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Species Composition and Relative Abundance of Birds at Nansebo Forest, Southern Ethiopia

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Abstract
Birds are one of the components of biodiversity. Avian community studies are effective tools for monitoring a forest ecosystem. The status of birds in the present study areas is very little known. Therefore, the objective of the study was to assess species composition and relative abundance of birds at Nansebo forest in southern Ethiopia. To this end, a stratified random sampling technique was employed. Accordingly, to collect data for the study, the whole habitat of the study area was divided into dominant vegetation types. Accordingly, Moist Afromontane forest and modified habitat were identified in Nansebo forest. A line transects count aided by binocular was employed to investigate avian species diversity and relative abundance. Accordingly, 20 transect lines of 1km with a width of 0.25km or less was used to cover 27.75% of the area in Nansebo forest. Quantitative Biodiversity indices such as H',E ,γ and α to measure species richness were used to calculate the bird species diversity and two way- ANOVA was used to test for significant variation in species richness and abundance per season among habitats. A total of 105 bird species consisting of 1endemic, 8 near endemics, 1 globally threatened and 9 Palearctic migrants were recorded in Nansebo forest. Species richness and abundance varied between the three habitats in Nansebo forest. There was significant difference in species richness among habitats in Nansebo forest (F1, 18=94.657 P=0.000) at 0.001 significance level. In Nansebo forest the highest Shannon-Wiener diversity index (H' = 4.17) was recorded from the modified habitat. It can be concluded that the area has high species diversity including endemics and endangered species. It can also be good potential for bird watching tourism that can integrate economic gain with biodiversity conservation. Hence, urgent conservation measures and further detail research is recommended to conserve the bird species.
Keywords/Phrases: Avian species, Habitat types, Species richness, Species similarity
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Introduction

Ethiopia has rich biodiversity resources of which 926 bird species comprising of 24 endemics (EBI, 2015 and Weldemariam Tesfahunegny, 2016). Birds are one of the most important components of biodiversity with ecological, economic and esthetic values. Birds are known as efficient and cost-effective insect pest controllers, Fruit-eating birds help in seed dispersal and seeds may grow everywhere in the fall of droppings and certain birds like hummingbirds and sunbirds also used for flower pollination that produce nectar. They are also the source of considerable fascination and folklore and have been used as symbols (Clout and Hay, 1989).

The distribution and abundance of many bird species are determined by the composition of the vegetation or habitat (Lee and Rotenberry, 2005). Climate influences habitats and movements of resident and migratory birds that are characteristic of particular habitats or biomes (Metzger *et al*., 2009). Studies from different parts of the world focused on characterizing the bird's species composition and abundance on specific regions of the country (eg. Study by Girma and Afework, 2008). There are a few isolated reports of bird species diversity outside of protected areas in Ethiopia (Aerts *et al*., 2008), although there is better documentation of birds in protected areas (EWNHS, 1996). Comprehensive baseline information is lacking even for several of the endemic bird species. The status of birds in the present study areas is very little known. As a result, the present study is aimed to investigate species diversity and relative abundance of birds in nansebo forest and contribute to the conservation of the species in the area.

Materials and Methods

Study area

The study was conducted in Nansebo forest that found in Nansebo District in west Arsi Zone of Oromiya Regional state of Ethiopia (Fig.1). Nansebo district is located between 6°10′ - 6°40′ N and 39°0′ - 39°40′ E (Fig.1). It is located 407 km far from Addis Ababa and 134.5 km away from Shashemene, the capital city of the zone.

