Composition and Diversity of Birds: A Comparative Study between Two Wetlands

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Abstract

Wetlands play a vital role in bird conservation and support diverse biological diversity. They are among the most productive ecosystems on Earth. For years, bird community evaluation has been used in biodiversity conservation, monitoring or identifying areas for conservation actions. Here, we examined and compared bird species composition, diversity and richness in Warwade and Kafin Gana Wetlands. Point count method was employed during the study. Overall, 56 species belonging to 32 families were recorded. The two Wetlands are similar in their species composition by 45%. Kafin Gana had higher species diversity (H` = 3.1) than Warwade (H` = 2.9), but the difference was not significant (t = 1.68, df = 402, p>0.0931). Bird species richness in Kafin Gana and Warwade were 44 and 31 species respectively. Relative abundance of birds ranges from 0.24 to 10.78. Seven feeding guilds were categorized in both Wetlands with most species (21) observed to be insectivores, while frugivores, nectivores and piscivores had least representation with one species each. The study shows that the Wetlands (especially Kafin Gana) are rich in bird diversity, including migratory birds. There is need for proper use of the Wetlands resources, especially fishing in order to minimize any disturbances that could negatively affect bird activities.

Keywords: Foraging Guild, Relative Abundance, Species Richness, Kafin Gana, Warwade

INTRODUCTION

Birds are the most studied taxa of all animal species (Gill, 2007). They are easily identified, highly mobile, diverse, and are found in all habitat types (Sinclair, 2004) including wetlands, which are among the most biologically diverse and productive of all ecosystems (Secretariat of the Ramsar Convention, 2013). Wetlands serve as home to a wide range of plant and animal life. Birds, waterfowl in particular, depend on wetlands for nesting, breeding, feeding, moulting and roosting (Kumar and Gupta, 2009). Wetlands not only provide refuge for resident bird species, but also serve as an important overwintering and staging ground for migratory bird species. Wetlands are extremely diverse in nature, depending on their method of formation, geographical location and altitude. However, the primary factor that distinguishes wetlands from other land forms or water bodies is the characteristic of the aquatic vegetation (Butler *et al.* 2010). Wetlands are important in water storage, water filtration and recycling, protection against storm and erosion, carbon sink, enrich soil fertility and provision of medicinal plants among others.

With increased wetland loss as a result of human activities in recent decades, e.g. agriculture, invasion of exotic species, etc. (McCauley *et al.* 2013), government, non-governmental organizations and policy makers embarked on the conservation of wetlands, especially as waterfowl habitat when the Ramsar Convention was adopted in 1971 (Griffin, 2012). To date, there are over 2, 000 Ramsar sites and 10, 000 IBAs worldwide (Secretariat of the Ramsar Convention, 2018). In Nigeria, there are 11 Ramsar sites, four EBAs (Endemic Bird Areas) and 27 IBAs (Important Bird Areas) (BirdLife International, 2018a). Despite these efforts, as

well as the immense value of wetlands, unfortunately their loss continue at an alarming rate, especially in developing countries. Thus, wetlands are viewed as one of the most threatened ecosystems on Earth (Zedler and Kercher, 2005), and many countries have already lost extensive areas of their wetlands.

Water resource development and the draining of wetlands are among the major factors leading to their destruction (Lemly *et al.* 2000), although urbanization has also been significant. Other factors include growing human population, which increased demand on wetland resources (Nicholls, 2004). In riverine areas, chemicals from agricultural runoff have severely polluted wetland habitats (International Union of Conservation of Nature, 1999). Furthermore, Johnson *et al*. (2005) has shown that climate change will result in the shift and decline of wetlands and increased temperature would result in decreased water levels and increased vegetation cover. In particular, salt marshes will be affected the most, through sea-level rise, particularly when sea walls prevent marsh vegetation from moving upward and inland (Johnson *et al*. 2005).

