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DIVERSITY, HABITAT UTILIZATION AND RELATIVE ABUNDANCE OF RAINY SEASON BIRD SPECIES IN DIFFERENT LAND USE TYPES OF KATSINA METROPOLIS, KATSINA STATE, NIGERIA

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ABSTRACT

The study assessed bird species diversity and relative abundance across land use types in Katsina metropolis. The point count method was adopted for bird count. Data were analyzed using the Shannon-Weiner diversity index. Simpson Index of Diversity, and descriptively. A total of 5803 individual birds belonging to 50 species in 30 families were recorded during the study period. White-billed buffalo weaver was the most abundant species with 696 individuals, followed by Laughing dove (686) and Chestnut-bellied starling (602) while the least species recorded was Yellow-crowned Gonolek and Tiny sunbird with one (1) individual each. The Shannon Weiner index ranged between 1.169-2.761 with the highest being in industrial area (2.761), recreational area (2.687), and golf course (2.647) and the lowest being road (1.16), business district (1.211) and road (1.436). The species like the laughing dove, chestnut-bellied starling and African silver bill were widely distributed across the study area, other species were restricted. The result of the study found that bird abundance and diversity was influenced by the level of anthropogenic activities of the various land uses. Efforts should be put towards creating an urban environment with green spaces to sustain birds and making urban populace realize the importance of avian species.

Keywords: Urbanization, avian species, diversity, anthropogenic activities, land use

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INTRODUCTION

Urbanization of the world has profound effects on global biodiversity, and it has been counted among the processes contributing to the homogenization of the world's biota (Lepcyk *et al*., 2017). Urban land development continues to increase, particularly in regions experiencing rapid growth (Li *et al*, 2018). The world of the twenty first century is an urban one, with the majority of people now settled in some type of city, town, or other urban areas. At present, 0.5-30% of the globes terrestrial land surface is in some form of urban land (Liu *et al.,* 2014). Though, the ecological changes produced by human land development can be dramatic, many aspects of an ecosystem remain in place. Ecosystem processes such as primary production and the trophic interactions that control energy flow through food chain and food web still occur (Ellis, 2015). Anthropogenic activities especially in the form of land-use affects biodiversity and alter how ecosystem processes occur. For example, a study on reptile communities in Caribbean islands by Jesse *et al*. (2018) revealed

that native species were most abundant in natural forest, while human dominated sites were dominated by non-native species. In another study on the influence of land use on avian diversity in North African urban environments by Aouissi *et al.* (2021), the authors confirmed the hypothesis that avian diversity decreases with urbanization and stressed the role of urban green spaces as biodiversity hotspot, and pleaded for the need of connecting them.

Understanding the ecological impact of land conversion from one dominated by vegetation to one dominated by humans is essential for maintaining ecosystem and its associated services. Birds are the most studied taxonomic group, and this is because they have been shown to be good indicator species in several studies considering the effect of urbanization on ecosystems (Suri *et al.*, 2017). Aside the fact that urbanization negatively affects avian species, cities still harbor unique habitats that allow the preservation of red listed species, endemic species and large diversity of birds. Sadly, city planners do not generally focus on urban nature of birds when planning, but instead concentrate on housing, industry and roads which continue to consume habitats (Aronson *et al*., 2014). However, conservation of areas for birds in cities not only needs effective dialogue between nature conservationist, city planners, and ornithologist and decision makers but also requires an understanding of what makes birds flourish in cities, what makes them avoid cities or perish and what makes them adapt to cities (Hedblom and Murgui, 2017). Ornithological studies investigating urban environments are scarce in Nigeria especially in the Northern Nigeria, and even more precise North Western Nigeria. Information is still fragmentary for avian species. Katsina being an urban center that keeps expanding can be planned to permit birds to thrive and thus increase the potential for positive experience of birds and nature.

The study assessed the abundance, diversity and habitat utilization of avian species in Katsina metropolis during the rainy season.

