at least 10cm or above in diameter (dbh) in each study site.

Tree species identification: Tree species in this study were identified using the works of Hutchinson and Dalziel (1968-1972) and certified by a plant taxonomistof the Cross River State Forestry Commission, Calabar.

Measurement of stem diameter (width) and tree height: Tree species including wildlings (dbh ≥ 2.5 cm but ≤ 10 cm) in the entire sample plot were marked, identified, measured and counted. Nevertheless, only individual trees whose diameters at breast heights (dbh) were 10cm and above were counted.The diameter at breast height of trees positioned on slopes were obtained from the upper side of the slope, while the dbh of trees with high buttresses were obtained at 30cm above the point of converge of the buttresses on the stem. Tree height and diameter (width) was used to evaluate the ratio or proportion of mature trees to wildlings. The Diameter at Breast Height (DBH) was measured at 1.4 – 1.5m from ground, at a value of ≥ 10 cm and above. Height of the

trees was measured using an Electronic Clinometer (INVICTA® USA), while DBH was measured using a metre tape and recorded using the methods of Herrick *et al.* (2005), Avery and Burkhart, (2002) and Williams *et al.*,(1994). Using class intervals, average DBH was used to determine the wildling size and mature trunk size. The stem width of the trees was distributed into eleven class intervals (sizes), as follows: Diameter (width) class (Dc) 1 (dbh ≥ 2.5cm but ≤ 9cm), Dc2 (10cm – 19cm), Dc3 (20cm – 29cm), Dc4 (30cm – 39cm), Dc5 (40cm – 49cm), Dc6 (50cm – 59cm), Dc7 (60cm – 69cm), Dc8 (70cm – 79cm), Dc9 (80cm – 89cm), Dc10 (90cm – 99cm), Dc11 (100cm and above) while that of height was classified into three intervals (classes) (height class 1) 0 ≤ 9m, 10-19m (class 2) and 20-29m (class 3).

Distribution of the various dbh class sizes and height of tree species in each study site/study area was calculated as follows:

$$\frac{\text{No. of trees in class interval}}{\text{Total no. of trees in population}} \times \frac{100}{1}$$

RESULTS

Diameter (width) class sizes of tree species (cm): The results of the various diameter (width) class sizes of tree species encountered in the study sites/area are presented in Figures 2-11 while a summary of the various diameter class sizes for trees in the study area is presented in Figure 12. Figure 2 shows the various diameter class sizes of all tree species enumerated and measured in Gbogbu forest. Of the 30 trees measured in the study site, 15 trees were in the width class of 30-39cm accounting for 50% of the overall trees measured for width. This was preceded by the width class of 40-49cm with 9 stands accounting for 30% of the total number of trees in the site. The width class of 20-29cm had 5 stands (16.66%) while the width class of 10-19cm had the least stand of 1 (3.34%) of the total tree population. The width class of 0-9, 50-59, 60-69, 70-79, 80-89, 90-99 and 100 cm and above had no stands in the study site.

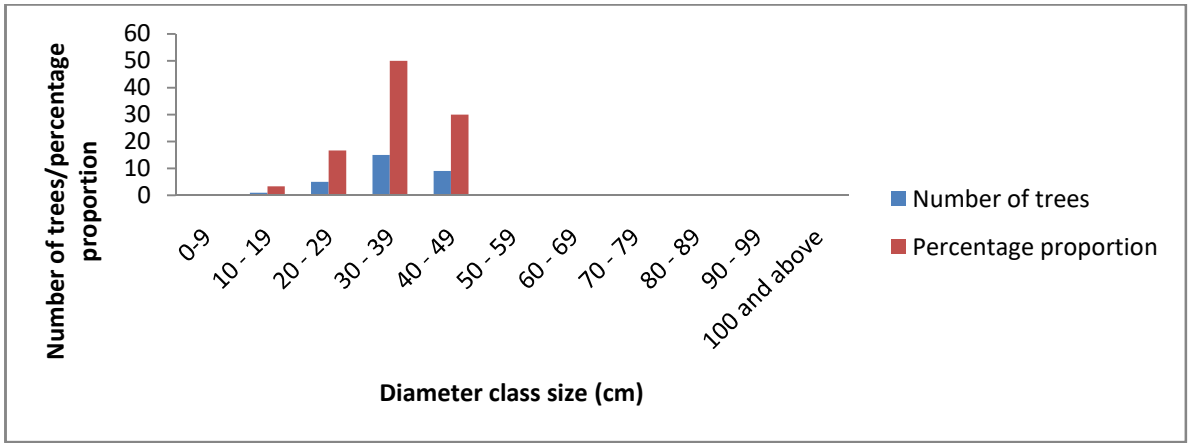

Fig. 2. Distribution of the different stem diameter class sizes in Gbogbu forest, Gabu, Yala Local Government Area

Figure 3 shows the various diameter class sizes of all tree species enumerated and measured in Omulako forest. Of the 25 trees measured in the study site, 10 trees were in the width class of 30-39cm accounting for 40% of the overall trees measured.This was preceded by the width class of 20-29 cm with 7 stands which is 28% of the total number of trees in the site. The width class of 40-49 cm had 6 stands (24%) while the width class of 10-19 cm had the least stands of 2 (8%) of the total tree population. The width class of 50-59, 60- 69, 70-79, 80-89, 90-99 and 100 cm and above had no stand in the study site.

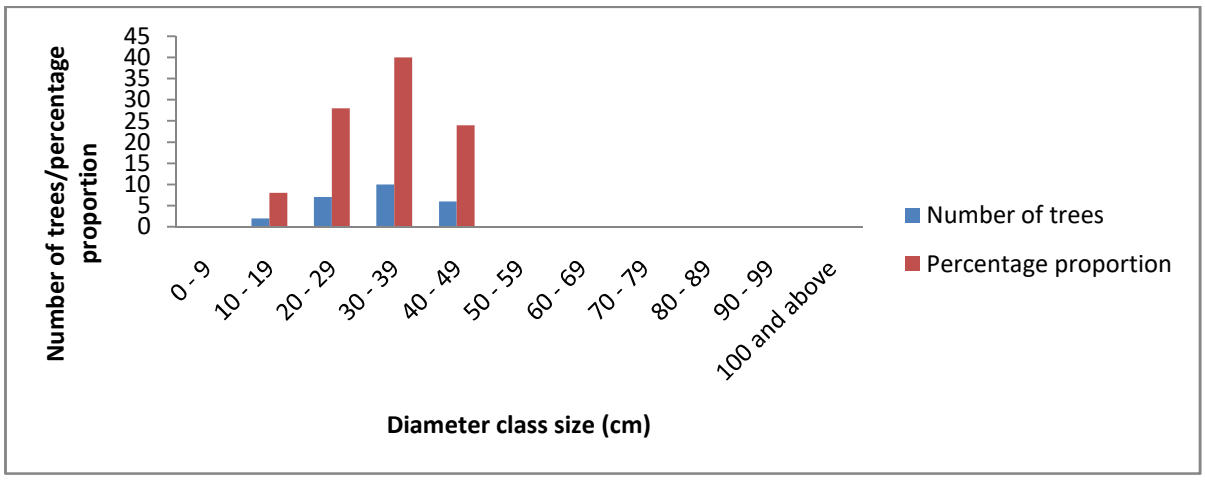

Fig. 3. Distribution of the different stem diameter class sizes in Omulako forest, Aliforkpa, Yala Local Government Area

Figure 4 shows the various diameter class sizes of all tree species enumerated and measured in Aguomoh forest. Of the 33 trees measured in the study site, 14 trees were in the width class of 20-29 cm accounting for 42.42% of the overall trees measured. This was preceded by the width class of 30-39 cm with 9 stands accounting for 27.28% of the total number of trees in the site. The width class of 10-19 cm had 6 stands (18.18%) while the width class of 50-59 cm had the least stand of 1 (3.03%) of the total tree population. The diameter class of 40-49, 60-69, 70-79, 80-89, 90-99 and 100 cm and above had no stand in the study site.

