

Anthropogenic impacts on the composition and population density of migratory and resident birds of selected wetlands sectors in northern Nigeria

Edegbene, A. O.

Department of Biological Sciences (Applied Hydrobiology and Fisheries Unit),
Sule Lamido University, Kafin Hausa, Nigeria.

*Corresponding author: ovieedes@gmail.com, edegbeneaugustine.ovie@jsu.edu.ng

Abstract

In recent times, there has been decrease in the number of migratory and resident birds in Hadejia-Nguru Wetlands in Nigeria. This, no doubt, is a subject of concern to conservationist and the country at large. The effect of anthropogenic activities on the composition and population density of migratory and resident birds in Hadejia-Nguru Wetlands, Nigeria, were undertaken for a period of two months. Point-count method was used in data collection in two sectors of the wetlands: Ox-Bow Lake and Marma Channel. Visual observation and interaction with the locals around the wetlands were used to assess the level of anthropogenic influences and scored on a scale of 0-5. Forty-five species of migratory and resident birds were recorded of which 25 were resident while 14 and 6 were migratory and Afro-migrant respectively. A total of 32,442 and 2,218 individual birds were recorded in Ox-Bow Lake and Marma Channel respectively. Garganey (*Anas querquedula*) was the highest recorded species during the survey and it was preponderant in Ox-Bow Lake. Garganey was also more densely populated (903.76 birds/hectares). Canonical correspondence analysis showed that washing/bathing and open defecation negatively affected the composition of *Anas querquedula* and *Anas acuta*. The study revealed Hadejia-Nguru Wetlands to be under threat. Therefore, appropriate enforcement of laws guiding migratory birds in Nigeria is hereby recommended.

Keywords: Anthropogenic activities; bird population density; migratory birds; Garganey (*Anas querquedula*); Hadejia-Nguru Wetlands; Nigeria.

Accepted: 4 January 2019.

Introduction

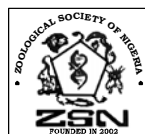
Close to a decade now, there has been growing data pool on freshwater bodies in Nigeria and the effect of anthropogenic activities on the diversity and distribution of aquatic biota such as fish and macroinvertebrates (Arimoro *et al*, 2014; Edegbene and Omovoh, 2014; Arimoro *et al*, 2015; Edegbene *et al*, 2015). Several organisms are been used to monitor the ecological condition of water courses globally (Bretschko and Moser 1993). Among the biota used for assessing ecological integrity of water bodies, birds have gained little attention as diagnostic tool in Africa and Nigeria in particular (Lameed, 2012; Soka *et al*, 2013; Edegbene, 2018).

Migratory and resident birds on a continuous basis are been subjected to varied anthropogenic influences which is affecting their functionality in their chosen habitat. In Nigeria group of bird migrate from Europe and other parts of Africa during the harmattan (cold weather condition) to wetlands in Nigeria (Edegbene, 2018). Most of the birds are been hunted down by locals as food and source of income. Aside the hunting activities, other environmental menace such as invasive grass are seriously affecting the

population density and assemblages of these biota (Edegbene, 2018). Hence, over the years the numbers of birds that migrate to wetlands in Nigeria, most especially the Hadejia-Nguru Wetlands are dwindling at an alarming rate (Ogunkoya and Dami, 2007), despite the laws protecting water bodies in Nigeria.

In Nigeria, there are laws protecting wetlands and other water bodies which should help to protect, preserve and manage the biodiversity in protected areas (PAs). These laws include: the National Park Service Act (1999/2006), Environmental Protection Law (1988/1989), Wild Animal Law (1963), Forestry Law (1938) among others. Nevertheless, lack of strong law enforcement is threatening the biodiversity of these ecosystems, particularly migratory and other resident birds of the wetlands, due to incessant anthropogenic activities (Akinsola *et al*, 2000, Blench, 2013). These un-enforcement and/or weak enforcement have its negative impact on the survival rate of both migratory and resident birds in these wetlands.

Hadejia-Nguru Wetlands is the first proclaimed Ramsar site in Nigeria and it cut across north eastern and western parts of the country (Birdlife International, 2013).