MATERIALS AND METHODS

Study area

The study was conducted in Katsina city in Katsina State (Figure 1). Urban Katsina lies between latitude 12^0 57’ 0” N to 13^0 1’ 0” N and longitude 7^0 34’0” E to 7^0 40’ 0’’E. It is located to the north of Kaita Local Government Area, west of Jibia, and to the south and east of Batagarawa. The area receives an annual rainfall of 700mm (Abaje *et al.*, 2014) and high temperature in most part of the year, with maximum day temperature of about 38^0C or higher in the months of March (Ruma and Sheikh, 2010). The area lies within the Sudan Savannah zone which combines the characteristics of both Sahel and Guinea savannah, the vegetation of the area is typically a grassland type. The area has various land use practices with different magnitude of anthropogenic disturbances.

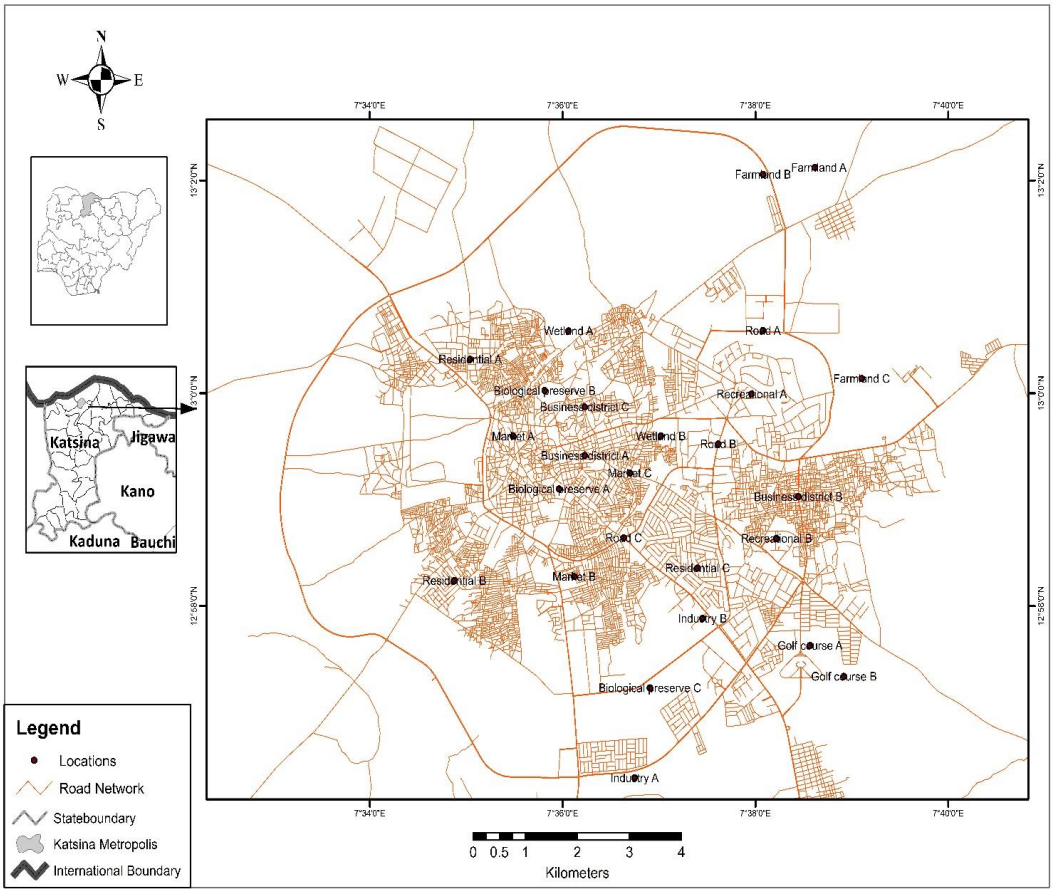

Figure 1: Map showing sample locations

Bird Survey Method

The study area was stratified into ten (10) land use gradients according to the varying anthropogenic disturbances as adapted from Blair (1996). The selected land use gradients included biological preserve, business districts, farmlands, golf course, industrial area, market areas, recreational area, residential area, roads, and wetlands. Using a fixed 50m radius, birds were counted using the point count method (Bibby *et al.*, 2000), all birds seen or heard for 6-10 minutes were recorded. Calls recorded were identified with the help of a specialist. Survey was conducted during the rainy season and between 7-9am in the morning and 5-7pm in the evening. Birds were identified and their taxonomic group properly categorized with the aid of a pair of binoculars and a field guidebook of Birds of West Africa (Borrow and Demey, 2008).

