Vol. 11(8), pp. 230-240, August 2019
DOI: 10.5897/IJBC2019.1306
Article Number: 5133C6161859
ISSN 2141-243X

http://www.academicjournals.org/IJBC

ACADEMIC JOURNALS
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International Journal of Biodiversity and Conservation

Full Length Research Paper

Diversity and relative abundance of birds in Loka Abaya National Park, Sidama Zone, Southern Ethiopia

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Received 13 May, 2019; Accepted 11 July, 2019

Understanding avian diversity and abundance is important for its conservation in a protected area. A study was conducted to investigate species diversity and relative abundance of birds in Loka Abaya National Park, Sidama Zone, Southern Ethiopia, between August 2017and February 2018 during wet and dry seasons. Based on satellite image and preliminary survey, the study area was stratified into riverine forest, wooded grassland and wetland habitats. A total of 46 blocks were established to cover 20% of the 500 km^2 of the park area. Some of the blocks were 16 km^2; the remaining blocks were at the periphery of the park and are less than 16 km^2. Data were collected using transect lines. The length of transect lines varied, 1 km in riverine forest, 4 km in wooded grassland and wetland. Sighting distance, one side of the line was 75 m in riverine forest but 100 m in wooded grassland and wetland. Biodiversity indices were used for diversity data analysis and encounter rate to determine relative abundance of birds. The effects of habitat types and seasons on abundance were analyzed using Two-way ANOVA. A total of 134 bird species belonging to 99 genera, 53 families and 18 orders were recorded during the study. Culumbidae followed by Accipitridae and Ploceidae was the most abundant recorded family. Riverine forest had the highest bird species diversity (H' = 3.98) while wetland is the lowest (H' = 3.43). The result showed 7 abundant, 20 common, 45 frequent, 30 uncommon and 32 rare species. The number of individuals of a species during the seasons was not significantly different ($F_{1, 340}$ = 0.36, P > 0.05). However, habitat types showed significant difference ($F_{2, 340}$ = 8.40, P < 0.05). This study revealed that the park harbors diverse and rare species of birds. Hence, the park is an important conservation area. Thus, urgent conservation measures and other long-term studies on bird communities of the park is recommended.

Key words: Birds, diversity, habitat association, Loka Abaya National Park, relative abundance.

INTRODUCTION

In terms of its avifauna, Ethiopia is one of the well-known countries in Africa. The country is home to an impressive 926 species of birds that vary from residents to breeding, migrants to wintering birds (Lepage, 2006). Twenty-four of these species are national endemics and 19 are listed as globally threatened (Lepage, 2013). Ethiopia has numerous stop-over sites for millions of migratory birds crossing the Sahara desert (Sekercioglu, 2012). These

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consists of forests, wetlands and riverine ecosystems which are important sites for wintering or passage migrant birds. Hence, the availability of different habitat types contribute to the diversity of birds in Ethiopia. Presently, Ethiopia has 73 sites listed as Important Bird Areas encompassing the already thirteen existing protected areas excluding the present study area and many other additional sites have also been identified (Wonderfrash, 2003).

Among the elements of the diversity of nature, birds are both visually and acoustically conspicuous organisms of most ecosystems and the best known class of organisms (Sekercioglu, 2012). They are an integral part of an ecosystem and occupy many trophic levels in a food chain ranging from consumers to predators; and they play roles in ecosystem functioning and socio-economic contributions (Sekercioglu et al., 2004). Birds have been used as environmental health indicators, plant pollinators and seed dispersers as well as pest controller (Hadley et al., 2012; Ramchandra, 2013). Moreover, they provide opportunities for enjoyment to our lives, because of their distinctive colors, songs, calls, displays and dancing. Thus, birds are usefull organisms, and the reduction in their abundance and species richness are likely to have comprehensive ecological consquences, with diverse societal impacts ranging from the spread of diseases and loss of agricultural pest control to plant extinctions and trophic cascades (Gaston et al., 2000).

Globally, wildlife that includes birds is threatened by various natural and anthropogenic factors. As a result, the loss of biodiversity in general and wild fauna in particular is a comprehensive global environmental challenge (Cardinale et al., 2012; Krause and Zambonino, 2013). Habitat loss, over-exploitation of wildlife and forest resources and climate change are major causes of biodiversity loss (Brooks et al., 2002). The condition is most severe in the tropical regions (Leuschner et al., 2013). Human population growth, particularly in developing countries, has intense effects on consumption patterns of land and wild resources, which is considered as an indirect driver of biodiversity loss (Kideghesho, 2009). In the tropics including Ethiopia, habitat losses and habitat degradation are causing rapid decline in bird species, which in turn cause reductions in ecosystem processes, services and benefits they provide (Sekercioglu et al., 2004).

Loka Abaya National Park is one of the protected areas of Ethiopia with little information on ecology of its avifauna. Although much is not known about its wildlife, the Park is believed to have varieties of wild fauna. Despite not being systematic, Sidama Zone Bureau of Culture and Tourism (SZBCT) conducted a survey report and recorded many mammals and bird species. The area was designated as a protected area to protect these wild animals. However, it is evident that wild animals are at present under heavy human pressure. According to the survey report of Loka Abaya National Park prepared by Sidama Zone Bureau of Culture and Tourism (SZBCT) in 2009, the major prevailing threats of wildlife diversity in the park include poaching, cultivation, uncontrolled fire and livestock grazing as well as forest clearing for fire wood and charcoal productions. Unless these conservation problems are controlled properly, the survival of the wildlife diversity will be grim in the future. Consequently, it is useful to formulate a wildlife development and protection strategy to avert the looming danger on wild animals and conserve them for posterity. Therefore, study on avian diversity and abundance is important for the development of a sound management plan for a given protected area. The ornithological information that will be available is also used to indicate the effects of environmental change on biodiversity (Salahudeen et al., 2013); and this emphasizes the need to study their abundance and diversity to monitor these changes. Thus, the current study was carried out to investigate species diversity and relative abundance of birds in Loka Abaya National Park to contribute to the building the site's checklist of its avifauna, the conservation, development and management of the species in the area.