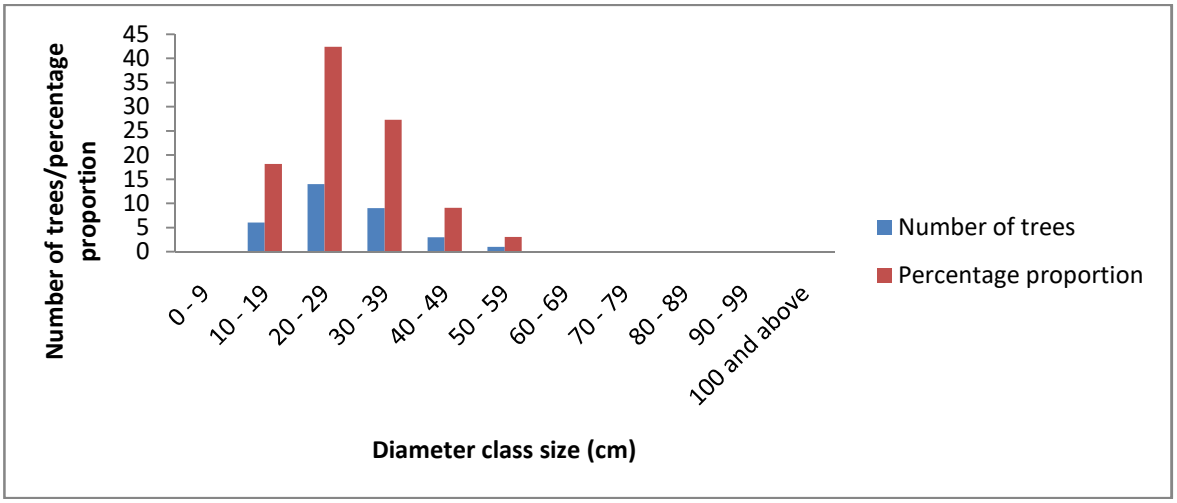

Fig. 4. Distribution of the different stem diameter class sizes in Aguomoh forest, Afrike, Bekwarra Local Government Area

Figure 5 shows the various width class sizes of all tree species enumerated and measured in Ukpah forest. Of the 34 trees measured in the study site, 15 trees were in the width class of 30-39 cm accounting for 44.11% of the overall trees measured.

This was preceded by the width class of 30-39 cm with 9 stands accounting for 27.28% of the total number of trees in the site. The diameter class of 10-19 cm had 6 stands (18.18%) while the diameter class of 50-59 cm had the least stand of 1 (3.03%) of the total tree population. The diameter class of 40-49, 60-69, 70-79, 80-89, 90-99, 100 cm and above had no stand in the study site.

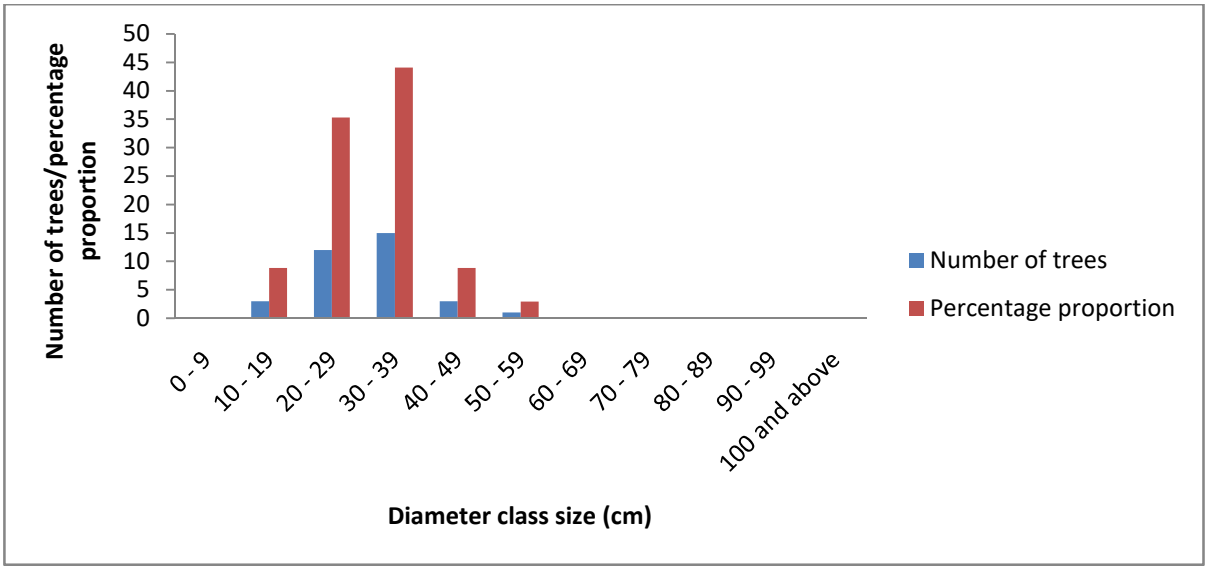

Fig. 5. Distribution of the different stem diameter class sizes in Ukpah forest, Ukpah, Bekwarra Local Government Area

Figure 6 shows the various width class sizes of all tree species enumerated and measured in Abeya forest. Of the 34 trees measured in the study site, 10 trees were in the width class of 20-29cm accounting for 30.3% of the overall trees measured. This was preceded by the width class of 30-39 cm with 9 stands accounting for 27.27% of the total number of trees in the site.

The width class of 40-49 cm had 7 stands (21.21%), 10-19 cm had 6 stands (15.15%) while the width class of 0-10cm had the least stands of 2 (6.06%) of the total tree population. The width class of 50-59, 60-69, 70-79, 80-89, 90-99 and 100 cm and and above had no stand in the site.

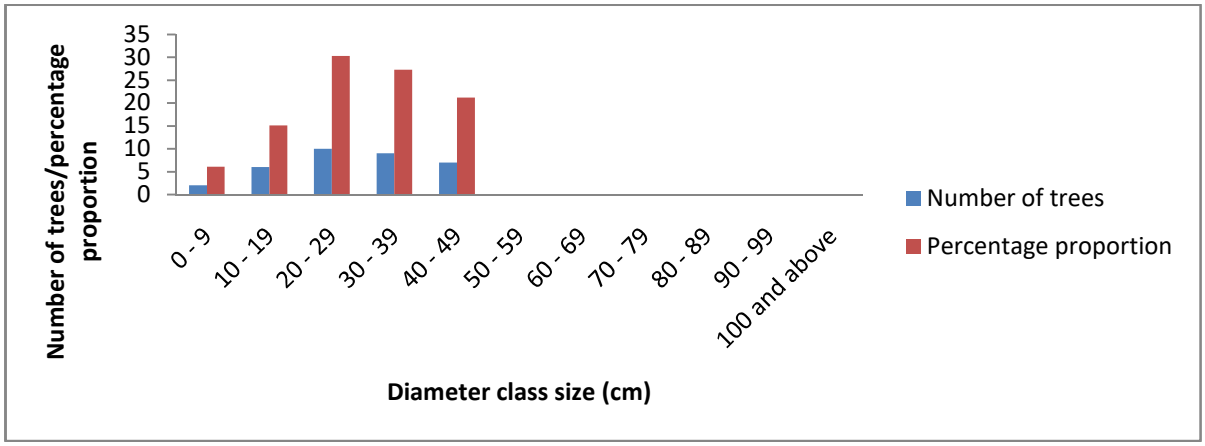

Fig. 6. Distribution of the different stem diameter class sizes in Abeya forest, Winniba-Ekajuk, Ogoja Local Government Area

