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Ecology and Diversity of Avian Species in Floodplains and Riparian Forest of Hadejia-Nguru, Nigeria

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SUMMARY

The Hadejia-Nguru is a natural wetlands ecosystem that supports native and migrant avian populations. Due to these reasons, this study is designed to know the diversity of birds in the study area. The point count method was used to know the diversity of birds, 60 points on 12 km of transect were used to count birds between July 2020 to June 2021. A total of 94,113 individuals from 97 bird species, 39 families and 17 orders were recorded. The highest avifauna species richness was recorded in Nguru transect b, and the highest avifauna species abundance was recorded in Nguru while the highest avifauna species diversity was recorded in Gashua. Resident birds were the most abundant with 49 species followed by Palaearctic migrants with 31 species and 14 intra-African, 2 nomadic and 1 unknown. Small-scale anthropogenic activities, such as farming, grazing, and fishing; do not affect avifauna species diversity.

Keywords: Birds, Wetland, Residents, Migrant

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INTRODUCTION

Wetlands are considered among the most productive ecosystems in the world (Altaf et al., 2014; Xu et al., 2020). Different wetland types are ecologically endowed with abundant resources that could exploited by a variety of avifauna species. Researchers describe wetlands as transition zones between terrestrial and aquatic systems where usually the water table is at or near the surface, or the land is covered with shallow water. They support rich biodiversity through the provision of suitable habitats for many water birds. Wetlands provide a range of important ecosystem services, e.g., flood control and water quality moderation, as well as providing habitats that support a rich biodiversity (Abdullahi et al., 2019; Ali et al., 2016; Altaf et al., 2015; Olaniyi et al., 2022). Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. The Ramsar Convention defines wetlands as “areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres”. They are important habitats for avian populations throughout the world (Frazier, 1999).

Mitsch and Hernandez (2013) reported that wetlands cover about 4 to 6 % of the Earth's land surface. Unfortunately, increased human population and rising demand for settlements and agricultural land have degraded these habitats in many tropical wetlands. The increasing number of humans is causing a severe impact on biodiversity globally due to pollution, deforestation, loss of habitats, and the introduction of non-native species. Nigeria has a considerable number of wetlands that perform vital ecological and socioeconomic functions. The exact sizes of these wetlands are difficult to estimate, as they vary greatly and are distributed in different locations. However, 11 Nigeria are designated by Ramsar Bureau, as wetlands of international importance they are Nguru Lake and Marma Channel Complex, Baturia, Dagona Bird Sanctuary, Foge Island, Lake Chad, Lower Kaduna-Middle Niger floodplain, Maladumba Lake, Oguta Lake Pandam and Wase Lake and Upper Orashi Forest Wetlands. Approximately 2.5% of Nigeria's total land area (1,076,728 hectares) was covered by wetlands. Other wetlands in Nigeria are not officially designated as Ramsar sites and are crucial for biodiversity conservation and other ecological functions. Such wetlands are comprised of river floodplains, mangrove forests, and coastal lagoons. The preservation and sustainable use of Nigeria's wetlands are crucial for maintaining biodiversity, ensuring food security, and supporting local livelihood. Due to the above written reasons, so this study is designed to know the diversity of birds in the study area.

MATERIALS AND METHODS

STUDY AREA

This study was conducted in the Hadejia-Nguru Floodplain Wetland, which is a section of the Hadejia Jama'are Komadugu Yobe Basin in Northeast Nigeria. The wetland is located between latitude 12° 15 N and 13° 00' N and longitude 10° 00'E and 11° 00'E (Figure 1) and covers an area of approximately 3,500 km^2, and part of the 27 Important Bird Areas (IBA) with high avifauna biodiversity hosting a significant number of Palaearctic winter in the Sahel (Birdlife International, 2013). It housed Nigeria's premier Ramsar site (The Hadejia-Nguru Marma Channel). The area is situated on an altitudinal range between 152-305 metres above sea level m. a. s. l. and is formed by the Hadejia and Jama'are rivers that flow through ancient, stabilized dunes, which later converged as a single river (Yobe River) at a point near Gashua and drained into Lake Chad (Ringim and Muhammad, 2017). The Hadejia-Nguru wetlands have two seasons: a wet season that runs from April to May and ends in September, sometimes extending into October, and a dry season that lasts from November to March, which is typical of a tropical climate. Rainfall in the Hadejia-Nguru wetland ecosystem is typically low, with an annual range of 300–500 mm and a month-long interval between the first rain events. The dry season lasts longer and is subdivided into cold and hot seasons.

IDENTIFICATION AND LOCATION OF STUDY SITES

A study was carried out between July 2020 and June 2021, to assess bird species abundance distribution and diversity in three sites within the study area. The

choice of the sites was based on their distinct ecological habitat characteristics; namely, Upstream (riparian floodplain forest) located a short distance from Hadejia town in Jigawa State. The Midstream (floodplain wetlands) is located a short distance from Nguru town Yobe State. The Downstream (riparia floodplain forest) is located a short distance from Gashua town Yobe State. These study sites were separated by a distance of more than thirty (30) kilometres, apart. Hardy free Global Positioning System on an Android mobile phone was used to obtain site coordinates and ten points on two lines of transects in each site (figure 1) to ensure the same points are used throughout the data collection period.

