Diversity, Abundance and Distribution of Birds in Guna Mountains Community Conservation Area, South Gondar, Ethiopia

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Abstract: *Ethiopian highlands are the center of endemism for fauna including birds. However, due to poor management practice, the habitats of animals have been encroached on from time to time. The main objective of this study was to assess the diversity, abundance and distribution of birds in the Guna Mountain Community Conservation Area. The study was conducted from August 2019 to April 2020, in wet and dry seasons. A stratified random sampling design was used to classify habitats based on vegetation type. The habitat types were: Erica moorland, Guassa grassland, and Rocky with lobelia. Point transects count method for Erica moorland, but line transects method for both Guassa grasslands and Rocky with lobelia habitats were employed. Data were collected in the morning (6:00-10:00 A.M.) and late afternoon (4:00-6:00 P.M.). A Chi-square test was used to test the distribution of birds among the three habitats and difference on the abundance of birds between wet and dry seasons. A total of 76 bird species that belong to 12 orders and 35 families were identified. Four species are endemic to Ethiopia, and nine were endemic both to Ethiopia and Eritrea. Five species were Inter African migrants, 18 highland biome species, and two Palearctic migrant bird species were identified. The Passeriformes were the most dominant order with 44 species and account for 58%, whereas Galliformes, Cuculiformes, Apodiformes and Strigiformes were the least represented orders that have only one species each. Relatively, high diversity of bird species was observed in the grassland habitat (H' =3.67) but the lowest species diversity was observed in the Rocky with lobelia habitat (H'=2.6). The highest evenness was recorded in the rocky with lobelia habitat (E = 0.88), whereas the lowest evenness was recorded in Erica moorland (E = 0.79). The species abundance of birds during the wet and dry seasons was significantly different ($\chi 2 = 904.541$, DF =1, $p<0.001$). There were also significant differences in the distribution of birds among the three habitats ($\chi 2 = 3315.965$, DF =75, $p<0.001$). Food availability, vegetation composition and breeding sites have affected the variety of birds' abundance in different habitats. It has been seen that habitat size, foraging modes and floristic composition influenced the distribution of birds. Grassland and highland biome restricted birds may be affected as they do not have any alternative foraging or breeding sites if the Guna Mountains Conservation Area habitat fragmentation continues. The area supports a variety of avian species with high endemics and habitat specifics. Conservation of the area is vital for habitat restricted and endemic birds.*

Keywords: Afro-alpine, Bird species diversity, Endemic birds, Guna Community Conservation Area

1. Introduction

Ethiopia is one of the top 25 biodiversity-rich countries in the world. It has the largest extent of Afro-alpine and Sub afro-alpine habitats in Africa (Yalden, 1983). The Ethiopian highlands are rich in endemic species (Yalden and Largen, 1992). The Ethiopian highlands are the home of 5200 species of plants of which 555 are endemic. They also host more than 860 species of birds among which 31 are endemic to both Ethiopia and Eretria. Moreover, about 55 of the nearly 311 mammals found in Ethiopian are found nowhere else (Lavrenchenko and Bekele, 2017). Endemic, rare and threatened mammals and birds are the unique features of this ecosystem. These ecosystems are characterized by eye-catching giant herb, known as *lobelia* (*Lobelia*

rhynchopetalum), the evergreen tree heather (*Erica arborea*) and shrubby and herbaceous everlasting flowers *(Helichrysum* species). The vegetation type is the major element to categorize the Ethiopian ecosystem. The Ethiopian Afro-alpine and Sub-afro-alpine ecosystem is described by marked altitudinal variations that create wide a range of climates affecting both flora and fauna distribution (Yalden and Largen 1992).

The temporal and spatial species diversity and abundance of birds are determined by vegetation structures that provide a food source, breeding sites and shelter. This could have resulted from climatic variations such as rainfall, temperature and the topographical nature of the area (Desalgn and Subramanian, 2015). Physical factors such as altitude, slope and others aspects control the diversity, structure and productivity of vegetation which again could also influence the diversity, abundance, distribution, and habitat use of birds (Girma *et al*., 2017).

