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RESEARCH ARTICLE

AVIAN DIVERSITY, SPECIES COMPOSITION AND HABITAT ASSOCIATION IN LEBU NATURAL PROTECTED FOREST, SOUTHWEST SHOWA, ETHIOPIA

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ABSTRACT: Forests embody much of Earth's ecosystem, species and genetic diversity. They have the largest reservoir of plants and animals on land. The diversity of birds in the forest fragments is still poorly documented, especially at spatial resolution of practical use for conservation. This study was conducted to determine the species composition, diversity and habitat association of avian fauna in Lebu Natural Protected Forest, Southwest Showa, Ethiopia. The survey was carried out from March to April 2019 during the dry season. The study area was classified into three discrete habitat types including natural forest, farmland and riverine forest which represent strata in a stratified random sample. Avian species were sampled from 20 randomly selected points in each of the habitat types and sighting within 30-50 meters radius was employed to record and identify birds. A total of 55 bird species belonging to 12 orders and 32 families were identified and recorded. Order Passeriformes was abundant with the highest relative abundance of 63.90 % (n = 370), while helmeted Guinea fowl *Numida meleagris* (13.13%) under the order Galliformes was the dominant bird species. The highest Shannon-Weiner diversity index and evenness index were recorded from the riverine forest (H′ = 2.99 and E = 0.85) while the lowest from the farmland habitat (H′ = 2.24 and E = 0.75). There were variations in species richness and abundance between the three habitats. These findings suggest the potential of the forest in supporting important bird communities and further suggest its conservation value for integrating economic gain of the local community through ecotourism.

Key words/phrases: Abundance, Bird survey, Lebu forest, Species diversity.

INTRODUCTION

Birds are one of the most diverse groups of modern vertebrates (Brusatte *et al*., 2015). They are among the well-studied parts of the Earth's Biodiversity (Bibby *et al*., 1998). Over the past two decades, our knowledge of extant bird's origin and evolutionary successes, leading to great diversity, has been revolutionized due to fossil discoveries, molecular phylogenetic analysis of

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living birds, and quantitative macro-evolutionary analyses (Brusatte *et al*., 2015).

As of the 2017 update by BirdLife International (2018) 1,469 bird species (13% of the total extant species, or one in eight) are globally threatened with extinction. Across the African continent there are about 2,477 bird species, 1,400 (57%) are endemic to the continent (BirdLife International, 2017) of which 245 are globally threatened with extinction (Weldemariam Tesfahunegny, 2016). Ethiopia, a country with one of the hotspots of biodiversity in the world has varied and unique environmental conditions (Convention on Biological Diversity, 2014). In Ethiopia, 866 bird species grouped into 26 orders and 95 families have been recorded, of these 19 are endemics, 38 globally threatened species and one introduced species (Lepage, 2019). This mega diversity is attributed to the variations in altitudinal range (Weldemariam Tesfahunegny, 2016).

Birds have a significant role in indicating biodiversity and ecosystem health. This could be due to their ecological diversity. Furthermore, they usually occupy high trophic levels in food webs and are relatively sensitive to environmental change. Birds are also economically important and are flagships for nature (BirdLife International, 2018). Birds reflect changes in the environment quickly and send out signals whenever there is deterioration in the ecosystem. For instance, birds have roles in ecosystem functioning such as pollination, seed dispersal, and disposal of animal carcasses and controlling insect pest populations on commercially valuable crops (Tabur and Ayvaz, 2015). Moreover, birds provide cultural, aesthetic and scientific importance to human beings (BirdLife International, 2018).

Despite their ecological roles, various threatening factors have been affecting birds. These include, habitat loss, fragmentation and degradation, decline in food availability and human disturbances (Zerihun Girma *et al*., 2017). Changes in vegetation structure and composition can impact bird communities (Addisu Asefa *et al*., 2015). Alterations of riverine ecosystems adversely affect bird assemblages (Figarski and Kajtoch, 2015). Thus, each of the aforementioned threats, solely or synergistically affects the welfare of avian biodiversity in different ecosystems worldwide.

