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Diversity, Abundance, and Conservation Status of Indigenous Tree Species in Binyaminu Usman Polytechnic, Hadejia, Jigawa State, Nigeria

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ABSTRACT
Indigenoustree species play an important ecological and socio-economic role in rural communities in Jigawa State. The study assessed the diversity, abundance and conservation status of native tree species at the Binyaminu Usman polytechnic in Hadejia, Jigawa. The site was divided into four sections and a full enumeration of native tree species with a diameter of more than 10 cm was made. The findings revealed 550 individual trees, of which 11 species were found in the arsenal of eight botanical families. The Fabaceae family was dominant with 36.4% species, while the other families *Ebenaceae, Meliaceae, Zygophyllaceae, Malvaceae, Mimosaideae, Rhamnaceae* and *Arecaceae* each accounted for one species each (9.1 each). The Shannon-Wiener Diversity Index calculated at 3.81 indicates a high diversity of species and a balanced distribution. However, most species have been classified as rare, vulnerable or endangered on the basis of the IUCN Red List and the GBIF. Notably, the highest relative density was found in the genus *Acacia* (30.0), while species such as *Diospyros mespiliformis* and *Tamarindus* indica had very low densities (0.36). The study recommends urgent conservation measures, including strict rules against cutting down native trees of more than 10 cm in diameter, annual plantation, and awareness campaigns to promote the environmental value of native trees. This effort is necessary to avoid further loss of biodiversity and to ensure the sustainable management of vegetative resources on the site. The study provides valuable input for biodiversity conservation and land-use management in semi-arid regions of Nigeria.

Keywords:
Indigenous trees,
Diversity,
Conservation,
Tree species,
Tree abundance.

INTRODUCTION

Academic environments, especially those located in urban areas, should be exemplars of sustainable development. These institutions not only serve as centers of learning but also provide ideal platforms for promoting environmental awareness and conservation practices. Trees within such campuses are more than landscape elements; they are integral components of urban forest ecosystems and can serve as defining features of the institutional environment. Indigenous tree species are ecologically valuable due to their ability to withstand local environmental pressures and reproduce periodically without causing adverse demographic impacts (Suratman, 2012; Ashman *et al.*, 2004). The deliberate planting of trees in educational institutions is often motivated by aesthetic appeal and the provision of ecosystem services such as air purification, shade, microclimate regulation, and noise reduction (Olajuyigbe and Akwarandu, 2019; Egunjobi, 1989; Babalola, 2000; Martens *et al.*, 2011). Despite these benefits, urban trees—including those on campuses—face significant threats. Uncontrolled population growth, expanding infrastructure, and unsustainable resource exploitation have led to severe anthropogenic pressures on tree populations. These include deforestation for firewood and charcoal production as well as land clearance for buildings and roads, which have disrupted natural regeneration cycles and altered forest structures (Omoro *et al.*, 2010). Tree species possess an inherent capacity for natural regeneration, a trait that provides a valuable ecological buffer against environmental degradation and supports sustainable resource use. However, realizing this potential requires reliable data on species composition, density, and spatial distribution. Such information forms the foundation for sound forest management strategies. Increasing anthropogenic disturbances over time have compromised the diversity and abundance of tree species, particularly in semi-arid zones like northern Nigeria (Omoro *et al.*, 2016).