There are about 10,000 avian species in the world grouped into 29 orders and 181 families (BirdLife International, 2004). More than 50% of the existing species of avian belong to the order Passeriformes (Avibase, 2010). Over 1850 bird species were recorded in Africa (Redman *et al*., 2009). The total number of birds in Ethiopia is estimated at 882, the number of endemics 16 (+2 near endemic), the number of globally threatened species is 42, and the number of introduced species is one (Lepage, 2022).

Guna Mountains Community Conservation Area (GMCCA) was proposed in 2016. The area is mostly covered with grass that uses for grazing. Grazing is one major factor that leads to habitat alteration in different ecosystems (Mamo *et al.,* 2014). This might increase the threat to avian species. It causes changes in the vertical and horizontal structural composition of vegetation through a combination of trampling and grazing (McIntyre *et al*., 2003). Similarly, the diversity of the species might be affected as a result of anthropogenic threats (Mengesha *et al*., 2014).

The Afroalpine ecosystem resources of Ethiopia have been used for millennia Ashenafi *et al.* (2012) but challenged the rapidly growing human population. The fauna and flora resources are threatened due to human pressure. The Afroalpine and Sub-afro alpine ecosystem of Ethiopia is not as such protected due to poor management practices. The natural vegetation is being changed into farmland, settlement, and grazing lands (Andreassen, *et al.,* 2007). The Guna Mountain Conservation Area provides fodder, water, and firewood for the community that lives around it. However, the natural vegetation has become patchy; for instance the *Erica* in Gedeba, Mokish, Amigno and Soras Kebele. This habitat patchiness could have a direct impact on the flora and fauna of the area. Birds are one of the taxonomic entities in which the land use cover change could have affected their ecology at large though some might have adapted to human-modified habitats (Sreekar *et al.,* 2016). The bird assemblage of the Guna Mountain Community Conservation Area is not known yet. Therefore, the present study aimed to study the existing species diversity, relative abundance and distribution of birds in the Guna Mountain Conservation Area for future follow up.

2. Materials and Methods

2.1. Description of the study area

Mount Guna is located in South Gondar Zone, 20 km away from Debre Tabor town. The altitude ranges from 3200 to 4113 m a.s.l; geographically, it is located $11^0 36' 06.07''$ to $11^0 49' 48.59''$ N Latitude, and $38^0 03' 13.81''$ to $38^0 24' 18.79''$ E Longitude (Figure.1). It is characterized by moist agro-climatic zones "Dega" and "Wurch". The highest average maximum monthly temperature was recorded from February to April and the lowest was during January and December (Amhara National Meteorological Services Agency, 2019). It has a bimodal rainfall distribution, described by an extended wet season from June to November. Low rainfall was also recorded in February and May. The dry season ranges from December to April.