In Ethiopia, different studies on avian diversity and abundance have been conducted (Zerihun Girma *et al*., 2017; Shimelis Aynalem and Afework Bekele, 2008). Despite birds being the best known class of living organisms, there are still substantial gaps in our knowledge of the distributions, abundances, and densities of species in Ethiopia. Especially, they are poorly

understood in forest fragments (Zerihun Girma *et al*., 2017). Among various fragmented protected forests in Ethiopia, Lebu Natural Protected Forest is believed to harbour different avian species. Although little research has been conducted in this area, more intensive investigations in the Lebu Natural Protected Forest can be a valuable contribution to understanding the fundamental attributes of such ecological landscape. Therefore, the main objective of the study was to investigate species composition, abundance, and habitat association of birds in Lebu Natural Protected Forest, Southwest Showa, Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was carried out in Lebu Natural Protected Forest situated in central part of Ethiopia, Oromia Regional State at about 110 km south of the capital city, Addis Ababa. It lies between 8°45′80″ to 8°47′14.80″N latitude and 38°65′40″ to 38°65′77.10″E longitude (Fig.1) and has an altitudinal range from 2100–2300 m.a.s.l. The study area is about 4.05 km^2 and is flanked by Gara Molcha Kebele to the north, Kerchufa Kebele to the east, Suten and Tiya Towns to the south and Cheeka Kebele to the west.

The study area was stratified into three habitats based on the type of vegetation structure, land cover and vegetation physiognomic features. These are Natural forest, Farmland and Riverine forest. Rainfall and temperature data were obtained from Ethiopian National Meteorological Agency (2018) which was collected from Lemen meteorological station. The station is located at 25 km far away from the study area. The climatic condition of the study area is mostly semi-humid. The mean monthly maximum and mean monthly minimum temperatures of the study area range from 24.5°C (August) to 28.75°C (April) and from 9.8°C (January) to 13.7°C (April), respectively. The study area has unimodal rainfall distribution, a long rainy season from June to September and a dry season from November to February. The mean monthly rainfall of the area varies between 3.5 mm (December) and 346.0 mm (July), while the average mean monthly rainfall of the area is 139.08 mm.

