

## Diversity and Abundance of Avian Species of Owena Multipurpose Dam, Ondo State, Southwest, Nigeria

Odewumi OS\*, Okosodo EF and Talabi O

Ecotourism and Wildlife Management Department, Federal University of Technology, Nigeria

### Abstract

The use of wetlands and their resources is widespread among many diverse bird taxa of the world. The diversity and abundance of avian species in Owena Multipurpose dam was assessed out between January and June, 2016 to provide baseline information of the birds in this area. The line transects method with lengths ranging from 350 m-1000 m was adopted for the survey. Birds recorded were categorized into order, family, species, migratory status and feeding guild. Relative abundance of bird species and diversity indices were determined. Significance in mean bird density in the two seasons was determined using T-test while One-Way ANOVA was used to test for significance in bird diversity indices. A total of 35 bird species belonging to 20 families and 10 orders were recorded in the study area. The common species includes *Ardea alba*, *Vanellus spinosus*, *Ardea cinerea*, *Phalacrocorax carbo*, *Milvus migrans*, *Ardeola ralloides*, *Actophilornis africanus*, *Microcarbo africanus*, and *Bubulcus ibis*. All the bird species recorded were in the Least Concern (LC) category. The bird species were categorized into seven feeding guilds. The granivores, insectivores and canivores were more in abundance than the nectarivores and frugivores. The order Passeriformes had the highest families (9) and species (17), followed by Pelecaniformes and Charadriiformes with 2 families each, 4 and 2 species respectively while others had one family each. The total mean number of bird was  $428 \pm 5.75$ / observation. *Lagonosticta sanguinodorsalis* had the highest mean number (156.4/ observation) and relative abundance of 36.54% while *Ardea cinerea* and *Phalacrocorax carbo* had the lowest mean number (0.2/ observation) and relative abundance of 0.05% each. Transect 1 had the highest Shannon diversity index ( $H' = 1.664$ ), while transect 3 had the least (1.168). All the transects had similar species evenness index except for transect 4. The findings can be attributed to the heterogeneity of the habitat resulting from alteration of the ecosystem through the construction of the dam. In conclusion, the Owena dam construction has both negative and positive impacts on avian species composition and abundance. The management programme of the Owena dam should incorporate avian conservation in the area.

**Keywords:** Wetland; Dam; Avian; Density; Diversity

### Introduction

Birds have been considered as useful biological indicators because they are ecologically versatile and inhabit all kinds of habitats [1]. Wetlands are fringe habitats between terrestrial and aquatic ecosystems [2]. Many authors, notably Wilkinson, Berg, Beury, Ramsar believed that wetlands are highly important habitat for diverse fauna including mammals, birds, fishes, reptiles, amphibians, and aquatic invertebrates [2-4]. However, the importance of wetlands depend on many factors namely; wetland size, connectivity to surrounding areas, diversity of vegetation, water quality, food resources and topography [5]. According to James et al. the use of wetlands and their resources is widespread among many diverse bird taxa of the world. Birds use wetlands for breeding, nesting and teaching young, as a source of drinking water, for feeding, resting, shelter and for social interaction [6]. Wetlands provide food for birds in the form of plants, vertebrates, and invertebrates [4]. 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 [7]. Submerged vegetation can attract a higher number of migratory birds in freshwater bodies [8]. According to the relation between wetlands and birds is shaped by many factors [9]. These include the availability, depth, and quality of water; the availability of food and shelter; and the presence or absence of predators. Birds have daily and seasonal dependencies on wetlands for food and other life-support systems. Niemi stated that avian adaptations to utilize wetlands and other aquatic systems are diverse and include anatomical,

morphological, and behavioral changes [10]. James et al. stated that because numerous bird taxa depend on these critical habitats, wetlands are important components in the conservation and management of continental populations of ducks, shorebirds, and other wetland-dependent species [11].

In all the three types of wetlands (marine/coastal, inland or man-made), the most significant point of reference is water management. The water demand in Ondo State, Nigeria increased tremendously over the years rendering the facility to become grossly under-dimensioned for the intended towns and villages, a development that called for a much larger supply scheme. Consequently, the Ondo State Government in 1976, commissioned the design of the Owena River Dam with the objective of supplying raw water from the resulting reservoir for the existing water scheme, but taken over by the Federal Government of Nigeria (through Benin-Owena River Basin Development Authority) and converted it to a multipurpose use in line with the functions of the River Basin Development Authorities. The design was reviewed to include in addition to provision of potable water, usage for irrigation