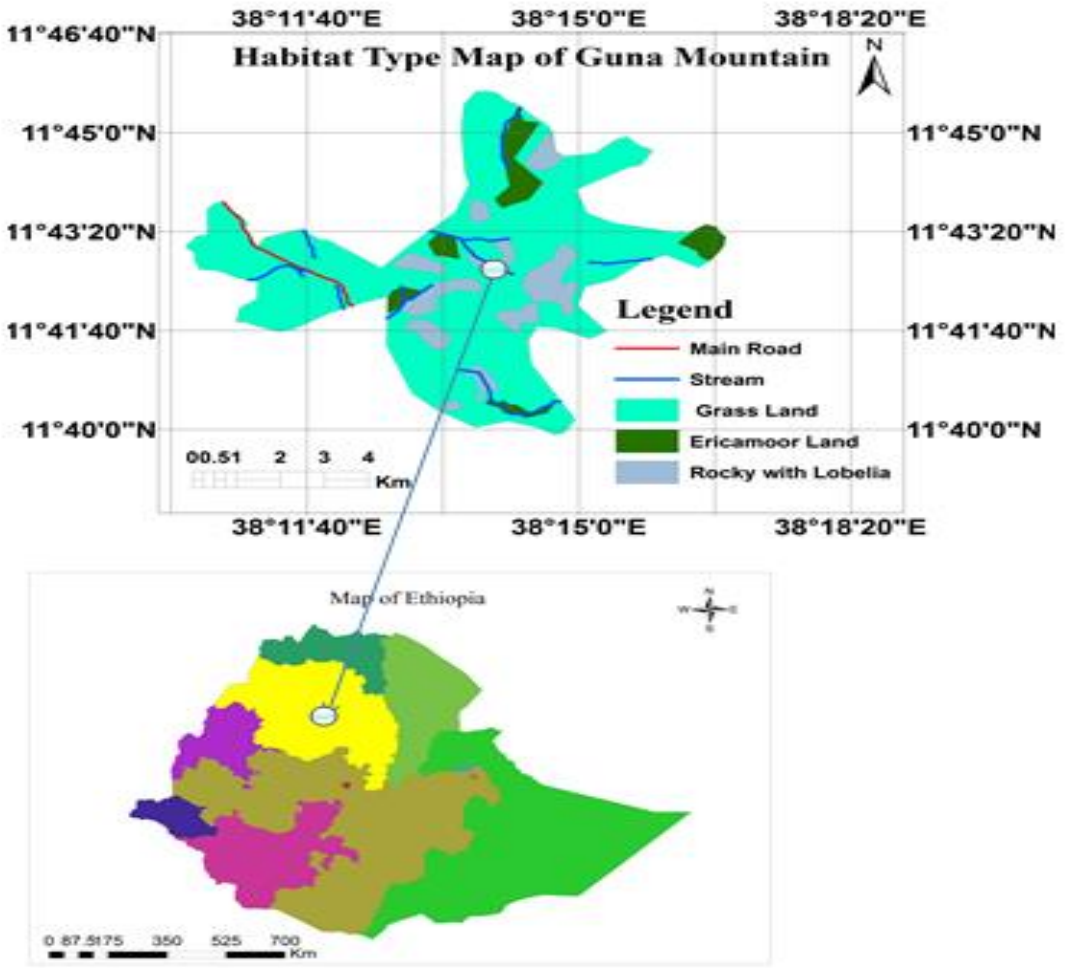

Figure 1: Map of the study area

2.2. Fauna, flora and human population

In the Guna Community Conservation Area 30 mammals are found; however, the most commonly occurring species are rock hyrax (*Heterohyrax brucei*), Common mole-rat (*Tachyoryctes splendens*), Unstriped grass rat (*Arvicanthis abyssinicus*), African wolf (*Canis aureus lupaster*), and Gelada monkey (*Theropithecus gelada*). About 89 bird species have also been reported for the diversity of this area (BoCTPD, 2012).

The area is characterized by Afroalpine and Sub-afro-alpine flora ecosystems. More than 96 species of plants are recorded in the area, out of which *Acanthu seminens*, *Echinopsellen beckii*, *Kniphofia foliosa*, *Lobelia rhynchopetalum* and *Helichrysum hochstetteri* are endemic once. The Afro-alpine zone is mainly covered with Erica moorland dominated by Guassa and rocky with lobelia habitats. In the Sub-afroalpine ecosystem zone, the evergreen tree heather (*Erica arborea*) mixed with *Hypericum revolutum* and *Echinops ellenbeckii* are recently rehabilitating in some parts of Kebeles. However, below the sub-afroalpines, *Eucalyptus globules*, *Juniperus procera*, *Erica arborea*, *Myrica salicifolia*, *Cupressus lusitanica*, *Mytenus arbutifolia*, *Hypericum revolutum* are commonly seen. *Dombeya torrida* along with cultivated land settlements and grazing lands are predominant.

The area is inhabited by 114,931 people. Their livelihood is subsistence agriculture; and the average landholding is less than half a hectare (CSA, 2010).

2.3. Sampling design and data collection

A preliminary survey was conducted at the beginning of August 2019. The overall landscape was surveyed to classify the study habitat. The physical features of the study area were observed using a ground survey. Based on this, the actual study was conducted from August 2019 to April 2020 covering both dry and wet seasons.

In this study, a stratified random sampling design was employed, since the study area has no uniform habitat types. Stratification was made following the methods of Jones (1998), and Krebs (1999). This approach was used to classify habitats and select sampling plots based on vegetation types. Based on the vegetation types and area encroachment, the area was stratified into three habitat types (Erica moorland, Rocky with Lobelia and Grassland). Sampling plots were randomly selected for each habitat type. To make sure that the results were generally representative of the total study area, the number of sampling plots was determined based on the size of the study area (Table 1) (Sutherland, 1996; Bibby et al., 1998). The area of each individual plot measures 300 m in length by 180 m in width. The distance between plots was 150 – 200 m to avoid double-counting among counting stations (Sutherland, 2006). From the total area, 20% of the study area was covered in each sample site (Bibby *et al*., 1992).

