

Bird species' richness, relative abundance and conservation status in protected and unprotected areas of the Hadejia-Nguru Wetlands, north-east Nigeria

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Abstract

The role of protected areas is for the long-term conservation of biodiversity. This study investigated the effectiveness of the Hadejia-Nguru Ramsar Wetlands Protected Areas in maintaining bird community. We assessed and compared species' richness, relative abundance and conservation status of birds between Protected Areas (PAs) and Unprotected Areas (UPAs) of the wetland. The study was conducted from October to December, 2015. Point-count method was employed during the study. Forty-eight points of 100 m radius and 400 m intervals were surveyed in PAs and 51 points in the UPAs. A total of 42, 255 individual birds of 148 species' belonging to 23 orders and 50 families were recorded. Unprotected Areas had 133 species and PAs 121 species ($p = 0.4514$), however, PAs had higher birds abundance than unprotected areas. The two areas shared a greater percentage of species composition by 85%. Two globally threatened species were also recorded, the European Turtle Dove *Streptopelia turtur* (Vulnerable) and Pallid Harrier *Circus macrourus* (Near Threatened). White-faced Whistling Duck *Dendrocygna viduata*, and Garganey *Spatula querquedula* were the dominant species in both areas. Results further revealed that PAs had slightly higher bird population with stable trend than UPAs, in contrast, though those with increasing population were more in UPAs. Overall, the population trend of birds in both habitats was found to be stable. Majority of resident species' population trend were found to be on the increase, or stable, while intra-African and Palearctic migrants were found to be declining. This study highlights that not only PAs of the HNWs are important for bird conservation, but UPAs, too, are of great significance for the long-term conservation of the wetland bird community. Legal protection of certain wetland areas especially in the UPAs may help preserve larger bird species.

Keywords: Bird conservation; Hadejia-Nguru Wetlands; protected and unprotected areas; threats.

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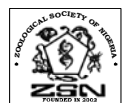
Introduction

The Hadejia-Nguru Wetlands (HNWs) is a Ramsar Site of international importance and an Important Bird Area (IBA) (*Birdlife International*, 2016a). The wetland was created by the Hadejia and Jama'are Rivers to form the Komodugu-Yobe River which drains into the Lake Chad. It lies on the southern edge of the Sahel savannah in north-eastern Nigeria. The mosaic habitats of the HNWs serve as home for resident and migratory birds (Intra-African and Palearctic migrants), as well as a stop-over site for many bird species to rest and refuel during their annual migration (Cresswell, 2012). It is recognized as the most important bird conservation area in Nigeria and among the most valued in West Africa (*Birdlife International*, 2013). There are about 377 bird species documented for the wetland including 16 globally threatened species (*Birdlife International*, 2013; 2016a).

The HNWs has four categories of PAs; Adiani Forest Reserves, Baturiya Wetland Reserve, Chad Basin National Park, Nguru Lake and Marma Channel (*Birdlife International*, 2013). In addition, there are several wetlands that are not legally protected by law which in

this study are termed Unprotected Areas (UPAs). The wetland covers about 350,000 hectares that cuts across three states; Bauchi, Jigawa, and Yobe, with an estimated human population of 1.5 million (Blench, 2013). Recently, there have been reports about the increase of anthropogenic activities within the wetland PAs and UPAs such as hunting, exploitation of wetland resources, e.g. illegal hunting of waterbirds, fuel wood and grazing (Ogunkoya and Dami, 2007; Blench, 2013), which may likely affect bird species. The wetland and birds also face great threats from the ongoing global climate change phenomenon due to its negative impacts, such as range constriction and/or expansion, specifically on migratory species (*Birdlife International*, 2016a). For instance, the population of overwintering Ferruginous goose *Aythya nyroca* has declined in the wetland, presumably, due to changes in the global climate (*Birdlife International*, 2016b).

In recent decades, there have been extensive studies on the role of PAs in maintaining regional, and local bird community (e.g. Devictor *et al* 2007; Greve *et al* 2011). This is because, the ultimate goal of PAs are to maintain



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regional diversity of ecosystems, communities and species (Franco *et al* 2007), especially at this point in time when many PAs are faced with anthropogenic pressures. Since after the establishment of the HNWs' PAs, it is not well known how they have contributed to biodiversity conservation and bird conservation in particular. In recent times, data on avian community in the HNWs is poorly understood due to Boko Haram insurgency in the north-east Nigeria, which made the wetland areas very difficult to access. It is on this basis that this study sought to explore the role of the HNWs PAs in maintaining bird community. The objective of this study was therefore to examine and compare bird species richness, relative abundance and conservation status in PAs and UPAs of the HNWs. It was hypothesized that PAs will have higher bird species richness, relative abundance, and more bird species with increasing or stable population trend than UPAs. This study is necessary in order to provide up to date information about the effectiveness of the HNWs' PAs in maintaining bird community, which is fundamental from monitoring and biodiversity conservation viewpoint.