<http://dx.doi.org/10.4314/tzool.v17i1.6>

© The Zoologist, 17: 32-38 December 2019, ISSN 1596 972X.

Zoological Society of Nigeria



Textflow Limited

Furthermore, in spite of the fact that Hadejia-Nguru Wetlands is both a Ramsar site and an important International Bird Area (IBA), studies reporting about the debilitating influence of anthropogenic activities in the wetlands are still scarce (Edegbene, 2018). It is against this backdrop, that this study is aimed at assessing the effect of anthropogenic activities on the composition and population density of migratory and resident birds' in the Hadejia-Nguru Wetlands.

Materials and methods

Study area

The Hadejia-Nguru Wetlands lie between Longitude 10°00' to 11°00'E and Latitude 11°05' to 11°55'N of the equator. It is situated in the sudano-sahelian zone of northern Nigeria (Figure 1).

The area is bounded by an axis that link the towns of Nguru, Hadejia, Katagum, Gashua and back to Nguru. The entire area is located in the meeting point of Hadejia and Jama'are (Katagum) Rivers and terminate at Lake Chad which is the wetlands draining point. The area is a flood plain wetland comprising of permanent water bodies and seasonally flooded area. The study-area is located in the tropical belt of West Africa which is characterized by rainy and dry seasons. The rainy season is usually between May and September while the dry season is between October to April annually (Edegbene, 2018). Rainfall is usually sparsely distributed in the area which is about 400-550 mm and temperature during hot season can be up to 42°C while a condition termed harmattan could be as cold as 10°C most especially between December and January. The wetlands cover an area of about 350, 000 hectares.

Two locations were selected for this survey. The first location is Dagona Bird Sanctuary (Ox-Bow Lake) (12.51206°N-10.73713°E) and the second is Nguru Lake (Marma Channel sector) (12.5408°N-10.40133°E). These sites were both protected areas (PAs) of the wetlands sectors.

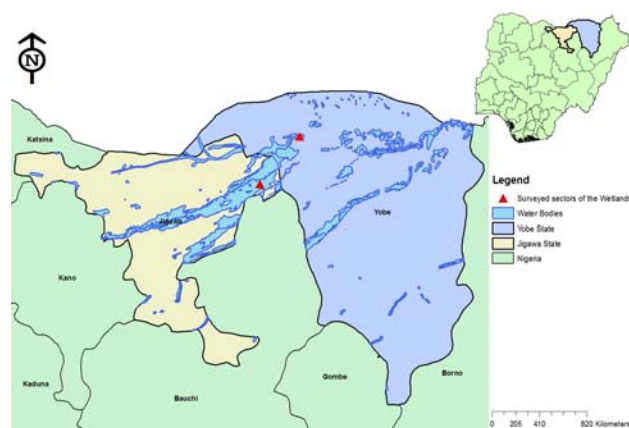


Figure 1. Study area map showing the surveyed sectors of Hadejia-Nguru Wetlands (Map of Nigeria Insert).

Sampling of birds

The survey was conducted between November and

December, 2017. Point count method as described by Edegbene (2018) was used in collection of data. This method takes into consideration the relative abundance of birds present in a given area. Counting of birds' present per time in a sector was done for a period of about 15 minutes. To calculate relative abundance of bird per survey location, visual observation and songs of birds were used as criteria to count birds at a point of about 100 meters radius from the observer.

The migratory and resident birds were then identified and counted during the survey using the methods of estimating number of birds in flock described by (Bibby *et al*, 1992). Birds in small flocks were counted directly while large flocks were counted in multiple of estimated identical blocks of birds. Braun Binocular was used to observe birds, while identification was done with the aid of pictorial guide by Borrow and Demey (2014).

Anthropogenic activities

This was done by visual observation and interaction with the locals around the wetlands sectors surveyed. They were asked the level at which they perform the various anthropogenic activities.

The following anthropogenic activities were assessed on a scale of 0-5:

- 5 - No activities recorded.
- 4 - Very low anthropogenic activities.
- 3 - Low anthropogenic activities.
- 2 - Moderate anthropogenic activities.
- 1 - Intense anthropogenic activities.
- 0 - Very intense anthropogenic activities.