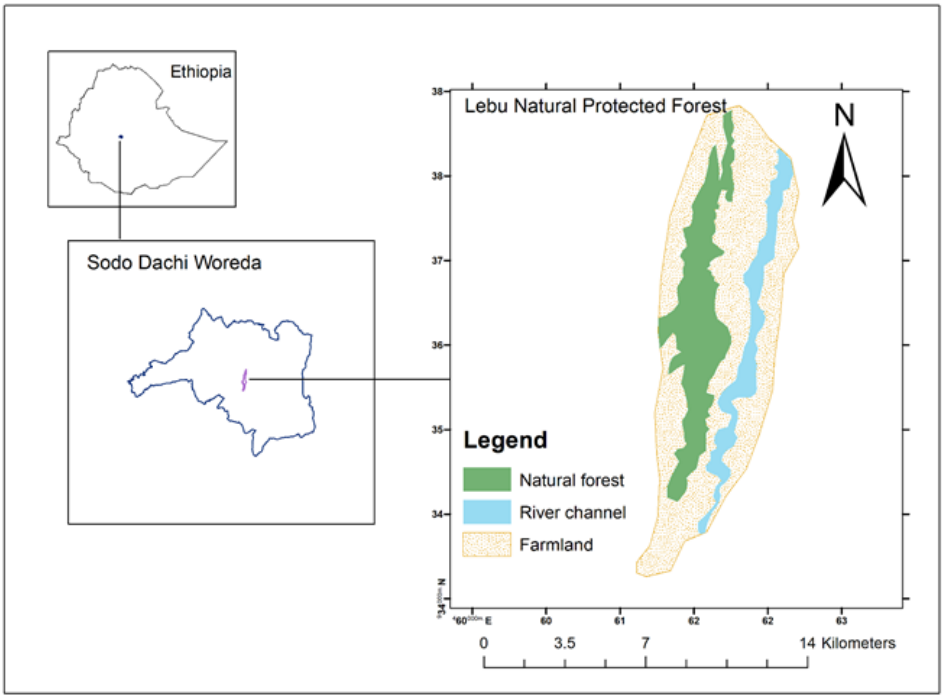

Fig. 1. Map of the study area, Sodo Dachi woreda, Ethiopia.

Methods of data collection

A stratified sampling method was used across the entire study area following Shimelis Aynalem and Afework Bekele (2008) and Zerihun Girma *et al*. (2017), to stratify the study area into three habitat types. Avian species were sampled from 20 randomly selected sites in natural forest (n = 8), farmland and bushland (n = 4) and riverine forest (n = 8). Only 4 survey points were used for farmland and bush land habitat as birds can be seen across long distance due to the open nature of the habitats. Each of the habitat type has different area coverage. Of the total 4.05 km^2 area coverage delineated for the present study, 1.05 km^2 of the study area is covered by natural forest, 0.9 km^2 is covered by riverine forest and about 2.1 km^2 of the rest of the area is covered by the farm land and bush land. For the analysis the number of bird species seen in the bush and farmland habitat was pooled together and represented by farmland.

The diversity and distribution of birds across the study area was studied using a point count technique (Shimelis Aynalem and Afework Bekele, 2008; Godoi and De Souza, 2016; Zerihun Girma *et al*., 2017). Counting

was done for each bird species seen at 30 metres radius for natural forest and riverine forest habitat, however, 50 metres radius was used for farmland following the methods of Godoi and De Souza (2016), Zerihun Girma *et al*. (2017) and Seyoum Kiros *et al*. (2018). Each of the point-count sites was spaced out at 300 metres. Before starting counting, a waiting period of 3 to 5 minutes was applied (Shimelis Aynalem and Afework Bekele, 2008) to reduce disturbance during the count depending on habitat types and the bird communities present. Each station was sampled for 10 minutes to avoid double counting of the available bird individuals. Each point count station, which represents a sample unit, was visited three times.

Field data collection was carried out from March to April, 2019. Survey of the birds was carried out in the early morning (6:30 a.m to10:00 a.m) and in the afternoon (4:30 p.m. to 6:00 p.m.) during the time when the birds are active (Bibby *et al*., 1998). The birds available at each point count station were observed by naked eye and with the aid of binoculars. Species were identified *in situ* and taxonomically grouped using bird field guide books of Birds of the Horn of Africa (Redman *et al*., 2011) and a comprehensive illustrated field guide of Birds of Africa south of the Sahara (Sinclair and Ryan, 2003).

Data analysis

All of the collected data analyses were performed using the Past software version 4.03 (https://folk.uio.no/ohammer/past/) and the analyzed data were presented in table, graph and narrative forms. Species diversity for birds from the study area was computed using Shannon-Weiner Diversity Index (H′): $H' = -\sum_{i=1}^{s} pi \ lnpi$

Where: H′= index of species diversity, Pi is the proportion of individuals of species in a sample, S = the number of species in each habitat and ln = Natural logarithm (Shannon and Weiner, 1949).

Richness index (D) was calculated by the following equation:

$$D = \frac{S - 1}{\ln N}$$

Where: D = Richness index, S = Total number of species and N = Total number of individuals.

Simpson index of diversity was followed (1−D) using the formula: J = H′/H′max, where H′ is the observed index of diversity and H′ max = ln(S); S = the number of species in each habitat.

