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Avifauna Composition of an Abandoned Dam Site in Biu, Borno State, Nigeria

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Abstract

Dam construction, a common anthropogenic activity, leads to significant habitat loss and fragmentation, mainly impacting aquatic ecosystems and also the surrounding terrestrial habitats. In addition, dams alter natural river flow impacting heavily on water-dependent bird species and other aquatic fauna. In this study, we examined a dam site abandoned 46 years ago for the presence of water bird species and other terrestrial avifauna within and around the dam/reservoir. Point count census method was employed to record avian species during morning and evening hours. A total of 1,263 individuals from 84 species of birds were recorded. Sixty-six (66) genera in 38 families and 16 bird orders were also recorded. The most species rich family was Ardeidea (herons and egrets) with a total of 8 species, followed by Columbidea (doves and pigeons) and Estrildidea (finches) families with 7 species each.

Passeriformes was the most species rich order with a total of 36 species drawn from 18 families of birds. Insectivores were the most abundant feeding guild accounting for 32.1% (N=27) of the total species recorded, followed by granivores (N=21). The most abundant bird species was the white-face whistling duck (*Dendrocygna viduata*) (N=177 individuals). We recorded 11 African Eurasian Wetland Agreement (AEWA) listed species, 10 of which are migratory. The presence of the Red-necked Falcon (*Falco chicquera*), a near threatened species (IUCN, 3.1) in the study area underscores the ecological and conservation significance of the Dam/reservoir. Overall, our findings highlight the ecological and functional roles of birds in agricultural landscapes as potential agents of insect and pest control, dispersers and pollinators. The high number of granivores recorded in the study area is a reflection of the type of crops cultivated around the dam/reservoir - constructed primarily as source of water for Biu municipality. The absence of a buffer zone and regulatory authorities to reduce human pressure around this crucial wetland ecosystem is a major threat to avian species well-being. Biu dam if properly managed could in addition to its current role as a perennial source of water for irrigation, also serve as a haven for migratory and resident bird species.

Keywords: Avian Species, Wetland, Dam, Species Abundance, Conservation.

Introduction

Human habitat alteration is the primary driver of habitat loss which has significant impact on biodiversity (Foley *et al*., 2005). Dam construction, a common example of anthropogenic activity, leads to significant habitat loss and fragmentation, mainly impacting aquatic ecosystems but also affecting surrounding terrestrial habitats. Dam construction alters the ecological integrity of naturally occurring wetlands, with dire implications for downstream aquatic and semi aquatic communities and biodiversity in general. Wetlands are one of the most unique ecosystems that support aquatic/semi-aquatic plants, making them suitable habitats for water dependent bird species, and other fauna (Nsor and Nya, 2025; Suleiman *et al*.,

2025). The importance of wetland ecosystems can never be overemphasized, making any form of distortion within or around them very grievous and deleterious to biodiversity and humans.

The construction of dams has immediate and profound impact on biodiversity within the wetland ecosystem, and follows a cascade of disruptive events, from alteration of water depth, river current, Geo-morphology, aquatic habitat loss and its incident impact on other related terrestrial biodiversity. There are more than 58,000 large dams (those >15 m in height) currently in operation globally (Anton, 2018). More than half of all large river systems including eight of the most bio-geographically diverse, and the three most biologically diverse tropical river basin systems (the Amazon, Congo, and Mekong), have been dammed (Winemiller *et al*., 2016).

The biodiversity impacts of altering and inundating both aquatic and terrestrial habitats act at a range of spatial and temporal scales and across international boundaries (Beketov 2013; Castello & Macedo, 2016). At the basin scale, fish migrations and population dynamics are disrupted in reservoirs and downstream of dams, leading to a loss of fish biomass and diversity, as well as endemic species extinctions (Latrubesse *et al*., 2017). In regions that are highly bio-diverse and centres of species endemism such as Amazonia, dam induced disruption to fisheries can be detrimental to globally important aquatic biodiversity, as well as the economic and food security of river dependent people over huge areas (Latrubesse *et al*., 2017). Furthermore, dams alter natural river flow regimes, by, for example, removing seasonal flood pulses that are critical for ecosystem service provision, productivity, and biodiversity (Sabo *et al*., 2017).