The ecological and economic significance of trees cannot be overstated. They contribute essential products and services including timber, food, medicinal ingredients, fuelwood, construction materials, and cultural artifacts. Trees also provide vital forage for livestock and serve as habitats for diverse fauna (Patel and Patel, 2013; Ajayi *et al.*, 2020). As a result, the diversity and abundance of tree species are crucial indicators of broader forest biodiversity, directly influencing the viability of associated wildlife and ecological resilience (Malik *et al.*, 2014; Singh *et al.*, 2016).Baseline data on tree species diversity and abundance enable the assessment of ecological health, inform conservation priorities, and guide restoration efforts. Such data are also indispensable for understanding forest dynamics, including regeneration processes, mortality rates, understory development, and disturbance regimes (Attua and Pabi, 2013; Gonçalves *et al.*, 2017). Unfortunately, this type of ecological data remains limited or outdated in many parts of Nigeria. Zisadza-Gandiwa *et al.*, (2013) emphasized that insufficient data on plant composition often leads to underestimation of extinction risks. Consequently, plant species presumed to be common may be endangered, while those assumed to be endangered may be nearing extinction due to a lack of monitoring and documentation (Ikyaagba *et al.*, 2015). This underscores the urgent need to generate and disseminate accurate data on indigenous tree species, particularly in regions like Hadejia, where existing ecological information is sparse or nonexistent.Thus, the current study aims to fill this critical knowledge gap by evaluating the diversity, abundance, and conservation status of indigenous tree species within Binyaminu Usman Polytechnic, Hadejia. The findings will provide essential data for biodiversity management, conservation planning, and policy formulation, thereby supporting the broader goals of sustainable development in northern Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out at the Binyaminu Usman Polytechnic in Hadejia, Jigawa State, Nigeria. The site was established in 2009 on the Hadejia-Mallam Madori highway and is geographically located at latitude 12° 28′ 53.85″ N and Longitude 10° 0′ 49.94″ E (Figure 1). The southern boundary of the campus is delimited by the Hadejia River. Hadejia has a semi-arid climate, with a long dry season and relatively short rainy season. Average annual temperature is around 25 degrees Celsius, with monthly temperatures ranging from around 21 degrees Celsius in the coldest months to around 31 degrees Celsius in the hottest. Annual rainfall is usually between 600 and 762 mm. The population of the Hadei local government area according to the 2006 national census was 104,286 people, with an estimated annual growth rate of 2.5 percent. The region is known for its extensive cultivation of staple crops, in particular rice and wheat, and for its strong trade sector, supported by several local markets (Gambo *et al.*, 2018). Vegetation in the study area can be divided into three main types: vandalism. The first is the savanna, which includes upland pasture and woodland dominated by the genus strict stricture. The second type is found in the forests of the Tudu dynasty - sandy slopes that remain dry throughout the year, except for temporary ponds. Other notable tree species in this zone include the legendary legendary genus of mysteriumwidespreades. (mainly A. albida), Ziziphus spp., Balanus aegyptiaca, Tamarindus indica and Adansonia digitata, with a mixture of grasses of species such as Cenchrus biflorus, Andropogon spp., and Vetiverianigricum. The third type of vegetation consists of riparian and floodplain ecosystems. The tropical forests - locally called kurmi - host species such as Khaya senegalensis, Mitragyna inermis and Diospyros mespiliformis, which are on the northern edge of their distribution. In some areas, the forests have been replaced by plantations of mangled vegetables from the species indica (mangile) and guajajuava (guava). In addition, seasonal flooded wetlands and fadama areas are characterised by species such as Acacia nilotica and Hyphaene thebaica (dumpling), which thrive on small, elevated areas. Unemployment of water is also supported by aquatic vegetation such as the extinct vegetation of the genus Echinochloa, sacred to the sacred massif. And Oryza spp., while the drier areas are inhabited by grasses such as Dactylocteniumaegyptium, Setaria spp., and Cyperus spp. Extensive stands of Jurassic Forest are also common, and thickets of Mimosa pigra often dominate the margins of lakes and bodies of water (BirdLife International, 2015; Roger, 2013).

