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EFFECT OF HABITAT VARIATION AND MICRO-SEASONS ON BIRD ABUNDANCE, AND SPECIES RICHNESS IN THE HADEJIA-NGURU WETLANDS NIGERIA

***Suleiman D. I., Egwumah P. O[2]., Tyowua B. T[2]. and Orsar T. J.[2]**
[1]Department of Forestry and Wildlife Management, Aliko Dangote University of Science and Technology Wudil
[2]Department of Wildlife and Range Management, Joseph Sarwuan Tarka University Makurdi, Nigeria
***Corresponding Author**: *isahdutse@yahoo.com, isahdutse@gmail.com*

ABSTRACT

The species abundance, diversity and richness of avifauna are influence by time and habitat suitability. Bird species abundance, diversity and richness were investigated in two habitat type, between July 2020 and June 2021 in Hadejia-Nguru wetlands in North-east Nigeria. Three sites were identified on which; two kilometer line transects separated by two kilometers apart were established. Ten points were marked at interval of 200 metres on each line transect for data collection on birds. A total of 97 bird species from 17 orders and 40 families were recorded during the period of study. The highest number of avifauna individuals was recorded in Down-stream site followed by Mid-stream while the Up-stream recorded the least. Similarly, the Down-stream recorded the highest diversity index (3.67) and species richness (72) and it was followed by Mid-stream (3.18) and species richness of (71). While the least diversity index (2.76) and species richness (50) were recorded in the Upstream.

Key words: Habitat, micro-season differences avifauna species abundance, distribution and diversity

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INTRODUCTION

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. This leads to a decline in the variety of plant and animal life including birdlife, which can have significant consequences on the ecosystem as a whole. Compared to other continents, Africa has the fastest growing human population, accounting for 2.7% per annum, (Sulaiman, 2018, Tappan and McGahuey, 2007;). The conversion of natural ecosystems into agricultural land, human settlements, or urban areas, along with the construction of large road networks and industrial development has significantly altered the original characteristics of global natural ecosystems. Anthropogenic activities, such as logging, to satisfy human needs are causing the destruction and degradation of natural ecosystems, threatening over 1,354 bird species (93%). According to Shannon *et al*. (2018), 54% of direct mortality and 33% of reduced reproductive success in threatened bird species were attributed to human activities. The outcome of these actions often results to the displacement or complete eradication of a large number of plant and animal species from their natural habitat. Altaf *et al.*, (2018) reported that development of new residential areas and allied facilities, tend to convert bigger ecosystems into fragments of smaller portions whose natural vegetation cover are transformed or completely removed, and many native species are replaced by sky-scrapper

or exotic plants that have high yielding or ornamental values. Agricultural expansion put 1,126 (77%) threatened bird species at risk, while logging and wood harvesting impacted 763 (52%) threatened species. Sohil and Sharma (2020) reported that 473 (32%) threatened bird species were affected by invasive species. Moreover, residential and commercial construction, hunting and trapping, livestock grazing and ranching, and climate change pose significant threats to bird populations and biodiversity in general.

The diversity, abundance, and distribution of bird species are largely influenced by the spatiotemporal distribution of key environmental resources (McCain 2009). Bird habitat requirements change seasonally due to nest and food requirements in both the breeding and non-breeding seasons (Sulaiman, 2014). The West African Sahel region has unique vegetation characterized by short trees that are less than 20 m in height, including Acacia woodlands and various deciduous plants that have adapted to the harsh conditions of drought due to low rainfall. These drought-resistant vegetation cover, supported diverse array of avian species, including both native and migrant species, as well as species from the Western Palearctic region. Philip *et al.*, (2014), reported about 2.1 billion birds that breed in Europe migrate to sub-Saharan Africa annually, and many of them concentrate in the semi-arid savannas. However, deforestation and the conversion of natural ecosystems are increasing. In Senegal, the extent of Acacia nilotica woodland has been declining in the last 40years due to deforestation (Stevens *et al.,* 2010). This substantially reduced woodland size, which adversely affects diversity, abundance, and distribution of avifauna. The Hadejia-Nguru wet lands over the years has served as a destination or staging, wintering and stop-over of migrant birds species in Northeastern Nigeria. This survey was to assess the bird species diversity, abundance and distribution within the micro-seasons in the area to add up to the baseline information which can support policy for management and conservation.

