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AVIFAUNA RICHNESS IN AQUATIC HABITATS OF THE INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE, IBADAN, NIGERIA

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ABSTRACT

Bird species offer important ecological indicator options to evaluate habitat quality. We therefore assessed avifauna richness/diversity indices and attendant effects of time of day, transect and season in three aquatic habitats within International Institute of Tropical Agriculture, Ibadan namely; John Craig reservoir, golf lake and rice paddies. Two line transects 1km each were placed on the east side of the reservoir and subdivided into 200m sections. Focal survey was used to monitor birds on the golf lake and six rice paddy plots. Both sections and focal surveys were conducted for five minutes and visited between 0700hrs to 0900hrs and 1600hrs to 1800hrs. All birds seen were identified to species with the aid of a binoculars, digital camera and Helms field guide to the birds of Western Africa. Analysis of variance and T-tests were used to determine difference in bird abundance and diversity indices (Shannon and Simpsons). A total of 48 bird species from 25 families were recorded. Bird species diversity and species richness were higher during the morning survey. The wet season had a higher bird species diversity and species richness. Dendrocygna viduata had the highest relative abundance on both reservoir (41.28%) and the golf lake (96.81%). Though 40% of species sighted in the study were observed only at the reservoir, three species were observed only at the rice paddies Rostratula benghalensi, Saxicola rubetra and Spermestes cucullatus. The reservoir had a higher bird species richness, abundance and diversity than the rice paddy and golf lake. Avitourism options abound at the site.

Key words: Avifauna, John Craig reservoir, Rice paddies, species richness, International Institute of Tropical Agriculture.

INTRODUCTION

The presence of diverse bird populations capable of sustainable reproduction is one of the best indications of a healthy environment (Kress, 2000). Birds are often used as a biological model because they are good ecological indicators and conspicuous (Clergeau *et al*., 2001). 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 (WCMC, 1992; 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 (Croonquist and Brooks, 1991; WRI, 1996; Canterbury *et al*., 2000; Sekercioglu, 2006; Surya and Manasvini, 2013). This method is gaining widespread use as strategy to measure baseline patterns of diversity, and gauge the effectiveness of management practices (Rosenstock *et al*., 2002).

Composition and long-term persistence of many bird populations depends upon precise habitat requirements, abundance and dispersal strategies by individual species. A species presence 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 (Green and Baker, 2002).

Birds are integral part of the ecosystem and they can be indicators of habitat quality. Diversity of avifauna is one of the most important ecological

indicators to evaluate the quality of habitats. Presently wildlife species including birds are in crisis all over the world due to the destruction of natural habitats and human disturbances (WCMC, 2002; Green and Baker, 2002; Manu *et al*., 2007). Wanton destruction of natural habitats by felling nesting trees and foraging plants for commercial use of woods and lands are the main factors responsible for decreases in availability of optimum areas which serve as avian foraging habitat, nesting sites, as well as their abundance and diversity (WCMC, 2002; Green and Baker, 2002; Manu *et al*., 2007).

The IITA Ibadan campus is among the 27 Important Bird Areas in Nigeria and known to hold at least 269 bird species in 64 families (Adeyanju *et al*., 2014). More importantly, wildbirds at the reservoir provide services for the community such as biological control and aesthetics (Millenium Ecosystem Assessment, 2003). These services among others showcase that wildlife habitat such as the John Craig reservoir in this study should be given concern when management actions are required. Therefore, monitoring of bird species is required from time to time, and this provides information on changing distribution and abundance that enable sustainable utilization of our environment (Adeyanju and Kambai, 2016). Hence this study is necessary to provide useful information on the bird species richness in aquatic habitats of IITA for sustainable management. This study assessed diversity and attendant effects of time of day and season in aquatic habitats of the International Institute of Tropical Agriculture, Ibadan.