The point count method was undertaken from a fixed location within the sample unit of a radius of 30 m with a fixed time interval of 15 minutes. The number of individuals of each species was recorded within a 30 m fixed radius and the unlimited radius points at first detection (Bibby *et al.*, 1998).

Transect lines within a plot were 200 m apart from each other to avoid double counting (Aynalem and Bekele, 2008). During the transect survey, all the birds found in a 45-meter belt length in both directions of the observer were recorded and counted. Line transects were laid in the grassland and rocky with lobelia measuring a length of 300 m each.

The fieldwork was carried out from August to November 2019 for the wet season, and from December 2019 to April 2020 for the dry season. The bird count was made for 15 minutes within the counting station. Stations were surveyed for 72 days during both wet and dry seasons; however, the frequency of data collection was every week twice a day in the morning (6:00-10:00 A.M.) and late in the afternoon (4:00-6:00 P.M.) during the active time of birds and when the weather condition was ideal (Centerbury *et al.*, 2000). For bird identification, the plumage pattern, size, shape, colour, songs and calls were considered (Aynalem and Bekele, 2009). Birds were physically observed using a pair of binoculars. Avian species were identified and their taxonomic groups were categorized using field guides of birds (Redman *et al.*, 2011; Zelelew, 2013). The taxonomic order and nomenclature follow Clements, version 2021.

Table 1: Sampled area and transect counts based on habitat types at Guna Mountain conservation area

Habitat types	Rock with Lobelia	*Erica moorland*	Grassland	Total
Total area coverage (ha)	348	299	3968	6415
Sampled area (ha)	69.6	60	793.4	923
No of sample plots	13	11	147	171
Numbers of line transect	26	-	294	320
Numbers of point transect	-	165	-	165

Note: The total area of the site is = 4615 ha; however, 923 ha (20%) of the area was considered for data collection

2.4. Data analysis

Shannon-Wiener diversity index of diversity was used for the analysis of species diversity in the sampled area (Krebs, 1999).

$$\text{Diversity index } (H') = -\sum P_i \ln P_i \quad [1]$$

Where:

pi = the proportion of species i and ln P_i = the natural logarithm of P_i.

The relative abundance of bird species was estimated using encounter rates that give basic ordinal scales of abundance (abundant, common, frequent, uncommon and rare) (Table 2) (Aynalem and Bekele, 2008). Encounter rate for each species was calculated as:

$$ER = \left(\frac{total\ number\ of\ individuals\ \ again\ observed}{\text{Period of observation in hour}}\right) X\ 100 \quad [2]$$

Where ER is encounter rate.

Table 2: Ordinal scale of abundance used to rank species

Abundance Category	Abundance Score	The ordinal rank of Abundance
< 0.1	1	Rare
0.1-2.0	2	Uncommon
2.1-10.0	3	Frequent
10.1-40.0	4	Common
> 40	5	Abundant

To get the evenness (the pattern of distribution) of birds in the study area, Shannon-Wiener Evenness Index (E) was calculated using the equation;

$$E = \frac{H'}{Hmax} \quad [3]$$

Where:
E = Shannon-Wiener Evenness Index
H' = Shannon-Wiener Diversity Index
H max = ln S= natural logarithm of the total number of species (S) in each site (Henderson and South wood, 2000).

The Chi-square test of independence was also used to test whether the distribution of bird species associated with the three habitats, and differences on the abundance of birds between wet and dry seasons.

3. Results and Discussion

3.1. Species composition

A total of 76 species of birds were observed during the study period. They were belonging to 12 orders and 35 families (Table 3). The order Passeriformes holds 44 bird species which accounted for 58% of the total species. However, the number of avian species identified in the present study was lower than what was reported (BoCTPD, 2012). Apodiformes, Galliformes, Cuculiformes, and Strigiformes were the least diverse orders represented by only one species each. These species are Little swift (*Apus affinis)*, Erckel's francolin (*Francolinus erckelii)*, *White*-cheeked turaco (*Tauraco leucotis)*, and Barn owl (*Tyto alba*), respectively. At the family level, the family Accipitridae was the large family which is represented by nine species and accounts for 11.7 %.