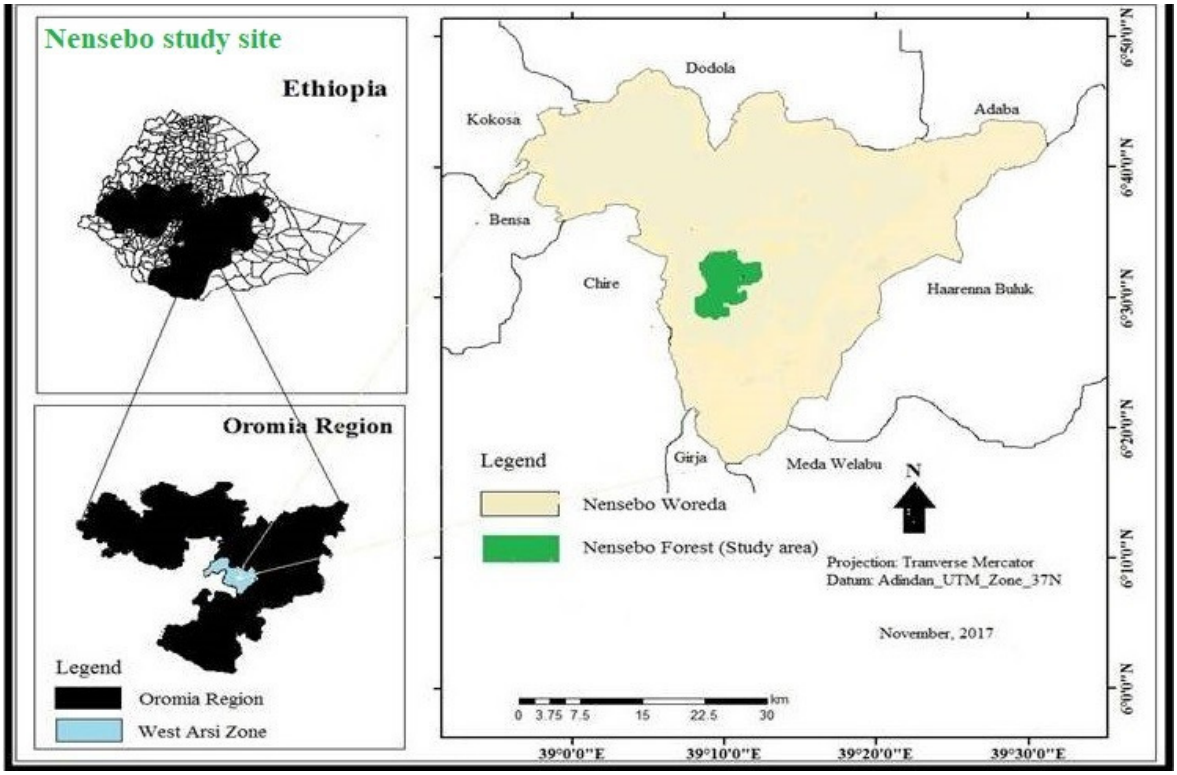

Figure 1: Location Map of Study Area

Nansebo district is characterized by mountainous landscape having an altitude ranges from 1500 m a.s.l to 3700 m a.s.l. The district exhibit bimodal rainfall pattern, with the annual rainfall ranges between 900 to 1100 mm with a temperature that varies between a minimum of 15 C° and a maximum 22 C° (NWAO, 2012).

Stratification of the study area and sampling design

For this study, Nansebo forest was stratified into two habitat types; modified habitat at the lower and Moist Afromontane forest at the higher altitude following vegetation type and altitudinal gradient. In Nansebo forest, modified habitat represents areas with altitudes occurs from 1882-2153m a.s.l. Moist Afromontane forest represents altitude areas between 2186-2392m a.s.l, with dominant stands of the indigenous tree species such as *Croton macrostachys*, *Strychnos spinosa*, *Clematis longicauda*, *Prunus africana* and *Millettia ferruginea*. The Moist Afromontane forest was relatively intact and undisturbed compared with modified habitat.

Based on the reconnaissance survey, sampling transects was systematically generated in a geographic information system (GIS) using ArcGIS software v. 10.1 (ESRI, 2012) in the Nansebo forest. Line transect method was used since the study area is accessible and species can be detected along transect line. With line transect method it is possible to cover large areas and can generate more species richness efficiently (Bibby *et al*., 1992). Therefore, this method is very important since comprehensive baseline information and status of bird species in Nansebo forest is lacking.

The total area of Nansebo forest was 11,350 ha. Of these 27.75% (3150 ha) of the area was sampled in Nansebo forest. A stratified random sampling technique was employed in which transect placement was proportional to the area of the habitat types and represents each of the habitat types (Bibby *et al*., 1998, Shimelis and Afework, 2008).

Accordingly, a total 20 transect lines , of which six transects in modified habitat while the rest fifteen (15) transects were used in Moist Afromontane forest to estimate the species diversity and relative abundance of birds in Nansebo forest (Fig. 2).

The distance between two adjacent transects was 1 km and the length of each transect line was 1km with a width of 0.25km or less in Nansebo forest. To avoid edge effect, transect lines were spaced 500m from the roadside (edge of the forest).