Figure 7 shows the various width class sizes of all tree species enumerated and measured in Aragban forest. Of the 42 trees measured in the study site, 20 trees were in the width class of 30-39cmaccounting for 47.61% of the overall trees measured. This was preceded by the width class of 40-49 cm with 8 stands accounting for 19.04% of the total number of trees in the site. The width class of 20 -29 cm had 7 stands (16.67%), 0-10 cm had 6 stands (9.3%) while the width class of 10-19 cm had the least stand of 1 (2.38%) of the total tree population. The width class of 0-10, 50-59, 60-69, 70-79, 80-89, 90-99 and 100 cm and above had no stand in the study site.

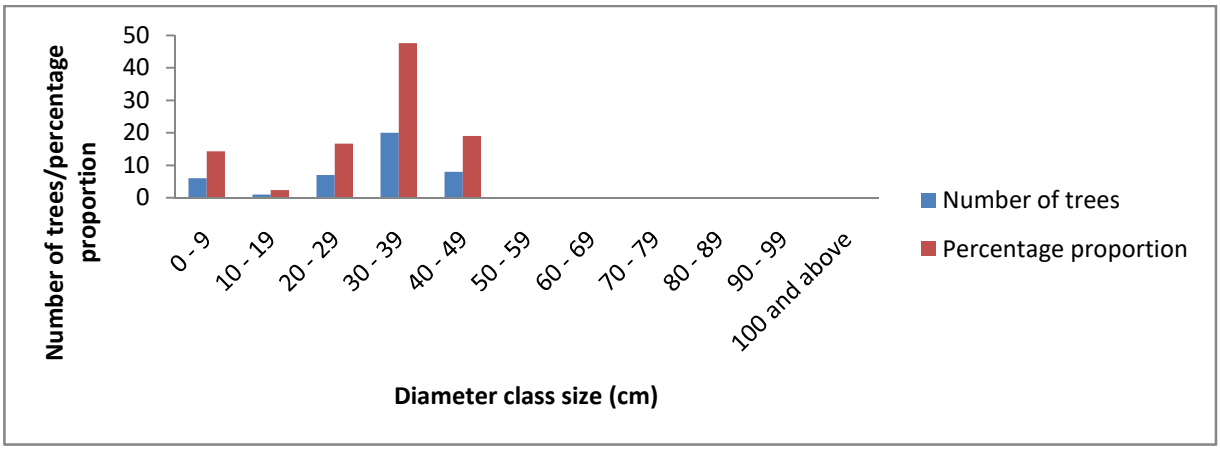

Fig. 7. Distribution of the different stem diameter class sizes in Aragban forest, Mbube, Ogoja Local Government Area

Figure 8 shows the various width class sizes of all tree species enumerated and measured in Alege forest. Of the 33 trees measured in the study site, 10 each were in the width class of 10-19cm and 20-29 cm making up 30.3% each of the overall trees measured.This was preceded by the width class of 30-39 cm with 8 stands accounting for 24.24% of the total number oftrees in the site. The width class of 40-49 cm had 3 stands (9.09%) while the diameter class of 0-10cm had the least stands of 2 (6.06%) of the total tree population. The width class of 50-59, 60-69, 70-79, 80- 89, 90-99 and 100 cm and above had no stand in the study site.

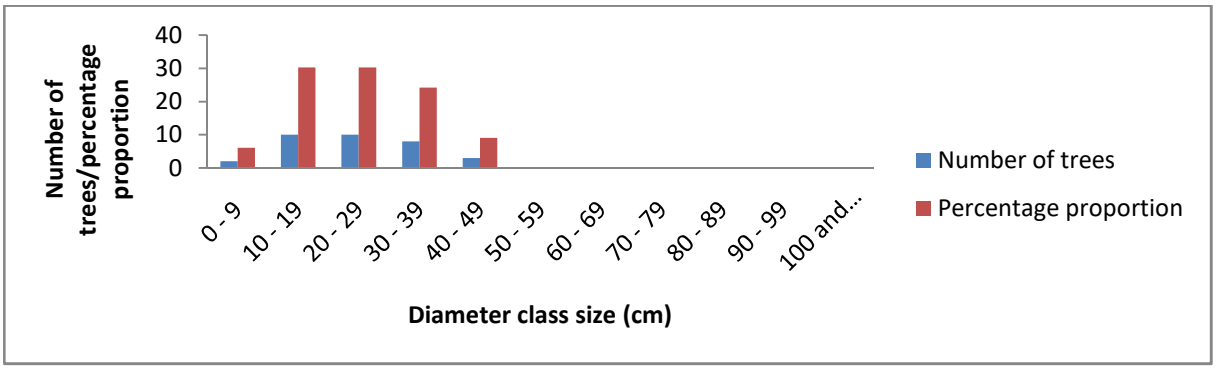

Fig. 8. Distribution of the different stem diameter class sizes in Alege forest, Alege, Obudu Local Government Area

Figure 9 shows the various width class sizes of all tree species enumerated and measured in Beteh forest. Of the 35 trees measured in the study site, 11 trees were in the width class of 30-39 cm accounting for 31.43% of the overall trees measured.

This was preceded by the width class of 20-29 cm with 9 stands accounting for 25.71% of the total number of trees population in the site. The width class of 10-19 cm had 7 stands(20%) while the diameter class of 0-9 cm and 40-49 cm had the least stands of 4 each making up 11.43% each of the total population. The width class of 50-59, 60-69, 70-79, 80-89, 90-99 and 100 cm and above had no stand in the study site.

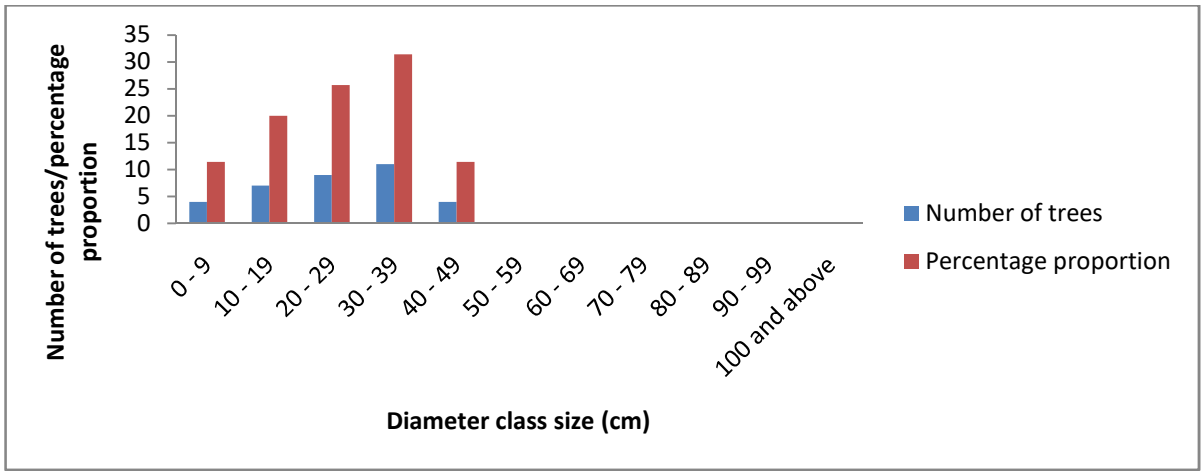

Fig. 9. Distribution of the different stem diameter class sizes in Beteh forest, Beteriku, Obudu Local Government Area

Figure 10shows the various width class sizes of all tree species enumerated and measured in Bechevie forest. Of the 42 trees measured in the study site, 17 trees were in the width class of 30-39cm accounting for 40.48% of the overall trees measured. This was preceded by the width class of 40-49 cm with 16 stands accounting for 38.09% of the total number of trees in the site.

