Assessment of Open Grown Tree Species Diversity in Nnamdi Azikiwe University, Awka, Nigeria

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ABSTRACT

Trees, which are important for the sustenance of life and the health of our planet, are disappearing at an alarming rate. In Nigeria, the impacts of climate change will further aggravate the plights of many indigenous and exotic tree species as climatic variability may limit the ability of forest trees to quickly adapt to the changing climate. This study focused on the assessment of open grown tree species diversity in the Nnamdi Azikiwe University, Awka, Nigeria which is considered as a crucial task to design strong conservation action strategies. Open grown tree species with diameter at breast height (Dbh) ≥10 cm in the study area were identified and recorded. Data collected were analyzed using descriptive statistics and alpha diversity analysis. A total number of 479 trees distributed among 25 tree species and 17 families were identified, with high Shannon-Weiner diversity index (2.50) and Simpson dominance index (0.88). The study indicated high species variability within the study area with Fabaceae family having the highest diversity of 4 species. Other important families dominating the study area include Apocynaceae, Lamiaceae, Moraceae and Myrtaceae with same number (2) of species. The study concluded that there is a huge presence of indigenous and exotic tree species in the study area and some are no longer found in most natural forests underscores the potentials of the campus as an important live gene bank. The study therefore recommends the need for policy intervention to aid the identification, documentation and conservation of forest tree resources in the University.

INTRODUCTION

Trees, which are important for the sustenance of life and the health of our planet, are disappearing at an alarming rate. Over the years, trees had undergone different levels of disturbance due to unprecedented increase in human population, which have led to cutting of trees for firewood collection, charcoal production, and infrastructural developments (Omoro *et al.*, 2010). Consequently, the need for actions to develop effective strategies to conserve trees is receiving considerable attention worldwide. Forest genetic resources are fast becoming depleted in most natural forests due to the pressures of deforestation, urbanization, poor management and a regeneration program that is virtually nonexistent. To protect trees from declining, it is essential to examine the current status of species diversity, composition as it will provide guidance for their management and valuable reference for assessment**,** as well as improving our knowledge in identification of ecologically useful species (Suratman, 2012).

Overpopulation has resulted in the rapid loss of tree diversity and is recognized as a major environmental and economic problem around the world (Mani and Parthasarathy, 2006). An open grown tree is a tree that has grown virtually all its life without competition from other trees. The importance and conservation of the open grown tree as natural, cultural and literary icons (Spector *et al.*, 2006) is now gaining recognition across the world. Therefore, information on composition, diversity of tree species and species-rich communities is of primary importance in the biodiversity conservation efforts (Suratman, 2012). The trees of a community such as university campus can be used as its defining features. They define the landscape by their beauty and presence. Trees also help in the amelioration of the university environment. Therefore, trees within such areas require proper management and documentation of their characteristics.

Diversity of tree species simply means the different tree species that can be found or the various variety of tree species present in a particular given area. Diversity of tree species is measured through a combination of species richness (the number of species present)

and species evenness (the abundance of each species). This information can be from a forest survey or from inventory data. Species diversity can be calculated at many scales, whether for a forest area, urban area, regionally or even nationally. Lafrankie *et al*. (2006) reported that**,** the tropical rainforests are vulnerable to deforestation and degradation. In Nigeria, population growth has led to an astronomical increase in anthropogenic activities, excessive logging and over exploitation. As a result, most of these forests have either been converted to farmland of arable and cash crops or other land uses.

Trees satisfy certain physiological and cultural needs of urban dwellers (Dwyer *et al.*, 1991). They play a social role in easing tensions and creating a serene environment that helps relax the minds of dwellers in the urban environment (Ulrich, 1990). The knowledge of the tree species diversity will enable inhabitants to positively relate with the trees as well as promote the diversity and sustainable management of the trees. Therefore, the aim of this study is to identify the diversity of open grown trees species found in Nnamdi Azikiwe University Awka, Nigeria.

MATERIALS AND METHODS

Study area: The study site is Nnamdi Azikiwe University Awka, Nigeria established in the southeastern zone in 1991 with mean elevation of 136 meters above sea level. It lies between the latitude 6.245^{o} to 6.283^{o} N and longitude 7.115^{o} to 7.1219^{o} E. The climate of the area is tropical indicating that it is basically within the tropical rainforest ecological zone with mean temperature of 26.3°C. Awka has seasonal climatic conditions; the rainy and the dry seasons with a short spell of harmattan as well as precipitation array of 1828 mm – 2002 mm (Ezenwaji *et al.,* 2013, Chukwu *et al.,* 2020). Figure 1 displayed the map of Awka South showing the location of the study area.