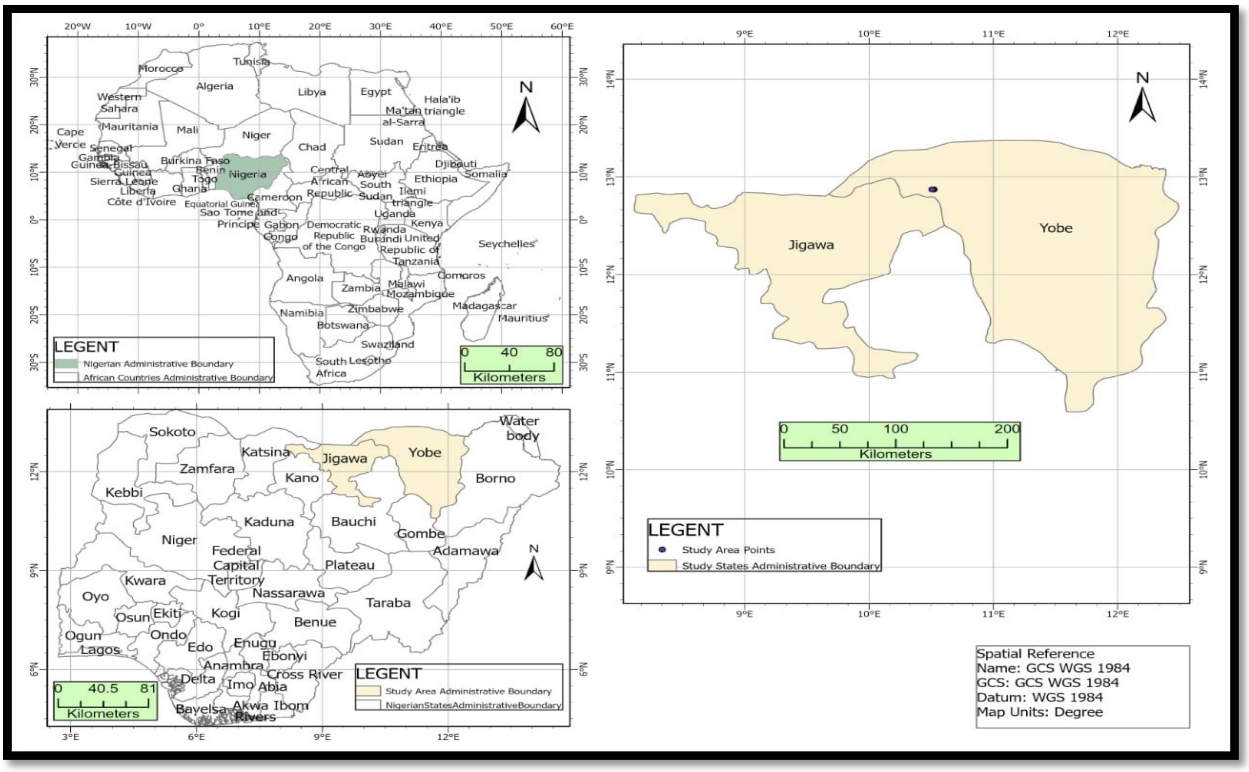

Figure 1: Map of study area.

DATA COLLECTION ON BIRD SPECIES ABUNDANCE, DISTRIBUTION AND DIVERSITY IN THE STUDY AREA

Data was collected twice a month between July 2020 and June 2021. This period of data collection falls within dry and wet seasons which were subdivided into the early dry season October to December, the late dry season January to March, the early wet season April to June and the late wet season July to September. Data on bird numbers were collected at each of the ten points on the six-line transects using the point count method. On arriving transect count started on the first point after standing calmly for a minute (1min.) to allow disturbed birds to settle and five minutes were used to identify, count and record bird species encountered within a 50-metre radius from each point on the transect line as studied by ornithologists (Stevens et al., 2010).

For large flocks of birds, the block count method was used where flocks are divided into smaller equal blocks one block is counted and the number of birds in one block is multiplied by the total number of blocks to obtain a total estimate of the entire flock. Each of the three observers blocked, identified and counted species, independently, and the count results from the three observers were added up and an average of three counts were recorded against the name of the bird identified on the recording sheet. One day is dedicated to each site for data collection on birds' trees and shrubs as well as active anthropogenic activities. After the day activities in the first site, we move to the next community where the second site is located and spend a night and the process starts again in the second site first thing in the morning. After the day's activities, we move to the community where the third site is located and in the morning we start the same process again. This is repeated after two weeks throughout the study period (July 2020 – June 2021).

A Guide to the Birds of Western Africa by Borrow and Demey (2014) was used for bird identification using the method outlined. The same procedure was repeated on each point along a line transect in each study site. Bird count usually begins, on long days, by 7:00 am and ends by 12:00 pm when the weather is clear of rain or wind. On short days birds count, beginning at 7:30 am and ending by 12:30 pm. All available birds observed within a 50m radius from a point as well as those heard including those flying over a 50m radius. The distance of birds from the observer was estimated at ≤10m distance from the position of the observer to the bird and >10m, a laser range finder was used to ensure birds recorded were within a 50m radius. The bird data recording process was repeated twice a month throughout the study period, except for the Upstream, which was in-accessible during October, November, and December 2020 and in January and February 2021.

CATEGORIZATION OF BIRDS ON FEEDING HABITS, RESIDENCY, GLOBAL TREND AND STATUS

Bird species in all the study sites were grouped based on feeding habits (Carnivorous (C), Frugivorous (F), Insectivorous (I), Nectivorous (N), Granivorous (G), Piscivorous (P) or feeding on more than one diet Mix diet (MD)). Each species was assigned to global population trend (stable decreasing increasing and unknown) and residency (Resident, Intr-African migrant, Vagrant and Palearctic) using the International Union of Conservation of Nature (IUCN) status Red List of Species (IUCN in Sulaiman 2018). While nomenclature and classification of bird species follow Borrow and Demey (2014).

DATA ANALYSIS

Data on bird species, number of trees and shrubs and record of anthropogenic activities from six line-transects in the study sites, across micro-seasons were entered into Microsoft Excel. The data were

scrutinized for errors, duplicates or in-accuracies before computation. Microsoft Excel Pivot Table Function was used to determine the diversity of bird species. Shannon-Weiner diversity indices (Shannon Weiner, 1969) and bird species evenness were calculated using the equation below, within and between study sites, within and between transects and within and between micro-seasons throughout the study.