**\*Corresponding author:** Odewumi OS, Ecotourism and Wildlife Management Department, Federal University of Technology, Akure, Ondo State, Nigeria, Tel: 8036710445; E-mail: [owumisunday@gmail.com](mailto:owumisunday@gmail.com)

**Received:** March 27, 2017; **Accepted:** April 19, 2017; **Published:** April 27, 2017

**Citation:** Odewumi OS, Okosodo EF, Talabi O (2017) Diversity and Abundance of Avian Species of Owena Multipurpose Dam, Ondo State, Southwest, Nigeria. J Biodivers Biopros Dev 4: 163. doi:10.4172/2376-0214.1000163

**Copyright:** © 2017 Odewumi OS, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

of 3000 hectares of farmland, fisheries, as well as generation of hydro-electric power. The dam, sited on the Owena River about 14 km upstream of the old Owena water scheme, was designed to create an impoundment of 36.25 million  $\text{cm}^3$  gross capacity, covering an area of approximately 7.38  $\text{km}^2$  at the normal water level [12].

Construction of large dams have led to the extinction of many aquatic species, the disappearance of birds in floodplains, huge losses of forest, wetland and farmland, erosion of coastal deltas, and many other immitigable impacts. Consequently, habitat loss and alteration causes the degradation of breeding sites, water level stabilization, sedimentation, nutrient inputs, invasion of exotic plants and animals [13-15]. Therefore, species' responses to habitat loss are a central issue of contemporary conservation biology [16]. This study will make comprehensive baseline information of the birds in this area for the future as well as to create awareness for their conservation in the area.

## Materials and Methods

### The study area

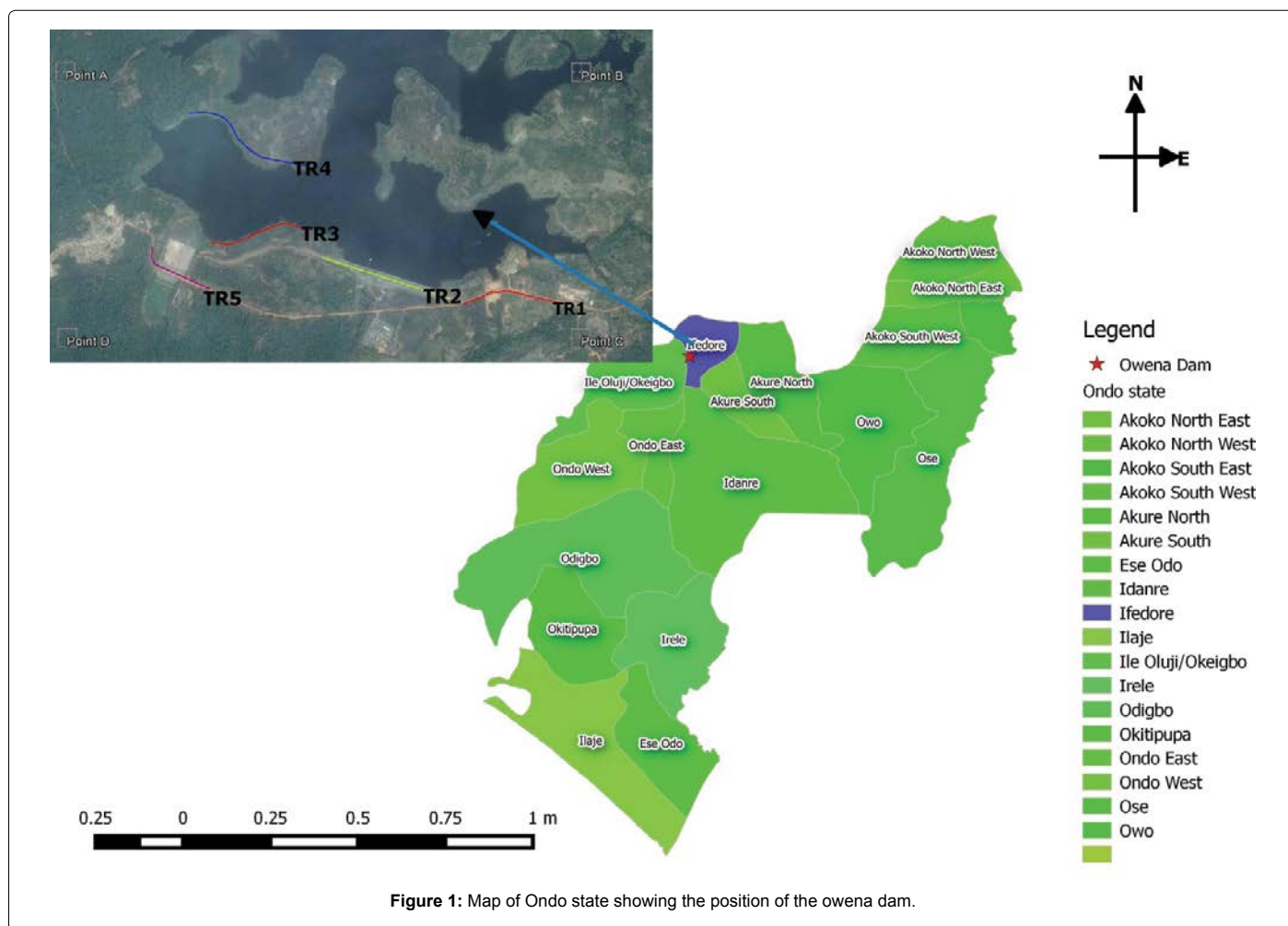
The study area The Owena Multipurpose Dam is located at Km10, off Akure-Ilesha Road, Igbara-Oke in Ifedore Local Government Area of Ondo State, Nigeria (Figure 1) between latitude 70 15' N, longitude 50 5' E and latitude 70 4' N, longitude 40 47' E in south West Nigeria. The dam is about 300 m long and 9 m in its deepest part. It covers

