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Urban Bird Species Diversity and Abundance in case of Wolkite Town, Southwestern Ethiopia

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ABSTRACT

Urban environments are a place where bird species are living due to the availability of considerable food and roosting sites, particularly in gardens and parks. However, bird species diversity and distribution is poorly known in urban areas. In order to fill the gaps, this study aimed to quantify bird species diversity and abundance for conservation priority of Wolkite town. The study area was stratified into different blocks namely abattoir, dump site, sacred site and home-garden, based on land characteristics and bird attracting features. Point transects were laid on stratified blocks randomly with the aid of GPS. Bird data have been collected via direct observation with help of a binocular. The data were analyzed through one-way ANOVA and Paired Sample t-test. The study recorded a total 30 bird species, of which 18 species are resident and 12 are seasonal migrants. Most of the identified birds (58.67%) are locally frequent and about 6.6% are rare species. In home-garden block, the highest species diversity was recorded in both wet and dry seasons. The bird species are distributed evenly in home-garden (E=0.976) and sacred site(E=0.944) during wet and dry seasons. Bird species abundance had a significant difference among the identified blocks ($F=5.47$, $df=3$, $P<0.05$. The result showed that Wolkite town harbors many rare, near endemic, critically endangered and seasonal migrant bird species. Hence, it is an important area of endemism and conservation priority and qualifies the criteria to be recognized as an important bird area of Ethiopia. In conclusions, similar small towns could have a diversified bird species and need to be considered as a conservation priority areas.

Key Words: Bird Species; Conservation Priority; Diversity; Endemism

INTRODUCTION

Birds are well-known indicator taxa due to their sensitivity to environmental perturbations, relevance to ecosystem functioning and relative ease in sampling (Posa and Sodhi 2006). They are indicators and useful models for studying variety of environmental changes (Sutherland and Green 2004, Urfi et al. 2005, Estrella 2007). Birds are important bioindicators of climate change and water quality and also potential tourist attractions (Gill 1994, Aynalem and Bekele 2009). Humans have been fascinated by birds, have observed, used, painted, wrote and sung, kept in captivity, protected and gave them great respect, since the earliest times (Daimond 1987). They are the most universally celebrated form of animals, found in pictures, photo-graphs, sculptures, words and songs (Frith and Beehler 1998). Honey guide birds are important to lead the tribal men to the site of an active bee's nest and in many industrialized countries, the revenue gain from bird watching activities. The birds' diversity and abundance can reflect ecological treads in other biodiversity (Furness and Greenwood 1993).

The species composition in a given area is mostly

explained by historical factors such as dispersal events, geographical isolation, and extinction due to past climatic and geological events, and in much less extent by some ecological factors such as competition and predation (Barrantes and Sandoval 2009). Environmental heterogeneity in the form of spatial variation in habitat and local climate can affect species distributions (Veech and Crist 2007). The abundance and distribution of animals are also affected by scale-dependent hierarchical processes that disturb the links between habitat suitability and their numbers (Telleria et al. 2009). Birds are both visually and acoustically conspicuous organisms of most ecosystems.

Urban areas have relatively little and often exotic vegetation in a landscape dominated by street pavement and concrete buildings when compared with natural areas (Mcdonnell and Pickett 1990,Slabbekoorn and Ripmeester 2007). Birds have adapted to life in urban areas and look for food in gardens, farms and rubbish dumps (Morgan 2004). Urban environments provide birds with considerable quantities of food and roosting sites especially in gardens and parks (Dorst 1974). Some species could be attracted to such areas since it introduces new exploitable resources such as water, ornamental plants and grasses (Posa and Sodhi 2006). Research on birds in cities worldwide has been steadily accumulating, particularly over the last few decades, and results indicate that as development intensifies, bird communities become increasingly homogenized (McKinney and Lockwood 1999).

