

Bird Species Abundance and Diversity in Montane Forest Research Station, Jos, Plateau State

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ABSTRACT

Forest is the most significant habitat for birds by supporting around 75% of all bird species while only 45% of all bird species have adapted to humans modified habitats. The research was conducted in the Montane Forest Research Station, Jos, Plateau State, in order to determine the abundance, diversity and effect of habitat types on bird's species diversity. Fifteen transects of 200m were laid in the three habitat types (riparian forest, farmland and residential area) using stratified random sampling method. The data collected were analysed using R console. Shannon Weiner diversity index was used to analyse species diversity while generalized linear model was used to determine the effect of the habitat variables on bird species diversity. The result showed a total number of 1466 individual birds belonging to 17 families and 60 bird species were sighted. The abundance of birds was highest in riparian forest (2252), farmland (1732) and Residential area (1094) with no significance difference ($p=0.177$). Species richness was higher in the riparian forest (57), farmland (49), and the residential area (44). It also revealed that bird diversity index was highly significant. Riparian forest had the highest diversity (4.77), and the species were more evenly distributed (0.6) as compared to the other habitat types. The higher the number of trees and canopy cover the higher the diversity of species as was observed in the riparian forest where forest species that weren't seen in the other habitats were found. The farmland and residential areas also hold a considerable number of some generalist bird species due to some patches of vegetation found in the habitat. Therefore, conservation efforts should be directed towards keeping vegetation intact in human dominated areas, as it serves as repository for bird species which are ecologically important. Hence, planting trees (economic, fruit and ornamental) should be encouraged.

Keywords: Bird species, diversity, abundance, richness, habitat

Introduction

Birds fulfill many ecological functions in their habitats; they are bio-indicators of healthy ecosystems (Sekercioglu, 2012). In addition,

insectivorous species and raptors regulate disease vectors, including mosquitoes and rodents, scavenger birds, such as the pied crow, contribute to biomass recycling and to some degree reduce

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levels of disposable water (Vandermeer and Perfecto, 2000). Birds are also important in plant pollination as demonstrated by sunbirds, which participate in crossbreeding of flowering plants, especially those with bird-pollination syndrome (Sun *et al.*, 2017). Due to the important role that birds plays in maintaining ecosystems and supporting biodiversity, many seek their protection to manage biological threats and efficiently protect the environment (Wenny *et al.*, 2011).

Some agro ecosystems can also harbor a substantial portion of the biodiversity found under the original land cover (Perfecto, 2001) and can buffer and complement protected areas (Curran *et al.*, 2004) for example, areas planted with rice (*Oryza spp*) are also used by a variety of bird species during the non-growing season and this plays an important conservation role in many part of the world (Elphick *et al.*, 2010). Agricultural intensification poses the largest threats to biodiversity besides climate change and spread of exotic, invasive species (Pullin, 2002). During the last decades, agricultural intensification has led to a serious decline in biodiversity, including that of farmland birds. (Chamberlain *et al.*, 2000; Donald *et al.*, 2001). This decline still continues (Gregory *et al.*, 2005) leading to decline in diversity and number of species of conservation concern and could result to the endangerment of species.

Tropical mountains are acknowledged for harbouring high diversity of avifauna with many coexisting species within habitat types (Jankowski *et al.*, 2009). Human activities such as farming, settlement, charcoal making, pole cutting and firewood collection have contributed in removal of forests (degradation) which has extensively damaged the natural habitat of birds, affecting their variety and variability (Storch *et al.*, 2003). Uluguru mountains is known as an important Bird Area due to its high diversity of avifauna in Africa including endemic species such as Uluguru bush-shrike and threatened species such as love ridge sunbird (Burgess *et al.*, 2002). The mountains have faced land use changes at the

expense of their forest resources. Birds are habitat specific and some can occupy more than one habitat type, however because of land use changes, most of the birds have been displaced from their original habitats (Burgess *et al.*, 2002). Nevertheless, human dominated and agricultural habitats vary a lot and therefore the effect on birds can be very different (Tworek, 2002). Responses of birds to habitat changes differ depending on their strategies, some benefit from habitat change, while for others it is a principal threat (Tworek, 2002).