The Sorenson's similarity index was used to compare the species richness among habitat types following Zerihun Girma *et al.* (2017), using the following formula of Sorenson's similarity coefficient:

$$SOR = \frac{2a}{2a + b + c}$$

Where *a* is the number of species common to both habitat, *b* is number of species unique to habitat 1 and *c* is number of species unique to habitat 2.

Relative abundance of avian species was determined using encounter rates that give crude ordinal scales of abundance (abundant, common, frequent, uncommon and rare) following methods of Bibby *et al*. (1998) to compare the bird species that are greater or lesser than the other using sorting. The abundance category (the number of individuals per 100 field hours) is given in Table 1. We also calculated relative abundance of bird species using the formula (%) = n/N x 100, where n is the number of individuals of particular species recorded and N is the total number of individuals of the species.

Table 1. Encounter rate and crude ordinal scale of relative abundance (Bibby *et al*., 1998).

Relative abundance category (numbers of individual per 100 field hours)	**Abundance score**	**Abundance category**
<0.1	1	Rare
0.1–2.0	2	Uncommon
2.1–10.0	3	Frequent
10.1–40.0	4	Common
40.0+	5	Abundant

RESULTS

Avian species composition

A total of 579 individual birds of 55 species grouped into 32 families and 12 orders were recorded (Table 2). The most abundant families recorded during the study period were Columbidae, Muscicapidae, and Estrildidae, with 6, 5 and 4 species, respectively.

The species richness varied across the three habitat types. Of the species recorded, 19, 34 and 20 species were sighted in natural forest, riverine forest and farmland habitat, respectively (Table 2). The helmeted guinea-fowl (*Numida meleagris*) was relatively the most abundant species (13.13%) followed by western yellow wagtail (*Motacilla flava*) (10.36%) and red-billed firefinch (*Lagonosticta senegala*) (10.02%) (Table 2).

In the study area 76.36%, 18.18% and 5.54% species were observed to fall in relative abundance categories of uncommon, frequent and common, respectively (Table 2).

Table 2. Avian species recorded, their occurrence and relative abundance in different habitat types during the study period.

Order	Family	Scientific name	Common name	Natural forest	Riverine forest	Farmland	RA	Abundance category
Galliformes	Numididae	*Numida meleagris*	Helmeted guineafowl	+	-	+	13.13	Common
	Phasianidae	*Pternistis erckelii*	Erckel's francolin	+	+	-	3.28	Frequent
Caprimulgiformes	Apodidae	*Apus apus*	Common swift	+	-	-	2.59	Frequent
		Apus caffer	White-rumped swift	-	-	+	1.73	Uncommon
Coliiformes	Coliidae	*Colius striatus*	Speckled mousebird	+	+	-	4.84	Frequent
Coraciiformes	Meropidae	*Merops variegatus*	Blue-breasted bee-eater	-	+	-	1.21	Uncommon
		Merops pusillus	Little bee-eater	+	-	-	0.35	Uncommon
	Alcedinidae	*Halcyon leucocephala*	Grey-headed kingfisher	-	+	-	0.17	Uncommon
Columbiformes	Columbidae	*Teronwa alia*	Bruce's green-pigeon	-	+	-	1.38	Uncommon
		Turtur afer	Blue-spotted wood-dove	+	-	-	0.52	Uncommon
		Streptopelia semitorquata	Red-eyed dove	-	+	-	0.35	Uncommon
		Oena capensis	Namaqua dove	-	+	-	0.35	Uncommon
		Columba guinea	Speckled pigeon	-	-	+	0.17	Uncommon
		Streptopelia lugens	Dusky turtle-dove	-	+	-	0.17	Uncommon
Pelecaniformes	Threskiornithidae	*Bostrychia carunculata*	Wattled ibis	-	+	+	0.86	Uncommon
Bucerotiformes	Bucerotidae	*Lophoceros hemprichii*	Hemprich's hornbill	+	-	-	0.17	Uncommon
		Tockus erythrorhynchus	Northern red-billed hornbill	+	-	-	0.69	Uncommon
	Bucorvidae	*Bucorvus abyssinicus*	Abyssinian ground hornbill	-	-	+	0.17	Uncommon
Piciformes	Picidae	*Dendropicos abyssinicus*	Abyssinian woodpecker	-	+	-	0.35	Uncommon
Accipitriformes	Accipitridae	*Buteo augur*	Augur buzzard	-	+	-	0.17	Uncommon
Musophagiformes	Musophagidae	*Tauraco leucotis*	White-cheeked turaco	-	+	-	1.55	Uncommon
		Corythaixoides personatus	Bare-faced go-away bird	-	+	+	1.38	Uncommon
Psittaciformes	Psittaculidae	*Agapornista ranta*	Black-winged lovebird	-	+	-	0.52	Uncommon
	Corvidae	*Corvus capensis*	Cape crow	-	-	+	0.35	Uncommon
Passeriformes	Motacillidae	*Motacilla flava*	Western yellow wagtail	-	-	+	10.36	Common
		Motacilla clara	Mountain wagtail	+	+	-	0.52	Uncommon
	Estrildidae	*Lagonosticta senegala*	Red-billed firefinch	+	+	+	10.02	Common
		Spermestes cucullata	Bronze mannikin	-	-	+	5.18	Frequent
		Uraeginthus bengalus	Red-cheeked cordonbleu	+	+	+	4.49	Frequent