Topographical variability and temperature are identified as the most important global predictors of avian species (Karr 1976, Karr 1980, Davies 2007). As the result of these rewards in Ethiopia, about 926 bird species are listed, of which 21 are endemic and 19 are globally threatened (Lepage 2006). Despite the rich diversity of birds in Ethiopia, habitat destruction, fragmentation and loss have been observed for decades and severely impacted the survival of bird species (Aynalem and Bekele 2009). Forest loss and forest fragmentation have been widely recognized for their significant impacts on avian biodiversity (ESRI 2012).

The ornithology of Ethiopia is still in its infancy, because of its limited concern and clearly not for lack of birds. The investigations on avian fauna in Ethiopia are negligible, when compared to other countries in the region. Only few researchers have also conducted study on the diversity and ecology of avian species in some parts of Ethiopia (Urban and Brown 1971, Ash 1979, Ash and Gullick 1989, EWNHS 1996). Despite the availability of diverse ecosystems in different regions of Ethiopia, the ecology of most avian species is only little known.

Measure of bird diversity might be valuable to prioritize areas and needs, understand community dynamics and identify causes of change where they occur, document trends and identify species that may be at risk, have a quantitative measure of diversity for future comparisons and intervention strategies.Wolkite town also play vital role for bird conservation. However, no study has been done in regards to species diversity, abundance and distribution of birds' communities in the town. Having this inconsideration, the species diversity and abundance of diurnal birds in Wolkite town was the main aim of this study. Hence, this study will be served as ideal or scientific information on current abundance and diversity of bird species including migratory, endemic and global conservation status and able serve as bench mark for local communities, researchers and ornithologists, allusion on birds and also further studies.

STUDY AREA

Wolkite town is the center of Gurage Zone and found in the southern Ethiopia. It covers an area of 10.29 km^2. Wolkite is located in the distance of 158 km from Addis Ababa. It is geographically located between latitude of 8°16''N to 8°18' N and longitude 37° 45' E to 37° 48' E (Figure 1) and between 1799 and 1926 meter above sea level. The mean annual temperature ranges from 14 °C to 25 °C with an average of 20.5 °C.

METHODS

Before commencing the actual data collection, a preliminary survey was conducted in November 2017. During the survey, climate, bock/habitat type and location data were collected with the help of a local assistant to become familiar with the physical features of the study area.

Study Design and Sample Site Selection

Number of sampling units were selected from each stratified bock/habitat. The technique involves dividing the study area into four block type based on land features and bird attracting features. These block/habitat types were abattoir, dump site, sacred site and home gardens