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 Palearctic winter in the Sahel. 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 *et al*., 2017). The Hadejia-Nguru wetlands have two seasons: a wet season that runs from April and ends in September, sometimes extending into October, and a dry season which lasts longer and is subdivided into cold and hot seasons, it starts from October mostly to March, typical of a tropical climate. These two seasons were further sub-divided for the purpose of this study to early dry (October to December), late dry (January to March), early wet (April to June) and late wet (July to September) seasons. 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 study was conducted to assess micro-seasonal bird species abundance distribution and diversity in three locations of the Hadejia-Nguru wetlands in three pre-determined sites namely Upstream (riparian forest wetlands), Mid-stream (floodplain wetlands) and Downstream (riparian forest wetlands) between July 2020 and June 2021. The Upstream (riparian floodplain forest Plate 1) 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 (riparian floodplain forest) is located a short distance from Gashua town Yobe State (figure 1). Each of the study sites was separated by a distance of more than thirty (30) kilometres, (figure 1). Hardy free

Global Positioning System on an Android mobile phone was used to obtain coordinates of two points in each of the three study sites. Each of these two points within a study site are 2 Km apart. Six transect line of 2 Km length were established on each point in all the three sites. Ten points were marked at interval of 200m on each of the six transect lines and coordinates of the marked points were recorded to ensure that same points were used for data collection throughout the study period. These points on the transect lines were used for data collection.

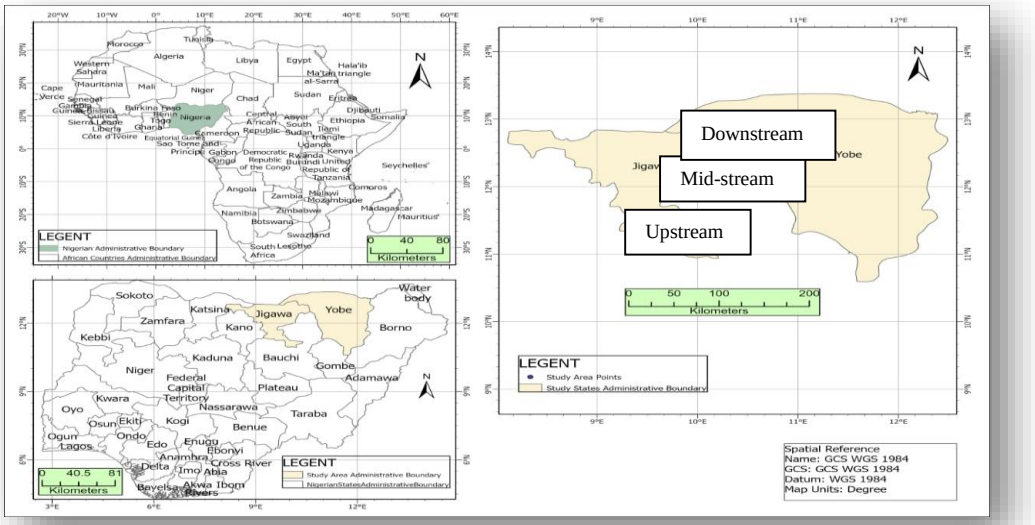

Figure 1: Map of the study Area and Sites

Plate 1: A riparian forest wetland in the Hadejia-Nguru wetlands

Plate 2: A floodplain wetland in the Hadejia-Nguru wetlands

Data Analysis

The birds recorded during the data collection were classified, in accordance with orders and families. They were further classified, based on habitat preference residential status (Rs), migratory (M) and afro-tropical migrant (AM)] and the IUCN red list such as Least concern (LC), Vulnerable (VU), Near Threatened (NT), and Endangered (EN) (IUCN 2020). The data obtained from the field survey were analyzed to determine bird species, abundance, distribution, diversity, richness and evenness in the three study sites across micro-seasons.

Microsoft Excel was used to clean the data for errors, duplicates or in-accuracies before computation. Microsoft Excel Pivot Table Function was used, to determine the abundance, distribution and richness of bird species across micro-seasons. Shannon Wiener diversity indices and bird species evenness between micro-seasons were calculated using equation below.

$$\mathbf{H} = -\sum_{\text{ith}}^{\text{s}}(\text{Pi} * \text{lnP}) \ldots\ldots. (1)$$

Where Pi is the proportion of individual bird to ith species

S is the total number of birds encountered and ln Pi is the natural log of 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
S = Species Richness

RESULTS

Bird abundance, distribution and diversity in the study area

A total of 94,113 individuals' birds belonging to 40 families from 17 orders and 97 species were recorded during the entire study period (Table 1). 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 (Muhammad *et al.*,2018). The most abundant individual species during the study were White faced whistling duck *Dendrocygna viduata* with 12,033 individuals followed by Ruff *Philomachus pugnax* 11,068, then Cattle egret 9,518 and Yellow wagtail *Motacilla flava* 9,268 individuals. While the least abundant recorded bird species were Dark chanting goshawk *Melierax metabates*, Common kestrel *Falco tinnunculus* and Hoppoe *Upupa epops* with 1 individual each (Figure 2).