Materials and methods

Study area

The study was conducted in the Hadejia-Nguru Wetlands (12° 1' N and 13° N, 1°15' E and 11° 3' E, Figure 1) between October to December, 2015. The wetlands experience two distinct seasons: wet season, May-September and dry season from October- April. Rainfall is between 500-600 mm and temperature ranges from 12°C in cold season to about 40°C in dry season (Ogunkoya and Dami, 2007). The wetland vegetation has been categorized into three namely, (i) scrub savannah (ii) raised areas locally known as *tudu*, and (iii) seasonally flooded areas (*Birdlife International*, 2015).

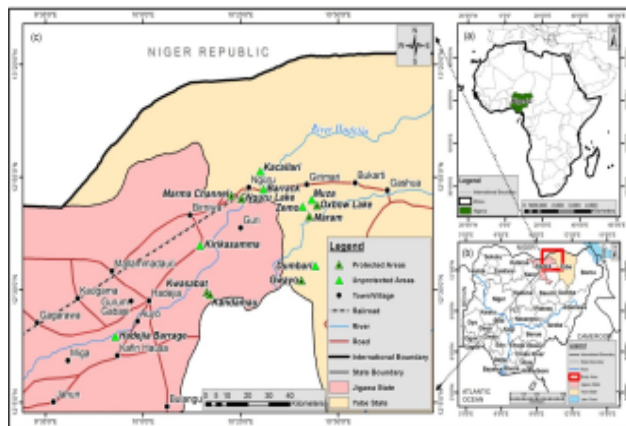


Figure 1. Map of the HNWs showing the location of the 14 sampling sites in PAs and UPAs.

A total of 99 point count stations were surveyed in seven wetlands in PAs (48 census point stations) and seven wetlands in the UPAs (51 census point stations).

Protected wetlands include Nguru Lake, Oxbow Lake, Gwayo, Kwasabat, Maram, Marma Channel and Kandamau, while wetland sites in the UPAs comprised of Barrack, Kirikasamma, Muzza, Dumbari, Kacallari, Hadejia Barrage and Zemo. Point count method described by Bibby (2000) was used to survey birds. Birds seen or heard were recorded for 10 minutes within 100 m radius. Point count stations were spaced 400 m to avoid double counting. All census points surveyed were visited in the morning from 6-10 hours and in the evening from 16-18 hours. Point count stations were replicated thrice and for standardization purposes, the average number of birds counted in the morning and evening for all the wetlands surveyed was taken throughout the study period (three months). Observation of birds was done using Braun Binocular 16 x 50 m, and was identified according to the *Field guide of the birds of Western Africa* by Borrow and Demey (2014).

Data analyses

Paleontological Statistical Package (Hammer *et al* 2001) was used for all analyses. Bird species' richness was interpreted as the number of species recorded in PAs and UPAs. *Chi-square* (χ^2) was used to test the difference in species' richness between PAs and UPAs. Bird species were categorized as resident, intra-African migrant, or Palearctic migrants (Borrow and Demey, 2014). Conservation statuses of all birds were based on the IUCN Red List, 2015 (*Birdlife International*, 2016b). These categories include: Least Concern-population trend increasing (\uparrow), Least Concern-population trend decreasing (\downarrow), Least Concern-population trend stable ($-$), Least Concern-population trend unknown (*), and Unassessed Population (**).

Sørensen's similarity index (C_s) was used to measure species' similarity between PAs and UPAs according to Magurran (1988), using the formula:

$$C_s = \frac{2j}{a+b}$$

Where C_s is the Sørensen's index of similarity, a is the number of species in the PAs, b is the number of species in the UPAs, and j is the number of species common to both areas. Relative abundance of bird species was calculated according to Rais *et al* (2013), given by the formula:

Relative abundance:

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

Results

Bird species richness and relative abundance

In total, 148 bird species were recorded from PAs and UPAs of the HNWs during the study (Table 1). UPAs had higher bird species richness (133 species) than PAs

Table 1. Descriptive data of bird species recorded in PAs and UPAs of the HNWS.