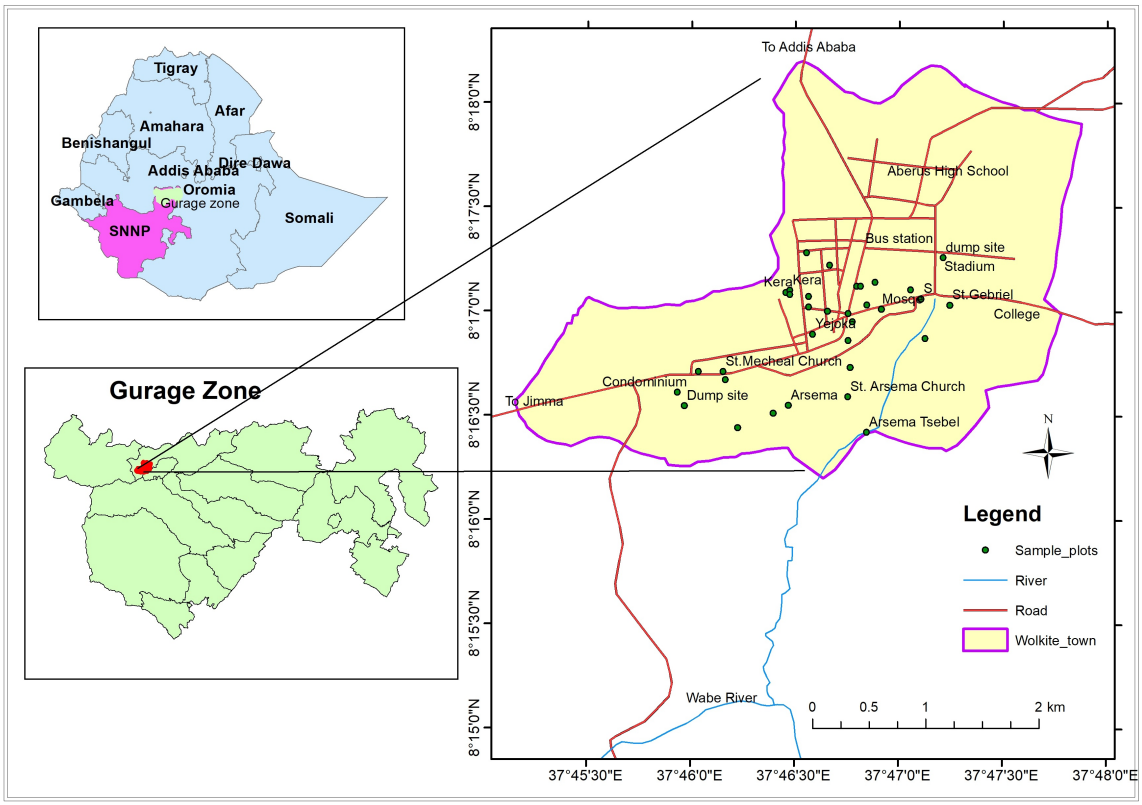

Figure 1. Location map of Wolkite Town with the sample plots distribution

that served as feeding, resting, roosting and nesting sites for different bird species. During the study period, the abattoir bock type was included all places where livestock slaughtered available including the surrounding area. Home-garden block comprised a place of building, cafes, village, grinding house of grains, markets and fruit tree garden places. Sacred sites encompassed churches, mosques and other holly places where the existing trees serve as nesting, feeding and resting palace of birds. Dump site block type is any place in the town where solid wastes are deposited in Wolkite town.

A sample transect points were laid on each of the stratified block in the random fashion. Each point transects had a minimum of 50 m distance from road side to avoid edge effect and double counting of the same individual of a species (Aynalem and Bekele 2008).

Data Collection

Actual data collection was carried out from November 2017 to October 2018 in wet and dry seasons. Data were collected from November to February during dry season and from July to October during wet season. A point transect count was employed to investigate avian species diversity and abundance per block per season (Bibby et al. 1992, Pomeroy 1992). Observations were made by standing in the middle of the point transect and observing 360° round quietly and gently up to a distance of 30 m radius. Observation at each point transect was lasted for 15 min.

The data were collected for four days per month depending on weather conditions and time of the day when most of the avian species are active. Data collection was carried out early in the morning from 7:00 to 10:00 a.m. and in the late afternoon from 3:00 to 6:00 p.m., when the activity of birds is prominent (Bibby et al. 1992). For identification of species present in the study area, plumage pattern, size, shape, color, songs and calls were important parameters (Aynalem and Bekele 2009). The habitats and sites which were conducive to access of food, water resources, nesting and roosting for birds were observed during the study period. During counting, all observers were organized to count the bird species simultaneously to avoid double counting. Birds in the study area were identified by direct observation with the help of binoculars, bird guide book and digital camera.

Digital camera photographs were used for further confirmation of the bird species and recorded in field data sheet. GPS was used to locate the points for the bird counting methods. Identification and categorization of birds to their respective taxonomic group was done based on field guide book (Redman et al. 2009).

Data Analysis

Number of bird species and abundance data were summarized per plot and the data of bird species were calculated using diversity indices. The species diversity of the area calculated based on Shannon-Weaver Diversity Index. Shannon-Weaver Diversity Index (H') is calculated as:

$$H' = -\Sigma(Pi \ln pi) \quad \ldots\ldots (1)$$

where, Pi = Proportion of the i^{th} species, and ln = Natural logarithm

Species evenness, which measures the pattern of distribution of the bird populations present in the area, was evaluated using Shannon-Wiener Evenness Index (E) as follows:

$$E = H'/ Hmax \quad \ldots\ldots (2)$$

where, H max = lnS = natural logarithm of the total number of species (S) in each month (Shannon and Weaver 1949).