Order	Family	Scientific name	Common name	Natural forest	Riverine forest	Farmland	RA	Abundance category
		Lagonosticta rubricata	African firefinch	-	+	-	0.17	Uncommon
	Sturnidae	*Lamprotomis chalybaeus*	Greater blue-eared starling	-	+	-	6.91	Frequent
		Lamprotomis purpuroptera	Ruppell's starling	-	+	-	2.59	Frequent
	Passeridae	*Passer swainsonii*	Swainson's sparrow	+	-	+	3.28	Frequent
	Phylloscopidae	*Phylloscopus trochilus*	Willow warbler	-	+	+	2.94	Frequent
	Pycnonotidae	*Pycnonotus barbatus*	Common bulbul	+	+	+	2.42	Frequent
		Phyllastrephus strepitans	Northern brownbul	-	+	-	1.38	Uncommon
	Corvidae	*Corvus rhipidurus*	Fan-tailed raven	-	-	+	1.90	Uncommon
	Ploceidae	*Ploceus baglafecht*	Baglafecht weaver	-	+	-	1.21	Uncommon
	Monarchidae	*Terpsiphone viridis*	African paradise flycatcher	-	+	-	1.73	Uncommon
	Malaconotidae	*Laniarus aethiopicus*	Ethiopian boubou	+	+	+	1.55	Uncommon
		Laniarius funebris	Slate-colored boubou	-	+	+	0.69	Uncommon
	Buphagidae	*Bughagus erythrorhynchus*	Red-billed oxpecker	-	-	+	0.86	Uncommon
	Cisticolidae	*Phyllolais pulchella*	Buff-bellied warbler	+	-	-	0.86	Uncommon
		Prinia subflava	Tawny-flanked prinia	-	+	-	0.17	Uncommon
	Muscicapidae	*Thamnolaeasemirufa*	White-winged cliff-chat	+	-	+	0.86	Uncommon
		Myrmecoci chlamelaena	Ruppell's chat	+	-	-	0.52	Uncommon
		Cossyphasemi rufa	Ruppell's robin-chat	-	+	-	0.52	Uncommon
		Ficedula semitorquata	Semi-collared flycatcher	-	-	+	0.35	Uncommon
		Oenanthe lugubris	Abyssinian wheatear	+	-	-	0.17	Uncommon
	Viduidae	*Vidua fischeri*	Straw-tailed whydah	-	+	-	0.69	Uncommon
	Nectariniidae	*Hedydipna collaris*	Collared sunbird	-	+	-	0.52	Uncommon
		Chalcomitra senegalensis	Scarlet-chested sunbird	-	+	-	0.17	Uncommon
		Cinnyris venustus	Variable sunbird	+	-	-	0.17	Uncommon
	Fringillidae	*Crithagra mozambica*	Yellow-fronted canary	-	+	-	0.17	Uncommon
	Dicruridae	*Dicrurus adsimilis*	Forked-tailed drongo	-	+	-	0.17	Uncommon

RA: Relative abundance, +: denote the species present, −: denote the species absent.