MATERIALS AND METHODS

Study Area

The International Institute of Tropical Agriculture Ibadan campus acquired for agricultural research in 1967, covers about 1000ha and it is one of the world's leading research partners in finding solutions to hunger, malnutrition and poverty (Figure 1; Adeyanju *et al*., 2012). It lies on latitude 7° 30'N and longitude 3° 55'E and according to Ezealor (2002), the area resembles mature Guinea-Congo lowland rainforest with scattered emergence of trees. The site falls within humid tropical lowland region with two distinct seasons. The wet season last for eight months and it extends from March to October while the dry season last for four months from November to February. The area was formerly a secondary forest with villages, farmland and bush until its acquisition for agricultural research work.

Avifauna Census Techniques

Two line transects 1km each subdivided into 200m sections were placed on the east side of the John Craig reservoir (largest of the lakes; Figure 1). Focal survey was used to monitor birds on the golf lake and rice paddy. Bird survey along sections and within focal points were conducted for five minutes to control/standardize effort. All birds seen were identified to species with the aid of a binoculars, digital camera and Helms Field guide to the birds of Western Africa (Borrow and Demey, 2001). Each section and focal point was visited twice a week between 0700hrs to 0900hrs and 1600hrs to 1800hrs. Variables taken during the survey included bird species present and abundance.

Data Analysis

i. Bird species diversity was calculated using both Simpson diversity index (Simpson, 1949) and Shannon-Wiener diversity index (Shannon and Weaver, 1948).

Simpson diversity index is expressed as:

$$D = \frac{\sum_{i=1}^{q} ni(ni-1)}{N(N-1)}$$

Where:

N= total number of individuals encountered

Ni = number of individuals of ith species enumerated for

i=1……q

q = number of different species enumerated.

Shannon-Wiener diversity index is expressed as:

$$H = -\sum_{i=1}^{s} pi \ln pi$$

Where:

pi = the proportion of individuals in the ith species

s = the total number of species

ln = natural logarithm

i = i^{th} species

ii. Relative abundance was measured for bird species using the formula below:

$$SRA = SA/TA\,x100$$

Where:

SRA = Species Relative abundance

SA = Species Abundance

TA = Total Abundance

Data was analyzed using descriptive statistics, analysis of variance (ANOVA), t-test and duncan multiple range test. Software packages used include Microsoft excel, Statistical Package for

the Social Sciences (SPSS) version16 and Palaentological Statistics (PAST) version 3.

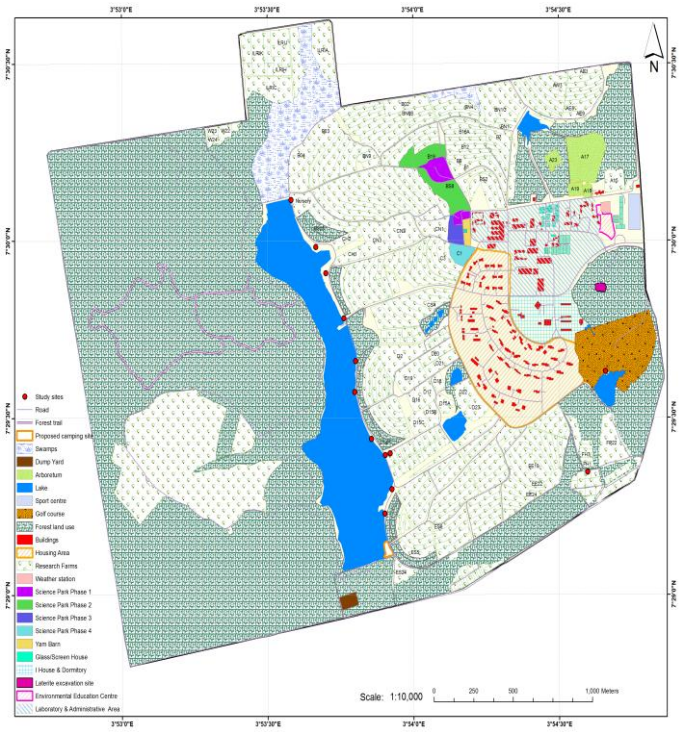

Figure 1: Map of the International Institute of Tropical Agriculture, Ibadan
Source: Geographic Information System (GIS) Unit 2016, International Institute of Tropical Agriculture, Ibadan.