Data analyses

All statistical tests were based on $\alpha = 0.05$ level of significance.

The total number of individuals of each migratory and resident bird group was determined as absolute composition at each surveyed sector. Population density (PD) of birds species was determined according to Sutherland (1996), using the formula; $PD = \text{Number of individuals of bird species/area of wetlands covered (in hectare)}$. The area covered in Dagona sector of the wetlands was 18.4 hectares while the area covered in Nguru sector of the wetlands was 37.6 hectares. Canonical correspondence analysis (CCA) was used to evaluate the relationship between migratory, resident birds' abundance and anthropogenic activities in the selected sectors, using PAST statistical package (Hammer *et al*, 2001). Prior to the final CCA, rare species occurring less than 1% in a sector were not included in the CCA. Anthropogenic activities based on the scales of 0-5 were used for the CCA analysis. A Monte Carlo test with 999 permutation (Jckel, 1986) was used to assess the significance of the canonical axes. Cluster analysis based on Bray-Curtis similarity index was used to ascertain whether migratory and resident birds composition and distribution was influenced mostly either by differences in sectors survey or not. Cluster analysis

was performed on log (x+1) transformed migratory and resident birds abundance data. Cluster analysis was performed using PAST statistical package (Hammer *et al*, 2001).

Results

Anthropogenic activities in the study area

Table 1 shows the various anthropogenic activities going on in the study-area of the Hadejia-Nguru Wetlands.

Table 1: Anthropogenic Activities and their scales recorded in the study-area.

Anthropogenic Activities	Ox-Bow Lake	Marma Channel
Farming	3	2
Fishing	3	0
Grazing	2	1
Open defaecation	3	1
Washing/bathing	5	2
Hunting	4	0

Fishing and hunting were the most intense activities in Nguru Lake (Marma Channel) sector of the Wetlands when compared to the Ox-Bow Lake. Washing/bathing as an activity was not recorded in OX-Bow Lake sector.

Composition of migratory and resident birds in the studied-sectors of Hadejia-Nguru Wetlands, Nigeria

Forty five (45) species of migratory and resident birds were recorded during the study period. Majority of the birds were resident represented by 25 species while 14 of the birds recorded were migratory and the least represented birds were the Afro-migrant birds represented by 6 species. A total of 32,442 and 2,218 individual birds were recorded in Ox-Bow Lake and the Marma Channel respectively (Table 2).

Garganey (*Anas querquedula*) a migratory bird, was the most abundant bird in the study-area and it was found more in Ox-Bow Lake while it was not recorded in Marma Channel. This was immediately followed by white faced

Table 2: Composition of migratory and resident birds in the studied sectors of Hadejia-Nguru Wetlands, Nigeria.

