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Diversity and Distribution of Aquatic Bird Species in Kanji Lake Dam, New Bussa, Niger State, Nigeria

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ABSTRACT

Quantifying the species richness of bird's communities has gained increasing importance in environmental impact assessment and conservation planning and ecology research. Species inventories not only help in understanding species losses but also help determine the characteristics of species that are vulnerable to habitat perturbations.The aim of this study is to provide a baseline data and checklist of the bird assemblages in Kainji Lake Dam, New Bussa, Nigeria. Bird sampling was conducted bi-monthly for 12 months, by using point sampling method along the course of the lake in order to enumerate the abundance, distribution and diversity of bird species in the study area. The populations of bird species were classified as rare, frequently seen and common based on the number of sightings, and abundance. Diversity indices such as evenness, Shannon-Weiner diversity, were estimated. The bird species diversity is 3.24 while the bird species evenness is 0.86. A total number of 726 birds consisting of 43 species in 11 families and 6 orders were recorded in the lake. White faced Whistling duck has the highest frequency (88). Seasonal variation indicates that more birds were observed during the wet season compared with the dry season. The Ciconidae family was the most abundant in terms of species distribution. The least population of aquatic bird species were found at dam area due to human disturbance such as fishing and hydro-electric generation. For continued residency of the birds in the lake, lake best management practices (LBMP) should be implemented. Continuous monitoring of the birds (bio- monitor) in the lake should also be done to give an insight into the ecological conditions of the lake and at the same time serving as aesthetic organisms in the lake.

Keywords: Aquatic, Avian, Point, Count**,** sampling

Introduction

Lakes serve as an important life support system by helping in recharging of aquifers and regulating hydrological regimes. The lake produces excellent feeding ground for nesting and also provides habitat for some aquatic and semi aquatic birds. (Suleiman *et al*.,2015). Aquatic and semiaquatic birds as a group are suited to feed and breed in environments in which water forms fundamental part. Aquatic and semi aquatic birds are biological indictors in aquatic environment because these birds belong to the top level of food chain in aquatic ecosystem (Stapanian M.A, 2003). Bird's populations are a sensitive indicator of pollution in terrestrial as well as in aquatic ecosystem (Colwell, 2009). Bird's habitat within the lake area seems to be strongly influenced by climatic changes and immediate human impact. Many natural habitats in the

study area are undergoing changes as a result of human activities. Under this condition the numbers of many species of birds are declining precipitously. To conserve birds and their natural habitats there is need to understand their life cycles, habitats in which they live (Gawlik, 2002).When consequent environmental changes exceed the tolerance limits of species, habitat change also becomes an ultimate cause for long term changes in bird species distribution (Amezaga*et al*., 2002).The major threat affecting bird populations is the unrestricted habitat loss and degradation of aquatic surrounding due to human activities. The density and diversity of water birds are influenced by rainfall, temperature humidity and cloudiness Briggs and Holmes(1988). Bird communities can be useful indicators of ecosystem structure since they depend on lower tropic levels for their current activities (feeding, nesting, resting) and population success. In addition birds can play an important role in the nutrient cycles of many aquatic ecosystems. An integral view of the functioning of aquatic ecosystem requires the incorporation of as many trophic levels as possible. (Cohen *et al*., 1990). The Kainji dam shows well defined dry and wet seasons (Osunsina *et al*.,2018). According to Yaduma *et al.* (2024), the site forms an isolated set of all other wet environments in terms of bird composition, with significantly high densities in certain areas.

The presence of enormous water bodies provide food and shelter to birds, so Kainji Lake Dam is one of the favorite spot for native as well as migratory birds. Being ecologically important with high nutritional value and productivity, it supports good diversity of bird species. (Osaguona *et al*., 2024). The present study was carried out to check the status of availability of aquatic birds in three different water courses of the dam sites: namely the upper, middle and lower course.

The Kainji Lake dam is an important water body in Niger state and Nigeria to birds associated with aquatic environments and muddy substrates (Adelakun and Kehinde, 2019). However, despite the remarkable significance of such region for the conservation of resident and migratory birds, the spatio-temporal patterns of distribution, habitat use, structure of bird communities and the status of populations of aquatic birds are little known in the study area (Tubelis and Tomas, 2003).

Thus, the study was carried out to answer the following questions: 1) Does the aquatic environments host different composition of aquatic birds? 2) Is there significant seasonal variation in the community of aquatic birds? The objective of this research work is to evaluate the abundance, distribution, bird diversity and seasonal variation of bird species in the study area.

Methodology and Materials

Study area

The vegetation of Borgu Local Government Area, Niger State, within Latitude 9°51'N and 11° N and longitude 2°E and 4° 31'E) is typical Guinea Savanna with intensive grass cover interspersed by a few trees and shrubs (Allen and Breshears,1998; Osunsina *et al*., 2018). The climate is characterised by low rainfall (Ogialekhe *et al*., 2024), mean annual rainfall of 659mm, relatively wide, and rapid changes in temperature and humidity. Temperature is generally high. (Aremu and Elekhizor 2007). The highest mean monthly temperature is about 40-45^{0}C in April while the lowest mean monthly temperature occurs in December/January when the temperature could come down to 15°C.

The scope of this study was restricted to categories of *aquatic*(bird species which are strong swimmers being dabblers or divers, with striking plumage features, whose habit and habitat are totally aquatic for nesting, feeding, or shelter during the dry and wet seasons, applicable to migratory species and otherwise for resident (including breeding) species), *near-aquatic* (bird species habit and habitat are dependent on water resource/ wetland products) and *waders* (the shoreline species depending mostly on lowland(water) and upland products) avian (Fretweil, *et. al.*, 1996; Hoyer, 2013).

