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Research Article

Plant and Animal Species Abundance and Distribution in Relation to Water Table Levels That Inhibit in the Hadejia-Nguru Wetlands in the Northern Part of Nigeria

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ABSTRACT

The Hadejia-Nguru wetlands in northern Nigeria are vital ecosystems, home to a diverse array of plant and animal species uniquely adapted to wetland conditions. These wetlands provide essential ecosystem services, including water filtration, flood control, and carbon sequestration, while also serving as critical habitats for numerous species, particularly migratory birds. However, the wetlands face increasing threats from climate change, agricultural expansion, and urban development, which can significantly alter water availability and biodiversity. This study aims to assess the abundance and distribution of plant and animal species in relation to water table levels in the Hadejia-Nguru wetlands. The research was conducted in the Ramsar-designated Nguru Lake and Marma Channel complex, which are internationally recognized for their importance to water birds. Vegetation sampling followed the National Vegetation Classification System (NVCS), which categorizes plants into six primary strata: tree, shrub, field, ground, floating aquatic, and submerged aquatic. The line transect sampling method was employed to estimate animal species distribution, particularly focusing on bird species. The study revealed significant ecological diversity within the wetlands, with various plant species representing different families. Bird surveys documented a wide range of species, emphasizing the wetland's role as a crucial habitat for both endemic and migratory birds. Climatic conditions in the study area were characterized by an average temperature of 30.62°C and an average humidity of 55.51%, which varied seasonally. These findings underscore the ecological importance of the Hadejia-Nguru wetlands and highlight the urgent need for conservation efforts to mitigate the impacts of environmental degradation and ensure the sustainability of these critical ecosystems.

Keywords: Abundance, Animal, Distribution, Plant, Water table

INTRODUCTION

Hadejia-Nguru wetlands in northern Nigeria serve as home to a diverse range of plant and animal species, especially those that adapted to wetland conditions (Adeleke, 2022). Wetlands provide critical ecosystem services such as water filtration, flood control, and carbon sequestration (Ye *et al.*, 2022). Many changes are expected in climatic conditions which can alter precipitation patterns and water availability of Hadejia-Nguru wetlands of northern Nigeria. Wetlands also play a crucial role in climate regulation by storing carbon (Salimi *et al.*, 2021). Northern Nigeria is experiencing rapid agricultural and urban development, which can lower water tables through increased water extraction and land use changes. Forested wetlands are an essential part of the ecosystems that provide several ecological, economic, and social benefits to the ecosystems. Forested wetlands are also essential for biodiversity conservation, water purification, flood control, and climate regulation (Nayak and Bhushan, 2022). Northern Nigeria's forested wetlands support a wide array of flora and fauna, including numerous endemic and

migratory bird species. The Hadejia-Nguru wetlands, for instance, serve as a critical stopover for migratory birds, emphasizing their global importance (Adekola and Mitchell, 2011). The wetland also play a crucial role in sustaining this local community and support a diverse array of plant and animal species living around communities (Bukar *et al.*, 2021). However, these habitats are increasingly under threat from both natural and anthropogenic factors, including climate variability, agricultural expansion, and urbanization, which can alter the biodiversity of the plants and animals species in the wetland. This study aims to investigate the plant and animal species abundance and distribution in relation to water table levels that inhabit in the Hadejia-Nguru wetlands in the northern part of Nigeria.

MATERIAL AND METHODS

Study Area

The study was carried out at the Hadejia-Nguru Wetlands, located in northeast Nigeria. The Hadejia-Nguru wetlands are recognized as a Ramsar Site of international importance. Nguru Lake and the Marma Channel complex, covering 58,100 hectares, are designated under the Ramsar site. These wetlands are important for water birds, supporting both breeding species and wintering and passage of Palearctic water birds. The water bird population is estimated to range between 200,000 and 325,000 and a total of 377 different bird species have been recorded to be seen in the wetlands, including occasional sightings of the near-threatened pallid harrier and great snipe species.