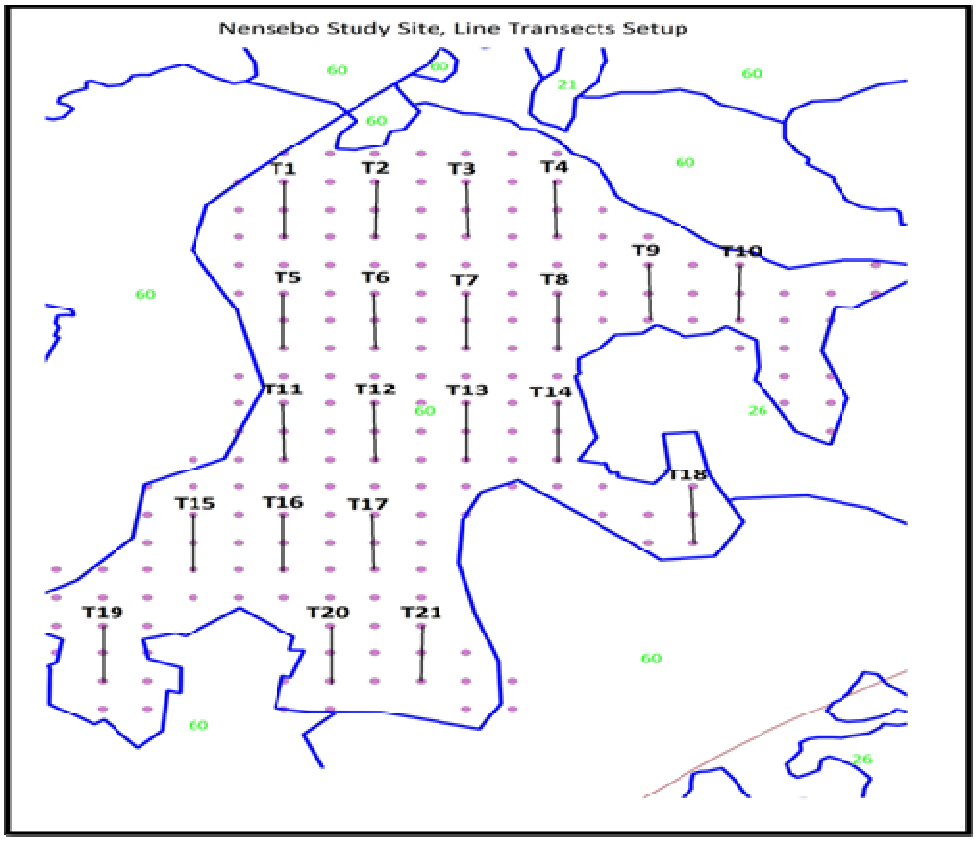

Figure 2: Line transect layout of the Nansebo forest

Data collection and analysis

Data collection was carried out on foot walking along transect lines. Bird identifications and counting of individuals conducted by direct observations aided with naked eye and binoculars (10x50). Sound records and photography were also taken for further confirmation by using Digital Camera. Location and distance of the observed birds was determined and recorded along transect lines using Geographic positioning system (GPS). Each day of survey, arrive at the starting point approximately 20 minutes before sunrise so that counting can begin at sunrise to minimize the effect of time and weather conditions on bird detectability.

Birds were counted when they were active in the mornings from 06:30–10:00 h and in the afternoon from 15:30–18.00 h (Bibby *et al.,* 1992; Centerbury *et al.,* 2000). Unfavorable weather (strong wind or rain) was also being considered. A bird flying over the area was observed and recorded on data gathering worksheets to identify for species richness. For identification of species, plumage pattern, size, shape, color, songs and calls were considered as important parameters (Afework and Shimelis, 2009). Songs and calls were also used for identifying nocturnal species.

Avian diversity of each habitat analyzed using Shannon-Wiener diversity Index (H') (Shannon and Wiener, 1949). Quantitative indices to measure species richness was used as α-diversity which is the average species richness per transect within a given habitat and γ-diversity as the habitat level richness (Schmitt *et al*., 2010).

Percent relative abundance was calculated using formula (%) = n/N × 100 where, n is the number of individuals of particular species recorded and N is the total number of individuals of the species. Data obtained during the survey was analyzed by using two-way ANOVA to analyze the effect of season and habitat on bird species richness and abundance.

RESULTS

Diversity

In Nansebo forest variation in the number of bird species was observed among the habitats and between seasons in the same habitat. The highest mean number of species per transect was recorded from modified habitat during wet (10.8±3.21) and dry (8.6±2.25) seasons (Table 1). The Moist Afromontane forest accounts mean species richness (5.5±2.47) during wet season and (5.2±1.02) during dry season in Nansebo forest (Table 1). The evidence from the present study shows variations were also observed in species diversity among the different habitat types during the wet and dry seasons in Nansebo forest. The highest avian diversity was recorded from modified habitat during dry (H'= 4.17) and wet (H'= 3.99) seasons (Table 1).

The Modified habitat had the evenness of bird species recorded during dry season (E=0.957 and wet (E=0.910) (Table 1).

Table 1: Seasonal variation in bird diversity in Nansebo Forest among the different habitat types

			Diversity Measures						
Study areas	**Habitat types**	**Season**	**BSRPH(γ-diversity)**	**BMSRPT(α-diversity)**	**BSAPH**	**BMSAPT**	**H'**	**H' max**	**Evenness**
Nansebo Forest	Moist Afromontane forest	dry	78.000	5.2±1.02	221.000	14.73±2.437	3.620	3.761	0.963
		wet	82.000	5.5±2.47	554.000	36.93±1.931	3.670	3.989	0.920
	Modified	dry	43.000	8.6±2.25	107.000	21.4±3.873	4.170	4.357	0.957
		wet	54.000	10.8±3.21	218.000	43.6±3.873	3.990	4.407	0.910