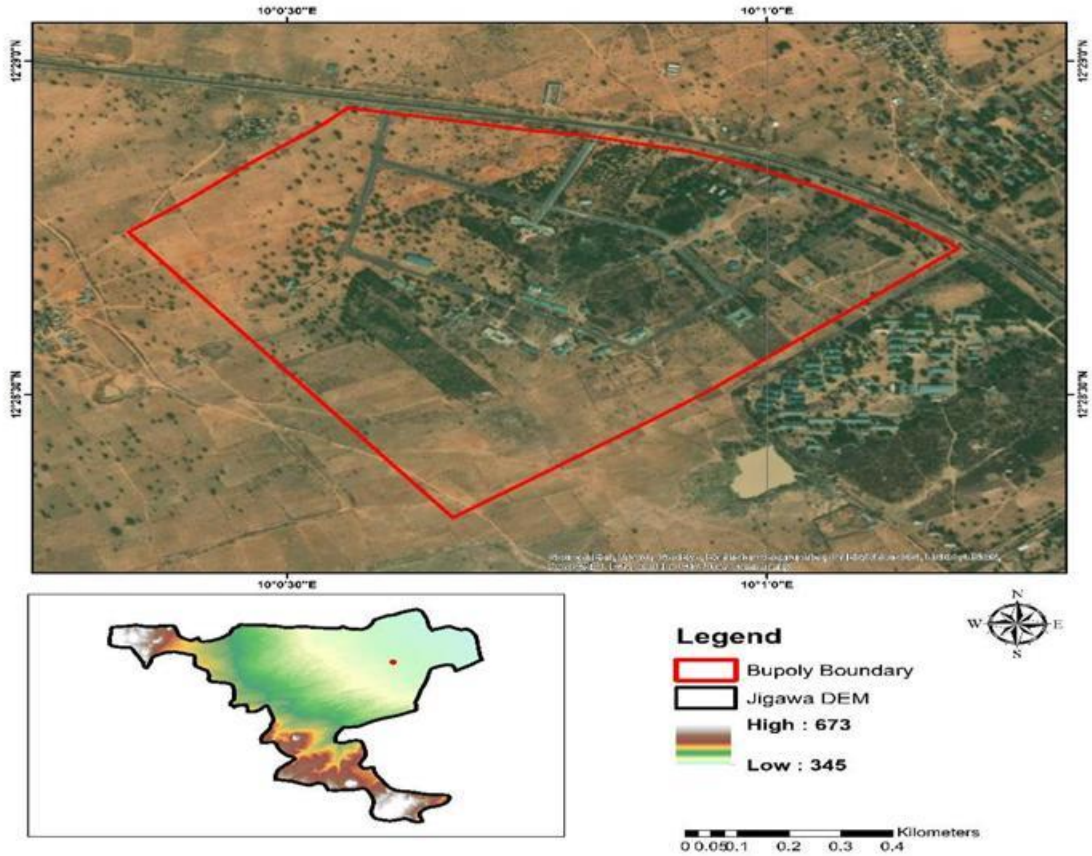

Figure 1. Map showing the Location of the Study Area

Data Collection

Standardized field data sheets were used to collect information on the vegetation. All native tree species with a diameter of 10 cm or more have been identified and recorded. Species identification was done by a combination of approaches: knowledgeable residents with long-term knowledge of the area helped to identify tree species based on local names, and mobile plant identification applications were used to help identify unknown species. This approach reduced the need for extensive sample collections for later identification and ensured a more efficient and accurate documentation process.

Data Analysis

To assess the diversity and distribution of indigenous tree species, several ecological indices and analytical methods were applied:

i. Margalef Species Richness Index (d):
This index provides a straightforward measure of species richness and was calculated based on the formula proposed by Margalef (1958):

$$d = (S - 1) / \ln N \quad (1)$$

where:
S = total number of species,
N = total number of individual trees recorded, and
ln = natural logarithm.

ii. Shannon-Wiener Diversity Index (H): This index evaluates species diversity within a community by considering both species richness and evenness, following the approach of Shannon and Wiener (1949):

$$H = -\sum Pi \ln Pi \quad (2)$$

where:
Pi = proportion of individuals of species *i* (i.e., *S / N*),
S = number of individuals of a particular species,
N = total number of individuals of all species, and
ln = natural logarithm (base *e*).

iii. Relative Density (RD): This metric was used to determine the proportion of each tree species relative to the total population:

$$RD = (\text{Number of individuals of a species} / \text{Total number of trees}) \times 100 \quad (3)$$

iv. Relative Abundance (Pi):
Relative abundance was calculated as the proportion of each species' relative density expressed as a percentage:

$$Pi = RD / 100 \quad (4)$$

v. Conservation Status Assessment:
Each tree species identified has been assessed for its overall conservation status using data from the Global Biodiversity Information Facility (GBIF) and the IUCN Red List (Version 2022-1). The IUCN Red List is widely considered the world's leading indicator of the risk of extinction of species and is widely used to guide biodiversity policy and practice. At the same time, the GBIF serves as a globally supported open research infrastructure providing comprehensive biodiversity data and ensuring that species information is available and usable worldwide (Bell *et al.*, 2019).