The Bade-Nguru Wetlands sector of the Chad Basin National Park covers 938 km² of the wetlands. Protection efforts include five Forest Reserves, a Wildlife Sanctuary, and a Ramsar Site. However, the reduction in flooding and an increasing population are leading to environmental degradation and growing competition between humans and wildlife. The farmers, attempting to eliminate the crop-destroying Quelea quelea, often use poison, inadvertently killing non-target species. Additionally, marginal lands are being cultivated, and tree cover in the forest reserves is being depleted. The area supports approximately 1.5 million farmers, herders, and fishermen. The wetlands facilitate wet-season rice farming, flood-recession agriculture, and dry-season farming through irrigation. Crops grown include peppers and wheat. In addition to supporting fishermen who often also engage in farming, the wetlands provide fuel wood and leaves used for making mats and ropes. The land is also grazed by Fulani cattle.

Vegetation Sampling

Plants in wetlands display a diverse range of physical forms and life history attributes. These characteristics significantly influence the structure of various wetland types and play a crucial role in their ecological functions.

The sample was collected following the National Vegetation Classification System (NVCS) guidelines, which identify six primary vegetation strata: tree, shrub, field, ground, floating aquatic, and submerged aquatic.

- **Tree Stratum:** This includes all woody plants taller than a certain height, usually 5 meters.
- **Shrub Stratum:** This stratum consists of woody plants shorter than trees but typically taller than 0.5 meters.
- **Field Stratum:** Often referred to as the herbaceous layer, this includes grasses, herbs, and other non-woody plants.
- **Ground Stratum:** This encompasses mosses, lichens, and low-lying plants that form a layer close to the soil surface.
- **Floating Aquatic Stratum:** This includes plants that float on the water's surface, such as water lilies and duckweed.
- **Submerged Aquatic Stratum:** These are plants that grow entirely below the water's surface, such as eelgrass and pondweed.

These strata help in organizing and classifying vegetation types, making it easier to study and manage wetland ecosystems.

Animal Species Surveys

Several methods exist for estimating the number of animal species in a designated area, though none are entirely free of bias. Complete counts yield the most accurate density estimates but often demand impractical sampling efforts, particularly over large areas. The line transect sampling method, on the other hand, is typically the most

practical. This method offers a convenient way to estimate the number of animal species in a study, relying on the premise that any animal species should be easily visible, at least at close range. In this study, the line transect method, which proved to be the most efficient in terms of data collection per unit effort, was applied. The census involves an observer moving slowly along designated routes and recording all birds detected on either side of the route.

Measurement of the Climate Conditions

Climatic conditions were measured using weather measuring instruments to measure the temperature, wind, precipitation, and other atmospheric factors that describe the local weather and climate. Different types of instruments are used to measure these parameters.

Temperature Measurement

The temperature was measured using the mercury thermometer. The thermometer was placed in a shaded area to avoid direct sunlight, which can affect the accuracy of the measurement.

Humidity Measurement

The relative humidity **was measured using the** hygrometers.

Data Analysis

The data generated in this study was presented in simple descriptive statistic expressed in mean, standard and simple frequencies.

RESULT

The study area experiences a warm climate with an average environmental temperature of 30.62°C, fluctuating by ±1.79°C. This translates to a range of 23°C during the colder, rainy season and reaching a maximum of 33.10°C during the dry season. Humidity levels are also relatively high, averaging 55.51% with a standard deviation of ±3.95%. This means humidity levels can vary between 49% and 64%, likely influenced by seasonal changes (Table 1). Table 2 provide the distribution of tree species found in the study area, including their English names, scientific names, local Hausa names, and respective plant families. The distribution of tree species in the study area reveals significant ecological diversity, with a range of species from various plant families. Table 3 presents the distribution of shrub species found in the study area, listing their English names, scientific names, local Hausa names, and respective plant families. This distribution highlights significant ecological diversity, with a variety of species representing different plant families. Tables 4, provide a comprehensive distribution of bird species found in the study area. Those tables include the English names, scientific names, local Hausa names, and respective families of the birds.