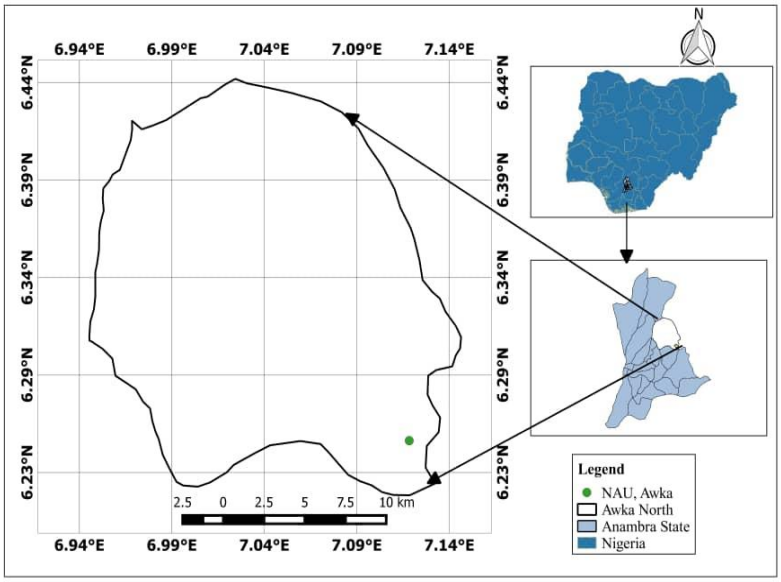

Figure 1: Map of Awka showing NAU.
Source: Ezenwenyi *et al.* (2020)

Data Collection and Sampling procedure

Field inventory of tree species was adopted for data collection. The study area was divided into two (sites A and B) for accurate recording of different trees species. Site A covered Faculty of Bio-sciences to Chike Okoli building and site B from Faculty of Environmental management to schools back gate. Using the main road as transect, sampling was done on both sides to enable accurate enumeration of all tree species. Through this survey, identification was limited to all the trees with diameter at breast height (Dbh) of ≥ 10 cm. These trees were identified at species level and recorded.

Data computation

Tree species Diversity: The following tree diversity indices were computed; Shannon – Wiener diversity index (H'), species evenness (E) and species dominance index to determine the tree species diversity.

Shannon – Wiener Diversity index (H'): The Shannon-Wiener diversity index is the most widely used index in community ecology. The values of Shannon – Wiener diversity index is usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5 (Magurran, 1998). It is given by

$$H' = -\sum_{i=1}^{s} P_i \ln P_i \quad (1)$$

Where, H′ = Shannon-Weiner index, P_i= the fraction of individual belonging to the ith species, ln = natural log, i = 1, 2, . . ., s.

Simpson's dominance index

Simpson's dominance index is weighted towards the abundance of the commonest species.

$$\text{Simpson index (c)} = 1 - \sum_{i=1}^{m} P_i^2 \quad (2)$$

Where, P_i = the proportional abundance of the ith species($P_i = \frac{n_i}{N}$), n_i = individual observation of ith species, N = Total number of all species, i = 1, 2, …, m

Data Analysis

Tree diversity and exploratory analyses: Alpha diversity method according to Magurran (2004) was used in the analysis of tree diversity for Shannon and Simpson indices while descriptive statistics (frequency, percentage, graphs etc.) was used in analyzing the species composition.

RESULTS

Identification and assessment of tree species composition

The results of tree species identified, their family and relative density (%) in the study area are presented in Table 1 and Figure 2. The total number of 25 tree species in 17 families were identified and recorded from this study area. *Azardirata indica* had the highest percentage of distribution of 26.1%. This was followed by *Vitex doniana* and *Daniella oliveri* with 10.0% and 9.6 % of distribution respectively. *Annona senegalensis, Holarrhena floribunda, Pentracletra macrophylla, Dalium guineense, Ficus capensis, Treculia africana* and *Carpolobia lutea* had the least and same value of percentage distribution of 0.2%. The number of species observed in each family as presented in Figure 2 showed that the family Fabaceae had the highest number (4) of species observed and they are *A. lebbeck* (4), *D. oliveri* (46), *P. macraphyla* (1) and *T. tetraptera*. This was followed by Apocynaceae, Lamiaceae, Moraceae and Myrtaceae all with same number of species observation of 2. Other families had only one (1) number of tree species observations.

