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Diversity and richness of avian community in Ekonde and Owala dams, Osun State, Nigeria

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Abstract Birds have been shown to be an effective means of identifying priority areas for conservation action and mitigation measures. A field survey of birds at Ekonde and Owala dams in Osun State, Nigeria was conducted between March and June 2018 to determine the species diversity, abundance and feeding guilds. Data were collected using line transect method. The birds sighted during the survey were categorized based on their species, migratory/ non-migratory status, and feeding guild. Mean bird density within the two dams was determined and compared using t-test, and species diversity indices were analyzed using PAST software. A total of 2,152 birds from 67 species (33 families and 12 orders) were recorded where Ekonde dam had 1,286 birds (59.76%) and Owala dam had 866 (40.24%). In Ekonde dam, *Vanellus spinosus* was the most abundant species (n = 72, 8.31%), while at Owala dam, *Oriolus nigripennis* was the most abundant (n = 204, 15.86%). Bird density was apparently higher at Ekonde dam (51.44 birds/km^2) than Owala dam (30.95 birds/km^2), yet there was no significant difference (t value=1.679; p= 0.097). At Ekonde dam, Black-winged oriole had the highest density (8.16 birds/km^2) while at Owala dam Spur-winged lapwing had the highest density (72 birds/km2). Shannon diversity index and evenness were higher at Ekonde dam (3.702 and 0.862) than at Owala dam (3.102 and 0.654). The birds were categorized into 10 and 8 feeding guilds in Owala and Ekonde dam respectively. Most reported species were insectivores (27, 33%) and carnivores (15, 19%). It can be suggested that as two dams have high avian richness, these can be sites for avian conservation and avitourism if properly managed. It is therefore recommended that strategy for avian conservation be incorporated into the dam management program for sustainability of the ecosystem.

Keywords: Avian conservation, avitourism, bird density, feeding guilds.

1 Introduction

Historical and current rates of land modification have resulted in the loss of more than half of the wetlands worldwide (Ma *et al*. 2010, Zedler and Kercher

2005), and affected biodiversity that depends on wetlands for its persistence (Paracuellos and Telleriá 2004). Efforts are being made worldwide, at national and international levels to conserve wetlands of importance (Ibrahim and Aziz 2012, Tiéga 2011). More than 2000 wetlands worldwide have been designated as Ramsar sites, covering an area of about 215 million ha. Many of those wetlands are artificial (Zedler and Kercher 2005), can vary in size and other biophysical characteristics ranging from small agricultural ponds (Sebastián-González *et al*. 2010) and rice-paddy fields (Lawler 2001) to water treatment facilities (Hsu *et al.* 2011) and large water reservoirs (Balcombe *et al.* 2005). Previous studies have shown that although the construction of artificial wetlands can have negative environmental effects (Winemiller *et al.* 2016, Poff *et al.* 2007) such as dams fragmenting river ecosystems, it also has the potential to play a crucial complementary role in conserving biodiversity (Márquez-Ferrando *et al.* 2014, Karakas 2017, Bellakhal *et al*. 2017) and in maintaining ecosystem services (Yang *et al*. 2008, Walton *et al.* 2015).

Water bodies are considered as a key factor that affects aquatic vegetation, composition and food resources that effects population, diversity and distribution of birds (Colwell and Taft 2000). Wetlands and water birds are inseparable elements and support a rich array of water bird communities (Grimmett and Inskipp 2007). Local people used the wetlands for various purposes for their livelihood, fishing, agriculture, irrigation, bath washing, grazing, grass cutting which cause the factors of degradation of wetland ecosystem, leads to the destruction of habitat of aquatic avifauna (Manakadan *et al*. 2011). Wetlands encompass a large and heterogeneous spectrum of aquatic habitats. Despite their limited extension when compared with marine and terrestrial biomes they are widely recognized as biodiversity hotspots (IPCC 2002) and among the most populated worldwide. Finlayson and Davidson (1999) estimated that wetlands cover more than 1,280 million ha, representing less than 3% of the total biome area of the Biosphere. However, because of the overall high specific richness, endemism levels and productivity of many wetlands have a worldwide conservation importance (i.e. Ramsar sites).

Avifaunal diversity has been decreasing due to the destruction of natural habitats and human disturbances (Bhadja and Vaghela 2013). Birds are essential to maintain ecosystem and tropic level. They play a functional role in the ecosystem as potential pollinators and scavengers and are rightly called as bioindicators (Puri and Virani 2016).