The width class of 50-59 cm had 4 stands (9.53%) while the width class of 10-19cm and 60-69cm had 2 stands each making up 4.76% each of the total tree population. The width class of 20-29cm had the least stand of 1 (2.38%) of the total treepopulation. The width class of 0-9, 70-79, 80-89, 90-99 and 100cm and above had no stand in the study site.

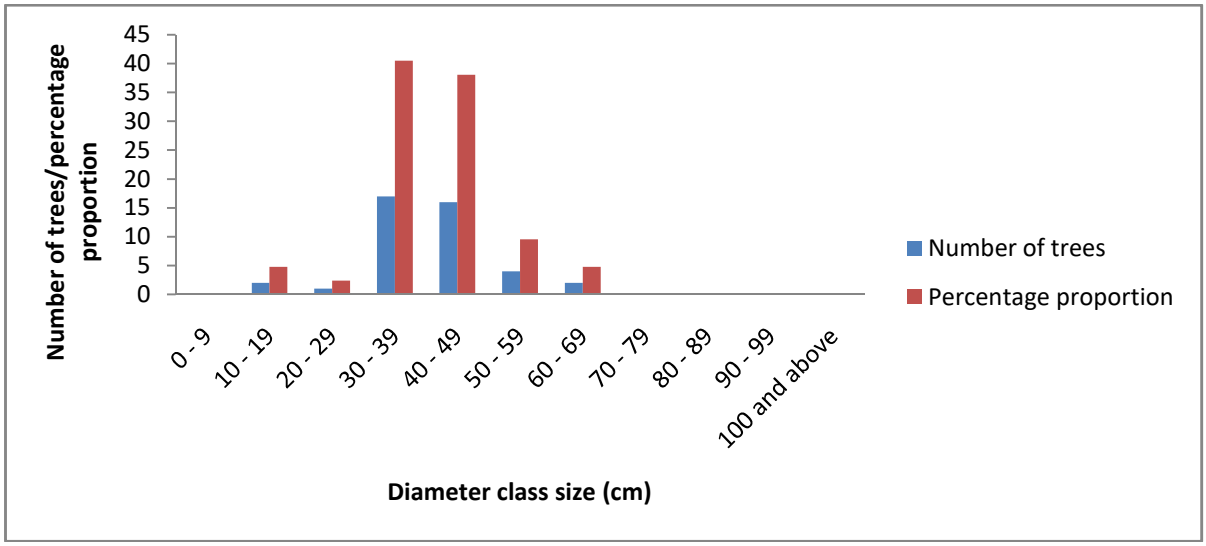

Fig. 10. Distribution of the different stem diameter class sizes in Bechevie forest, Bechevie, Obanliku Local Government Area

Figure 11 shows the various width class sizes of all tree species enumerated and measured in Sankwala forest. Of the 44 trees measured in the study site, 17 trees were in the width class of 30-39cm accounting for 38.63% of the total trees measured. This was preceded by the width class of 10-19cm and 40-49cm with 9 stands each which is 20.46% each of the total number of trees in the site.

The width class of 20-29cm had 8 stands (18.18%) while the width class of 0-9cm had the least stand of 1 making up 2.27% of the total tree population. The width class of 50-59, 60-69, 70-79, 80-89, 90-99 and 100cm and above had no stand in the study site.

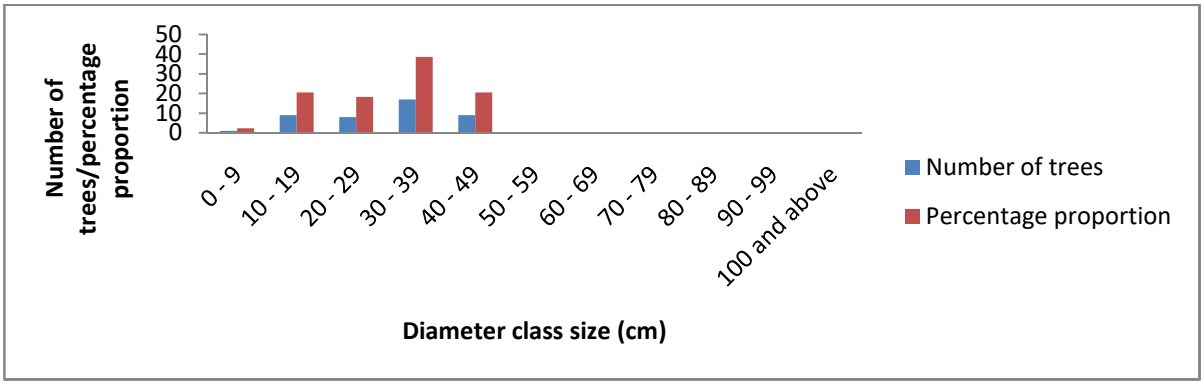

Fig. 11. Distribution of the various stem diameter class sizes in Sankwala forest, Sankwala, Obanliku Local Government Area

Figure 12 shows a summary of various width class sizes of all tree species enumerated and measured in the study area (Gbogbu, Omulako, Aguomoh, Ukpah, Abeya, Aragban, Alege, Beteh, Bachevie and Sankwala) forests. Of the 352 trees measured in the study area, 131 trees were in the width class of 30-39cm accounting for 37.97% of the overall trees measured. This was preceded by the width class of 20-29 cm with 83 stands accounting for 26.96% of the overall tree population. The width class of 40-49cm had 68 stands (15.08%), 10-19cm had 47 stands (13.34%), 0-10 cm had 15 stands (4.35%), 50-59 cm had 6 stands (1.73%) while the width class of 60-69cm had the least stands of 2 making up 0.57% of the total tree population. The widthclass of 70-79, 80-89, 90-99 and 100cm and above had no stand in the study area. Results of the various width class sizes of tree species enumerated and measured across the study area therefore, shows that there were more trees with mature trunk sizes than wildlings.