an area of about 790 sqkm. The dam is supplied with water from the Owena River and it covers an appropriate surface area of 7.8 sq km. Currently, the water from the dam is to feed the 60,000  $\text{m}^3/\text{day}$  capacity water treatment plant built beside the dam. Fishing activities by registered local fishermen are also presently taking place within the dam lake [12]. The annual mean temperature is 27.3°C, annual rainfall ranges from 1150 mm-2000 mm. Some common plant species in the area includes, *nymphaea alba*, *eichhornia crassipes*, *ludwigia peploidies*, *panicum rapens*, *anacardium occidentale*, *ficus capensis*, *albizia zygia*, *polygonum lanigerium* and also have different species of reptiles and amphibians.

### Data collection

The line transect method as described by Bibby et al. was adopted for the survey. A total of five transects were placed at existing paths, tracts, and the river bank in the study area [17]. The length of each transect varied and ranged from 350 m-1000 m depending on the prevalent situation in the area. The transects were visited thrice. During each visit, transect were walked slowly and at every 50 m interval the observer stop for some minutes (10 minutes) to observe bird species. Readings were taken at intervals of each point with the help of Global Positioning System (GPS).

Surveys were carried out during early mornings (7.00-10.00 hr) and the evenings (16.00-18.30 hr.). The start time and end time for each



transect was recorded. All birds observed or calls heard and recorded including those in flight were identified. A pair of binocular (Barska 8 × 32 with 8MP Digital camera) was used to aid in the identification of birds sighted while voice recorder (Sony digital voice recorder) was used to record bird calls and later played back to confirm through the call of birds downloaded. Birds recorded were categorized to species, family and order with the aid of field guide book on West African Birds by [18].

### Bird status and feeding guilds

Birds sighted during the survey were categorized based on their migratory nature as follows: Resident Migrant (RM), Resident (R), and Migrant (M) according to Teneson and Ravichandran as well as their conservation status following IUCN Red Data list of species (2016 version). The feeding guilds of the birds was categorized into Insectivores (I), Nectarivores(N), Omnivores (O), Scavengers (S), Frugivores (F), Carnivores, Piscivores (P), and Granivore (G) according to Odewumi et al. and Nikunj et al. [19,20].

### Calculations

Relative abundance (%) of bird species was calculated using the expression:

$$(n/N \times 100) \quad (1)$$

Where n=Number of recorded bird species

N=Total number of birds observed [21].

Diversity Index: Shannon-Weiner diversity index was calculated using PAST ((Paleontological statistics software package for education and data analysis) statistical software [v. 16]. The equation is given as:

$$H' = - \sum_{i=1}^s (Pi \ln Pi) \quad (2)$$

Where;

Pi=proportion of individual species

S=Total number of species of the site. (I.e. number of species sighted)

i=no of individual species.

### 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 [v. 16] [11]. Significance in mean bird density in the two seasons was determined using T-test while One-Way ANOVA was used to test for significance in bird diversity indices in the four transects.