Of the 97 near threatened species; Pallid harrier *Circus macrourus* was recorded and the remaining 96 are of least concern. The IUCN global trend of the avifauna species record during study period revealed that 45 species have stable population, 26 have decreasing population, 15 species are increasing and 11 species have unknown population trend. Feeding guild record revealed that majority are mix feeders, feeding on more than one diet. However, insectivores and carnivores form a significant population (Table 1). Among the three sites studied Midstream recorded the highest avifauna species with 4,107 (48 %), followed by the Downstream with 3,919 (46 %) and the Upstream recorded least avifauna species of 547 (6 %) (Figure 3).

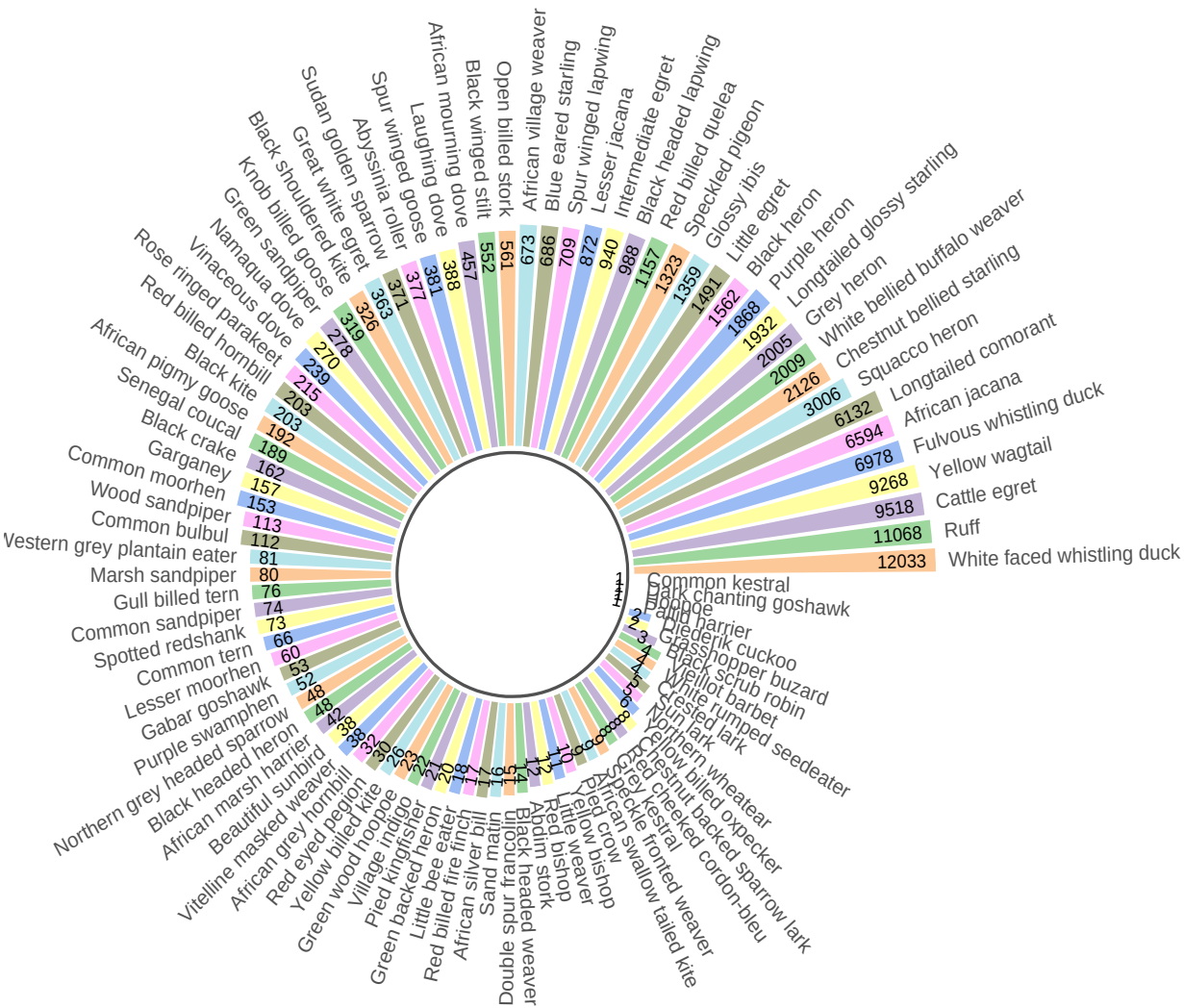

Figure 2: Radial plot of individual bird species and species richness encountered in the study area ($N_{species}$= 97, $N_{total\ indviduals}$= 94113)

Table 1: **Record of avifauna species in the study area by Order, Family, IUCN status, global trend, feeding guild, Residency and frequency of occurrence**