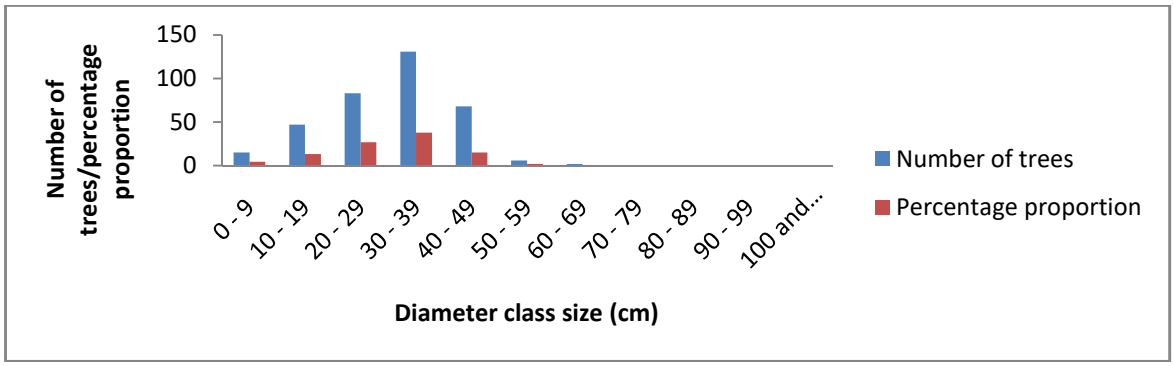

Fig. 12. Summary of number/distribution of the different stem diameter class sizes in forest in the study area

Height class of tree species (m): The results of the various height classes for tree species assessed in the study sites/area (Gbogbu, Omulako, Aguomoh, Ukpah, Abeya, Aragban, Alege, Beteh, Bechevie and Sankwala) are presented in Figures 13-22.Summary of height classes of the tree species measured in the study area is presented in Figure 23. Figure 13 shows the various height classes of tree species assessed in Gbogbu forest. Of the 30 stands assessed for height in the study site, 24 were in the height class of 10-19m.making up 80% of the overall trees assessed. This was preceded by the height class of 0-9 m with 4 stands accounting for 13.33% oftheoverall number of trees in the site. The height class of 20-29 m had the least stands of 2 making up 6.67% of the total tree population.

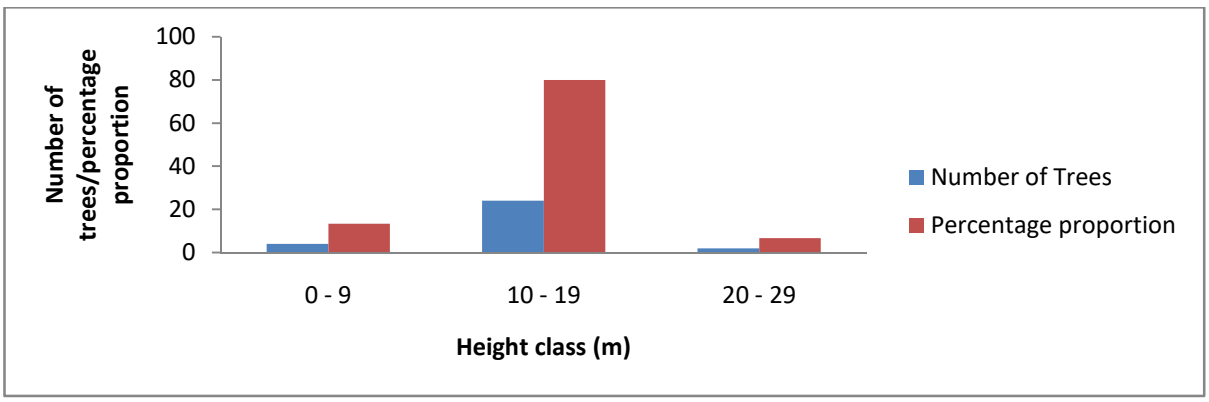

Fig. 13. Percentage distribution of the various height classes in Gbogbu forest, Gabu, Yala Local Government Area

Figure 14 shows the various height classes of tree species assessed in Omulako forest. Of the 25 stands assessed for height in the study site, 18 were in the height class of 10-19 m making up 72% of the overall trees assessed. This was preceded by the height class of0-9 mwith 5 stands accounting for 20% of the overall number of trees in the site. Theheight class of 20-29 m had the least stands of 5 making up 8% of the total tree population.

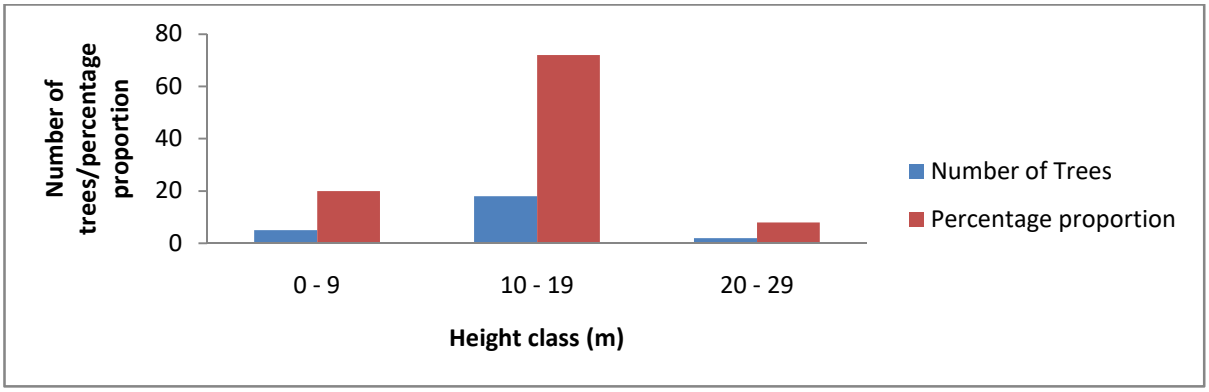

Fig. 14. Percentage distribution of the various height classes in Omulako forest, Aliforkpa, Yala Local Government Area

Figure 15 shows the various height classes of tree species assessed in Aguomoh forest. Of the 33 stands assessed for height in the study site, 23 were in the height class of 10-19 m making up 69.70% of the overall trees assessed. This was preceded by the height class of 0-9 m with 9 stands accounting for 27.27% of the overall number of trees in the site. The height class of 20-29 m had the least stand of 1 making up 3.03% of the total tree population.

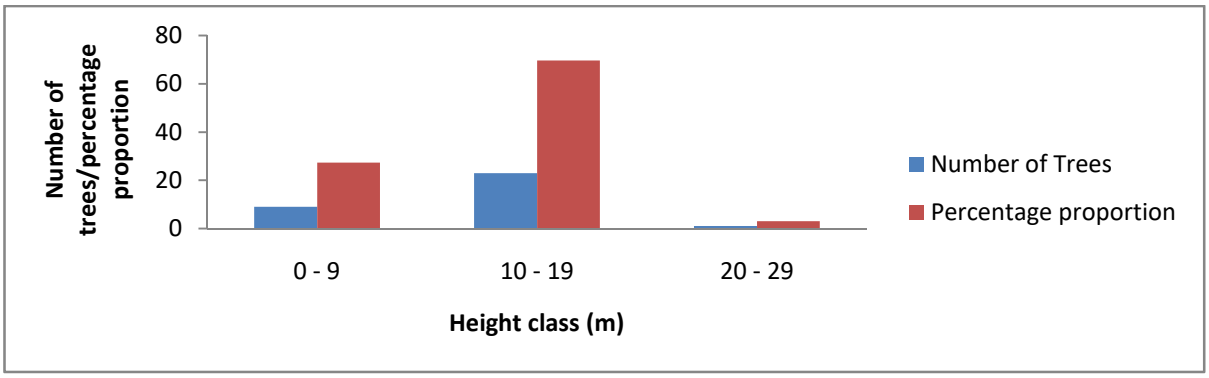

Fig.15. Percentage distribution of the various height classes in Aguomoh forest, Afrike, Bekwarra Local Government Area

Figure 16 shows the various height classes of tree species assessed in Ukpah forest. Of the 34 stands assessed for height in the study site, 27 were in the height class of 10-19 m making up 79.42% of the overall trees assessed. This was preceded by the height class of 0-9 m with 4 accounting for 11.76% of the overall number of trees in the site. The height class of 20-29m had the least stands of 3 making up 8.82% of the total tree population.