Sampling Technique

Population estimation for aquatic birds was done by point count method and also by walking around the peripheral-accessible area of the pond using the line transects sampling method. Secondary data was used to obtain residency status and conservation status as categorised by international union for the conservation of nature and natural resources (Hills, 2020)

.Motorised wooden canoes of the local fishermen were used to facilitate closer surveys, at the proximity of birds in the water. Strict care was taken, not to overlook or bias the count for any individual species encountered. The study was conducted bi-monthly, late dry season (November-April) wet season (May -October), the count was conducted at the upper course, middle course, and at the dam site. The surveys was carried out in different hours of the day for Point count studies starting 6-8am and 5-7pm onwards till visibility is reduced, depending on the prevailing season and weather conditions the appropriate time slot was opted for as per the ability, convenience and other needful field resources available, each survey lasted for 2hrs. The aquatic, near-aquatic and wader species seen, and of interest were recorded by the aid of 8-16 X 40 metres binoculars of Panasonic make, photographs and videos was taken by Canon Digital Cameras for later prudent identification and other studies following (Osunsina *et al*., 2018; Ogialekhe *et al*., 2024), .The nomenclature of the recorded avifauna was done following (Borrow and Demey, 2013). The Shanon-Weiner diversity index (H'), Hmax and Evenness index (J‘) was calculated. The calls and behaviour of the aquatic birds were taken into account to ascertain their identity and support the study. The data obtained was subjected to descriptive statistics such as frequency distribution.

Species diversity across the entire area was determined using the Shannon-Weiner diversity index. Shannon-Weiner diversity index takes into account the number of species richness as well as evenness. Shannon index (H) = $-(Pi\ x\ Ln\ Pi)$ ……(1)

Where:

Pi= the relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community niN

The value of the index ranges from 0 (low species richness and evenness) to 5.0 (high species richness and evenness)

Evenness = EH = $H\ln(S)$

Where,

Hi = Shannon-Weiner index

Ln(S) = natural logarithm of species richness

Results

Checklist and bird species abundance in the study area

The results from this study reveals that from the three courses of the dam, a total of 43 species belonging to 6 orders (Figure 1) and 11 families were recorded, comprising of (33) species as Resident(R), (6) species as Intra -African

Migrants (M), and 4 species as Palearctic (PM). According to the International Union for the conservation of nature (IUCN, 2017). One (1) bird species was Near Threatened (NT) Nineteen (19) species were of Least Concerned (LC). (Table 2) The family-wise analysis revealed, the approximate abundance frequency with respect to total species was worked out which resulted into Anatidae- 9 species and Ardeidae – 11 species being the most abundant, with respect to high scores of different species records.

The total number of birds enumerated was (726), the upper course of the dam has (277), the middle course (230) while the least was the dam site (219). The most abundant bird species are the Whistling duck (88), Fulvous whistling duck (64) and Little egret (60). The rarest species are Hadada ibis (1), Sacred ibis (1), Abdims stork (2), African open billed stork (1) and Garganey (1). (Table 1).The highest numbers of bird species were found in the Ardeidae family (11), Alcedinidae (8) and Anatidae (9). The rarest bird species are in the following families Pandonidae (1), Ahingidae (1) Pelicanidae (1) Phalacrocoracidae (1), Scopidae (1) Podicipidae (1) and Threskionithidae (2) (Figure 2). Fourteen (11) families, 6 order and 43 bird species were identified in the study area. The number of bird species in the upper course of the dam is (41), middle course (39) and the dam site (33).

