International Scholars Journals

International Journal of Agroforestry and Silviculture ISSN: 2375-1096 Vol. 9 (10), pp. 001-012, October, 2021. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Species diversity and abundance of wild birds in Dagona-Waterfowl Sanctuary Borno State, Nigeria

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Accepted 13 July, 2021

The study of bird species diversity and richness in Dagona-Waterfowl sanctuary was carried out in early wet and late dry seasons. This was to provide some information on the wild birds of the sanctuary. Dagona sanctuary is located within the Bade-Nguru wetland sector; it is one of the important bird areas strategized for the conservation of avifauna species in Sub-Sahara region, Nigeria. Line transect method was used to carry out birds' survey at three different lake sites, namely: Gatsu (Site:1), Mariam (Site: 2) and Oxbow (Site: 3). The data were analyzed with the Kolmogorov-Smirnov test to determine the distribution level of the birds. The birds' diversity was assessed using Shannon-Weiner diversity index. The results showed that bird species diversity was not equally distributed in the sites Site 2 had the highest diversity with an index of 2.74 compared to Site 1 with 1.84 and Site 3 with 1.62. Likewise, bird species diversity in the area was normally distributed birds' abundance were significantly different (P<0.05) among the three sites. Site 1 had the highest number of bird (16.36) compared to Site 2 (14.32) and site 3 (11.51). It was observed that there was a significant relationship between vegetation density and bird species diversity; because as tree density increases, diversity of bird species decreases. Therefore, there is a significant relationship between vegetation density and bird species diversity. Total number of 135 bird species in 40 families was recorded during the survey. Seventy-four percent were found in site1, sixty-three percent in Site 2 and seventy-one percent in site 3. The birds that were observed during this study were made up of resident (*Ardeidae* family), migratory (*Accipitridae* family) and palearctic species (yellow wagtail, warblers, northern shoveler and sandpipers). It can be concluded that wild birds are good indicators of the ecosystem, revealing the state of the wetland. Some sites were more disturbed, as observed in site: 1 and site: 3. It was however recommended that regular monitoring of the sites should be carried out so as to control changes in the state of wetland ecosystem.

Key words: Wetland, birds, diversity, richness, vegetation.

INTRODUCTION

Wetland is an important ecological significance area in the tropical region, which serves as a major link between the natural resource management and agricultural practices. It is a store house or hot-spot for the conservation of important species that rural inhabitants mostly depended upon as source of protein and at the same time serving deep interest of the conservationists for protection. In all the three types of wetlands (marine/coastal, inland or man-made), the most significant point of reference is water management. Therefore wetland or riparian ecosystem is a servicing point for diverse species of animals (fishes, birds, antelopes, primates and carnivores) that need water either for drinking, wallowing and abode (Ramsar Convention Bureau, 2000).

Wetlands are unique biotic communities involving diverse plants and animals that are adapted to shallow and often the dynamic water regimes. The convention on wetland of international importance on waterfowl habitat, commonly called the "convention on wetlands", Ramsar, signed in Ramsar, Iran, in 1971, defines wetlands as "areas of marsh, fen, peat land or water, whether natural or artificial, temporary or permanent, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tides does not exceed six meters". In addition, the convention provides

that wetlands "may incorporate riparian and coastal zones adjacent to the wetlands and islands or bodies of marine water deeper than six meters at low tide lying within the wetland" (Ramsar convention bureau, 2000). There are also man-made wetlands such as fish and shrimp ponds, farm ponds, irrigated agricultural land, salt pans, reservoirs, gravel pits, sewage pits, sewage farms, and canals (Ramsar Convention Bureau, 2002).

Although wetlands occupy a small portion of earth's land area, they are very important in the biosphere. Over geologic time, wetland environments produced the vegetation that has been converted today as coal. Saltwater marshes are important breeding areas for many oceanic animals and many invertebrates. Dominant animal species in freshwater wetlands include many species of insects, birds, and amphibians; few mammals also are inclusive inhabitants of this biome (Rana, 2005).