RESULTS AND DISCUSSION

Composition of Indigenous Tree Species in Binyaminu Usman Polytechnic

The list of native tree species found in the new campus of Binyamin University is summarised in Tables 1 and 2, with an emphasis on their taxonomic groupings, variety, abundance and conservation status. A total of 11 native tree species were recorded, representing 8 botanical families. Among these, the Fabaceae family was most dominant with four species, corresponding to approximately 36.4 percent of the total number of species observed. This predominance is in line with the findings of Salami (2017), who found that Fabaceae and Meliaceae are similarly widespread in the Omo Forest reserve because of their efficient seed dispersal mechanisms, especially by wind, which promote their wide distribution and colonisation potential.

The other families--*Ebenaceae, Meliaceae, Zygophyllaceae, Malvaceae, Mimosaideae, Rhamnaceae, and Arecaceae*--each had one species each, indicating that the richness of the species within each group was lower. Certain species, such as Paupartiabirrea, Adansonia digitata and Acacia nilotica, had the lowest incidence of mortality on the study plots. This can be attributed to several environmental and physiological factors, to the adaptations of these species to arid and semi-arid environments. Trees typical to these areas often face problems linked to soil moisture stress, limited availability of nutrients and competition from other vegetation. Moreover, the anatomical and structural characteristics of these species may prevent them from growing and surviving in the prevailing climate and eddy conditions in the Hadei region. The limited presence of these species may also indicate a decline in natural regeneration or an increase in anthropogenic pressure, which may further jeopardise their long-term survival. Understanding the distribution patterns and the ecological challenges faced by these native trees is essential for the development of informed strategies for the protection of biodiversity and sustainable land management in the Polytechnic and in the wider region.

Table 1. Species Composition, family and Conservation Status of Indigenous Trees in Bupoly

S/No.	Local Name	Scientific Name	English Name	Family	Conservation Status
1.	Kanya	*Diospyros mespiliformis*	African Ebony	*Ebenaceae*	Endangered
2.	Madaci	*Khaya senegalensis*	Mahogany	Meliaceae	Vulnerable
3.	Tsamiya	*Tamarindus indica*	Tamarind	Fabaceae	Endangered
4.	Farar Kaya	*Acacia seyel*	Shittimwood	*Fabaceae*	Threatened
5.	Bagaruwa	*Acacia nilotica*	Thorn mimosa	Fabaceae	Vulnerable
6.	Aduwa	*Balanites aegyptiaca*	Egyptian balsam	Zygophyllaceae	Vulnerable
7.	Kuka	*Adansonia digitata*	Baobab	Malvaceae	Threatened
8.	Gawo	*Faidherbiaalbida*	Apple-ring acacia	*Mimosoideae*	Vulnerable
9.	Magarya	*Ziziphus mauritiana*	Indian Jujube	Rhamnaceae	Vulnerable
10	Kalgo	*Ficus Thonnongii*	Purple orchid	*Fabaceae*	Endangered
11	Goruba	*Hyphaene thabaica (big)*	Doum palm	Arecaceae	Threatened

Source: Fieldwork, 2024

Tree Species Diversity

The concept of species diversity is an essential element of ecological studies and is usually understood to consist of two main elements: the richness of the species (the number of different species present in the community) and the abundance of the species (the relative abundance of each species in the community). In order to quantify these elements, environmentalists often rely on different indices of rarity. Some of the most widely used are the Shannon index, the Simpson index and the Magurran index, each of which capture different aspects of biodiversity based on abundance and distribution patterns. For the purpose of this study, the Shannon-Wright Diversity Index (also known as the Shannon index or H) was used because of its sensitivity to rare and common species in the population. The index gives a comprehensive picture of biodiversity, not only the number of species (the richness), but also the degree of distribution of individuals between species (the relativity). As noted by Shannon (1948), the index becomes more sensitive to the presence of rare species as the value of H rises. Kent and Coker (1992) also note that Shannon indices tend to be between 1.5 and 3.5 in most natural ecosystems, with values above 3.5 being uncommon and indicating an exceptionally high biodiversity.

In this study, the calculated Shannon index for 550 native tree species recorded at the new campus of Binyaminu Usman Polytechnic was 3.81 (Table 3). This value is above the upper limit of the typical range observed in many ecological systems, indicating that the tree community in the study area is both rich in species and well balanced in terms of distribution of the population. A high Shannon diversity index like this reflects a stable and resilient natural world. This means that no single species dominates the landscape, and that the community is made up of many species, each of which contributes significantly to the overall structure of the ecosystem. This level of diversity improves the functionality of the ecosystem by promoting inter-species interactions, supporting different ecosystem services and improving adaptability to environmental changes or disturbances. The high diversity observed in this study therefore underlines the environmental importance of the Polytechnic's native tree population and the need to prioritize conservation efforts to maintain and increase this biodiversity.