The relative abundance of the bird species was determined by using the equation:

$$\text{Relative abundance (\%)} = n/Nx100 \quad \ldots\ldots (3)$$

where, n is the numbers of individuals of particular recorded species and N is the total number of individuals of recorded species.

According to Bibby et al. (1992), Simpson's similarity index (SI) was used to assess the similarity among different blocks/habitats with reference to the composition of species using the formula:

$$SI=2C/A+B \quad \ldots\ldots (4)$$

where, C= Number of species common between sites, A= Number of species in site A, and B=Number of species in site B.

Encounter rate method was used to explain a species list with an index of relative abundance based on the number of encounters with individuals per block of time. It was calculated as:

$$\text{Encounter rate} = \frac{\text{Total Number of Individual Birds Observed}}{\text{Period of Observation in Hours}} \times 10 \quad \ldots\ldots (5)$$

Encounter rate was used to give a crude ordinal scale of abundance (Bibby et al. 1992) as given in (Table 1.

Table 1. Encounter rates used to give a crude ordinal scale of abundance

Abundance category	Abundance score	Ordinal scale
<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

Finally, the data were analyzed through one-way ANOVA for abundance comparison between wet and dry season and abundance among different blocks. Paired sample t-test was used to compare abundance difference among bocks in wet and dry season and Microsoft excel 2010 was also used to calculate bird species diversity index.

RESULTS

Seasonal Bird Species Composition

A total 30 bird species belonging to 8 orders and 18 families were recorded during the study period in Wolkite town. Among them, Wattled Ibis (*Bostrchia carunculata*) and White Collared Pigeon (*Columba albitorques*) were near endemic (endemic to Ethiopia and Eritrea) whereas Hooded Vulture (*Necrosyrtes monachus*) and White Backed Vulture (*Gyps africanus*) were critically endangered species at global scale. A total 25 and 23 bird species were recorded during wet and dry seasons, respectively. While 18 bird species were common to both wet and dry seasons, 7 and 5 species

were exclusively recorded in wet and dry seasons, respectively (Table 2). Of the identified species 50% (15 species) belonged to the order Passeriformes followed by Columbiformes (13.3%) and Accipitriformes(13.3%) (Figure 2).

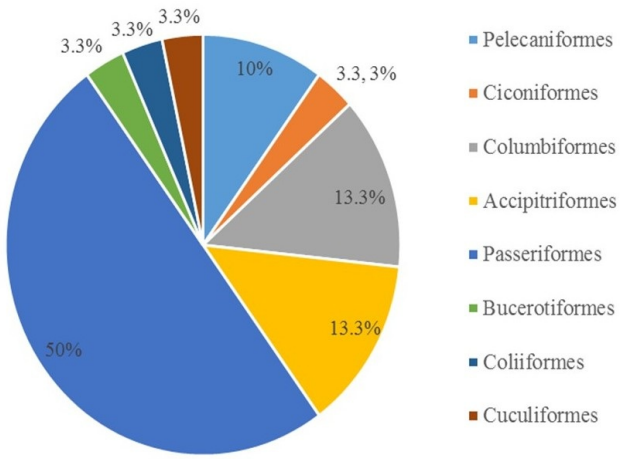

Figure 2. Species percentage belonging to the different orders

Encounter Rate and Relative Abundance

Of the total bird species, 6.6%(two species) were locally rare, 6.6%(two species) uncommon, 58.67% (17 species) frequent, 26.67% (8 species) common and 3.3%(one species) abundant species in Wolkite town (Figure 3). Hooded Vulture was recorded the highest relative abundance (18.24%) followed by Wattled Ibis (*Bostrchia carunculata*) (10.1%),while White crested helmet Shrike (*Prionops plumatus*) (0.31%) and Tacaze sun Bird (*Nectarinia tacazze)* (0.31%) were recorded the lowest relative abundance (Table 2).