Common names	Scientific names	Dagona	Nguru	Status
		Ox-Bow Lake	Marma Channel	
Squacco heron	<i>Ardeola raloides</i>	52	8	R
Long tail commorant	<i>Phalacrocorax carbo</i>	19	58	R
African jacana	<i>Actophilornis africana</i>	137	339	R
Spur winged lapwing	<i>Vanellus spinosus</i>	47	19	R
Black headed lapwing	<i>Vanellus tectus</i>	32	-	R
White face whistling duck	<i>Dendrocygna viduata</i>	12,351	15	R
Cattle egret	<i>Bulbulcus ibis</i>	202	9	R
Little egret	<i>Egretta garzetta</i>	9	24	R
Intermediate egret	<i>Mesophox intermedia</i>	25	-	R
Purple heron	<i>Ardea purpurea</i>	45	3	R
Grey heron	<i>Ardea cinerea</i>	32	-	R
Great white egret	<i>Ardea alba</i>	87	-	R
Northern pintail	<i>Anas acuta</i>	6	-	M
Garganey	<i>Anas querquedula</i>	16,633	-	M
Ruff	<i>Philomachus pugnax</i>	243	-	M
Marsh sandpiper	<i>Tringa stagnatilis</i>	210	-	M
Knob-bill goose	<i>Sarkidiornis melanotos</i>	179	-	R
Spur winged goose	<i>Plectropterus gambensis</i>	366	1	R
Black shouldered kite	<i>Elanus axillaris</i>	-	1	AM
Lanner falcon	<i>Falco biarmicus</i>	-	1	AM
Pygmy kingfisher	<i>Ispidina pictus</i>	-	7	R
Knob-billed duck	<i>Sarkidiornis melanotos</i>	250	-	R
Green sand piper	<i>Tringa ochropus</i>	39	-	M
Black shouldered kite	<i>Elanus caeruleus</i>	1	-	AM
Black kite	<i>Milvus migrans</i>	1	1	AM
Open bill stork	<i>Anastomus lamelligerus</i>	68	-	AM
Yellow wagtail	<i>Motacilla flava</i>	638	908	M
Pied Kingfisher	<i>Ceryle rudus</i>	3	-	M
Common redshank	<i>Tringa totanus</i>	6	-	R
Little stint	<i>Calidrus minuta</i>	4	-	M
Abdim's stork	<i>Ciconia abdimii</i>	2	-	AM
Common sandpiper	<i>Actitis hypoleucos</i>	1	-	M
Common moorhen	<i>Gallinula chloropus</i>	-	125	R
Purple swamp hen	<i>Porphyrio porphyrio</i>	-	105	M
Black crane	<i>Amaurornis flavirostris</i>	-	84	R
Black winged stilt	<i>Himantopus himantopus</i>	-	10	R
Fulvus duck	<i>Dendrocygna bicolor</i>	750	12	R
African pygmy goose	<i>Nettapus auritus</i>	-	16	R
Lesser jacana	<i>Microparra capensis</i>	-	269	R
Lesser moorhen	<i>Gallinula angulata</i>	-	52	R
White winged tern	<i>Chlidonias leucopterus</i>	-	7	M
Black headed gull	<i>Larus cirocephalus</i>	-	67	M
Caspian tern	<i>Sterna caspia</i>	-	7	M
Whiskered tern	<i>Chilido hybrid</i>	-	70	M
Absolute Abundance		32,442	2,218	

Note: R= Resident, M= Migrant and AM= Afro-migrant.

whistling duck (*Dendrocygna viduata*), a resident bird, with a total composition of 12,351 individuals in Ox-Bow Lake and 15 individuals in Marma Channel.

Population density of migratory and resident birds in the studied sectors of Hadejia-Nguru Wetlands, Nigeria

Overall bird species density was relatively higher in Ox-Bow Lake than Marma Channel. Garganey (*Anas querquedula*) had the highest population density of 903.76 birds/hectares. This was followed by Fulvus duck

(*Dendrocygna bicolor*) with a population density of 40.76 birds/hectares (Table 3). Yellow wagtail (*Motacilla flava*) had the highest population density in Marma Channel (24.15 birds/hectares) and 34.67 birds/hectares in Ox-Bow Lake. Generally the population density of Marma Channel was relatively low when compared with that of Ox-Bow Lake. Of the 45 species of birds recorded, 19 species had a density of 0 birds/hectares in Marma Channel while 14 birds had a density of 0 birds/hectares in Ox-Bow Lake (Table 3).

Table 3: Population density of migratory and resident birds in the studied sectors of Hadejia-Nguru, Wetlands, Nigeria.

