Journal of Research in Forestry, Wildlife & Environment Vol. 14(1) March, 2022
E-mail: *jrfwe2019@gmail.com; jfewr@yahoo.com*
http://www.ajol.info/index.php/jrfwe

jfewr ©2022 - jfewr Publications
ISBN: 2141 – 1778
Eveso et al., 2022

DIVERSITY AND ABUNDANCE OF AVIFAUNA SPECIES IN FEDERAL UNIVERSITY, GASHUA, NORTH-EAST NIGERIA

[1]Eveso, J. O.[*], [1]Wakawa, L. D. and [2]Richard, R.

[1]Department of Forestry and Wildlife Management, Federal University, Gashua, Yobe State, Nigeria
[2]Department of Biological Sciences, Federal University, Gashua, Yobe State, Nigeria
***Corresponding author:** *jonathaneveso@gmail.com;* +234 813 566 7865

ABSTRACT

The study examined the diversity and abundance of bird species at the Federal University, Gashua, Northeast, Nigeria. The campus was divided into four (4) distinct habitat types-Acacia Woodlot (predominantly with Acacia spp), Neem (predominantly with Azadiracta indica) area, Open Grassland, and Lake Area. Bird survey was carried out for four (4) months (October, 2019–January, 2020) covering late wet season till early dry season using the Point count method. Counting stations of 20 m radius each were randomly selected within each habitat with the minimum distance of 100 m between two counting stations. Bird count was from 06:30 h to 10:00 h in the morning, and 16:00 h to 18:00 h in the evening. Each habitat was visited twice in one day per week resulting in a total of 64 man-days, 128 count visits and 32 visits per habitat type. A total of 71 bird species in 32 families comprising of 13, 812 individuals in the wet season, and 16,682 individuals in the dry season was recorded in this study. The relative abundance of bird species across habitats was comparatively homogeneous throughout the wet season with the exception of Neem area (0.6). On the other hand, Open grassland area had the lowest abundance in the dry season (-1.6). The lake area had the highest abundance in both the wet (1.2) and dry (1.0) seasons. Bird species were more diverse and even, but less dominant in the lake area (H'=3.413; D=0.0374; e^H/S=0.8205), while the Open grassland area showed less diversity and evenness, with more dominance (H'=2.836; D=0.07304; e^H/S=0.6818) during the dry season respectively. Bird species were comparatively abundant and diverse, while revealing the need to plant more trees and protect the lake area which sustained the highest birdlife at the Federal University Gashua.

Keywords: Urban Birds, Abundance, Checklist, Diversity, habitat preference

Correct Citation of this Publication
Eveso, J. O., Wakawa, L. D. and Richard, R. (2022). Diversity and abundance of avifauna species in Federal University, Gashua, northeast Nigeria. *Journal of Research in Forestry, Wildlife & Environment,* 14(1): 98 - 109

INTRODUCTION

In comparison to other animal groups, birds are an important taxon that provides considerable ecosystem services (Şekerciolu *et al.*, 2016). These ecosystem services could be supporting, regulatory, or provisional (Whelan et al., 2008). Furthermore, they are mobile and can be found in a variety of habitats across wide geographic areas, where they link numerous trophic and physical processes (Şekerciolu 2006). Birds are frequently important agents in seed dispersal, as they have the ability to transport seeds across long distances (Gaston *et al.*, 2018). Birds provide a low-cost, natural method of urban forest regeneration (Overdyck *et al.*, 2013). Birds' consumption of insects and rodents may aid in the control of agricultural pest populations. Birds are at the centre of recreational activities like bird watching, which has been linked to improved human health (Gaston et al., 2018). One of the most ubiquitous and dominating kinds of land use worldwide is urbanization, which is the process of changing a natural ecosystem to one dominated by human activity (Grimm *et al.*, 2015). According to studies, the low quantity of many bird species in most regions of the world today, particularly in metropolitan areas, is of

particular concern, as many cities are fast rising both in size and population (David *et al.*, 2015). This may well be true of any fast-growing institution wherein land has to be cleared for infrastructural development like roads, buildings of offices, lecture theatre, laboratories among others. Such development is inevitable in newly established institution like the Federal University Gashua, which was set up by the Federal Government of Nigeria in 2013. The university is still younger than a decade; hence, it is at the fast development stage which may affect resident biodiversity, especially birds since it is located not far from the Dagona Waterfowl Sanctuary (DWS) of Chad Basin National Park (CBNP) as well as the Hadejia-Nguru Wetlands (HNWs), a recognised Ramsar site and Important Bird Area (IBA). Estimates of bird's abundance are widely used in bird conservation. For example, they allow us to measure changes in population size of birds (Buckland *et al.*, 2008).

Information on population sizes of individual bird species can also be used to set priorities, allowing conservation effort to be focused on those species mostly in need of attention (Richard *et al.*, 2004). A few studies have been carried out in the Dagona Waterfowl Sanctuary where Lameed (2012) recorded a total of 135 bird species in 40 families. He noted that the study revealed a positive relationship between percentage ground cover, shrub density and tree density to bird recorded, while Sabo, (2016) recorded a total of 88,105 individual birds that belong to 165 species of 50 families in Hadejia-Nguru Wetlands. These studies were carried out in protected and semi-protected wilderness areas. However, there is dearth of information on the diversity and abundance of bird species in fast developing urban areas in North-eastern part of the country such as the Federal University, Gashua. As the university develops its infrastructure and increase in other anthropogenic activities such as tree felling, there is likelihood of bird disturbance, displacement and possible change in bird behaviour. This might adversely affect their survival. Composition and long-term persistence of many avian populations depends upon the precise habitat requirements, abundance and dispersal strategies of individual species (Yu and Guo, 2013).