Common/ Scientific name	No. of indi- dual	Rela- tive abun- dance	No. of indi- dual	Rela- tive abun- dance	Migra- tory status	IUCN status
African Pygmy Goose <i>Nettapus auritus</i>	22	0.0913	12	0.0671	R	↓
Fulvous Whistling Duck <i>Dendrocygna bicolor</i>	93	0.3871	56	0.3033	R	↓
Garganey <i>Spatula querquedula</i>	5210	22	6103	33	PM	↓
Knob-billed Duck <i>Sarkidiornis melanotos</i>	198	0.8293	106	0.5758	IA	↓
Spur-winged Goose <i>Plectropterus gambensis</i>	165	0.6932	31	0.1689	R	↑
White-faced Whistling Duck <i>Dendrocygna viduata</i>	1379 4	58	7344	40	R	↑
African Palm Swift <i>Cypsiurus parvus</i>	78	0.3229	11	0.0599	R	↑
Common Swift <i>Apus apus</i>	2	0.0008	-	-	PM	-
Little Swift <i>Apus affinis</i>	1	0.0008	19	0.1035	R	↑
African Grey Hornbill <i>Lophoceros nasutus</i>	10	0.0432	11	0.059	IA	-
Northern Red- billed Hornbill <i>Tockus erythrorhynchus</i>	23	0.0969	19	0.1016	R	-
African Harrier Hawk <i>Polyboroides typus</i>	1	0.0004	1	0.0005	R	-
African Swallow-tailed Kite <i>Chelictinia riocourii*</i>	-	-	2	0.0111	IA	-
Black Shouldered Kite <i>Elanus axillaris</i>	-	-	6	0.0335	R	↑
Black kite <i>Milvus migrans</i>	7	0.0299	7	0.039	PM	*
Dark Chanting Goshawk <i>Melierax metabates</i>	-	-	2	0.0008	R	-
Gabar Goshawk <i>Micronisus gabar</i>	2	0.0008	4	0.019	R	-
Grasshopper Buzzard <i>Butastur rufipennis</i>	-	-	2	0.0108	R	↓
Lizard Buzzard <i>Kaupifalco mono- grammicus</i>	-	-	5	0.0245	R	-
Montagu's Harrier <i>Circus pygargus</i>	2	0.0008	-	-	PM	↓
Pallid Harrier <i>Circus macrourus</i>	3	0.0132	5	0.0281	PM	↓/ NT

Table 1 (cont'd)

Common/ Scientific name	No. of indi- dual	Rela- tive abun- dance	No. of individ- ual	Rela- tive abun- dance	Migra- tory status	IUCN status
Shikra <i>Accipiter badius</i>	2	0.0008	-	-	IA	-
Western Marsh Harrier <i>Circus aeruginosus</i>	8	0.0334	13	0.0717	PM	↑
Yellow-billed Kite <i>Milvus migrans parasitus</i>	1	0.0008	1	0.0007	IA	*
Abdim's Stork <i>Ciconia abdimii</i>	40	0.1674	3	0.0163	IA	↓
African Openbill Stork <i>Anastomus lamelligerus</i>	6	0.0251	10	0.0544	IA	↓
White Stork <i>Ciconia ciconia</i>	-	-	11	0.0599	PM	↑
Great Spotted Cuckoo <i>Clamator glandarius</i>	-	-	4	0.0217	PM	-
Senegal Coucal <i>Centropus senegalensis</i>	5	0.0195	28	0.1543	R	-
Blue-naped Mousebird <i>Urocolius macrourus</i>	-	-	10	0.0517	R	↓
African Pygmy Kingfisher <i>Ispidina picta</i>	5	0.22	2	0.0009	IA	-
Grey-headed Kingfisher <i>Halcyon leucocephala</i>	4	0.0167	-	-	IA	-
Malachite Kingfisher <i>Corythornis cristatus</i>	9	0.0369	3	0.0163	R	-
Pied Kingfisher <i>Ceryle rudis</i>	9	0.0376	5	0.0245	R	*
African Mourning Dove <i>Streptopelia decepiens</i>	359	1.5031	163	0.8901	R	-
Black-billed Wood Dove <i>Turtur abyssinicus</i>	5	0.0021	1	0.0005	R	-
Blue-spotted Wood Dove <i>Turtur afer</i>	-	-	1	0.0005	R	-
European Turtle Dove <i>Streptopelia turtur*</i>	28	0.1171	-	-	PM	↓/ VU
Laughing Dove <i>Streptopelia senegalensis</i>	18	0.0732	28	0.1525	R	-
Namaqua Dove <i>Oena capensis</i>	2	0.0008	5	0.029	R	↑
Speckled Pigeon <i>Columba guinea</i>	7	0.0292	19	0.1053	R	-

Table 1 (cont'd)