Common names	Scientific names	Ox-Bow Lake (Density/ hectare)	Marma channel (Density/ hectare)
Cattle egret	<i>Bulbulcus ibis</i>	10.97826	0.239362
Little egret	<i>Egretta garzetta</i>	0.48913	0.638298
Intermediate egret	<i>Mesophoyx intermedia</i>	1.358696	0
Purple heron	<i>Ardea purpurea</i>	2.445652	0.079787
Grey heron	<i>Ardea cinerea</i>	1.73913	0
Great white egret	<i>Ardea alba</i>	4.728261	0
Black headed heron	<i>Egretta ardesiaca</i>	0.217391	0
Squacco heron	<i>Ardeola ralloides</i>	2.826087	0.212766
Long tail commorant	<i>Phalacrocorax carbo</i>	1.032609	1.542553
African jacana	<i>Actophilornis africana</i>	7.445652	9.015957
Spur winged lapwing	<i>Vanellus spinosus</i>	2.554348	0.505319
Black headed lapwing	<i>Vanellus tectus</i>	1.73913	0
White face whistling duck	<i>Dendrocygna viduata</i>	671.25	0.398936
Knob-bill goose	<i>Sarkidiornis melano</i>	9.728261	0
Spurg winged goose	<i>Plectropterus gambensis</i>	19.8913	0.026596
Northern pintaic	<i>Anas acuta</i>	0.326087	0
Garganey	<i>Anas querquedula</i>	903.9674	0
Ruff	<i>Philomachus pugnax</i>	13.20652	0
Marsh sandpiper	<i>Tringa stagnatilis</i>	11.41304	0
Green sand pipper	<i>Tringa ochropus</i>	2.119565	0
Black shouldered kite	<i>Elanus caeruleus</i>	0.054348	0
Black kite	<i>Milvus migranus</i>	0.054348	0.026596
Open bill stork	<i>Anastomus lamelligerus</i>	3.695652	0
Yellow wagtail	<i>Motacilla flava</i>	34.67391	24.14894
Pied Kingfisher	<i>Ceryle rudus</i>	0.163043	0
Common redshank	<i>Tringa totanus</i>	0.326087	0
Little stint	<i>Calidrus minuta</i>	0.217391	0
Abdim's stork	<i>Ciconia abdimii</i>	0.108696	0
Common sandpiper	<i>Actitis hypoleucos</i>	0.054348	0
Common moorhen	<i>Gallinula chloropus</i>	0	3.324468
Purple swamp hen	<i>Porphyrio porphyrio</i>	0	2.792553
Black crake	<i>Amaurornis flavirostris</i>	0	2.234043
Black winged stilt	<i>Himantopus himantopus</i>	0	0.265957
Fulvus duck	<i>Dendrocygna bicolor</i>	40.76087	0.319149
African pygmy goose	<i>Nettapus auritus</i>	0	0.425532
Lesser jacana	<i>Microparra capensis</i>	0	7.154255
Lesser moorhen	<i>Gallinula angulata</i>	0	1.382979
White winged tern	<i>Chlidonias leucopterus</i>	0	0.18617
Black headed gull	<i>Larus cirocephalus</i>	0	1.781915
Caspian tern	<i>Sterna caspia</i>	0	0.18617
Whiskered tern	<i>Chilido hybrida</i>	0	1.861702
Black shouldered kite	<i>Elanus caeruleus</i>	0	0.026596
Lanner falcon	<i>Falco biarmicus</i>	0	0.026596
Pygmy kingfisher	<i>Ispidina pictus</i>	0	0.18617
Knob-billed duck	<i>Sarkidiornis melanotos</i>	13.58696	0

Impacts of anthropogenic influences on the migratory and resident birds in the studied sectors of Hadejia-Nguru Wetlands, Nigeria

Canonical Correspondence Analysis (CCA) triplot performed showed that a weak relationship existed between anthropogenic activities and birds' species in the study-area (Figure 2). The Eigen value of the first axis of CCA triplot was 0.5854 while the 999 Monte Carlo permutation test performed showed that the surveyed sectors varied significantly in bird relative abundance with $p = 0.486$ ($p > 0.05$). Most of the birds were restricted to axis 1 except for *Dendrocygna viduata*, *Anas querquedula* and *Anas acuta* that were associated to axis 2. It was discovered from the CCA triplot that washing/bathing and open defecation negatively associate with the composition of *Anas querquedula* and *Anas acuta* while hunting was related to the composition of *Motacilla flava* in Ox-Bow Lake. Other birds' species were not associated to any of the anthropogenic activities in the study area. Fishing, farming and grazing were not determining factors of the migratory and resident birds' assemblage in the study-area.