The estimation of local densities of Avifauna helps to understand the abundance of various species of other organisms (Caughley, 1982). There is need to determine the present diversity and abundance of birds and their relationship with the vegetation in order to understand the best conservation and management steps to take. Urban planners need better information about the factors affecting the distribution of species and structure of communities in order to create or maintain biodiversity in urban areas (Clergeau *et al.*, 2001).

The study aims to identify bird species, generate a checklist of birds, and determine the diversity and abundance of bird species within Federal University, Gashua, Yobe State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Federal University Gashua (FUGA), Yobe State, Nigeria. The University covers an area of about 177.1ha, and is located between $12^0 87'58''$ N, $11^0 01'20''$Ein Gashua, the capital of Bade Local Government Area of Yobe State, North-eastern Nigeria. Gashua is about 70km East of Hadejia-Nguru Wetlands a recognized Ramsar site and Important Bird Area (IBA) with one of its seasonal pockets of wetlands directly opposite the University. The climate of the area shows a dry season stretching from October to June and the rainy season between July to September. The mean annual rainfall is 275mm and mean annual temperature varies between 35 and 40^0C (YOSADP,1992). The major vegetation type is the Sahel savannah. It consists of open thorny savannah with short trees and grasses. The trees are about 5 to 10m high. Some of the common trees found in the area include *Acacia seyel, Balanite aegyptiaca, Azadiracta indica, Adansonia digitata, Faidherbia albida, Tamarindus indica, Hyphaene thebaica, Anogeissus leiocarpus, Khaya senegalensis, Pakia biglobosa, Vitex doniana, Borassus aethiopum, Phoenix dacrtylifera, Vitellaria paradoxa,*and *Ziziphusspina-christy.*

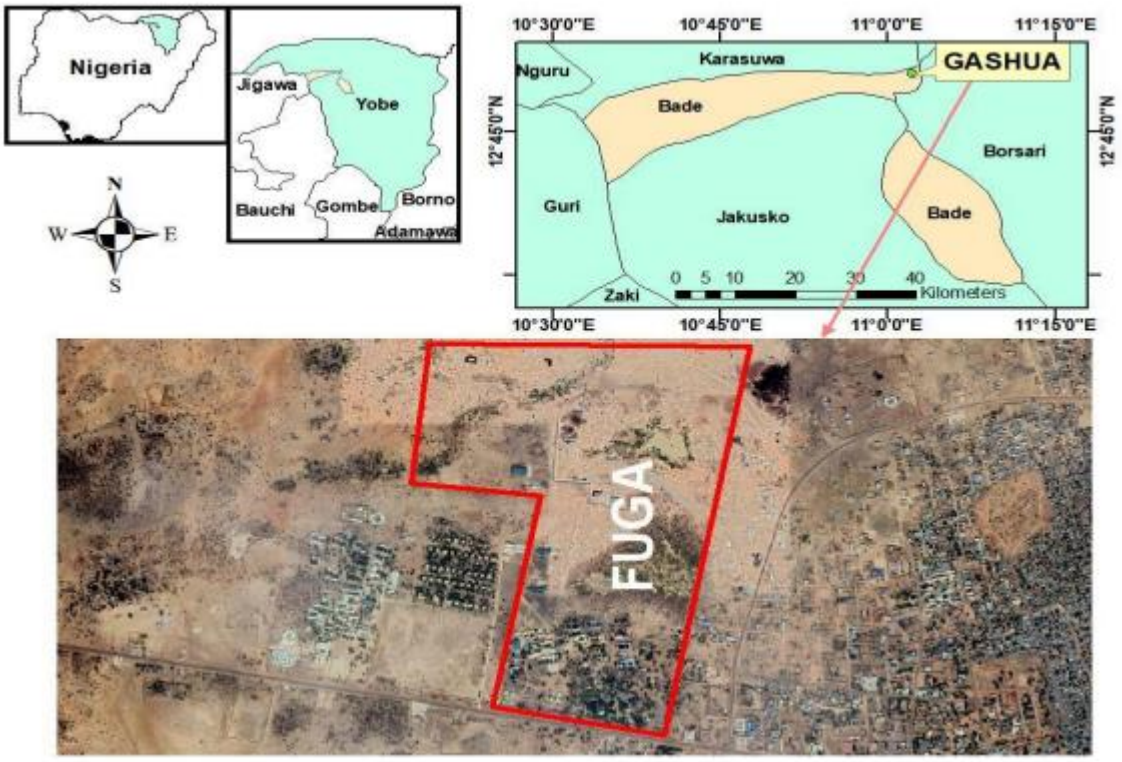


Figure 1: Map of Federal University, Gashua (FUGA) in Bade Local Government Area, Yobe State, Nigeria
Source: Adam *et al.*, 2021

Habitat Delineation

A reconnaissance survey was carried out to divide the campus into Four well defined habitat types: (1) Lake area (2) Acacia Woodlot, (3) Open Grassland (4) Introduced vegetation (Neem) area. The Lake area on the North-eastern part of the university covered the lake, main gate, and agriculture field stations. The Acacia woodlot (Comprising majorly *Acacia* spp of trees) in the south-eastern part of the university, covered from the Vice-chancellor's complex, through the back of New students' hostel, Centre for irrigation and Desertification, and terminated at the General studies Department. The open grassland area in the Northwest covered the 1000 capacity auditorium, 218 lecture theatre, new student hostel and ended at the lecture theatres, while the introduced vegetation (Neem) area (composed majorly of Neem *Azadirachta indica*) trees on the southwest covered the second gate, office complex areas, lecture theatres, works department and staff quarters. Count stations for bird survey was also randomly pre-determined within each siteand their GPS coordinates taken.