Birds are very visible and integral part of the ecosystem and they occupy many trophic levels in a food chain ranging from consumers to predators. Their occurrences have been helpful as environmental health indicator, plant pollinators and seed dispersal as well as pest controller (Hadley *et al.*, 2012; Ramchandra, 2013). The Study on diversity and abundance of birds with respect to different habitat types is important since this will provide an understanding on the avifauna diversity and abundance within natural and human occupied habitats.

Generally, it has been reported that human activities such as farming, settlement, pole cutting and fire-wood collection have contributed in removal of tropical forest which has extensively damaged the natural habitat of birds affecting their variety and variability and also affecting the role they play in that ecosystem. This can displace the birds from their original habitat (Burgess *et al.*, 2002). Many studies in time past in the Montane station has focused only on other component of the forest ignoring the role birds perform in a functional ecosystem. There is no data on the avian community in the Montane Forest Research Station, hence the need to conduct this research.

The aim of this study is to investigate the effects of habitat types on bird species diversity and abundance in the Montane Forest Research outstation (MFRS), Jos.

Materials and Methods

In this survey, line transect was used (Bibby *et al.*, 2000). Habitat types and transect route was selected using stratified random sampling. Five transect in each habitat type was laid. During each visit all birds seen or heard along each transect were recorded and within 100m in the opposite direction. Start point of each transect was marked with a global positioning system (GPS). Each transect was 200m and were placed 100m apart to avoid counting the same individual twice and to ensure that each of the bird counts were independent. Field survey was carried out between the hours of 6:30 am to 10:30 pm daily. A pair of oblivion binocular was used to identify birds at a distance, birds' field guide by Borrow and Demey was used to confirm identifications. Survey was carried out in habitat types namely; farmland, human settlement (residential area) and riparian forest.

Vegetation measurements such as; species of trees and shrubs, numbers of trees and shrubs per transect, crop type grown on farmland and percentage canopy cover were measured. Species of trees, shrubs and crops was identified by a plant taxonomist, individual trees found in each transect were counted, canopy cover was measured in percentages with the wrong side of the binocular. Shrubs were between 3- 6 metres while trees were between 7 metres and above with a girth of 10cm (FAO, 2000).

Statistical Analysis

R console (statistical package, version 2.12.2) was used for statistical analyses. Microsoft Excel (2003) was in addition used for inputting data, some plots and illustrations.

For each transect, total number of birds was calculated as; (the number of birds seen) + (number of birds heard).

Shannon wiener diversity index H' , was used to calculate species diversity using the formula below:

$$H' = - \sum_{i=1}^S p_i \ln p_i$$

Where: H' = Diversity of species; S = Number of species; P_i = the proportion of individuals abundance of the i^{th} species and \ln =natural log base.

Species Evenness was also calculated using the formula: ($H'/\ln(S)$)

Where: H' = Diversity of species and $\ln(S)$ natural log of sum

A Generalized Linear Model was used to calculate the effects of vegetation variables on the three habitat types and their relationships. Analysis of variance (ANOVA) was used to check the level of variation and post hoc was used to compare the variation in each pair of habitat variable.

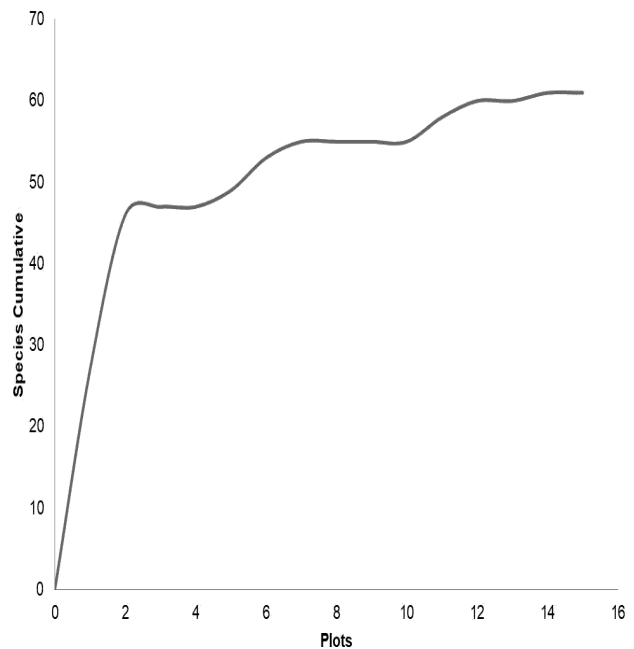


Figure 1: Species Cumulative curve

The above graph shows that as you keep progressing new species increases, then it reaches

to a certain level (above 40) where there are no new species found.