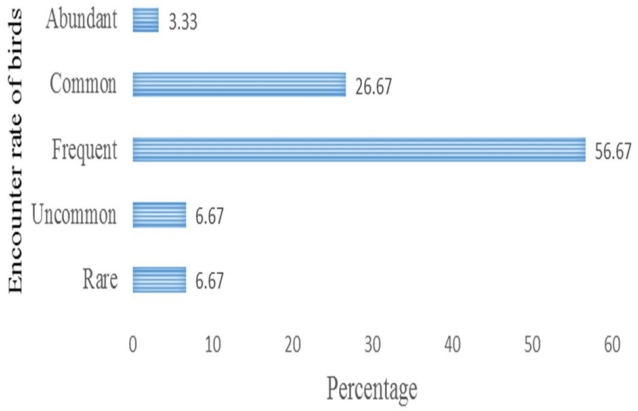

Figure 3: Encounter rate of bird species

Seasonal Bird Species Diversity and Abundance

In both wet and dry seasons, the highest species diversity was recorded in home-garden block. In this block, the highest species richness (19 species) was also recorded in wet season. While in the abattoir harbored, the highest (15 species) species richness was recorded in dry season. Whereas in dump sites and scared sites,13 species and 10 species were recorded, respectively. In both sites, the lowest species richness are available in wet and dry seasons. The bird species were evenly distributed in home-garden block (E=0.976) and sacred site (E=0.944) during wet and dry seasons, respectively. In the abattoir block, less evenly distributed species were recorded during wet and dry season (Table 3).

A total of 617 individual birds were recorded through study period in the study area. The mean abundance of bird species between wet and dry seasons was not significantly difference ($F= 1.26$, $df=1$, $p > 0.05$), however there was a significant difference in abattoir block between wet and dry season ($t = 2.201$, $df=29$, $p < 0.05$. The abundance of bird species was significant difference in dump site block type between wet and dry seasons ($t = 2.16$, $df=29$, $p < 0.05$. Furthermore, abundance of bird species was significantly different among block type ($F=5.47$, $df=3$, $P<0.05$. Abundance of birds in abattoir was recorded the highest (6.53±2.15) in the study area.

During wet season, bird community showed similarity between abattoir and scared sites, and between abattoir and home-garden. During dry season, bird community showed similarity between scared sites and dump sites. However, less similarity was showed in all other bock during wet and dry seasons (Table 4).

DISCUSSION

The occurrence of diversity of bird species is an indication of habitat heterogeneity in the area (Pomeroy 1992). The high number of species and individuals in a given area implies the importance of the area for the species conservation (Mengesha and Bekele 2008). This study recorded a total 30 diurnal bird species in Wolkite town. A total of 70 species were recorded in Metro Manila green spaces (Quezon City), Philippines (Vallejo et al. 2009). This study has been recorded Wattled Ibis and White Collared Pigeon as a near endemic (endemic to Ethiopia and Eritrea) and Hooded Vulture and White Backed Vulture as critically endangered species at global

Table 2: Birds composition and relative abundance in Wolkite Town

[2] = Endemic to Ethiopia and Eritrea (EWNHS 1996), + = Critically endangered, * = Least concern (IUCN 2017) and RA= Relative abundance.