Avian species diversity

The highest diversity of birds was recorded from riverine forest habitats (H′ = 2.99) and the lowest diversity index (H′ = 2.24) from farmland habitat. The highest evenness index (E = 0.85) was also recorded from riverine forest habitat and the lowest from farmland habitat (E = 0.75) (Table 3).

Table 3. Avian species diversity in different habitat types.

Diversity measures	Natural forest	Riverine forest	Farmland	Overall diversity indices
Taxa (S)	19	34	20	55
Individuals	158	204	217	579
Dominance (D)	0.12	0.08	0.15	0.06
Simpson (1-D)	0.88	0.92	0.85	0.94
Shannon (H′)	2.44	2.99	2.24	3.28
Equitability (J′)	0.83	0.85	0.75	0.82

S - Number of species, H′ - Shannon-Weiner diversity index, E - Shannon-Weiner evenness index, D - Dominance 1-D: Simpson index of diversity

The highest Sorensen species similarity index was recorded between the farmland and natural forests (0.44) and the lowest was recorded between riverine and natural forest (0.33) (Table 4).

Table 4. Sorensen bird species similarity index among three habitat types.

	Habitat types		
Habitat types	Natural forest	Riverine forest	Farmland habitat
Natural forest	1.00		
Riverine forest	0.33	1.00	
Farmland habitat	0.44	0.34	1.00

Habitat association

Among the twelve orders recorded, Passeriformes and Galliformes were relatively well represented across the three habitat types (Fig. 2). On the other hand, Accipitriformes, Bucerotiforms, Piciformes and Psittaciformes were the least represented orders across the three habitat types. Among the recorded species, greater blue-eared starling (*Lamprotomis chalybaeus*), helmeted guineafowl (*Numida meleagris*) and western yellow wagtail (*Motacilla flava*) dominated the riverine forest (19.60%), natural forest (26.58%) and farmland (27.65%) habitats, respectively.