The alteration of river flows can also lead to the loss of unique riverine habitats such as rocky outcrops and short-lived sand beaches used by a range of other aquatic and terrestrial taxa including birds, bats, and freshwater turtles (Isabel *et al*., 2016). In addition, dam construction can trigger deforestation, which leads to increased human activity in surrounding areas, intensifying habitat loss consequently creating more challenges for biodiversity.

Birds are among the most studied and most often sighted of the vertebrate taxa. Their distribution and diversity is also well known, globally. They are ubiquitous and highly sensitive to environmental change orchestrated by anthropogenic activities (Gregory *et al*., 2003). The periodic monitoring of bird species abundance

and distribution can offer useful insights to the state of health of the environment and the implication for ecological communities, species survival and persistence in the face of growing human demands for land.

Agricultural intensification and urbanization are among the foremost causes or drivers of biodiversity loss (Danso *et al*., 2021). By monitoring and studying bird species composition at different local and spatial scales, we can provide useful insights to how specific anthropogenic activities (e.g. dam construction) impact avian species well-being at regional and global scales.

Anthropogenic activities tend to have more effect in regions that are ecologically fragile due to the interplay of myriads of natural drivers of environmental degradation such as drought, windstorms, desertification etc. Biu lies within this region and suffers other socio-cultural threats such as insurgency and banditry. These challenges has forced farmers to cluster around places considered to be safe for agricultural activities; places such as Biu reservoir and environs. Birds are often the first to disappear in the face of threats because of their high mobility and sensitivity to environmental change (Gregory *et al*., 2003). This study aims to develop the first checklist of birds within the Biu area and specifically the dam and surrounding landscapes. There is little or nothing done on avian species diversity or abundance in the study area. The goal is to provide baseline information and complement ongoing effort to capture avian distribution across Nigeria (Ringim *et al*., 2022). The study sought to identify species of conservation importance and those prioritized for protection under African Eurasian Wetland Agreement (AEWA). We assessed avian functional and feeding guilds to understand the ecological interactions between species (flora and fauna) and the implication for sustainable agriculture and biodiversity conservation within the study area.

Study site

Biu dam is located in Biu Local Government Area in Borno state and located on latitude 10°38’00”N and longitude 12°05’31’’E. The dam construction began in 1979, but was never completed. It was supposed to supply drinking water to Biu community being the second largest town in Borno state and for irrigation; regrettably these projects were abandoned by successive governments. Currently, the reservoir is mainly used in irrigation, fishing and as source of water for large cattle farmers in the surrounding areas. The water is encircled by farmlands and

settlements making it somewhat unbearable and inhabitable by wildlife and large vertebrates. The vegetation is reminiscent of the Guinea savanna of the semi-arid North-East Nigeria. Remnant native tree species include, *Parkia biglobosa, Tamarindus indica, Adansonia digitata, Hyphaene thebaica, Balanytes aegyptiaca, Zizipus-spina Christi, Zizipus mauritiana, Borassus aethiopium, Calatropis procera, while Phragmites australis* and *Typha domingensis* were among the most common water plants in the area.