Common Name	Scientific Name	Family	RA
White browed Cloucal*	*Centropus superciliosus*	Cuculidae	0.94
African Scared Ibis*	*Threskiornisaethiopicus*	Threskiornithidae	1.26
Glosse Ibis*	*Plegadisfalcinellus*	Threskiornithidae	1.57
Watteled Ibis[2]	*Bostrchiacarunculata*	Threskiornithidae	10.1
Marabou Stork*	*Leptoptiloscrumeniferus*	Ciconiidae	5.97
Laughing(Palm) Dove*	*Streptopelia senegalensis*	Columbidae	1.89
Speckled Pigeon*	*Columba guinea*	Columbidae	3.46
White collared Pigeon[2]	*Columba albitorques*	Columbidae	0.94
Red eyed Dove*	*Sreptopeliasemitorquata*	Columbidae	4.09
Yellow billed Kite*	*Milvus aegypticus*	Accipitridae	6.60
Hooded Vulture[+]	*Necrosyrtes monarchs*	Accipitridae	18.24
White Backed Vulture[+]	*Gaps africanus*	Accipitridae	9.75
Ruppel's Vulture*	*Gyps rueppellii*	Accipitridae	6.60
Swanson's Sparrow*	*Passer swainsonii*	Passeridae	5.03
Pin tailed Whydah*	*Vidua macroura*	Viduidae	0.94
Greater blue Starling*	*Lamprotornischalybaeus*	Sturnidae	2.52
Ruppell's Starling*	*Lamprotornispurpuroptera*	Sturnidae	0.94
Pied Crow*	*Corvusalbus*	Corvids	1.57
Slivery cheeked horn Bill*	*Bycanistes brevis*	Bucerotidae	0.94
White crested helmet Shrike*	*Prionopsplumatus*	Vangidae	0.31
Black headed siskin*	*Serinusnigriceps*	Fringillidae	1.57
African fire Finch*	*Lagonostictarubricata*	Estrildidae	4.09
Red cheeked cordon Blue*	*Uraeginthusbengalus*	Estrildidae	2.20
Speckled mouse Bird*	*Coliusstriatus*	Coliidae	0.94
Little Weavers*	*Ploceusluteolus*	Ploceidae	1.26
Northern Red Bishop*	*Euplectesfranciscanus*	Ploceidae	0.63
Variable sunbird*	*Cinnyrisvenustus*	Nectariniidae	0.63
Tacaze sun Bird*	*Nectariniatacazze*	Nectariniidae	0.31
Village indigo Bird *	*Viduachalybeata*	Viduidae	2.20
Common Bulbul*	*Pycnonotus barbatus*	Pycnonotidae	2.52

Table 3. Species diversity of birds in the study area

Block type	Abundance		Species Richness		H'		H-max		E	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Abattoir	117	253	16	15	2.30	2.17	2.77	2.71	0.83	0.80
Scared site	33	22	15	10	2.58	2.17	2.71	2.3	0.95	0.94
Dump site	64	37	13	11	2.44	2.21	2.57	2.39	0.95	0.92
Home-garden	49	62	19	14	2.87	2.42	2.94	2.64	0.98	0.92

Table 4. Similarity index among habitat types

Bock		Abattoir		Sacred site		Dump site		Home garden	
		Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Abattoir	Wet	…	…	0.66	0.4	…	…	0.88	…
	Dry		…	0.7	0.47	…	….	0.41	…
Sacred site	Wet			…	0.92	0.42	0.31	…	…
	Dry				….	0.57	0.42	…	…
Dumpsite	Wet					…	…	…	…
	Dry						…	0.87	…
Home garden	Wet							…	…
	Dry					…	...	...	...

scale. This is related to the area uniqueness and in providing heterogeneous habitats for the bird species. The occurrence of endemic, endangered and rare bird species makes an area of conservation priority (Mengesha and Bekele 2008). Hence, Wolkite town landscape consists of small patches of forest becomes an important area of endemism and conservation priority area.

The bird species richness was not considerably varying in the seasons of study period. The multi-bird species composition study at micro geographic or local scale, the effect of season or the role of climate could be negligible. Therefore, seasons might account for insignificant effect on bird species composition in the study area (Aynalem and Bekele 2008). The study showed that 18 species were resident throughout the study period and 12 species were seasonal migrants including wintering birds such as Sacred Ibis, Marabou Stork and Yellow Billed Kite which was observed from November to February.