Common/Scientific name	No. of individual	Relative abundance	No. of individual	Relative abundance	Migratory status	IUCN status
Tambourine Dove <i>Turtur tympanistris</i> *	2	0.0007	-	-	R	-
Vinaceous Dove <i>Streptopelia vinacea</i>	5	0.0209	6	0.0344	R	-
Abyssinian Roller <i>Coracias abyssinicus</i>	14	0.0599	20	0.0189	R	↑
Black-headed Lapwing <i>Vanellus tectus</i>	3	0.0139	19	0.01	R	*
Spur-winged Lapwing <i>Vanellus spinosus</i>	32	0.1345	62	0.3369	R	↑
African Jacana <i>Actophilornis africanus</i>	205	0.8558	256	1.3933	R	-
Lesser Jacana <i>Microparra capensis</i>	13	0.0544	9	0.049	R	*
Gull-billed Tern <i>Gelocheidon nilotica</i> *	20	0.8387	2	0.0122	PM	↓
Grey-headed Gull <i>Larus cirrocephalus</i> *	4	0.0167	-	-	PM	-
Whiskered Tern <i>Chlidonias hybrida</i>	7	0.0292	3	0.163	PM	-
Common Sandpiper <i>Actitis hypoleucos</i>	4	0.0167	2	0.0008	PM	↓
Common Snipe <i>Gallinago gallinago</i>	-	-	5	0.0272	PM	↓
Green Sandpiper <i>Tringa ochropus</i>	29	0.1206	79	0.4286	PM	-
Little Stint <i>Calidris minuta</i>	-	-	38	0.207	PM	↓
Ruff <i>Calidris pugnax</i>	6	0.0251	71	0.386	PM	↓
Spotted Redshank <i>Tringa erythropus</i>	6	0.0215	63	0.3451	PM	-
Wood Sandpiper <i>Tringa glareola</i>	379	2	653	3.558	PM	-
Black-winged Stilt <i>Himantopus himantopus</i>	58	0.2413	33	0.1779	R	↑
Grey Kestrel <i>Falco ardosiaceus</i>	-	-	2	0.0122	R	-
Lanner Falcon <i>Falco biarmicus</i>	4	0.0136	3	0.0149	R	↑
Red-necked Falcon <i>Falco ruficollis</i>	1	0.0008	4	0.0208	R	↓
Helmeted Guineafowl <i>Numida meleagris</i> *	-	-	12	0.0653	R	-

Table 1 (cont'd)

Common/Scientific name	No. of individual	Relative abundance	No. of individual	Relative abundance	Migratory status	IUCN status
Stone Partridge <i>Ptilopachus petrosus</i>	-	-	6	0.0308	R	-
Allen's Gallinule <i>Porphyrio alleni</i>	33	0.1381	5	0.0272	IA	↓
Black Crane <i>Zapornia flavirostra</i>	43	0.1813	11	0.0617	R	*
Common Moorhen <i>Gallinula chloropus</i>	26	0.011	18	0.0962	PM	-
Lesser Moorhen <i>Gallinula angulata</i>	10	0.0428	8	0.0417	IA	*
Purple Swampphen <i>Porphyrio porphyrio</i>	33	0.1381	12	0.0662	R	*
Western Grey Plantain-eater <i>Crinifer piscator</i>	3.2	0.0132	6	0.0299	R	-
Bearded Barbet <i>Pogonornis dubius</i>	2	0.0008	-	-	R	*
Vieillot's Barbet <i>Lybius vieilloti</i>	1	0.0008	2	0.0008	R	*
Yellow-fronted Tinkerbird <i>Pogoniulus chrysoconus</i>	1	0.0008	-	-	R	-
Black Heron <i>Egretta ardesiaca</i>	80	0.3354	15	0.0835	R	-
Black-headed Heron <i>Ardea melanocephala</i>	11	0.046	3	0.0149	R	↑
Cattle Egret <i>Bubulcus ibis</i>	232	0.9702	540	3	R	↑
Great Egret <i>Ardea alba</i>	5	0.0202	15	0.0835	R	*
Green-backed Heron <i>Butorides striata</i>	10	0.0418	3	0.0163	R	↓
Grey Heron <i>Ardea cinerea</i>	10	0.0397	18	0.0962	PM	*
Intermediate Egret <i>Ardea intermedia</i>	12	0.0487	13	0.0708	R	↓
Little Bittern <i>Ixobrychus minutus</i>	3	0.0125	1	0.0005	PM	↓
Little Egret <i>Egretta garzetta</i>	16	0.0662	21	0.1125	IA	↑
Purple Heron <i>Ardea purpurea</i>	42	0.1771	23	0.1253	PM	↓
Squacco Heron <i>Ardeola rolloides</i>	150	0.627	63	0.3433	PM	↓
Glossy Ibis <i>Plegadis falcinellus</i>	31	0.1283	39	0.2106	PM	↓
Red-headed Lovebird <i>Agapornis pullarius</i> *	3	0.0125	-	-	R	↓