BSRPH: Bird species richness per habitat
BMSRPT: Bird mean species richness per transect
BSAPH: Bird species abundance per habitat
BMSAPT: Bird mean species abundance per transect

In Nansebo forest in terms of habitat types, variation in the number of bird species was observed among the habitats. The highest number of average species richness (4.70 ±1.647) and individuals (32±4.103) was recorded from modified habitat followed by Moist Afromontane forest in average species richness (3.95 ±4.128) and individuals (25±7.535) in Nansebo forest. There was significant difference in mean species richness among habitats (F 1, 18=94.657 P= 0.000), and insignificant in species abundance (F1, 18=0.853 P=0.368) at 0.05 significance level in Nansebo forest (Appendix 2).

The highest bird diversity (H'=4.131) was also recorded from modified habitat. The highest even distribution (E=0.956) was observed in Moist Afromontane forest (Table 2).

Table 2: Bird diversity in Nansebo forest among habitat types

		Diversity Measures						
Study areas	**Habitat types**	**SRPH(γ-diversity)**	**MSRPT(α-diversity)**	**SAPH**	**MSAPT**	**H'**	**H' max**	**Evenness**
Nansebo Forest	Moist Afromontane forest	96	3.95 ±4.128	764	25±7.535	3.795	3.970	0.956
	Modified	53	4.70 ±1.647	163	32±4.103	4.131	4.564	0.905

SRPH: Species richness per habitat
MSRPT: Mean species richness per transect
SAPH: Species abundance per habitat
MSAPT: Mean species abundance per transect

Species Accumulation Curve

The species accumulation curve of bird species of Nansebo forest flattened before the total numbers of samples considered were exhausted. The following species accumulation curve showing that sufficient numbers of samples were considered to determine bird species diversity of each habitat (Figure 3: A and B).

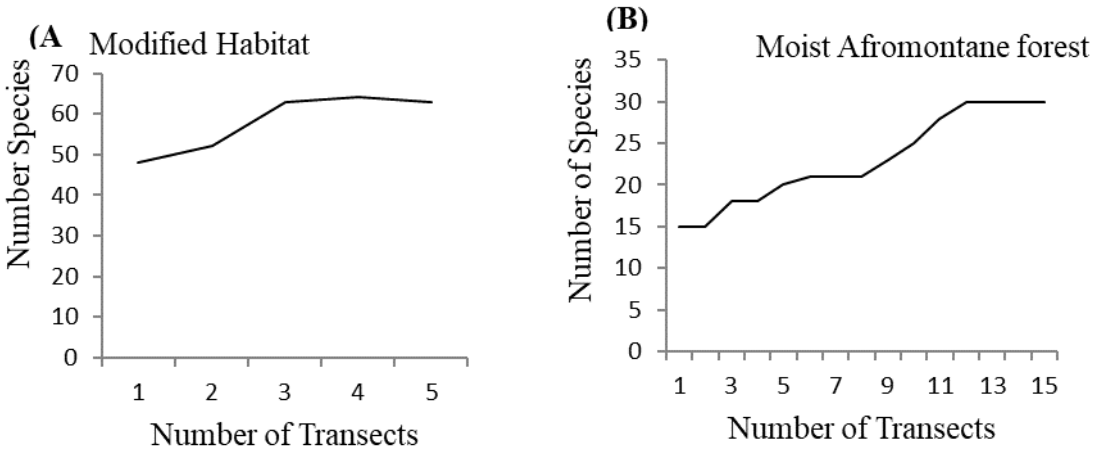

Figure 3 Aand B: Species Accumulation curve of Nansebo forest per habitat types.

Species Composition and Relative Abundance

A total of 105 species were recorded from Nansebo forests (Table 4). Among the recorded species, Wattled ibis (*Bostrychia carunculata*), Thick billed raven (*Corvus crassirostris*), Black winged love bird (*Agapornis taranta),* Ethiopian cisticola (*Cisticola lugubris),* Abyssinian oriole (*oriolus monacha)* , Abyssinian slaty flycatcher (*Chocolatina ficedula*), Abyssinian wood pecker (A*byssinicus phylloscopus*) and Banded Barbet (*Lybius undatus*) were endemic to Ethiopia and Eritrea in Nansebo forest. The endemic Yellow-fronted Parrot (*Poicephalus flavifrons*) was also recorded from Nansebo forest.

One globally threatened bird species i.e Semi collared flycatcher (*Semi torquata*) were near threatened bird species (IUCN red list, 2016) (Table 3).

Among the recorded bird species, 96 species were resident whereas 9 were Palearctic migrants' species (Table 3).

In Nansebo forest the highest number of bird species was recorded from the family Sylviidae (10 species) followed by Accipitridae (8 species), Columbidae (7 species) and Cisticolidae (6 species) (Table 3).