Table 1: Tree species identified, their Families and percentage of occurrence in the study area

Family	Species	No of Tree	Percentage
Annonaceae	*Annona senegalensis*	1	0.2
Apocynaceae	*Alstonia boonei*	15	3.1
	Holarrhena floribunda	1	0.2
Arecaceae	*Borrassus aethiopum*	37	7.7
Bignoniaceae	*Newbouldia laevis*	39	8.1
Fabaceae	*Albizia lebbeck*	4	0.8
	Daniellia oliveri	46	9.6
	Pentaclethra macrophylla	1	0.2
	Tetrapleura tetraptera	5	1.0
Gentianaceae	*Anthocleista Schweinfurthii*	6	1.3
Lamiaceae	*Gmelina arborea*	25	5.2
	Tectona grandis	5	1.0
leguminosae	*Dialium guineense*	1	0.2
Longaniaceae	*Anthocleista vogelli*	16	3.3
Malvaceae	*Ceiba pentandra*	2	0.4
Meliaceae	*Azardirachta indica*	125	26.1
	Melicia excels	11	2.3
Moraceae	*Ficus capensis*	1	0.2
	Treculia Africana	1	0.2
Myrtaceae	*Eucalyptus camaldulensis*	32	6.7
	Eucalyptus globulus	20	4.2
Pinaceae	*Pinus caribaea*	32	6.7
Polygalaceae	*Carpolobia lutea*	1	0.2
Rubiaceae	*Morinda lucida*	4	0.8
Verbenaceae	*Vitex doniana*	48	10.0

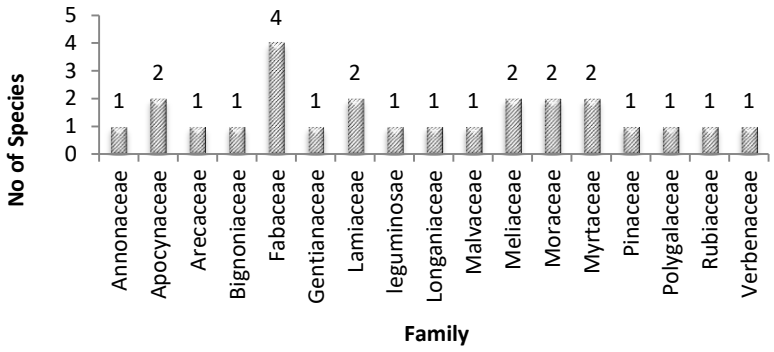

Figure 2: The number of species identified in each family

The graph (Figure 3) showing the frequency distribution of individual tree species observation according to their families revealed that, the family Meliaceae had the highest frequency of observation (136 trees); followed by Fabaceae and Myrtaceae of 56 and 52 trees respectively. Annonaceae, Leguminosae and Polygalaceae families had the least number of observations (1) each. The family and species of the trees encountered in the study area and their respective relative abundance (Pi), Simpson's dominance index and Shannon –Weiner diversity (H') are presented in Tables 2 and 3. The result of Shannon-Weiner diversity Index (H') for species diversity was 2.51 and this is greater than 1. Simpson index (C) value for species abundance was 0.88. Tree species diversity is one of the indicators of forest health. If H' <1, this implies that the tree diversity of the forest is low and vice versa. This simply means that the trees diversity of the study area is high because the result is >1.

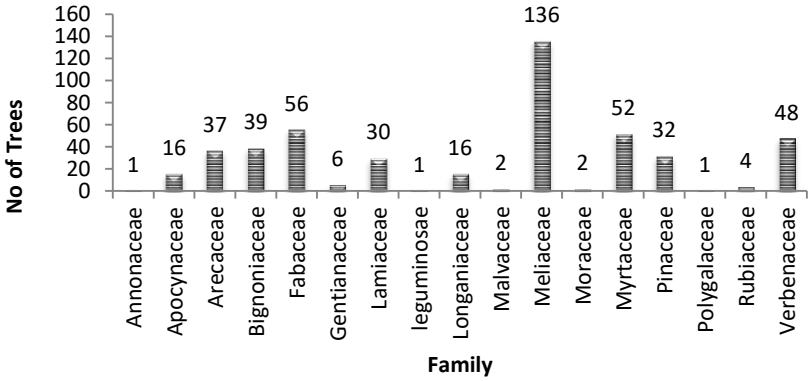

Figure 3: The frequency distribution of individual tree species according to their families