RESULTS

Bird Species Composition

A total of 48 bird species from 25 families were recorded during the study between January and June, 2016 (Table 1). Forty three bird species were seen at the John Craig reservoir making it the site with the highest species richness, followed by the rice paddies with 21 bird species and 8 bird species were seen at the golf lake, making it the site with the least number of bird species.

Effect of Time of Day and Season on Bird Species Diversity and Species Richness

Bird species diversity was higher during morning period as compared to evening as shown in Figure 1. Likewise bird species richness was higher during the morning survey than the evening (Figure 2). The wet season had higher bird species diversity and species richness compared to the dry season as shown in Figures 3 and 4 respectively.

Effect of Transect on Bird Species Richness and Abundance

T-test showed that the two transects significantly differ in bird species mean abundance ($T=2.703$, $P<0.05$; Table 2), with the bird species abundance in transect 1 higher than that of transect 2.

Effect of site on bird species abundance, species richness and diversity.

The reservoir had lower bird species abundance than the golf lake (Table 3). T-test showed that the two habitats significantly differ in their mean abundance values ($T=6.353$, $P<0.05$; Table 3). White-faced Whistling Duck (*Dendrocygna viduata*) had the highest relative abundance on both the reservoir (41.28%; Table 1) and the golf lake (96.81%; Table 1). However, the reservoir had a higher bird species richness and diversity than the rice paddies and golf lake (Table 6). Eight species had an abundance index above 1.0 in either of the sites and these included: *Ardeola ralloides, Egretta intermedia, Dendrocygna viduata, Actophilornis africanus, Burhinus senegalensis, Vanellus albiceps, Vanellus spinosus, and Ploceus cucullatus* (Table 1). Species only sighted at the rice paddies included *Rostratula benghalensi, Saxicola rubetra a Spermestes cucullatus*.

Table 1: Bird species Abundance index at the International Institute of Tropical Agriculture