Shannon-Wiener diversity index (H) equation for species diversity and evenness equation were used to obtain the species diversity indices (how diverse species are) and evenness within and between study sites, between and within transect and between micro-season.

$$H = -\sum_{ith}^{s} (Pi * lnP)$$

Where Pi is the proportion of individual birds to the species
S is the total number of birds encountered and lnPi is the natural log of the proportion of ith species

Species Evenness was calculated to understand whether species were distributed evenly across the transects using the equation below

$$E = H'/lnS$$

E = Evenness
H' = Shannon Diversity Index
And S = Species Richness

RESULTS

The sum of 94,113, individuals belonging to 39 families from 17 orders and 97 species were recorded during the entire study period. This represented 11% of the total Nigerian bird species and 26% of the water and water related bird species recorded to date in Nigeria and the Hadejia-Nguru Wetlands respectively (Table 1).

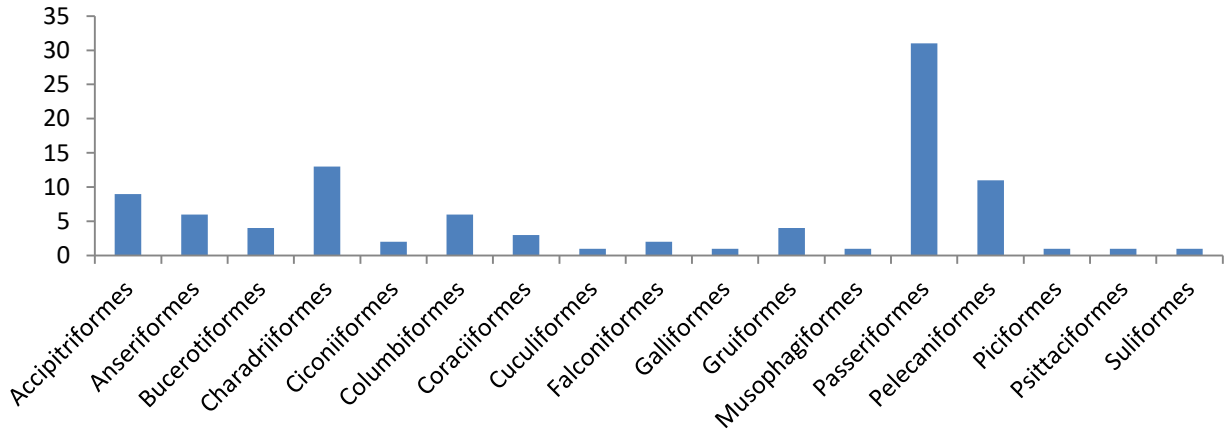

Figure 2: Distribution of bird species encountered across order in the study area.

Avian species from the order Passeriforms are dominant in the study area (Figure 2). Out of the total bird noted during the study period 57.73% are resident, 26.80% are Palaearctic migrants, 13.40% are Intra-African migrant and 2.06% are Vagrant (Figure 3). Total population from the study area was noted as 94113 (Figure 4). During study we have noted that 5315 individuals from up-stream (Figure 5), 40034 from down-stream (Figure 6), and 48764 from mid-stream of study area (Figure 7). Evenness index of up-stream was 0.71, Down-stream was 0.73 and Mid-stream was 0.13, while Species from up-stream was 51, Down-stream was 72 and Mid-stream was 7 and Shannon-weiner Diversity index up-stream was 2.76, Down-stream was 3.12 and Mid-stream was 0.56 (Table 2).

Out of 14 bird species in Nigeria listed as near threatened and vulnerable under IUCN red list, one near threatened species Pallid harrier (*Circus macrourus*) was recorded. This species was recorded at the downstream site (Gashua floodplain south of bridge a) during late rainy season. The most abundant bird species recorded during the period were White faced whistling duck *Dendrocygna viduata* followed by Ruff *Philomachus pugnax* and Cattle egret *Bubulcus ibis* with 12,033, 11,068 and 9,518 individuals respectively. While Pallid harrier *Circus macrourus*, Dark chanting goshawk *Melierax metabates* and Common kestrel *Falco tinnunculus* recorded one individual each.