Results

A total of 1456 birds belonging to 17 families across 60 species were sighted in the study site during the study.

Table 1 shows the bird species were more abundant in the Riparian forest (2252), secondly the farm land (1732) and lastly the residential area (1094). Bird species richness was highest in the Riparian forest (57 species), followed by the farmland (49 species) and lastly the residential area (44 species). Species was more evenly distributed in the riparian forest (0.6) followed by the Residential area (0.5), then the farmland (0.4). Bird species diversity was highest in the riparian forest (4.77), followed by the farmland (3.23) and then the residential area (3.21).

Table 2 shows the number of occurrence of bird species in the three habitat types. From the results, the highest abundance were; laughing dove, Scarlet-chested sunbird, Common bulbul, Black shouldered kite, while the least abundant were; African grey hornbill, Common wattle eye, Cattle egret, Bearded barbet, Northern red bishop, Orange-cheeked waxbill, Singing cisticola, Cardinal woodpecker, Speckled mousebird, Yellow-crowned Tchagra, Yellow-fronted thinker bird. Some bird species were not recorded in some habitat type.

Figure 2 shows the Riparian forest had the highest abundance (n= 2252), followed by the farmland

(n=1732) and finally the Residential area (n=1094), though there was no variation between the different habitat types (p= 0.67).

Figure 3 show that the riparian forest had the highest diversity (4.77), followed by the farmland (3.23) and finally the Residential area (3.21).

Figure 4 shows the relationship between species diversity and canopy cover which was significant. Riparian forest had the highest canopy cover while residential area had the least canopy cover. As canopy cover increases, the diversity of birds' increases and as canopy cover decreases, the diversity of birds also decreases.

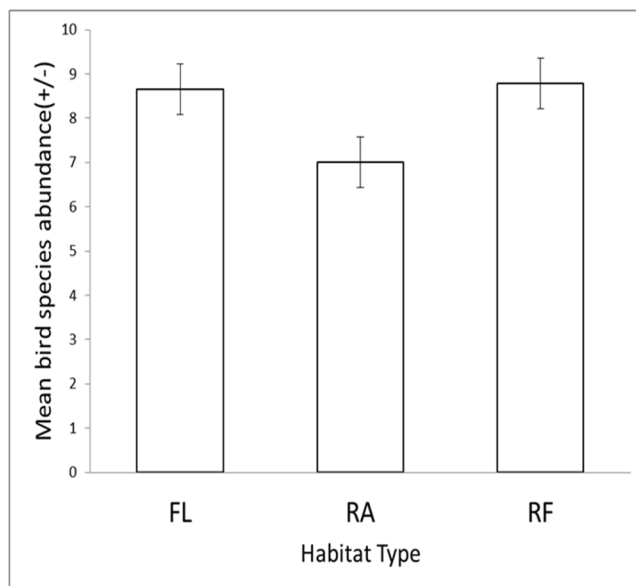


Figure 2: Mean Bird Species abundance across the three Habitat types (Farmland (FA), Riparian area (RA) and Riparian forest (RF))

Table 1: Summary of analysis showing Bird abundance, richness and diversity in the habitat types

Habitat	Sum. of Individual	Mean	Species Richness	Shannon Wiener Diversity Index(H')	Species evenness (H'/ ln(s))
FL	1732	30.38	49	3.23	0.4
RA	1094	19.19	44	3.21	0.5
RF	2252	39.5	57	4.77	0.6