Relative Density of Trees Species

Relative abundance is a critical ecological parameter used to determine the proportion of each species in relation to the total number of tree species present in a study area. This metric provides an insight into the dominance or rarity of each species and thus helps to understand the composition and ecological balance of the forest population. The relative densities of all identified native tree species were calculated in this study and reported in Table 2. Among the species recorded, *Acacia nilotica* was the most dominant, with a relative abundance of 30.00, which means that almost one third of all tree species in the site are of this species. *Khaya senegalensis* followed closely with a relative density of 22.18 percent, also reflecting its significant presence on the landscape. At the other end of the spectrum, species such as Diospyros mespiliformis and Tamarindus indica had the lowest relative abundance, accounting for only 0.36 per cent of the total tree population. Similarly, *Adansonia digitata* had a slightly higher but still low relative density of 0.91 percent. The low percentage indicates that these species are either naturally rare in the area or have experienced a significant decline in their populations over time.

One plausible explanation for the low density of these species is the ongoing infrastructure development within the polytechnic campus. Expanding buildings, roads and other infrastructure is likely to contribute to habitat fragmentation, the removal of trees and the suppression of natural regeneration processes. In addition, human-induced pressures such as land clearing, soil compaction and reduced seed dispersal could further reduce the ability of less dominant species to prosper. The consequences of reduced relative density, especially among the ecologically valuable and culturally important native trees, are profound. Reducing the diversity and abundance of species may lead to environmental imbalances, such as habitat loss, soil degradation and nutrient cycling disruption. Moreover, these changes may have a negative impact on the livelihoods of local communities, many of which depend on trees for fuel, food, medicine and income. Finally, the figures highlight the need for targeted conservation strategies to protect less common tree species and restore the ecological balance of the site. Promoting a more balanced diversity of species will not only protect biodiversity but also promote the long-term sustainability and environmental integrity of Binyamin Usman Polytechnic and the surrounding environment.

Table 2. Relative Density and Abundance of Indigenous trees

S/No.	Species	Number of Individuals	Relative Density	Relative Abundance
1.	*Diospyros mespiliformis*	2	0.36	0.0036
2.	*Khaya senegalensis*	122	22.18	0.22
3.	*Tamarindus indica*	2	0.36	0.0036
4.	*Acacia seyel*	65	11.82	0.12
5.	*Acacia nilotica*	165	30.00	0.3
6.	*Balanites aegyptiaca*	37	6.73	0.07
7.	*Adansonia digitata*	5	0.91	0.009
8.	*Acacia albida / F. albida*	25	4.55	0.05
9.	*Ziziphus mauritiana*	70	12.73	0.13
10.	*Piliostigmarecticulatum*	46	8.36	0.08
11.	*Hyphaene thabaica (big)*	11	2.00	0.02

Source: Fieldwork, 2024

Table 3. Species Composition and Diversity of Indigenous Trees in Bupoly

S/No.	Species	Total Number(n)	Pi	lnPi
1.	*Diospyros mespiliformis*	2	0.04	-3.22
2.	*Khaya senegalensis*	122	0.22	-1.51
3.	Tamarindus indica	2	0.04	-3.22
4.	Acacia seyel	65	0.12	-2.12
5.	Acacia nilotica	165	0.3	-1.20
6.	Balanites aegyptiaca	37	0.07	-2.66
7.	Adansonia digitata	5	0.01	-4.61
8.	Acacia albida / F. albida	25	0.05	-2.99
9.	Ziziphus mauritiana	70	0.13	-2.04
10.	Piliostigmarecticulatum / F. Thonnongii	46	0.08	-2.53
11.	Hyphaene thabaica (big)	11	0.02	-3.91