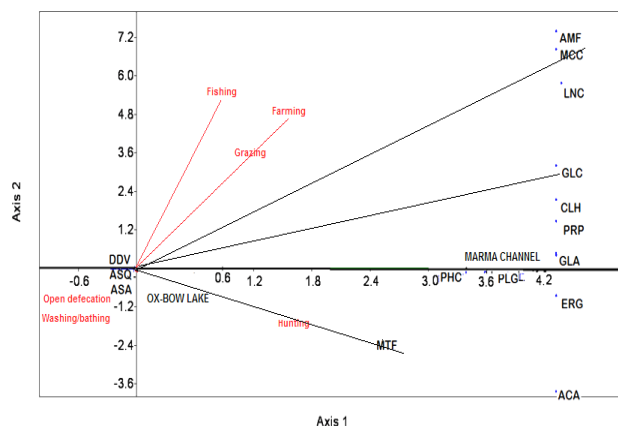


Figure 2. Triplot of the first two CCA axes of migratory and resident birds in relation to anthropogenic activities in Ox-Bow Lake and Marma channel of the Hadejia-Nguru Wetlands during the study period. **Birds abbreviation:** DDV (*Dendrocygna viduata*), PLG (*Plectropterus gambensis*), ASQ (*Anas querquedula*), ASA (*Anas acuta*), MTF (*Motacilla flava*), DRB (*Dendrocygna bicolor*), ERG (*Egretta garzetta*), PHC (*Phalacrocorax carbo*), ACA (*Actophilornis africana*), GLC (*Gallinula chloropus*), PRP (*Porphyrio porphyrio*), AMF (*Amaurornis flavirosira*), MCC (*Microparra capensis*), GLA (*Gallinula angulata*), LNC (*Lanas cirocephalus*), CLH (*Chilido hybrid*).

Similarities between the surveyed sectors of migratory and resident birds in relation to anthropogenic activities during the study period in Hadejia-Nguru Wetlands, Nigeria

Cluster analysis computed for migratory and resident birds ($\log x + 1$) transformed composition data using Bray-Curtis

similarity clearly showed that migratory and resident birds were weakly clustered based on the degree of anthropogenic activities in Ox-Bow Lake and Marma Channel of the Hadejia-Nguru Wetlands. Ox-Bow Lake and Marma Channel had similarity value of about 0.38 (Figure 3).

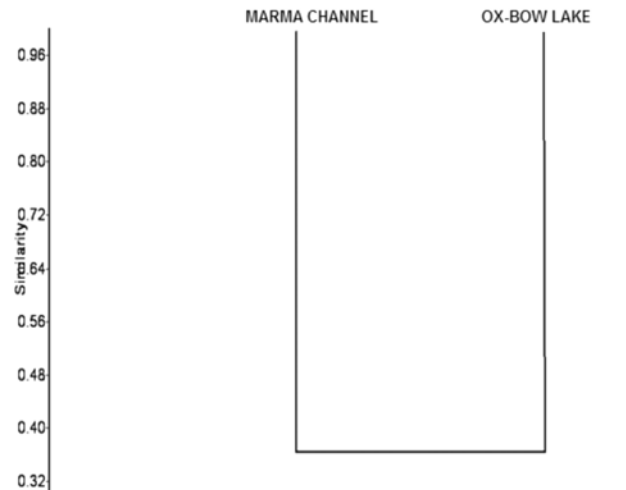


Figure 3: Dendrogram (Bray-Curtis similarity index) of $\log (x+1)$ transformed composition of migratory and resident birds in Ox-Bow Lake and Marma Channel of the Hadejia-Nguru Wetlands, Nigeria.

Discussion

Forty-five (45) species of birds were recorded in this study and 14 species were migrants. This is not in conformity with 50 species recorded by Edegbene (2018). This confirms the dwindling species composition and population density of migrant birds in Hadejia-Nguru Wetlands and it may be attributed to diverse human influences and other environmental factors which have debilitating effect on flocks of birds from Europe to wetlands in Africa. Edegbene (2018) had recently attributed the decline in abundance of migratory and other water related birds to the menace posed by invasive grass (*Typha* sp.). Coupled with invasive grass are the various anthropogenic activities which might have contributed to the reduced population density and composition of most especially migratory and Afro-migrant birds in Hadejia-Nguru Wetlands.