Table 2: Bird species abundance in the habitat types

S/N	Species	Scientific names	FL	RA	RF
1	Adamawa Turtle Dove	<i>Streptopelia hypopyrrha</i>	29	22	40
2	African Grey Hornbill	<i>Tockus nasutus</i>	2	0	1
3	African Moustached Warbler	<i>Melocichla mentalis</i>	1	0	1
4	African Paradise Flycatcher	<i>Terpsiphone viridis</i>	2	3	2
5	African Thrush	<i>Turdus pelios</i>	1	0	1
6	African Yellow-white Eye	<i>Dyahorophya concreta</i>	0	0	2
7	Bearded Barbet	<i>Lybius dubius</i>	1	0	3
8	Beautiful Sunbird	<i>Cinnyris pulchellus</i>	6	7	6
9	Black Shouldered Kite	<i>Elanus caeruleus</i>	39	33	37
10	Black-capped Babbler	<i>Turdoides reinwardtii</i>	1	0	6
11	Bronze Mannikin	<i>Spermestes cucullatus</i>	16	12	0
12	Bruce's Green Pigeon	<i>Treron waalia</i>	6	5	4
13	Cardinal Wood Pecker	<i>Dendronopicus fuscescens</i>	0	0	3
14	Cattle Egret	<i>Bubulcus ibis</i>	1	2	1
15	Common Bulbul	<i>Pycnonotus barbatus</i>	45	31	36
16	Common Kestrel	<i>Falco tinnunculus</i>	2	1	2
17	Common Wattle Eye	<i>Platysteira cyanea</i>	0	0	1
18	Copper Sunbird	<i>Cinnyris cupreus</i>	4	5	3
19	Double-spurred Francolin	<i>Francolinus bicalcaratus</i>	12	0	18
20	Green Headed Sunbird	<i>Cyanomitra verticalis</i>	14	7	8
21	Green Wood Hoopoe	<i>Phoeniculus purpureus</i>	0	0	7
22	Grey Headed Bush Shrike	<i>Malaconotus blanchoti</i>	0	1	2
23	Grey Kestrel	<i>Falcon ardosiaceus</i>	9	7	9
24	Hammerkop	<i>Scopus umbretta</i>	7	11	11
25	Lanner Falcon	<i>Falcon biarmicus</i>	3	2	4
26	Laughing Dove	<i>Streptopelia senegalensis</i>	72	70	68
27	Lavender WaxBill	<i>Estrilda caerulescens</i>	1	1	0
28	Northern Black Flycatcher	<i>Melaenornis edolioides</i>	3	2	5
29	Northern Grey Headed Sparrow	<i>Passer cordofanicus</i>	4	3	2
30	Northern Red Bishop	<i>Euplectes franciscans</i>	1	0	0
31	Orange Cheeked WaxBill	<i>Estrildamelopoda</i>	1	1	2
32	Piaciac	<i>Ptilostomusafer</i>	16	13	16
33	Pied crow	<i>Corvus albus</i>	5	4	5
34	Purple Glossy Starling	<i>Lamprotornis purpureus</i>	6	6	6
35	Red cheeked Cordon Bleu	<i>Uraeginthus bengalus</i>	9	7	9
36	Red-billed Fire Finch	<i>Lagonosticta senegala</i>	4	3	2
37	Red-eyed Dove	<i>Streptopelia semitorquata</i>	2	0	2
38	Scarlet chested Sunbird	<i>Chalcomitra senegalensis</i>	48	39	48
39	Senegal Batis	<i>Batis senegalensis</i>	1	1	3
40	Senegal Coucal	<i>Centropus senegalensis</i>	25	22	25
41	Senegal Eromomela	<i>Eremomelapusilla</i>	3	3	1
42	Senegal Parrot	<i>Poicephalus senegalus</i>	10	0	10
43	Singing Cisticola	<i>Cisticola cantans</i>	0	1	2
44	Snowy Crowned Robin Chat	<i>Cossyphaniweicapilla</i>	1	10	1
45	Speckled Mousebird	<i>Colius striatus</i>	1	1	1
46	Speckled Pigeon	<i>Columba guinea</i>	33	23	27
47	Sulphur Breasted Bush Shrike	<i>Malaconotus sulfureopectus</i>	0	0	6
48	Tawny Flanked Prinia	<i>Prinia subflava</i>	0	2	2
49	Variable Sunbird	<i>Cinnyris venustus</i>	30	20	21
50	Vieillot's Barbet	<i>Lybius vieilloti</i>	0	2	8
51	Village Weaver	<i>Ploceus cucullatus</i>	11	6	10
52	Vinaceous Dove	<i>Streptopelia vinacea</i>	4	9	4
53	Violet Turaco	<i>Musophaga violacea</i>	0	0	5
54	Western Grey Plantain Eater	<i>Crinifer piscator</i>	15	17	19
55	Whinchat	<i>Saxico larubetra</i>	3	0	3
56	Yellow Crowned Gonolek	<i>Laniarius barbatus</i>	1	2	1
57	Yellow Crowned Tchagra	<i>Tchagra australis</i>	0	1	1
58	Yellow Fronted Thinkerbird	<i>Pogoniulus chrysononus</i>	1	1	1
59	Yellow-billed Shrike	<i>Corvinella corvina</i>	5	1	2
60	Yellow-throated Leaflove	<i>Macronyx croceus</i>	3	1	1