Table 2: Tree species diversity analysis

Sn	Family	Species	Frequency	Simpson's dominance Index	Relative Abundance (Pi)	LnPi	PiLnPi
1	Fabaceae	*Albizia lebbeck*	4	0.00007	0.00835	4.78541	0.03996
2	Apocynaceae	*Alstonia boonei*	15	0.00098	0.03132	3.46365	0.10847
3	Annonaceae	*Annona senegalensis*	1	0.000004	0.00209	6.17170	0.01289
4	Gentianaceae	*Anthocleista Schweinfurthii*	6	0.00016	0.01253	4.37994	0.05486
5	Gentianaceae	*Anthocleista vogelli*	16	0.00112	0.03340	3.39911	0.11354
6	Meliaceae	*Azardirachta indica*	125	0.06810	0.26096	1.34339	0.35057
7	Arecaceae	*Borrassus aethiopum*	37	0.00597	0.07724	2.56078	0.19781
8	Polygalaceae	*Carpolobia lutea*	1	0.000004	0.00209	6.17170	0.01289
9	Malvaceae	*Ceiba pentandra*	2	0.000017	0.00418	5.47855	0.02288
10	Fabaceae	*Daniellia oliveri*	46	0.00922	0.09603	2.34306	0.22501
11	Leguminosae	*Dialium guineense*	1	0.000004	0.00209	6.17170	0.01289
12	Myrtaceae	*Eucalyptus camaldulensis*	32	0.00446	0.06681	2.70597	0.18077
13	Myrtaceae	*Eucalyptus globulus*	20	0.00174	0.04175	3.17597	0.13261
14	Moraceae	*Ficus capensis*	1	0.000004	0.002088	6.171701	0.012885
15	Lamiaceae	*Gmelina arborea*	25	0.00272	0.052192	2.952825	0.154114
16	Apocynaceae	*Holarrhena floribunda*	1	0.000004	0.002088	6.171701	0.012885
17	Meliaceae	*Melicia excelsa*	11	0.00053	0.022965	3.773805	0.086664
18	Rubiaceae	*Morinda lucida*	4	0.00007	0.008351	4.785406	0.039962
19	Bignoniaceae	*Newbouldia laevis*	39	0.00663	0.08142	2.508139	0.204212
20	Fabaceae	*Pentaclethra macrophylla*	1	0.000004	0.002088	6.171701	0.012885
21	Pinaceae	*Pinus caribaea*	32	0.00446	0.066806	2.705965	0.180774
22	Lamiaceae	*Tectona grandis*	5	0.00011	0.010438	4.562263	0.047623
23	Fabaceae	*Tetrapleura tetraptera*	5	0.00011	0.010438	4.562263	0.047623
24	Moraceae	*Treculia africana*	1	0.000004	0.002088	6.171701	0.012885
25	Verbenaceae	*Vitex doniana*	48	0.01004	0.100209	2.3005	0.23053
			479	0.88346			2.50817

Table 3: Diversity indices

Diversity indices	Values
Number of species	25
Number of family	17
Shannon-Weiner	2.51
Simpson dominance index (C)	0.88

DISCUSSION

The tree species (25) distributed into 17 families in the study area implies that the vegetation is rich but lower than what was reported by Olajuyigbe *et al*. (2013) for tree species diversity in the Department of Forest Resources Management, University of Ibadan, Nigeria where a total of 76 trees of 27 species distributed in 15 families were recorded. The result of this study is higher than that of Kacholi (2019) who reported 24 species belonging to 11 families in his study on the assessment of tree species richness, diversity, population structure and regeneration in Nongeni forest reserve, Morogoro, Tanzania. Compositions of plants species across ecological zones varied greatly. The variances in the result of this study may be due to the degradations by anthropogenic activities as well as climate, topographical localities, ecological zones of the study area. Bello *et al*. (2013) affirmed that unpredictability in terms of anthropogenic activities; ecological zones, climate and weather are major driving factors determining the abundance and distribution of plant species.

The family Fabaceae has the highest diversity of four (4) species in this study. Other important families dominating the study area include the Apocynaceae, Lamiaceae, Moraceae and Myrtaceae with same number of species (2) identified. This is similar to the

findings of Omorogbe (2004) and Kacholi (2019) who reported 14 and 9 species from Fabaceae family having the highest species diversity in Sakponba Forest Reserve, Edo State, Nigeria and Nongeni forest reserve, Morogoro, Tanzania respectively. Omorogbe (2004) also reported that Fabaceae was distantly followed by Meliaceae with seven species; Annonaceae and Sterculiaceae with six species each, Moraceae and Apocynaceae had five while Euphorbiaceae had four.

