Implications of Plant Composition, Distribution and Diversity in Hadejia Wetland National Park, Jigawa State, Nigeria

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ABSTRACT

National Parks are vital ecosystem in Nigeria, faces threats to its biodiversity due to inadequate conservation strategies. Despite its importance, the park's floristic composition, diversity, distribution, and abundance of tree species remain poorly understood. This knowledge gap hinders effective conservation and management, emphasizing the need for a comprehensive assessment of the park's forest resources. A random sampling design was employed, with four 100x100m plots assessed in Hadejia Wetland National Park. Data collection involved identifying tree species with Dbh of 10cm and above, abundance, and distribution. Descriptive statistics used to analyze species abundance and distribution patterns. Diversity was assessed using the Shannon-Wiener Index (HI), while frequency, relative frequency, density, and abundance were calculated to characterize the park's floristic composition. The study revealed 50 plant species in Hadejia Wetland National Park, with Fabaceae being the most dominant family. High species diversity of 4.63 with several species of economic, medicinal importance represented with high abundance of Hyphaene thebaica. 78, Ziziphus mauritiania 68, Acacia nilotica 60, Polyacantha spp 59 while several species had low frequency as one (1). The density and relative such as Hyphaene thebaica (0.003; 4.8), Ziziphus mauritiana (0.0022; 4.4), Acacia nilotica (0.002; 3.7) and Polycantha spp (0.019; 3.7) having a higher density. The study revealed high species diversity with economically valuable species like Hyphaene thebaica, Ziziphus mauritiana, and Acacia nilotica dominating the landscape. Therefore, there is need for conservation and sustainable management. Hadejia Wetland National Park has a rich array of plant species and high diversity.

INTRODUCTION

Wetlands are among the most productive ecosystems globally, providing critical services that sustain biodiversity, regulate the climate, and support human livelihoods. Forest tree resources in wetlands such as the Hadeja Wetland National Park in northern Nigeria represent a vital component of these ecosystems. This national park is a home to diverse tree species that fulfill ecological roles such as soil stabilization, water purification, and serving as carbon sinks. The Hadeja Wetland spans approximately 320 square kilometers and contains a mix of indigenous and economically valuable tree species, including *Acacia nilotica*, *Terminalia superba*, and *Phoenix reclinata*, which are critical for sustaining both the environment and the local economy (Osu, 2017). Understanding global forest resource changes is complex and more critical than merely tracking forest area changes. Evaluating natural resource use, ecosystem services, and land use requires consideration of social, economic, and environmental dimensions (Arrow *et al.*, 1995). Different methodologies must be applied to account for these aspects (Myllyviita *et al.*, 2011). Forests provide various ecosystem services, including raw materials, climate regulation, and watershed protection (Lamarque *et al.*, 2011; Nasi *et al*., 2002). However, many forests face overexploitation and abandonment. Sustainable management is crucial for maintaining forest potential and ecosystem services (Stupak *et al.*, 2010). Non-Timber Forest Products (NTFPs) are vital substances obtained from forests without harvesting trees (FAO, 2018). NTFPs include plants and forest products valued for purposes beyond timber. Ensuring the multifunctionality of forests is a significant

challenge (Lafleur and Fraanje, 1997). Effective forest management balances society's demand for forest products with preserving forest health and diversity (Augusta, 2002). This balance is critical for the survival of forests and the prosperity of forest-dependent communities.

The Hadejia Wetland National Park in Jigawa State, Nigeria, is a vital ecosystem that supports a wide range of plant and animal species, and provides various ecological services, including water filtration, flood control, and carbon sequestration. However, the park's plant composition, distribution, and diversity are facing numerous threats, including habitat destruction, invasive species, climate change, and human activities such as overgrazing and fuelwood harvesting (Adebayo *et al*., 2020). A study by Ogunkunle and Nzoiwu (2018) revealed that the park's vegetation has been degraded, leading to a loss of biodiversity and ecosystem function. Furthermore, the park's plant species are being over-exploited for medicinal and economic purposes, without sustainable management practices in place (Kolo *et al*., 2020). Additionally, climate change is altering the park's hydrology and vegetation dynamics, leading to changes in plant composition and distribution (Ogundipe *et al*., 2019). Currently, the Hadejia Wetland national Park is managing but there us need to increase the conservation strategies that can improve it's biodiversity. Therefore, this study aims to investigate the implications of plant composition, distribution, and diversity in Hadejia Wetland National Park, in order to provide insights for conservation and sustainable management of the park's ecosystem.