Table 3: ANOVA for abundance of bird species

Source of Variation	SS	Df	MS	F	P-value
Between Groups	118.4111	2	59.20556	0.397612	0.672522
Within Groups	26355.83	177	148.903		
Total	26474.24	179			

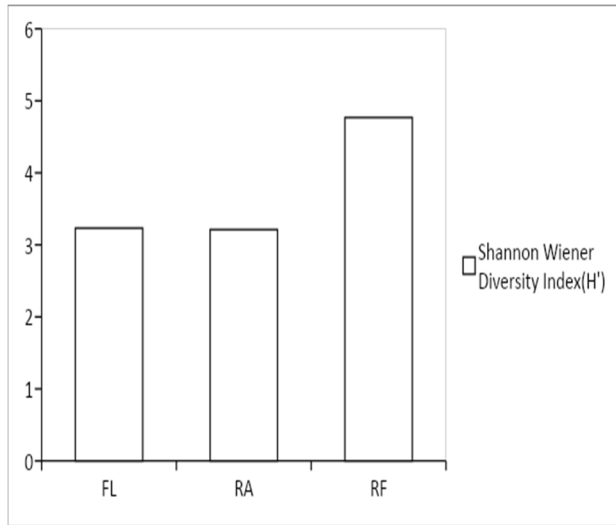


Figure 3: Bird diversity across the three Habitat types (Farmland (FA), Riparian area (RA) and Riparian forest (RF)).