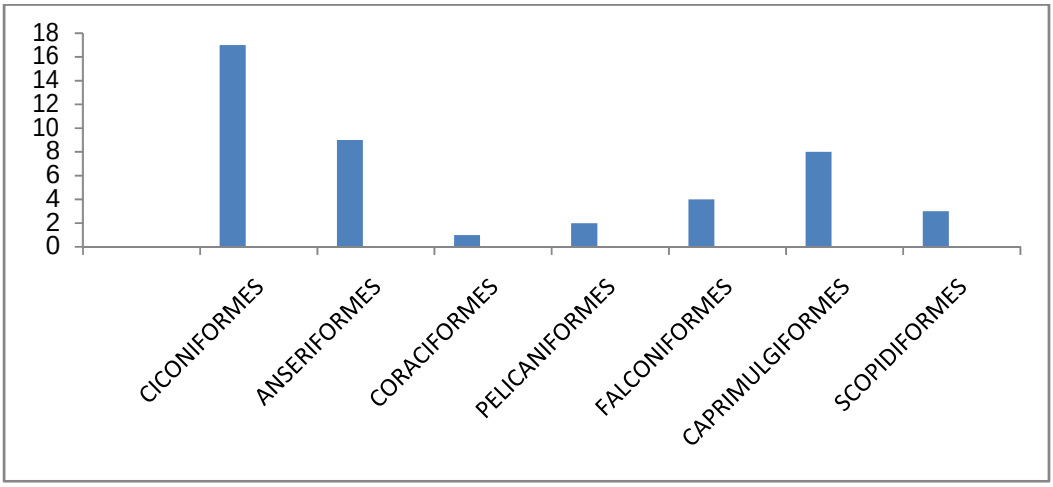


Figure 1: Order and number of bird species. Source: Field survey, 2025

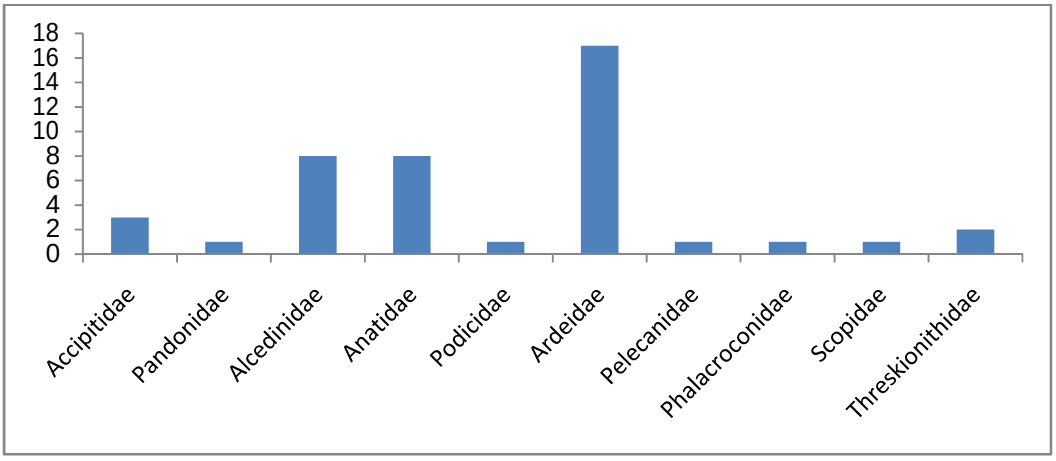


Figure 2: Family and number of bird species. Source: Field survey, 2025

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Table 1: Checklist of Aquatic Bird Species in the Study Area

Order	Family	Common names	Scientific names	Upper	Middle	Lower	Frequency
Falconiformes	Accipitridae	Eurasian marsh harrier	*Circus aeruginosus*	24	13	6	43
		Montagu's harrier	*Circus pygargus*	2	1	0	3
		Pallid harrier	*Circus macrourus*	1	2	3	6
	Pandionidae	Osprey	*Pandion haliaetus*	3	1	0	4
Caprimulgiformes	Alcedinidae	African pygmy kingfisher	*Ceyxpictus*	2	1	5	8
		Blue breasted kingfisher	*Halcyon malimbica*	1	0	1	2
		Giant kingfisher	*Megaceryle maxima*	2	5	7	14
		Grey headed kingfisher	*Halcyon leucocephala*	1	3	2	6
		Malachite kingfisher	*Alcedocristata*	21	2	8	31
		Pied kingfisher	*Cerylerudis*	3	1	0	4
		Striped kingfisher	*Halcyon chelicuti*	1	2	0	3
		Woodland kingfisher	*Halcyon senegalensis*	23	1	4	28
Anseriformes	Anatidae	African pygmy goose	*Nettapusauritus*	2	5	7	14
		Egyptian goose	*Alopacheneagyptiaca*	2	1	6	9
		Fluvous whistling duck	*Dendrocygna bicolor*	23	26	15	64
		African darter	*Anhingasrufa*	2	17	2	21
		Garganey	*Anas querquedula*	0	0	1	1
		Knob billed duck	*Sarkidionismelanotes*	23	12	17	52
		Spur winged goose	*Plectropterusgambensis*	2	12	8	22
		White faced whistling duck	*Dendrocygnaviduata*	23	27	38	88
	Podicipidae	Little grebe	*Tachybaptusrufilcallis*	16	6	2	24

Ciconiformes	Ardeidae	Black headed heron	*Ardeamelanocephala*	2	5	2	9
		Dwarf bittern	*Ixobrychussturmii*	0	1	2	3
		Green backed heron	*Buteriodesstriata*	2	4	8	14
		Grey heron	*Ardeacinerea*	3	8	12	23
		Intermediate egret	*Egrettaintermedea*	2	1	0	3
		Little bittern	*Ixobrychusminutus*	2	1	5	8
		Little Egret	*Egrettagarzetta*	32	12	16	60
		Purple heron	*Ardeapurpurea*	4	7	9	20
		Squacco heron	*Ardeolaralloides*	15	6	8	29
		Goliath heron	*Ardea goliath*	4	6	2	12
		Great egret	*Egretta alba*	12	2	1	15
		Abdims stork	*Ciconia abdimii*	1	0	1	2
		African open billed Stork	*Anastomuslamellegerus*	1	0	1	2
		Black stork	*Ciconia nigra*	1	1	0	2
		White stork	*Ciconia ciconia*	2	1	0	3
		Woolly necked stork	*Ciconia episcopus*	3	1	0	4
		Yellow billed stork	*Mycteria ibis*	1	2	0	3
Pelicaniformes	Pelecanidae	Pink backed pelican	*Pelecanusrufescens*	3	4	7	14
	Phalacrocoracidae	Long tailed cormorant	*Phalacrocorux africanus*	7	23	4	34
Scopidiformes	Scopidae	Hamerkop	*Scopus umbretta*	2	6	9	17
	Treshkionithidae	Hadada ibis	*Bostrychiahagedash*	1	0	0	1
		Sacred ibis	*Threskionis aethiopica*	0	1	0	1
Total				**277**	**230**	**219**	**726**

Residency /IUCN status of bird species in the study area

The residency status of the bird species in the study area indicates that (33) bird species are resident in the study area, (6) are intra African migrant species while (4) are Palearctic migrants.(Figure 3). International union for the conservation of nature and natural resources has given the following conservation status for all species of wildlife animals in the following categories; Category A: Bird species that are commonly seen, B; Fairly common species, C; Uncommon, S; Scarce, R; Rare bird species and NT: Near threatened bird species. The following results were obtained from the study area, 19 bird species are common, 8 fairly common, 18 uncommon, 7 scarce, 6 Rare, Locally seen bird species 13 and 1 near threatened. Table 2. More birds were observed in the wet season(378) than in the dry season(348). Table 4.