Table 1 Hadejia-Nguru Wetlands Climate Conditions

Variables	Mean	STD	Minimum	Maximum
Temperature (°C)	30.62	1.79	23.00	33.10
Humidity (%)	55.51	3.95	49.00	64.00

Table 2 Distribution of the Tree Species

S/N	English name	Scientific Name	Hausa Name	Family
1	Apple-ring acacia	*Faidherbia albida* (*Acacia albida*)		Fabaceae
2	Indian jujube	Ziziphus mauritina	Magarya	Rhamnaceae
3	Desert date	Balanites aegyptiaca	Aduwa	Zygophyllaceae
4	Tamarind	Tamarindus indica	Tsamiya	Fabaceae
5	African baobab	*Adansonia digitata*	Kuka	Malvaceae

6	African birch	Anogeissus leiocarpus	Marke	Combretaceae
7	African locust bean	Parkia biglobosa	Dawadawa	Fabaceae
8	Shea tree	Vitellaria Paradoxa	Ka'danya	Sapotaceae
9	Fig trees	Ficus sycomorus	Baure	Moraceae
10	Camel's foot tree	*Piliostigma thonningii*	Kalgo	Fabaceae
11	African ebony	*Diospyros mespiliformis*	*Kanya*	Ebenaceae
12	Neem	*Azadirachta indica*	Dogonyaro	Meliaceae

Table 3 Distribution of Shrubs Species

S/N	English name	Scientific Name	Hausa Name	Family
1	Indian sandbur	*Cenchrus biflorus*	Karanciya	Poaceae
2	Gamba grass	*Andropogon gayanus*	Gamba	Poaceae
3	Warkin Maciji	*Chrozophora senegalensis*		Euphorbiaceae
4	Hippo grass	*Vossia cuspidata*	Tattakiya	Poaceae
5	False abura	*Mitragyna inermis*	Giyyaya	Rubiaceae
6	Bulrush	*Typha Australis*	Bundu	Typhaceae
7	Water Lilly	Nymphaea nouchali	Bado	Nymphaeaceae
8	Southern cattail	*Typha domingensis*	Bundu	Typhaceae

Table 4a Distribution of the Birds Species

S/N	English name	Scientific Name	Hausa Name	Family
1	African Harrier Hawk	*Polyboroides typus*	Bura kogo/Hura	Accipitridae
2	African Marsh Harrier	*Circus ranivoros*	Shirwa	
3	Black Kite	*Milvus migrans*	Bakin shaho	
4	Dark Chanting Goshawk	*Melierax metabates*	Farin komo	
5	Lizard Buzzard	*Kaupifalco monogrammicus*	Ci ƙadangaru	
6	Shikra	*Accipeter badius*	Kusarkama	
7	Malachite Kingfisher	*Corythornis cristatus*	Tsintara/Tsinyar	
8	Pied kingfisher	*Ceryle rudis*	Dan kwalam	
9	African Pygmy goose	*Nettapus auritus*		Anatidae
10	Fulvous Whistling Duck	*Dendrocygna bicolor*	Kici	
11	Garganey	*Spatula querquedula*	Kakira	
12	Knob-billed Duck	*Sarkidiornis melanotos*	Kwarwa	
13	Spur-winged Goose	*Plectropterus gambensis*	Dinya	
14	White-faced Whistling Duck	*Dendrocygna viduata*	Kirinjijiya	

15	African Palm Swift	*Cypsiurus parvus*	Tsatstseewala	Apodidae
16	Black Heron	*Egretta ardesiaca*		Ardeidae
17	Black-headed Heron	*Ardea melanocephala*	Baƙin zalbe	
18	Cattle Egret	*Bubulcus ibis*	Balbela	
19	Great Egret	*Ardea alba*	Farin Zalbe	
20	Purple Heron	*Aredea purperea*	Jan zalbe	
21	Squacco Heron	*Ardea rolloides*	Makwabo	
22	African Grey Hornbill	*Lopoceros nasutus*	Cilakowa, Gaula	Bucerotidae
23	Northern Red-billed Hornbill	*Tockus erythrorhynchus*	Kokaci, Kumare	
24	Black-headed Lapwing	*Vanellus tectus*	Zakaran ƙeƙuwa	Charadriidae
25	Abdim's Stork	*Ciconia abdimii*	Shamuwa	Ciconiidae
26	African Openbill Stork	*Anastomus lamelligerus*	Ci ma kankare	