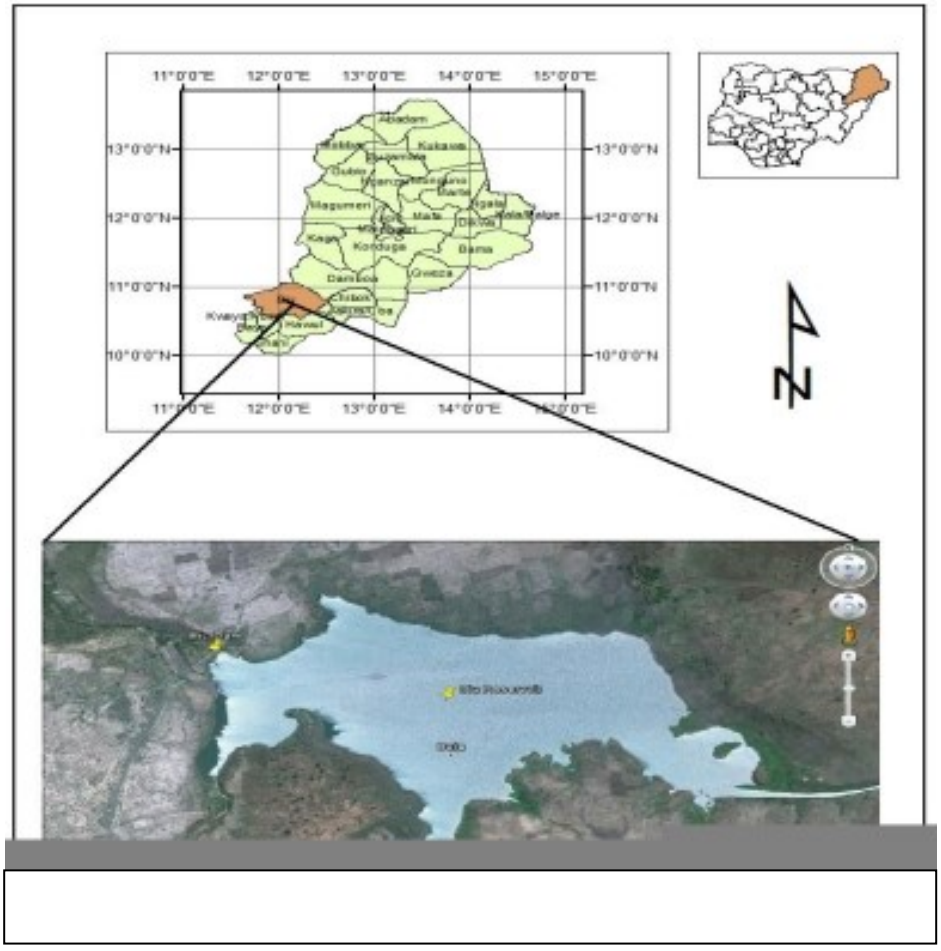


Figure 1. Map of Biu LGA showing the Biu dam and reservoir (Shinggu *et al*., 2015)

Data Collection and Analysis

Point count census technique (Bibby *et al*., 2000) was used to determine avian diversity and abundance. Each point was monitored twice a day (0630-0930am and 0330-0630pm) in the morning and evening respectively. Twelve randomly selected points were sampled for the presence of avian species. Each point was at least 200 meters from the other, to avoid recording same individual more than once. Bird identification was facilitated through the use of field guides (Borrow and Demey, 2014). Parameters such as bird species identity, number of individuals, time of sighting, distance to water, and activity of the bird species at the time of the observation were recorded. We recorded bird species for a period of three days in the month of April 2023 and two days in the month of September of the same year. To calculate species richness, we totaled all recorded bird species so that each species was counted only once. Species richness was therefore calculated as the total number of species recorded (species count), while species abundance was calculated as the sum total of all individuals of a species recorded at the end of the survey. Species diversity was determined using the Shannon Weiner Diversity index (H). To determine Shannon Weiner species diversity, the proportion of species (i) relative to the total number of species (pi) is calculated, and then multiplied by the natural logarithm of this proportion (lnpi), see equation below.

$$\text{Shannon Weiner index H}' = -\sum_{i=1}^{S} p_i log_e p_i$$

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$$\text{H}'(\text{Shannon Weiner index}) = -p_i log_e p_i$$

Where pi = the proportion of individuals of species "i" in relation to the total population of all species. H' = Shannon Wiener Diversity Index. $\log_e$ = natural logarithm of base e

H' is a measure of uncertainty in predicting the species identity of an individual that is taken at random from the data set.

H' is not a measure of true diversity. True diversity, the *effective number of species* (Jost, 2006) is the number of equally-common species required to give a particular value of an index), and requires further mathematical exploration to derive the true diversity.