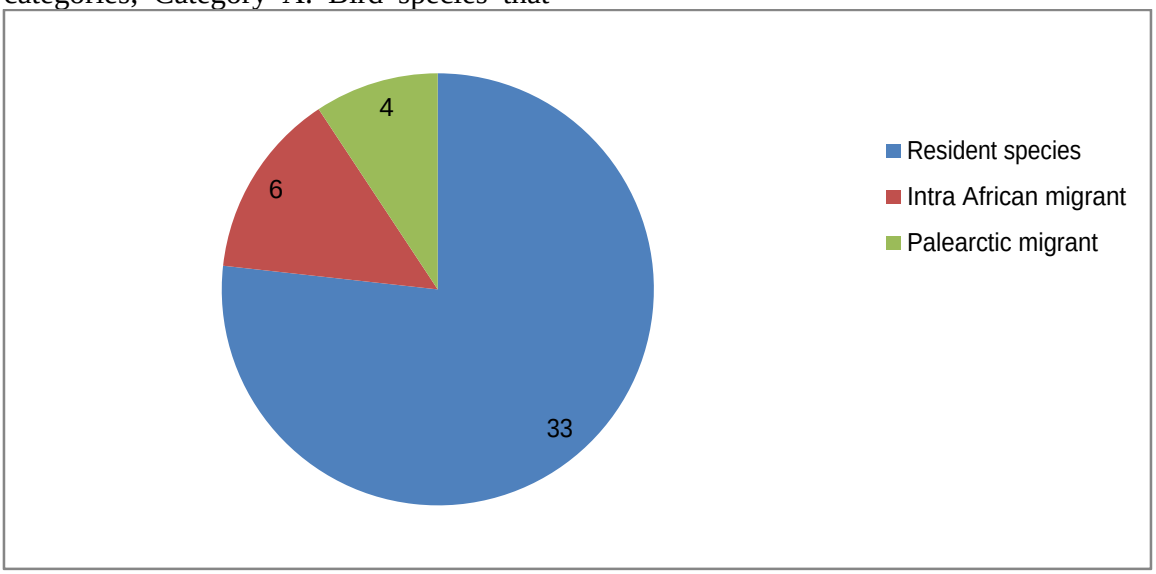


Figure 3: Chart indicating the distribution and residency status of aquatic bird species in the study area. Source: Field survey, 2025

Table 2: Residency/IUCN status of bird species in the study area

Common names	Resident	Intra African Migrant	Palearctic	Vagrant	Common	Fairly common	Uncommon	Scarce	Rare	Local	Near threatened
Abdims stork	R	M	NIL	NIL	C	Nil	Nil	Nil	**R**	**L**	Nil
African darter	R	NIL	NIL	NIL	Nil	Nil	**U**	**S**	Nil	Nil	Nil
African open billed Stork	NIL	M	NIL	NIL	Nil	Nil	**U**	Nil	**R**	**L**	Nil
African pygmy goose	R	NIL	NIL	NIL	Nil	F	Nil	**S**	Nil	Nil	Nil
African pygmy kingfisher	R	NIL	NIL	NIL	C	Nil	**U**	Nil	Nil	Nil	Nil
Black headed heron	R	NIL	NIL	NIL	Nil	Nil	Nil	**S**	**R**	Nil	Nil
Black stork	R	NIL	NIL	NIL	Nil	Nil	**U**	**S**	Nil	Nil	Nil
Blue breasted kingfisher	R	NIL	NIL	NIL	Nil	F	Nil	Nil	Nil	**L**	Nil
Dwarf bittern	NIL	M	NIL	NIL	C	F	Nil	Nil	Nil	**L**	Nil
Egyptian goose	R	NIL	NIL	NIL	C	Nil	Nil	Nil	Nil	**L**	Nil
Eurasian marsh harrier	NIL	NIL	P	NIL	C	Nil	**U**	Nil	Nil	Nil	Nil
Fluvous whistling duck	R	NIL	NIL	NIL	Nil	Nil	**U**	**S**	Nil	Nil	Nil
Garganey	NIL	NIL	P	NIL	C	F	Nil	Nil	Nil	Nil	Nil
Giant kingfisher	R	NIL	NIL	NIL	C	Nil	Nil	Nil	Nil	Nil	Nil
Goliath heron	R	NIL	NIL	NIL	C	F	Nil	Nil	Nil	Nil	Nil
Great egret	R	NIL	NIL	NIL	Nil	F	**U**	Nil	Nil	Nil	Nil
Green backed heron	R	NIL	NIL	NIL	C	Nil	**U**	Nil	Nil	Nil	Nil
Grey headed kingfisher	NIL	M	NIL	NIL	C	Nil	**U**	Nil	Nil	Nil	Nil
Grey heron	R	NIL	NIL	NIL	C	Nil	**U**	Nil	Nil	**L**	Nil
Hadada ibis	R	NIL	NIL	NIL	Nil	Nil	**U**	Nil	Nil	Nil	Nil