Wetlands are known for their abundance of birds. The use of wetlands and their resources is widespread among many diverse bird taxa of the world. Avian adaptation to utilize wetlands and other aquatic systems are diverse and include anatomical, morphological, behavioral changes. Anatomically, they include designs for diving and swimming, such as body compression to increase gravity, or adaptation for plunge diving from great heights (Niemi, 1985). Respiratory physiology differs dramatically in those bird species that engage in long term and deep diving (Ezealor, 2002). Morphological adaptations include bills that strain, peck, spear, store and grab, and feet that allow swimming, diving, walking on mudflat, wadding or grabbing and holding fish. Not only do body parts differ in general form, but also size of bills, legs, and flight patterns differ across a gradient of wetland edges (Ezealor, 2001). As a result of these adaptations, birds are better equipped as a group to exploit wetland resources and are often used as indicators of conditions within a wetland ecosystem (Niemi, 1985).

In Nigeria, the Hadeija-Nguru Lake (Marma channel) complex is a designated Ramsar site. The surface area enclosed is about 58,100 hectares, with an elevation of 340 to 345 m, located northeastern Nigeria (10° 22' N, 012° 46' E), with two-third of this site in Jigawa State and one-third in Yobe State. The Nguru Lake is a good representative of a natural or near-natural wetland, which embodies all the diverse flora and fauna of both the Sahel and the Sudan savanna in a single limited location. It regularly supports more than 20,000 water birds and it is also a wintering ground to many palearctic migrants. A total of 377 species of wetland birds have been recorded in this wetland. African Water bird census counts were 259,769 in 1995; 201,133 in 1996 and 324,510 in 1997 (Bibby**,** et al., 2000). Birds are good environmental indicators, revealing the state of the ecosystems such as wetland, fadama and forest edges. It also serves as dispersal agents in transferring nutrients and spores from one place to another during their migration and local movements (Niemi, 1985). The aim of this study is to assess the species diversity and abundance of wild birds in Dagona waterfowl sanctuary.

METHODOLOGY

The study area

Dagona wildlife sanctuary is located within the Bade-Nguru wetland sector. The sanctuary covers an area of 938sq.km and comprises of the 1966 legislated Bade native authority Gogoram and Zurgum Baderi forest reserves. It is situated southwest of Bade and Jakusko local government areas of Yobe state (Map 1). It is located between latitude 12°13' and 13°00' and longitude 10°00' and 11°00'. Dagona Waterfowl Sanctuary is significant by the internationally assisted conservation effort to protect the palaearctic migrant birds. It is open Sudan/scrub Sahelian vegetation, though a small part of the wetland is covered with water all year round yielding support for water birds and other wildlife found in that area.

The sanctuary is bordered by some villages and the main occupation of the villagers is pastoral farming. So, there is very high incidence of grazing by the Fulani community in the area. The waterfowl sanctuary is among the Hadeija-Nguru wetlands and the management of the sanctuary is under the jurisdiction of the Chad basin national park. The sanctuary is under a multiple use management, and there is no free access to its wild resources (Wild animals, fish, birds). However, grazing and collection of wild resource are practiced by the local population illegally, and there is therefore a need for more strict enforcement of laws (Borrow and Demey, 2000).

Method of data collection

Line Transect method was used for the bird survey. This method proved most efficient in terms of data collection per unit effort (Yallop et al., 2003). This census involves an observer moving slowly along the routes and recording all birds detected on either side of the route. The length of transects depend on the type of survey but is usually constrained by accessibility and thus may not be fixed. Line transects are often used to collect data in large, open areas and is more efficient than point count as one tends to record more birds per unit time.

The survey was carried out at three different lakes (Gatsu, Mariam and Oxbow Lakes, referred to as sites 1 to 3) in 2009 using the line transect method. A Garmin^{TM} *12* geographic positioning system (GSP) was used to mark each point. In each site, bird observation was carried out twice daily; morning between 0630 to 1000 h and evening, between 1600 and 1800 h by walking slowly along transects. The length of each transect was one kilometer and was subdivided into 50 m sub-sections to aid data collection and habitat measurements. In each site, transects were placed 100 m apart.