Table 3: Bird species recorded at Nansebo forest (a, Near Endemic c, endangered b, Endemic e, near threatened NM, Northern Migratory AM, Inter-African migrant)

Order	Family	Common Name	Scientific Name	Abundance				
				Wet	Dry	Total	RA (%)	Rank
Passeriformes	Oriolidae	Abyssinian oriole	*Oriolus monacha*[a]	68	46	74	6.9	1st
Passeriformes	Turdidae	Mountain thrush	*Turdus olivaceus*	34	14	48	4.5	2nd
Passeriformes	Zosteropidae	Montane white eye	*Zosterops poliogastrus*	23	12	35	3.3	3rd
Passeriformes	Passeridae	Swaisons sparrow weaver	*Passer swainsonii*	22	11	33	3.1	4th
Passeriformes	'Sturnidae	Red winged starling	*Onychognathus morio*	17	13	30	2.8	5th
Passeriformes	Fringillidae	Streaky seed eater	*Serinus striolatus*	22	7	29	2.7	6th
Passeriformes	Estrildidae	Yellow bellied waxbill	*Coccopygia quartinia*	19	10	29	2.7	6th
Passeriformes	ploceidae	Baglafecht weaver	*Ploceus baglafecht*	16	7	26	2.4	8th
Passeriformes	Oriolidae	Black headed oriole	*Oriolus larvatus*	13	3	26	2.4	8th
Passeriformes	Muscicapidae	Abyssinian slaty flycatcher	*Melaenornis chocolatina*[a]	16	9	25	2.3	10th
Passeriformes	Muscicapidae	Semi collared flycatcher	*Ficedula semitorquata*[c]	22	3	25	2.3	10th
Passeriformes	Nectariniidae	Variable sun bird	*Cinnyris venustus*	16	7	23	2.1	12th
Passeriformes	'Pycnonotidae	Common bulbul	*Pycnonotus barbatus*	12	10	22	2.1	12th
Trogoniformes	Trogonidae	Narina's Trogon	*Apaloderma narina*	15	5	20	1.9	14th
Passeriformes	Viduidae	Pin tailed whydah	*Vidua macroura*	16	4	20	1.9	14th
Passeriformes	Muscicapidae	Rupels robin chat	*Cossypha semirufa*	11	9	20	1.9	14th
Passeriformes	Corvidae	Thick billed raven	*Corvus crassirostris*[a]	12	7	19	1.8	17th
Piciformes	Indicatoridae	Greater honey guide	*Indicator indicator*	16	2	18	1.7	17th
Passeriformes	Estrildidae	Red billed fire finch	*Lagonosticta senegala*	14	4	18	1.7	17th
Passeriformes	Monarchidae	African dusky flycatcher	*Muscicapa adusta*	9	7	16	1.5	20th
Passeriformes	Sylviidae	Cinnamon bracken warbler	*Bradypterus cinnamomeus*	14	2	16	1.5	20th
Passeriformes	Fringillidae	African citril	*Serinus citrinelloides*	9	6	15	1.4	22th
Galliformes	phasianidae	Chestnut naped francolin	*Pternistis castaneicollis*	11	4	15	1.4	22th
Passeriformes	Cisticolidae	Ethiopian cisticola	*Cisticola lugubris*[a]	13	2	15	1.4	22th
Passeriformes	Cisticolidae	Green backed cameroptera	*Camaroptera brachyura*	6	9	15	1.4	22th
Psittaciformes	Psittaculidae	Black winged love bird	*Agapornis taranta*[a]	10	4	14	1.3	26th
Psittaciformes	Nectariniidae	Collared sun bird	*Hedydipna collaris*	12	2	14	1.3	26th
Columbiformes	Columbidae	Red eyed dove	*Strepetopelia semitorquata*	10	4	14	1.3	26th
Passeriformes	Monarchidae	*African paradise flycatcher[AM]	*Terpsiphone viridis*	9	4	13	1.2	29th
Passeriformes	Fringillidae	Brown rumped seed eater	*Crithagra tristriatus*	8	5	13	1.2	29th
Piciformes	Indicatoridae	Lesser honeyguide	*Indicator minor*	9	4	13	1.2	29th
Accipitriformes	Accipitridae	Lesser spotted eagle	*Aquila pomarina*	8	4	12	1.1	32th
Cuculiformes	Cuculidae	*Levaillant's cuckoo[AM]	*Clamator levaillantii*	9	2	11	1.0	33th
Passeriformes	Fringillidae	Yellow crowned canary	*Crithagra mozambicus*	11	0	11	1.0	33th
Passeriformes	Cisticolidae	Tawny flanked prinia	*Prinia subflava*	6	4	10	0.9	35th