As indicators, birds show trends that reflect the health status of the environment. Bird monitoring in Europe (Diamond and Devlin 2003) have shown how wild bird indicators can be successfully used to enhance and improve management of natural resources, and inform environmental decision making. The presence of diverse bird populations capable of sustainable reproduction is one of the best indications of a healthy environment (Kress 2000). The presence of rare or endangered species, concentration of species,

affiliations of certain species with a site, and other bird complement have shown corresponding significance for biodiversity (Chase *et al*. 2000, Vielliard 2000, Mikusinski *et al*. 2001, Sauberer *et al*. 2004, Thomson *et al*. 2007). Birds have been shown to be effective monitoring tools in the management of coastal and marine ecosystems (Canterbury *et al*. 2000, Sekercioglu 2006). The aquatic avifauna is quite susceptible to the changes in wetlands. This helps us to know whether the area is ecologically healthy or getting polluted, as total absence of birds from an area may be considered as pollution indication or human disturbance such as excessive hunting or human pressure (Borale *et al*. 1994).

Birds use wetlands for breeding, nesting and teaching young, as a source of drinking water, for feeding, resting, shelter and for social interaction. Wetlands provide food for birds in the form of plants, vertebrates, and invertebrates (Birdlife International 2017, Ramsar Convention Bureau 2000). Submerged vegetation can attract a higher number of migratory birds in freshwater bodies as birds have daily and seasonal dependencies on wetlands for food and other life-support systems (Okagbare and Adeyanju 2018).

In all the three types of wetlands (marine/coastal, inland or manmade), the most significant point of reference is water management (Odewumi *et al*. 2017, Kyohei and Toshio 2013). Water reservoirs serve primarily for irrigation, agriculture, drinking water, energy production, protection against flooding, recreation and fishing. On other hand, these water reservoirs could create some type of compensation for destroyed natural wetlands and water plots, mainly during bird migration (Kyohei and Toshio 2013).

Human activities change wildlife environments, and in many development projects man substantially alters the landscapes. Many landscape alterations, such as the construction of water reservoirs, can lead to extinction of species or populations, and some populations are reduced in numbers and density (Ackermann *et al.* 1973).

There are over 48,000 large dams worldwide supplying drinking water sources, generating hydroelectric power, irrigating land and preventing floods (WWF 2016). Whilst more construction projects are underway to meet the demands of global population growth, there has been increasing concern over the far-reaching adverse environmental impacts of such hydrological structures (Junk *et al*. 2013, Sun *et al.* 2012, WWF 2016). Large dams and barrages fragment river basins, leading to the loss of valuable ecosystem services, the deterioration of complex ecosystems and declines in biodiversity (Hagenmaier *et al*. 2016, Atnafu *et al.* 2011). Of the 338 globally Important Bird and Biodiversity Areas (IBAs) categorized as 'in Danger' (IBAs under very high pressure presently and in need of immediate action– BirdLife International 2017), 15% (50) are threatened by dams and water management. Wetlands are particularly vulnerable to the presence of dams and river management activities as they are dependent on seasonal flooding to sustain ecosystem function (Junk *et al*. 2012, Sun *et al.* 2012). Almost all (48) of the

IBAs threatened by damming contain areas that qualify as wetlands (BirdLife International 2017), with 58% of these encompassing or overlapping Ramsar wetlands sites. Consequently, decreasing wetland water levels have directly impacted a range of waterbirds dependent on these wetlands, such as the Critically Endangered Siberian Crane (*Grus leucogeranus*) and Vulnerable White-naped Crane (*Antigone vipio*) (BirdLife International 2017). Thus, avifaunal study is essential in Ekonde and Owala dams to conserve the biodiversity and its habitat.