Hamerkop	R	NIL	NIL	NIL	C	Nil	Nil	Nil	Nil	Nil	Nil
Intermediate egret	R	NIL	NIL	NIL	C	Nil	Nil	Nil	Nil	**L**	Nil
Knob billed duck	R	NIL	NIL	NIL	C	Nil	Nil	Nil	Nil	Nil	Nil
Little bittern	R	NIL	NIL	NIL	Nil	F	Nil	**S**	Nil	**L**	Nil
Little Egret	R	NIL	NIL	NIL	C	Nil	**U**	Nil	Nil	**L**	Nil
Little grebe	R	NIL	NIL	NIL	Nil	Nil	Nil	Nil	Nil	Nil	NT
Long tailed cormorant	R	NIL	NIL	NIL	C	Nil	Nil	Nil	**R**	**L**	Nil
Malachite kingfisher	R	NIL	NIL	NIL	C	Nil	**U**	Nil	Nil	Nil	Nil
Montagu's harrier	NIL	NIL	P	NIL	Nil	Nil	**U**	**S**	Nil	Nil	Nil
Osprey	R	NIL	NIL	NIL	C	Nil	**U**	Nil	Nil	**L**	Nil
Pallid harrier	NIL	NIL	P	NIL	Nil	F	Nil	Nil	Nil	Nil	Nil
Pied kingfisher	R	NIL	NIL	NIL	C	Nil	Nil	Nil	Nil	**L**	Nil
Pink backed pelican	R	NIL	NIL	NIL	Nil	Nil	**U**	Nil	Nil	**L**	Nil
Purple heron	R	NIL	NIL	NIL	Nil	Nil	**U**	Nil	**R**	Nil	Nil
Sacred ibis	R	NIL	NIL	NIL	Nil	Nil	**U**	Nil	**R**	Nil	Nil
Spur winged goose	R	NIL	NIL	NIL	Nil	Nil	**U**	**S**	Nil	Nil	Nil
Squacco heron	R	NIL	NIL	NIL	C	Nil	**U**	Nil	Nil	**L**	Nil
Striped kingfisher	R	NIL	NIL	NIL	Nil	F	Nil	Nil	Nil	Nil	Nil
White faced whistling duck	R	NIL	NIL	NIL	C	Nil	Nil	Nil	Nil	**L**	Nil
White stork	R	NIL	NIL	NIL	Nil	Nil	**U**	Nil	Nil	**L**	Nil
Woodland kingfisher	NIL	M	NIL	NIL	Nil	Nil	**U**	Nil	**R**	Nil	Nil
Woolly necked stork	R	NIL	NIL	NIL	Nil	Nil	**U**	Nil	**R**	Nil	Nil
Yellow billed stork	NIL	M	NIL	NIL	**Nil**	**Nil**	**U**	**Nil**	**R**	**Nil**	**Nil**

Total	**33**	**6**	**4**	**0**	**19**	**8**	**18**	**7**	**6**	**13**	**1**	

Table 3: Bird species diversity indices in the study area

Family	Common names	Scientific names	Upper	Middle	Lower	Freq.	RF(%)	Pi	LnPi	H=PiLnPi	Hmax	EH	M
Accipitridae	Eurasian marsh harrier	*Circus aeruginosus*	24	13	6	43	5.92	0.06	-2.83	-0.17	3.78	-0.04	6.53
	Montagu's harrier	*Circus pygargus*	2	1	0	3	0.41	0.00	-5.49	-0.02	3.78	-0.01	
	Pallid harrier	*Circus macrourus*	1	2	3	6	0.83	0.01	-4.80	-0.04	3.78	-0.01	
Pandionidae	Osprey	*Pandion haliaetus*	3	1	0	4	0.55	0.01	-5.20	-0.03	3.78	-0.01	
Alcedinidae	African pygmy kingfisher	*Ceyxpictus*	2	1	5	8	1.10	0.01	-4.51	-0.05	3.78	-0.01	
	Blue breasted kingfisher	*Halcyon malimbica*	1	0	1	2	0.28	0.00	-5.89	-0.02	3.78	0.00	
	Giant kingfisher	*Megaceryle maxima*	2	5	7	14	1.93	0.02	-3.95	-0.08	3.78	-0.02	
	Grey headed kingfisher	*Halcyon leucocephala*	1	3	2	6	0.83	0.01	-4.80	-0.04	3.78	-0.01	
	Malachite kingfisher	*Alcedocristata*	21	2	8	31	4.27	0.04	-3.15	-0.13	3.78	-0.04	
	Pied kingfisher	*Cerylerudis*	3	1	0	4	0.55	0.01	-5.20	-0.03	3.78	-0.01	
	Striped kingfisher	*Halcyon chelicuti*	1	2	0	3	0.41	0.00	-5.49	-0.02	3.78	-0.01	
	Woodland kingfisher	*Halcyon senegalensis*	23	1	4	28	3.86	0.04	-3.26	-0.13	3.78	-0.03	
Anatidae	African pygmy goose	*Nettapusauritus*	2	5	7	14	1.93	0.02	-3.95	-0.08	3.78	-0.02	
	Egyptian goose	*Alopacheneagyptiaca*	2	1	6	9	1.24	0.01	-4.39	-0.05	3.78	-0.01	
	Fluvous whistling duck	*Dendrocygna bicolor*	23	26	15	64	8.82	0.09	-2.43	-0.21	3.78	-0.06	
	African darter	*Anhingasrufa*	2	17	2	21	2.89	0.03	-3.54	-0.10	3.78	-0.03	
	Garganey	*Anas querquedula*	0	0	1	1	0.14	0.00	-6.59	-0.01	3.78	0.00	
	Knob billed duck	*Sarkidionismelanotes*	23	12	17	52	7.16	0.07	-2.64	-0.19	3.78	-0.05	
	Spur winged goose	*Plectropterusgambensis*	2	12	8	22	3.03	0.03	-3.50	-0.11	3.78	-0.03	
	White faced whistling duck	*Dendrocygnaviduata*	23	27	38	88	12.12	0.12	-2.11	-0.26	3.78	-0.07	