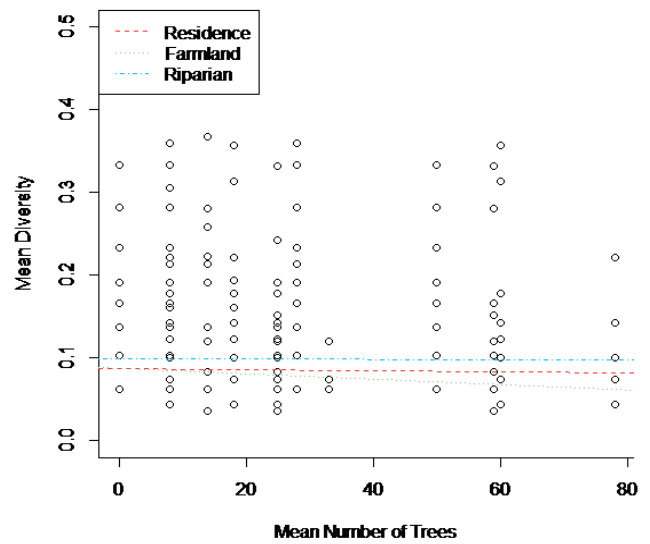


Figure 5: Relationship between species diversity and number of trees

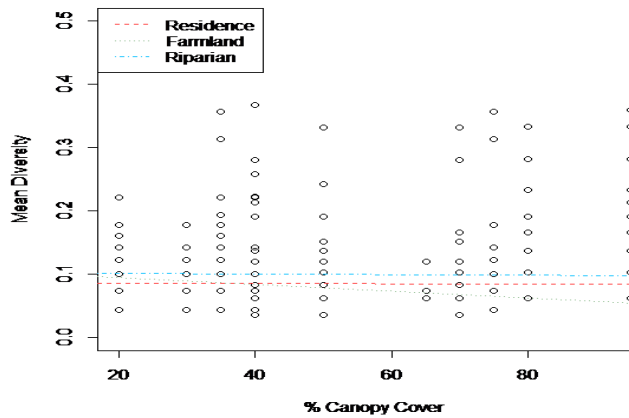


Figure 4: Relationship between bird species diversity and canopy cover

Table 4: ANOVA on tree species abundance

Habitat types	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Farm land	5	29.60	15.694	7.019	10.11	49.09	14	56
Residential area	5	22.20	3.834	1.715	17.44	26.96	18	25
Riparian forest	5	41.20	12.050	5.389	26.24	56.16	28	50
Total	15	31.00	13.475	3.479	23.54	38.46	14	56

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Table 5: Post hoc on mean abundance of tree species in the habitat types

Habitat types	Abundance of tree species
Farmland	29.60 ^{ab}
Residential area	22.20 ^b
Riparian forest	41.20 ^a

Means on the same column with the same letter do not differ significantly from each other ($P = 0.05$)

Table 6: ANOVA on abundance of shrubs found in the habitat types

Habitat type	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Farm land	5	19.60	12.740	5.697	3.78	35.42	7	36
Residential area	5	13.60	3.286	1.470	9.52	17.68	10	16
Riparian forest	5	25.80	6.573	2.939	17.64	33.96	21	33
Total	15	19.67	9.401	2.427	14.46	24.87	7	36

Table 7: Post hoc on shrub species abundance

Habitat types	Abundance of herb species
Farmland	19.60 ^a
Residential area	13.60 ^a
Riparian forest	25.80 ^a

Discussion

Abundance of bird species was highest in the riparian forest (table 1), followed by the farmlands then the Residential area, although it did not differ significantly ($P=0.67$). This is probably due to the presence of generalist birds (that flock) observed across all the habitat types. This is similar to study by Burgess *et al.* (2002) that documented that some birds species can occupy more than one habitat type even though some can be restricted to a particular kind of habitat (known as specialist species). Since statistically the abundance of birds was not significant in the three habitat types (Table 1), it infers that all the habitats can serve as a repository for birds and other biodiversity, particularly the generalist bird species. The relatively greater abundance in the Riparian forest and the farmland may be linked with abundance of vegetation which consists of trees and shrubs that provides food and cover for different bird species, as the results showed that trees and shrubs were more abundant in the riparian forest followed by the farmlands. This also goes in line with the findings of Askin *et al.* (2012) who observed that there is positive correlation in bird abundance and vegetation cover, Hobson *et al.* (2007) has also linked greater abundance and diversity in forest as a result of the presence of shrub, trees and other vegetation cover with high food availability, water, breeding sites, breeding materials and cover from predators.

The high bird species abundance in the riparian forest may be attributed to the presence of water during the dry season and at the onset of the rainy season, many species visit water sites to drink after foraging or feeding. Babbit (2000) has shown in his study that species abundance of animals generally is positively correlated with wetland area and water surface area which supports diverse species of organisms which either visits such area to drink or to utilize it as their habitat. Milligan (1985) has equally shown that the wetlands support variety of birds' species.

There was also a significantly high abundance of birds in the farmlands which may be due to the complex nature of the habitat (farmlands have trees with fruits, flowers, insects and crops) for variety of the generalists species of bird to get their source of food but the vegetation cover which protects birds from predators is not as high as the riparian forest which may be the reason why the abundance was higher in the riparian forest. Observation from the field work revealed that granivorous and omnivorous bird species were the most encountered in the farmland. Birds such as Bronze Manikins, Northern red Bishops, Village Weaver, Laughing Dove and Speckled Pigeon which can flock in large size; this also influenced the high abundance in the farmland area. Granivorous bird's frequent visit was probably due to seed availability in the farmlands during the raining period. Akogwu *et al.* (2012) had also recorded high abundance of granivorous birds in the surrounding farmlands of Assop Forest Reserve in Jos attributing to presence of grains and also their ability to exploit habitats and landscapes already transformed by human activities to expand their home ranges. This may also be responsible for high number of birds that are considered to be generalist, which are also known to be successful in most human-disturbed landscape with no particular conservation concern (Soderstom *et al.*, 2003).