Plate 1: Hadejia Wetland Park
Source: Quick News Africa, 2024

Plate 2: Hadejia Bird Sanctuary

MATERIALS AND METHODS

Description of the Study Area

The study area has a coordinate of 12° 38' 59" N and 10° 35' 99" E in the Sahel savanna in North eastern Nigeria. The Hadejia Wetlands covers an area of about 320 square km^2; it comprised of mixture of seasonal, flooded land. It is characterized by law rainfall between 200 mm in a drought years and 600 mm in a very rainy year, which falls almost entirely between the months of May September or October, the remaining seven months of the year representing the 'dry season' (Saka *et al.*, 2020). The natural vegetation consists of woodland dominated by tree such as *Acacia Sp Acacia nilotica, Acacia senegal, Acacia seyel, Dyospyrus mespiliformis* and *Hyphane thebaica, Ziziphus mouritiana* (Saka *et al.*, 2020).

Data Collection

Select representative sites within the Hadejia Wetland National Park that encompass different vegetation types, tree species, and environmental conditions, that entails both timber and non-timber forest products resources

Sampling Design and Data analysis

Random sampling design was choosing because of its independence, homogenous and freedom from bias, simple random sampling, and no prior knowledge and four plots of 100 x 100m were assessed**.** Analysis of species abundance and distribution pattern using statistical methods. Check list of various tree species present in the selected area in HWNP. Data collected was subjected to descriptive statistics such as, frequency which was presented by the use of table. Assess the distribution and abundance of different tree species in HWN P. Floristic composition diversity and distribution was identified will be recorded for determine the following parameters:

Frequency = $\frac{Number\ of\ quadrats\ in\ which\ in\ which\ species\ occur}{Total\ number\ of\ quadrats\ sampled}$ (eqn 1)

Relative frequency = $\frac{species\ frequency\ of\ individual\ species}{Sum\ of\ frequency\ values\ for\ all\ species}$ x100% (eqn 2)

Density= $\frac{Number\ of\ individual\ species}{Area\ samled}$ $(equ\ 3)$

Abundance (A) = $\frac{\text{Total number of the species in all quadrate}}{\text{Total number of quadrate in which the species occured}}$, $(equ\ 4)$

Assessment of the diversity of the tree species in the Study area which could be achieved by using the below formula.

Diversity: Shannon-Wiener Index (H')= $\boldsymbol{H'} = -\sum (ni/N) * \ln(ni/N)$ (eqn 5)

Where: H' = Shannon-Wiener Index **;** ***ni*** = number of individuals of species I**; N** = total number of individuals**; ln** = natural logarithm

RESULTS

The floristic composition and diversity of Hadejia Wetland National Park, Jigawa State, Nigeria, is characterized by a rich array of plant species. The table below represents the results of a study that recorded 50 plant species belonging to 27 families. The most dominant family was Fabaceae, with 10 species, followed by Combretaceae with 6 species and Moraceae with 4 species each. The study also revealed that the park is home to several species of economic and medicinal importance, such as *Acacia nilotica, Azadirachta indica,* and *Khaya senegalensis.* The frequency and relative frequency of the species showed that some species, such as *Hyphaene thebaica* (0.048) and *Ziziphus mauritiania* (0.042), were more abundant than others. The density and relative density of the species also varied, with some species, such as *Hyphaene thebaica* (0.003; 4.8), *Ziziphus mauritiana* (0.0022; 4.4), *Acacia nilotica (*0.002; 3.7) and *Polycantha spp* (0.019; 3.7) having a higher density than others. The diversity indices, including the Shannon-Wiener index, revealed a high level of species diversity in the park. The study's findings have important implications for conservation and management efforts in the park. The high level of species diversity also underscores the importance of preserving the park's ecological integrity. Furthermore, the study's results can inform strategies for restoring degraded habitats and promoting the regeneration of native species. The study provides valuable insights into the floristic composition and diversity of Hadejia Wetland National Park, highlighting the need for conservation and sustainable management efforts to protect this unique and valuable ecosystem. The findings of this study can also contribute to the development of effective conservation strategies for other protected areas in Nigeria and beyond.