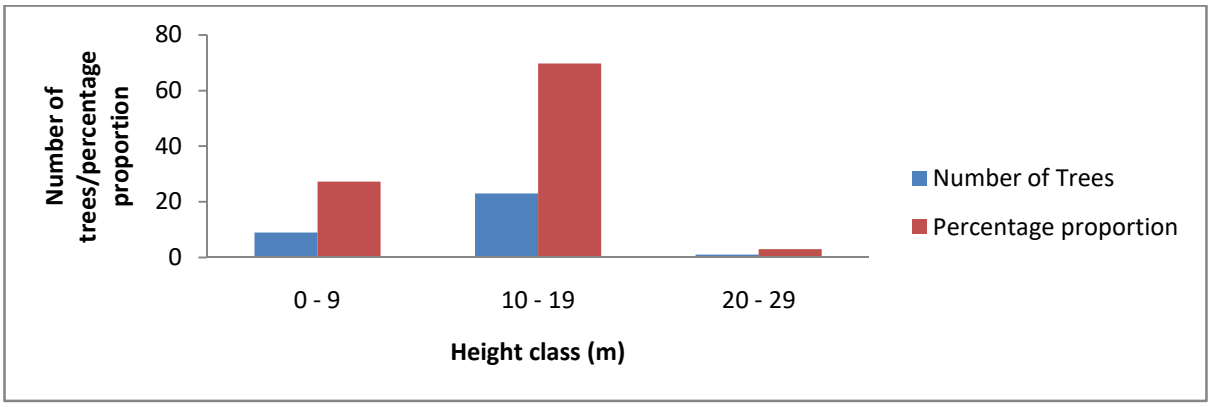

Fig.16. Percentage distribution of the various height classes in Ukpah forest, Ukpah, Bekwarra Local Government Area

Figure 17 shows the various height classes of tree species assessed in Abeya forest. Of the 34 stands assessed for height in the study site, 22 were in the height class of 10-19m making up 64.70% of the overall trees assessed. This was preceded by the height class of 0- 9 m with 10 stands accounting for 29.42% of the overall number of trees in the site. The height class of 20-29m had the least stands of 2 making up 5.88% of the total tree population.

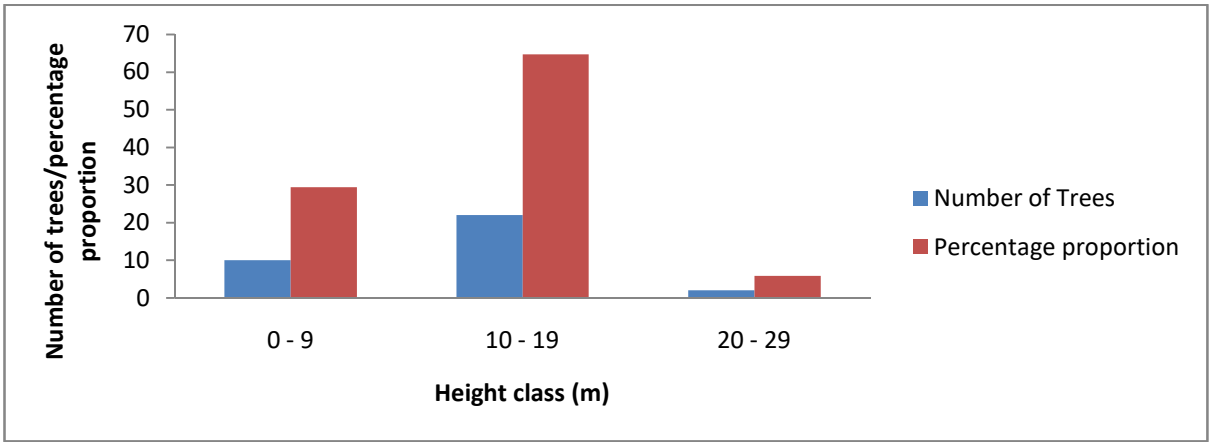

Fig.17. Percentage distribution of the various height classes in Abeya forest, Winniba-Ekajuk, Ogoja Local Government Area

Figure 18 shows the various height classes of tree species assessed in Aragban forest. Of the 42 stands assessed for height in the study site, 35 were in the height class of 10-19m making up 83.73% of the overall trees assessed. This was preceded by the height class of 0-9 m with 4 stands accounting for 9.30% of the overall number of trees in the site. The height class of 20-29m had the least stands of 3 making up 6.97% of the total tree population.

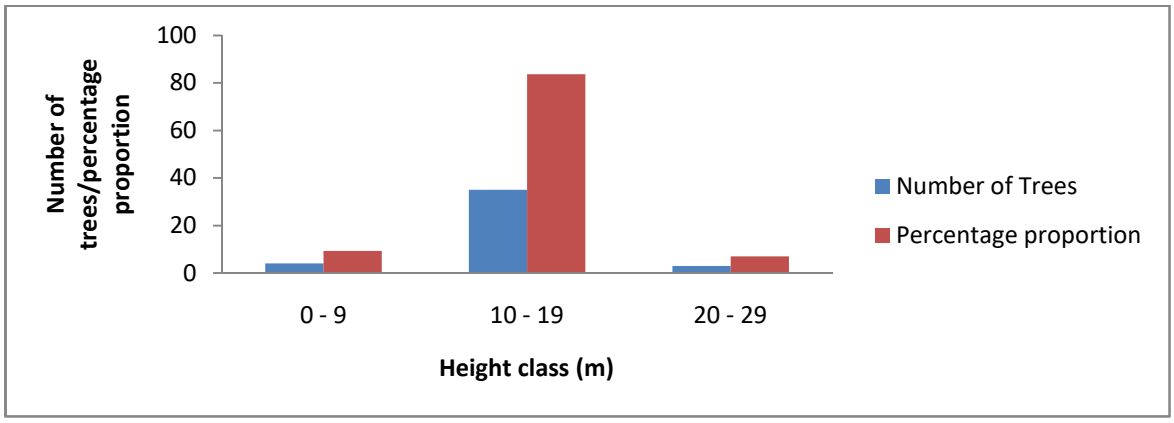

Fig.18: Percentage distribution of the various height classes in Aragban forest, Mbube, Ogoja Local Government Area

Figure 19 shows the various height classes of tree species assessed in Alege forest. Of the 33 stands assessed for height in the study site, 23 were in the height class of 10-19m making up69.70% of the overall trees assessed. This was preceded by the height class of 0-9m with 10 stands accounting for 30.30% of the overall number oftrees in the site. Theheight class of 20-29m had no stand.