To get the *effective number of species*, (the true value of diversity), we used the equation:

$$\exp\ (\mathrm{H}')\ or \exp\ (-\sum_{i=1}^{s} p_i log_e p_i)$$

Results

At the end of the survey, a total of 1263 individuals from 84 species of birds were recorded (Table 2). Sixty-six (66) genera in 38 families and 16 bird orders were also recorded. The most species rich family was Ardeidea (Herons and Egrets) with a total of 8 species followed by Columbidea (doves and pigeons) and Estrildidea (finches) families with 7 species each (Figure 2). Passeriformes was the most species rich order with a total of 36 species drawn from 18 families of birds, and encompassing all feeding/functional guilds (Figure 3). Insectivores were the most diverse feeding guild with a total of 27 species followed by granivores with a total of 21 species of birds (Figure 4).

The most abundant bird species was the white-face whistling duck (*Dendrocygna viduata*) with 177 individuals, followed by cattle egret (*Bulbus ibis*), with a record of 69 individuals. We recorded 11 African Eurasian Wetland Agreement (AEWA) listed species, 10 of which are migratory (Table 1). Overall, there were 23 migratory species in total; of this number, 3 species are intra-African migrants, 4 species were partial migrants and 61 species are resident. With a species richness of 84 species and a total abundance of 1263 individuals (Table 2), we estimated the species diversity using the Shannon Weiner Diversity Index, and got an index H' of 0.64003336. To derive the effective number of species we obtained the exponential value of H' as 0.527275.