### Results

A total of 35 bird species belonging to 20 families and 10 orders were identified and recorded in the study area. The common species in the study area includes Great egret (*Ardea alba*), Spur winged lapwing (*Vanellus spinosus*), Grey heron (*Ardea cinerea*), Great cormorant (*Phalacrocorax carbo*), Black Kite (*Milvus migrans*), Squacco heron (*Ardeola ralloides*), African jacana (*Actophilornis africanus*), Long Tailed Cormorant (*Microcarbo africanus*) and Cattle egret (*Bubulcus ibis*) as shown in Table 1. However according to IUCN 2015 status categorization all the bird species recorded were in the Least Concern (LC) category. The table also shows that bird species were categorized

into seven feeding guilds; Insectivores, Frugivores, Omnivores, Nectarivores, Granivores, Piscivores and the Carnivores. The order Passeriformes had the highest number of families (9) and species (17). This was followed by *Pelecaniformes* and *Charadriiformes* with 2 families each, (4) and (2) species respectively. The *Columbiformes*, *Coraciiformes*, *Suliformes*, *Accipitriformes*, *Cuculiformes*, *Galliformes* and *Anseriformes* had one family each as shown in Table 2.

The hirundinidae family (Figure 2) had the highest number of species (6) of the total number of bird species observed in the study area. The Ardeidae family had (4) species, *Columbidae*, and *Meropidae* families had (3) species, *Estrilidae*, *Ploicedae* and *Phalacrocoracidae* had (2) individual species, the families *Motacillidae*, *Jacaniae*, *Passeridae*, *Pycnonotidae*, *Cuculidae*, *Accipitriidae*, *Bucerotidae*, *Charadriidae*, *Viduidae*, *Corvidae*, *Nectarinidae* and *Anatidae* had one species each.

The total mean number of bird was  $428 \pm 5.75$  individuals per observation (Table 3). However Fire finches (*Lagonosticta sanguinodorsalis*) had the highest mean number (156.4 per observation) and relative abundance of 36.54% (n=782). This was followed by village weaver (*Ploceus cucullatus*) with mean number of (136.6 per observation) and relative abundance of 31.92% (n=683). In contrast, grey heron (*Ardea cinerea*) and great cormorant (*Phalacrocorax carbo*) had the lowest mean number (0.2 per observation) and relative abundance of 0.05% each.

The result of the diversity index (Table 4) revealed that transect 1 had the highest Shannon diversity index ( $H'=1.664$ ), followed by transect 5 ( $H'=1.510$ ), transect 4 had ( $H'=1.391$ ), and transect 2 had ( $H'=1.240$ ); while transect 3 had the least value ( $H'=1.168$ ). All the transects had similar species evenness index except for transect 4.

### Discussion

Wetlands are of great variety and birds' adaptation as well as usage of wetland environment varies greatly from species to species. Differences in resources availability between habitats such as breeding sites, roosting materials, cover, food and water restricts some species to certain type of habitat while allowing others to be widely distributed.

The study recorded 35 species of birds some of which are dependent on wetland such as jacana, herons, spur winged lapwing, egrets, white faced whistling duck, cormorants. Others such as weavers, finches, swallows, bee-eaters, whydahs, and mannikins are not wholly dependent on the dam. Though all the bird species recorded were under the Least Concern category of IUCN Red Data List, however, there is the need to ensure that the birds are conserved so that the local population will not decline. Bird species diversity index was low in the area but higher number of bird species and individuals were recorded in transect 1 and 5 which is located in open areas where structures such as buildings, electric poles and wires, and farmlands which have more grasses and shrub cover than in the other three transects (2, 3 and 4) along the banks of the dam. This agrees with the finding of Clergeant et al, Chale, Wash, Sandstorm et al [22-24]. that human disturbed areas provide heterogeneous habitats which attracts human tolerant bird species. Species that can co-exist with humans such as mannikins, swallows, pied crow, village weaver, common bulbul, finches etc. were recorded in the two transects.

Birds like white faced whistling duck were found on the vegetation on the water while spur winged lapwing were found at scattered shores. The grey heron recorded was found on a tree. The squacco heron were found during the survey majorly on the bare ground feeding along the mudflats on fishes and other vertebrates. However, African