It is clear that as altitude increases biodiversity decreases, but the endemicity of species increases. In this study, relatively the number of endemic species was higher as compared to Entoto protected area (Esayas and Bekele, 2011). And hence in this study four species, which account for 5% were endemic to Ethiopia and nine (11.7%) were endemic to Ethiopia and Eritrea. Four species of Inter African Migrate, 16 species of highland biome species and two Palearctic migrant species were also recorded.

Table 3: Bird species identified at Guna Mountain conservation area

Order	Family name	Common name	Scientific name
Apodiformes	Apodidae	Little swift	*Apus affinis*
Anseriformes	Anatidae	Blue-winged goose [E]	*Cyanochen cyanopterus*
		Egyptian goose	*Alopchen aegyptiaca*
Strigiformes	Tytonidae	Barn owl	*Tyto alba*
Pelecaniformes	Ardeidae	Grey heron	*Ardea cinerea*
		Cattle egret	*Ardeola ibis*
		Black-headed heron	*Ardea melanocephala*
	Threskiornithidae	Wattled ibis [E] ♠♦	*Bostrychia carunculata*
		Hamerkop	*Scopus umbretta*
	Scopidae	Spur-winged plover	*Vanellus spinosus*
Charadriiformes	Charadriidae	Spot-breasted plover [E]♦	*Vanellus melanocephalus*
	Recurvirostridae	Black-winged stilt	*Himantopus himantopus*
Columbiformes	Columbidae	White-collared pigeon[E] ♦	*Columba albitorques*
		Speckled pigeon	*Columba guinea*
		Red-eyed dove	*Streptopelia semitoquata*
		Dusky turtle dove♦	*Streptopelia lugens*
Accipitriformes	Accipitridae	Tawny eagle	*Aquila rapox*
		Black kite ♠	*Milvus migrans*
		Common buzzard	*Buteo buteo*
		Augur buzzard	*Bueto augur*
		Lammergeier	*Gypaetus barbatus*
		Rüppell's vulture	*Gyps rueppellii*
		Egyptian vulture	*Neophron percnopterus*
		Hooded vulture	*Necrosyrtes monachus*
		White backed vulture	*Gyps africanus*
Coraciiformes	Bucerotidae	Hemprich´s hornbill	*Tockus hemprichii*
	Upupidae	Eurasian hoopoe	*Upupa epops*
	Phoeniculidae	Black-billed hoopoe	*Phoeniculus somaliensis*
	Buphagidae	Red-billed oxpecker	*Buphagus erythrorhynchus*
Passeriformes	Cisticolidae	Tawny-flanked prinia	*Prinia subflava*
	Corvidae	Pied crow	*Corvus albus*
		Thick-billed raven [E] ♦	*Corvus crassirostris*
		Cape rock	*Corvus capensis*
		Fan-tailed raven	*Corvus rhipidurus*
	Hirundinidae	Red-rumped swallow	*Cecropis daurica*
	Monarchidae	African paradise-flycather	*Terpsiphone viridis*
	Fringillidae	Streaky seedeater♦	*Serinus striolatus*
		White-throated seedeater♦	*Serinus xanthopygius*
		Black-headed siskin (E)♦	*Serinus nigriceps*
	Paridae	White-backed Black Tit	*Parus leuconontus*