Bird Survey (Point Count)

Point counts was used to record birds within study sites (Bibby *et al.*, 2000; Richard *et al.*, 2004). This involved recording birds at predefined count stations within each habitat site. Point counts was used because it allowed the observer travel within the area and stop at predefined spots, allow the birds time to settle, and then record all the birds seen or heard for a predetermined time, ranging, at the extremes, from 2 to 20 min. Counting bands of the 20m radius was used for all the stations. To remove error of double counting, the minimum distance between two counting stations of 100m was be maintained. Bird calls were recorded with a voice recorder and played back later for confirmation using Bird call recordings. Bird count was from 06:30h to 10:00h in the morning and 16:00h to 18:00h in the evening. Upon arrival at a site, care was taken not to flush or disturb the birds. Global Positioning System (GPS) was used to mark location of each point. Bird identification was aided by the use of a pair of Binoculars (8 × 40), long range spotting scope and a field guide to West African Birds by Borrow and Demey, (2014) as well as the Africa Bird Club's Bird of Africa Mobile

application. Bird survey was carried out for four (4) months (October 2019-January 2020) covering late wet season till early dry season. Data was collected four days per week with each habitat type being visited one day per week. Each habitat type was visited twice a day (morning and evening) resulting in a total of 64 man-days, 128 count visits and 32visits per habitat type at the end of the survey.

Bird Diversity and Abundance

Abundance: The total number of all bird species for each site was calculated as:

N = nS + nH……(i)

Where:
N = Abundance (Total Number of birds of all species)
nS = the number of birds seen
nH = the number of birds heard.

Relative abundance: The relative abundance bird species per habitat was determined according to Ijeomah *et al.,* (2013) using:

RA = n/N × 100 …… (ii)

Where:
RA =Relative abundance
n = the total number of birds of a particular species
N = the total number of birds of all species.

Bird Diversity: Birds' diversity was calculated using the following diversity indices:

Shannon-Weiner Diversity Index: was calculated in order to know the species diversity using the formula by Shannon and Weaver (1949); Ijeomah *et al.,* (2013); Issa (2019).

$$H' = \sum_{i=1}^{s} [(P_i) \times Ln(P_i)] \quad \ldots\ldots\ldots\ldots (iii)$$

Where:
H' = Shannon-Weiner diversity index
P_i = Proportion of individual species
S = Total number of species in the community
LnP_i = Natural log of the Proportion of individual species

Simpson index of Dominance: measures the probability of any two individuals drawn from noticeably large community belonging to different species (Simpson, 1949)); Ijeomah *et al.,* (2013)

$$D = \frac{\sum n\,(n-1)}{N(N-1)} \quad \ldots\ldots\ldots\ldots\ldots (iv)$$

Where:
D = Simpson index of dominance
n = the total number of birds of a particular species
N = the total number of birds of all species.

Species Evenness index: Evenness of bird species compares the similarity of the population size of each species (Issa, 2019). Evenness (e^H/S) was calculated using the ratio of observed diversity to maximum diversity using the equation

$$e^{H/S} = \frac{H'}{H'_{max}} \quad \ldots\ldots\ldots (v)$$

Where:
e^H/S = Evenness
H' = Shannon-Weiner index
H'_{max}= is the natural log of total number of species

The value of the index ranges from 1.5 (low species richness and evenness) to 5.0 (high species evenness and richness). The index of dominance was also measured in order to find the probability of taking randomly two individuals belonging to different species. Dominance measures the extent of common species in the habitat and it ranges from 0 to 1. The higher the index, the higher the bird species diversity. Average bird diversity was calculated by getting a mean of the replicated surveys of bird diversity at each point for mornings and evenings for all sites.

Statistical Analysis

Data obtained were analysed by both descriptive and inferential analysis. Diversity indices were determined using the PAST (Paleontological statistics software package for education and data analysis) statistical software [v. 4.09] (David *et al.,* 2001). Principal component analysis was carried out to determine habitat preferences of bird species across seasons. Significance level for the study was set at $P<0.05$.

RESULTS

Bird Diversity

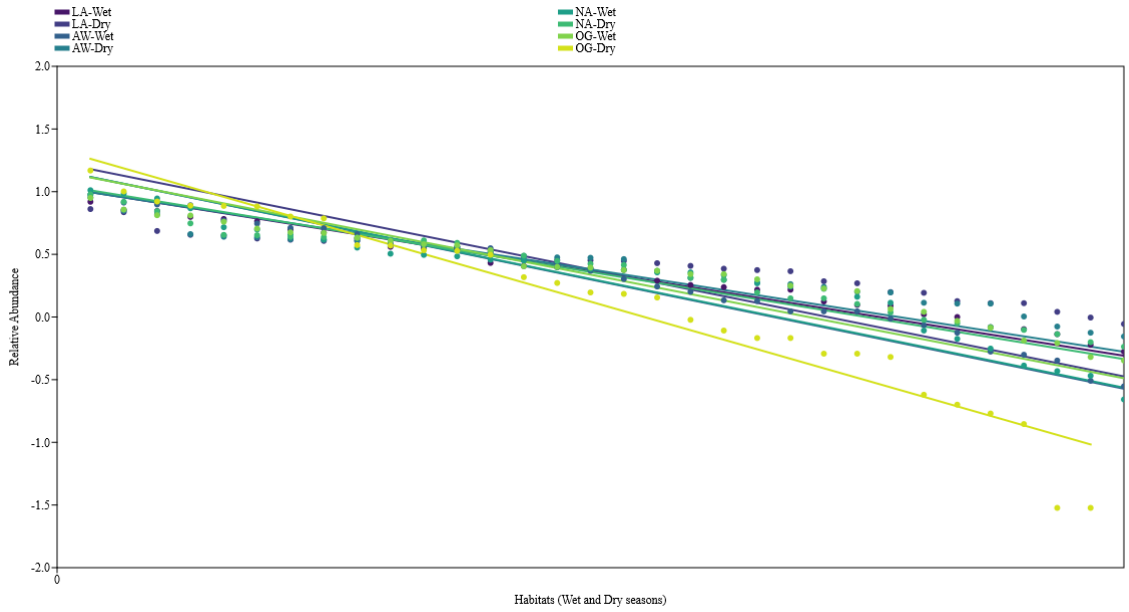
The results show that Bird species diversity was strong and normally distributed in all the habitats (Table 1). Lake area habitat had the highest bird species diversity during the dry and wet seasons respectively (3.413; 3.346). Open grassland on the other hand, had the least bird diversity during the dry season (2.836).