The aforementioned threats have detrimental impacts on bird community composition, structure and diversity (Ringim and Harry, 2017). The failure to understand the consequences of changes in these natural habitats on wetland biodiversity, including birds is likely to increase the human impacts on wetland natural resources (Brown and Aebischer, 2005). Bird community evaluation has become an important tool in biodiversity conservation, monitoring and for identifying conservation actions, since birds are widely used as bioindicators. Bird community have been studied well in different wetland habitats both in temperate and tropical regions (e.g. Ntongani and Andrew, 2013). In Nigeria, data on bird composition and diversity in different wetland habitats is scanty. Understanding this is essential to delineate the importance of local avian assemblages. In this paper, we provide data on the bird species composition, diversity, richness, and relative abundance in Warwade and Kafin Gana wetlands. It was hypothesized that bird species composition, diversity, richness, and relative abundance differs among Warwade and Kafin Gana wetlands.

MATERIALS AND METHOD

Sites description

The study was conducted in Kafin Gana (11º 31' 19.3N/9º 21 05.8E) and Warwade wetlands (11º 45' 06.1N/9º 13' 03.6E). The former is located in Bauchi State, while the latter in Jigawa State. The two wetlands are located 43 kilometres apart (Figure 1). Warwade is larger than Kafin Gana and thus, harbor considerable number of fishermen fishing mainly with boats, unlike in Kafin Gana where Calabash (*gora,* in its local name) are used as fishing gears. All the areas are under agricultural practises. The vegetation of both Wetlands are under Sudan savannah and experience two distinct seasons: wet season from June to September, and dry season from October to May. Total annual rainfall received in the area range between 600-1000 mm per year and mean annual temperature of 26ºC (Muhammad *et al.*, 2018).

Warwade wetland is a man-made wetland created since in the 1970s and support diverse vegetation of plant species including shrubs, herbs, and trees. Some important plant species are Neem (*Azadirachta indica*), Date palm (*Phoenix dactylifera*), Giant sensitive tree (*Mimosa asperata*), while shrubs include Kharroub (*Piliostigma reticulum*), Kapok tree (*Calotropis procera*), and grass species: Coco grass (*Cyperus rotundus*), Sicklepod (*Cassia tora*) and Cane grass (*Eragrostis tremula*). On the other hand, dominant plant species in Kafin Gana include *A. indica,* Tasmanian oak (*Eucalyptus camaldulensis*), shrubs and submerged vegetation of Water Lily (*Nymphae lotus*).

Bird survey

We conducted bird surveys in June and July 2018, at 30-point count stations (15 each in Kafin Gana and Warwade wetlands). The timing of field visits was between 06:00 to 10:00 hr when birds were more active. Point count method described by Bibby *et al.* (2000) was used to survey birds. Birds seen or heard were recorded within a radius of 100 m using binocular (Nikon Monarch 3, 10 x 8 m). At each point count station, we observed birds for 5 minutes. Point count stations were spaced 100 m apart to avoid multiple counting, and this was measured using GPS (Garmin 76 CSx). The nomenclature for bird species follows Borrow and Demey (2014).