Table 1 (cont'd)

Common/Scientific name	No. of individual	Relative abundance	No. of individual	Relative abundance	Migratory status	IUCN status
Rose-ringed Parakeet <i>Psittacula krameri</i>	6	0.0264	7	0.0381	R	↑
Senegal Parrot <i>Poicephalus senegalus</i>	6	0.023	3	0.0154	R	-
Four-banded Sandgrouse <i>Pterocles quadricinctus</i>	4	0.0167	63	0.3451	IA	-
Standard-winged Nightjar <i>Caprimulgus longipennis</i> *	2	0.0008	-	-	IA	-
Hoopoe <i>Upupa epops</i>	1	0.0005	1	0.0005	PM	↓
Green Wood-hoopoe <i>Phoeniculus purpureus</i>	1	0.0004	7	0.0381	R	↓
Crested Lark <i>Galerida cristata</i>	3	0.0139	13	0.0717	R	?
Grey-backed Camaroptera <i>Camaroptera brachyura</i>	-	-	1	0.0005	R	↑
Tawny-flanked Prinia <i>Prinia subflava</i>	5	0.0209	5	0.0263	R	-
Zitting Cisticola <i>Cisticola juncidis</i>	-	-	4	0.022	R	↑
Winding Cisticola <i>Cisticola galactotes</i>	1	0.0008	5	0.0253	R	-
Piapiac <i>Ptilostomus afer</i>	-	-	23	0.1253	R	-
Pied Crow <i>Corvus albus</i>	1	0.0008	15	0.0826	R	-
Cut-throat Finch <i>Amadina fasciata</i>	7	0.0292	3	0.0172	R	-
Green-winged Pytilia <i>Pytilia melba</i> *	1	0.0008	2	0.0108	R	-
Red-billed Firefinch <i>Lagonosticta senegala</i>	33	0.1387	17	0.0899	R	-
Red-cheeked Cordon Blue <i>Uraeginthus bengalus</i>	52	0.219	92	0.5013	R	-
Yellow-fronted Canary <i>Serinus mozambicus</i>	-	-	2	0.0108	R	↓
Common Sand Martin <i>Riparia riparia</i>	15	0.0627	30	0.1634	PM	↓
Ethiopian Swallow <i>Hirundo aethiopica</i>	35	0.1464	2	0.0108	IA	↑
Plain Martin <i>Riparia paludicola</i>	13	0.0554	24	0.128	R	↓
West African Swallow <i>Cecropis domicella</i>	-	-	2	0.0108	IA	**

Table 1 (cont'd)

Common/Scientific name	No. of individual	Relative abundance	No. of individual	Relative abundance	Migratory status	IUCN status
Southern Grey Shrike <i>Lanius meridionalis</i>	-	-	2	0.0108	R	**
Woodchat Shrike <i>Lanius senator</i> *	-	-	5	0.0286	PM	↓
Yellow-billed Shrike <i>Corvinella corvina</i>	-	-	1	0.0005	R	*
Black-crowned Tchagra <i>Tchagra tchagra</i>	1	0.0036	1	0.0005	R	-
Yellow-crowned Gonolek <i>Laniarius barbarus</i>	15	0.0641	3	0.0172	R	-
Little Bee-eater <i>Merops pusillus</i>	33	0.137	4	0.0217	R	↓
Little Green Bee-eater <i>Merops orientalis</i>	-	-	5	0.0271	R	↑
Yellow Wagtail <i>Motacilla flava</i>	289	1	333	2	PM	↓
Black Scrub Robin <i>Cercotrichas podobe</i>	1	0.0004	2	0.0009	R	-
Northern Wheatear <i>Oenanthe oenanthe</i> *	2	0.0009	7	0.0354	PM	↓
Beautiful Sunbird <i>Nectarinia pulchella</i>	43	0.1792	9	0.0463	IA	-
Osprey <i>Pandion haliaetus</i>	1	0.0008	-	-	PM	↑
Northern Grey-headed Sparrow <i>Passer griseus</i>	123	0.5129	48	0.2615	R	-
Sudan Golden Sparrow <i>Passer luteus</i>	42	0.1764	21	0.1144	IA	-
Speckle-fronted Weaver <i>Sporopipes frontalis</i>	23	0.0962	34	0.1852	R	-
Long-tailed Cormorant <i>Microcarbo africanus</i>	323	1.3496	150	0.9174	R	↓
Double-spurred Francolin <i>Pternistis bicalcaratus</i>	2	0.0008	-	-	R	↓
Black-headed Weaver <i>Ploceus melanocephalus</i>	8	0.0324	1	0.0005	R	-
Little Weaver <i>Ploceus luteolus</i>	106	0.4429	7	0.0367	R	-
Northern Red Bishop <i>Euplectes franciscanus</i>	26	0.1098	14	0.0771	R	-