S/N	Birds Species	Order	Family	Scientific Name	IUCN Status	Global Trend	Feeding Guild	Residency	Birds species frequency
1.	Black-winged Kite	Accipitriformes	Accipitridae	*Elanus caeruleus*	LC	Stable	Carnivorous	R	226
2.	Black Kite			*Milvus migrans*	LC	Decreasing	Omnivorous	M	133
3.	Gabar Goshawk			*Micronisus gabar*	LC	Stable	Carnivorous	R	32
4.	African Marsh-harrier			*Circus ranivorus*	LC	Stable	Carnivorous	UK	29
5.	Yellow-billed Kite			*Milvus aegyptius*	LC	Stable	Carnivorous Omnivorous	AM	16
6.	Swallow-tailed Kite			*Elanoides forficatus*	LC	Decreasing	Carnivorous	M	5
7.	Grasshopper buzard			*Actitis hypoleucos*	LC	Unknown	Carnivorous	M	2
8.	Dark chanting goshawk			*Melierax metabates*	LC	Stable	Carnivorous	R	1
9.	Pallid harrier			*Circus macrourus*	NT	Decreasing	Carnivorous	M	1
10.	White-faced Whistling-duck	Anseriformes	Anatidae	*Dendrocygna viduata*	LC	Stable	Herbivorous Carnivorous	AM	280
11.	Fulvous Whistling-duck			*Dendrocygna bicolor*	LC	Decreasing	Herbivorous	AM	216
12.	Spur-winged Goose			*Plectropterus gambensis*	LC	Increasing	Herbivorous	R	64
13.	Knob-billed Goose			*Sarkidiornis melanotos*	LC	Decreasing	Herbivorous	AM	56
14.	African Pygmy-goose			*Nettapus auritus*	LC	Stable	Herbivorous Insectivorous	R	23
15.	Garganey			*Anas querquedula*	LC	Decreasing	Omnivorous Carnivorous	M	14
16.	Red-billed Hornbill	Bucerotiformes	Bucerotidae	*Tockus erythrorhynchus*	LC	Stable	Granivorous Insectivorous	R	80
17.	African Grey Hornbill			*Lophoceros nasutus*	LC	Stable	Insectivorous Granivorous	R	9
18.	Green Woodhoopoe		Phoeniculidae	*Phoeniculus purpureus*	LC	Decreasing	Insectivorous	R	5
19.	Common Hoopoe		Upupidae	*Upupa epops*	LC	Decreasing	Insectivorous	M	1
20.	African Jacana	Charadriiformes	Jacanidae	*Actophilornis africanus*	LC	Stable	Insectivorous Herbivorous	AM	416
21.	Black-headed Lapwing		Charadriidae	*Vanellus tectus*	LC	Unknown	Insectivorous	R	274
22.	Spur-winged Lapwing			*Vanellus spinosus*	LC	Increasing	Insectivorous Carnivorous	M	228
23.	Lesser Jacana		Jacanidae	*Microparra capensis*	LC	Unknown	Insectivorous	R	152
24.	Black-winged Stilt		Recurvirostridae	*Himantopus himantopus*	LC	Increasing	Insectivorous Carnivorous	M	88
25.	Wood Sandpiper		Scolopacidae	*Tringa glareola*	LC	Stable	Insectivorous Omnivorous	M	25
26.	Common Sandpiper			*Actitis hypoleucos*	LC	Decreasing	Omnivorous	M	18
27.	Green Sandpiper			*Tringa Ochropus*	LC	Increasing	Omnivorous	M	46
28.	Marsh Sandpiper			*Tringa stagnatilis*	LC	Decreasing	carnivorous	M	18
29.	Spotted Redshank			*Tringa erythropus*	LC	Stable	Insectivorous	M	13
30.	Common Tern		Laridae	*Sterna hirundo*	LC	Unknown	Pisivorous	M	26
31.	Gull-billed Tern			*Gelochelidon nilotica*	LC	Decreasing	Insectivorous	M	20
32.	Ruff			*Philomachus pugnax*	LC	Decreasing	Insectivorous Carnivorous	M	209
33.	African Openbill	Ciconiiformes	Ciconiidae	*Anastomus lamelligerus*	LC	Stable	carnivorous Pisivorous Insectivorous	AM	84
34.									
35.	Abdim's Stork			*Ciconia abdmii*	LC	Decreasing	Insectivorous	AM	4