Method of Data Analysis

A checklist of bird species was compiled in Microsoft office excel showing Families, species common and scientific names, and land use type in which the birds occur. Results were presented using simple descriptive statistic such as tables, bar charts and plates. Data on avian species diversity in the various land uses was calculated using the Shannon Weiner and Simpson Indices . The relative abundance, Shannon Weiner diversity index and simpson index of diversity were calculated using the following formulas:

Relative abundance of species per land use was calculated using:

$$\text{Relative Abundance (RA)} = \frac{n}{N} \ldots (1)$$

Where *n* is the total number of birds of a particular species and N is the total number of birds of all species.

Shannon Weiner diversity index (*H*) was calculated using:

$H = -\sum_{i=1}^{s} Pi\ lnPi$ …. (2)

Where H is the Diversity Index, P_i is the Proportion of each individual (i^{th}) species in the sample, and ln (pi) is the natural logarithm of the species proportion

Values are generally between 1.5 and 3.5 in most ecological studies. The Shannon index increases as both the richness and the evenness of the community increases.

Equitability index/ evenness of avian species was calculated using:

$$E_H = \frac{H}{Hmax} \quad \ldots\ldots (3)$$

Where H is the Shannon- Weiner Diversity Index and H_{max} is the natural log of total number of species.

The Simpson Index of Diversity is was calculated by the formula:

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)} \quad \ldots\ldots (4)$$

Where n is the total number of individuals of each species and N is the total number of birds of all species. The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity. D ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity.

RESULTS

Avian checklist and Abundance

The checklist in Table 1 shows that the total number of bird species recorded during the study was 5803 birds, belonging to 50 different species and 30 families. Family Muscicapidae and sturnidae were the dominant ones represented by four species each. All species recorded had no threat status, all were of least concerned status. The most abundant species in order of ranking were white billed buffalo weaver (696), laughing dove (686) Chestnut-bellied starling (602) and little swift (532). The least abundant species were the lesser blue eared starling, tiny sunbird and Yellow crowned Gonolek, each having one individual recorded respectively.

Distribution, Relative Abundance of Avian Species across all Land Uses

The result in Table 2 reveals that Golf course, recreational area, and biological preserve are considered as the less disturbed land uses had the highest abundance with a total number 1022, 990 and 836 birds respectively whereas roads, market and business district considered as highly disturbed land uses had the lowest abundance with a total number of 92, 186 and 186 birds respectively. While certain species like the laughing dove, red-billed fire finch, African silver bill, barn swallow and little swifts were widely distributed across the various land uses, other species like the swamp palm bulbul, African thrush, black-headed gonolek and common quail were restricted to only one land use. The white billed buffalo weaver which was found in all but three land uses had the highest relative abundance (11.99%), followed by the laughing dove (11.82%) and little swift (9.17%). Yellow crowned Gonolek (0.02%) which was sighted only in the industrial land use, the little green bee- eater (0.03) which was sighted on farmland and the African grey hornbill and lesser kestrel (0.03%) which were sighted only in Golf course (0.05%) had the lowest relative abundance.