Species	Common name	Family	John Craig Reservoir	Golf	Rice Paddies

Phalacrocorax africanus	Long-tailed Cormorant	Phalacrocoracidae	0.4	0.09	X
Nycticorax nycticorax	Black-crowned Night Heron	Ardeidae	0.21	0.04	X
**Ardeola ralloides*	**Squacco Heron**	Ardeidae	**6.56**	X	✓
Bubulcus ibis	Cattle Egret	Ardeidae	0.25	X	✓
Butorides striata	Green-backed Heron	**Ardeidae**	0.01	X	X
Egretta gularis	Western Reef Heron	**Ardeidae**	0.06	X	X
Egretta garzetta	Little Egret	Ardeidae	0.32	X	✓
**Egretta intermedia*	**Intermediate Egret**	Ardeidae	**2.63**	X	✓
Egretta alba	Great Egret	Ardeidae	0.31	X	✓
Ardea purpurea	Purple Heron	**Ardeidae**	0.33	X	X
Ardea cinerea	Grey Heron	Ardeidae	**0.25**	**0.09**	✓
Ardea melanocephala	Black-headed Heron	**Ardeidae**	0.01	X	X
Bostrychia hagedash	Hadada Ibis	Threskiornithidae	0.36	X	✓
***Dendrocygna viduata*	**White-faced Whistling Duck**	Anatidae	**41.28**	**96.81**	X
Milvus migrans	Yellow-billed Kite	Accipitridae	0.39	X	✓
Accipiter badius	Shikra	**Accipitridae**	0.01	X	X
Falco tinnunculus	Common Kestrel	**Falconidae**	0.01	X	X
Falco ardosiaceus	Grey Kestrel	**Falconidae**	0.04	X	X
Amaurornis flavirostra	Black Crake	Rallidae	0.15	X	✓
Porphyrio alleni	Allen's Gallinule	**Rallidae**	0.06	X	X
Gallinula chloropus	Common Moorhen	Rallidae	0.03	X	✓
***Actophilornis africanus*	**African Jacana**	Jacanidae	**17.82**	X	✓
#Rostratula benghalensis	Greater Painted-snipe	Rostratulidae	X	X	✓
**Burhinus senegalensis*	**Senegal Thick-knee**	**Burhinidae**	**6.87**	X	X
Charadrius forbesi	Forbes's Plover	**Charadriidae**	0.11	X	X
***Vanellus albiceps*	**White-headed Lapwing**	Charadriidae	**1.27**	**2.68**	X
***Vanellus spinosus*	**Spur-winged Lapwing**	Charadriidae	**13.81**	X	✓
Tringa glareola	Wood Sandpiper	Scolopacidae	0.18	X	✓
Actitis hypoleucos	Common Sandpiper	Scolopacidae	0.5	X	✓
Columba guinea	Speckled Pigeon	Columbidae	0.26	X	✓
Streptopelia semitorquata	Red-eyed Dove	**Columbidae**	0.43	X	X
Halcyon senegalensis	Woodland Kingfisher	**Alcedinidae**	0.24	X	X
Alcedo cristata	Malachite Kingfisher	**Alcedinidae**	0.01	X	X
Tockus fasciatus	African Pied Hornbill	**Bucerotidae**	0.04	X	X
Tockus nasutus	African Grey Hornbill	**Bucerotidae**	0.07	X	X
Crinifer piscator	Western Grey Plantain-eater	Musophagidae	X	0.04	X
Riparia paludicola	Plain Martin	Hirundinidae	X	0.22	X
Anthus leucophrys	Plain-backed Pipit	Motacillidae	0.03	X	✓
Macronyx croceus	Yellow-throated Longclaw	Motacillidae	0.01	X	✓
Pycnonotus barbatus	Common Bulbul	**Pycnonotidae**	0.06	X	X
#Saxicola rubetra	Whinchat	Turdidae	X	X	✓
Turdus pelios	African Thrush	**Turdidae**	0.01	X	X
Corvinella corvine	Yellow-billed Shrike	**Laniidae**	0.01	X	X
Corvus albus	Pied Crow	Corvidae	0.31	0.04	X
Ploceus nigerrimus	Vieillot's Black Weaver	**Ploceidae**	0.03	X	X
***Ploceus cucullatus*	**Village Weavers**	Ploceidae	4.22	X	✓
#Spermestes cucullatus	Bronze Mannikin	Estrildidae	X	X	✓
Vidua macroura	Pin-tailed Whydah	Viduidae	0.01	X	X
Total		**25**	**43**	**8**	**21**

note: Bird species with index above 1 have their common names bolded. Species only sighted at the rice paddies have their scientific names bolded. species sighted only at the John Craig reservoir have family name bolded