Table 1: Showing the Species Name, Family Name, Density, Diversity

S/N	Species Name	Family Name	Frequency	Relative frequency	Density	Relative Density	Shannon weiner
1.	*Acacia nilotica*	Fabaceae.	60	0.037	0.002	3.7	0.12
2.	*Polyacantha spp*	Fabaceae	59	0.036	0.0019	3.7	0.12
3.	*Acacia senegal*	Fabaceae	53	0.032	0.0017	3.3	0.11
4.	*Acacia seyal*	Fabaceae	45	0.027	0.0015	2.8	0.09
5.	*Acacia sieberana*	Fabaceae	51	0.031	0.0017	3.2	0.10
	Anogeissus			0.015	0.0008	1.6	0.06
6.	*leiocarpus*	Combretaceae	25				
7.	*Azadirachta indica*	Meliaceae.	25	0.015	0.0008	1.6	0.06
	Balanite			0.034	0.0018	3.4	0.11
8.	*aegyptiaca*	Zygophyllaceae.	55				
9.	*Bauhinia rufescens*	Caesalpiniodeae	38	0.023	0.0011	2.4	0.86
10.	*Boswellia odorata*	Burseraceae	29	0.017	0.0009	1.8	0.07
	Calostropis			0.014	0.0008	1.5	0.06
11.	*Procera*	Apocynaceae	24				
	Canavalia			0.009	0.0005	0.99	0.04
12.	*ensiformis*	Fabaceae	16				
	Capparis			0.006	0.0003	0.7	0.03
13.	*tomentosa*	Capparaceae.	11				
14.	*Cassia singueana*	Fabaceae	45	0.027	0.0015	2.8	0.09

15.	*Celosia argentea*	Amaranthaceae	25	0.015	0.0008	1.6	0.06
16.	*Celtis integrifolia*	Ulmaceae	32	0.019	0.0010	1.9	0.08
	Combretum			0.014	0.0008	1.5	0.6
17.	*glutinosum*	Combretaceae	24				
18.	*Daniellia oliverii*	Caesalpioidaceae	6	0.003	0.0002	0.4	0.02
	Diospyros			0.035	0.0019	3.5	0.02
19.	*mespiliformis*	Ebenaceae	57				
	Eragrostis			0.020	0.0011	2.0	0.09
20.	*gangetica*	Poaceae.	33				
	Euphorbia			0.014	0.0007	1.4	0.06
21.	*kamerunica*	Euphorbiaceae	23				
22.	*Euphorbia poissoni*	Euphorbiaceae.	24	0.014	0.0008	1.5	0.06
23.	*Faidhebia albida*	Fabaceae	29	0.017	0.0009	1.8	0.07
24.	*Ficus iteophylla*	Moraceae	29	0.017	0.0009	1.8	0.07
25.	*Ficus lutea*	Moraceae	36	0.022	0.0012	2.2	0.08
26.	*Ficus polita*	Moraceae	30	0.018	0.001	1.9	0.07
27.	*Ficus ptatyphylla*	Moraceae	27	0.016	0.0009	1.7	0.07
28.	*Ficus sycomorus*	Moraceae	32	0.019	0.0010	1.9	0.08
29.	*Ficus thonningii*	Moraceae	29	0.017	0.0009	1.8	0.07
30.	*Gardenia aqualla*	Rubiaceae	38	0.023	0.0012	2.4	0.09
	Guiera			0.020	0.0011	2.0	0.08
31.	*senegalensis*	Combretaceae	33				
32.	*Hyphaene thebaica.*	Arecaceae	78	0.048	0.0026	4.8	0.01
33.	*Khaya senegalensis*	Meliacea	29	0.017	0.0009	1.8	0.07
	Hippocratea			0.001	0.0001	0.2	0.01
34.	*guineensis*	Celastraceae	3				
	Lannea			0.011	0.0006	1.2	0.05
35.	*macrocarpa*	Anacardiaceae	19				
36.	*Mimosa pigra*	Fabaceae	23	0.014	0.0007	1.4	0.06
37.	*Mitragyna inermis*	Rubiaceae.	18	0.011	0.0006	1.1	0.05
38.	*Nauclea latifolia*	Rubiaceae.	25	0.015	0.0008	1.6	0.06
	Oxytenanthera			0.012	0.0006	1.2	0.05
39.	*abyssinica*	Poaceae	20				
	Parinari			0.015	0.0008	1.6	0.06
40.	*macrophylla*	Chrysobalanaceae	25				
	Parkiasonia			0..013	0.0007	1.4	0.06
41.	*acculeata*	Fabaceae	22				
	Piliostigma			0.017	0.0009	1.7	0.07
42.	*recticulatum*	Leguminosaceae	28				
43.	*Prosopis Africana*	Leguminasae.	41	0.025	0.0013	2.5	0.09
	Securidaca			0.018	0.001	1.9	0.07
44.	*longepedunculata*	Polygalceae	30				
45.	*Sterculia setigera*	Sterculiaceae	26	0.016	0.0008	1.6	0.07
46.	*Strychnos spinosa*	Loganiaceae	35	0.021	0.0011	2.2	0.08
	Terminalia			0.014	0.0008	1.5	0.06
47.	*macroptera*	Combretaceae	24				
48.	*Trema orientalis*	Cannabaceae.	18	0.01	0.0006	1.1	0.05
49.	*Vitex doniana*	Verbenaceae.	37	0.022	0.0012	2.3	0.08
	Ziziphus			0.042	0.0022	4.2	0.013
50.	*mauritiania*	Rhmnaceae.	68				
		SUM	1612	0.955	0.052	100.09	4.633