Table 1: Bird species encountered in Katsina Metropolis

Family	Common Name	Scientific Name	Abundance	Conservation Status
Accipitridae	Black -shouldered kite	*Elanus axillaris*	10	LC
Alaudidae	Crested lark	*Galerida cristata*	77	LC
Apodidae	Common swift	*Apus apus*	55	LC
	Little swift	*Apus affinis*	532	LC
	African palm swift	*Cypsiurus parvus*	8	LC
Ardeidae	Cattle egret	*Bubulcus ibis*	102	LC
Bucerotidae	African grey hornbill	*Lophoceros nasutus*	3	LC
	Red-billed hornbill	*Tockus erythrorhynchus*	7	LC
Buphagidae	Yellow-billed oxpecker	*Buphagus africanus*	10	LC
Charadriidae	Black-headed lapwing	*Vanellus tectus*	122	LC
Columbidae	Laughing dove	*Spilopelia senegalensis*	686	LC
	Speckled pigeon	*Columba guinea*	89	LC
Coraciidae	Abyssinian Roller	*Coracias abyssinicus*	2	LC
Corvidae	Piacpiac	*Ptilostomus afer*	107	LC
Cuculidae	Senegal coucal	*Centropus senegalensis*	30	LC
Estrildidae	Red billed fire finch	*Lagonosticta senegala*	474	LC
	African Silver bill	*Euodice cantans*	356	LC
	Red cheeked cordon bleu	*Uraeginthus bengalus*	11	LC
Falconidae	Common kestrel	*Falco tinnunculus*	42	LC
	Lesser kestrel	*Falco naumanni*	2	LC
Hirundinidae	Barn swallow	*Hirundo rustica*	258	LC
Laniidae	Yellow-billed shrike	*Lanius Corvinus*	42	LC
Leiothrichidae	Brown Babbler	*Turdoides plebejus*	40	LC
Lybiidae	Bearded barbet	*Lybius dubius*	4	LC
Malaconotidae	Black-headed Gonolek	*Laniarius erythrogaster*	3	LC
	Yellow-crowned Gonolek	*Laniarius barbarous*	1	LC
Meropidae	Little green bee eater	*Merops orientalis*	2	LC
Muscicapidae	Yellow-footed flycatcher	*Muscicapa sethsmithi*	90	LC
	Northern Anteater chat	*Myrmecocichla aethiops*	23	LC
	Common nightingale	*Luscinia megarhynchos*	37	LC
	Cassins flycatcher	*Muscicapa cassini*	25	LC
Nectariniidae	Tiny sunbird	*Cinnyris minullus*	1	LC
	Beautiful sunbird	*Cinnyris pulchellus*	15	LC
Passeridae	Northern grey-headed sparrow	*Passer griseus*	63	LC
Pycnonotidae	Common bulbul	*Pycnonotus barbatus*	128	LC
Phoeniculidae	Greenwood hoopoe	*Phoeniculus purpureus*	17	LC
Ploceidae	village weaver	*Ploceus cucullatus*	542	LC
	White-billed buffalo weaver	*Bubalornis albirostris*	696	LC
	Northern red bishop	*Euplectes franciscanus*	14	LC
Pycnonotidae	Common Bulbul	*Pycnonotus barbatus*	128	LC
	Swamp palm Bulbul	*Thescelocichla leucopleura*	3	LC
Rallidae	Common moorhen	*Gallinula chloropus*	4	LC
Sturnidae	Chestnut - bellied starling	*Lamprotornis pulcher*	602	LC
	Long-tailed glossy starling	*Lamprotornis caudatus*	158	LC
	Bronze-tailed starling	*Lamprotornis chalcurus*	16	LC
	Lesser blue eared starling	*Lamprotornis chloropterus*	1	LC
Turdidae	Song thrush	*Turdus philomelos*	12	LC
	African thrush	*Turdus pelios*	5	LC
Viduidae	Village indigo bird	*Vidua chalybeate*	188	LC
	Pin-tailed Whydah	*Vidua macroura*	8	LC

Source: Field survey, 2022

Table 2: Distribution and relative abundance of avian species across all the selected land uses