Cuculiformes	Musophagidae	White cheeked turaco	*Tauraco leucotis*	4	6	10	0.9	35 th
Piciformes	Picidae	Abyssinian wood pecker	*Dendropicos abyssinicus*	4	5	9	0.8	37 th
Passeriformes	Sylviidae	Brown wood warbler	*Phylloscopusumbrovirens*[a]	7	2	9	0.8	37 th
Passeriformes	Laniidae	Common fiscal	*Lanius collaris*	7	2	9	0.8	37 th
Coliiformes	Collidae	Speckled mouse bird	*Colius striatus*	5	4	9	0.8	37 th
Psittaciformes	Psittacidae	Yellow fronted parrot	*Poicephalusflavifrons*[b]	7	2	9	0.8	37 th
Passeriformes	Passeridae	Bush petronia	*Petronia dentata*	6	2	8	0.7	42 th
Columbiformes	Columbidae	Dusky turtle dove	*Streptope lialugens*	2	6	8	0.7	42 th
Passeriformes	Buphagidae	Red billed oxpecker	*Buphagus erythrorhynchus*	4	4	8	0.7	42 th
Piciformes	Indicatoridae	Scaly throated honey guide	*Indicator variegatus*	8	0	8	0.7	42 th
Coraciiformes	Alcedinidae	Wood land kingfisher	*Halcon senegalensis*	3	5	8	0.7	42 th
Passeriformes	Sylviidae	Wood warbler	*Phylloscopus sibilatrix*	6	2	8	0.7	42 th
Falconiformes	Accipitridae	Augur buzzard	*Buteo augur*	4	3	7	0.7	42 th
Cuculiformes	Sylviidae	Brown parisoma	*Parisoma lugens*	5	2	7	0.7	42 th
Piciformes	Picidae	Eastern grey wood pecker	*Dendropicos goertae*	5	2	7	0.7	42 th
Piciformes	Picidae	Nubian wood pecker	*Campethera nubica*	5	2	7	0.7	42 th
Columbiforme	Columbidae	*Tambourine dove[AM]	*Turtur tympanistria*	6	1	7	0.7	42 th
Cuculiformes	Cuculidae	African emerald cuckoo	*Chrysococcyx cupreus*	4	2	6	0.6	53 th
Piciformes	Lybiidae	Banded barbet	*Lybius undatus*[a]	3	3	6	0.6	53 th
Passeriformes	Hirundinidae	*Barn swallow[NM]	*Hirundo rustica*	2	4	6	0.6	53 th
Passeriformes	Sylviidae	Black start	*Cercomela melanura*	6	0	6	0.6	53 th
Passeriformes	Estrildidae	Common waxbill	*Estrilda astrild*	6	0	6	0.6	53 th
Passeriformes	Buphagidae	Grey cuckoo shrike	*Coranica caesia*	4	2	6	0.6	53 th
Passeriformes	Turdidae	Ground scraper thrush	*Psophocichla litsipsirupa*	4	2	6	0.6	53 th
Passeriformes	Sylviidae	Little rush warbler	*Bradypterus baboecala*	4	2	6	0.6	53 th
Passeriformes	Muscicapidae	Northern black flycatcher	*Melaenornis edolioides*	6	0	6	0.6	53 th
Coraciiformes	Coraciidae	Abyssinian roller	*Coracias abyssinicus*	5	0	5	0.5	53 th
Apodiformes	Apodidae	African black swift	*Apus barbatus*	3	2	5	0.5	53 th
Columbiformes	Columbidae	Black billed wood dove	*Turtur abyssinicus*	4	1	5	0.5	53 th
Passeriformes	Buphagidae	Black cuckoo shrike	*Campephaga flava*	3	2	5	0.5	53 th
Accipitriformes	Buphagidae	Lesser white throat	*Sylvia curruca*	5	0	5	0.5	53 th
Cuculiformes	Cuculidae	Red chested cuckoo	*Cuculus solitarius*	5	0	5	0.5	53 th
Passeriformes	Cisticolidae	Red faced cisticola	*Cisticola erythrops*	3	2	5	0.5	53 th
Ciconiiformes	Threskiornithidae	Silvery checked hornbill	*Bycanistes brevis*	3	5	5	0.5	53 th
Cuculiformes	Paridae	White winged black tit	*Parus leucomelas*	4	1	5	0.5	53 th