The human settlement (residential area) was the least in terms of abundance, but with no variation from the other two habitat types, table 3 (0.67), it is very obvious that it is a good habitat for birds because quite a number of species such as the speckled Pigeon, Laughing Dove, Red-cheeked-bleu, Red-billed Firefinch and Northern grey-headed Sparrow were abundantly encountered in this habitat during the survey period. This abundance concurs with the findings of Clergeau *et al.* (1998) and Sandstrom *et al.* (2006) that documented that human-disturbed areas provides heterogeneous habitat and such habitats attract

and can equally interact with their domestic counterparts (Shochat *et al.*, 2010). Their result shows that high abundance in settlements can be triggered by habitat heterogeneity such as buildings, trees and gardens created by humans. This result shows therefore, that it is evident that residential area can serve as a refuge or repository for birds, if there is adequate vegetation (ornamental and fruit trees and shrubs).

Bird species diversity was highest in the riparian forest (107.29) which was highly significant from the farmland (39.65) and the residential area (34.03) as shown in Table 1. Riparian forest had mostly the specialist species that can only live there while the farmland had a heterogeneous habitat where there is higher food choices, with frugivores such as Violet Turacco (*Musophaga violacea*) and Western Grey Plantain-eater (*Crinifer piscator*) feeding on fruits from the trees, nectarivores such as Scarlet-chested Sunbird (*Chalcomitrasengalensis*) sucking nectar from flowers, insectivores picking insects from the ground and granivores feed on grains found in such habitat. Birds will prefer to select habitat with relatively stable food supply. This is in line with studies by Rotenberry (1985) who deduced that birds prefer habitats with complex vegetation structure. Vegetation structure such as, canopy cover, presence of trees, occurrence of leaf litter, diversity of trees could also lead to increase bird species diversity. Such habitats are ecologically partitioned by birds into vertical and horizontal patches based on species habitat preference. Availability of these patches at different strata of the vegetation culminates in holding diverse bird species unlike homogeneous habitats (Karr, 1990). The retention of old-growth trees in a habitat has been shown to particularly benefit hole-nesting species (Soderstrom *et al.*, 2003), and a mixture of farmland and native vegetation recorded the highest numbers of species in a South African survey (Mangnall and Crowe, 2003) which indicates that the potential for bird species

diversity could be high on human-disturbed land with high vegetation cover (Connell, 1978) which is in line with the high bird species diversity in the farmlands. Bird species richness in this study was higher in the riparian forest (57), the farmland (49) and residential area (44), which is the same trend as the diversity index and in line studies by Lindenmayer *et al.* (2010) who observed that it is important to know how the patterns of avian species richness and composition respond both within and between vegetation types. Species richness in the riparian forest was high with some forest specialist like the African yellow white-eye, Bearded barbet, Common wattle eye, Black-capped babblers, Cardinal woodpecker, Green wood hoopoe, singing cisticola, Yellow-crowned tchagra, and Violet turacco were seen only in the riparian forest. Forest specialists were characterized by higher selectivity of forest landscapes and avoidance of agricultural dominated landscapes, whereas generalists, despite showing positive selection of forest landscapes, did not clearly avoid agricultural landscapes. The results are largely consistent with past findings that reported lower richness and abundance of birds in more disturbed sites (Peh *et al.*, 2005; Shahabuddin and Kumar, 2007). Selective removal of large mature trees reduces habitat suitability for many species of birds (Eyre *et al.*, 2009; Touihri *et al.*, 2014) that rely on them for foraging and nesting (Sekercioglu, 2002; Vergara and Marquet, 2007).