Common Name	Scientific Name	Res	Bp	Fld	Rd	Mkt	Bd	Wtld	Ind	Rec	Gc	RA (%)
Black -shouldered kite	*Elanus axillaris*	0	4	0	0	0	0	0	0	0	6	0.17
Crested lark	*Galerida cristata*	0	24	15	0	0	0	0	0	38	0	1.33
Common swift	*Apus apus*	15	30	0	0	0	0	0	0	0	10	0.94
Little swift	*Apus affinis*	57	80	0	0	75	101	25	0	180	14	9.17
African palm swift	*Cypsiurus parvus*	0	0	0	0	0	0	8	0	0	0	0.14
Cattle egret	*Bubulcus ibis*	0	10	32	0	0	0	38	4	15	3	1.76
African grey hornbill	*Lophocerus nasutus*	0	0	0	0	0	0	0	0	0	3	0.05
Red-billed hornbill	*Tockus erythrorhynchus*	0	0	0	0	0	0	0	1	1	5	0.12
Yellow-billed oxpecker	*Buphagus africanus*	0	10	0	0	0	0	0	0	0	0	0.17
Black-headed lapwing	*Vanellus tectus*	0	0	0	0	0	0	0	4	0	118	2.1
Laughing dove	*Spilopelia senegalensis*	149	160	12	16	8	20	21	65	95	140	11.82
Speckled pigeon	*Columba guinea*	9	0	12	0	0	0	38	15	0	15	1.53
Abyssinian Roller	*Coracias abyssinicus*	0	0	2	0	0	0	0	0	0	0	0.03
Piacpiac	*Ptilostomus afer*	0	12	95	0	0	0	0	0	0	0	1.84
Senegal coucal	*Centropus senegalensis*	0	12	0	0	0	0	0	2	0	16	0.52
Red billed fire finch	*Lagonosticta senegala*	97	75	3	0	38	0	71	73	55	62	8.12
African Silver bill	*Lonchura cantans*	77	50	0	4	0	4	47	57	32	85	6.13
Red cheeked cordon bleu	*Uraeginthus bengalus*	0	0	0	0	0	0	0	0	0	11	0.19
Common kestrel	*Falco tinnunculus*	3	8	4	0	0	2	4	12	9	0	0.72
Lesser kestrel	*Falco naumanni*	0	0	0	0	0	0	0	0	0	2	0.03
Barn swallow	*Hirundo rustica*	17	26	0	0	32	10	100	0	73	0	4.45
Yellow-billed shrike	*Lanius corvinus*	0	0	0	0	0	0	0	18	2	22	0.72
Brown Babbler	*Turdoides plebejus*	0	0	0	0	0	0	0	40	0	0	0.69
Bearded barbet	*Lybius dubius*	0	0	4	0	0	0	0	0	0	0	0.07
Black-headed Gonolek	*Laniarius erythrogaster*	0	0	0	0	0	0	0	0	0	3	0.05
Yellow-crowned Gonolek	*Laniarius barbarous*	0	0	0	0	0	0	0	1	0	0	0.02
Little green bee eater	*Merops orientalis*	0	0	2	0	0	0	0	0	0	0	0.03
Yellow-footed flycatcher	*Muscicapa sethsmithi*	16	8	0	0	0	0	0	49	17	0	1.55
Northern Anteater chat	*Myrmecocichla aethiops*	0	0	0	0	0	0	0	0	23	0	0.4
Common nightingale	*Luscinia megarhynchos*	0	0	0	0	0	0	0	27	10	0	0.64
Cassins flycatcher	*Muscicapa cassini*	0	0	0	0	0	0	25	0	0	0	0.43
Tiny sunbird	*Cinnyris minullus*	0	0	0	0	0	0	0	0	1	0	0.02
Beautiful sunbird	*Cinnyris pulchellus*	10	0	0	0	0	0	0	3	2	0	0.26
Northern grey-headed sparrow	*Passer griseus*	12	0	24	0	0	0	7	6	14	0	1.09
Common quail	*Coturnix coturnix*	0	0	0	0	0	0	0	0	0	80	1.38
Greenwood hoopoe	*Phoeniculus purpureus*	0	0	0	0	0	0	2	7	8	0	0.29
village weaver	*Ploceus cucullatus*	160	63	0	58	33	49	20	69	55	35	9.34
White-billed buffalo weaver	*Bubalornis albirostris*	21	225	112	0	0	0	112	37	34	155	11.99
Northern red bishop	*Euplectes franciscanus*	0	2	4	0	0	0	8	0	0	0	0.24
Common Bulbul	*Pycnonotus barbatus*	27	0	0	5	0	0	9	46	34	7	2.21
Swamp palm Bulbul	*T. leucopleura*	0	0	0	0	0	0	3	0	0	0	0.05
Common moorhen	*Gallinula chloropus*	0	0	0	0	0	0	0	0	0	4	0.07
Chestnut - bellied starling	*Lamprotornis pulcher*	11	160	80	7	0	0	110	47	60	127	10.37
Long-tailed glossy starling	*Lamprotornis caudatus*	2	7	25	2	0	0	27	12	38	45	2.72
Bronze-tailed starling	*Lamprotornis chalcurus*	2	0	0	0	0	0	0	12	2	0	0.28
Lesser blue eared starling	*L. chloropterus*	0	0	0	0	0	0	0	0	0	1	0.02
Song thrush	*Turdus philomelos*	0	0	0	0	0	0	0	0	5	7	0.21
African thrush	*Turdus pelios*	0	0	0	0	0	0	0	0	0	5	0.09
Village indigo bird	*Vidua chalybeate*	30	24	0	0	0	0	37	29	33	35	3.24
Pin-tailed Whydah	*Vidua macroura*	0	0	0	0	0	0	2	0	0	6	0.14
Total		**715**	**990**	**426**	**92**	**186**	**186**	**714**	**636**	**836**	**1022**	