2 Material and Methods

2.1 Study Sites

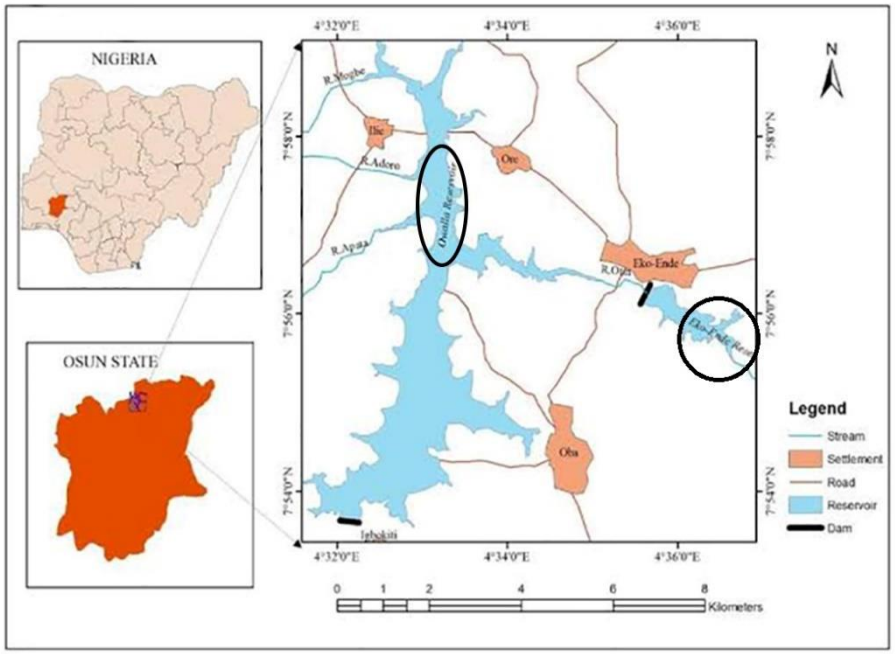

Fig 1: **Map of Owala and Ekonde dams in Osun State**.

The Erinle river dam (renamed as Owala dam) (7°57′00.79” N, 7°44′30.44” E; 250-450 above mean sea level) is located on the Erinle-River approximately 12 km upstream of the Okinni town and forms part of the Osogbo-Ede water supply extension scheme (Figure 1). The expanded reservoir was designed to improve on the existing water supply system of cities as well as other towns and rural communities in Osun central, Osun West and Ife area in Osun state. The reservoirs created behind the dam extend

some 12 km northward along the Erinle river and its Otin river tributary with maximum width of 3.5 km. The reservoir covers about 14 km^2 at the normal water level, and about 15 km^2 at maximum water level.

Ekonde dam (7° 45' 0" N, 4° 49' 0" E) is located in Ekonde town, an agrarian community in the Ifelodun Local Government Area of Osun State, Nigeria. The dam is an earth structure, completed in 1979, with a capacity of 910,000 cubic meters. The reservoir supplies potable water to the entire Local Government. The dam provides potentials for fishery enterprise as well as tourism. The region is classified as tropical with mean annual rainfall of about 1400 mm and the rainy season covers eight months (April to November).

2.2 Data Collection

The line transect method as described by Bibby *et al*. (2000) was adopted for the survey. A total of six (three transects each at the two dams) transects were randomly placed at existing paths and the riverbank in the study area. The length of each transect varied and ranged from 800-1000 m depending on the prevalent situation in the area with a fixed width of 50 m on either side of the transect. Each transect was traversed 12 times. During each visit, transects were walked slowly and at every 200 m interval, the researcher stopped for about 10 minutes to observe bird species. The exact location of each point was recorded using a GPS (Garmin 77). Surveys were carried out during early mornings (0800-1000 h), in the afternoons (1200-1400 h) and the evenings (1600-1800 h). All birds seen or heard were recorded including those in flight. A pair of binoculars (Olympus) was used to observe birds while a voice recorder (Sony) was used to record bird calls. Calls were identified using an online database (www.xeno- canto.org/explore). Birds recorded were identified up to the species level using standard field guides to West African birds, e.g. Borrow and Demey (2008) and Odewumi and Ariyo (2018).

2.3 Species diversity indices

Species diversity was calculated using Shannon-Weiner diversity index, evenness and Simpson diversity index.
Bird abundance in the two dams was calculated using this formula

$$R = \left(\frac{n}{N}\right) * 100$$

where, R = Relative abundance
n = number of recorded bird species
N = total number of birds observed

2.4 Statistical analysis

Data obtained were analyzed by both descriptive and inferential analysis. Diversity indices were determined using the PAST (Paleontological Statistics software package for education and data analysis) statistical software (version 16). Significance in mean bird density in the two dams was determined using a t-test, while a One-Way ANOVA was used to test for significance in bird diversity indices in the six points at the two dams.