Podicipidae	Little grebe	*Tachybaptusrufilcallis*	16	6	2	24	3.31	0.03	-3.41	-0.11	3.78	-0.03
Ardeidae	Black headed heron	*Ardeamelanocephala*	2	5	2	9	1.24	0.01	-4.39	-0.05	3.78	-0.01
	Dwarf bittern	*Ixobrychussturmii*	0	1	2	3	0.41	0.00	-5.49	-0.02	3.78	-0.01
	Green backed heron	*Buteriodesstriata*	2	4	8	14	1.93	0.02	-3.95	-0.08	3.78	-0.02
	Grey heron	*Ardeacinerea*	3	8	12	23	3.17	0.03	-3.45	-0.11	3.78	-0.03
	Intermediate egret	*Egrettaintermedea*	2	1	0	3	0.41	0.00	-5.49	-0.02	3.78	-0.01
	Little bittern	*Ixobrychusminutus*	2	1	5	8	1.10	0.01	-4.51	-0.05	3.78	-0.01
	Little Egret	*Egrettagarzetta*	32	12	16	60	8.26	0.08	-2.49	-0.21	3.78	-0.05
	Purple heron	*Ardeapurpurea*	4	7	9	20	2.75	0.03	-3.59	-0.10	3.78	-0.03
	Squacco heron	*Ardeolaralloides*	15	6	8	29	3.99	0.04	-3.22	-0.13	3.78	-0.03
	Goliath heron	*Ardea goliath*	4	6	2	12	1.65	0.02	-4.10	-0.07	3.78	-0.02
	Great egret	*Egretta alba*	12	2	1	15	2.07	0.02	-3.88	-0.08	3.78	-0.02
	Abdims stork	*Ciconia abdimii*	1	0	1	2	0.28	0.00	-5.89	-0.02	3.78	0.00
	African open billed Stork	*Anastomuslamellegerus*	1	0	1	2	0.28	0.00	-5.89	-0.02	3.78	0.00
	Black stork	*Ciconia nigra*	1	1	0	2	0.28	0.00	-5.89	-0.02	3.78	0.00
	White stork	*Ciconia ciconia*	2	1	0	3	0.41	0.00	-5.49	-0.02	3.78	-0.01
	Woolly necked stork	*Ciconia episcopus*	3	1	0	4	0.55	0.01	-5.20	-0.03	3.78	-0.01
	Yellow billed stork	*Mycteria ibis*	1	2	0	3	0.41	0.00	-5.49	-0.02	3.78	-0.01
Pelecanidae	Pink backed pelican	*Pelecanusrufescens*	3	4	7	14	1.93	0.02	-3.95	-0.08	3.78	-0.02
Phalacrocoracidae	Long tailed cormorant	*Phalacrocorux africanus*	7	23	4	34	4.68	0.05	-3.06	-0.14	3.78	-0.04
Scopidae	Hamerkop	*Scopus umbretta*	2	6	9	17	2.34	0.02	-3.75	-0.09	3.78	-0.02
Treshkionithidae	Hadada ibis	*Bostrychiahagedash*	1	0	0	1	0.14	0.00	-6.59	-0.01	3.78	0.00
	Sacred ibis	*Threskionis aethiopica*	0	1	0	1	0.14	0.00	-6.59	-0.01	3.78	0.00
			277	**230**	**219**	**726**	**100.00**			**-3.24**		**-0.86**

H' = 3.24 **EH = 0.86**

Table 4: Seasonal distribution of aquatic bird species in the study area

	Dry season			Wet season			
Month	**Upper course**	**Middle course**	**Lower course**	**Upper course**	**Middle course**	**Lower course**	**Total**
November	13	3	7	16	4	21	64
December	4	7	4	15	7	7	44
January	5	15	13	4	15	12	64
February	17	11	6	16	13	14	77
March	14	14	5	24	13	5	75
April	12	8	10	11	9	6	56
May	21	6	8	14	13	3	65
June	7	8	14	4	7	23	63
July	8	9	4	6	18	4	49
August	11	16	7	8	11	2	55
September	5	8	19	14	8	14	68
October	16	4	9	12	3	2	46
Total	133	109	106	144	121	113	**726**

Discussions

Virtually all human activities can affect wildlife populations either positively or negatively. Those activities that are likely to have adverse effects can be divided into those that function primarily by altering the physical environment in a relatively permanent way and those that cause changes to an animal's behavior (Adelakun and Kehinde 2019). Activities that alter the physical environment change the amount or the suitability of habitat for a species. Widespread and large-scale examples include activities that directly alter the structure and composition of the landscape, such agriculture, forestry, livestock grazing and Illegal mining. The dam area has many human disturbances such as hydroelectricity generation, irrigation of farmland, fishing and therefore the area has the lowest bird species abundance when compared with the upper course and middle courses of the lake in the study area.

During the cause of carrying out this research Forty three bird species were sighted in the study area; with the Little grebe labeled as near threatened by the IUCN. Occurrence of four Palearctic species (Pallid harrier, Montagu's harrier, Garganey and Eurasian marsh harrier) of winter visitors during the study period provides insights on availability of suitable stopover sites for migratory water birds within the study area. Six intra African migrants Abdims stork, African open billed stork, Dwarf bitten, Grey headed Kingfisher and Woodland kingfisher also added to bird species diversity of the study area (Forcey *et al.*, 2007).