Azardirata indica, *Vitex doniana*, *Tectona grandis*, *Eucalyptus camaldulensis*, *Ficus capensis* and *Daniella oliveri* had the high percentage of distributions. The trees cover a wide range of tangible and intangible uses which include medicinal, timber, food, fodder, fuel, aesthetics and soil protection, carbon sequestration and shade. This high species diversity is a representation of the tree stock found on the University campus. Some of these species are threatened and endangered, thus, raises an alarm on the need to begin deliberate conservation and regeneration for these trees. Some of these species listed in the IUCN threatened species red list include: *Khaya grandifoliola* C. DC., *K. senegalensis* (Desr.) A. Juss., *Milicia excelsa* (Welw) C. and *Delonix regia* (Hook) Raf. (IUCN, 2012).

CONCLUSION AND RECOMMENDATION

This study revealed that there is diversity of open grown tree species found in Nnamdi Azikiwe University, Awka. The disturbances caused by the demand for timber and non-timber products by both the University administration and community, coupled with the challenges of species adaptation to climate change pose a great threat to the continuous survival and sustenance of these tree species. Therefore, there is an urgent need for conservative measures and policy intervention in the management of trees on the campus as well as prompt conservation of the genetic resources found on the campus.

Reference

Bello, A.G., Isah, A.D. and Ahmad, B. (2013): Tree species diversity analysis of Kogo Forest Reserve in north-western, Nigeria. International Journal of Plant, Animal and Environmental Sciences. 3(3): 189-196.

Chukwu, O., Ezenwenyi, J.U. and Kenechukwu. T. V. (2020). Checklist and abundance of open grown medico ethnoforest tree species in NnamdiAzikiwe University, Awka, Nigeria. *Asian Journal of Biological Sciences*, 13(1):105-112.

Dwyer, J.F., Schroeder, H.W. and Gobster, P. H. (1991): The significance of urban trees and forests toward a deeper understanding of values. *Journal of Arboriculture* 17(10):276-284.

Ezenwaji E.E., Phil-eze P.O., Otti V.I. and Eduputa B.M. (2013). Household water demand in the pen-urban communities of Awka, Capital of Anambra State, Nigeria. *Journal of Geography and Regional Planning* 6:237-243.

Ezenwenyi, J.U., Chukwu, O. and Innocent, F. M. (2020). Stability assessment of open grown forest tree species in Nnamdi Azikiwe University Awka, Nigeria. *Research Journal of Agriculture and Forestry Sciences* 8(4): 9-16.

IUCN. (2012): The IUCN Red List of Threatened Species. Version 2012. 1. http://www.iucnredlist.org.

Kacholi, D.S (2019). Assessment of Tree Species Richness, Diversity, Population Structure and Natural Regeneration in Nongeni Forest Reserve in Morogoro Region, Tanzania *Tanzania Journal of Science* 45(3): 330-345.

Lafrankie, J, V., Ashton, P .S., Chuyong, G.B., Co, L., Condit, L., R., Davies, R., S. J., Foster, S. J., R., Hubbell, R., S. P., Kenfack, S. P., D., Lagunzad, D., D., Losos, D., Nor, N. S.M., Tan, S., Thomas, D. W., Valencia, R., and Villa, G. (2006): *Contrasting structure and composition of the under story in species-rich tropical rainforests*. 87: 2298-2305.

Magurran, A. E. (1998): *Ecological diversity and its Measurement*. Chapman and Hall, London,

Magurran, A. E. (2004): *Measuring Ecological Diversity*. Blackwell Publishing, Oxford. 256.

Mani, S. and Parthasarathy, N. (2006): Tree diversity and stand structure in inland and coastal tropical dry evergreen forest of peninsular India. Current science 90:1238-1246.

Olajuyigbe, S.O., Akinyele, A. O., Jimoh, S.O. and Adegeye, A.O. (2013): Tree species Diversity in the Department of Forest Resources Management, University of Ibadan, Nigeria. *African Journal of Sustainable Development* 3(1): 1-13.

Omoro, L.M.A., Pellika, P.K.E. and Rogers, P.C. (2010): Tree species diversity, richness, and similarity between exotic and indigenous forests in the cloud forests of eastern Arc Mountains,Taita Hills, Kenya. *Journal of forestry Research* 21(3):255-264.

Omorogbe, R.U (2004): Status of Flora Biodiversity and Exploitation of Biological Resources in Sakponba Forest Reserve, Edo State. M.Sc. Thesis. Ambrose Alli University, Ekpoma. 133p.

Suratman, M. N. (2012): Tree species Diversity and forest stand structure of Pahang National Park, Malaysia. In Biodiversity Enrichment in a Diverse World (18):473-492.

Ulrich, R. S. (1990): *The role of trees in wellbeing and health*. Fourth Urban Forestry Conference, St. Louis, Missouri, 15: (19) 116.