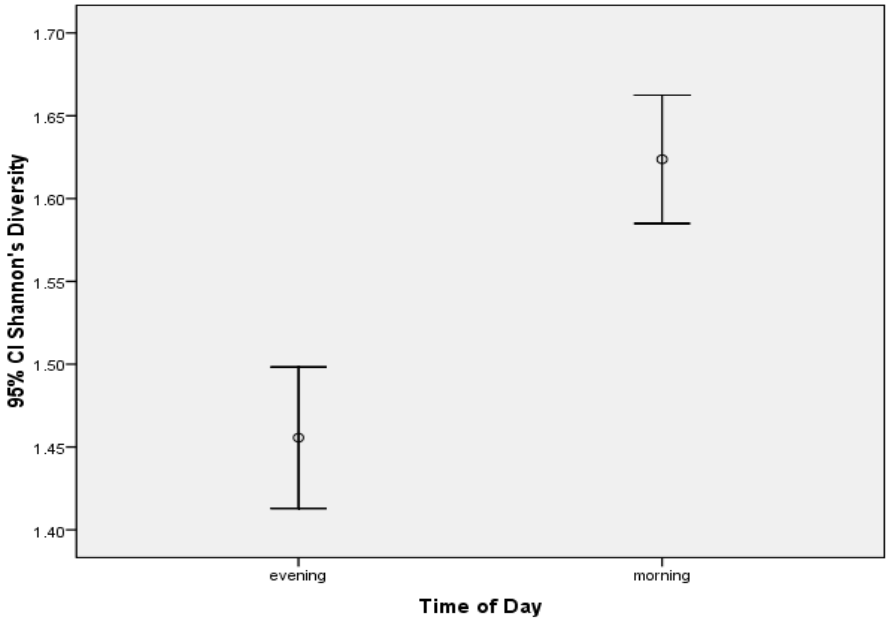

Figure 1: Effect of time of day on bird species diversity

Table 2: T-test showing the effect of transect on bird species mean abundance

				T-test for Equality of Means		
	Transect	**N**	**Mean**	**T**	**Df**	**Sig.**
Abundance	1.00	325	13.2492	2.703	662	.007*
	2.00	339	8.4720			

* = significant at 5% probability level

Table 3: T-test showing the effect of habitat on bird species mean abundance

				T-test for Equality of Means		
	Habitat	**N**	**Mean**	**T**	**Df**	**Sig.**
Abundance	Reservoir	664	10.8102	6.353	722	.000*
	Golf lake	60	38.6167			

*= significant at 5% probability level

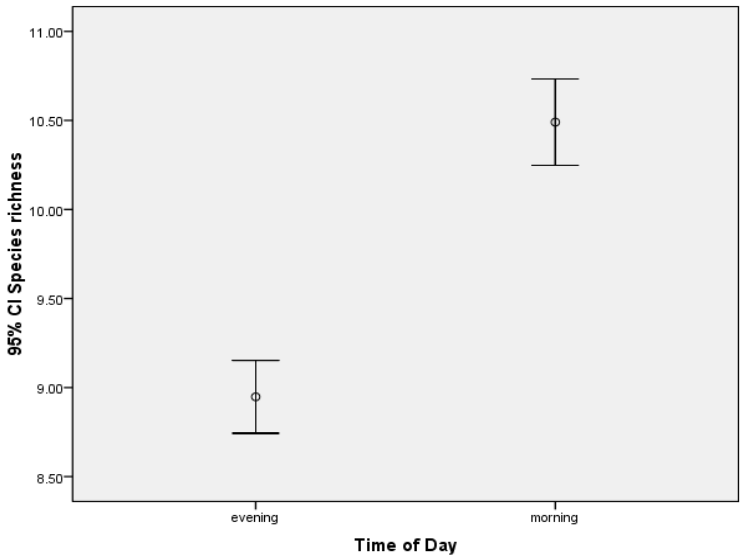

Figure 2: Effect of time of day on bird species richness

Table 6: Diversity of bird species between the reservoir and golf lake

	Reservoir			Golf lake		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
Taxa_S	43	42	43	8	8	8
Individuals	7178	7178	7178	2317	2317	2317
Dominance_D	0.23	0.23	0.24	0.94	0.92	0.95
Simpson_1-D	0.77	0.76	0.77	0.06	0.05	0.08
Shannon_H	1.93	1.9	1.96	0.16	0.14	0.2
Evenness_e^H/S	0.16	0.16	0.17	0.15	0.14	0.15