Order	Family name	Common name	Scientific name
	Laniidae	Common fiscal	*Lanius collaris*
	Turdidae	Alpine /moorland chat♦	*Cercomela sordida*
		Rüppell´s black chat [E]	*Myrmecocichla melaena*
		Rüppell´s robin chat♦	*Cossypha semirufa*
		Abyssinian Slaty-flycatcher	*Melaenornis chocolatinus*
		Northern black-flycatcher	*Melaenornis edolioides*
		White-winged cliff-chat [E] ♦	*Myrmecocichla semirufa*
		Black-eared wheatear	*Oenanthe hispanica*
	Passeridae	Swainson's sparrow	*Passer swainsonii*
	Motacillidae	Abyssinian long claw E♠♦	*Macronyx flavicollis*
		Mountain wagtail	*Motacilla clara*
		Grey wagtail	*Motacilla cinerea*
		Yellow wagtail ♥	*Motacilla flava*
		Tree pipit	*Anthus trivialis*
	Nectariniidae	Variable Sunbird	*Cinnyris venustus*
		Tacazze sunbird♦	*Nectarinia tacazze*
	Ploceidae	Red collard widowbird	*Euplectes ardens*
		Yellow bishop	*Euplectes capensis*
	Pycnonotidae	Baglafecht weaver♦	*Ploceus baglafecht*
		Common bulbul	*Pycnonotus barbatus*
	Sturnidae	White-billed starling [E] ♦	*Onychognathus albirostris*
	Vidudae	Village indigobird	*Vidua chalybeate*
	Turdidae	Abyssinian ground thrush	*Zoothera piaggiae*
		African thrush	*Turdus pelios*
		Mountain thrush	*Turdus olivaceus*
		Ground scraper thrush	*Psophocichla litsitsirupa*
	Sylviidae	Pectoral patch cisticola	*Cisticola brunnescens*
		Common chiffchaff	*Phylloscopus collybita*
		Blackcap	*Sylvia atricapilla*
		Ethiopian cisticola	*Cisticola lugubris*
	Muscicapidae	Rea breasted wheatear	*Oenanthe bottae*
		Pied wheatear ♥	*Oenanthe pleschanka*
Psittaciformes	Psittacidae	Black-winged lovebird [E]	*Agapornis taranta*
		Yellow-fronted parrot E ♠	*Poicephalus gulielmi*
Galliformes	Phasianidae	Erckel's francolin♦	*Francolinus erckelii*
Cuculiformes	Musophagidae	White-cheeked turaco[E]	*Tauraco leucotis*

Note: E = Endemic to Ethiopia, [E] = Endemic to Ethiopian and Eretria, ♥ = Palearctic Migrant, ♠ = Inter African Migrant, ♦ = Highland biome bird species

3.2. Relative abundance of birds

During the wet and dry season in each study habitat, the relative abundance of birds was different. A total of 86 birds were uncommon species, 83 were frequent, 12 were common, and only six were rare in the area (Table 4).

The seasonal abundance of bird species was compared. The comparison was made on the bases of sightings and hence only the first seven bird species were considered. These species were: Wattled ibis (*B. carunculata*), Brown rumped seedeat er (*S. tristraitus*), Black headed siskin (*S. nigriceps*), White-collared pigeon (*C. albitorques*), Dusky turtle dove (*S. turtus*). The number of counts for the above species was 167, 141, 133 and 126, respectively. The other two species were the Pied crow (*C. capensis*) and Thick-billed raven (C. *crassirostris)*. The abundance difference between the two seasons was statistically significant ($\chi 2 = 7.100$, DF =1, $p < 0.001$).

The variation in abundance of bird species was observed between different habitats. The variation in the abundance of birds could be determined by food availability and breeding sites (Moges *et al.,* 2018).

The last seven bird species with the lowest number of sightings were Variable sunbird (*C. Vanuatu)*, Barn owl (*T. alba*), Tacazze sunbird (*N. tacazze)*, and Abyssinian long claw (*M. flavicollis*). These species were observed only once in the study period, whereas Erckel's francolin (*F. erckelii)*, Blue-winged goose *(C. cyanopterus)*, and Hemprich´s hornbill (*T. hemprichii)* were observed twice. The abundance of these seven listed species were also statistically significantly different between seasons ($\chi 2 = 3.600$, DF=1, $p<0.001$). The distinct seasonality of rainfall and seasonal variation in the abundance of food resources could account for seasonal changes in the species abundance of birds (Gaston *et al*. 2000; Karr and Roth, 1971).