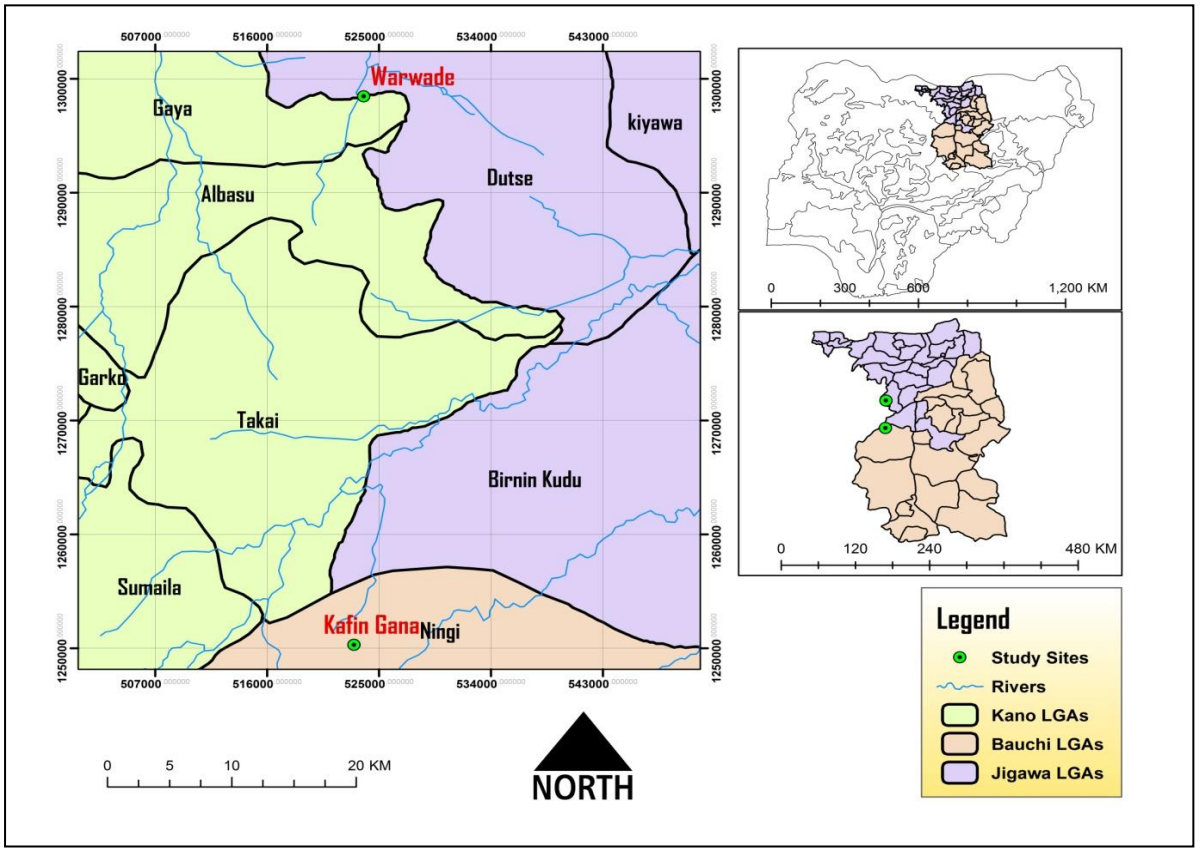

Figure 1: Location of Kafin Gana and Warwade wetlands

Statistical analyses

Bird diversity was determined using Shannon-Weiner diversity index. To minimize the effect of multiple counts, the average number of birds counted was taken for each site and for each bird species after the two months data was collected. Diversity *t*-test was used to compare bird species diversity between the two-wetland areas. The level of significance was set at $p < 0.05$. Sorensen's similarity index was used to measure the extent of similarity between the two sites (Magurran, 2004) as follows:

$$Cs = 2c/a + b$$

Where *Cs* is the SØrensen's index of similarity, *a* is the number of species in the Kafin Gana, *b* is the number of species in the Warwade, and *c* is the number of species common to both areas. Species richness for each site was determined by counting the number of bird species recorded from each wetland area. Relative abundance of bird species was calculated according to Rais *et al.* (2013), using the formula below;

$$\text{Relative abundance} = \frac{\text{Abundance of a bird species}}{\text{Total abundance of all bird species}} \text{ x } 100$$

Paleontological statistical package (PAST version 2.17, Hammer *et al.* 2001) was used for the analyses.

RESULTS

In total, 56 species belonging to 32 families were recorded (Table 1). The Sorenson's similarity index shows that the two-wetland areas are similar in species composition by 45%. Kafin Gana had higher species diversity (H' = 3.1) than Warwade (H' = 2.9), and the difference was not significant (t = 1.68, df = 402, p > 0.0931). Relative abundance of bird species ranges from 0.24 to 10.78 (Table 1). Bird species richness in Kafin Gana was 44 species, while 31 species were recorded in Warwade (Table 2).