Table 1 (cont'd)

Common/Scientific name	No. of individual	Relative abundance	No. of individual	Relative abundance	Migratory status	IUCN status
Red-billed Quelea <i>Quelea quelea</i>	594	2.4886	759	4	IA	-
Village Weaver <i>Ploceus cucullatus</i>	93	0.3913	49	0.2624	R	-
Masked Weaver <i>Ploceus intermedius</i>	7	0.0292	-	-	R	-
White-billed Buffalo Weaver <i>Bubalornis albirostris</i>	141	0.5914	227	1	R	-
Yellow-crowned Bishop <i>Euplectes afer</i>	-	-	2	0.0108	R	-
Common Bulbul <i>Pycnonotus barbatus</i>	3	0.0111	3	0.0181	R	↑
Chestnut-bellied Starling <i>Lamprotornis pulcher</i>	20	0.088	40	0.2143	R	-
Great Blue-eared Starling <i>Lamprotornis chalybaeus</i>	36	0.1492	14	0.078	R	-
Long-tailed Glossy Starling <i>Lamprotornis caudatus</i>	16	0.0676	26	0.1416	R	-
Yellow-billed Oxpecker <i>Buphagus africanus</i>	-	-	1	0.0006	R	↓
African Reed Warbler <i>Acrocephalus baeticus*</i>	6	0.023	6	0.0326	IA	**
Common Whitethroat <i>Sylvia communis*</i>	-	-	4	0.0231	PM	↑
European Reed Warbler <i>Acrocephalus scirpaceus*</i>	6	0.0251	8	0.0408	PM	-
Greater Swamp Warbler <i>Acrocephalus rufescens</i>	16	0.0662	9	0.0463	R	-
Lesser Swamp Warbler <i>Acrocephalus gracilirostris</i>	7	0.0306	2	0.0008	R	-
Northern Crombec <i>Sylvietta brachyura</i>	3	0.0125	-	-	R	-
Sedge Warbler <i>Acrocephalus schoenobaenus</i>	48	0.1987	14	0.0744	PM	-
Brown Babbler <i>Turdoides plebejus</i>	5	0.0188	4	0.0217	R	-
Sahel Paradise Whydah <i>Vidua orientalis</i>	-	-	2	0.0122	R	**
Village Indigobird <i>Vidua chalybeata</i>	5	0.0188	2	0.0122	R	-

Key: PAs (Protected Areas), UPAs (Unprotected Areas), R (Resident), PM (Palearctic migrant), IA (Intra-African migrant), VU (Vulnerable), NT (Near Threatened), Least Concern-population trend increasing (↗), Least Concern-population trend decreasing (↘), Least Concern-population trend stable (→), Least Concern-population trend unknown (*), Unassessed Population (**).

(121 species) which does not support the hypothesis, however, the difference was not significant ($\chi^2 = 0.5669$, $df = 1$, $p = 0.4514$). The two areas were similar in species composition by 81% indicating that they shared a high number of bird species. Families with the richest species were Accipitridae (13 species), Ardeidae (11 species), and Columbidae (9 species), while those with the lowest were Bucerotidae and Jacanidae (2 species each), Coliidae, Coraciidae and Pandionidae (1 species each). Two species on the IUCN Red List of Threatened Species (2015) were also recorded; the Near Threatened Pallid Harrier *Circus macrourus* recorded from both areas, and the Vulnerable European Turtle Dove *Streptopelia turtur* recorded only in the PAs. The latter and 13 other species were not previously reported in HNWs as shown in Table 1. Bird abundance in both PAs and UPAs recorded were categorized into resident, intra-African and Palearctic migrant as shown in the Table 2.

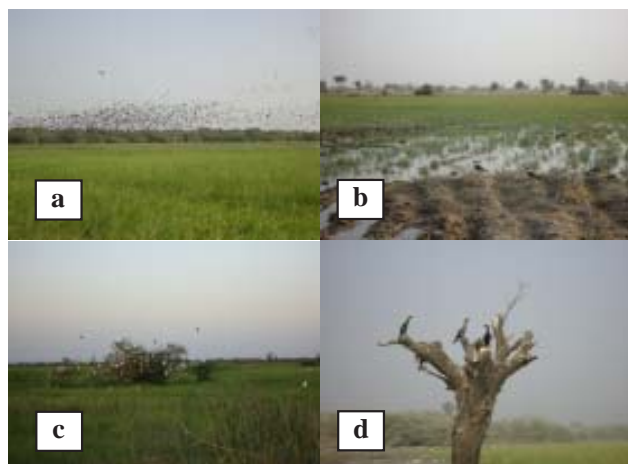
Table 2. A comparison of bird abundance in PAs and UPAs of HNWs.