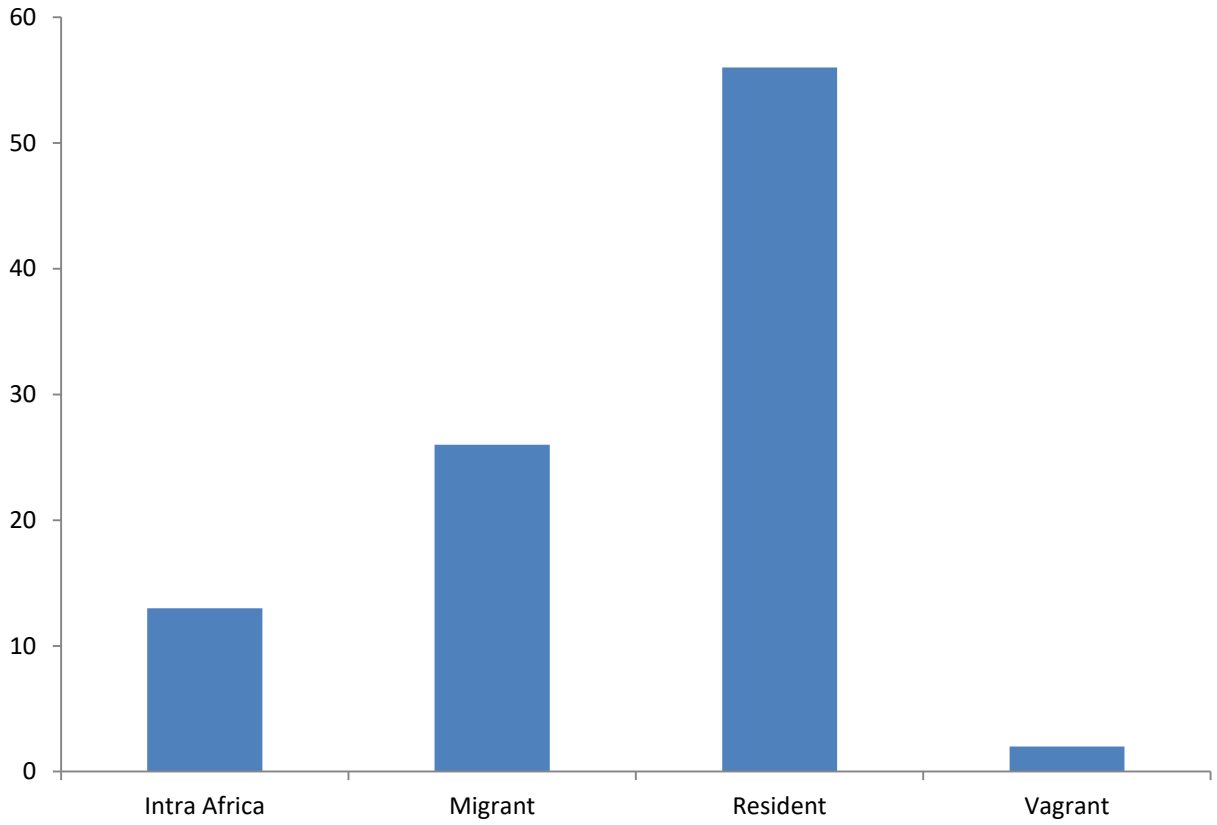

Figure 3: Bird distribution of birds present in Hadejia-Nguru wetlands during study period.

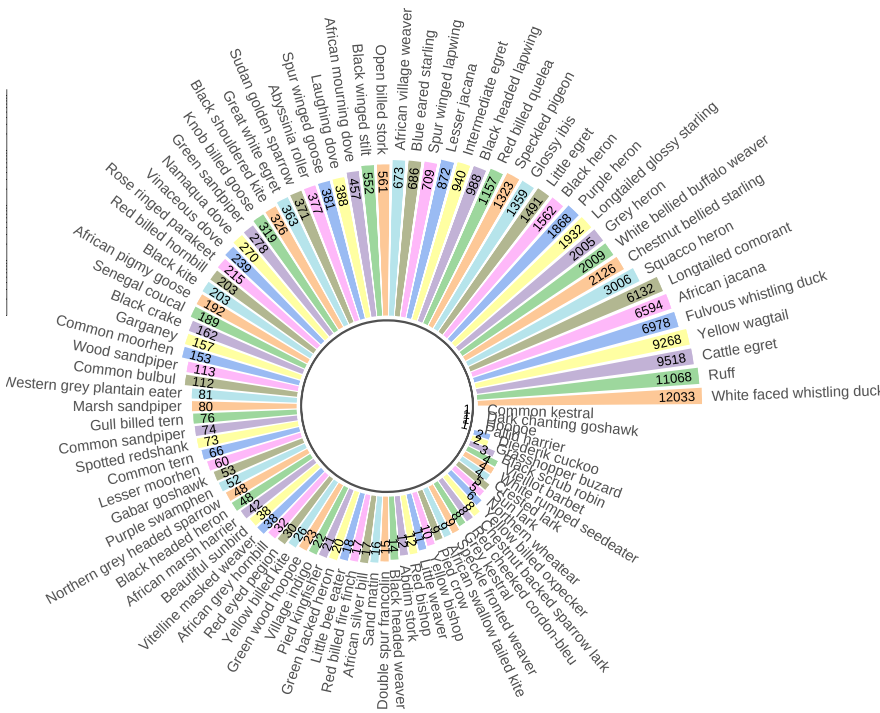

Figure 4: Radial plot of avian species noted in the study area ($N_{species}$= 97, N_{total}= 94113).

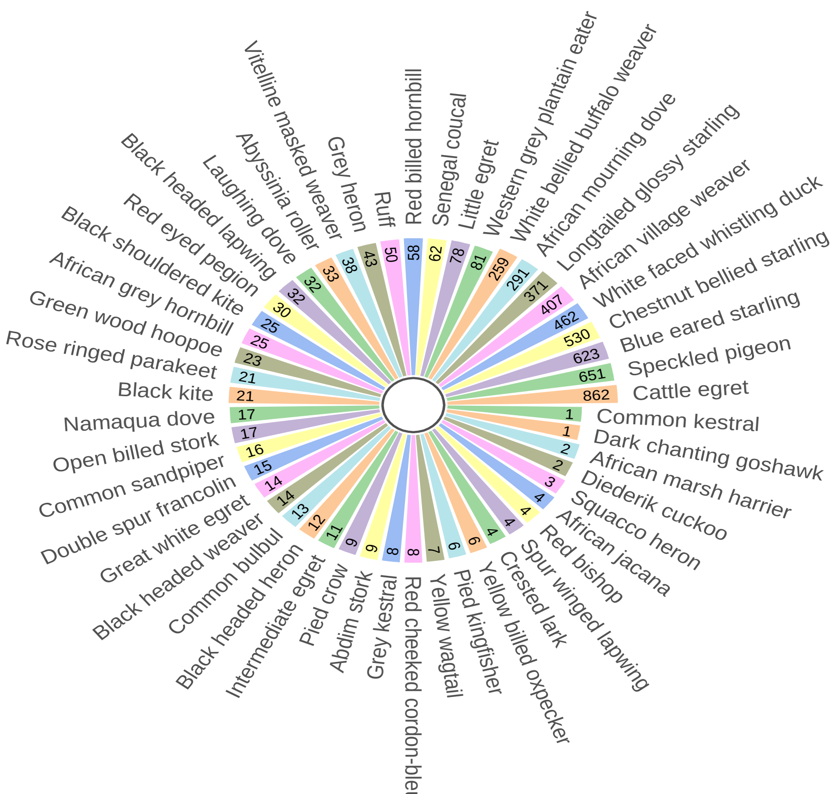

Figure 5: Radial plots of bird abundance and species richness in Upstream ($N_{species}$= 50, N_{total} = 5315).