S/N	Birds Species	Order	Family	Scientific Name	IUCN Status	Global Trend	Feeding Guild	Residency	Birds species frequency
36.	Speckled Pigeon	Columbiformes	Columbidae	*Columba guinea*	LC	Stable	Frugivorous Granivorous Insectivorous	R	217
37.	Laughing Dove			*Streptopelia senegalensis*	LC	Stable	Frugivorous Granivorous Insectivorous	AM	161
38.	Namaqua Dove			*Oena capensis*	LC	Increasing	Frugivorous Granivorous Insectivorous	AM	141
39.	Mourning Collared-dove			*Streptopelia decipiens*	LC	Stable	Frugivorous Granivorous Insectivorous	R	116
40.	Vinaceous Dove			*Streptopelia vinacea*	LC	Stable	Frugivorous Granivorous Insectivorous	AM	98
41.	Red-eyed Dove			*Streptopelia semitorquata*	LC	Increasing	Granivorous	M	1
42.	Abyssinian Roller	Coraciiformes	Coraciidae	*Coracias abyssinicus*	LC	Increasing	Insectivorous	AM	204
43.	Pied Kingfisher		Alcedinidae	*Ceryle rudis*	LC	Unknown	Pisivorous Insectivorous Carnivorous	R	13
44.	Little Bee-eater		Meropidae	*Merops pusillus*	LC	Decreasing	Insectivorous	R	10
45.	Diederik Cuckoo	Cuculiformes	Campephagidae	*Chrysococcyx caprius*	LC	Stable	Insectivorous	M	1
46.	Grey Kestrel	Falconiformes	Falconidae	*Falco ardosiaceus*	LC	Stable	Carnivorous	R	7
47.	Common kestral			*Falco tinnunculus*	LC	Decreasing	Carnivorous	M	1
48.	Double-spurred Francolin	Galliformes	Phasianidae	*Pternistis bicalcaratus*	LC	Decreasing	Granivorous	R	4
49.	Black Crake	Gruiformes	Rallidae	*Zapornia flavirostra*	LC	Stable	Carnivorous	R	48
50.	Common Moorhen			*Gallinula chloropus*	LC	Stable	Omnivorous	M	41
51.	Lesser Moorhen			*Paragallinula angulata*	LC	Unknown	Omnivorous	R	21
52.	Purple Swamphen			*Porphyrio porphyrio*	LC	Unknown	Herbivorous Insectivorous Carnivorous	R	20
53.	Western Plantain-eater	Musophagiformes	Musophagidae	*Crinifer piscator*	LC	Increasing	Frugivorous Granivorous	R	15
54.	Western Yellow Wagtail	Passeriformes	Motacillidae	*Motacilla flava*	LC	Decreasing	Insectivorous Granivorous	M	373
55.	Long-tailed Glossy Starling		Sturnidae	*Lamprotornis caudatus*	LC	Stable	Frugivorous Insectivorous	R	174
56.	White-billed Buffalo-weaver		Ploceidae	*Bubalornis albirostris*	LC	Increasing	Granivorous Frugivorous Insectivorous	R	163
57.	Red-billed Quelea			*Quelea quelea*	LC	Stable	Granivorous Insectivorous	AM	69
58.	Village Weaver			*Ploceus cucullatus*	LC	Stable	Granivorous Insectivorous	R	45
59.	Yellow Bishop			*Euplectes capensis*	LC	Stable	Granivorous Insectivorous	R	6
60.	Little Weaver			*Ploceus luteolus*	LC	Stable	Granivorous Insectivorous	R	5
61.	Northern Red Bishop			*Euplectes franciscanus*	LC	Increasing	Granivorous Insectivorous	R	8
62.	Vitelline Masked Weaver			*Ploceus vitellinus*	LC	Stable	Granivorous Insectivorous	R	4
63.	Black-headed Weaver			*Ploceus melanocephalus*	LC	Stable	Granivorous Insectivorous	R	1