Birds were counted as bird seen and heard and birds in flight were also recorded. A pair of binoculars with magnification 7× 50 was used in identification of birds visually alongside a field guide (Ramsar convention bureau, 2000).

The data was tested with the Kolmogorov- Smirnov to determine whether or not the data were normally distributed and parametric tests were applied for all data.

Birds' diversity was calculated using Shannon-Weiner diversity index, H:

$$H = -\sum_{I=1}^{S} P_I \ln P_I$$

Map 1. Map of Nigeria showing location of all sectors of Chad Basin National Park.

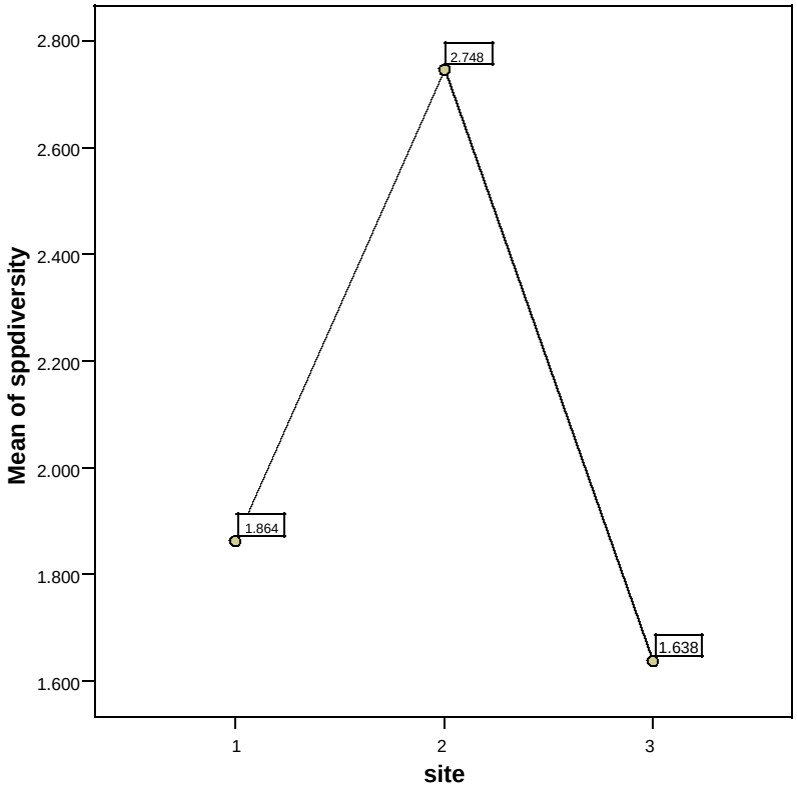

Figure 1. Bird species diversity in each site.

P_i = Proportion of individual species
S = Total number of species of the community (number seen and heard).

Average bird diversity was calculated by getting a mean of the replicated surveys of bird diversity in each point for mornings and evenings for all sites. One-way ANOVA was used to determine if the differences in mean bird species diversity across sites were significant. A post hoc test was carried out to ascertain the level of variance in bird species diversity in the three sites. Descriptive statistic such as mean, percentage and standard deviation were used for results.

The means of vegetation variables were calculated. Pearson's correlation was used to determine if there were significant associations between habitat variables and mean bird diversity. Using the bird diversity as the dependent variable, Generalized linear model (GLM) was used to test if vegetation variables had any relationship with bird diversity.

Model equation is given as,

$Y=b_0 +b_1x$
Where Y= dependent variable
b_0= corrected R^2, b_1= independent variables and x =error.

RESULTS

Species diversity

The results of this study showed that bird species diversity was normally distributed in all the sites (Table 2). A one-way ANOVA showed that bird diversity varies significantly ($P<0.05$) between the three sites. Site 2 (Maram) had the highest diversity (2.74) compared to site 1 (Gastu) (1.84) and site 3 (Oxbow) (1.62). Thus, site 2 had the highest diversity as indicated in Figure 1.

Species abundance

Bird species abundance in the area was normally distributed among the three sites (Table 3). There is significant difference ($P<0.05$) within species abundance at the three sites (Table 4). Site 1 has the highest species richness (16.36) compared to the other two sites 2 and 3 that were 14.32 and 11.51 respectively.