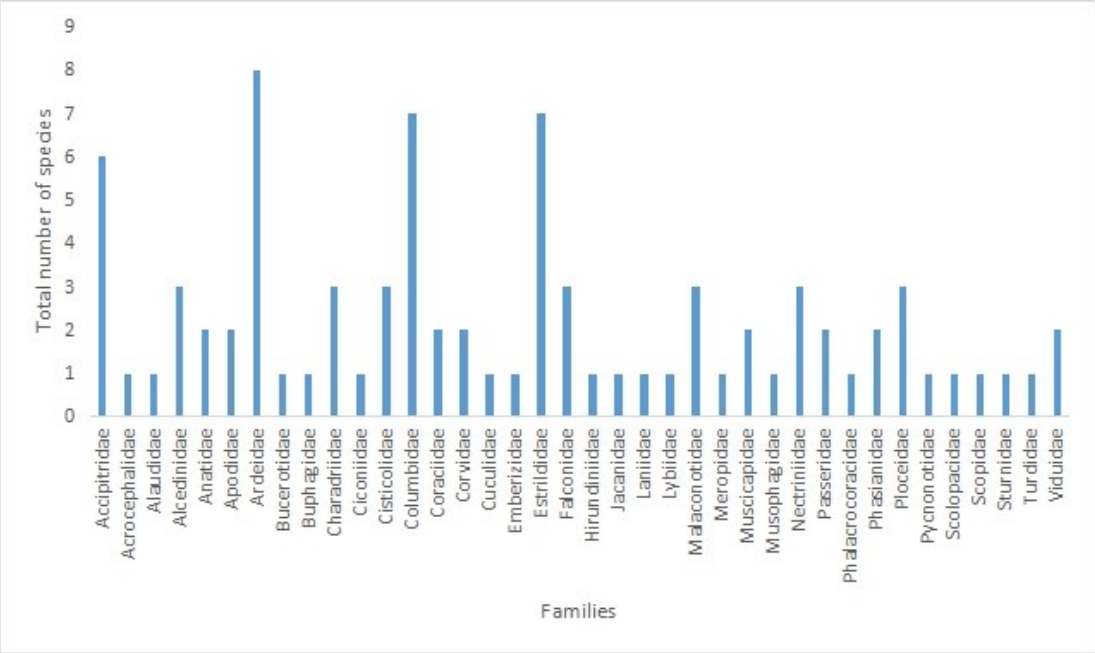


Figure 2. Species richness across various families of birds

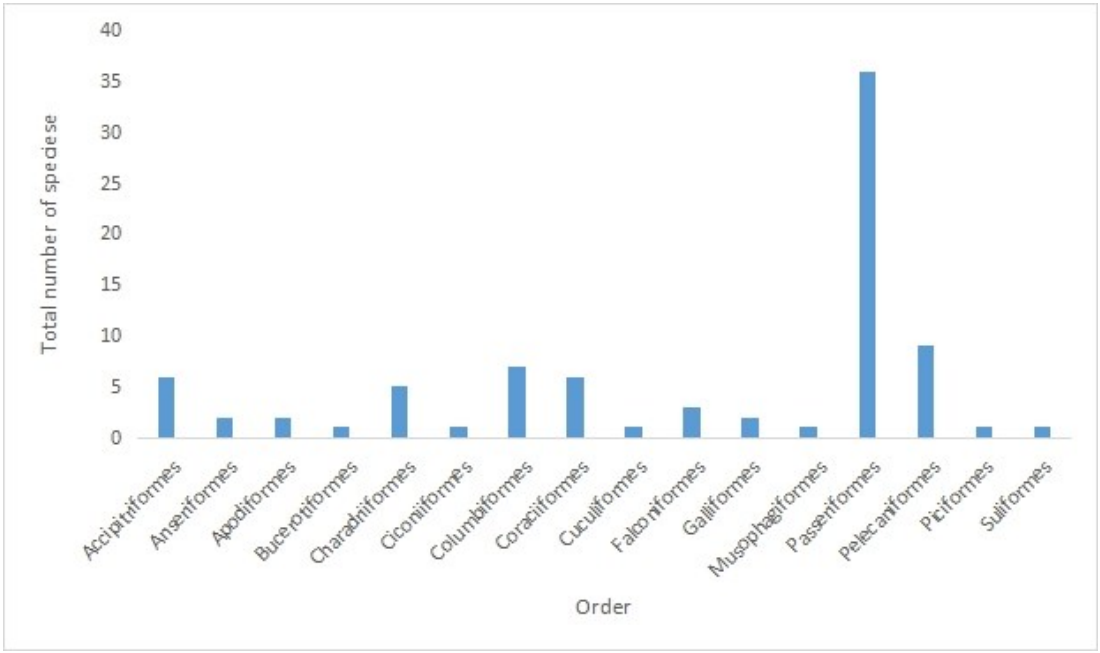


Figure 3. Species Richness across various Order

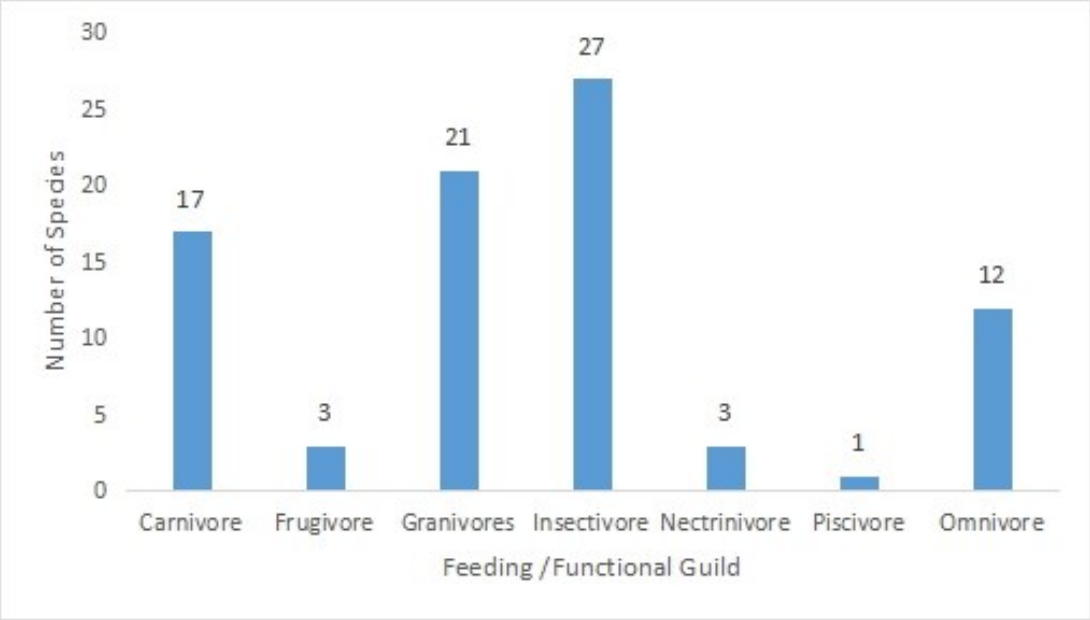


Figure 4. Functional and Feeding Guild Diversity in the Study Area

Table 1. Distribution of AEWA species in Biu Reservoir.