The study revealed that most species of bird (58.67%) were locally frequent while 6.6% species were rare and again 6.6% were locally uncommon species in the study area. Hooded Vulture recorded the highest relative abundance, while White crested helmet Shrike and Tacaze sun Bird were recorded the lowest relative abundance. The relative abundance of bird species might be related to the availability of food, habitat condition and breeding season of the species. The distinct seasonality of rainfall and seasonal variation in the abundance of food resources result in changes in the species abundance of birds (Aynalem and Bekele 2008). In home-garden block, the highest species diversity was recorded in both wet and dry seasons and also the highest species richness was recorded in the wet season, while the abattoir harbored the highest species richness during the dry season. Bird species richness and abundance are influenced by resource availability in addition to the size of habitat patches. This is could be the biotic factors affecting species distribution and interspecies interaction which are essential for a species or a group of species having a non-uniform distribution in space (Nabaneeta and Gupta 2010). According to Lyon and Caccamise (1981), birds prefer different habitats for resting, roosting and nesting. These include both manmade and natural habitats. Human induced feature such as roofs of terminal buildings and offices, light poles, antennas and related features can attract for diversity of bird species for nesting, resting and roosting in home-garden area. Similarly, large size of home-garden as compared other block might contribute to recorded highest diversity and species richness. This is also related to availability of various food items in the site (Aynalem and Bekele 2008, Mengesha and Bekele 2008).

The bird species was evenly distributed in home-garden and sacred site during wet and dry seasons in Wolkite town, respectively. This might have relation to the presence of variety of food items, water and cover throughout the study period contributed to have highest species richness and evenness in this block/habitat (Girma et al. 2017).

There was no significant difference in mean abundance of bird species between wet and dry seasons.However, there was a significant difference in abattoir and dumpsites between wet and dry season.

Disturbance, nesting site and food availability could influence urban bird species abundance (Jokimaki 1996). The variation in bird species abundance could be due to the migratory behavior, the availability of food, habitat condition, and breeding season of the species (Mengesha and Bekele 2008).

Bird species abundance was significance different among bock types. Abundance of birds in abattoir was recorded the highest in the study area. Birds in abattoir perch on poles and fences to have a look over their foods. Following high disposal scrap of slaughtered animals, large numbers of worms sometimes move out of the soil adjacent to the other area looking for a dry place this could contribute their high abundance of birds of prey (Bruder et al. 1997). Hooded and White Backed Vulture, Marabou Stork, Wattled and Sacred Ibises were observed foraging on wastes of the abattoir, disposed scrap of slaughtered animals and feeds on insects' other invertebrates. Similarly, Swainson's Sparrow and Speckled Pigeon also observed in this habitat type feeds on invertebrates as well as food wastes. Improper dumping of food left over from residence, cafeterias, and catering services are other attractants for birds in the abattoir (Weller 1999).

CONCLUSION

Despite its small size, Wolkite town supports a diversified bird community. Wolkite town becomes home to many rare, near endemic and critically endangered bird species. In addition, there is an occurrence of migratory bird species in the town. Hence, Wolkite town is an important area of endemism and conservation priority in Ethiopia. The study site is very significant for the conservation of birds at the global, regional or sub-regional level since it qualifies the criteria of importance bird areas (IBAs). However, the area has not yet received conservation concern at local, national and international level. Therefore, responsible bodies shall give attention for conservation by registering the town as an IBA. Since the study area faced with many anthropogenic factor, biodiversity conservation integration and conservation measures are inevitable to conserve the endemics and globally threatened bird species in and surrounding to Wolkite town. Despite this study attempted many efforts to investigate diversity and abundance of bird in the study area, there wasa limitation in identification of cryptic, nocturnal and very small bird species. Hence, further study shall be carried out to identify out these species. The study indicates that the area has a potential to host diversified bird species and needs to be considered as a conservation priority area.

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We declare that there is no conflict of interest.

Availability of data and materials
All raw data and/or analyzed data during the current study are available from the corresponding author on reasonable request.

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