Figure 2 showed that site 1(Gastu lake) had the highest number of bird species (16.36) as compared to site 2 (Maram lake) (14.32) and site 3(Oxbow lake) (11.51); site 3 has the least number of bird species.

Vegetation distribution and species diversity

There is a significant relationship between vegetation densities and bird species diversity. As tree density increases, diversity of bird species decreases (figure 3). At tree density of 1.0 the bird species diversity recorded at evening is above 4,000; while at 2.0 tree density the

Table 1. One-sample Kolmogorov Smirnov test for species diversity of the sites.

Site	Z-score		N		Sig.	
	Morning	Evening	Morning	Evening	Morning	Evening
Gastu	0.6726	0.3680	18	2	0. 7562	0.9992
Maram	0.52185	0.5928	10	10	0.8737	0.9482
Oxbow	0.5558	0.9047	33	15	0.9168	0.3862

Table 2. Least significant difference for multiple comparisons of species diversity (dependent variable).

(I) site	(J) site	Mean difference (I-J)
1	2	-0.88419
	3	0.22575
2	1	*0.884193
	3	*1.109942
3	1	-0.22575
	2	-1.10994

* indicating the significant mean values.

Table 3. One-Sample Kolmogorov Smirnov Test for bird species richness in each site.

Site	Z-score		N		Sig.	
	Morning	Evening	Morning	Evening	Morning	Evening
Gastu	1.049485	0.368049	2	18	0.22	0.99
Maram	0.550998	0.654709	10	10	0.92	0.78
Oxbow	1.869643	0.810866	15	33	0.00	0.53

Table 4. Least significant difference for multiple comparisons of species richness (dependent variable).

(I) site	(J) site	Mean difference (I-J)
1	2	*2.047969481
	3	*4.850705329
2	1	-2.047969481
	3	*2.802735848
3	1	-4.850705329
	2	-2.802735848

diversity of bird is 2,500. It was noted that there were more human disturbance (anthropogenic activity) at the forested area of the lakes. Activities like fire-wood collection, poaching, bush burning and forest's fruit gathering were common. Likewise, more birds were recorded at evening period (>4,000 birds) than during the morning time (3,000 birds) within the vegetation area. This indicated greater bird activities at evening period before nest-roosting than early-morning hours' activity at Maram and Oxbow sites rather than at Gatsu, (Table 1).

Checklist of bird species in Dagona Waterfowl Sanctuary

A total number of 135 bird species in 40 families were

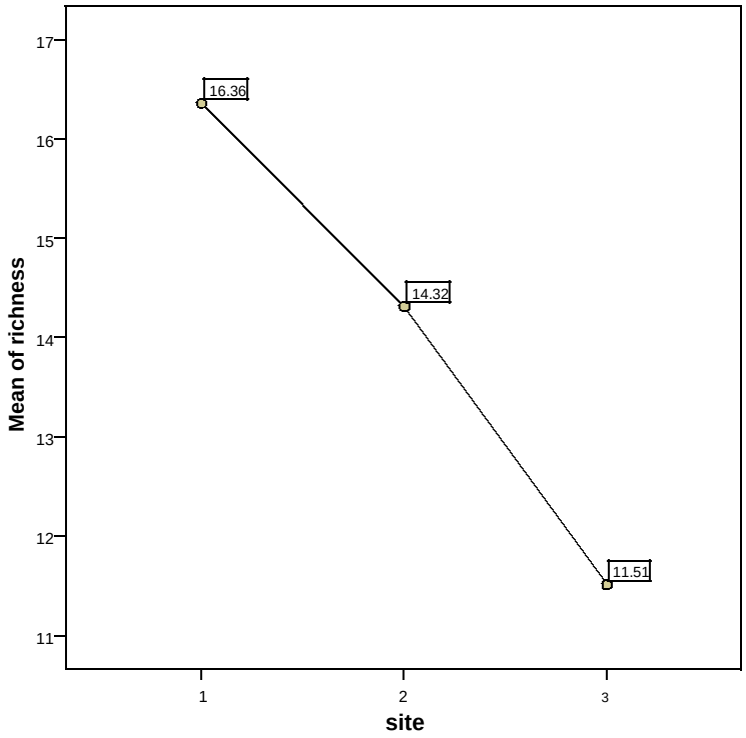

Figure 2. Mean bird species abundance of the three sites.