Table 1: List of bird species recorded in Kafin Gana and Warwade wetlands

Family	Species	Scientific name	Relative abundance	Foraging guild	Habit
Accipitridae	Black-shouldered Kite	*Elanus caeruleus*	0.49	C	WG
Accipitridae	Shikra	*Accipiter badius*	0.24	C	WG
Alaudidae	Crested Lark	*Galerida cristata*	1.47	G	WG
Alcedinidae	Pied Kingfisher	*Ceryle rudis*	1.22	P	WS
Anatidae	White-face Whistling Duck	*Dendrocygna viduata*	5.14	G	WS
Apodidae	African Palm Swift	*Cypsiurus parvus*	1.71	G	WG
Ardeidae	Black Heron	*Egretta ardesiaca*	1	O	WS
Ardeidae	Cattle Egret	*Bubulcus ibis*	8.57	I	WG
Ardeidae	Dwarf Bittern	*Ixobrychus sturmii*	0.49	I	WS
Ardeidae	Great Egret	*Ardea alba*	0.49	I	WS
Ardeidae	Green-backed Heron	*Butorides striata*	0.49	I	WG
Ardeidae	Grey Heron	*Ardea cinerea*	0.73	O	WS
Ardeidae	Little Egret	*Egretta garzetta*	1.22	O	WG
Ardeidae	Squacco Heron	*Ardeola ralloides*	0.98	I	WS
Bucerotidae	Northern Red-billed Hornbill	*Tockus erythrorhynchus*	0.73	I	WG
Burhinidae	Senegal thick-Knee	*Burhinus senegalensis*	0.24	O	WS
Charadriidae	Spur-winged Lapwing	*Vanellus spinosus*	1.96	I	WS
Cisticolidae	Rufous Cisticola	*Cisticola rufus*	0.24	I	WG
Cisticolidae	Tawny-flanked Prinia	*Prinia subflava*	1.71	I	WG
Cisticolidae	Winding Cisticola	*Cisticola galactotes*	0.24	I	WG
Cisticolidae	Zitting Cisticola	*Cisticola juncidis*	1.22	I	WG
Columbidae	African Mourning Dove	*Streptopelia decipiens*	0.24	G	WG
Columbidae	Laughing Dove	*Streptopelia senegalensis*	2.69	G	WG
Columbidae	Speckled Pigeon	*Columba guinea*	8.08	O	WG
Columbidae	Vinaceous Dove	*Streptopelia vinacea*	1.47	G	WG

Coraciidae	Abyssinian Roller	*Coracias abyssinicus*	0.49	I	WG
Cuculidae	African Cuckoo	*Cuculus galaris*	0.24	I	WG
Cuculidae	Senegal Coucal	*Centropus senegalensis*	1.96	O	WG
Estrildidae	Red-billed Firefinch	*Lagonosticta senegala*	0.73	G	WG
Estrildidae	Zebra Waxbill	*Sporaeginthus subflava*	0.29	G	WG
Falconidae	Common Kestrel	*Falco tinnunculus*	0.49	C	WG
Falconidae	Grey Kestrel	*Falco ardosiaceus*	0.24	C	WG
Hirundinidae	Plain Martin	*Riparia paludicola*	0.24	I	WG
Jacanidae	African Jacana	*Actophilornis africanus*	10.29	O	WS
Jacanidae	Lesser Jacana	*Microparra capensis*	0.24	O	WS
Laniidae	Yellow-billed Shrike	*Corvinella corvina*	1.22	I	WG
Malaconotidae	Yellow-crowned Gonolek	*Laniarius barbarus*	0.24	I	WG
Nectariniidae	Beautiful Sunbird	*Cinnyris pulchellus*	0.24	N	WG
Passeridae	Northern grey-headed Sparrow	*Passer griseus*	0.98	O	WG
Phalacrocoracidae	Long-tailed Cormorant	*Microcarbus africanus*	0.98	I	WS
Phoeniculidae	Green Wood-Hoopoe	*Phoeniculus purpureus*	0.49	I	WG
Ploceidae	Little Weaver	*Ploceous luteolus*	1.96	O	WG
Ploceidae	Northern Red Bishop	*Euplectes franciscanus*	1.22	G	WG
Ploceidae	Red-billed Quelea	*Quelea quelea*	10.78	G	WS
Ploceidae	Village Weaver	*Ploceus cucullatus*	3.67	G	WG
Ploceidae	White-billed Buffalo Weaver	*Bubalornis albirostris*	2.2	G	WG
Ploceidae	Yellow-crowned Bishop	*Euplectes afer*	0.24	G	WG
Psittacidae	Rose-ringed Parakeet	*Psittacula krameri*	3.18	F	WG
Psittacidae	Senegal Parrot	*Poicephalus senegalus*	0.73	G	WG
Pycnonotidae	Common Bulbul	*Pycnonotus barbatus*	0.49	G	WG
Rallidae	Black Crake	*Zapornia flavirostra*	0.24	C	WS
Rostratulidae	Greater painted-Snipe	*Rostratula australis*	0.98	O	WS
Sturnidae	Chestnut-bellied Starling	*Lamprotornis pulcher*	0.73	I	WG
Sturnidae	Long-tailed glossy Staling	*Lamprotornis caudatus*	9.31	O	WG
Timaliidae	Brown Babbler	*Turdoides plebejus*	0.98	I	WG
Viduidae	Pin-tailed Whydah	*Vidua macroura*	0.49	I	WS