Table 1: Bird species Diversity indices

DiversityMeasure	Lake Area		Acacia Woodlot		Neem Area		Open Grassland	
	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
Dominance (D)	0.04332	0.0374*	0.04913	0.04504	0.05593	0.04164	0.04472	0.07304*
Shannon (*H'*)	3.346	3.413*	3.231	3.28	3.133	3.375	3.283	2.836*
Evenness (e^H/S)	0.7095	0.8205*	0.6837	0.7385	0.6953	0.7304	0.7201	0.6818*
Brillouin	3.312	3.384	3.197	3.249	3.091	3.348	3.248	2.807
Menhinick	0.6288	0.551	0.6088	0.5797	0.6584	0.545	0.6201	0.4618
Margalef	4.696	4.279	4.383	4.239	4.087	4.539	4.402	3.006
Equitability_J	0.907	0.9452	0.8947	0.9154	0.8961	0.9148	0.9091	0.881
Fisher_alpha	6.165	5.516	5.716	5.491	5.365	5.861	5.755	3.753
Berger-Parker	0.08206	0.07363	0.09204	0.09673	0.1099	0.08912	0.08876	0.1477

Bird Abundance

The relative abundance of bird species across habitats was comparatively homogeneous throughout the wet season with the exception of Neem area (0.6). On the other hand, Open grassland area had the lowest abundance in the dry season (-1.6). The lake area had the highest abundance in both the wet (1.2) and dry (1.0) seasons respectively (Figure 2).



LA= Lake Area, AW=Acacia Woodlot, OG=Open Grassland, NA=Neem Area, Wet=Wet Season, Dry= Dry Season

Figure 2: Species Abundance across habitats during the wet and dry season

Habitat preference of bird species in the Wet Season

The principal component analysis of Lake area and Acacia Woodlot habitats shows that eigenvalue of African collared dove (3.5) and Cattle Egret *Bubulcus ibis* (1.8) were more correlated with the Lake area while the Long-tailed Glossy Starling *Lamprotornis caudatus*

was least correlated during the wet season. In the Acacia Woodlot, the Black-headed Heron *Ardea melanocephala*, and Common Whitethroat *Sylvia curruca* had the least correlation while Purple Glossy Starling *Lamprotornis purpureus* and Speckled Pigeon *Columba guinea* were more correlated with the habitat (Figure 3).

On the other hand, the principal component analysis of Neem Area and Open Grassland shows that in the Neem area habitat, Cattle Egret *Bubulcus ibis* was least correlated (-4.6), while African Collared Dove *Streptopelia roseogrisea* (1.7) and Northern Grey-headed Sparrow *Passer griseus* (1.8) was most correlated. On the other hand, Purple Glossy Starling *Lamprotornis purpureus* (1.9) and Green-wood Hoopoe *Phoeniculus purpureus* (2.0) were most correlated with Open grassland habitat while Chestnut-bellied Starling *Lamprotornis pulcher* (2.1) and Red-billed Firefinch *Lagonosticta senegala* (2.9) was least correlated respectively during the wet season. (Figure 4)

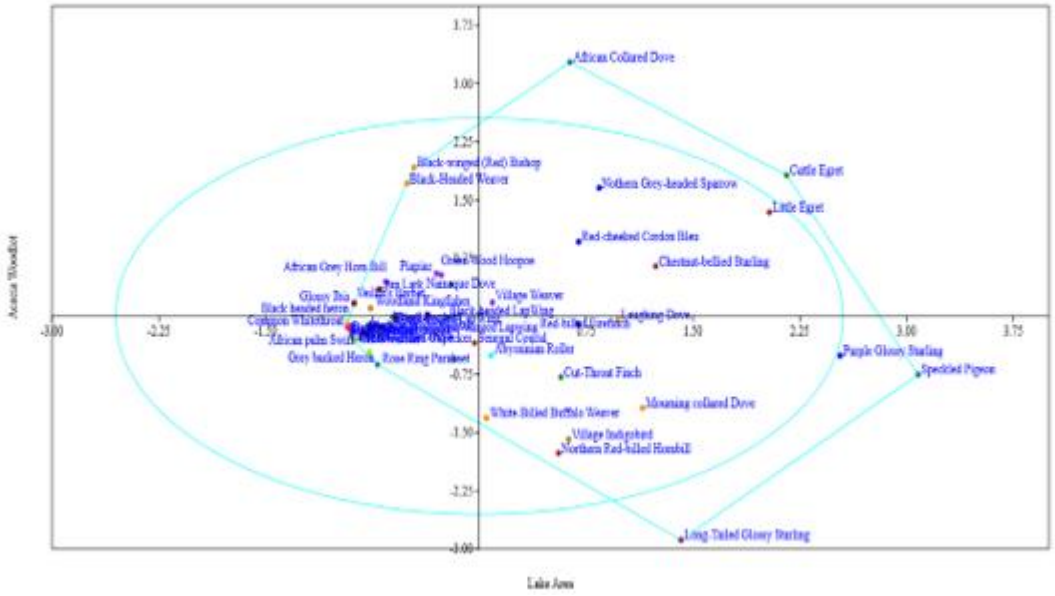


Figure 3: Principal component analysis of Lake area and Acacia Woodlot Habitat preference by bird species in Wet season