Source: Fieldwork, 2024

$H = -\sum pi\ lnpi = 3.81$

Conservation Status of Indigenous Tree Species Based on IUCN Criteria

For the conservation status of native tree species in the study area, each species was assessed based on data from two databases that are internationally recognized: the International Union for Conservation of Nature Red List (IUCN Red List 2022-1) and the Global Biodiversity Information Facility (GBIF). The IUCN Red List is widely considered the most authoritative global source of risk assessments for species extinction and helps to guide biodiversity policy, conservation priorities and initiatives to protect habitats. At the same time, the GBIF is an open access platform, supported by international governments, that provides comprehensive biodiversity data and facilitates species monitoring and conservation planning worldwide (Bell *et al.*, 2019).The analysis revealed that a significant proportion of native species at Binyaminu Usman Polytechnic fall under different categories of conservation. Specifically, 45.4 percent of the species recorded are classified as Vulnerable to Terrorism (VAT) on the IUCN Red List. The group includes the *genera Khaya senegalensis, Acacia nilotica, Balanites aegyptiaca and Ziziphus vulgaris*. Another 27.3 percent were classified as endangered, including Diospyros mespiliformis and Tamarindus indicus. In addition, the category of endangered species - which may include species facing an immediate threat due to habitat loss or limited natural regeneration - also represented 27.3 percent of the total, including *Acacia nilotica, Adansonia digitata and Hyphaenathabaica* (see Table 1). These findings are consistent with previous studies in similar ecological landscapes. For example, the Nobel Prize for short notice. (2019) carried out a local conservation assessment in the Sudanese savanna area of Katsina State and reported *Mangifera indica and Borassus aethiopum to be classified as near threatened, while Linnaea schimperi and Pterocarpus erinaceus* were classified as vulnerable. Species such as *Prosopis africanana and Diospyros mespiliformis* have been classified as critically endangered (CR) and Tamarindus indica and Balanites aegyptiaca as endangered (EN). Similarly, Borokini (2014) reported that of the 164 species of plants found in Nigeria classified as endangered, 132 are in the vulnerable category.

The Federal Ministry of the Environment (FME, 2006b) notes that of the 7,895 documented species of flora in Nigeria, approximately 0.4 percent are endangered, and 8.5 percent are vulnerable. Regional studies in dryland regions such as in the north-west of Nigeria (Mohammad and Sa'adu, 2017) and in the Takht-e-Nasratti region of Pakistan (Musharraf *et al.*, 2013) have also identified a high incidence of endangered and vulnerable flora, with 22 species of these species being classified in the EPC. The presence of many vulnerable or endangered species can have far-reaching environmental, social and economic impacts. From an environmental point of view, these species often play a crucial role in maintaining the health of the ecosystem, promoting biodiversity and stabilizing soil and microclimate conditions. Their decline can lead to weakened ecosystems that are more vulnerable to invasive species, pests, disease and climate change. Furthermore, the loss of culturally and economically important tree species can reduce the aesthetic, recreational and utilitarian value of forests. Given the limitations of applying global IUCN criteria to local contexts, it is imperative that Nigeria develop a national blacklist tailored to its unique ecological situation. Many species currently classified as least concern (LC) at global level may in fact be endangered (EN), near-endangered (NT) or even critically endangered (CR) at national or regional level due to local threats and pressures on their habitats. Developing such a localized framework would greatly increase the effectiveness of the conservation dimension of the policy in Nigeria.

CONCLUSION

This study comprehensively assessed the diversity, abundance, and conservation status of indigenous tree species within the campus of Binyaminu Usman Polytechnic, Hadejia, Jigawa State. The findings reveal a concerning trend: a significant proportion of the indigenous trees surveyed are classified as vulnerable, threatened, or endangered. This high-risk status poses multiple ecological challenges, including the potential decline of ecosystem functions, loss of biodiversity, and a reduction in the campus's aesthetic, cultural, and recreational value.

The presence of many tree species with low population density suggests that without immediate intervention, several native species may be pushed toward local extinction. Such a loss could have long-term consequences on ecological balance and the ability of the environment to support both wildlife and human livelihoods. It is clear from the analysis that urgent conservation measures are required to prevent the further degradation of these native tree populations.

However, it is important to note that not all plant species require the same level of conservation priority. Conservation efforts should focus on species categorized under threatened, vulnerable, and endangered classes, as these are most at risk. Moreover, species vary in their resilience and ability to adapt to environmental pressures such as urban development and climate change. Therefore, context-specific and species-relevant strategies must be applied when determining conservation priorities.