Table 4b Distribution of the Birds Species

S/N	English name	Scientific Name	Hausa Name	Family
27	Marabou Stork	*Leptoptilos crumenifer*	Babba da jaka	
28	White Stork	*Ciconia ciconia*	Galantoyi	
29	Blue-naped Mousebird	*Urocolius macrourus*	Kileoandamma	Coliidae
30	African Mourning Dove	*Streptopelia decipiens*	Mai zobe	Columbidae
31	Laughing Dove	*Streptopelia senegalensis*	Kurciya	
32	Namaqua Dove	*Oena capensis*	Kafirdo/Bardo sarkin hakuri	
33	Speckled Pigeon	*Columba guinea*	Hasbiya	
34	Vinaceous Dove	*Streptopelia vinacea*	Farar waalaa	
35	Abyssinian Roller	*Coracias abyssinicus*	Tsanwaka	Coraciidae
36	Great Spotted Cuckoo	*Clamator glandarius*	Sura	Cuculidae
37	Senegal Coucal	*Centropus senegalensis*	Ragon maza	
38	Common Kestrel	*Falco tinnunculus*	Karamatta	Falconidae
39	Grey Kestrel	*Falco ardosiaceus*	Surau	
40	Bearded Barbet	*Pogoniulus dubius*	Dodon duhuwa	Lybiidae
41	Western Grey Plantain-eater	*Crinifer piscator*	Kulkulu	Musophagidae
42	Helmeted Guinefowl	*Numida meleagris*	Zabuwa	Numididae
43	Long-tailed Cormorant	*Microcarbus africanus*	Caaga	Phalacrocoracidae
44	Double-spurred Francolin	*Pternistis petrosus*	Fakara	
45	Grey Woodpecker	*Mesopicos goertae*	Maƙwaƙƙwafí	Picidae

46	Senegal Parrot	*Poicephalus senegalus*	Tsirwa	Psittacidae
47	Rose-ringed Parakeet	*Psittacula krameri*	Kaloo	
48	Four-banded Sandgrouse	*Pterocles quadricinctus*	Burkulli	Pteroclidae
49	Black Crake	*Zapornia flavirostra*	Babura	Rallidae
50	Purple Swamphen	*Porphyrio porphyrio*	Gwandara	
51	Green wood-hoopoe	*Phoeniculus purpureus*	Jabar kogo	Upupidae
52	Hoopoe	*Upupa epops*	Alhudahuda/Ka	

Table 4c Distribution of the Birds Species

S/N	English name	Scientific Name	Hausa Name	Family
53	Black-crowned Sparrow Lark	*Eremopterix nigriceps*	Takatoyi	Alaudidae
54	Crested Lark	*Galerida cristata*	Maala	
55	Piapiac	*Ptilostomus afer*	Carkin giwa	Corvidae
56	Pied Crow	*Corvus albus*	Hankaka	
57	African Silverbill	*Lonchura cantas*	Taru mu kwana	Estrildidae
58	Red-billed Firefinch	*Lagonosticta senegala*	Baa'u /Benu	
59	Red-cheeked Cordon-bleu	*Uraeginthus bengalus*	Asisi	
60	White-rumped Seedeater	*Crithagra leucopygia*	Farari daka	Fringillidae
61	Mosque Swallow	*Cecropis senegalensis*	Alallaka	Hirundinidae
62	Yellow Wagtail	*Motacilla flava*	Hana noma	Motacillidae
63	Northern Anteater-chat	*Myrmecocichla nigra*	Feri	Muscicapidae
64	Beautiful Sunbird	*Nectarinia pulchella*	Janjau/Sha	Nectariniidae
65	Northern Grey-headed Sparrow	*Passer griseus*	Magwara/Gwara	Passeridae
66	Sudan Golden Sparrow	*Passer luteus*	Bankwalo	
67	Little Weaver	*Ploceus luteolus*	Kabarai	Ploceidae
68	Northern Red Bishop	*Euplectes franciscanus*	Janja luguda/Dogari	
69	Red-billed Quelea	*Quelea quelea*	Janbai	
70	Red-headed Quelea	*Quelea erythrops*	Janbai	
71	Village Weaver	*Ploceus intermedius*	Kabaréé	
72	White-billed Buffalo Weaver	*Bubalornis albirostris*	Cakwai-kwaiwa	
73	Yellow-crowned Bishop	*Euplectes afer*		
74	Common Bulbul	*Pycnonotus barbatus*	Koji	Pycnonotidae
75	Chestnut-bellied Starling	*Lamprotornis pulcher*	Shaya mai jan kirji	Sturnidae
76	Great Blue-eared Starling	*Lamprotornis chalybaeus*	Shaaya	