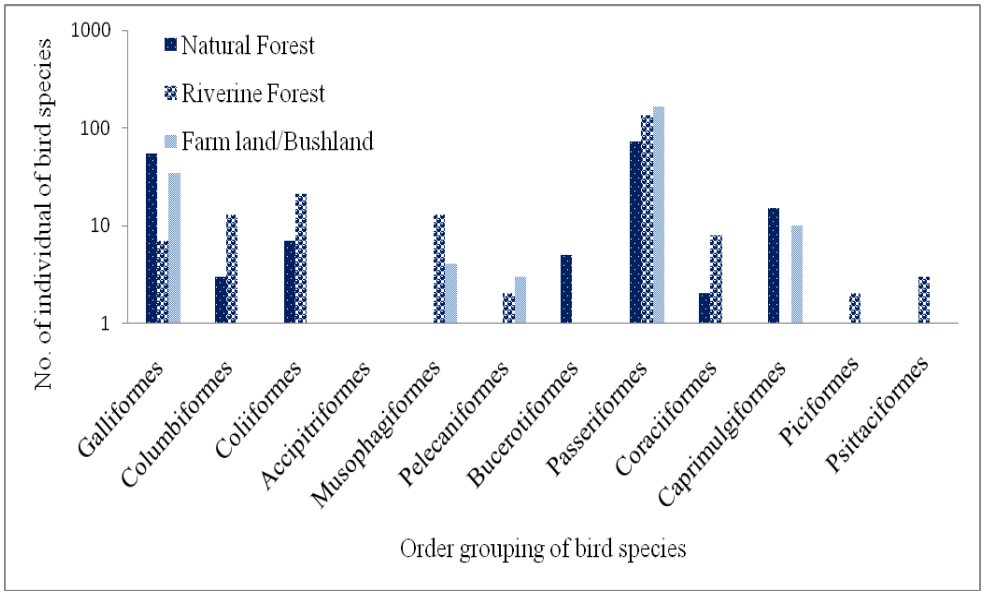

Fig. 2. Abundance of birds by habitat type and order.

DISCUSSION

During the present survey, a total of 55 bird species were recorded in the study area. A comparable number of species (50 species) were also recorded from Wabe fragmented forests around Gubre subcity and Wolkite town, Southwestern Ethiopia (Seyoum Kiros *et al*., 2018) that have similar vegetation structure to Lebu natural protected forest. Lebu forest is under human influence, through deforestation, grazing, charcoal production, fuel wood collection and agricultural expansion until it was declared as a protected forest by the Woreda's Natural Resources Conservation and Management Authority (Chala Adugna and Afework Bekele). Such activities are still being practiced due to poor law enforcement affecting the biodiversity including birds (personal observation).

Among the different habitats in the study area, variation in species diversity was observed. For instance, the highest species diversity and evenness were recorded in the riverine forest. This might be because riverine forests provide nesting sites and fruits to some bird species as well as water during the dry season. Similarly, Godoi and De Souza (2016) have reported that riparian forests exhibit the highest richness and abundance of birds when compared to savannas and grasslands. Riverine forests having more heterogeneous vegetation structures and buffering effect are responsible for the preservation of high forest specialist birds including those sensitive to

forest loss, fragmentation, and disturbance (Godoi and De Souza, 2016). Girma Mengesha and Afework Bekele (2008) also recorded highest avian diversity in riverine woodland habitats of Alatish National Park in the dry season.

In the present study, the highest species similarity was observed between the farmland and natural forests that could be attributed to the adjacent occurrences of the two habitat types. Furthermore, after foraging on farmlands, the bird species might move to natural forests seeking for refuge. Zerihun Girma *et al*. (2017) indicated that the adjacent occurrences of two habitats could contribute to similar bird species inhabitation, interchanging of bird species between the habitat types and support equivalent foraging opportunities and nesting sites.

Among the different species recorded, the helmeted guineafowl (*Numida meleagris*) had the highest relative abundance in the overall study area and the highest relative abundance in the natural forest. On the contrary, Zerihun Girma *et al*. (2017) found helmeted guineafowl in highest abundance in the grassland habitat. Although this species mainly prefers dry open habitats with scattered shrubs trees, the highest abundance in the natural forest in the present study might be explained by their behavioural flexibility. They also use such forest to escape from being trapped by the local people and predation risk during the dry season in the farmland where they feed on various food items. Hence, the birds may have flexibly directed their foraging behaviour and seek refuge in the forest habitat. In line with this study, Seyoum Kiros *et al*. (2018) recorded numerically the most abundant helmeted guineafowl in Wabe fragmented forest.

CONCLUSION

Lebu natural protected forest possessed a relatively high diversity of avian fauna showing importance of the protected forest for biodiversity conservation. The highest bird species diversity in the riverine forest as compared to the other habitats reflects its suitability for the birds during the study dry season. The study area supports relatively large number of avian species which requires the attention of government officials to avoid any aspect of human pressures on the protected forest and its environs. One of the limitations of any bird diversity studies is that the numbers of detected species are habitat-dependent and more species may be observed in open habitats compared to forest and that autonomous sound recording should be promoted in such forest habitats to get more reliable result. The area has an important bird community for ecotourism and it is necessary to integrate the

economic gain of the local community with biodiversity conservation. Therefore, joint conservation practice with the local community should be initiated in the area.

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