Species	Scientific Name	IUCN Status	Distribution
Abdim's Stork	*Ciconia abdimii*	LC	Intra-African Migrant
African wattled Lapwing	*Vanellus senegalensis*	LC	Seasonal M
Black-crowned Night Heron	*Tchagra senegalus*	LC	Migratory
Black-headed Heron	*Ardea melanocephala*	LC	Resident
Cattle Egret	*Bulbus ibis*	LC	Migratory
Common Sand Piper	*Actitis hypoleucos*	LC	Migratory
Great Egret	*Ardea alba*	LC	Partial Migrant
Grey Heron	*Ardea cinerea*	LC	Migratory
Little Egret	*Egretta garzetta*	LC	Migratory
Spur-winged Lapwing	*Vanellus spinosus*	LC	Migratory
Squacco Heron	*Ardeo laralloides*	LC	Migratory
White-face Whistling Duck	*Dendrocygna viduata*	LC	Resident

Table 2. Checklist of bird species in the study area. (**R**=Resident, **IAM**=Intra African Migrant, **SM**= Seasonal Movement, **PM**=Partial Migrant, **R/SM**= Resident and Seasonal Movement, **NBV**= Non-Breeding Visitor, **M**= Migratory)

S/N	English Name	Scientific Name	Abundance	Status
1	Abdim Stork	*Ciconia abdimii*	19	IAM
2	Abyssinian Roller	*Coracias abyssinicus*	15	R
3	African Grey Hornbill	*Tockus nasatus*	12	R
4	African Jacana	*Actophilornis africana*	5	R
5	African Mourning Dove	*Streptopelia decepiens*	3	R
6	African Palm Swift	*Cypsiurus parvus*	30	R
7	African Pygmy Kingfisher	*Ispidina picta*	5	IAM
8	African Silverbill	*Eudice cantans*	12	R
9	African Thrush	*Turdeus pelios*	21	R
10	African Wattled Lapwing	*Vanellus senegalensis*	6	SM
11	Black-billed Wood Dove	*Turtur abyssinicus*	3	R
12	Black-crowned Night Heron	*Tchagra senegalus*	8	M
13	Black-crowned Tchagra	*Tchagra senegalus*	3	R
14	Black-headed Heron	*Ardea melanocephala*	11	R
15	Black-headed Lapwing	*Vanellus senegallus*	9	R
16	Black-shouldered Kite	*Elanus caeruleus*	3	R
17	Broad-billed Roller	*Eurystomus glaucurus*	6	M
18	Bronze Mannikin	*Spermetescuccullatus*	24	R
19	Bruce's Green Pigeon	*Treron waalia*	4	R
20	Bush Petronia	*Petronia dentata*	3	R
21	Cattle Egret	*Bulbus ibis*	69	M
22	Chestnut-bellied Starling	*Lamprotornis pulcher*	11	R
23	Common Bulbul	*Pycnonotus barbatus*	7	R
24	Common Quail	*Coturnix coturnix*	2	M
25	Common Sand Piper	*Actitis hypoleucos*	3	M
26	Common Swift	*Apus apus*	2	M
27	Common Waxbill	*Estrilda astrild*	37	R
28	Copper Sunbird	*Cinnyris cupreus*	5	R
29	Dark Chanting Goshawk	*Melierax metabates*	2	R
30	Double-spurred Francolin	*Francolinusbicalcaratus*	5	R
31	Common Kestrel	*Falco alopex*	3	PM
32	Fulvous Whistling Duck	*Dendrocygna bicolor*	13	R
33	Garbar Goshawk	*Micronisus gabar*	3	R