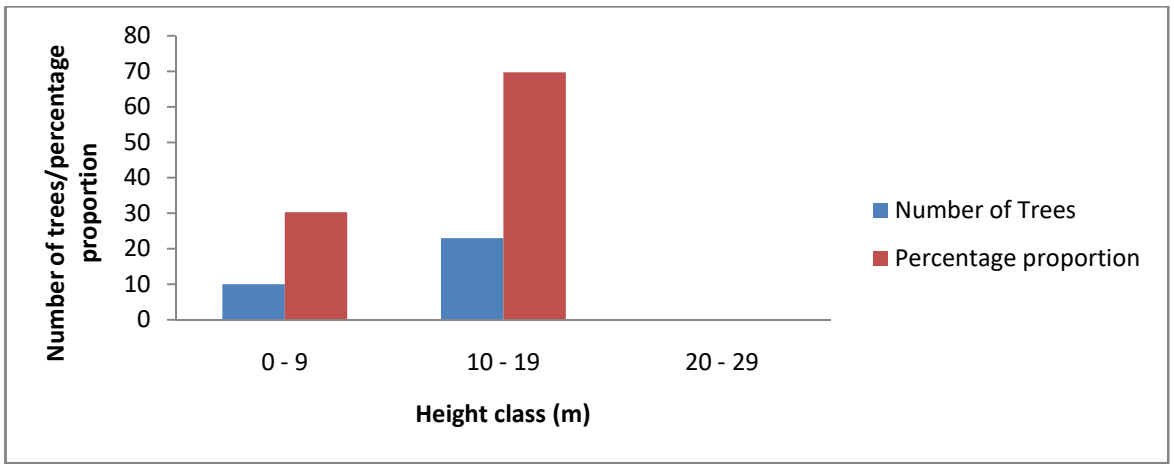

Fig.19. Percentage distribution of the various height classes in Alege forest, Alege, Obudu Local Government Area

Figure 20 shows the various height classes of tree species assessed in Beteh forest. Of the 35 stands assessed for height in the study site, 26 were in the height class of 10-19 m making up 74.29% of the overall trees assessed. This was preceded by the height class of 0-9m with 5 stands accounting for 14.28% of the overall number of trees in the site. The height class of 20-29m had the least stands of 3 making up 11.43% of the total tree population.

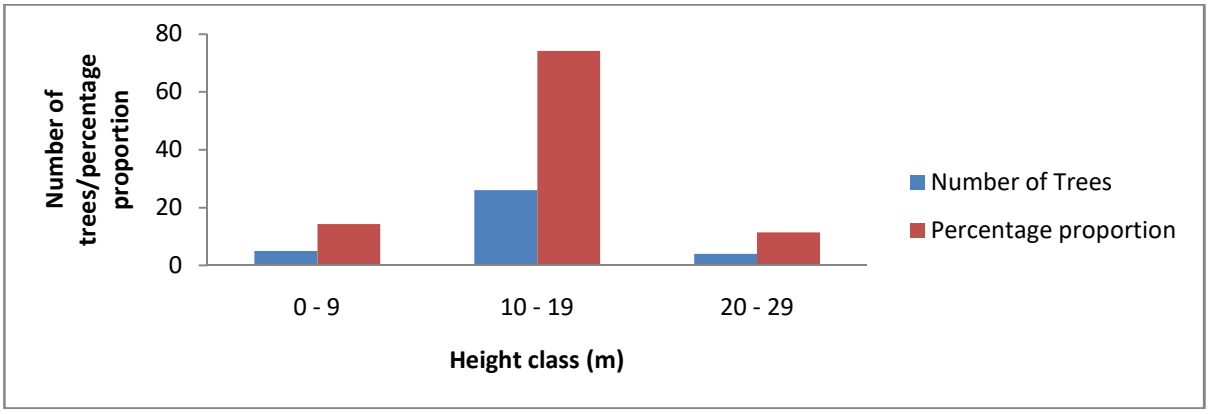

Fig. 20. Percentage distribution of the various height classes in Beteh forest, Beteriku, Obudu Local Government Area

Figure 21 shows the various height classes of tree species assessed in Bechevie forest. Of the 42 stands assessed for height in the study site, 30 were in the height class of 10-19m making up 71.43% of the overall trees assessed. This was preceded by the height class of 20-29m with 12 stands accounting for 28.57% of the overall number of trees in the site. The height class of 0-9m had no stand.

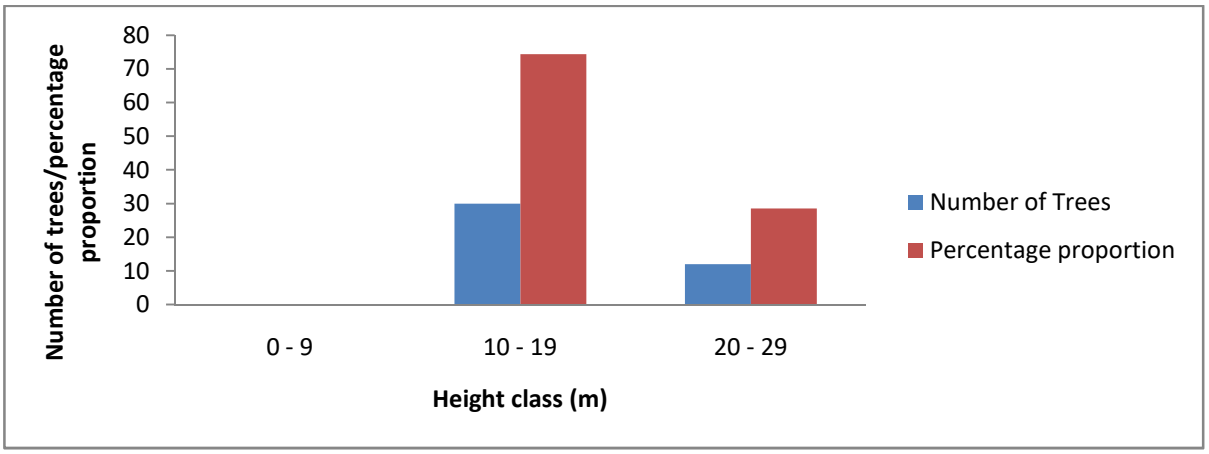

Fig.21: Percentage distribution of the various height classes in Bechevie forest, Bechevie, Obanliku Local Government Area

Figure 22 shows the various height classes of tree species assessed in Sankwala forest. Of the 44 stands assessed for height in the study site, 37 were in the height class of 10-19m making up 84.09% of the overall trees assessed. This was preceded by the height class of 0-9 m with 5 stands accounting for 11.36% of the overall number of trees in the site. The height class of 20-29m had the least stands of 2 making up 4.58% of the total tree population.

Figure 23 shows a summary of various height classes of all tree species assessed in all sampling locations in the study area (Gbogbu, Omulako, Aguomoh, Ukpah, Abeya, Aragban, Alege, Beteh, Bechevie and Sankwala) forests. Of the 352 stands assessed for height in the study area, 275 were in the height class of 10-19 m making up height 91.19% of the total trees assessed. The height class of 20-29 m had the least stands of 31 making up 8.81% of the total tree population in the study area.