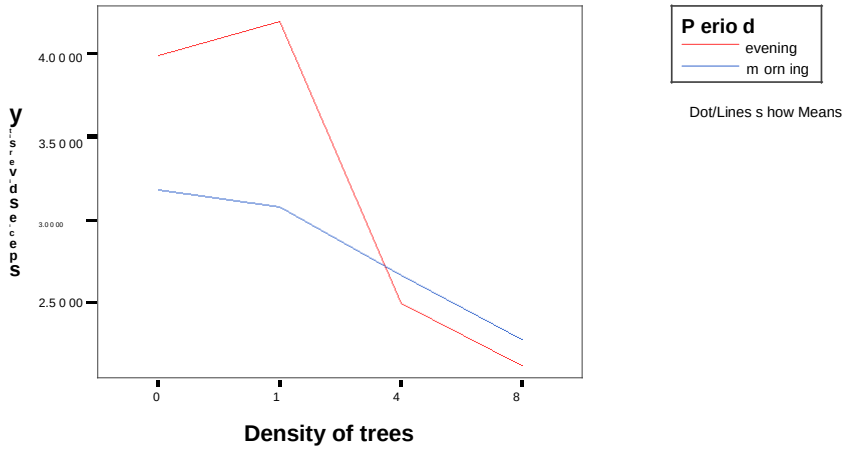

Figure 3. Relationship of tree density and bird species diversity.

recorded during the survey (Table 5). Seventy-four percent were found in Gastu Lake, sixty-three percent in Maram Lake and seventy-one percent in Oxbow Lake. More bird species were recorded at disturbed area (Site 1) compared to least disturbed sites (Sites 2 and 3).

DISCUSSION

The majority of wetland birds observed during this study were resident species, migratory and palearctic species. Some of the palearctic species recorded includes the yellow wagtail, the warblers, northern shoveler, the sandpipers and the migrants and residents were also of a considerable number. The species that are winter migrants used the wetlands area for rest and other activities while waiting for the favorable condition of their home range. They involved in activities that afford them opportunity to store enough fats for the journey back to Europe (Manu, 2000). Migrant species observed during

Table 5. Checklist of bird species in Dagona Waterfowl sanctuary.

Family	Scientific name	Common name
Accipitridae	*Accipiter tachiro*	African goshawk
	Circus ranivorus	African marsh harrier
	Accipitridae	Bird of prey
	Elanus caeruleus	Black-shouldered kite
	Melierax metabates	Dark chanting goshawk
	Kaupifalco monogrammicus	Lizard buzzard
	Circus ranivorus	Marsh harrier
	Accipiter ovampensis	Ovambo sparrowhawk
	Circus macrourus	Pallid harrier
	Acccipiter badius	Shikra
Alcedinidae	*Ceyx lecontei*	African dwarf kingfisher
	Halcyon leucocephala	Grey-headed kingfisher
	Ceryle rudis	Pied kingfisher
Ardeidae	*Egretta ardesiaca*	Black heron
	Bubulcus ibis	Cattle egret
	Egretta alba	Great egret
	Ardea cinerea	Grey heron
	Egretta intermedia	Intermediate egret
	Egretta garzetta	Little egret
	Egretta garzetta	Lesser egret
	Ardea purpurea	Purple heron
	Ardeola ralloides	Squacco heron
Anatidae	*Dendrocygna viduata*	White-faced whistling duck
	Anas querquedula	Garganey
	Sarkidiornis melanotos	Knob-billed duck
	Anas clypeata	Northern shoveler
	Plectropterus gambensis	Spur-winged goose
Alaudidae	*Galerida modesta*	Sun lark
	Eremopterix nigriceps	Black-crowned sparrow lark
	Eremopterix leucotis	Chestnut-backed sparrow lark
	Galerida cristata	Crested lark

Table 5. Contd.