S/N	Birds Species	Order	Family	Scientific Name	IUCN Status	Global Trend	Feeding Guild	Residency	Birds species frequency
64.	Chestnut-bellied Starling		Sturnidae	*Lamprotornis pulcher*	LC	Stable	Frugivorous Insectivorous	R	155
65.	Senegal coucal		Cuculidae	*Centropus senegalensis*	LC	Stable	Insectivorous	R	189
66.	Common Bulbul		Pycnonotidae	*Pycnonotus barbatus*	LC	Stable	Frugivorous Insectivorous Nectavorous	R	52
67.	Blue-eared Starling		Sturnidae	*Lamprotornis Chalybaeus*	LC	Stable	Insectivorous	R	40
68.	Northern Grey-headed Sparrow		Passeridae	*Passer griseus*	LC	Stable	Granivorous Insectivorous	R	28
69.	Sudan Golden Sparrow			*Passer luteus*	LC	Stable	Granivorous Insectivorous	AM	26
70.	Beautiful Sunbird		Nectariniidae	*Cinnyris pulchellus*	LC	Stable	Nectivorous Insectivorous	R	22
71.	Village Indigobird		Viduidae	*Vidua chalybeata*	LC	Stable	Granivorous Insectivorous	R	14
72.	Red-billed Firefinch		Estrildidae	*Lagonosticta senegala*	LC	Stable	Granivorous Insectivorous	R	10
73.	Collared Sand Martin		Hirundinidae	*Riparia riparia*	LC	Decreasing	Insectivorous	Migrant	6
74.	Speckle-fronted Weaver		Passeridae	*Sporopipes frontalis*	LC	Stable	Granivorous Insectivorous	R	5
75.	Chestnut-backed Sparrow-lark		Alaudidae	*Eremopterix leucotis*	LC	Stable	Granivorous Insectivorous	R	4
76.	Sun lark			*Galerida modesta*	LC	Stable	Granivorous Insectivorous	R	4
77.	Crested lark			*Galerida cristata*	LC	Decreasing	Insectivorous Frugivorous Granivorous	M	3
78.	African Silverbill		Estrildidae	*Euodice cantans*	LC	Stable	Frugivorous Insectivorous	R	3
79.	Black Scrub-robin		Muscicapidae	*Cercotrichas podobe*	LC	Stable	Omnivorous	R	3
80.	Northern Wheatear			*Oenanthe oenanthe*	LC	Decreasing	Insectivorous	M	3
81.	Pied Crow		Corvidae	*Corvus albus*	LC	Stable	Insectivorous Granivorous	R	3
82.	White-rumped Seedeater		Fringillidae	*Serinus leucopygius*	LC	Increasing	Granivorous	R	2
83.	Yellow-billed Oxpecker		Buphagidae	*Buphagus africanus*	LC	Decreasing	Insectivorous	R	2
84.	Red-cheeked Cordon-bleu		Estrildidae	*Uraeginthus bengalus*	LC	Stable	Insectivorous Granivorous	R	1
85.	Cattle Egret	Pelecaniformes	Ardeidae	*Bubulcus ibis*	LC	Increasing	Insectivorous Pisivorous	AM	689
86.	Grey heron			*Ardea cinerea*	LC	Unknown	Insectivorous Carnivorous	M	379
87.	Squacco Heron			*Ardeola ralloides*	LC	Unknown	Insectivorous Pisivorous	M	373
88.	Purple Heron			*Ardea purpurea*	LC	Decreasing	Pisivorous Insectivorous Carnivorous	M	364
89.	Little Egret			*Egretta garzetta*	LC	Increasing	Pisivorous Insectivorous	M	345
90.	Intermediate Egret			*Ardea intermedia*	LC	Decreasing	Pisivorous Insectivorous	M	244
91.	Black Heron			*Egretta ardesiaca*	LC	Stable	Carnivorous Insectivorous	Resident	226
92.	Great White Egret			*Egretta alba*	LC	Unknown	Insectivorous Carnivorous	Intra Africa	117
93.	Black-headed Heron			*Ardea melanocephala*	LC	Increasing	Insectivorous Pisivorous	Intra Africa	18

S/N	Birds Species	Order	Family	Scientific Name	IUCN Status	Global Trend	Feeding Guild	Residency	Birds species frequency
94.	Green-backed Heron			*Butorides striata*	LC	Decreasing	Insectivorous Carnivorous	Migrant	7
95.	Glossy Ibis		Threskiornithidae	*Plegadis falcinellus*	LC	Decreasing	Insectivorous Carnivorous	Migrant	112
96.	Vieillot's Barbet	Piciformes	Lybiidae	*Lybius vieilloti*	LC	Unknown	Frugivorous	Resident	2
97.	Rose-ringed Parakeet	Psittaciformes	Psittacidae	*Psittacula krameri*	LC	Increasing	Frugivorous Granivorous	Resident	27
98.	Long-tailed Cormorant	Suliformes	Phalacrocoracidae	*Microcarbo africanus*	LC	Decreasing	Pisivorous	Resident	410
									8573