The results showed that bird species increases with increasing vegetation cover (canopy cover and number of trees) in the riparian forest and residential areas (Figure 3 and 4). From the results, the riparian forest which had the highest diversity and abundance of birds species could be as a result of the thick vegetation with reasonable numbers of trees/shrubs and high percentage canopy cover which influence the abundance of species, such as raptors, omnivorous, insectivores, granivores, frugivores and nectarivores. The

trees/shrubs were probably being utilized by the birds for cover, nesting sites, roosting and perching. This significance difference in the diversity of birds in relation to the vegetation parameters concurs with the findings of Akogwu *et al.* (2012) that shows trees density were significant in determining species diversity in Assop Forest Reserve.

From the result (table 4), tree species were more abundant in the riparian forest, followed by the farmland, then the residential area. Post hoc test (table 5) showed that there was significant difference between the riparian forest and the residential area. Table 6 showed that, shrubs were more abundant in the riparian forest, followed by the farmland, then the residential areas with no significant difference ($p= 0.117$), table 7 and 8. This may be the possible reason why diversity is high in the riparian forest, followed by the farmland and finally the residential area which is in line with MacArthur *et al.* (1962), who stated that foliage diversity of a forest stand has an important role in providing food for birds. Other vegetation characters, which have significant effect on bird diversity, are foliage volume, percentage vegetation cover, percentage canopy cover (Karr and Roth, 1971; Munn, 1985). Functional characteristics of shrubs and levels of food they support for birds (Hagar, 2007) may also influence bird abundance and diversity more than overall understory plant diversity. Thus, at least in relation to biomass accumulation, ecosystem productivity appears to influence bird response. For long, studies have shown the relationship between bird diversity and vegetation structure (Verner and Larson, 1989). Wiens (1989) observed that vertical distribution of bird species in the canopy is related to microhabitat use and resource availability. Also, Díaz (2006) determined the strong influence of understory vegetation (species composition, cover and height) in increasing both bird species richness and abundance. Bird species use the canopy layer

for foraging, so removing parts of the canopy can have a negative impact on species richness, abundance and composition. A recent study by Leal *et al.* (2013) in a Mediterranean region, found that foliage gleaning species such as great tit and chiffchaff (*Phylloscopus collybita*) were most affected by canopy pruning activities. In this study, heavily grazed sites had only half the species richness of lightly grazed sites, indicating a strongly detrimental effect of grazing practices on bird communities. Heavy grazing significantly affects the population of many species of birds (Martin and McIntyre, 2007). Grazing and trampling reduces understorey vegetation (Whitehorne *et al.*, 2011, Piana and Marsden, 2014), thereby affecting understory-foraging species (Martin and McIntyre, 2007) and ground-dwelling bird species (Maron and Lill, 2005, Inskipp and Baral, 2013).

Landscapes with more forest cover support a larger species pool (Radford and Bennett, 2007, Haslem and Bennett, 2008, Taylor *et al.*, 2002) through both sampling effects, and because a greater extent of forest cover in landscapes offers habitat diversity (Radford *et al.*, 2005, Maron *et al.*, 2010), and can serve source habitats for range of species (Pulliam, 1988). Birds are a mobile taxon, and their presence at a particular site does not necessarily mean they are resident, nor that they solely use the resources within that site. Thus, complementary resources may be more widely distributed within the occupied landscape. More habitats within the surrounding landscape increases the chance that suitable refugial or complementary habitat exists (Dunning *et al.*, 1992), increasing the likelihood of occupancy within the landscape and thus the chance of detection at a site, even a degraded one. Therefore, maintaining more forest cover has important ecological consequences for the ability of a wide-range of avifaunal species to persist as was seen from the result in this study.

Conclusion

Riparian forest had the highest birds species diversity, richness, evenness and more abundant trees and shrubs, hence vegetation plays a critical role in conserving birds species especially the "specialist species". The farmland and residential areas had a considerable number of "generalist species" due to the heterogenous nature of their habitat with more granivorous and insectivorous birds utilizing it, hence it can be deduced that it is important that vegetation such as trees and shrubs be left or planted in human dominated areas.

Competing interests

The authors declare no conflict of interest.

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