Accipitriformes	Cisticolidae	Yellow breasted apalis	*Apalis flavida*	5	0	5	0.5	53 th
Pelecaniformes	Timaliidae	Abyssinian cat bird	*Parophasma galinieri*[b]	3	1	4	0.4	72 th
Piciformes	Lybiidae	Black billed barbet	*Lybius guifsobalito*	4	0	4	0.4	72 th
Columbiformes	Columbidae	Ring necked dove	*Streptopelia capicola*	2	2	4	0.4	72 th
Accipitriformes	Accipitridae	Rupels vulture	*Gyps rueppellii*	0	4	4	0.4	72 th
Falconiformes	Accipitridae	*Tawny eagle[NM]	*Aquila rapax*	3	1	4	0.4	72 th
Pelecaniformes	Threskiornithidae	Wattled ibis	*Bostrychia carunculata*[a]	2	2	4	0.4	72 th
Falconiformes	Accipitridae	White backed vulture	*Gyps africanus*	4	0	4	0.4	72 th
Passeriformes	Sylviidae	Willow warbler	*Phylloscopus trochilus*	0	4	4	0.4	72 th
Passeriformes	Cisticolidae	Buff-bellied warbler	*Phyllolais pulchella*	0	3	3	0.3	80 th
Passeriformes	Sylviidae	Dark caped yellow warbler	*Chloropeta natalensis*	2	1	3	0.3	80 th
Passeriformes	Motacillidae	*Yellow wagtail[NM]	*Motacilla flava*	3	0	3	0.3	80 th
Passeriformes	Estrildidae	African fire finch	*Lagonosticta rubricata*	0	2	2	0.2	81 th
Columbiformes	Columbidae	African olive pegion	*Columba arquatrix*	0	2	2	0.2	81 th
Coraciiformes	Alcedinidae	African pigmy kingfisher	*Ceyx pictus*	2	0	2	0.2	81 th
Passeriformes	Sylviidae	*Black cap[NM]	*Sylvia atricapilla*	0	2	2	0.2	81 th
Piciformes	Platysteiridae	Black headed batis	*Batis minor*	0	2	2	0.2	81 th
Columbiformes	phoeniculidae	Black- billed wood hoopoe	*Phoeniculus somaliensis*	2	0	2	0.2	81 th
Cuculiformes	Cuculidae	Blue headed coucal	*Centropus monachus*	0	2	2	0.2	81 th
Passeriformes	Sylviidae	*Common redstart[NM]	*Phoeniculus phoenicurus*	2	0	2	0.2	81 th
Coraciiformes	Bucerotidae	Crowned hornbill	*Tockus alboterminatus*	2	0	2	0.2	81 th
Columbiformes	Threskiornithidae	Hadada ibis	*Bostrychia hagedash*	2	0	2	0.2	81 th
Passeriformes	'Malaconotidae	Northern puff back	*Dryoscopus gambensis*	0	2	2	0.2	81 th
Passeriformes	Nectariniidae	Takazze sun bird	*Nectarinia tacazze*	0	2	2	0.2	81 th
Ciconiiformes	Ciconiidae	Woolly-necked stork	*Ciconia episcopus*	0	2	2	0.2	81 th
Passeriformes	Turdidae	Abyssinian ground thrush	*Zoothera piaggiae*	0	1	1	0.1	96 th
Falconiformes	strigidae	Cape eagle owl	*Bubo capensis*	0	1	1	0.1	96 th
Passeriformes	Corvidae	Fan tailed raven	*Corvus rhipidurus*	1	0	1	0.1	96 th
Falconiformes	strigidae	Greyish eagle owl	*Bubo cinerascens*	1	0	1	0.1	96 th
Pelecaniformes	Ardeidae	Little egret	*Egretta garzetta*	0	1	1	0.1	96 th
Accipitriformes	Accipitridae	Lizzard buzzard	*Kaupifalco monogrammicus*	0	1	1	0.1	96 th
Passeriformes	Muscicapidae	Mocking cliff chat	*Thamnolaea cinnamomeiventris*	1	0	1	0.1	96 th
Columbiformes	Columbidae	Namaqua dove	*Oena capensis*	0	1	1	0.1	96 th
Accipitriformes	Accipitridae	Pallied harrier[NM]	*Circus macrourus*	0	1	1	0.1	96 th
Accipitriformes	Accipitridae	Yellow billed kite	*Milvus(migrans) aegyptius*	0	1	1	0.1	96th