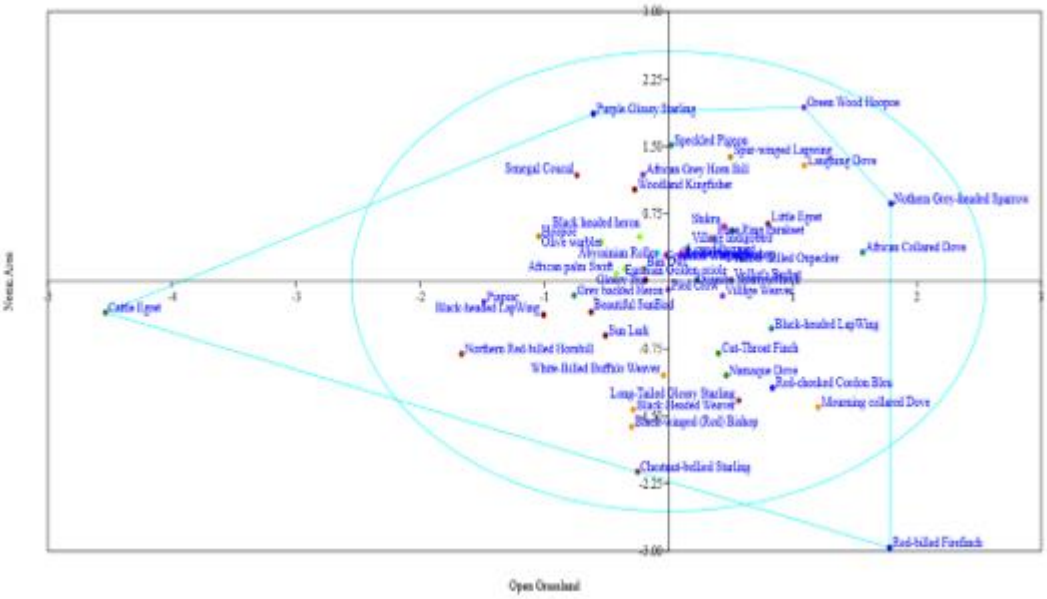


Figure 4: Principal component analysis of Neem area and Open Grassland habitat preferencesby bird species in Wet season

Habitat preference of bird species in the Dry Season

The principal component analysis of Lake area and Acacia Woodlot habitats during the dry season shows that Long-tailed Glossy Starling *Lamprotornis caudatus*, Piapiac *Ptilostomus afer*, and Chestnut-backed Sparrow Lark *Eremopterix leucotis* had eigenvalues around or above 1.5 at P<0.05 which showed they were strongly correlated with the lake area while the Red-billed Firefinch *Lagonosticta senegala* (-2.7) was least correlated to that habitat. In the Acacia Woodlot, most of the species were clustered around eigenvalues 0 to -1 which shows very weak correlation. The only exception is Speckled Pigeon *Columba guinea* which showed strong preference for the habitat with eigenvalue (3.2) (Figure 5).

The principal component analysis of Neem Area and Open Grassland during the dry season shows that Chestnut-backed Sparrow Lark *Eremopterix leucotis* (1.9) and Village indigobird *Vidua chalybeate* (2.4) Showed strong preference for Open grassland area while Red-billed Firefinch *Lagonosticta senegala* (-2.2) showed less preference. On the other hand, Green-wood Hoopoe (-2.7), Village Weaver *Ploceus cucullatus*(-2.3) and Veillot's barbet *Lybius vielloti* (-2.2) showed weak preference for Neem area as opposed to African collared dove (2.2) and Laughing Dove *Streptopelia senegalensis* (2.9) which showed strong correlation with Neem area (Figure 6).

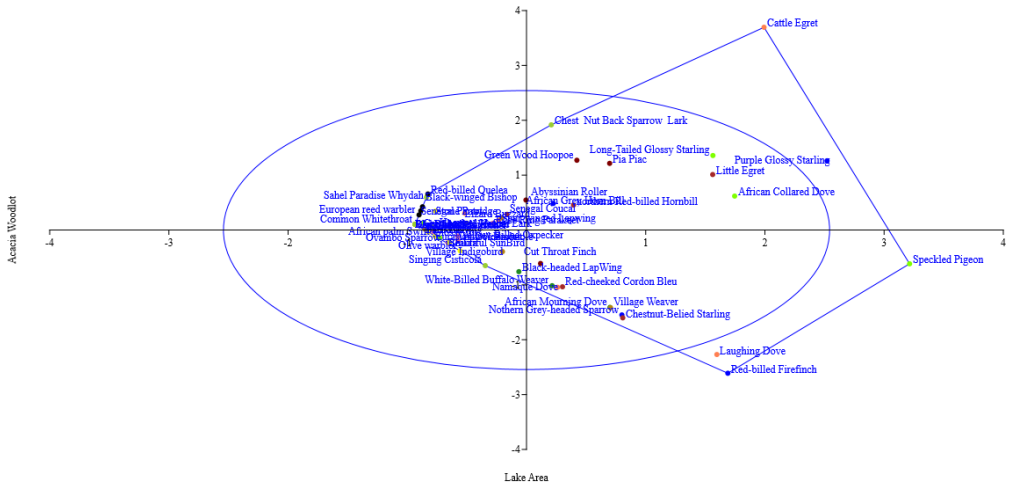


Figure 5: Principal component analysis of Lake area and Acacia woodlot habitat preferences by bird species in dry season.