Key: C (Carnivore, F (Frugivore), G (Granivore), O (Omnivore), I (Insectivore), N (Nectivore), P (Piscivore), WG (Wetland Generalist), WS (Wetland Specialist), LC (Least Concern), UA (Unassessed)

Bird families with the highest number of species were Ardeidae and Columbidae with 8 and 5 species, respectively. Furthermore, bird abundance was higher in Kafin Gana (225 total individuals) than in Warwade (183). The most abundant species in the Kafin Gana wetland were Red-billed quelea *Quelea quelea* (44 individuals), while in Warwade, Speckled pigeon *Columba guinea* (32 individuals). Some bird species recorded from both Wetland areas include: Cattle Egret *Bubulcus ibis*, African Jacana *Actophilornis africanus*, and Laughing Dove *Streptopelia senegalensis* among others. White-faced Whistling Duck *Dendrocygna viduata*, Senegal Thick-nee *Burhinus senegalensis*, Dwarf bitten *Ixobrychus sturnii* and Great Snipe *Gallinago media* were recorded only in Kafin Gana, whereas species such as, Zebra Waxbill *Sporaeginthus subflava* and Plain Martin *Riparia paludicola* were recorded only from Warwade.

Table 2: Diversity attributes recorded in Kafin Gana and Warwade wetlands

Site	Species richness	Diversity index	Evenness
Kafin Gana	44	3.1	0.48
Warwade	31	2.9	0.58

Based on the IUCN conservation statuses, 32 bird species observed are categorized as Least Concern (LC), while the others (15 species) were categorized as Unassessed (UA). Furthermore, based on the dependency of the birds on wetlands environment, 41 species were wetland generalist and 16 species specialist. The general foraging guilds of the bird species in both wetlands include five Carnivore species, one Frugivore, 15 Granivore, 21 Insectivore, one Nectivore, 12 Omnivore, and one Piscivore.

DISCUSSION

The study revealed that Kafin Gana wetland had higher bird diversity, abundance and richness, compared to Warwade, as hypothesized. There was also no similarity of species composition between the two wetlands. The reason for the higher bird diversity in Kafin Gana could be attributed to the low human disturbances, compare to Warwade where fishing, especially with boats were greatly practised (Ringim and Harry, 2017). This could also be due to wetland settings, such as presence of vegetation, specifically water lily in Kafin Gana, which provide an important foraging ground and cover for a number of birds (Tews *et al.* 2004).