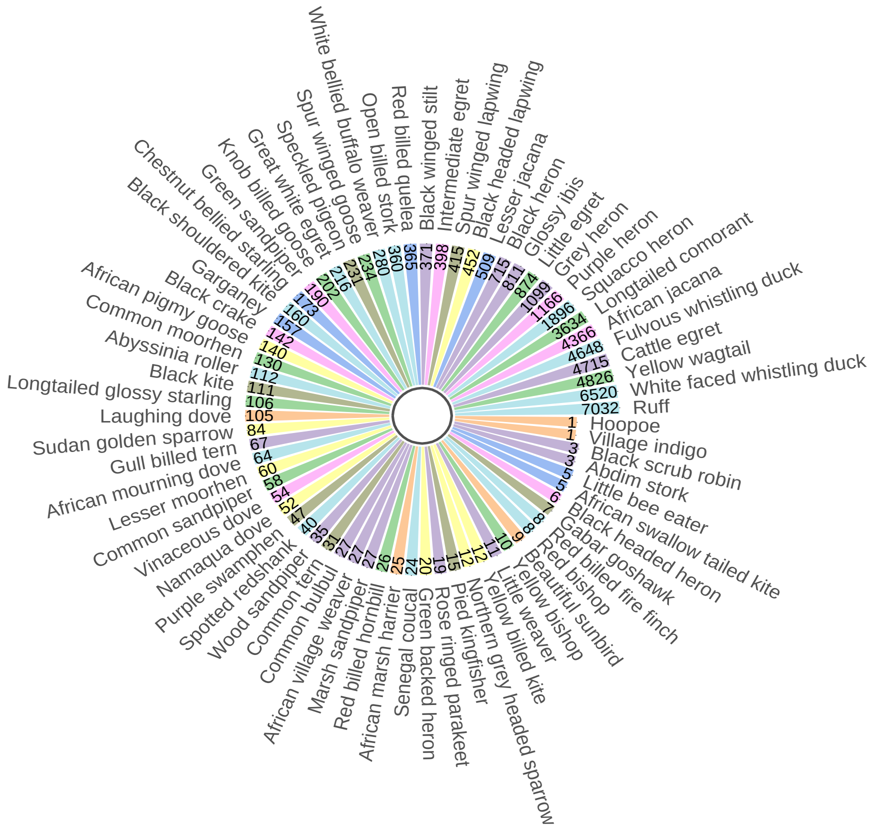

Figure 6: Radial plot of bird abundance and species richness in Midstream site ($N_{species}$= 71, N_{total} = 48764).

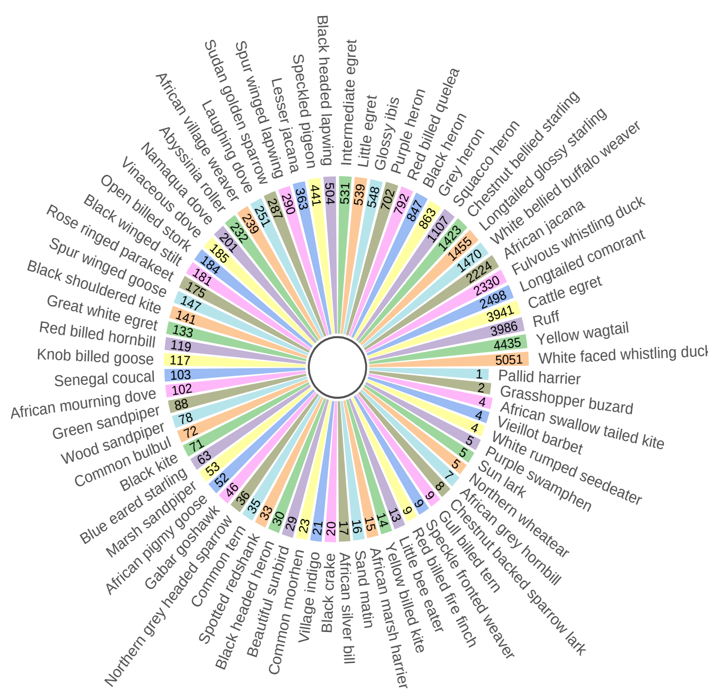

Figure 7: Radial plot of bird abundance and species richness in Downstream ($N_{species}$= 72, N_{total}= 40034).

DISCUSSION

Wetlands attract a large number of avifauna because they provide suitable habitats for most birds (Ali et al., 2018; Altaf, 2016), especially those birds that are associated with water, and the existence of vegetation cover is a vital component of bird life cycles. 94,113 individual birds from 97 species, 39 families and 17 orders were encountered from three locations in the Hadejia-Nguru wetlands and was more than 50 % of recent avifauna checklist of the entire area (Ringim and Muhammad, 2017). Wetlands attract variety of birds that may include waterfowl, waders, shorebirds, and songbirds. Many bird species use wetlands as breeding grounds, building nests in the vegetation, laying their eggs, and raise their young. Wetlands offer a safe and productive environment for raising chicks because of food availability. They are important stopover points for migratory birds, during annual migratory journeys between breeding and wintering grounds, where they use them as wintering point or stop-over point to rest and refuel.