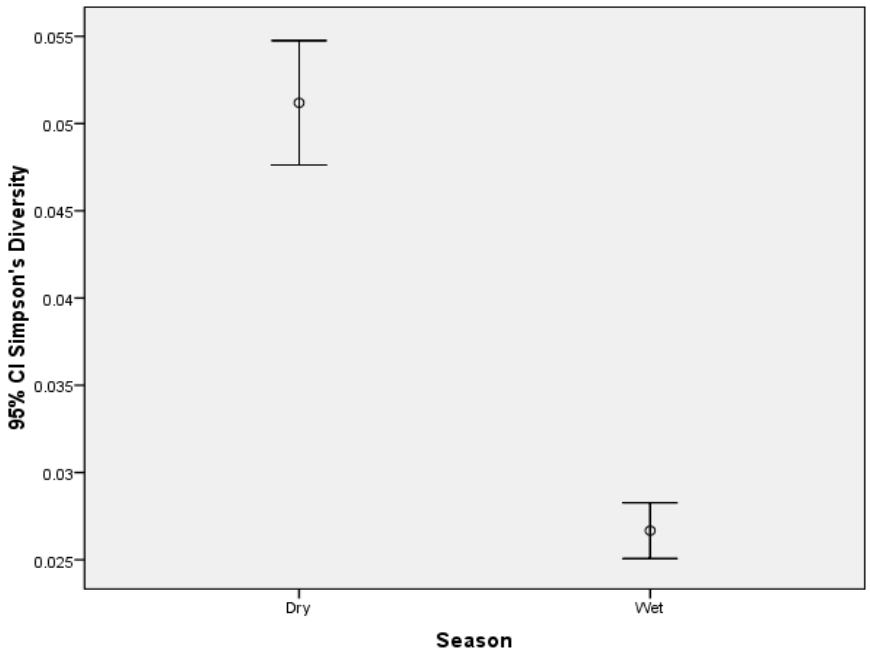

Figure 3: Effect of season on bird species diversity

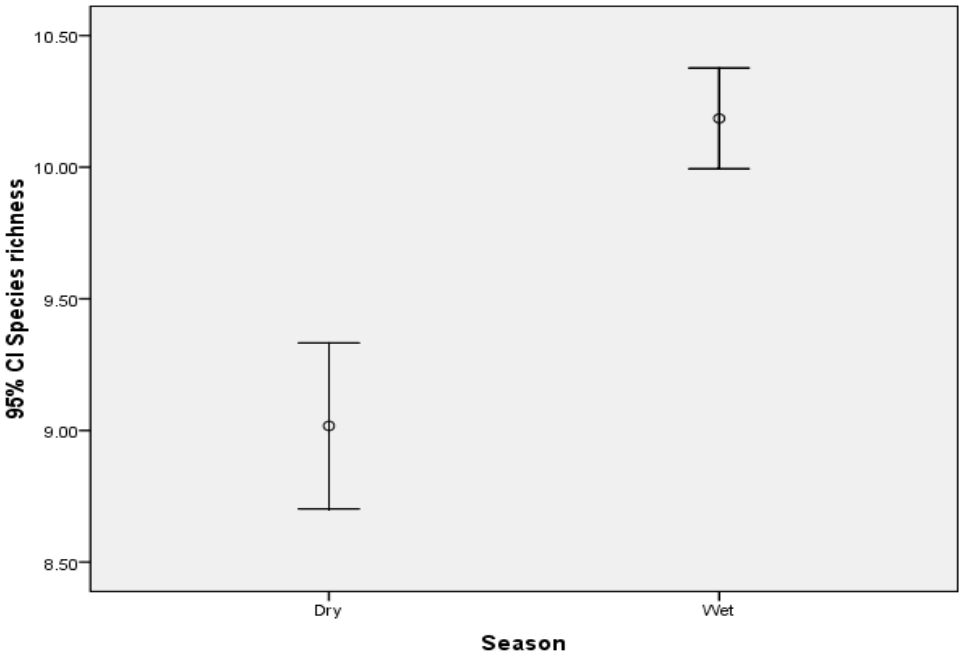

Figure 4: Effect of season on bird species richness

DISCUSSION

Time of Day and Season on Bird Species Diversity and Species Richness

Bird species richness and diversity were higher in the morning than in the evening. This is because bird species activity falls with increase in hour of day (Adeyanju *et al*., 2009; Manu *et al*., 2007). One of the most active feeding times for bird species is early in the morning as the sun rises, making it mandatory to refuel after a long night. As the temperature rises however, bird species activity reduces due to higher rate of transpiration and most birds would not risk high energy demand of the sunny hours.