The most abundant species recorded in both areas throughout the study period was the Red-billed Quelea *Quelea quelea*. This might be because both areas are under intensive agricultural activities, and the species prefer such areas for foraging (BirdLife International, 2018b). Moreover, the presence of more waterbird species, especially White-faced whistling duck *Dendrocygna viduata* in Kafin Gana might strongly be associated with the presence of the Water lily, which serve as food and a key factor determining the abundance and distribution of the bird, as well as other species (BirdLife International, 2018b).

However, fish-eating species, especially Pied Kingfisher *Ceryle rudis* and Little Egret *Egretta garzetta* shows preference for Warwade wetland, presumably due to abundance of fishes, compared to Kafin Gana. The differences in the abundance and composition of bird species between the two areas might be related to the availability of food, and habitat condition of the species. This is because availability of food resources result to changes in the abundance and distribution of birds, which are determined by the composition of the vegetation that forms a major element of their habitats (Aynalem and Bekele, 2008). Thus, as vegetation changes, a particular bird species may appear, increase or decrease in number, and disappear as the habitat changes.

The study corresponded with the wet season and some intra-African migrant bird species were recorded, such as *G. media*, Little Egret *Egretta garzetta*, Red-billed Quelea *Quelea quelea*, Beautiful Sunbird *Nectarinia pulchella*, as well as Palearctic visitors: Squacco Heron *Ardea ralloides* and Grey Heron *Ardea cinerea*. Squacco Heron *Ardeola rolloides* and *A. cinerea* being Palearctic winters should not be in sub-Saharan Africa at this time owing to fact that they should be breeding in Europe in summer. It is suggested that the birds seen may be sub-adults who do not need to migrate back to Europe since they would not be breeding (Borrow and Demey, 2014).

Muhammad *et al.* (2018) recorded some bird species in Warwade that were not recorded in this study and include, Beaudouin's Snake Eagle *Circaetus beaudouini*, Vulnerable (IUCN, 2016), Pallid Harrier *Circus macrourus*, Near Threatened (IUCN, 2016), and Western Marsh Harrier *Circus aeruginosus*. However species, such as Dwarf bittern *Ixobrychus sturnii*, and Plain Martin *Riparia paludicola* were not recorded in their study. This variation could be as a result of differences in the habitats covered, and sampling effort (Bibby *et al.* 2000). More so, their study where mostly on land birds.

Despite both wetlands are under farming, fishing and grazing, they provide shelter and foraging ground for many bird species. Other studies (e.g. Maeda, 2001) indicated that farmland areas, rice fields in particular, are valuable habitats for waterbirds. Similarly, an invaluable stopover site for migratory birds (Elphick and Oring, 2003). In Spain (Ebro delta), rice fields were observed to be the most preferred feeding grounds for wintering herons (Lane and Fujioka, 1998). In this study, the main species observed foraging in rice fields were *B. ibis*, and were the most numerous herons in both Wetlands. Nonetheless, increase in these activities: fishing, grazing and agriculture in Kafin Gana and Warwade wetland areas can affect bird species (Loe *et al.* 2007). Agriculture and degradation of riparia due to grazing by livestock has shown to negatively influence bird species, especially ground nesting birds like Spur-winged Lapwing *Vanellus spinosus* (Martin and McIntyre, 2007). Intense fishing activity on the other hand, can prevent the congregation of waterbirds (Ringim and Harry, 2017).

CONCLUSION

The survey of the diversity and composition of birds of the Kafin Gana and Warwade wetlands shows that the sites (especially Kafin Gana) are rich in birds, including migratory birds. Warwade is a habitat of threatened bird species like the Beaudouin's Snake Eagle *Circaetus beaudouini*, and the Pallid Harrier *Circus macrourus* (Muhammad *et al.* 2018). Both wetlands are surrounded by agricultural fields and fishing is greatly practised, especially in Warwade. These activities have shown to destroy wetland habitats critical for birds, specifically migratory birds. They have been found to disrupt foraging and breeding activity of birds, as well as fish resources. We recommend that the survey be extended at different seasons to account for complete checklist of the birds of Kafin Gana and Warwade wetlands. There is need for better-organized fishing activities in the wetlands in order to minimize any disturbances that could negatively affect bird species/activities.

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