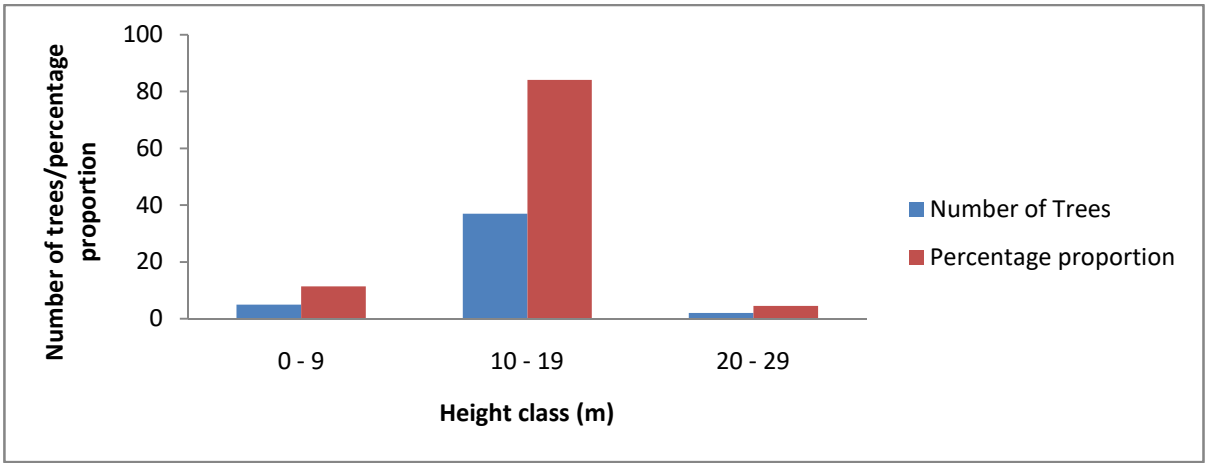

Fig.22: Percentage distribution of the various height classes in Sankwala forest, Sankwala, Obanliku Local Government Area

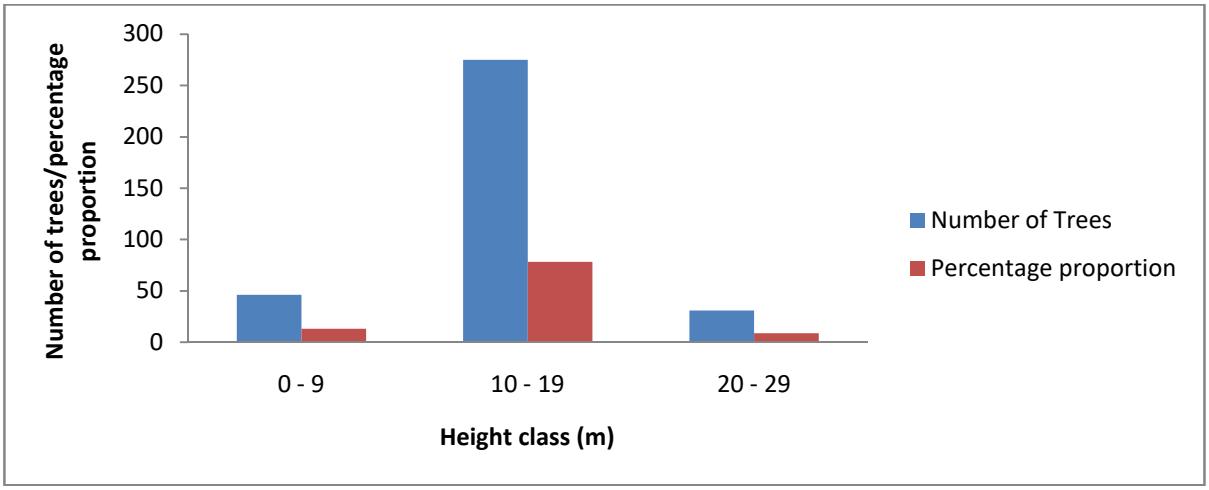

Fig.23: Summary of number/percentage distribution of the various height classes in forests in the study area

DISCUSSION

In this study carried out in ten communal forests of Northern Cross River State, Results (Figure 2-11) shows the various width class sizes of all tree species enumerated and measured in the study area (Gbogbu, Omulako, Aguomoh, Ukpah, Abeya, Aragban, Alege, Beteh, Bachevie and Sankwala) forests while Figure 12 shows the summary. Of the 352 trees measured in the study area, 131 trees were in the width class of 30-39cm accounting for 37.97% of the overall trees measured. This was preceded by the width class of 20-29 cm with 83 stands accounting for 26.96% of the overall tree population. The width class of 40-49cm had 68 stands (15.08%), 10-19cm had 47 stands (13.34%), 0-10 cm had 15 stands (4.35%), 50-59 cm had 6 stands (1.73%) while the width class of 60-69cm had the least stands of 2 making up 0.57% of the total tree population. The widthclass of 70-79, 80-89, 90-99 and 100cm and above had no stand in the study area. Results of the various width class sizes of tree species enumerated and measured across the study area therefore, shows that there were more trees with average trunk sizes than wildlings and no trees in the higher diameter class sizes. This result contradicts that of Oduwaiye *et al.,* (2002) who stated that all sites assessed by them had the lowest diameter class of less than 10 cm at the Okomu permanent sampled plots in Benin City, Edo State, Nigeria. They also had the lowest population of trees in the diameter class of 25-30 cm. Also, Oduwaiye and Ajibode (2005) gave an account of the highest number of trees for diameter class of 11-30 cm preceded by those of between 0-10cm at Onigambari Forest Reserve, Ibadan. Aigbe*et al.,* (2014) reported the abundance of trees with small diameter in Afi Forest Reserve in Cross River State, Nigeria. Similar accounts have also been given by preceding workers in other tropical rain forests of Nigeria (Adekunle *et al.*, 2004; Adekunle and Olagoke, 2008). The reason for the very poor absence of trees in the higher diameter classes in this study can be ascribed to forest degradation activities which probably destroyed large individuals as well as the actuality that some massive trees would have been eliminated through logging activities for some uses a long time ago (Hadi *et al.*,2009). Also, the decrease with increase in girth size classes in the study area could be as aresult of anthropogenic activities such as the logging of trees for timber, felling of trees for construction and deforestation of forest for plantation crops as reported by Deka *et al.*, 2012). Furthermore, abundance or rarity of a timber tree species of economic value in an area of rainforest is a function of the intensity and pattern of its exploitation. Therefore, the absence of trees in the higher diameter size classes observed in the study area can be linked to overexploitation of the trees for timber. This would also cause gross inadequacy of seeds for regeneration, as a lot of mother trees must have been felled as established by Olajide (2004). However, Aigbe*et al.,* (2014)reported the minimum and maximum diameter at breast height (dbh) of trees at Afi River Forest Reserve at 11.1 cm and 180.0 cm respectively. This is to be expected since the logging operation in the area is well regulated from excessive timber operation. Results of height classes of trees is shown in (Figures 13-23). Figure 23 shows a summary of various height classes of all tree species assessed in all sampling locations in the study area (Gbogbu, Omulako, Aguomoh, Ukpah, Abeya, Aragban, Alege, Beteh, Bechevie and Sankwala) forests. Of the 352 stands assessed for height in the study area, 275 were in the height class of 10-19 m making up 91.19% of the total trees assessed. The height class of 20-29 m had the least stands of 31 making up 8.81% of the total tree population in the study area.Aigbe*et al.,* (2014) reported the least and highest merchantable heights of trees at 2.7 m and 55.0 m respectively and least and highest total tree heights at 12.0 m and 62.2 m respectively in Afi Mountain Wildlife Sanctuary of Nigeria. The implication of this is that the forests are still undergoing regeneration and recruitment, which are vital indicators of forest health and vigour as reported by Jimoh*et al.*, (2012).

CONCLUSION

Anthropogenic activities have been blamed for the extinction of several plants and wildlife species as a result of unsustainable natural resources exploitation and habitat destruction. The result obtained from this study shows that there were few wildlings, more average trunk sizes and no trees in the higher diameter class sizes in the study area. This study has therefore given baseline information on the structural framework of trees in these forests and the need for the different stakeholders to take appropriate decisions and measures in sustainable forest management.

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