Based on the percent relative abundance computation, Abyssinian oriole (*Oriolus monacha*) (6.92%) was the most abundant bird species when all habitat types considered together in Nansebo forest (3).

When each habitat type was considered separately, Abyssinian oriole (*Oriolus monacha*) (9.95%) and Yellow bellied waxbill *(Coccopygia quartinia)* (5.52%) were abundant in the Moist Afromontane forest and modified habitat, respectively in Nansebo forest (Table 4).

Table 4: Top five ranking abundant species between two habitat types and across the study area based on percent relative abundance in Nansebo forest

	Habitat Types					
	Wooded NF		Modified		Across the study area	
Species Name	RA (%)	Rank	RA (%)	Rank	RA (%)	Rank
Abyssinian oriole	9.95	1st	-	-	6.92	1st
Mountain thrush	4.19	2nd	4.91	2nd	4.49	2nd
Montane white eye	3.27	4th	-	-	3.27	3rd
Swaisons sparrow weaver	3.40	3rd	4.29	4th	3.08	4th
Red winged starling	3.01	5th	-	-	2.80	5th
Yellow bellied waxbill	-	-	5.52	1st	2.71	6th
Rupels robin chat	-	-	4.91	3rd	1.87	7th
Thick billed raven	-	-	3.68	5th	1.78	8th

DISCUSSION

Diversity

In Nansebo forest the modified habitat had the most diversified avian species and most evenness as compared to the other habitat types. This variation could be due to variation in habitat heterogeneity. The more heterogeneous vegetation and vegetation strata in the modified habitat compared to the other habitat types could have provided several niches for birds making the modified habitat with high diversity of birds. The importance of the availability of different vegetation strata for different bird species is also supported by other studies. For example, Cueto and Casenava (1999) reported positive correlation between bird species richness and the availability of vegetation strata. Similarly, Erdelen (1984) indicated significant correlation between bird species diversity and vegetation structure.

The highest number of species recorded from modified habitat during wet and dry seasons. The outcome of this result coincides with the report of Karr (1976); where structurally complex vegetation buffers the influence of seasonality and there is a great stability in resource availability, which allows species to occur as residents throughout the year. Species richness of different feeding guilds might respond differently to changes in vegetation structure and complexity across tropical ecosystems (Oliveira-Filho *et al*., 2013). During the wet season, flowering plants were flourishing and as a result, food was plentiful for birds in almost all the habitats. However, during the dry season, the deciduous trees defoliate and in the absence of food, many species of birds were restricted to specific habitat where sufficient resource was available.

The variations in species composition recorded during the wet and dry seasons among habitats were significantly different. This is also reported by Aynalem Shimelis and Afework (2008) who showed the important effect of season or the role of climate in affecting the diversity of birds of a particular habitat. According to Karr (1976), the distinct seasonality of rainfall and seasonal variation in the abundance of food resources result in seasonal changes in the abundance of birds.

Relative Abundance

The relative abundance of bird species during seasons might also be related to the availability of food, habitat condition and breeding season of the species. Therefore, species distribution and abundance can be influenced by seasonal variation. Many factors could account for this. For example, Karr (1976) related the seasonality in the number of bird species with the availability of resources such as food and vegetation strata and found that the number of bird species varied seasonally with peaks in the late dry and early wet seasons.

In Nansebo forest, Abyssinian oriole (*Oriolus monacha*) had the highest percent relative abundance in Moist Afromontane forest. This was due to the favorable environment of the habitat that supported the species in different ways. Since, *Oriolus monacha* is a forest specialist species, it could be confined to the natural forest habitat types unlike many other species recorded from the area that tend to concentrate in heterogeneous human modified habitat ignoring the homogenous natural forest. Similar observation has been made in a study carried out in Tanzania, where by forest specialists were only confined to the homogenous forest ignoring the heterogeneous human modified habitat types.

CONCLUSION AND RECOMMENDATIONS

The Nansebo forest had high bird species diversity including endemic and endangered species revealing the importance of the sites for bird conservation. Therefore, it can serve as good potential for bird watching tourism that can integrate economic gain with biodiversity conservation.

The number of individual species of both study areas shows seasonal variation. This seasonal variation is due to the cumulative effect of both biotic and a biotic factors. The distribution of avian species is also closely

related to type of the habitat, which is influenced by environmental factors such as rainfall, altitude, slope, and temperature.

The data collected provide valuable information on the ecology of birds and their significance for the environment. Conserving the habitats as well as the species has great biological and social values. Therefore, to maintain the habitat and the avifauna species, the following recommendations are forwarded:

- Conservation work through community participation should be properly developed and practiced.
- As abundance and distribution of the bird species is determined by abundance and distribution of vegetation, equal conservation priority should be given to the bird habitats.
- Further study especially on smaller and cryptic bird species needs to be conducted to provide more information on the diversity of birds in the area.
- Additional detailed studies on bird species together with the other ecological aspects of the birds should be conducted.

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9. APPENDICES

Appendix 1: ANOVA Table (Species Richness versus Vegetation Height of Nansebo forest)

			Sum of Squares	df	Mean Square	F	Sig.
Species richness* Vegt.Height[a]	Between Groups	(Combined)	3058.109	55	611.622	6.578	0.000
	Within Groups		5392.5	86	92.974		
	Total		8450.609	3			
Abundance * Vegt.Height[a]	Between Groups	(Combined)	109817.4	55	21963.49	27.36	0.000
	Within Groups		46560	86	802.759		
	Total		156377.4	3			

Appendix 2: ANOVA Table Species Richness and Abundance per Habitat Types of Nansebo forest

			Sum of Squares	df	Mean Square	F	Sig.
SR * Habitat	Between Groups	(Combined)	4788.267	1	4788.267	94.657	0.000
	Within Groups		910.533	18	50.585		
	Total		5698.8	19			
AB * Habitat	Between Groups	(Combined)	1083.75	1	1083.75	0.853	0.368
	Within Groups		22868	18	1270.444		
	Total		23951.75	19			