Nigeria avifauna as documented, are made up of about 863 species, 14 are listed as near threatened and vulnerable majority are of least concern LC (Birdlife International 2016). The study was conducted in two habitat types (floodplain and riparian forest) in the Hadejia-Nguru wetlands. A total of 94,113 individuals from 17, orders, 39 families and 97 species were encountered. This form about 50% of avifauna for the entire study area as reported in avian checklist of Hadejia-Nguru wetland (Muhammad et al., 2018; Sulaiman Inuwa, 2018). Riparian floodplain especially in developing countries are threatened with intensive anthropogenic activities such as agricultural production, urbanization which reduce foraging and breeding habitat through habitat transformation, fragmentation or total loss which affect biodiversity abundance, distribution and diversity including birds. The transformation, fragmentation or total loss of the original habitat type resulted in shaping the abundance, distribution and diversity of the existing biotic communities. The birds communities present in the upstream during the study period were found to be dominated by species associated with in areas dominated by human activities. This result is in consistent with finding of Ntongani and Andrew (2013) that anthropogenic activities such agriculture affect bird abundance and distribution.

The distribution of bird species between study sites revealed that, the highest bird species abundance are water or water related and therefore habitat restricted species such as terrestrial birds does not appear in habitat characterized with moist surface or floodplains. The midstream and downstream that remains moist for longer period were found to have higher species richness dominated by water related bird, with 72 and 71 different species such ducks, geese and waders in addition to generalist species whose feeding guild are associated with moist or aquatic habitat. Food availability is an important factor which facilitate bird abundance and distribution as observed in result in midstream which supported the highest bird abundance this coincide finding by Paillisson et al. (2002) that reported, food availability and accessibility and the presence of safe roosting or breeding sites determine habitat selection by water birds.

The most abundant individual species are white-faced whistling duck, ruff, cattle egret, yellow wagtail and fulvous whistling duck. The habitat guild for these groups is closely associated with aquatic or moist environments. For example, the

ducks in the group, feed on aquatic plant material and build nests on aquatic grasses. Ruff (winter migrant), feeds on aquatic grass seeds aquatic worms and larvae of aquatic insects. Yellow wagtails and cattle egrets feed on insects some aquatic invertebrates. The ruff and yellow wagtail are Palaearctic visitors.

The midstream and downstream sites recorded the highest bird abundance and species richness, throughout the micro-seasons. The highest bird abundance and species richness was recorded in the late dry season and late wet season this coincides with the presence of winter migrant and the late dry period as the wetland is recognized as the important wintering site of Palaearctic winter visitors and in the late wet season coincide with afro-tropical and breeding resident and visiting species. The upstream is characterised by, flooded rice fields, upland farms and scattered pastoral settlements. These anthropogenic activities translate to high anthropogenic disturbance which in turn affects the food availability, shelter or even breeding and nesting sites, therefore, affect bird species abundance and richness. The result coincides with the finding by Amira et al. (2018) and Sulaiman Inuwa (2018) that reported that human-induced change in landscape and vegetation structure may influence bird species composition. The presence of bird species such as speckled pigeon chestnut-bellied starlings and long-tailed glossy starling were closely associated with human habitat including human shelter.

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Table 1: List of Birds in the study area.

Sr.	Family Name	Scientific Name	Common Name	IUCN Status	Global Trend	Guild	Residency
1	**Ciconiidae**	*Ciconia abdmii*	Abdim stork	LC	Decreasing	Insectivorous	Migrant
2	**Coraciidae**	*Coracias abyssinicus*	Abyssinia Roller	LC	Increasing	Insectivorous	Resident
3	**Bucerotidae**	*Tockus nasutus*	African Grey HornBill	LC	Stable	Insectivorous Granivorous	Resident
4	**Jacanidae**	*Actophilornis africanus*	African Jacana	LC	Stable	Insectivorous Herbivorous	Resident
5	**Accipitridae**	*Circus ranivorus*	African Marsh Harrier	LC	Stable	Carnivorous	Resident/ Intra Africa
6	**Columbidae**	*Streptopelia decipiens*	African Mourning Dove	LC	Stable	Frugivorous Granivorous Insectivorous	Resident
7	**Anatidae**	*Nettapus auritus*	African pigmy goose	LC	Stable	Herbivorous Insectivorous	Resident
8	**Estrildidae**	*Euodice cantans*	African silver bill	LC	Stable	Frugivorous Insectivorous	Resident
9	**Accipitridae**	*Elanoides forficatus*	African swallow tailed kite	LC	Decreasing	Carnivorous	Migrant
10	**Nectariniidae**	*Cinnyris pulchellus*	Beautiful Sunbird	LC	Stable	Nectivorous Insectivorous	Resident/ Intra Africa
11	**Rallidae**	*Zapornia flavirostra*	Black Crake	LC	Stable	Carnivorous Insectivorous	Resident/ Intra Africa
12	**Ardeidae**	*Ardea melanocephala*	Black headed heron	LC	Increasing	Pisivorous	Resident
13	**Charadriidae**	*Vanellus tectus*	Black headed lapwing	LC	Unknown	Insectivorous Carnivorous	Resident
14	**Ardeidae**	*Egretta ardesiaca*	Black Heron	LC	Stable	Insectivorous	Resident/ Intra Africa
15	**Accipitridae**	*Milvus migrans*	Black Kite	LC	Decreasing	Omnivorous	Migrant
16	**Turdidae**	*Cercotrichas podobe*	Black Scrub robin	LC	Stable	Omnivorous	Resident
17	**Accipitridae**	*Elanus caeruleus*	Black shouldered Kite	LC	Stable	Carnivorous Insectivorous	Resident
18	**Recurvirostridae**	*Himantopus himantopus*	Black winged Stilt	LC	Increasing	Carnivorous Granivorous	Migrant
19	**Ploceidae**	*Ploceus melanocephalus*	Black-headed Weaver	LC	Stable	Insectivorous	Resident
20	**Sturnidae**	*Lamprotornis Chalybaeus*	Greater Blue Eared Starling	LC	Stable	Insectivorous Insectivorous	Resident
21	**Ardeidae**	*Bubulcus ibis*	Cattle Egret	LC	Increasing	Pisivorous	Resident