S/N	COMMON NAME	ORDER	FAMILY	SCIENTIFIC NAME	FEEDING GUILD	MIGRATORY STATUS	IUCN STATUS (2015)
1	Grey heron	Pelecaniformes	Ardeidae	<i>Ardea cinerea</i>	Carnivore	Resident migrants	LC
2	Squacco heron	Pelecaniformes	Ardeidae	<i>Ardeola ralloides</i>	Carnivore	Resident migrants	LC
3	African jacana	Charadriiformes	Jacaniidae	<i>Actophilornis africanus</i>	Piscivores	Resident	LC
4	Yellow Billed Black kite	Accipitriformes	Accipitridae	<i>Milvus migrans</i>	Carnivore	Migrants	LC
5	Pied crow	Passeriformes	corvidae	<i>Corvus albus</i>	Scavenger	Resident	LC
6	Red eyed dove	Columbiformes	Columbidae	<i>Streptopelia semitorquata</i>	Granivore	Resident	LC
7	Grey headed sparrow	Passeriformes	Passeridae	<i>Passer griseus</i>	Granivore	Resident migrants	LC
8	Laughing dove	Columbiformes	Columbidae	<i>Spilopelia senegalensis</i>	Granivore	Resident	LC
9	Plain backed pipit	Passeriformes	Motacillidae	<i>Anthus leucophrys</i>	Granivore	Resident migrants	LC
10	Common bulbul	Passeriformes	Pycnonotidae	<i>Pycnonotus barbatus</i>	Insectivore	Resident	LC
11	Red chested swallow	Passeriformes	Hirundinidae	<i>Hirundo lucida</i>	Insectivore	Residentsws	LC
12	Senegal coucal	Cuculiformes	Cuculidae	<i>Centropus senegalensis</i>	Carnivore/ insectivore	Resident	LC
13	Village weaver	Passeriformes	Ploceidae	<i>Ploceus cucullatus</i>	Insectivore	Resident migrants	LC
14	Bronze Mannikin	Passeriformes	Hirundinidae	<i>Lonchura castaneothorax</i>	Granivores	Resident	LC
15	Grey Headed firefinch	Passeriformes	Estrildidae	<i>Lagonosticta sanguinodorialis</i>	Granivores	Resident migrants	LC
16	White throated bee eater	Coraciiformes	Meropidae	<i>Merops albicollis</i>	Insectivore	Resident migrants	LC
17	Double-spurred francolin	Galliformes	Phasianidae	<i>Francolinus bicalcaratus</i>	Granivores	Resident	LC
18	Great comorant	Suliformes	Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Carnivore	Local migrant	LC
19	Piping horn bill	Coraciiformes	Bucerotidae	<i>Ceratogymna fistulator</i>	Frugivores	Resident	LC
20	Cattle egret	Pelecaniformes	Aredidae	<i>Bubulcus ibis</i>	Omnivores	Resident	LC
21	White faced whistling duck	Anseriformes	Anatidae	<i>Dendrocygna viduata</i>	Piscivores	Resident migrant	LC
22	Great egret	Pelecaniformes	Aredidae	<i>Ardea alba</i>	Carnivores	Resident	LC
23	Spur winged lap wing	Charadriiformes	Charadriidae	<i>Vanellus spinosus</i>	Omnivores	Resident	LC
24	Pin tailed whydah	Passeriformes	Viduidae	<i>Vidua macroura</i>	Granivores	Resident	LC
25	Pearl breasted swallow	Passeriformes	Hirundinidae	<i>Hirundo albigularis</i>	Insectivore	Resident	LC
26	Double collared sunbird	Passeriformes	nectariniidae	<i>Cinnyris chalybeus</i>	Nectarivore	Resident migrants	LC
27	Orange cheeked waxbill	Passeriformes	Estrildidae	<i>Estrilda melpoda</i>	Granivores	Resident migrants	LC
28	Red throated bee eater	Coracciformes	meropidae	<i>Merops pusillus</i>	Insectivore	Resident	LC
29	Plain martin	Passeriformes	hirundinidae	<i>Riparia paludicola</i>	Insectivore	Resident migrants	LC
30	Blue breasted bee eater	Coracciformes	Meropidae		Insectivore	Resident	LC
31	Red rumped swallow	Passeriformes	Hirundinidae	<i>Cecropis daurica</i>	Insectivore	Resident	LC
32	Greater striped swallow	Passeriformes	Hirundinidae	<i>Cecropis abyssinica</i>	Insectivore	Resident	LC
33	Viellot's Black weaver	Passeriformes	ploceidae	<i>Ploceus nigerimus</i>	Granivores	Resident	LC
34	Blue headed wood dove	Columbiformes	Columbidae	<i>Turtur brehmeri</i>	Granivores	Resident	LC
35	Long tailed cormorant	Suliformes	Phalacrocoracidae	<i>Microcarbo africanus</i>	Carnivores	Resident	LC

Table 1: Checklist of birds recorded during the survey in Owena Multipurpose Dam.