3 Results

3.1 Bird species composition and richness

A total of 67 bird species in 33 families and 12 orders were identified at Owala and Ekonde dams (Appendix 1). Owala dam had a total of 47 species belonging to 26 families and 11 orders. Ekonde dam had 34 species belonging to 24 families and 11 orders. Fourteen (14) species were common to both dams and these include Broad-billed roller (*Eurystomus glaucurus)*, Common bulbul (*Pycnonotus barbatus)*, Diederik cuckoo *(Chrysococcyx caprius)*, Green-headed sunbird (*Cyanomitra verticalis)*, Lizard buzzard (*Kaupifalco monogrammicus)*, Purple starling (*Lamprotornis purpureus)*, Red eyed dove (*Streptopelia semitorquata)*, Senegal coucal (*Centropus senegalensis)*, Spur-winged lapwing (*Vanellus spinosus)*, Tawny-flanked prinia *(Prinia subflavai)*, Village weaver (*Ploceus cucullatus)*, Grey-backed camaroptera (*Camaroptera brachyuran*), Little greenbul (*Andropadus virens*) and Yellow-fronted Tinkerbird (*Pogoniulus chrysoconus)*. Thirty-three (33) species were found only at Owala dam and 21 species were exclusive to Ekonde dam.

3.2 Bird species abundance at Owala and Ekonde dams

A total of 2152 individual birds were recorded during the present survey at Owala dam (n = 1286, 59.76%) and Ekonde dam (n = 866, 40.24%). In Owala dam, the Spur-winged Lapwing was the most abundant (n = 72, 8.31%) followed by Village Weaver (n = 38, 4.39%), while Chestnut-breasted Nigrita was the least abundant (n = 1, 0.12%). At Ekonde Dam, Black-winged Oriole was the most abundant bird (n = 204, 15.86%) followed by Common Bulbul (n = 165, 12.83%) while Great Cormorant was the least abundant (n = 2, 0.16%) (Table 1). The overall individual bird density was higher at Ekonde dam (51.44 birds/ km^2) than Owala dam (30.95 birds/ km^2). A test of homogeneity showed that there is no significant difference in bird density between the two dams (t=1.679; p= 0.097). However, at Ekonde dam Black-winged Oriole had the highest density of 8.16 birds/ km^2 while at Owala dam Spur-winged Lapwing had the highest density of 72 birds/ km^2.

Table 1: Relative abundance (RA) and bird density at Ekonde (ED) and Owala (OD) dams.

Common name	ED	OD	RA (%) ED	RA (%) OD	Density (n/ km^2) ED	Density (n/km^2) OD
African darter	0	17	0	1.96	0	0.61
African jacana	33	0	2.57	0	1.32	0
African palm swift	55	0	4.28	0	2.2	0
African thrush	0	16	0.00	1.85	0.00	0.57
Barn swallow	44	0	3.42	0	1.76	0
Bearded barbet	0	17	0	1.96	0	0.61
Black & white manikin	0	14	0	1.62	0	0.5
Black headed weaver	0	17	0	1.96	0	0.61
Black-shoulder shrike	0	8	0	0.92	0	0.29
Black-winged oriole	204	0	15.86	0	8.16	0
Blue breasted kingfisher	0	5	0.	0.58	0.00	0.18
Blue-billed malimbe	0	14	0	1.62	0.00	0.5
Blue-spotted wood dove	35	0	2.72	0	1.4	0
Broad-billed roller	34	18	2.64	2.08	1.36	0.64
Chestnut breasted nigrita	0	1	0	0.12	0.00	0.04
Collared sunbird	14	0	1.09	0	0.56	0
Common bulbul	165	15	12.83	1.73	6.6	0.54
Diederick cuckoo	9	27	0.7	3.12	0.36	0.96
Emerald cuckoo	0	23	0	2.66	0	0.82
Fork tailed drongo	0	20	0	2.31	0	0.71
Giant kingfisher	0	10	0	1.15	0	0.36
Great cormorant	2	4	0.16	0.46	0.08	0.14
Great egret	0	16	0	1.85	0	0.57
Green-backed camaroptera	0	14	0	1.62	0	0.5
Green-backed heron	0	10	0	1.15	0	0.36
Green combrec	5	0	0.39	0	0.2	0
Green turaco	28	0	2.18	0	1.12	0
Green-headed sunbird	17	8	1.32	0.92	0.68	0.29
Grey-backed camaroptera	13	0	1.01	0	0.52	0
Grey-headed nigrita	0	5	0	0.58	0	0.18
Intermediate egret	0	15	0	1.73	0	0.54
Klaas's cuckoo	0	23	0	2.66	0	0.82
Laughing dove	11	0	0.86	0	0.44	0
Lesser striped swallow	69	0	5.37	0	2.76	0
Little greenbul	19	21	1.48	2.42	0.76	0.75
Little swift	0	24	0.00	2.77	0	0.86
Lizard buzzard	55	18	4.28	2.08	2.2	0.64
Long-crested eagle	0	15	0.00	1.73	0	0.54
Malachite kingfisher	0	13	0.00	1.5	0	0.46
Orange-breasted bush shrike	0	9	0.00	1.04	0	0.32
Pied crow	29	0	2.26	0	1.16	0
Pin-tailed whydah	13	0	1.01	0	0.52	0
Purple starling	4	22	0.31	2.54	0.16	0.79
Red eyed dove	40	25	3.11	2.89	1.6	0.89
Red-headed bluebill	38	0	2.95	0	1.52	0
Red-headed malimbe	0	9	0	1.04	0	0.32
Senegal coucal	52	28	4.04	3.23	2.08	1