22	**Alaudidae**	*Eremopterix leucotis*	Chestnut Backed sparrow Lark	LC	Stable	Granivorous Insectivorous	Resident
23	**Sturnidae**	*Lamprotornis pulcher*	Chestnut Bellied Starling	LC	Stable	Frugivorous Insectivorous	Resident
24	**Pycnonotidae**	*Pycnonotus barbatus*	Common Bulbul	LC	Stable	Frugivorous Insectivorous Nectavorous	Resident
25	**Falconidae**	*Falco tinnunculus*	Common kestral	LC	Decreasing	Carnivorous	Migrant
26	**Rallidae**	*Gallinula chloropus*	Common Moorhen	LC	Stable	Omnivorous	Resident
27	**Scolopacidae**	*Actitis hypoleucos*	Common sandpiper	LC	Decreasing	Omnivorous	Vagrant
28	**Alaudidae**	*Sterna hirundo*	Common tern	LC	Unknown	Pisivorous	Migrant
29	**Alaudidae**	*Galerida cristata*	Crested Lark	LC	Decreasing	Insectivorous Frugivorous Granivorous	Vagrant
30	**Accipitridae**	*Melierax metabates*	Dark Chanting Goshawk	LC	Stable	Carnivorous	Resident
31	**Campephagidae**	*Chrysococcyx caprius*	Diederik Cuckoo	LC	Stable	Insectivorous	Migrant
32	**Phasianidae**	*Pternistis bicalcaratus*	Double spur Francolin	LC	Decreasing	Granivorous	Resident
33	**Anatidae**	*Dendrocygna bicolor*	Fulvous Whistling Duck	LC	Decreasing	Herbivorous	Resident/ Intra Africa
34	**Accipitridae**	*Micronisus gabar*	Gabar Goshawk	LC	Stable	Carnivorous	Resident
35	**Anatidae**	*Anas querquedula*	Garganey	LC	Decreasing	Omnivorous Carnivorous Insectivorous	Migrant
36	**Threskiornithidae**	*Plegadis falcinellus*	Glossy ibis	LC	Decreasing	Carnivorous	Migrant
37	**Accipitridae**	*Actitis hypoleucos*	Grasshopper Buzard	LC	Unknown	Carnivorous	Migrant
38	**Ardeidae**	*Egretta alba*	Great white egret	LC	Unknown	Insectivorous Carnivorous	Resident/ Intra Africa
39	**Ardeidae**	*Butorides striata*	Green backed heron	LC	Decreasing	Insectivorous Carnivorous	Resident/ Intra Africa
40	**Rallidae**	*Tringa Ochropus*	Green sandpiper	LC	Increasing	Omnivorous	Migrant
41	**Phoeniculidae**	*Phoeniculus purpureus*	Green wood Hoopoe	LC	Decreasing	Insectivorous	Resident
42	**Ardeidae**	*Ardea cinerea*	Grey Heron	LC	Unknown	Insectivorous Carnivorous	Migrant
43	**Falconidae**	*Falco ardosiaceus*	Grey Kestral	LC	Stable	Carnivorous	Resident
44	**Sturnidae**	*Gelochelidon nilotica*	Gull billed tern	LC	Decreasing	Insectivorous	Migrant
45	**Upupidae**	*Upupa epops*	Hoopoe	LC	Decreasing	Insectivorous	Migrant

46	**Ardeidae**	*Ardea intermedia*	Intermediate Egret	LC	Decreasing	Pisivorous Insectivorous	Intra Africa
47	**Anatidae**	*Sarkidiornis melanotos*	Knob billed Goose	LC	Decreasing	Herbivorous Frugivorous Granivorous	Intra Africa
48	**Columbidae**	*Streptopelia senegalensis*	Laughing Dove	LC	Stable	Insectivorous	Resident
49	**Rallidae**	*Microparra capensis*	Lesser Jacana	LC	Unknown	Insectivorous	Resident
50	**Rallidae**	*Gallinula angulata*	Lesser Moorhen	LC	Unknown	Omnivorous	Intra Africa
51	**Meropidae**	*Merops pusillus*	Little bee eater	LC	Decreasing	Insectivorous	Resident
52	**Ardeidae**	*Egretta garzetta*	Little Egret	LC	Increasing	Pisivorous Insectivorous	Resident
53	**Ploceidae**	*Ploceus luteolus*	Little weaver	LC	Stable	Granivorous Insectivorous	Resident
54	**Phalacrocoracidae**	Microcarbo africanus	Longtailed Comorant	LC	Decreasing	Pisivorous	Resident
55	**Sturnidae**	*Lamprotornis caudatus*	Longtailed Glossy Starling	LC	Stable	Frugivorous Insectivorous	Resident
56	**Scolopacidae**	*Tringa stagnatilis*	Marsh sandpiper	LC	Decreasing	carnivorous	Migrant
57	**Columbidae**	*Oena capensis*	Namaqua Dove	LC	Increasing	Frugivorous Granivorous Insectivorous	Resident/ Intra Africa
58	**Passeridae**	*Passer griseus*	Northern Grey Headed Sparrow	LC	Stable	Granivorous Insectivorous	Resident
59	**Muscicapidae**	*Oenanthe oenanthe*	Northern Wheatear	LC	Decreasing	Insectivorous	Migrant
60	**Ciconiidae**	*Anastomus lamelligerus*	Opened billed stork	LC	Stable	carnivorous Pisivorous Insectivorous	Intra Africa
61	**Accipitridae**	*Circus macrourus*	Pallid Harrier	NT	Decreasing	Carnivorous	Migrant
62	**Corvidae**	*Corvus albus*	Pied Crow	LC	Stable	Insectivorous Granivorous	Resident
63	**Alaudidae**	*Ceryle rudis*	Pied Kingfisher	LC	Unknown	Pisivorous Insectivorous Carnivorous	Resident
64	**Ardeidae**	*Ardea purpurea*	Purple Heron	LC	Decreasing	Pisivorous Insectivorous Carnivorous	Migrant
65	**Rallidae**	*Porphyrio porphyrio*	Purple Swamphen	LC	Unknown	Herbivorous Insectivorous Carnivorous	Resident