34	Gosling's Bunting	*Emberiza goslingi*	11	R
35	Great Egret	*Ardea alba*	61	PM
36	Grey Heron	*Ardea cinerea*	11	M
37	Grey-backed Camaroptera	*Camaroptera brevicaudata*	4	R
38	Grey-headed Kingfisher	*Halcyon malimbica*	4	R
39	Hamerkop	*Scopus umbretta*	6	R
40	Intermediate Egret	*Ardea intermedia*	3	M
41	Lanner Falcon	*Falco biarmicus*	2	R
42	Laughing Dove	*Streptopelia senegalensis*	20	R
43	Lavender Waxbill	*Glaucestrilda caerulescens*	9	R
44	Little Egret	*Egretta garzetta*	7	PM
45	Northern Ant eater Chat	*Myrmec cocichlaaethiops*	5	R
46	Northern Black Flycatcher	*Melaenornis edolloides*	5	R
47	Northern Carmine Bee-eater	*Merops nubicus*	45	R
48	Northern grey-headed Sparrow	*Passer griseus*	14	R
49	Northern Red-billed Hornbill	*Tockus erythrorhynchus*	12	R
50	Orange-breasted Bush-shrike	*Chlorophoneus sulfureopectus*	4	R
51	Orange-checked Waxbill	*Estrilda melpoda*	28	R
52	Ovambo Sparrow Hawk	*Accipiter ovampensis*	1	NBV
53	Piapiac	*Ptilosto musafer*	19	R
54	Pied Crow	*Corvus albus*	17	R
55	Pied Kingfisher	*Ceryl erudis*	26	R
56	Pin Tail Whydah	*Vidua macoura*	1	R
57	Purple Glossy Starling	*Lamprotornis purpureus*	16	R
58	Red-billed Fire Finch	*Lagonostictasenegala*	48	R
59	Red-billed Quelea	*Quelea quelea*	35	M
60	Red-cheeked Cordon-bleu	*Uraeginthusbengalus*	34	R
61	Red-headed Quelea	*Quelea erythrobs*	18	R
62	Red-necked Buzzard	*Buteo auguralis*	1	PM
63	Red-necked Falcon	*Falco chicquera*	4	R
64	Red-rumped Swallow	*Cecropis daurica*	3	M
65	Reed Cormorant	*Microcarbo africanus*	40	RSM
66	Scarlet-chested Sunbird	*Chalcomitra senegalensis*	4	R
67	Sedge Warbler	*Acrocephalus schoenobaenus*	4	M
68	Senegal Coucal	*Centropus senegalensis*	15	R
69	Senegal Eremomela	*Eremomela pusilla*	3	R

70	Speckled Pigeon	*Columba guinea*	63	R
71	Spur-winged Lapwing	*Vanellus spinosus*	16	M
72	Squacco Heron	*Ardeo laralloides*	36	M
73	Tawny-flanked Prinia	*Prinia subflava*	2	R
74	Variable Sunbird	*Cinnyris venustus*	6	R
75	Village Indigo Bird	*Vidua chalybeate*	4	R
76	Village Weaver	*Ploceus cucullatus*	26	R
77	Vinaceous Dove	*Streptopelia vinacea*	5	R
78	Western Grey Plantain Eater	*Crinifer piscator*	5	R
79	White-face Whistling Duck	*Dendrocygna viduata*	177	R
80	Yellow-billed Kite	*Milvus aegyptius*	5	IAM
81	Yellow-billed Oxpecker	*Buphagus africanus*	3	R
82	Yellow-billed Shrike	*Lanius corvinus*	6	R
83	Yellow-crowned Gonolek	*Laniarus barbarus*	4	R
84	Yellow-fronted Tinker Bird	*Pogoniulus bilineatus*	1	R
	Total		**1263**	

Discussion

The study's primary focus was to determine the composition of birds within and around the Biu dam/reservoir. Our goal was to assess the abundance and diversity of birds in a modified, aquatic and semi-aquatic landscape. Of the 866 known species of birds that occur in Nigeria (Bird Life International 2024), we documented 84 species representing (9.7%) of the avifaunal composition of Nigeria. Our research documents the first checklist of the study area, providing baseline information for periodic monitoring of species abundance and diversity in the years to come. We documented 11 African Eurasian Wetland Agreement (AEWA) listed species (Boere, 2010), 10 of which are migratory. The implication of this is that Biu reservoir and environs has potential as a key biodiversity area (KBA) and could be pivotal to the survival of species of global conservation importance. Overall, our results revealed the presence of 23 migratory species (27.4 %) while the remaining 61 species (72.6 %) were resident bird species. Of the 23 migratory species, 3 species were intra-African migrants, 4 species were partial migrants, one (1) non-breeding visitor, while 15 were Palearctic migrants. The presence of migratory bird species suggest that Biu reservoir and surrounding habitats could serve as wintering grounds for these species of birds.