Note: *Res, Residential, BP, Biological preserve, Fld, Farmland, Mkt, Market, Bd, Business district, Wtld, Wetland, Ind, Industry, Rec, Recreational area, Gc, Golf course, RA, Relative Abundance*

Bird species Diversity and Richness

In the ten land uses, *H* range was between 1.169 and 2.761 while *D* range was between 0.567 and 0.927. Simpson diversity and Shannon-Weiner diversity index were higher in industry (*H*= 2.761, *D*= 0.927), recreational area (*H*=0.908, *D*=2.687) and Golf Course (*H*=2.647, *D*=0.908) (Table 3). Wetland followed with a diversity of 2.577. Road, business district and market study sites had the lowest diversity index with values of 1.16, 1.211 and 1.436 respectively. Equitability index were higher in market (E_H=0.892), industry (E_H=0.88) and wetland (E_H=0.846) but lower in roads (E_H=0.652), business district (E_H=0.676) and farmland (E_H=0.76). Bird species richness for all land uses shows that from all 50 species recorded during the survey, 28 species were recorded in industrial area, 25 in recreational area and 24 in wetland. Market, road and business district had the lowest species richness at 5 and 6 species respectively.

Table 3: Diversity indices of bird species for the selected land uses

Land Use	Richness	Simpson Index	SID	Shannon-Weiner Index	Equitability Index
Residential	18	0.135	0.865	2.293	0.793
Biological preserve	20	0.125	0.875	2.38	0.794
Farmland	15	0.168	0.832	2.059	0.76
Road	6	0.433	0.567	1.169	0.652
Market	5	0.263	0.737	1.436	0.892
Business district	6	0.376	0.624	1.211	0.676
Wetland	24	0.095	0.905	2.577	0.846
Industry	28	0.073	0.927	2.761	0.88
Recreational	25	0.092	0.908	2.687	0.835
Golf course	21	0.092	0.908	2.647	0.794

Note: SID, Simpson Diversity Index

Habitat utilization by Birds

As shown in Table 4, majority of birds utilized tree species as resting site while few utilized trees as nesting site. A total number of 30 species were sighted on trees with the *Centropus senegalensis*, *Ploceus cucullatus* and the *Bubalornis albirostris* using trees as nesting site. The birds utilized neem tree which was the dominant tree species in the study area, leafless Acacia specie was the most preferred nesting site for the *Bubalornis albirostris*. 9 of the bird species were seen on electric pole, 15 of the birds were seen on fences, 4 of the birds were seen on/in building roofs with 2 species using building roofs as nesting site. The *Ptilostomus afer* was the only bird species sighted on Gp tank using it as source of water, *Elanus axillaris* was the only bird sighted on greenhouse frame and the *Lonchura cantans* was seen on street light using it as resting and nesting site. Other bird species like the *Coturnix coturnix* and *Vanellus tectus* that weren't sighted on any of the facilities were seen utilizing grass patches and bare ground.