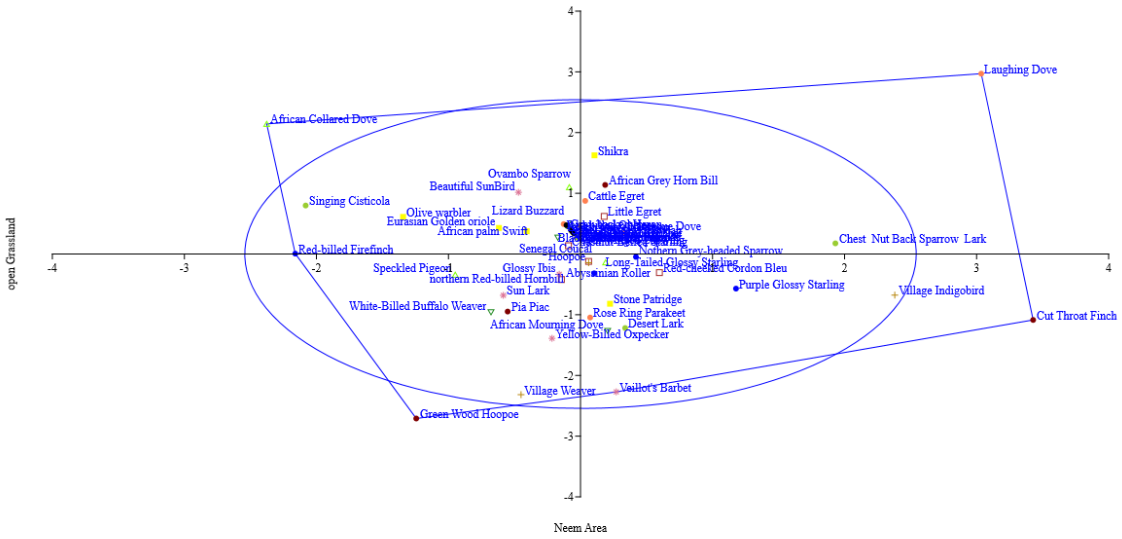


Figure 6: Principal component analysis of Neem area and Open Grassland habitats preferences by bird species in Dry season

Checklist of Bird Species in Federal University, Gashua

A total of 71 bird species in 32 families comprising of 13, 812 individuals in the wet season, and 16,682 individuals in the dry season were recorded during the survey. Ploceidae family had the highest number of species (9), followed by Ardeidae (8) and Columbidae (5) respectively (Table 2).

Table 2: Checklist of Bird Species in Federal University, Gashua

S/No	Family	Common Name	Scientificname	NA	AW	LA	OG
1	Accipitridae	Lizard Buzzard	*Kaupifalco monogrammicus*	+	+	+	+
		Shikra	*Accipiter badius*	+	+	-	+
		Ovambo SparrowHawk	*Accipiter ovampensis*	+	+	+	+
2	Alaudidae	Sun Lark	*Galerida modesta*	+	+	+	+
		Chestnut-backed Sparrow Lark	*Eremopterix leucotis*	-	+	+	+
3	Alcedinidae	Grey-Headed Kingfisher	*Halcyon leucocephala*	+	-	+	+
		Woodland Kingfisher	*Halcyon senegalensis*	+	+	+	+
4	Anatidae	White-Faced Whistling Duck	*Dendrocygna viduata*	-	-	+	-
5	Apodidae	African Palm Swift	*Cypsiurus parvus*	+	+	-	-
6	Ardeidae	Little Bittern	*Ixobrychus minutus*	-	-	+	-
		Striated Heron	*Butorides striata*	+	+	+	+
		Black Heron	*Egretta ardesiaca*	-	-	+	-
		Purple Heron	*Ardea purpurea*	-	-	+	-
		Black-headed Heron	*Ardea melanocephala*	-	-	+	-
		Cattle Egret	*Bubulcus ibis*	+	+	+	+
		Little Egret	*Egretta garzetta*	+	+	+	+
		Squacco Heron	*Ardeola ralloides*	-	-	+	-
7	Bucerotidae	Red-Billed Hornbill	*Tockus erythrorhynchus*	+	+	+	+
		African Grey Hornbill	*Tockus nasutus*	+	+	+	+
8	Buphagidae	Yellow-billed Oxpecker	*Buphagus africanus*	+	-	+	+
9	Burhinidae	Senegal Thick-Knee	*Burhinus senegalensis*	-	+	-	-
10	Capitonidae	Veillot's Barbet	*Lybius vielloti*	+	+	+	+
11	Charadriidae	Spur-Winged Lapwing	*Vanellus spinosus*	+	+	+	+
		Black-headed Lapwing	*Vannellus tectus*	+	+	+	+
12	Columbidae	Speckled Pigeon	*Columba guinea*	+	+	+	+