ORDER	NO OF FAMILY	%	NO OF SPECIES	%
Pelecaniformes	2	10	4	11.43
Charadriiformes	2	10	2	5.71
Accipitriformes	1	5	1	2.86
Columbiformes	1	5	3	8.57
Passeriformes	9	45	16	45.71
Cuculiformes	1	5	1	2.86
Coraciiformes	1	5	4	11.43
Galliformes	1	5	1	2.86
Suliformes	1	5	2	5.71
Anseriformes	1	5	1	2.86
<b>TOTAL</b>	<b>20</b>	<b>100</b>	<b>35</b>	<b>100</b>

Table 2: Bird order and family relative abundance at the Owena dam.

jacanas' were found mostly around shallow area of the dam walking on floating vegetation to pick up insects and vertebrates from the floating vegetation. This can be attributed to the heterogeneity of the habitat

which is in support of what Weins stated in his research that the species composition of a specific area is inter-linked to the available resources in the area which includes physical structures of the habitat, food availability and biotic factors [25].

The granivores, insectivores and carnivores were more abundant than the nectarivores and frugivores. This is as a result of the disturbance/alteration to the ecosystem through the construction of the dam. This is in agreement with the findings of Odewumi et al. who reported that infrastructural development can lead to changes in bird species composition and abundance [19-26].

During the late dry season, the river level was extremely low and more birds were sighted especially black kite and white-faced whistling duck but in the rainy season, the water level was high and few birds were sighted. It was also observed that the population of black kite has reduced drastically as a result of their migration which may be due to them not having access to their prey. This may also be connected to reduced fishing activities in the rainy season in the area.

## Conclusion



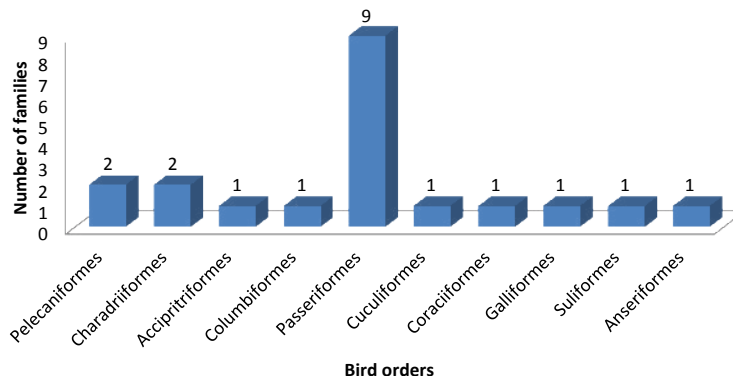


Figure 2: Frequency of occurrence of bird family in each order in the study area.

SPECIES	NO OF INDIVIDUAL	MEAN	R.A (%)	DENSITY (n/ha)
Rock fire finch	782	156.4 ± 39.34	36.54	625.6
Village weaver	683	136.6 ± 94.97	31.92	546.4
Chestnut breasted Mannikin	110	22 ± 1.25	5.14	88
White throated bee eater	87	17.4 ± 2.00	4.07	69.6
Black weaver	73	14.6 ± 3.25	3.41	58.4
White chested swallow	59	11.8 ± 5.20	2.76	47.2
White faced whistling duck	55	11 ± 4.22	2.57	44
Africa jacana	32	6.4 ± 4.36	1.50	25.6
Black kite	22	4.4 ± 1.65	1.03	17.6
Orange cheeked waxbill	22	4.4 ± 2.81	1.03	17.6
Pin tailed whydah	21	4.2 ± 2.68	0.98	16.8
Red breasted swallow	18	3.6 ± 1.25	0.84	14.4
Red high dove	17	3.4 ± 1.22	0.79	13.6
Long tailed comorant	15	3 ± 1.32	0.70	12
Common bulbul	14	2.8 ± 2.18	0.65	11.2
Red rumped swallow	12	2.4 ± 2.0	0.56	9.6
Blue breasted bee eater	11	2.2 ± 1.54	0.51	8.8
Plain backed pipit	11	2.2 ± 2.5	0.51	8.8
Great egret	11	2.2 ± 1.03	0.51	8.8
Red throated bee eater	10	2 ± 1.89	0.47	8
Laughing dove	8	1.6 ± 0.96	0.37	6.4
Senegal coucal	8	1.6 ± 0.5	0.37	6.4
Greater striped swallow	8	1.6 ± 0.43	0.37	6.4
Piping horn bill	7	1.4 ± 1.75	0.33	5.6
blue headed wood dove	6	1.2 ± 0.48	0.28	4.8
Grey headed sparrow	6	1.2 ± 0.50	0.28	4.8
Squacco heron	6	1.2 ± 1.19	0.28	4.8
Double collared sunbird	5	1 ± 0.75	0.23	4
Cattle egret	5	1 ± 1.25	0.23	4
Pied crow	5	1 ± 0.25	0.23	4
Spur winged lapwing	3	0.6 ± 0.47	0.14	2.4
Plain martin	3	0.6 ± 0.48	0.14	2.4
Double spurred francolin	3	0.6 ± 0	0.14	2.4
Grey heron	1	0.2 ± 0.25	0.05	0.8
Great cormorant	1	0.2 ± 0.25	0.05	0.8
<b>TOTAL</b>	<b>2140</b>	<b>428 ± 5.75</b>	<b>100.00</b>	<b>1712</b>