(a) Bubulcus ibis (b) *Vanellus tectus* (c) *Lamprotornis caudatus* (d) *Tockus eryrthrohyncus* (e) Centropus senegalensis (f) *Vidua macroura* (g) *Lamprotornis pulcher* (h) *Corturnix corturnix* (i) *Vidua chalybeate* (j) *Lonchura cantans* (k) *Galerida cristata*

Table 4. Utilization of urban facilities by birds

Scientific Name	Electric pole/wire	Mast	Fence	Building	Gp tanks	Trees/Shrub	Green house frame	Street light
Elanus axillaris						RS	RS	
Galerida cristata								
Apus apus								
Apus affinis								
Cypsiurus parvus						RS		
Bubulcus ibis								
Lophoceros nasutus						RS		
Tockus erythrorhynchus				RS		RS		
Buphagus africanus			RS					
Vanellus tectus								
Spilopelia senegalensis	RS		RS	RS/NS		RS		
Columba guinea				RS				
Coracias abyssinicus						RS		
Ptilostomus afer					DS	RS		
Centropus senegalensis						RS/NS		
Lagonosticta senegala	RS		RS					
Lonchura cantans	RS		RS			RS		RS/NS
Uraeginthus bengalus			RS			RS		
Falco tinnunculus								
Falco naumanni						RS		
Hirundo rustica	RS							
Lanius corvinus		RS	RS			RS		
Turdoides plebejus			RS					
Lybius dubius						RS		
Laniarius erythrogaster						RS		
Laniarius barbarous						RS		
Merops orientalis						RS		
Muscicapa sethsmithi			RS					
Myrmecocichla aethiops						RS		
Luscinia megarhynchos			RS					
Muscicapa cassini						RS		
Cinnyris minullus								
Cinnyris pulchellus			RS			RS		

Passer griseus	RS	RS	NS	RS
Coturnix coturnix				
Phoeniculus purpureus				RS
Ploceus cucullatus		RS		NS/RS
Bubalornis albirostris				NS/RS
Euplectes franciscanus				RS
Pycnonotus barbatus		RS		RS
Thescelocichla leucopleura				RS
Gallinula chloropus				
Lamprotornis pulcher	RS			
Lamprotornis caudatus	RS			RS
Lamprotornis chalcurus	RS			RS
Lamprotornis chloropterus				RS
Turdus philomelos		RS		
Turdus pelios				
Vidua chalybeate	RS	RS		
Vidua macroura				RS

Note: RS= Resting Site, NS= Nesting Site, DS= Drinking Source

DISCUSSION

A total number of bird species recorded during the rainy season period in urban Kastina was 5803 birds. This was higher than the abundance of birds recorded during the dry season (Musa *et al.*, 2023). The observed difference in abundance between seasons (dry season=2865, rainy season=5803) indicates that season plays a vital role in terms of bird species abundance. According to studies by Mengesha *et al.* (2011) and Bideberi (2013) seasonality affects food and cover availability as seasonal variation in the amount of rainfall and spatial and temporal microhabitat conditions affect reproduction, survival, and the availability of various food items for birds. Golf Course had the highest abundance of birds. During the study, it was observed that golf course was one amongst the few green spaces in the study area, with diversity of vegetation (tree and herbaceous species) and presence of water body. This result of this study is consistent with the results of Colding and Folke (2009) who concluded that golf courses enhance local biodiversity of an area by providing a greater variety of habitat than intensively managed agricultural areas. White-billed buffalo weaver, laughing dove and chestnut-bellied starling were the most abundant species. These bird species especially the laughing dove were found everywhere including human settlements. The laughing dove has a strong association with the presence of humans, especially with the discovery of its nests near human settlements (Hanane, 2015; Almaliki, 2023).