S/No	Family	Common Name	Scientificname	NA	AW	LA	OG
		Mourning Collared Dove	*Streptopelia decipiens*	+	+	+	+
		African Collared Dove	*Streptopelia roseogrisea*	+	+	+	+
		Laughing Dove	*Streptopelia senegalensis*	+	+	+	+
		Namaqua Dove	*Oena capensis*	+	+	+	+
13	Coraciidae	Abyssinian Roller	*Coracias abyssinicus*	+	+	+	+
14	Corvidae	Pied crow	*Corvus albus*	+	+	+	+
		Piapiac	*Ptilostomus afer*	+	+	+	+
15	Cuculidae	Senegal Coucal	*Centropus senegalensis*	+	+	+	+
16	Estrildidae	Red-Billed Firefinch	*Lagonosticta senegala*	+	+	+	+
		Red-Cheeked Cordon-bleu	*Uraeginthus bengalus*	+	+	+	+
		Cut-throat Finch	*Amadina fasciata*	+	+	+	+
17	Fringillidae	White-Rumped Seedeater	*Serinus leucopygius*	+	+	-	+
18	Musophagidae	Western Grey Plantain-Eater	*Crinifer piscator*	+	-	-	-
19	Nectariniidae	Pygmy Sunbird	*Hedydipna platura*	+	+	-	-
		Beautiful Sunbird	*Cinnyris pulchellus*	+	+	+	-
20	Oriolidae	Eurasian Golden Oriole	*Oriolus oriolus*	+	+	-	-
21	Passeridae	Bush Petronia	*Petronia dentate*	-	+	-	+
		Speckle-Fronted Weaver	*Sporopipes frontalis*	-	-	-	+
		Northern Grey-Headed Sparrow	*Passer griseus*	+	+	+	+
22	Phasianidae	Stone Patridge	*Ptilopachus petrosus*	-	-	+	+
23	Phoeniculidae	Green-wood Hopoe	*Phoeniculus purpureus*	+	+	+	+
24	Ploceidae	Red-headed Weaver	*Anaplectus rubriceps*	-	-	+	-
		Black Headed Weaver	*Ploceus melanocephalus*	-	-	+	-
		Vittelin Masked Weaver	*Ploceus vitellinus*	-	-	+	-
		Northern Red Bishop	*Euplectes franciscanus*	-	-	+	-
		Black-winged (red) Bishop	*Euplectes hordeaceus*	-	-	+	-
		Red-billed Quelea	*Quelea quelea*	-	+	-	+
		White-billed Buffalo Weaver	*Bubalornis albirostris*	+	+	+	+
		Village Weaver	*Ploceus cucullatus*	+	+	+	+
		Vittelin Masked Weaver	*Ploceus vitellinus*	-	-	+	-
25	Psittacidae	Senegal Parrot	*Poicephalus senegalus*	+	+	+	+
		Rose-Ringed Parakeet	*Psittacular krameri*	+	+	+	+
26	Pycnonotidae	Common Bulbul	*Pycnonotus barbatus*	+	+	-	-
27	Sturnidae	Purple Glossy Starling	*Lamprotornis purpureus*	+	+	+	+
		Greater Blue-Eared Starling	*Lamprotornis chalybaeus*	+	+	+	+
		Long-Tailed Glossy Starling	*Lamprotornis caudatus*	+	+	+	+
		Chestnut-Bellied Starling	*Lamprotornis pulcher*	+	+	+	+
28	Sylviidae	Subalpine Warbler	*Sylvia cantillans*	+	+	-	-
		Great Reed Warbler	*Arocephalus arundinaceus*	+	+	-	+
		Eurasian Reed Warbler	*Acrocephalus scirpaceus*	-	+	-	-
		Common Whitethroat	*Sylvia curruca*	-	-	-	+
		Singing Cisticola	*Cisticola cantans*	+	+	-	-
29	Threskiornithidae	Glossy ibis	*Plegadis falcinellus*	-	-	+	-
30	Tytonidae	Western Barn Owl	*Tyto alba*	+	+	+	+
31	Upupidae	Hoopoe	*Upupa epops*	+	+	+	+
32	Viduidae	Village Indigo Bird	*Vidua chalybeata*	+	+	+	+
		Sahel paradise Whydah	*Vidua orientalis*	-	-	-	+

LA=lake Area; NA=Neem area; AW=Acacia woodlot; OG=Open Grassland; + = species present; - = species absent.

DISCUSSION

The seventy (71) bird species in thirty-two (32) families recorded in this study showed an increase from the fifty (50) species and twenty-eight (28) families recorded by Adam et al., (2019) in the Bade catchment area of river

Yobe. The catchment area covers Gashua town where this study was carried out. That study was carried out in an open and unprotected area in contrast to this study which was carried out within the secured University Campus where there is less likelihood of habitat encroachment and disturbance as compared to the catchment area. Furthermore, it is still higher than the thirty-seven (37) bird species in twenty-five (25) families recorded by Adang *et al.*, (2015) at the Gombe State University (GSU), Northeast Nigeria during the dry season. The bird species abundance across habitats was normally distributed throughout the wet season. The high abundance of bird species in the Neem area during the dry season could be as a result of the shade provided by the *Azadiracta indica* trees, and possibility of food availability for nectarivores and insectivores which may be otherwise insufficient in the other habitats during that season. This finding is in contrast to Lameed, (2012) who observed that bird species were more abundant in open and disturbed habitats compared to habitats with high tree density. A major factor that may have influenced this contrast is the season of the year. As seasons change, so does the requirements of birds which ultimately alters the behaviour of birds. However, this study is in tandem with the findings of David *et al.*, (2015) who studied the bird diversity in Gashaka-gumti National Park (GGNP) whereby they opined that Savannah woodlands of GGNP are capable of sustaining abundant birdlife especially if there were less anthropogenic activities. The Open grassland area had the lowest abundance in the dry season. This may be as a result of decline in available food and possible heat stress due to exposure to excess heat around that season of the year which will predispose the birds to choose habitats with considerable tree density with enough shade such as the Neem or Lake area. This shows a negative relationship with the open grassland that has higher percentage ground cover and lesser tree density. This is in contrast with the findings of Lameed (2012) whose study revealed a positive relationship between percentage ground cover, shrub density and tree density to bird recorded. This is possible because Lameed's work was carried out in the protected DWS where there is limited disturbance as compared to FUGA which is literarily a construction site. The lake area on the other hand maintained a relatively fair abundance throughout the two seasons. The abundance in the lake area remained fair throughout the two seasons may be dues to availability of water all year round especially for waterfowls. Bird diversity was highest across seasons in the lake area. This could be as a result of less disturbance and habitat fragmentation from infrastructural development as compared to the open grassland area with the least diversity. This declining diversity is similar to the habitat destruction, alteration and modification resulting from the massive construction works and landscaping activities on the Gombe State University Campus as recorded by Adang *et al.*, (2015). FUGA, DWS and GGNP are all in the northeast, and they share similarities in their savannah habitat characteristics. However, season of the year, climatic conditions, changing habitat variables caused by anthropogenic activities such as construction, wood felling, bush burning, etc are possible influences on the habitat preferences of different categories of bird species.

CONCLUSION

Bird species are diverse within the Federal University Gashua campus, and they can survive the harsh dry season owing to the conducive Lake Area and Neem area which provides water and food all year round respectively. However, the open grassland habitat had the least capacity to sustain birdlife within the campus due to the sparse vegetation and infrastructural development.