66	**Bucerotidae**	*Tockus erythrorhynchus*	Northern Red Billed Hornbill	LC	Stable	Granivorous Insectivorous	Resident
67	**Estrildidae**	*Lagonosticta senegala*	Red billed fire finch	LC	Stable	Granivorous Insectivorous	Resident
68	**Ploceidae**	*Quelea quelea*	Red billed Quelea	LC	Stable	Granivorous Insectivorous	Resident/ Intra Africa
69	**Ploceidae**	*Euplectes franciscanus*	Red Bishop	LC	Increasing	Granivorous Insectivorous	Resident
70	**Columbidae**	*Streptopelia semitorquata*	Red eyed pegion	LC	Increasing	Granivorous	Migrant
71	**Estrildidae**	*Uraeginthus bengalus*	Red-cheeked Cordon-Bleu	LC	Stable	Insectivorous Granivorous	Resident
72	**Psittacidae**	*Psittacula krameri*	Rose ringed Parakeet	LC	Increasing	Frugivorous Granivorous	Resident
73	**Scolopacidae**	*Philomachus pugnax*	Ruff	LC	Decreasing	Insectivorous Carnivorous	Migrant
74	**Hirundinidae**	*Riparia riparia*	Collard Sand Matin	LC	Decreasing	Insectivorous	Migrant
75	**Cuculidae**	*Centropus senegalensis*	Senegal Coucal	LC	Stable	Insectivorous	Resident
76	**Passeridae**	*Sporopipes frontalis*	Speckle fronted weaver	LC	Stable	Granivorous Insectivorous Frugivorous	Resident
77	**Columbidae**	*Columba guinea*	Speckled Pigeon	LC	Stable	Granivorous Insectivorous	Resident
78	**Rallidae**	*Tringa erythropus*	Spotted redshank	LC	Stable	Insectivorous	Migrant
79	**Anatidae**	*Plectropterus gambensis*	Spur winged Goose	LC	Increasing	Herbivorous	Resident
80	**Charadriidae**	*Vanellus spinosus*	Spur winged Lapwing	LC	Increasing	Insectivorous Carnivorous Insectivorous	Resident
81	**Ardeidae**	*Ardeola ralloides*	Squacco Heron	LC	Unknown	Pisivorous	Migrant
82	**Passeridae**	*Passer luteus*	Sudan Golden Sparrow	LC	Stable	Granivorous Insectivorous	Migrant
83	**Alaudidae**	*Galerida modesta*	Sun lark	LC	Stable	Granivorous Insectivorous	Resident
84	**Lybiidae**	*Lybius vieilloti*	Vieillot's Barbet	LC	Unknown	Frugivorous	Resident
85	**Viduidae**	*Vidua chalybeata*	Village indigobird	LC	Stable	Granivorous Insectivorous	Resident
86	**Ploceidae**	*Ploceus cucullatus*	Village Weaver	LC	Stable	Granivorous Insectivorous	Resident
87	**Columbidae**	*Streptopelia vinacea*	Vinaceous Dove	LC	Stable	Frugivorous Granivorous	Resident

						Insectivorous	
88	**Ploceidae**	*Ploceus vitellinus*	Vitelline Masked weaver	LC	Stable	Granivorous Insectivorous	Resident
89	**Musophagidae**	*Crinifer piscator*	Western Grey Plantain eater	LC	Increasing	Frugivorous Granivorous	Resident
90	**Ploceidae**	*Bubalornis albirostris*	White bellied buffalo weaver	LC	Increasing	Granivorous Frugivorous Insectivorous	Resident
91	**Anatidae**	*Dendrocygna viduata*	White Faced Whistling duck	LC	Stable	Herbivorous Carnivorous	Resident
92	**Fringillidae**	*Serinus leucopygius*	White rumped seedeater	LC	Increasing	Granivorous	Resident
93	**Scolopacidae**	*Tringa glareola*	Wood sandpiper	LC	Stable	Insectivorous Omnivorous	Migrant
94	**Accipitridae**	*Milvus aegyptius*	Yellow Billed Kite	LC	Stable	Carnivorous Omnivorous	Resident
95	**Sturnidae**	*Buphagus africanus*	Yellow billed Oxpecker	LC	Decreasing	Insectivorous	Resident
96	**Ploceidae**	*Euplectes capensis*	Yellow Bishop	LC	Stable	Granivorous Insectivorous	Resident
97	**Motacillidae**	*Motacilla flava*	Yellow Wagtail	LC	Decreasing	Insectivorous Granivorous	Migrant

Table 2: Statistical analysis of avian species in the study area.

Indices	Up-stream	Down-stream	Mid-stream
Population	5315	40034	48764
Evenes E	0.71	0.73	0.13
Species S	51	72	71
Shannon diversity index H’	2.76	3.12	0.56