High relative abundance of certain granivorous birds like the laughing dove, African silver bill and red billed fire-finch was recorded in human dominated areas like residential area and other highly disturbed land uses. These bird species have adapted to anthropogenic activities and rarely flee in the presence of humans. The findings of this research coincides with Sekercioglu (2012); Coelho *et al.* (2016) who

reported that certain granivorous and omnivorous birds have been commonly associated with anthropogenic land covers and the increase of these avian groups in anthropogenic landscapes has been linked with their ability to track spatiotemporal resources such as seeds, fruits and small sized vertebrates and their tolerance to human modified landscapes. Species of birds like the common moorhen and barn swallow were sighted in areas that had water body or were close to water bodies. The existence of water bodies like lakes or rivers in certain land uses brought about presence of birds associated with water. This agrees with Chamberlain *et al.* (2010). The authors described water areas as places that can provide more opportunities for birds to forage and nest, and described such areas as being responsible for increase in bird diversity. Of the recorded 50 species, some were specialist (restricted to one or two land uses) and others were generalist (occurring in all and/or almost all land uses). During the survey, some birds were found roosting or picking nesting materials in one area and found nesting or feeding in other areas. This goes a long way to show that birds occupy variety of habitat and each species is restricted in distribution by its requirements in terms of food, nest, cover, migration stop overs and other requirements. Several studies indicated multiple stressors such as anthropogenic noise and human disturbance known to affect avian health and behavior force birds to avoid, adapt to, or exploit urban areas, ultimately influencing their distributions and community composition along urban gradient (Blair, 1996; Grimm, 2008; Issakson, 2018).

The high diversity recorded in recreational, industrial and golf course areas was clearly due to the presence of trees and the heterogenous nature of the land uses, having in combination, small farmlands, water bodies, trees and grass patches. The result of this study agrees with other studies, where it was observed that complex and heterogeneous landscapes provided a high number of niches and increased resources available to birds thereby increasing species diversity, interaction and foraging behavior (Tews *et al*., 2004; Schuldt *et al.*, 2019: Seibold *et al*., 2013). Unlike other undisturbed land uses, Farm land recorded low species richness. This was attributed to farmlands nearness to road, the presence of only few tree species and the monocultural crop fields observed during the survey. This is in line with Stanton *et al*. (2018) but in contrast with the findings of Katuwal *et al*. (2022); the former observed decline in farmland birds due to intensive agriculture, hunting, pesticide, and increasing anthropogenic pressure while the latter recorded high species richness in some farmlands in low land Nepal, and suggested that cropping practices (mixed cropping), season, crop types, and number of trees were the fundamental factors that shape assemblages of farmland birds. Business districts, roads and markets were the highly disturbed land uses, characterized by human noise, anthropogenic activities and car honks, these areas recorded low species diversity. Synanthropic bird species were the most sighted. The result of this study is in agreement with other studies where lower bird species diversity was recorded near road, especially vicinity of roads carrying heavy traffics (Summers *et al*., 2011; Polak *et al.*, 2013).

Almost all species were found on trees using trees as either nesting site, roosting site or source of nesting material. This study reveals the utmost importance of trees in urban environment as birds sighted across land uses were mostly found on trees, including roadside trees. In a study by Mardiastuti (2021) on the role of urban trees in attracting wild birds, the author revealed that trees provide nectar, fruits, seeds and insects as food for birds, nest materials and function as birds' cover and nesting material. Other bird species including those found on trees were seen on urban artificial facilities such as roof of houses, electric poles and fences using these facilities as nesting and resting sites. This shows how well these bird species have adapted to urban environment, utilizing available artificial facilities for survival. Isaksson (2018) reported that although bird species decline once an area is urbanized, many bird species flourish by exploiting anthropogenic resources such as food sources and artificial nesting holes like nest boxes and under roof tiles.

CONCLUSIONS

The results of this study provided valuable information regarding avian species diversity and utilization of urban facilities across various land uses in urban katsina. The findings confirm that bird diversity is affected by the level of anthropogenic disturbance and habitat heterogeneity. Industrial, recreational, golf course and biological preserve areas had the highest species diversity and abundance which is attributed to the fact that these areas were green and had resources required for survival of birds. The study also showed that trees and other urban artificial facilities are utilized by birds as these facilities serve as nesting materials, nesting and roosting sites. It can be concluded that vegetation and level of anthropogenic disturbance altered avian abundance, distribution and diversity across land use types. Finally, it is Important that urban decision makers implement land use plans that will benefit avian and urban biodiversity at large.

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