Recommendations

There is urgent need to aggressively plant trees in the open grassland habitat as a priority, and in other habitats that may be cleared now or in the future for development, so as to increase the abundance and diversity of bird species within the campus.

Limitations

First, this study is a baseline study on the bird species without consideration for the vegetation indices, since as a growing institution; there was on-going clearing of vegetation in the various habitats for infrastructure during the period of the study. Secondly, the study only covered the fenced area of the university which is roughly 1/3rd of the total landmass. As the University expands, there will be need to carry out a follow up study in the future.

Acknowledgements

The authors will like to acknowledge the Tertiary Education Trust Fund (TETFUND) for the Institution Based Research (IBR) Grant that funded this research.

Appreciation also goes to the Management of Federal University, Gashua for approval to conduct the research as well as to Mr Isuwa Aminu and Mr Lawan Idris Adam, both of the Department of Forestry and Wildlife Management, who helped as field assistants during data collection.

REFERENCES

Adam, L. I, Gambo A. A., Eveso, J. O.,Mohammed A. Ya 'u M. A. and Modu M. B. (2021).Preliminary Study on Composition and Ecological Distribution of Small MammalSpecies in Federal University, Gashua, Yobe State Northeast Nigeria. *Journal of Research inForestry, Wildlife&Environment,13*(4): 57 - 65

Adam, L. I., Eveso, J. O., Mbaya, Y. P., Ojo, V. A. and Abdullahi, M. (2019) Avifauna checklist along Bade Catchment Area of River Yobe, Northeast Nigeria. In Adeyanju, O. T., Orimaye, J. O., Coker, O. M., Alarape, A. A., Ayodele, I A., Omonona, A. O., Ojo, S. O., Ajani, F. and Ogunjinmi, A. A. (Eds.). Proceedings of the 3rd Annual Conference of the Wildlife Society of Nigeria(WISON), University of Ibadan, Ibadan, Nigeria.Pp. 256-261

Adang, K. L., Nsor, C. A. and Tela, M. (2015) Survey of avifauna of Gombe State University, Gombe, Nigeria. *International Journal of Biology and BiologicalSciences*, *4*(2): 032-036

Bibby, C. J., Burgess, N. D., Hill, D. A. and Mustoe, S. (2000) Bird Census Techniques. (2nd Ed.) Academic Press, London. pp. 120

Borrow, N. and Demey, R. (2014) Birds of Western Africa. Christopher Helm, London.

Buckland, S. T., Stuart, J. M. and Rhys, E. G. (2008). Bird Conservation International. Pp 18.

Caughley, G. (1982) Analysis of vertebrate populations. John Wiley, New York, pp.17-52

Clergeau, P., Jokimäki, J. and Savard, J. I. (2001) Are urban bird communities influenced by the bird diversity of adjacent landscapes? *Journal of Applied Ecology*.*38*: 1122–1134

David, D. L., Wahedi J. A., Danba, E. P., Buba U., Barau, B. W., Usman, D. D. and Daniel I. M. (2015) Diversity and abundance of birds in the Savannah Woodlands of Gashaka-GumtiNational Park,Taraba State, Nigeria. *Annals of Biological Research, 6* (7):11- 16

David, O. H., Harper, A. T.,and Ryan, P. D. (2001) PAST: Palaeontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica, 4*: 4-9

Gaston, K. J., Cox, D. T. C., Canavelli, S. B., García, D., Hughes, B., Maas, B., Martínez, D., Ogada, D., Inger, R. (2018) Population Abundance and EcosystemService Provision: The Case of Birds**.** *BioScience*, *68*, (4): 264–272

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X.,and Briggs, J.M.. (2015) Global change and the ecology of cities. *Science*, *319*: 756– 760.

Ijeomah, H.M., Chima, U.D. and Okagbare, O. H. (2013) Ecological Survey of AvifaunalResources in University of Port Harcourt, Nigeria. *Ethiopian Journal ofEnvironmental Studies and Management*, *6*(6):648-660.

Issa, M. A.A. (2019) Diversity and abundance of wild birds'species'in two different habitats at SharkiaGovernorate, Egypt.*The Journal of Basic and Applied Zoology*, *80*:34-40

Lameed, G. A. (2012) Species Diversity and Richness of Wild Birds in Dagona WaterfowlSanctuary, Nigeria. *African Journal of Food, Agriculture, Nutrition and Development.12* (5): 6460-6478

Overdyck, E., Clarkson, B. D., Laughlin, D. C., Gemmill, C. E. C. (2013) Testing broadcast seeking methods to restore urban forests in the presence of seed predators.*Restoration Ecology*,*21*:396–423

Richard, D. G., David, W. G. and Paul, F. D. (2004) Birds Census and Survey Techniques. *Suther*,*2*:17-52.

Sabo, B. B. (2016) Checklist of Bird Species at the Hadejia-Nguru Wetlands, Nigeria.

Global Advanced Research Journal of Agricultural Science. *5*(11):405-412

Şekercioğlu, Ç. H. (2006) Increasing awareness of avian ecological function *Trends in Ecology and Evolution21*: 464–471

Şekercioğlu, Ç. H., Wenny, DG., Whelan, CJ, eds. (2016) *Why Birds Matter: AvianEcological Function and Ecosystem Services*. University of Chicago Press

Shannon, C. E., & Weaver, W. (1949). The mathematical theory of communication,Urbana: University of Illinois Press. (p. 144).

Simpson, E. H. (1949). Measurement of diversity. *Nature*, *163*: 688.

Whelan, C. J., Wenny, D. G., Marquis, R. J., (2008). Ecosystem services provided by birds. *Annals of the New York Academy of Sciences*,*1134*: 25–60

YOSADP (1992). Yobe state environmental and sustainable agriculture in proceedings of the Yobe state economic summit 2008 Pp 166

Yu, T. and GuoY. (2013). Effects of urbanization on bird species richness and community composition. *Pakistan Journal of Zoology*,*45*:59–69