According to Lammed (2011), open water habitats are used by pelicans, cormorants and ducks while the shallow bank areas and muddy areas allow egrets, herons, ibises and spoonbills to hunt for food. This variety of habitat types provided by the dam could be the possible reason for having a high year around water bird diversity in the study area (Osaguona *et al.*, 2024).

Relative abundance and commonness indicated that White faced whistling duck, Fluvous whistling duck and Knob billed duck were the most common bird followed by Little egret and Eurasian marsh Harrier . Long tailed Cormorants dive underwater to capture their prey, usually sit for longer period on dead trees, half-merged rocks and river banks with its wings spread to dry their wings and breeds in colonies during December to May in the study area. Therefore, they are well adapted to the variety of habitats offered by the Kainji Lake dam throughout the year. The minimum relative abundance was observed in Hadada ibis (1), Sacred ibis (1), Abdims stork (2), African open billed stork (1) and Garganey (1). Availability of habitat types varied greatly among the months with the availability of rainfall. The dead trees, logs and rocks were fully inundated with water when the reservoir was filled with water and they gradually emerged when the dam water reduces. This exposed areas provided more platforms for the birds to rest. This study identified that water birds exhibit different behaviors in different habitat types. Trees around the reservoir were identified as the most utilized habitat type for both breeding and resting purposes(Roshnath and Sinu, 2017). Most colonial water birds nest in woody trees surrounded by water, which acts as a

barrier to predators (White *et al*., 2005). The large trees in the vicinity of the reservoir provided breeding habitats for large water birds such as Grey herons. Easy access to the available foraging grounds of the reservoir and they provided protection from predators thiscould be partly attributed to the selection of trees around the Lake as their breeding areas.

The Rocks was the second most utilized habitat type at the upper course of the lake which accommodated both resting and comfort activities of water birds. Specially diving water birds, for example cormorants, require places to stay during their foraging periods to consume the captured prey and also to take the aim to catch the prey item during foraging. Not only diving birds, wading birds belonging to the Order Ciconiformes were observed resting on rocks at the upper course of the lake. Comfort activities, especially the wing stretching and sun basking of large flocks of cormorants were highly observed on rocks.

Kainji Lake Dam has been identifiedas a lake with a good potential for fish production. Ultimately, this provides a good food source for water birds, especially for the pelicans, cormorants and larger storks. Some of piscivorous water birds forage using group methods called mixed-flock fishing, which make the prey more accessible and correspondingly it increase the foraging efficiency (White *et al*,. 2005). Long tailed cormorants indicated higher preference to construct nests on *Daniella olivera* trees as these trees provided more flat surfaces due to the bushy arrangement of leaves to construct their expanded, larger and irregular shaped nests. By accommodating a rich water bird community, the dam provides an insight of having ideal habitats for water birds. Therefore, conservation of this large reservoir is required as an important habitat for the conservation of water birds.

Conclusion

Bird species diversity was higher in the area with less human activities, i.e. especially the upper course of the lake. The study provided information about the diversity and structure of bird communities in the aquatic habitat along the course of the lake, and the result suggests that differences in resource availability between the different sites such as breeding sites, nesting materials, cover, food and water was able to restrict some species to certain habitat type while allowing others to be widely distributed, the study also concluded that any human activity that alters the habitat structure impact birds abundance, diversity and their distributions in the study area.

Recommendations

The results of this study have further relevance when considering conservation of the Kainji Lake Dam and its bird. International bodies such as Ramsar Convention, Birdlife International, RSPB, Wetlands International and other donor agencies should come with technical and financial assistance to improve the management of the lake bird diversity.

Since communities lack awareness that birds are important part of ecosystem as environmental health indicator, pollinators and pest controller, the Management of Mainstream has to provide conservation education to the communities so that the contribution of birds in the ecosystem can be realized.

Cooperation among different stakeholders i.e. ecologists, land surveyors, Local government council officials, social scientists, environmentalists, communities and bird watcher groups is required to ensure birds are conserved. A conservation group such as National Park Service (NPS, Nigeria) should initiate the cooperation.

It was observed during field visit that the communities do not know the biological resource and value that made the lake area popular. This suggests that research findings are not communicated back to the society. As result, societies have no knowledge on the importance of the area for this and coming generations.

Birds are less sensitive if they are visually shielded from observers , so birdwatchers should make use of inconspicuous clothing blinds, telescopes, vegetation and other ways to minimize being seen by birds (Osaguona *et al.*, 2024) to limiting disturbance. Minimizing bird disturbance and flushing will improve the quality of birdwatching and may increase bird abundance and species richness in the study area. Mining activities especially around the dam area should discouraged and stopped. This will further reduce the pollution of the water through the course of the river.

References

Adelakun, K. M and Kehinde, A. S. (2019).Occurrence of Heavy Metals in Selected Fish Species of River Oli, Kainji Lake National Park, Nigeria. *SINET:Ethiopian Journal of Science*, *42*(1), Pp.18- 24.

Amezaga, J.M., Santamaria, L, and Green A.J. (2002). Biotic Wetlands Connectivity Supporting a New Approach for Wetland Policy. *Acta Oecologia*, 23, Pp.213-223

Allen and Breshears (1998). Drought-induced shift of a Forest Woodland Ecotone, Rapid Landscape Response to Climate Variation. Proceedings of the National Academy of Sciences, USA95-14842.