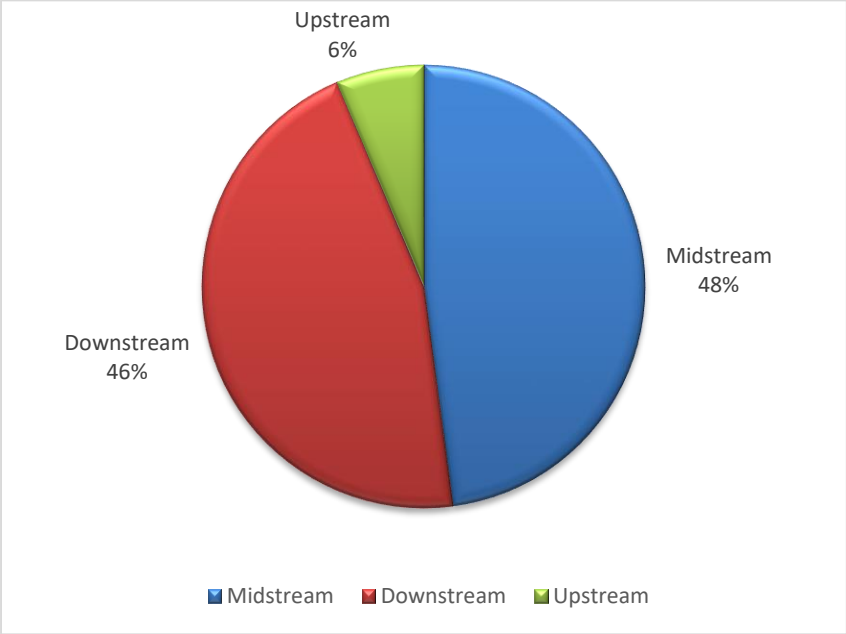

Figure 3: Bird species count in study sites

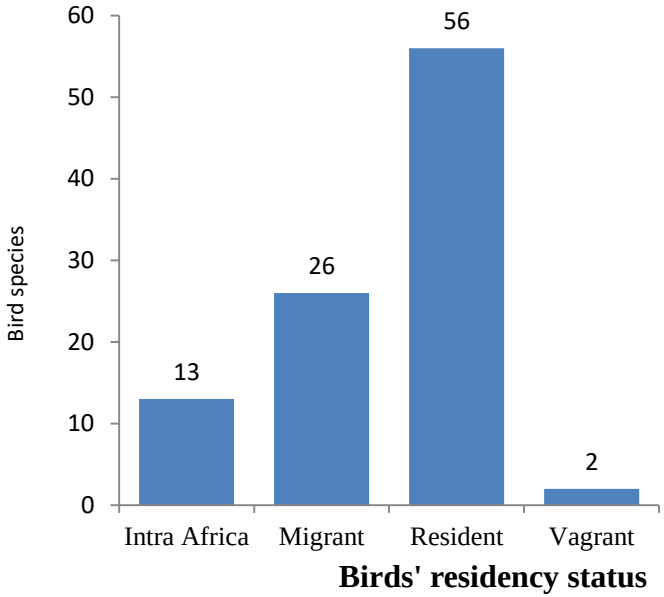

Figure 4: Avifauna species abundance by Residency status in the study area

Of the 97 bird species encountered during the study period 57.73% (56) are resident, 26.80% (26) are Palaearctic migrants, 13.40% (13) are Intra-African migrant and 2.06% (2) are Vagrant (Figure 4). Seasonal avifauna species richness, revealed that, late dry season recorded the highest number of birds species with 87 different species followed by late rainy season with 69 avifauna species while early dry and early rainy season recorded the least species of 40 species each. However, late dry season recorded highest individual avifauna abundance with 68,432 followed by early rainy season with 10,397 individuals. While the least record of avifauna species abundance was in early dry season with 5,496 individuals. The highest avifauna species diversity was recorded in late rainy season (3.28) followed by late dry season (3.05) while least was in early rainy season (2.91).

Table 2: Summary of Micro-seasonal species abundance, richness diversity and evenness during study period

Species	Early Dry season	Early Rainy season	Late Dry Season	Late Rainy season
Abundance	5,496	10,397	68,432	9,788
Richness	40	40	87	69
Diversity	3.04	2.91	3.05	3.28
Evenness	0.08	0.07	0.04	0.05

The highest avifauna abundance was recorded during late dry season (68,432) followed by early rainy season (10,397). However, species diversity index was highest in late rainy season (3.28) (Table 2). Among the three sites studied Mid-stream recorded highest number of bird with (4,107) followed by the Downstream (3,919) while Upstream recorded the least (547). The Downstream and Midstream recorded 72 and 71 species (species richness) each and the Upstream recorded 50 species. The highest species diversity index was recorded in Downstream (3.123) followed by Midstream (2.864) and the least was in Upstream (2.763). However, birds' distribution between sites revealed that they were not evenly distributed (Table 3).

Table 3: Number of species encountered, species richness, species diversity and species evenness in study sites.

Sites	Indices	Downstream	Mid-stream	Upstream
	Species encountered	3,919	4,107	547
	Species Richness	72	71	50
	Shannan Diversity Index	3.123	2.864	2.763
	Species Evenness	0.026	0.026	0.052

DISCUSSION

The bird surveys were carried out twice a month, between 6:30 – 11:30am during short days and 7:00 – 12:00 noon during longer days from July 2020 to June 2021. The study area is an important wintering and staging habitat of palearctic and afro-tropical migrant. It attracts a large number of avifauna species because it provides suitable habitat for most birds (Ali et al., 2018; Altaf, 2016). A total of 94,113 individual birds from 97 species, 40 families and 17 orders were encountered from three locations in the Hadejia-Nguru wetlands and were 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. The transformation, fragmentation or total loss of the original habitat type resulted in regulating the abundance, distribution and diversity of the existing biotic communities. Bird's communities present in the Up-stream during the study period were dominated by species associated with human habitat. This is consistent with finding of Ntongani and Andrew (2013), where anthropogenic activities such agriculture affected bird abundance and distribution. The distribution of bird species between study sites revealed highest abundance of water and water related birds species and therefore habitat restricted species such as terrestrial birds does not appear in moist habitat such as floodplains and riparian forest. The midstream and downstream that retains moisture for longer period were found to have higher species richness dominated by water related bird.