Bucerotidae	*Tokus camurus*	Red-billed hornbill
	Tokus nasutus	African grey hornbill
Columbidae	*Streptopelia hypopyrrha*	African collared dove
	Streptopelia decipiens	African mourning dove
	Turtur abyssinicus	Black-billed wood dove
	Streptopelia spp	Dove
	Streptopelia sensgalensis	Laughing dove
	Oena capensis	Namaqua dove
	Streptopelia vinacea	Vinaceous dove
	Streptopelia semitorquata	Red-eyed dove
	Columba guinea	Speckled pigeon
Ciconiidae	*Anastomus lamelligerus*	African openbill stork
	Ciconia nigra	Black stork
	Leptoptilos crumeniferus	Marabou stork
	Anastomus lamelligerus	Open-bill stork
Collidae	*Urocolius macrourus*	Blue-naped mousebird
Corvidae	*Corvus albus*	Pied crow
Coraciidae	*Coracias abbyssinicus*	Abyssian rollerS
Capitonidae	*Pogoniulus scolopaceus*	Yellow-fronted tinkerbird
	Lybius vieilloti	Veillot barbet
Charadriidae	*Charadrius marginatus*	White-fronted plover
	Vanellus spinosus	Spur-winged lapwing
Cuculidae	*Centropus sensgalensis*	Senegal coucal
Estrildidae	*Euodice cantans*	African silverbill
	Estrilda troglodytes	Black rumped waxbill
	Amadina fasciatus	Cut-throat
	Lagonosticta Senegal	Red-billed firefinch
	Estrilda troglodytes	Black-rumped waxbill
	Uraeginthus bengalus	Red-cheeked cordon bleu
	Serinus leucopygius	White rumped seedeater

Table 5. Contd.

Falconidae	*Falco ardosiaceus*	Grey kestrel
Jacanidae	*Actophilornis Africana*	African jacana
	Microparra capensis	Lesser jacana
Laniidae	*Lanius meridionalis*	Southern grey Shrike
Malaconotidae	*Laniaruus barbarous*	Yellow-crowned gonolek
Motacillidae	*Motacilla flava*	Yellow wagtail
	Motacilla flava	Common wagtail
Meropidae	*Merops pusillus*	Little bee-eater
	Merops orientalis	Little green bee-eater
Musophagidae	*Crinifer piscator*	Western grey plantain-eater
	Crinifer piscator	Plantain eater
Nectariniidae	*Cinnyris pulchellus*	Beautiful sunbird
	Hedydipna platura	Pygmy sunbird
Ploceidae	*Ploceus* spp	Weavers
	Bubalornis albirostris	Buffalo weaver
	Plcepasser superciliosus	Chestut-crowned sparrow weaver
Anomalospiza	*imberbis*	Cuckoo finch
	Quelea quelea	Red-billed quelea
	Ploceidae	Bishop
	Ploceus luteolus	Lttle weaver
	Anaplectes rubriceps	Red-headed quelea
	Ploceus cucullatus	Village weavers
	Sporopipes frontalis	Speckle-fronted weaver
	Ploceus vitellinuus	Vitelline masked weaver
Passeridae	*Passer luteus*	Sudan golden sparrow
	Petronia dentate	Bush petronia
	Passer griseus	Northern grey-headed sparrow

Table 5. Contd.