The preponderance of Garganey (*Anas querquedula*) is not unexpected as it has been reported recently by Edegbene (2018) as the most abundant migrant bird in the Hadejia-Nguru Wetlands. Garganey was also highly abundant in Ox-Bow Lake where anthropogenic activities were slightly high. It was generally discovered that Ox-Bow Lake with minimal disturbance harbour more birds than Marma channel with intense anthropogenic activities. Garganey (*Anas querquedula*) had the highest population density of 903.76 birds/hectares. With this it can be argued

that Garganey (*Anas querquedula*) is a pollution less tolerant species, as they thrive well in areas with varied degree of human influences as revealed from the CCA ordination performed in this study (Figure 2). The CCA triplot revealed washing/bathing and open defecation to negatively affect the composition of *Anas querquedula* and *Anas acuta*. Despite these human influences on Garganey assemblage, the number of individuals and population density still out-numbered other birds species recorded in the study-area. Earlier studies have attributed the decline in population density and assemblages of migratory and other water related birds to perturbation occasioned by human activities around wetlands catchments (Hockin *et al*, 1992; Tews *et al*, 2004; Rajpar and Zakaria, 2011).

Fishing, farming and grazing were not showed by the CCA triplot to have effects on the migratory and resident birds in the study-area. This does not totally rule out the fact that these activities had no negative influence on the population density and composition of birds in this study area (Lameed, 2012). The study affirmed that anthropogenic activities had minimal effect on the community structure of the migratory and resident birds in the studied sectors of Hadejia-Nguru Wetlands.

Similarity test showed a low association of bird population density and composition between the two surveyed sectors of Hadejia-Nguru Wetlands. Generally, the effect of anthropogenic activities affected negatively Marma channel more than Ox-Bow Lake. This may not be unconnected to the closeness of Chad Basin National Park (Dagona Water Fowl Sanctuary) at Barde Local Government Area of Yobe State to Ox-Bow Lake.

Conclusion and recommendations

The Hadejia Nguru Wetlands from this study was revealed to be affected by varied degree of human influences. Despite the fact that one of the sectors where this study was conducted is highly protected by Chad Basin National Park, the wetlands is still been disturbed by poaching and other anthropogenic influences. Therefore, more stringent and vigorous protection by the appropriate law enforcement agencies and managers of the wetlands is hereby recommended to retain the Ramsar status of Hadejia-Nguru Wetlands.

Acknowledgements

My gratitude goes to Mr. Harry Hasson (Jr.) of Nigerian Conservation Foundation (NCF) for his assistance in providing the binocular and field guide used in identification of birds. Some of the data for this study were collected during a field course exercise for my 400 level students; I appreciate their cooperation and understanding even in time of thick and thin in the field. The staff of Chad Basin National Park (Dagona Water Fowl Sanctuary) most especially Malams Kimbian Usman and Sani Mohammed are highly appreciated for helping during the field survey and providing accommodation for me and my

students. Special thanks to Mrs. Edegbene Ovie Tega Treasure for her painstaking efforts in proof reading the initial and final manuscript. Miss Bawinile Mahlaba of the Institute for Water Research, Rhodes University, Grahamstown, South Africa is hereby acknowledged for helping with the study-area map.