Category	Protected area (%)	Unprotected area (%)
Resident species	64.4	66.2
Intra-African migrant	14.1	12.0
Palearctic migrant	21.5	21.8
Total	100	100

Source: Field data, October-December, 2015.

Bird abundance was higher in PAs than UPAs, as hypothesized (see Table 1). White-faced Whistling Duck *Dendrocygna viduata* was the most abundant species in both areas; PAs (13,793, 57.7%, Plates 1) and UPAs (7,343, 40.3%), followed by Garganey *Spatula querquedula*; PAs (5,210, 21.8%) and UPAs (6,103, 33.3%), and Red-billed Quelea *Quelea quelea*; PAs (594, 1.3%) and (UPAs 759, 4%). African Harrier Hawk *Polyboroides typus*, and Hoopoe *Upupa epops* were represented by single individual equivalent each to 0.0004% in the PAs. In the UPAs on the other hand, Black-crowned Tchagra *Tchagra senegalus*, and Little Bittern *Ixobrychus minutus* had a relative abundance of 1 equivalent to 0.0005%. Moreover, some more bird species were found in both areas and include Allen's Gallinule *Porphyrio alleni*, Black-wined Stilt *Himantopus himantopus*. Grey-headed Gull *Larus cirrocephalus*, and Bearded barbet *Pogonornis dubius* much were recorded

in PAs only, while African swallowed-tailed Kite *Chelictinia riocourii*, and Blue-naped Mousebird *Urocolius macrourus* were recorded only in UPAs.



Plates 1(a). Flock of White-faced whistling duck *Dendrocygna viduata* and other waterbirds in Kandamau wetland area (Baturiya Wetland Reserve, December, 2015), **(b)** Spur-winged Lapwing *Vanellus spinosus* in Kacallari wetland (UPAs, December, 2015), **(c)** Cattle egrets *Bubulcus ibis* and Long-tailed Cormorants *Microcarbo africanus* in Barrack area (UPAs, November, 2015), **(d)** Long-tailed Cormorants *Microcarbo africanus* in Kandamau wetland area (October, 2015).

Bird conservation statuses

The bird conservation statuses for all bird species recorded in PAs and UPAs was ascertained by comparison with the IUCN conservation status. The results are shown in Figure 2. Results showed that the population of most

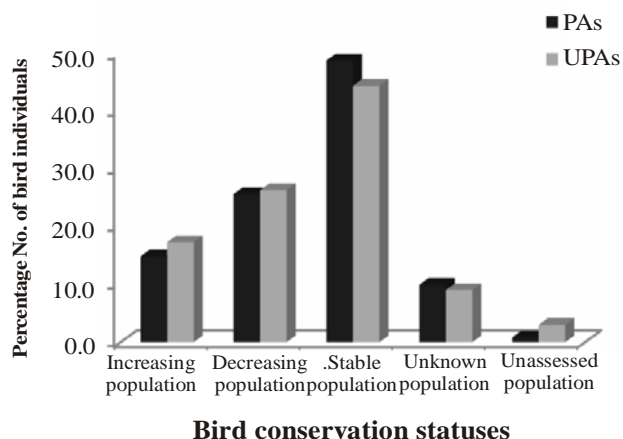


Figure 2. Comparison of birds conservation statuses between PAs and UPAs of the HNWS.

resident species is on the increase or stable. In contrast, migratory species; intra-African and Palearctic migrants are not, with only two species found in the PAs to be on the increase; the Western Marsh Harrier *Circus aeruginosus* and Osprey *Pandion haliaetus*. In the UPAs,

only three species were found to be on the increase; Common Whitethroat *Sylvia communis*, *C. aeruginosus*, and White Stork *Ciconia ciconia*, or stable, e.g. Green Sandpiper *Tringa ochropus*, and Spotted Redshank *Tringa erythropus*. Overall, the population of bird species on the increase were more in UPAs than PAs, which does not supported the hypothesis. But, the population of those on stable occurs more in PAs, as hypothesized.