Table 4: Relative abundance of bird species in the dry and wet seasons at Guna Mountain conservation area

Habitat	Season	Uncommon	Frequent	Rare	Common
Grassland	Dry	21	17	3	4
	Wet	22	13		1
Erica moorland	Dry	20	14		
	Wet	16	19		2
Rocky with *lobelia*	Dry	4	16		2
	Wet	3	4	3	3

3.3. Distribution of birds in Guna Mountains Community Conservation Area

Of the total species of bird identified during the study period, the highest species (53 species) were recorded from the grassland and the least (22 species) were recorded from rocky with lobelia habitat. Of these avian species, 64 and 59 species were recorded during the wet and dry seasons, respectively (Table 5). Birds showed differences in the distribution among the three habitats ($\chi 2 = 3315.965$, DF =75, $p<0.001$). The difference could be due to the variation in the size and vegetation composition of the study areas. Antos *et al.* (2006) justified that as the size of survey areas increases, the richness and diversity of bird species also increase. Davidar *et al*. (2001) have also reported that size could be a factor in this variation. Passeriformes and Accipitriformes were the most abundant families and they were commonly distributed. Strigiformes families were the least abundant in the study area and their distributions were not common in the study area.

The highest number of avian species was encountered in moorland **(**Blackwell *et al*., 2013**)**. But, the present study showed that the number of avian species in grassland habitats was highest than in *Erica* moorland. The *Erica* moorland habitat is dominated by few plant species and has little flowers and fruits that could account for the presence of less number of species than the grassland. Therefore, birds that are dependent on fruit such as frugivores birds could not be attracted to the area (Yirdew *et al*,, 2013). Moreover, low species abundance in the *Erica* moorland might be related to the absence of a different variety of plant species, which might be selected only by a few bird species. According to Girma *et al.* (2017); Mengesha and Bekele (2008), a natural forest which is dominated by a few tree species are not suitable for different bird species.

There was also a difference in the number of avian species between the dry and wet seasons. This result agrees with Asmare (2009). The availability of food increases during the wet season as the species richness might increase. Tellaria (1992) pointed out that habitat structure tends to affect the distribution of individual avian species. Similarly, habitat size, foraging modes and floristic composition are also among the other driving factors that tend also to influence the distribution of bird species (Aynalem and Bekele, 2008; Girma *et al.*, 2017).

Table 5: Distribution of bird species in different habitat types and seasons in the study area (+ indicates presence and (-) indicates an absence of species at GMCA

Common name	Scientific name	Habitat types			Season	
		Erica moorland	Grassland	Rocky with Lobelia	Wet	Dry
Abyssinian ground thrush	*Z. piaggiae*	+	+	-	+	+
Abyssinian long claw	*M. flavicollis*	+	+	-	+	-
Abyssinian slaty-flycatcher	*M. chocolatinus*	+	-	+	+	+
African thrush	*T. pelios*	+	+	+	+	+
African paradise-flycatcher	*T. viridis*	+	-	-	+	-
Alpine/moorland chat	*C. sordida*	-	+	+	+	+
Augur buzzard	*B. rufofuscus*	+	+	+	+	+
Baglafecht weaver	*P. baglafecht*	+	+	-	+	+
Barn owl	*T. alba*	+	-	-	-	+
Black kite	*M. migrans*	+	+	-	+	+
Black-billed hoopoe	*P. somaliensis*	-	+	-	+	-
Blackcap	*S. atricapilla*	-	+	-	+	-
Black-eared wheatear	*O. hispanica*	+	-	-	+	+
Black-headed heron	*A. melanocephala*	-	+	-	+	-
Black-headed siskin	*S. nigriceps*	+	+	-	+	+
Black-winged lovebird	*A. taranta*	+	+	-	+	+
Black-winged stilt	*H. himantopus*	+	+	-	+	-
Blue-winged goose	*Cyanochen cyanopterus*	-	+	-	+	-
Cape rock	*C. capensis*	-	+	-	+	+
Cattle egret	*A. ibis*	-	+	-	+	-
Common bulbul	*P. barbatus*	+	-	-	+	+
Common buzzard	*B. buteo*	+	+	+	+	+
Common chiffchaff	*P. collybita*	+	-	-	+	+
Common fiscal	*L. collaris*	+	-	-	-	+
Dusky turtle dove	*S. logins*	+	+	+	+	+
Egyptian goose	*A. aegyptiaca*	-	+	-	+	-
Egyptian vulture	*N. percnopterus*	-	+	-	-	+
Erckel's francolin	*F. erckelii*	+	+	-	+	+
Ethiopian cisticola	*C. lugubris*	+	+	-	+	+
Eurasian hoopoe	*U. epops*	-	+	-	+	-
Fan-tailed raven	*C. rhipidurus*	-	+	-	+	+
Fan-tailed raven	*C. rhipidurus*	-	+	-	+	+
Grey heron	*A. cinerea*	-	+	-	+	-