References

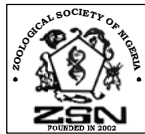
- Akinsola, O. A., Ezealor, A. U. and Polet, G. 2000. Conservation of Waterbirds in the Hadejia-Nguru Wetlands, Nigeria: current efforts and problems. *Ostrich*, 71: 118-121.
- Arimoro, F. O. Odume, O. N., Uhunoma, S. I. and Edegbene, A. O. 2015. Anthropogenic impact on water chemistry and benthic macroinvertebrate associated changes in a southern Nigeria stream. *Environ. Monit. Assess.*, 187(2): 1-14.
- Arimoro, F. O., Ikomi, R. B., Nwadukwe, F. O., Eruotor, O. D. and Edegbene, A. O. 2014. Fluctuating salinity levels and increasing pollution gradient on fish community structure and trophic levels in a small creek in the Niger Delta, Nigeria. *Intern. Aqua. Res.*, 6(4): 187-202.
- Bibby, C. J., Burgess, N. D., Hill, D. A. 1992. *Bird Census Techniques*. Academic Press, London, 67-84.
- Bird Life International 2013. State of Africa's birds: Indicators for our changing world, Bird Life International, Cambridge, UK.
- Blench, R. 2013. An overview of the context of the Jewel Project: Access rights and conflict over Common pool resources in the Hadejia-Nguru Wetlands, report of ITAD, Cambridge CB1 2AL, United Kingdom. Downloaded from <http://www.rogerblench.info/Pastoralism/PastAf/Nigeria/Hadejia-Nguru%20wetm%20lands%202003.pdf> on 15 March 2018.
- Borrow, N. and Demey, R. 2014. *Field Guide to the Birds of Western Africa*. Princeton University Press, United States.
- Bretschko G. and Moser H. 1993. Transport and retention of water in riparian ecotones. *Hydrobio.*, 25(1): 95-101.
- Edegbene, A. O. 2018. Invasive grass (*Typha domingensis*): A potential menace on the assemblage and abundance of migratory/water related birds in Hadejia-Nguru Wetlands, Yobe State, Nigeria. *Trop. Fresh. Biol.*, 27(2): 13-30.
- Edegbene, A. O. and Omovoh, G. O. 2014. Community structure and diversity of macrobenthic invertebrates in relation to some water quality parameters in a municipal river in southern Nigeria. *The Zool.*, 12: 69-77.
- Edegbene, A. O., Arimoro, F. O., Odoh, O. and Ogidiaka, E. 2015. Effect of anthropogenicity on the composition and diversity of aquatic insects of a municipal river in north-central Nigeria. *Biosci. Resear. in Today's World*, 1(1): 69-80.
- Hammer, Ø., Harper, D. A. T. and Ryan, P. D. 2001. PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica* 4(1), 9pp. http://palaeo-electronica.org/2001_1/past/issue1_01.htm.
- Hockin D., Ounsted M., Gorman M., Hill D., Keller V. and Barker M. A. 1992. Examination of the effects of

- disturbance on birds with reference to its importance in ecological assessments. *Journ. of Environ. Manag.*, 36: 253-286.
- Jckel, K. 1986. Finite sample properties and asymptotic efficiency of Monte Carlo tests. *Journ. of Appl. Economet.*, 14: 85-118.
- Lameed, G. A. 2012. Species diversity and richness of wild birds in Dagona Water Flow Sanctuary, Nigeria. *Afr. Journ. of Food, Agric., Nutrit. and Develop.*, 12(5): 6460- 6477.
- Ogunkoya, O. O. and Dami, A. 2007. Information sheet on Ramsar Wetlands (RIS); 2006-2008 Version: Dagona Sanctuary Lake, Hadejia-Nguru Wetlands. Ramsar Convention Bureau, Gland, Switzerland.
- Rajpar M. N. and Zakaria M. 2011. Bird species abundance and their correlationship with microclimate and habitat variables at Natural Wetland Reserve, Malaysia, Peninsular. *Internat. Journ. of Zool.* doi:10.1155/2011/758573.
- Soka, G. E., Pantaleo, K., Munishi, T. and Mgina, B. T. 2013. Species diversity and abundance of Avifauna in and around Hombolo Wetland in Central Tanzania. *Journ. of Biodiver. and Conserv. Res.*, 1 (1): 63-71.
- Sutherland, W. J. 1996. *Ecological census technique: A handbook*. Cambridge University Press, United Kingdom.
- Tews J., Brose U., Grimm V., Tielbörger K., Wichmann M. C., Schwager M. and Jeltsch F. 2004. Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. *Journ. of Biogeo.*, 31: 79-92.

Citation: Edegbene, A. O.

Anthropogenic impacts on the composition and population density of migratory and resident birds of selected wetlands sectors in northern Nigeria.

<http://dx.doi.org/10.4314/tzool.v17i1.6>



The Zoologist, 17: 32-38 December 2019, ISSN 1596 972X.
Zoological Society of Nigeria.