We recorded 17 species of birds that survive on animal based diets (carnivores) ranging from fish meals, small rodents and invertebrates. Six (6) of these were raptors from the Accipitrideae family, while the remaining species were kingfishers, crows, invertebrate eating water birds etc. However, our findings revealed that insectivores were the most abundant species in the study area followed by granivores with a total number of 27 and 21 bird species respectively. The implication of this is the potential benefit for farmers with regards to pest control activities of insect-eating bird species (Wyckhuys *et al*., 2019). In addition, raptors also act as pest control agents when the capture and eat preys such as rodents, and other crop raiding small mammals (Sulieman *et al*., 2025).

White face whistling duck, a resident water bird was the most abundant bird species. The high abundance of this species could be attributed to its social and gregarious nature, feeding and breeding in clusters often in hundreds of thousands in suitable sites. Our finding is in congruence with similar wetland focused studies for example Delphine *et.al*., (2013), Nsor *et al*., (2022); Nsor and Nya, (2025) and Muhammad *et al*., (2025). Similarly, the Ardeidea family was the most diverse (Suleiman *et al*., 2025; Nsor and Nya, 2025).

The results of this study highlight the resilience of wetland avifauna and terrestrial bird species in the face of anthropogenic activities (dam construction, fishing, all-season crop cultivation etc), within a matrix of agricultural landscape and human settlements. Our findings underscore the ecological significance of the reservoir and surrounding agricultural landscape, especially with the record of red necked falcon (*Falco chicquera*), a near threatened species (IUCN 3.1). Our finding is quite significant when compared to similar studies (Delphine *et al*., 2013; Adang *et al*., 2015; Ringim *et al*., 2017; Hadejia *et al*., 2019; Nsor *et al*., 2025) with more sampling effort and size of study area.

Biodiversity loss poses a critical threat to human societies on local and global scales, highlighting the pressing need for understanding the complex and intricate relationship between human pressures and their effects on ecosystems (Emmerson, 2016). In this study we identified the following as ongoing human pressures within and around the dam/reservoir and contiguous landscape; conversion of natural habitats to agricultural fields, the abandoned dam, and ongoing construction of an amusement park adjoining the wetland and reservoir area. Studies have ranked the identified threat as top among the many anthropogenic activities in order of impact

(Danso *et al*., 2021). However, agricultural intensification (Emmerson 2016) and urbanization are globally acclaimed as the foremost causes or drivers of biodiversity loss (Danso *et al*., 2021).

In Biu reservoir, apart from the threats mentioned above, and its use as a primary source of municipal water supply, we observed a high level of resource exploitation (sand excavation, overfishing, fuel wood collection and hunting). These drivers can singly or synergistically enhance or reduce species diversity locally which may result in biotic homogenization as a consequence of reduction in species diversity, and increase in local population of favored species on a spatio-temporal scale **(**Ruiyang *et al*., 2023). By monitoring and studying bird species composition at different local and spatial scales, we can detect bird species population declines on time and activate targeted intervention programs for their protection and conservation.

Conclusion and Recommendations

In conclusion, this study has provided a checklist of avian species, the dominant feeding guilds, and the species of conservation interest. This crucial information is a good step going forward in terms of further research and awareness creation to possibly reverse or halt ongoing threats that may adversely affect bird species and other forms of biodiversity in the area. We recommend immediate intervention by the relevant authorities to designate the reservoir and surrounding area as a Key Biodiversity Area (KBA). In addition, seasonal avian monitoring to understand the inter-play between seasonality, cultural practices (agriculture) and water volume on the abundance and diversity of avian species in the area. Biu dam/reservoir is a wetland of conservation importance being that it serves as wintering grounds for migratory bird species. A buffer zone should be created around the wetland area to delineate the agricultural fields from the core area of interest to reduce pressure on the already distressed landscape.

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