Table 3: mean number and relative abundance of bird species recorded at the Owena dam.

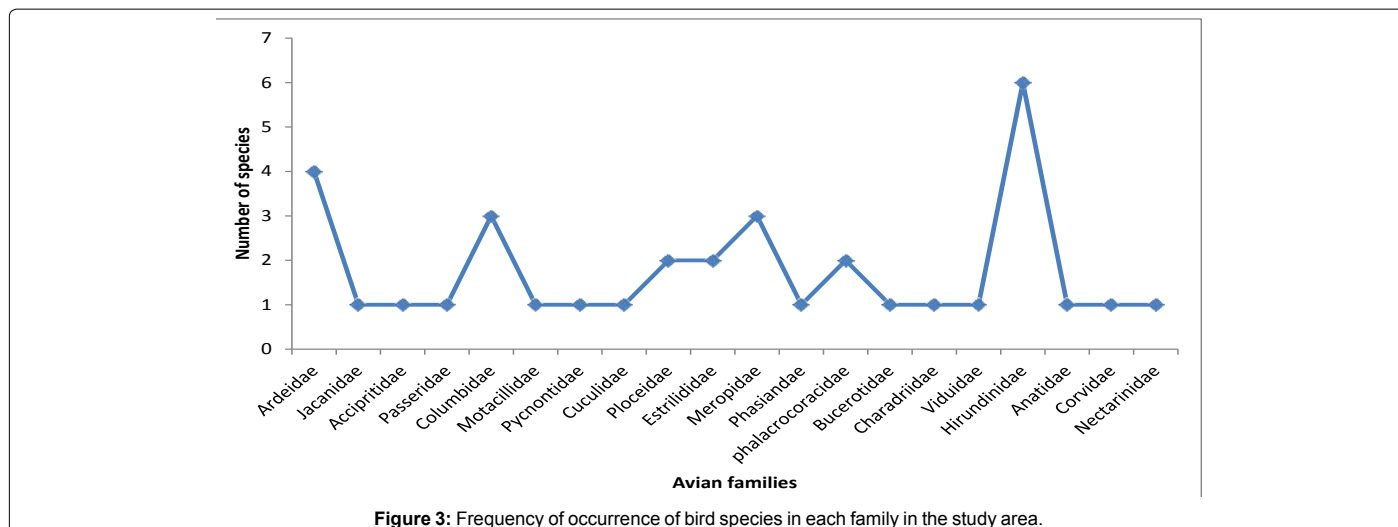


Figure 3: Frequency of occurrence of bird species in each family in the study area.

Diversity Variables	TR1	TR2	TR3	TR4	TR5
Individuals	913	215	268	85	659
Dominance_D	0.3299 <sup>c</sup>	0.5409 <sup>a</sup>	0.5635 <sup>a</sup>	0.3738 <sup>b</sup>	0.4046 <sup>b</sup>
Shannon_H	1.664 <sup>a</sup>	1.24 <sup>b</sup>	1.168 <sup>b</sup>	1.391 <sup>c</sup>	1.51 <sup>a</sup>
Evenness_e^H/S	0.24 <sup>b</sup>	0.216 <sup>b</sup>	0.2475 <sup>b</sup>	0.4018 <sup>a</sup>	0.2264 <sup>b</sup>
Equitability_J	0.5383 <sup>a</sup>	0.4473 <sup>b</sup>	0.4555 <sup>b</sup>	0.604 <sup>a</sup>	0.5041 <sup>a</sup>

Note: Values with the same superscript are not significantly different at 95% confidence limit.

Table 4: Avian species diversity index of each transect in the study area.

The finding of this study revealed that construction of dam in the study area has led to the presence of species associated with different habitat types and with different feeding habit. The vegetation along the banks of the dam provides food, nesting place and hide out for some bird species recorded in the area. It is therefore recommended that the management programme for the Owena dam should incorporate avian conservation in the area. Human activities that could be detrimental to the conservation of bird should be discouraged in the area. Regular monitoring of the sites should be carried out so as to control changes in the state of wetland ecosystem.