Phasianidae	*Ptilopachus petroosus*	Stone partridge
	Francolinus clappertoni	Clapperton's francolin
Phalacrocoracidae	*Phalacrocorax africanus*	Long-tailed comorant
Picidae	*Dendropicos goertae*	Grey woodpecker
Psittacidae	*Psittacula krameri*	Rose-ringed parakeet
	Poicephalus sensgalus	Senegal parrot
Phoeniculidae	*Phoeniculus purpureus*	Green woodhoopoe
Pycnonotidae	*Pycnonotus barbatus*	Common bulbul
Recurvirostridae	*Himantopus himantopus*	Black-winged stilt
Sturnidae	*Lamprotornis pulcher*	Chestnut-bellied starling
	Lamprotornis purpureus	Purple glossy starling
	Lamprotornis caudatus	Long-tailed starling
Scolopacidae	*Actitis hypoleucos*	Common sandpiper
	Calidris minuta	Little stint
	Philomachus pugnax	Ruff
	Tringa glareola	Wood sandpiper
Sylviidae	*Sylvia communis*	Common whitethroat
	Sylvia curruca	Lesser whitethroat
	Hippolias polyglotta	Melodious warbler
	Sylvietta brachyuran	Northern combrec
	Hippolais spp	Olivaceous warbler
	Acrocephalus schoenobaenus	Sedge wabler
	Prinia subflava	Tawny-flanked prinia
	Sylvia spp	Warbler
	Phylloscopus trochilus	Willow warbler
Threskiornithidae	*Plegadis falcinellus*	Gossy ibis
	Threskiornis aethiopica	Sacred ibis

Table 5. Contd.

Timaliidae	*Turdoides plebejus*	Brown babblers
	Cercotrichas podobe	Black scrub robin
Turdidae	*Myrmecocichla aethiops*	Northern anteater chat
Upupidae	*Upupa epops*	Hoopoe
	Vidua macroura	Pin-tailed whydah
	Vidua orientalis	Sahel paradise whydah
Viduidae	*Vidua chalybeate*	Village indigobird
	Euplectes spp	Widow bird

because they need more protein and less of other tannins and other poisonous substances, which was required by the carnivorous birds such as the herons and the storks, because quality of food is important but not quantity (Cody, 1985). The extents to which wetland birds utilize wetland as cover and hiding areas depend and vary among wetland birds and the absence of such hiding cover may result to some species been scarce. Well vegetated wetlands seem attractive to wetland bird species (Weins, 1997).

The absence of a specific and proper nesting site may affect the abundance and diversity of wetland bird species, ducks nest over the water, while the spur-winged goose on the sand bars as the study were quite few especially the family *Accipitridae* which were observed to have moved down south. The period of the study favoured the level of water that is deep enough for wetland birds especially the water-birds to carry out their daily activities such as feeding, resting, nesting and predator escape. An important observation is that the bird diversity and abundance (richness) varies across sites and this was influenced by various factors, some of which include: wetlands provide food for birds in form of plants, vertebrates and invertebrates, some of them forage for food in wetland soil, some in the water column, and some use the dry landscape, along the streams. They may be affected by quality and quantity of food. Vegetarian birds (follivore) like white-faced whistling duck will be affected by quality of the vegetation as it was observed during this study. Birds were found on the vegetation on the water, observed during the study, also the spur-winged lapwing found on the lake shore scattered. The jacanas were observed in the vegetated part of the lake in the three sites and same for the lily trotters. The bird species found in wetlands need specific areas to carry out reproductive activities especially nesting sites (Hansen et al., 2005).

This study revealed a positive relationship between percentage ground cover, shrub density and tree density to bird recorded. More birds were observed in areas with higher percentage of ground cover (disturbed sites) and same for shrub density but fewer birds were observed as tree density increased. This observation indicating that some wetland birds used the trees as roosting site, as it was observed with some species such as the egrets, ibises, herons and storks. These species were found during the survey on the bare ground feeding along the mudflats on fishes and other vertebrate. Thus, habitat has long been used as a predictor of bird species abundance, and variety of birds has developed different preferences for habitat (Huston, 1994). Birds select vegetation variables in manner in which an individual habitat may have important effect on its access to food, mates or its vulnerability to predators (Manu, 2000).

Conclusion

Wetlands are of great variety and birds' adaptation as well as usage of wetland environment varies greatly from species to species. Some depend on wetland totally while other uses it as wintering ground. Whatever the use, wetland birds have been found to be good

indicators of the wetland environment and it must be managed sustainably. They could serve as indicators revealing the state of the wetland, as dispersal agents in transferring nutrients and spores from one wetland to another during migration and local movements (Boecklen, 1991).