The table below presents the frequency distribution of 50 plant species in Hadejia Wetland National Park, Jigawa State, Nigeria. The families are diverse, with Fabaceae being the most dominant, accounting for 10 species. Moraceae and Combretaceae are also well-represented, with 6 and 4 species, respectively. Other families, such as Euphobiaceae, Rubiaceae, and Poaceae, have fewer species. The presence of single-species families, such as Arecaceae and Amaranthaceae, suggests that these families may be less diverse in the park. The diversity of plant families in the park is consistent with other studies that have reported high levels of plant diversity in tropical wetland ecosystems. The findings of this study have implications for conservation and management efforts in the park, highlighting the need to protect and sustainably manage the diverse range of plant species present.

Table 2: Names of the Families and Frequency

SN	Family	Frequency
1	Arecaceae	1
2	Amaranthaceae.	1
3	Apocynaceae.	1
4	Burseraceae.	1
5	Capparaceae.	1
6	Ebenaceae.	1
7	Poaceae.	2
8	Euphobiaceae	2
9	Fabaceae	10
10	Moraceae	6
11	Leguminosecaceae.	1
12	Leguminasae.	1
13	Polygalceae	1
14	Sterculiaceae.	1
15	Comberataceae.	4
16	Rubiaceae.	3
17	Chrysobalanaceae	1
18	Loganiaceae.	1
19	Cannabaceae.	1
20	Verbenaceae	1
21	Rhemnaceae.	1
22	Anacardiaceae.	1
23	Zygophyllaceae.	1
24	Ulmaceae.	1
25	Caesalpiniodeae.	2
26	Meliaceae.	2
27	Celastraceae.	1
Total		50

DISCUSSION

The floristic composition and diversity of Hadejia Wetland National Park, Jigawa State, Nigeria, is characterized by a rich array of plant species (Kent, 2012). The frequency and relative frequency of the species showed that some species, such as *Hyphaene thebaica* and *Ziziphus mauritiania*, were more abundant than others, indicating a varied distribution of species within the park (Magurran, 2004). The density and relative density of the species also varied, with some species, such as *Acacia nilotica* and *Diospyros mespiliformis*, having a higher density than others, suggesting a complex community structure (Begon *et al.*, 2006). The diversity indices, including the Shannon-Wiener index, revealed a high level of species diversity in the park, indicating a healthy and resilient ecosystem (Spellerberg and Fedor, 2003). The diversity index of 4.633 (Table 1) recorded in this study is significantly higher than those reported in some northern Nigerian Forest Reserves, specifically Kurba Forest Reserve (1.94) Salami *et al.*, (2022) and Rabadi Forest Reserve (2.9) Bello *et al.*, (2022), indicating a more diverse and resilient ecosystem in Hadejia Wetland National Park. Similarly, the diversity index in this study surpasses those reported in southern Nigerian Forest Reserves, including Omo Biosphere Reserve (4.01) Salami, (2017); Salami and Akinyele (2018), Owo Forest Reserve (3.08) Salami and Jibo, (2019), and Gambari Forest Reserve (3.56) (Salami and Akinyele, 2017; Salami *et al.*, 2018; Salami *et al*., 2019). This suggests that Hadejia Wetland National Park has a unique and rich ecosystem that is comparable to, or even exceeds, those found in other protected areas in Nigeria. The higher diversity index in this study may be attributed to the effective management and conservation measures in place, which have contributed to the preservation of the park's ecological integrity. The findings of this study highlight the importance of good management and conservation practices in maintaining biodiversity and ecosystem health, providing valuable insights for conservation efforts in other protected areas in Nigeria and beyond.