Discussion

The findings of this study show that UPAs had higher total species' richness than PAs, although the richness did not differ significantly between the two areas. Bird abundance was higher in PAs than UPAs, and the two areas shared a greater closeness in species' composition. UPAs supported more bird population with increasing trend than PAs. In contrast, PAs had higher bird population with stable trend than UPAs. The higher species' richness recorded in this study is similar to that of Rayner *et al* (2014) in Australia who found PAs to be less species' rich than UPAs. Differences in species' richness in this study could be related to influence of vegetation composition, wetland settings such as type, size as shown by other studies (e.g. Paracuellos, 2006; Sulaiman *et al* 2015). Birds were more abundant in PAs than UPAs, with the exception of some species, especially migratory species. Gunnarsson *et al* (2005) reported that migratory birds can utilize a wide range of habitats on their wintering ground provided they are not severely degraded. The study recorded two globally threatened species, i.e. the vulnerable European Turtle Dove and the Near Threatened Pallid Harrier. The former was recorded in both areas, while the latter was recorded only in the PAs. Some unprotected wetland sites, such as Dumbari and Kacallari supported large congregation of migratory species, which indicated that it can serve as a good wintering ground, and refuge for the migratory birds during the winter period.

White-faced whistling duck was the most ubiquitous species, probably because of their large population size in both areas. This finding is similar to that of Carboneras and Kirwan (2016) that showed that the species is abundant in Africa and might have benefited from PAs. Garganey was the most abundant migratory species recorded in both areas in thousands, which was attributed to annual migration that coincided with the period when this study was conducted. This support the findings of Cramp and Simmons (1977) and Madge and Burn (1988) as observed elsewhere on their wintering ground in Africa and Asia. Protected Areas support more birds with stable population trend than UPAs. Although, the population trend of those species on the increase were slightly higher in UPAs than PAs. Overall, the population of bird species in both habitats was found to be stable. Majority of resident species were found to be either on the increase, or stable, while intra-African and Palearctic migrants were found to be declining.

Regrettably, the global population of migratory species is declining especially on their wintering compared to breeding grounds (Cresswell, 2012). The decline has been strongly connected to several factors, the most prominent of which are habitat loss and degradation, over exploitation, wetland reclamation for power plants and wind energy, fresh water diversion for dams and reservoirs, and global climate change among others (Inouye *et al* 2000; Kirby *et al* 2008). Moreover, the decline has been shown to have more devastating effect on the population wintering in the Sahel than those wintering in the humid tropics and Guinea forest zones (Vickery *et al* 2014). In the Sahel, the decline is more noticeable in these four wetlands: the HNWs, Senegal's inner Niger Delta, Lake Chad Basin and the Sudd (Vickery *et al* 2014). The drought of the 1970s experienced in the regions has been implicated for the decline. Other contributing factors are deforestation, overgrazing, and increased agriculture (Birdlife International, 2016b). In the inner Niger Delta, for instance, extensive cultivation has resulted in the decline of about 12% population of migratory birds (Wymenga and Zwarts, 2010). Nevertheless, some studies (Vickery *et al* 2014) showed that for species that prefers farmland areas, such as Ruff *Philomachus pugnax* and Black-tailed godwit *Limosa limosa* benefitted from the cultivation.

The HNWs are facing persistent and overwhelming human pressures, in addition to many factors as mentioned above, i.e. habitat loss and degradation, increased farming, invasive species, climate change, etc. which may compromise bird conservation, and the recognition of the HNWs as Ramsar site and an IBA. The study-area is one of the wintering sites of the threatened species recorded, i.e. European Turtle Dove and Pallid Harrier, which have shown to intensely be affected by increase farming activities through clearance of Acacia woodland and scrub. These activities which interferes with their feeding and breeding sites are among the main drivers of their global population decline (Birdlife International, 2016b). Although, several studies in other parts of the world has investigated their ecology (e.g. Verma, 2005; Terraube *et al* 2009), such information regarding their habitat use is lacking for the HNWs.

Conclusion

Protected Areas are widely recognized as an effective approach for birds, and other biodiversity conservation. Nonetheless, this study demonstrated that not only PAs of the HNWs are important for bird conservation, but UPAs, too, are of great significance for the long-term conservation of the wetland bird community.

Recommendations

It is recommended that legal protection of certain wetland areas especially in the UPAs may help preserve larger bird species. In addition, managers of PAs and indigenous people living in the HNWs should be prompted

to realize the significant importance of the wetland in serving as home for resident and migratory bird species. Thus, the viable option is for the wetland management to increase public awareness, and join hands with other stakeholders in the wetland particularly the indigenous people in managing the wetland in accordance to the Ramsar Convention.

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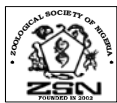
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