Grazing, fishing and logging were the main illegal activities in the Dagona waterfowl sanctuary and this might be of detrimental effect to bird species diversity at long term. Fulani cattle grazers mostly invade the sanctuary and fell trees to get leaves for their cattle, several attempts by the authority to curtail these activities were abortive. Studies have shown that selective logging can affect the diversity of bird species positively (Birdlife International, 2000). This can be introduced in some parts of the sanctuary that are experiencing fewer disturbances of bird species at sustainable management level.

Finally, bird diversity and abundance are normally distributed among the sites in Dagona waterfowl sanctuary and some species are more abundant than the others. This is due to the fact that some parts were more disturbed than others as it was observed that Gastu and Oxbow lakes had more disturbance than the Maram lakes. Also, the communities around the Gastu and Oxbow lake were more than those of Maram which means reduced human disturbance on the habitat and the bird communities. A check-list of 135 avian compositions was generated and habitat structure affects avian diversity and the species abundance in this study. Therefore, it was recommended that regular monitoring of the site should be carried out so as to control changes in the state of wetland especially on the resident and palearctic species. Thus, protection of this ecosystem (Dagona wetland Sanctuary) will ensure better protection of resource richness (water, soil, animals and plants etc) and thereby enable future sustainable utilization of the resources. If this ecosystem is under threat by the people and poorly managed by the policy makers, then it will send a serious signal to agricultural viability of the region and invariably affect the general food productivity and security.

REFERENCES

Bibby CJ, Burgess N, Hill DA (2000). Bird Census Techniques. Academic Press, London. p. 265.

Birdlife International (2000). Threatened Birds of the World. BirdLife International, Cambridge. 2nd Edition, 2000, p. 43.

Boecklen WJ (1991). Conservation status of insects: mass extinction, scientific interest, and statutory protection. Entomology serving society: emerging technologies and challenges (ed.by S.B Vinson and R.L Metcalf) pp. 40 – 57. Entomol. Society of Africa, Lanham, Maryland.

Borrow N, Demey R (2000). Birds of Western Africa. Christopher Helm, London. 2nd Ed., p. 821.

Cody ML (1985). An introduction in habitat selection in birds. *In* Habitat selection in birds (Cody ed.) Academic Press Inc. London, pp. 191-248.

Ezealor AU (2001). Nigeria: Important Bird Areas in Africa and associated islands: Priority sites for Conservation. BirdLife Conservation series in L.D.C and M.L. Evans, eds. Newbury, U.K.: Pisces publications, No.11., pp. 673- 682.

Ezealor AU (2002). Hadejia-Nguru Wetlands. Critical Sites for Biodiversity Conservation in Nigeria, Nigerian Conservation Foundation, Lagos, pp. 66-68.

Hansen AJ, Knight RL, Marzluff JM (2005). Effects of exurban development on biodiversity: Patterns, mechanism and research needs. Ecol. Appl., 15: 1893-1905.

Huston MA (1994). Biological Diversity. Cambridge University Press, Cambridge. 3rd Editition., p. 78.

Manu SA (2000). Effects of habitat fragmentation on the distribution of forest birds in south western Nigeria with particular reference to the Ibadan Malimbes and other Malimbes, PhD thesis. University of Oxford, p. 205.

Niemi GJ (1985). Patterns of morphological evolution in bird genera of New World and Old World Peatland. Ecology, 66: 1215-1228.

Ramsar Convention Bureau (2002). What is Ramsar convention on Wetlands? Gland, Switzerland: Ramsar Convention Bureau, p. 87.

Ramsar Convention Bureau (2000). Background papers on Wetland values and Function.Gland, Switzerland: Ramsar Convention Bureau, http://www.ramsar.org/info/values.

Rana SVS (2005). Essentials of ecology and environmental sciences. Chaudhary Charan Singh University, Prentice- Hall of India, New Delhi-110001, p. 65.

Weins JA (1997). The Ecology of Bird Communities. Foundations and Patterns, Cambridge University Press, Cambridge, 1: 539.

Yallop ML, Connell MJ, Bullock R (2003): Water birds Herbivory on a newly created wetland complex: Potential implication for site management and habitat creation. Wetland Ecol. Manage., 12: 395-408.