3.4. Diversity of birds

The highest species diversity was obtained in grassland habitat (H'=3.67), whereas low diversity was recorded in rocky with *lobelia* habitat (H´=2.6). The highest species evenness was recorded in grassland and rocky with lobelia habitat (E=0.88) and the lowest species evenness was recorded in *Erica* moorland habitat and rocky with lobelia (E=0.79). The diversity and evenness of bird species among habitat types between wet and dry seasons are presented in (Table 6). The lowest species diversity was obtained in the rocky with *lobelia* habitat in wet seasons (H´=1.84), whereas grassland had the highest bird species diversity (H´= 3.86). Similarly, during the dry season, the lowest species diversity was obtained in the rocky with lobelia habitat (H´=2.34) and the highest species diversity was obtained in the grassland habitat (H´=3.48). The floristic composition might have a great influence on the distribution of the avian species in the grassland than others (Aynalem and Bekele, 2008; Girma *et al.*, 2017). According to Nancy (1995), larger covered habitats support more species of birds and individuals than smaller ones as they possess diversified microhabitats. This result could be due to the adaptable nature of birds in the grassland habitats (Smith, 1992). The results of the present study, in agreement with the findings of Mengesha and Bekele (2008) and Genet and Ejigu (2017), showed that grassland interspersed patchy habitats have contribution to high diversity, richness, and evenness of birds. The openness of sites compared to *Erica* moorland might have also contributed to the easy identification of species (Hailu, 2008). The overall bird species diversity in the wet season (H'=2.50) was slightly higher than that of the dry season in the study area (H´=1.83). The distinct seasonality of rainfall and seasonal variation in the abundance of food resources could account for seasonal changes in the species abundance of birds (Gaston *et al*., 2000; Karr and Roth, 1971).

Guna Mountains Conservation Area is highly fragmented and exposed to different threats caused by anthropogenic activities. Habitat loss and degradation as a result of anthropogenic activities have caused a significant decline in avian diversity around the world (Taylor and Pollard, 2008). This might lead to a change in the diversity, abundance and distribution of birds (Mengesha *et al.*, 2011). Especially grassland and highland biome restricted birds may be affected as they do not have any alternative foraging or breeding sites.

Table 6: Diversity and evenness indexes of birds at GMCA study habitats

Habitat Types	Season	Individuals	Taxa- S	H'	H'max	Evenness
Rocky with *Lobelia*	Wet	215	15	1.84	2.7	0.68
	Dry	170	19	2.34	2.94	0.8
	Both	323	26	2.6	3.29	0.79
Guassa grassland	Wet	482	49	3.86	3.89	0.99
	Dry	601	43	3.48	3.76	0.93
	Both	1092	64	3.67	4.15	0.88
Erica moorland	Wet	302	33	2.63	3.49	0.75
	Dry	543	42	2.47	3.74	0.66
	Both	969	59	3.22	4.08	0.79

4. Conclusions and Recommendations

The results of this study demonstrate that Guna Mountains Community Conservation Area has a total of 76 species, 12 orders, and 35 families. It is an important area for highland biome restricted species and home of endemic, and nearly threatened species. At this site, four endemic species, and nine species that are endemic both to Ethiopia and Eritrea, four inter African migrants, 16 highland biome species and two Palearctic migrant species were recorded.

The study showed that season and habitat types are the important determining factor for both Palearctic migrant and resident bird species. Most of the species were uncommon. The highest diversity and

distribution of bird species were observed in the grassland and relatively, the lowest diversity and distribution were observed in the rocky with lobelia.

Human activities such as overgrazing, deforestation, agricultural expansion, human settlements and eucalyptus plantation expansions were observed in Guna Mountains Community Conservation Area. Unless appropriate community conservation measures are taken, the entire habitat and the bird species will be affected in the area. This study, recommends that the conservation of the area must be strengthened in order to safeguard the birds and their habitats. The grazing and agricultural land encroachment into the area would affect the fauna and flora of the area at large. Sustainable utilization of the natural resource could maintain the ecological integrity of this afro-alpine habitat.

Conflicts of interest

The authors declare that there is no conflict of interest in publishing the manuscript in this journal.

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