Table 4d Distribution of the Birds Species

S/N	English name	Scientific Name	Hausa Name	Family
77	Long-tailed Glossy Starling	*Lamprotornis caudatus*	Kila-Kilai	
78	Yellow-billed Oxpecker	*Buphagus africanus*	Carki	
79	Brown Babbler	*Turdoides plebejus*	Kaca-kaca	Timalidae
80	Sahel Paradise Whydah	*Vidua orientalis*	Zallaidu	Viduidae
81	Village Indigobird	*Vidua chalybaeta*	Ɗan baƙi	

Discussion

The Hadejia-Nguru Wetlands represent a complex and dynamic landscape where human activities and natural processes intersect. The presence of various types of vegetation, including dense and open forests, shrubs, and specific plantations, indicates the ecological diversity of the wetlands. Maintaining this vegetation is crucial for biodiversity, carbon sequestration, and providing ecosystem services. True wetlands, with their hydrophytic vegetation and seasonal or permanent waterlogging, are critical for supporting unique plant and animal species (Balwan and Kour, 2021). They also offer important ecosystem services such as flood mitigation and water filtration (Agaton and Guila, 2023). However, these areas are often vulnerable to degradation from human activities such as agriculture and urban development.

The report of this study observed Hadejia-Nguru wetlands covered by cultivation land dedicated to the growth of annual crops, and vegetables. The cultivation of land is crucial for local agriculture, providing food and economic resources to the local communities (Giller et al., 2021). The grazing area is characterized by grasses with scattered trees, that serve as pasture for grazing cattle and supports livestock farming, which is an important livelihood for many local communities in the region. The water body in the area encompasses rivers, streams, lakes, ponds, and open water within the wetland, including irrigation canals. These water bodies are critical for sustaining the wetland ecosystem, providing water for irrigation, supporting aquatic life, and offering resources for domestic and agricultural use (Jisha and Puthur, 2021).

The climate conditions of an environment are essential tools that provide valuable insights into the environmental factors and influence the region (Bramer et al., 2018). The report of the climate conditions of the Hadejia-Nguru Wetlands was recorded as characterized by warm temperatures and moderate humidity, which create a stable environment that can support agriculture, biodiversity, and human activities in the area. The result of the present study agreed with what was recorded by Ringim et al. (2015), Dami et al. (2017) and Gujja et al. (2023) all recorded a temperature range between 22.32^{o}C to 38.17^{o}C.

The diversity of tree species in the Hadejia-Nguru Wetlands contributes significantly to the region's ecological stability, economic sustainability, and cultural richness. Protecting and managing these trees is vital for maintaining the health and productivity of these wetlands, ensuring that they continue to support the local communities and wildlife (Balwan and Kour, 2021). This is confirmed by the study done by Kutama et al. (2016) and that of Bello et al. (2022). These trees play a crucial role in the ecosystem, providing ecological, economic, and cultural benefits that include habitat and food for various wildlife, maintaining the environmental balance (Oguh et al., 2021). The Hadejia-Nguru Wetlands are home to a diverse array of bird species. The rich avian biodiversity observed in this wetland highlights the ecological importance of the wetlands and their role as a habitat for various bird families. Birds are key indicators of environmental health, and their presence signifies a balanced and functioning ecosystem (Fraixedas et al., 2020). The studies done by other researchers including Sabo (2016), Ringim and Muhammad (2017), Babura and Muhammed (2021), and Sabo and Mohammed (2022) all confirmed the distribution of bird species in their studies.

Conclusion

The Hadejia-Nguru Wetlands exhibit a rich and diverse ecosystem characterized by various vegetation types, including forests, shrubs, and plantations. These wetlands provide critical ecosystem services such as flood

mitigation, water filtration, and support for biodiversity. The presence of unique plant and animal species underscores the ecological importance of maintaining these habitats.

Recommendations

Based on the outcome of this study the following recommendations were made: There is need for

1. Implement conservation programs to protect and restore critical wetland habitats, ensuring the preservation of biodiversity and ecosystem services.
2. Engage local communities in conservation and resource management initiatives, leveraging traditional knowledge and practices.

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