Table 1 continued.

Common name	ED	OD	RA (%) ED	RA (%) OD	Density (n/ km^2) ED	Density (n/km^2) OD
Senegal thick-knee	0	20	0	2.31	0	0.71
Simple leaf-love	0	17	0	1.96	0	0.61
Spur-winged lapwing	20	72	1.56	8.31	0.8	2.57
Squacco heron	0	24	0	2.77	0	0.86
Swamp palm bulbul	0	24	0	2.77	0	0.86
Tawnly-flanked prinia	32	22	2.49	2.54	1.28	0.79
Village weaver	96	38	7.47	4.39	3.84	1.36
Vinaceous dove	0	21	0	2.42	0	0.75
Western plantain eater	0	14	0	1.62	0	0.5
White-faced whistling duck	22	0	1.71	0	0.88	0
White-headed lapwing	0	31	0	3.58	0	1.11
White-throated bee-eater	0	25	0	2.89	0	0.89
Winding cisticola	27	0	2.1	0	1.08	0
Wire-tailed swallow	0	20	0	2.31	0	0.71
Woodland kingfisher	0	12	0	1.39	0	0.43
Yellow billed kite	28	0	2.18	0	1.12	0
Yellow-billed kite	34	0	2.64	0	1.36	0
Yellow-billed shrike	9	0	0.7	0	0.36	0
Yellow-fronted thinker bird	13	25	1.01	2.89	0.52	0.89
Yellow-throated longclaw	17	0	1.32	0	0.68	0
Total	1286	866	100	100	51.44	30.95

3.3 Diversity indices

Shannon-Weiner and Simpson diversity indices were higher at Ekonde Dam (3.702; 0.971) than Owala Dam (3.102; 0.935 respectively). Diversity t-test revealed that there is no significant difference in the bird species diversity of the two locations (t=1.3613; p=0.177). The bird species evenness (Shannon Wiener) was also observed to be slightly higher at Ekonde Dam (0.862; 0.654) than at Owala Dam (0.23; 0.57). In contrast, there was greater species dominance in Owala dam (0.065) than Ekonde dam (0.029) (Table 2).

Table 2: Avian diversity indices of the two dams**.**

Diversity variable	Ekonde dam	Owala dam
Individuals	1286	866
Dominance_D	0.02861	0.065
Simpson_1-D	0.9714	0.935
Shannon_H	3.702	3.102
Evenness_e^H/S	0.8622	0.654

3.4 Feeding guilds of bird species recorded at the two dams

The birds were categorized into 10 and 8 feeding guilds in Owala and Ekonde Dams respectively. However, greater proportions (n=16; 34.04%; n=11; 32.35%) of the bird species at the two dams are insectivores. The proportion of piscivores in the two dams is low (n=4; 8.51%and n=3; 8.82% at Owala and Ekonde dams respectively) (Table 3).

Table 3: Proportion of birds in different feedings guilds at the two dams.