One of the critical insights from this study is that while the Polytechnic hosts many trees, most of them are exotic species. Although some indigenous species like *Khaya senegalensis, Acacia nilotica, Ziziphus mauritiana, Piliostigmareticulatum, and Acacia albida* were found in notable numbers, many other native species were sparsely distributed, indicating a risk of local extinction if no action is taken.

Considering these findings, the following **recommendations** are proposed:

1. Institutional Conservation Action: The establishment and empowerment of a Campus Greening and Conservation Committee is essential. This body should be tasked with overseeing tree planting programs, regulating felling activities, and initiating awareness campaigns on the importance of native tree conservation.
2. Focus on Threatened Species: Priority should be given to the propagation and protection of native species that are classified as endangered or vulnerable. These should be targeted for enrichment planting and regular monitoring.
3. Policy Support: Localized conservation policies should be developed and enforced, including guidelines to prevent the removal of any indigenous tree with a diameter ≥10 cm without appropriate authorization.
4. Educational and Research Utility: The results of this study can serve as a valuable reference for students, educators, and researchers seeking to establish orchards, botanical gardens, or engage in ecological studies related to forest biodiversity and campus sustainability.

Ultimately, safeguarding indigenous tree species is not only about preserving biodiversityit is also a step toward ensuring ecological stability, improving the environmental quality of the campus, and enriching the educational experience of students and future researchers.

REFERENCE

Ajagbe, A. A. (Ed.). (2013). State of Africa's Birds: Outlook for Our Changing Environment. BirdLife International Africa Partnership.

Ajayi, I. K., Kayode, J., &iAdemiluy, B. O. (2020). Study on urban trees in Ekiti State University, Ado Ekiti, Nigeria: 1. structure and composition. Budapest International Research in Exact Sciences (BirEx) Journal, 2(2), 147-156.

Ashman, T. L., Knight, T. M., Steets, J. A., Amarasekare, P., Burd, M., Campbell, Attua, E. M., & Pabi, O. (2013). Tree species composition, richness and diversity in the northern forest-savanna ecotone of Ghana. Journal of Applied Biosciences, 69, 5437-5448.

D. R., ... & Wilson, W. G. (2004). Pollen limitation of plant reproduction: ecological and evolutionary causes and consequences. Ecology, 85(9), 2408-2421.

Babalola, F. D. (2010). Issues and option for appropriate management strategies of campus tree at university of Ibadan, Nigeria. Nigerian Journal of Ecology, 11, 33-42.

Bello, A., Jamaladdeen, S., Elder, M. T., Yaradua, S. S., Kankara, S. S., Wagini, N. H., ... & Muasya, M. (2019). Threatened medicinal and economic plants of the Sudan Savanna in Katsina State, northwestern Nigeria. Bothalia-African Biodiversity & Conservation, 49(1), 1-17.

Borokini, T. I. (2014). A systematic compilation of endemic flora in Nigeria for conservation management. Journal of Threatened Taxa, 6(11), 6406-6426.https://doi.org/10.11609/JoTT.o4010.6406-26

Borokini, T. I. (2014). A systematic compilation of IUCN red-listed threatened plant species in Nigeria.

International Journal of Environmental Sciences, 3(3), 104-133.

Chiarucci, A., Maccherini, S., & De Dominicis, V. (2001). Evaluation and monitoring of the flora in a nature reserve by estimation methods. Biological Conservation, 101(3), 305-314.

Gambo J. Garba A., Hadiza, Z. , Ahmad M. I, Bashir S. B, Yusuf A.Y (2018): Assessing the impacts of improper medical waste disposal and residents perception of their disposal practices in Hadejia Metropolis, Jigawa state, nigeria . Nigerian Research Journal of Chemical Sciences, Vol. 4, 2018.

Gasu, M. B., Gasu, G. N., & Ntemuse, U. E. (2021). A review of biodiversity loss and climate change: Policy measures and adaptation strategies in Nigeria. Malaysian Journal of Tropical Geography (MJTG), 47(1 and 2), 100-122.

Gonçalves, F.M.P., R. Revermann, A.L. Gomes, M.P.M. Aidar, M. Finckh and N. Juergens, (2017). Tree species diversity and composition of miombo woodlands in South-Central Angola: A chronosequence of forest recovery after shifting cultivation. Int. J. For. Res., Vol. 2017. 10.1155/2017/6202093.