Dry season results in a period of relatively lower food availability for some feeding guilds and this is a factor that possibly limits bird species richness and diversity. At IITA irrigation is practiced at the rice paddies, making food and water available throughout the year artificially. Waterbirds have reportedly used the availability of water as proximate cues to assist in their broad scale selection of habitat preference (Kushland, 1987; Austin, 2002). The increase bird species richness and diversity in the wet season and at the rice paddies compared to the golf lake could be attributed to the variation of food types available, presence of denser vegetation (serving as secured nesting sites and escape sites from predators) and stable hydrological period (Mengesha and Bekele, 2008).

Bird Species Richness and Abundance in Relation to Transects

Bird species abundance in transect 1 was higher than transect 2 because most of the bird species in transect 1 were seen mostly in congregations and this contributed to its high mean abundance. However transect 2 had a higher bird species richness than transect 1 and this could be supported by the availability of food and cover (habitat structure). This agrees with the work of Smith (1992) who indicated that difference in feeding habits and habitat structure could result in different species richness and evenness. We therefore recommend transect 2 for birders and avitourists because of the high bird species richness encountered in transect 2 during this study (Adeyanju and Kambai, 2016).

Bird Species Abundance, Species Richness and Diversity in Relation to Site

The difference in the total abundance of birds recorded between the reservoir and the golf lake could be attributed to the availability of food, size differences of aquatic habitats, habitat condition and roosting nature of the bird species on the reservoir. However, White-faced whistling duck had a higher relative abundance (96.81%) on the golf lake than that of the reservoir (41.28%) and this contributed to the high mean abundance of bird species on the golf lake.

The reservoir is larger than the golf lake in size and it is closer to the forest and farmlands. This must have contributed to its higher bird species richness and diversity than the golf lake because some forest and farmland bird species were sighted alongside waterbirds on the transects. The reservoir has avenue trees planted along it, with the presence of emergent vegetation (water lilies) on it unlike the golf lake. Thus the difference in the vegetation structure between the reservoir and golf lake could also have contributed to the reservoir having a higher bird species richness and diversity than the golf lake as seen in Erdelen (1984), who reported that the diversity of bird species is significantly correlated with the vegetation structure. The emergent vegetation is an important habitat for Moorhens, Crakes and Herons. These waterbird species used the emergent vegetation for different purposes such as hunting, perching and escape cover. The Moorhens and Crakes were observed using the dense stands of emergent vegetation. This was because the dense emergent vegetation provided a hiding cover from predator's visual detection (Surdick, 1998). Apparently, the Herons and Egrets also selected the emergent vegetation with shallow water for their foraging activity because they have long bills that enables them to strike prey while wading in shallow water (Katzir *et al*., 1999) and capturing their prey by performing direct head movement (Lotem *et al*., 1991).

The Spur-winged Lapwings and Jacanas were observed only on the reservoir and this might be due to diverse food resources occurring in emergent vegetation (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. Terrestrial birds such as Kites and Crows were observed both on the trees along the reservoir. This might be because the trees attracted diverse insects and provided suitable foraging surfaces, shelter and nesting sites for the bird species, and the grasses provided a variety of seeds that attracted insects, whereby the seeds and

insects were the main sources of energy for these bird species.

CONCLUSION

Bird species richness and diversity were higher in the morning than in the evening because bird species activity falls with increase in hour of day. Also the wet season had a higher bird species richness and diversity than the dry season of which the abundances of food types, presence of dense vegetation (serving as secured nesting sites) and stable hydrological period during the wet season could be responsible.

The size of the reservoir, its closeness to the forest and farmlands and the difference in the vegetation structure between the reservoir and the golf lake could have influenced the reservoir having a higher bird species richness and diversity than the golf lake.

Recommendation

Further studies should be carried out at least every five years to update status and distribution of wildbirds in the study area.

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