Feeding guilds	Owala dam	Ekonde dam
Carnivores	11	5
Frugivores	5	4
Granivores	4	7
Insectivores	16	1
Insectivores/frugivores	1	0
Insectivores/granivores	1	0
Insectivores/nectarivores	1	0
Nectarivores	1	2
Omnivores	4	1
Piscivores	4	3
Scavengers	0	1

4 Discussion

Differences in resources availability between habitats such as breeding sites, roosting materials, cover, food and water restricts some species to certain types of habitat while allowing some others to be widely distributed (Ramsar convention Bureau 2000). There are diverse species of birds in the two dams, however, more bird species were recorded in Owala dam than Ekonde dam. This is in support of the findings by Giosa *et al*. (2018) who reported that on average natural wetlands have more species and support higher abundances, certain artificial wetlands have the potential to support similarly diverse communities. It is also within the range of birds recorded by Lodhi & Rao (2017) at Samoha Dam. These bird species are either wholly water dependent such as African Jacana, Grey-backed Heron, Spur-winged Lapwing, White-headed Lapwing, White-faced Whistling Duck, and Cormorants, or are partially dependent on water such as Egrets.

Furthermore, there are some bird species such as Red-eyed Dove, Vinaceous Wood Dove, Broad-billed Roller, Common Bulbul, and Village Weaver that depend on the surrounding vegetation that provide them with habitat, nesting sites and food. Payne *et al*. (1989), Green and Baker (2002), Weins (1997) and Odewumi *et al.* (2017) state that the presence of a species in a particular habitat patch is influenced not only by the size and structure of the patch but other factors such as food supply, water, habitat suitability and

climatic conditions of that patch. All the birds recorded at the two Dams were on the Least Concern category of IUCN Red List of 2017. However, there is still a need for the sustenance of the dam ecosystem for the conservation of birds around these areas.

The African Jacanas were found mostly on around shallow area of Ekonde dam during the survey. Birds such as the White-faced whistling duck were found on the vegetation on the water while Spur-winged Lapwing was found scattered on shores. The Black-winged Orioles were found in large numbers, nesting at the center of the Ekonde dam. This means that the different bird species recorded was as a result of their ability to occupy/ use different areas of the dam. This is in tandem with the statement by (Sebastián-González and Green 2014) that water depth is important because it affects habitat accessibility, while Ma *et al*. 2010, and Guadagnin & Maltchik (2007) stated that shallower wetlands tend to have more species because they are more suitable to a wider range of non-diving water birds, which cannot forage in deep waters. Hamilton *et al.* (2017) stated that different bird species will use farm dams in different ways. For some species dams may serve as important foraging sites, yet for others they might function as safe havens or permanently wet drought refuges.

Higher level of abundance, density and diversity indices recorded at Ekonde Dam can be attributed to a higher density of vegetation surrounding it with a relatively undisturbed riparian forest which serves as a roosting site as well as provide cover for birds and farming activities in the area. Fahrig *et al*. (2010), Chace and Walsh (2006), and Sandstrom *et al*. (2005) revealed that higher vegetation covers support higher diversity of birds. The shallow open water and marshy area support a variety of aquatic and semi-aquatic vegetation that provides an adequate food spectrum and good habitation for the living of the wetland birds (Arya *et al*. 2014).

The total bird densities recorded were within the density range recorded by Odewumi & Ariyo (2018). The distribution of bird species into diverse feeding guilds is an indication of the ability of the ecosystem to support birds with different niches. Odewumi and Ariyo (2018), and Okagbare and Adeyanju (2018) stated that wetlands provide birds with diverse food resources (for example, amphibians, fish and aquatic invertebrates such as snails, insects, larvae, crustaceans and aquatic annelids), refuge from predators and potential nursery sites for their chicks. This also agrees with the work of Nikunj *et al.* (2013) who indicated that difference in feeding habits and habitat structure could result in different species richness and evenness. It is also in tandem with the statement by Joshi (2012) that the abundance of avifauna indicates the healthy status of lakes owing to the availability of water, safe habitat and food sources for both adults and nestlings, and essential nesting/ roosting sites in and around the lakes are important abundance of aquatic bird populations.

5 Conclusions

This study has shown that construction of dams in the study areas has influenced on avian species composition and abundance (favouring more of terrestrial species than water birds) as well as the presence of species associated with different habitat types and feeding habits. Therefore, it is recommended that avian conservation in the two sites should be incorporated because they are both rich in diversity and abundance. Regular monitoring of the sites should be carried out to monitor the changes that might occur in the wetland environments later in the future.

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Supplementary document: s1-s3

Appendix 1. Checklist of bird species, feeding guilds and migratory status at the Ekonde and Owala dams, Osun State, Nigeria.