Aremu, O.T. Elekhizor B.T.and Likita, I.B. (2007). Rural People Awareness of Wildlife Resources Conservation around Kainji Lake National Park, Niger State. *ROAN*- The *Journal of Conservation*: Pp. 80-87.

Briggs, S.V. and J.E. Holmes, (1988). Bag Size of Water Fowl Research in New South Wales and their relation antecedent Rainfall. Australian Wild Life Research, 15: Pp.459-468.

Borrow, N., and Demey, R. (2013). Field Guide to the Birds of Western Africa. Christopher Helm, London. Pp 25-350.

Cohen, J.E.F. (1990): Briand and C.M. Newman (eds.): Community Food Webs, Springer- verlag, Pp.308.

Colwell, R.K. (2009), Biodiversity: Concepts, Patterns and Measurement. In Princeton Guide to Ecology. Edited by Simon A. Levin. Princeton, N.J: Princeton Univ. Press Pp 257- 260

Forcey, G.M., Linz, G.M., Thogmartin, W.E. and Bleier, W.J. (2007) Influence of Land Use and Climate on Wetland Breeding Birds in the Prairie Pot-hole Region of Canada. *Canadian Journal of Zoology , 85, 421-436. https://doi.org/10.1139/Z07-005*

Fretweil, J. D., Williams, J.S and Redman, P. J. (1996).National Water Summary on Wetland Resources, United States Geological Survey Water Supply Paper. Pp. 242, ISBN- 0607856963

Gawlik, D.E. (2002). The Effects of Prey Availability on the Numerical Response of Wading Birds, *Ecological Monography, Vol.72*.Pp.329-346.

Hills, R. (2020). *Afzeliaafricana*. The IUCN Red List of Threatened Species 2020: T33032A67742420.https://dx.doi.org/10.2305/IUCN.UK.2020 032A67742420.

Hoyer, M. V. (2013) Lake Management and Aquatic Birds, Fish and Wildlife Management, *LAKELINE*, Pp.17-20

IUCN (2017). International Union for the Conservation of Nature. International Union for Conservation of Nature. Annual Report 2017. Publication year 2018.

Lammed, G.A. (2011). Species Diversity and Abundance of Wild Birds in Dagona-Waterfowl Sanctuary, Borno State, Nigeria. *African Journal of Environmental Science and Technology, Vol.5(10) Pp.855-866*

Ogialekhe P., Osunsina I.O.O.,Ihidero A.A., Olakunle S.D., Ogundele S.G., Wealth A.S. and Adenika O.A. (2024). Diversity of bird species in Kainji Lake National Park (Borgu Sector), Nigeria.*NigerianJournal of Wildlife Management*Vol.8(2) https;//wildlifesocietyng.org/ojs/index.php/wildlfesocietyng.journal/index

Osaguona P.O.,OgialekheP.,Ajayi S.R.,AdelakunK.M.,Mohammed N., Umar H. and Abubakar S.(2024).Bird Species Diversity in Surrounding Communities of Zurguma Sector, Kainji Lake National Park, Nigeria. Proceedings of Wildlife Society of Nigeria, Conference, Kano, Kano State**.** ISSN: 2735-9301.

Osunsina I.O.O. Ogialekhe P. Adebayo O.A and Yisau (2018) Birds Species Diversity and Abundance in Borgu Sector of Kainji Lake National Park ,Nigeria. Nigerian *Journal of WildlifeManagement Vol.*2(22). Pp.41-50 https;//wildlife society ng.org/ojs/index.php/wildlfesocietyng.journal/index

Roshnath, R. and Sinu, P.A. (2017) Nesting Tree Characteristics of Heron, Birds of Urban Ecosystems in Peninsular India: Implications for Habitat Management. Current Zoology, 63, Pp.599-605. https://doi.org/10.1093/cz/zox006

Shanon, C. and W. Weiner (1963). *A Mathematical Theory of Communication*, Univ. of Illinois Press, Chicago.

Stapanian, M.A. (2003). Species Density of Water Birds in Offshore Habitats in Western Lake Eerie, *Journal of Field Ornithology , Vol.74, Pp.381-393*.

Suleiman, L.M., Abubakar, M,M., Ringim, A.S., Apeverga P.T, and Dikwa, M.A(2015) Effects of Wetlands Type and Size on Bird Diversity and Abundance at the Hadeija –Nguru Wetlands, Nigeria. *International Journal of Research Studies in Zoology(IJRSZ) Volume 1 Issue 1, June, 2015, Pp 15-21. www.arcjournals.org*

Tubelis, D.P. and Tomas, W.M., (2003). Bird's Species of the Pantanal Wetland, Brazil. *RevistaBrasileira de Ornitologia, Vol. 11 (1), Pp. 5-37*.

White, C.L., Frederick, P.C., Main, M.B. and Rodgers, J.A. (2005) Nesting Island Creation for Wading Birds. Wildlife Ecology and Conservation Department, Florida Cooperative Extension Service, Institute of Food and Agricultural

Sciences, Univer- sity of Florida, Circular, 1473. https://doi.org/10.32473/edis-uw223-2005 DOI: 10.4236/oje.2021.1110042 685 *Open Journal of Ecology*

Yaduma Z.B., Halidu S.K., AdelakunK.M.,Olakunle S.D. and Mohammed. (2024).Assessment of Wild-Animal Crop Raiding and its Influence on Wildlife Conservation around Kainji Lake National Park, Nigeria. *Bangladesh Journals online. Journal of Biodiversity Conservation and Bio-Resource Management. Vol.10(1), Pp.45-58*. https//doi.org/10.3329/jbcbm.v10/1.74595