Ikyaagba, T. E., Tee, T. N., Dagba, B.I., Ancha, U. P., Ngibo, K. D., and Tume, C. (2015). Tree composition and distribution in federal university of agriculture makurdi, Nigeria. Journal of research in forestry, wildlife and environment, 7 (2):147 – 157.

IUCN, UK.IUCN (2021). IUCN Red List Categories and Criteria 2021: Version 3.1 second edition, IUCN, Gland, Switzerland. Available at: www.iucnredlist.org.

Kent, M. & Coker, P. (1992). Vegetation Description and Analysis. A Practical Approach. John Wiley and Sons, Chichester, England

Malik, Z.A., A. Hussain, K. Iqbal and A.B. Bhatt, (2014). Species richness and diversity along the disturbance gradient in Kedarnath Wildlife Sanctuary and its adjoining areas in Garhwal Himalaya, India. Int. J. Curr. Res., 6: 10918-10926.

Margalef, D.R. (1958); Information theory in Ecology General System Bulletin. 3:36-71.

Martens D, Gutscher H, Bauer N (2011). Walking in "wild" and "tended" urban forests: The Impact on Psychological well-being. Environmental Psychology 31(1):36-44.

Muhammad, N. D. and Sa'adu, M. A. (2017). Conservation status of Vegetation in the Dryland of Northwestern Nigeria. International Journal ofAgriculture, Forestryand Fisheries,5(2),18-24.

Musharaf, K., Farrukh, H. and Shahana, M. (2013). Conservation status of trees in Tehsil Takht- e-Nasratti, Karak Pakistan. African Journal of Plant Science, 7(6), 201-207.

Olajuyigbe SO, Akwarandu KE (2019). Floristic Composition and Stand Structure in a Tropical Watershed Forest: Implication for biodiversity conservation. Environtropica 15:79-94.

Omoro, L.M.A., P.K.E. Pellikka and P.C. Rogers, (2010). Tree species diversity, richness, and similarity between exotic and indigenous forests in the cloud forests of Eastern Arc Mountains, Taita Hills, Kenya. J. For. Res., 21: 255-264.

Pande, P. K., Negi, J. D and Sharma, S. C (1996). Plant species diversity and Vegetation Analysis in Moist Temperate Himalayan Forests. Abstracted in first Indian Ecological congress. New Delhi, 27-31, December.

Patel, H.R. and R.S. Patel, (2013). Ethnobotanical plants used by the tribes of R.D.F. Poshina forest range of Sabarkantha District, North Gujarat, India. Int. J. Sci. Res. Publ., Vol. 3.

Salami, K.D. (2017). Tree species Diversity and Soil status of Omo Biosphere and Gambari Forest reserves in Southwestern Nigeria. Ph.DThesis, Department of Forest Resources Management, University of Ibadan, Nigeria.

Shamaki, S. B., Bello A.G and Dikko, A. A. (2015). Tree species Density and Distribution in Dabagi Forest Reserve in Semi-Arid Region of Nigeria. Proceedings of the 4th Biennial National Conference of the Forest and Forest Products Society, 144 - 149Pp

Shannon, C.E. (1948). A Mathematical Theory of Communications. Bell System Technical Journal, 27: 379-423.

Singh, S., Z.A. Malik and C.M. Sharma, (2016). Tree species richness, diversity, and regeneration status in different oak (Quercus spp.) dominated forests of Garhwal Himalaya, India. J. Asia-Pac. Biodivers., 9: 293-300.

Suratman, M. N. (2012). Tree Species Diversity and Forest Stand Structure of Pahang National Park, Malaysia. In:Biodiversity Enrichment in a Diverse World. Chapter 18. INTECH. 473-492pp.

World Conservation Monitoring Centre (1998). Khaya senegalensis. The IUCN Red List of Threatened Species 1998:e.T32171A9684583. https://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T32171A9684583.en. Accessed on 21 May 2025.

Zisadza-Gandiwa, P., Mabika, C.T., Kupika, O.L., Gandiwa, E and Murungweni, C. (2013). Vegetation Structure and Composition across Different Land Uses in a Semiarid Savanna of Southern Zimbabwe. International Journal of Biodiversity Volume 2013.