A total of 72 and 71 different species such ducks, geese and waders in addition to generalist species whose feeding guild are associated with aquatic habitat were also found. Food availability is an important factor, which facilitate bird abundance and distribution as observed in this result. The midstream which supported the highest bird abundance coincide with the finding by Paillisson *et al*., (2002), where food availability, accessibility and the presence of safe roosting or breeding sites determined habitat selection by water birds. The midstream and downstream sites recorded the highest bird abundance and species richness, among the micro-seasons. The highest bird abundance and species richness recorded in the late dry season and late wet season coincides with the presence of winter and Afro-tropical migrant species that use the area as important wintering and staging site of Palaearctic winter visitors and afro-tropical and breeding resident and visiting species. The results of this study has contributed to the understanding of the contributions of the micro seasons to the abundance and diversity of birds utilizing the riparian forest and the floodplain habitats in the wet lands which is important in policy formulation for management and conservation

CONCLUSION

Spacio-temporal attributes have fundamental effect on abundance and diversity of avifauna of Hadejia-Nguru wetland as revealed in the result of this study. Human activities such as farming, livestock grazing fishing and wild resource exploitation has mild effect on avifauna.

RECOMMENDATION

The micro-seasonal avifauna abundance and diversity result provide insight to government institution and policy makers on planning and harnessing tourism potentials such as bird watching and sport hunting in Hadejia-Nguru wetland.

REFERENCES

Ali, A., M. S. H. Khan, and M. Altaf. 2018. Winter survey of birds at district of the Badin, Pakistan. *Journal of Wildlife and Ecology. 2: 11-22*

Ali, A., M. S. H. Khan, and M. Altaf. 2018. Winter survey of birds at district of the Badin, Pakistan. *Journal of Wildlife and Ecology. 2: 11-22*.

Altaf, M. 2016. Assessment of avian and mammalian diversity at selected sites along river Chenab, University of Veterinary and Animal Sciences, Lahore, Pakistan. Publshed PhD Thesis

Altaf, M., Javid, A., Khan, A. M., Khan, M. S. H., Umair, M., & Ali, Z. (2018). Anthropogenic impact on the distribution of the birds in the tropical thorn forest, Punjab, Pakistan. *Journal of Asia-Pacific Biodiversity, 11(2), 229–236*. https://doi.org/10.1016/j.japb.2018.03.001

McCain, C. M. (2009). Global analysis of bird elevation diversity. *Global Ecology and Biogeography, 18, 346–360.*

Muhammad, A. S. R. and S. I. (2017). A Checklist for Birds of Hadejia-Nguru Wetlands, influenced bird assemblage structure in Nigeria. Ostrich, 89(3), 221–231 Nigeria.

Dutse Journal of Pure and Applied Sciences (DUJOPAS), Vol. 3 No.(June 2017).

Ntongani, W. A., and S. M. Andrew. (2013). Bird species composition and diversity in habitats with different disturbance histories at Kilombero Wetland, Tanzania: (write the publication here properly)

Philip Atkinson, W. Adams, W. M., Brouwer, J., Buchanan, G., Cheke, R. A., Cresswell, W., Vickery, J. A. (2014). Defining the key wintering habitats in the Sahel for declining African-Eurasian migrants using expert assessment. *Bird Conservation International, 24(4), 477–491*. https://doi.org/10.1017/S0959270913000531 (accessed on February 12, 2024)

Paillisson J.-M., S. Reeber, and L. Marion. 2002. Bird assemblages as bio-indicators of water regime management and hunting disturbance in natural wet grasslands. Biological Conservation. 106: 115-127.

Sohil and N. Sharma (2020). Bird diversity and distribution in mosaic landscapes around Jammu, Jammu & Kashmir, *Acta Ecologica Sinica*, Vol. 40, Issue 4, Pg. 323-338 https://doi.org/10.1016/j.chnaes.2020.02.005 (Accessed on Febdruary 12, 2024)

Sulaiman I. M., (2018). The effects of seasonality, landscape variables and anthropogenic activities in structuring bird community in Dutse, Nigeria. A PhD thesis Institute of Biological Sciences Faculty of Science University of Malaya Kuala Lumpur. (Unpublished).

Tappan G. and McGahuey M., (2007). Tracking environmental dynamics and agricultural intensification in southern Mali. *Science Direct Volume 94, lssue 1, Pg. 38-51*