References

- Sivaperuman C, Jayson EA (2006) Status and conservation of bird fauna in the vemanad-Lole.
- Beury, JH, Baker DS, Huggins DG (2008) Wetlands in Three Eco regions of the Central Plains. Kansas Biological Survey Report.
- Wilkinson L, Berg G (2005) Research Amphibian Number in Alberta Provincial Summary. Alberta Species at Risk Report No 110.
- Ramsar Convention Bureau (2000) The Ramsar Handbooks for the wise use of wetlands. (4th edn) Ramsar Convention Secretariat Gland Switzerland.
- Mitsch, WJ, Gosselink JG (2000) The value of wetlands importance of scale and landscape setting. Ecological Economics 35: 25-33.
- James CS, Birkhead AL, Jordanova AA, Kotschy KA, Nicolson CR, et al. (2001) Interaction of Reeds, Hydraulics and River Morphology, Report 856/1/01, Water Research Commission, South Africa.
- Borale RP, Patil JV, Vyawahare PM (1994) Study of population of local migratory Aquatic birds observed in and around Dhule, Maharashtra. 32: 81-86.
- Sahu HK, Raut SD (2005) Checklist of water birds in Mayurbhanj District, Orissa, Zoos Print J. 20: 1992-1993.

- Robert ES (2016) Wetlands as Bird Habitat. National Water Summary on Wetland Resources Technical Aspects of Wetlands. National Biological Service.
- Niemi GJ (1985) Patterns of morphological evolution in bird genera of New World and Old World Peatland. Ecology 66: 1215-1228.
- David OH, Harper AT, Ryan PD (2001) PAST: Palaeontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica 4: 4-9
- Oyhakilome GI, Aiyesanmi AF, Akharaiyi FC (2012) Water Quality Assessment of the Owena Multi-Purpose Dam, Ondo State, Southwestern Nigeria. Journal of Environmental Protection 3: 14-25.
- Davidson NC, Rothwell P (1993) Disturbance to waterfowl on estuaries: the conservation and coastal management implications of current knowledge. Wader Study Group Bulletin 68: 97-105.
- Parish D, Lane B, Sagar PM, Tomkovich I (1987) Wader migration systems in East Asia and Australasia. In: The conservation of international flyaway populations of waders. Davidson NC, Pienkowski MW (eds). International Wader Study Group Bulletin 49. International Waterfowl Research Bureau Special Publication 7: 4-14.
- Scott DA, Poole C (1989) A status overview of Asian wetlands. Kuala Lumpur, Asian Wetland Bureau. Issue 53 of AWB Publication.
- Mikusiński G, Angelstam P (2004) Occurrence of mammals and birds with different ecological characteristics in relation to forest cover in Europe: Do macroecological data make sense? Ecological Bulletins 51: 265-275.
- Bibby CJ, Burgess ND, Hill DA (2000) Bird Census Techniques. (2nd edn). Academic Press: London. pp: 265.
- Borrow N, Demey R (2008) Birds of Western Africa. Christopher Helm: London. pp: 511.
- Odewumi OS, Hagher I, Agbelusi EA (2015) Effect of Development on Avian Diversity and Abundance in Federal University of Technology, Akure, South-west Nigeria. Applied Tropical Agriculture 20: 24-30.
- Nikunj BG, arun kumar RM, Vijay Kumar V (2013) status, distribution, and diversity of birds in mining Environment of Kachchh, Gujarat 3-10.
- Rajpar MN, Zakaria M (2013) Avian density in different habitat types at payaindah natural wetland reserve, peninsular Malaysia. J Anim Plant Sci 23: 1019-1033.
- Clergeau PJ, Savard PL, Mennechez G, Falardeau G (1998) Bird abundance and diversity along an urban rural gradient: a comparative study between two cities on different continents. The condor 100: 413-435.
- Chace JF, Walsh JJ (2006) Urban effects on native avifauna: A review. Landscape Urban Plan 74: 46-69.
- Sandstrom UG, Angelstam P, Mikusinski G (2005) Ecological diversity of birds in relation to the structure of urban green space. Landscape Urban Plan 77: 39-53.
- Weins (1997) Scientific Responsibility and Responsible Ecology. Conservation Ecology 1:16.
- Ramsar (2006) In Pro Nat Conference on Wetland Biodiversity Kerala, India. 23: 31-37.