The study's findings have important implications for conservation and management efforts in the park, highlighting the need to protect and sustainably manage the park's natural resources (IUCN, 2012). The presence of several species of economic and medicinal importance, such as *Acacia nilotica* and *Khaya senegalensis*, underscores the importance of preserving the park's ecological integrity (Lamoreux *et al.*, 2006). Furthermore, the study's results can inform strategies for restoring degraded habitats and promoting the regeneration of native species, contributing to the development of effective conservation strategies for other protected areas in Nigeria and beyond (WWF, 2016). The frequency distribution of

50 plant families in Hadejia Wetland National Park, Jigawa State, Nigeria, reveals a diverse range of families, with Fabaceae being the most dominant, accounting for 10 species (Kent, 2012). Moraceae and Combretaceae are also well-represented, with 6 and 4 species, respectively, indicating a high level of plant diversity in the park (Magurran, 2004). The presence of single-species families, such as Arecaceae and Amaranthaceae, suggests that these families may be less diverse in the park (Begon *et al.*, 2006). The findings of this study are consistent with other research that has reported high levels of plant diversity in tropical wetland ecosystems (Lamoreux *et al*., 2006). The results of this study have important implications for conservation and management efforts in the park, highlighting the need to protect and sustainably manage the diverse range of plant species present (IUCN, 2012).

The findings of this study have significant implications for conservation and management efforts in Hadejia Wetland National Park, highlighting the need to protect and sustainably manage the park's diverse range of plant species to maintain ecosystem resilience and promote ecological integrity (IPBES, 2019). The high level of species diversity and endemism in the park underscores the importance of preserving the park's ecological integrity, which is essential for maintaining ecosystem services, including carbon sequestration, water filtration, and soil conservation (WWF, 2020). The presence of several species of economic and medicinal importance, such as *Acacia nilotica* and *Khaya senegalensis*, further emphasizes the need to conserve and sustainably manage the park's natural resources to ensure the long-term provision of these benefits (IUCN, 2020). Furthermore, the study's results can inform strategies for restoring degraded habitats and promoting the regeneration of native species, contributing to the development of effective conservation strategies for other protected areas in Nigeria and beyond (UNEP, 2020). Overall, the findings of this study emphasize the need for a multi-faceted approach to conservation and management that incorporates ecological, economic, and social considerations to ensure the long-term sustainability of Hadejia Wetland National Park's natural resources (CBD, 2020).

CONCLUSION

In conclusion, the floristic composition and diversity of Hadejia Wetland National Park, Jigawa State, Nigeria, is characterized by a rich array of plant species, with a total of 50 species represented. The park's ecosystem is healthy and resilient, with a high level of species diversity, as indicated by the Shannon-Wiener index. The dominance of Fabaceae, Moraceae, and Combretaceae families suggests that these families play a key role in maintaining the park's ecological integrity. The presence of several species of economic and medicinal importance, such as *Acacia nilotica* and *Khaya senegalensis*, underscores the importance of preserving the park's natural resources. The study's findings have important implications for conservation and management efforts in the park, highlighting the need to protect and sustainably manage the diverse range of plant species present. Furthermore, the results of this study can inform strategies for restoring degraded habitats and promoting the regeneration of native species, contributing to the development of effective conservation strategies for other protected areas in Nigeria and beyond.

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