Study area

Loka Abaya National Park, which was established in 2009, is found in Loka Abaya "Woreda" in Sidama Zone of South Nations, Nationalities and Peoples' Region (SNNPR). The park was given the name after the name of the "woreda" where it is found (that is, Loka Abaya Woreda, which is one of the 19 "Woredas" of Sidama Zone). The park encompasses an area of approximately 500 km^2 of which 52 km^2 is water body (northern portion of Lake-Abaya) (Figure 1). It is located at 70 km south west of Hawassa and 340 km from Addis Ababa and occurs between 6°27'0" and 6°45'0"N latitude and 37°54'30" to 38°15'0"E longitude. The park is fortunate in possessing a number of water basins that drains to Lake Abaya which is the largest lake in the Ethiopian rift valley system. Bilate, Derba, Gidabo, Loka and Mencha are the major five river basins of the park that finally feed Lake Abaya located inside the park.

The study area harbors different vegetation types that comprise wooded grassland, hilly scrubland, riverine forest and wetland vegetation (Figure 2).The wooded grassland areas are mainly dominated by *Comberetum* spp., *Acacia drepanolobium*, *A. mellifera, A. seyal, A. tortilies, A. senegal, A. albida, A. nilotica, A. olifera, A. nubica, Aloe vera, Euophorbia tirucalli, Ricinus communes, Caparis tomoentosa, Balanites aegypitica and Balanites routindifolia*. The trees in Loka Abaya National Park are associated with a wide range of grasses, shrubs and herbs. Riverine forest comprises tree species like *Ficus sur, Ficus vasta, Petrolatum stelatium, Trechlea* sp*., Zizihpusspina-christi and Tamarindus indica.* The

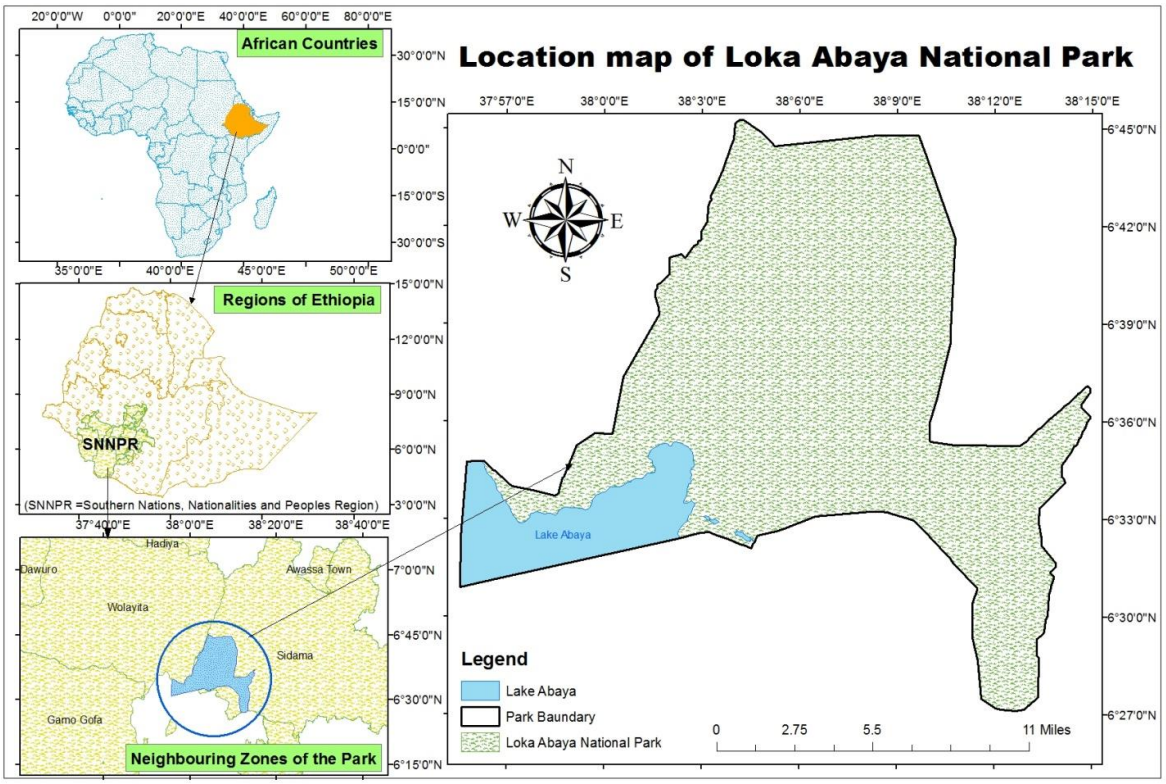

Figure 1. Map showing the location of the study area.

western area of undulating lands of the reserve including river banks of Bilate and Derba River are highly deforested for fire wood and charcoal production by the local communities; whereas, the eastern areas of the park are relatively in a better condition with thick woody species. The park is home for diverse species of mammals and birds. The most conspicuous and observed mammals of the park include Lesser Kudu (*Tragelaghus imberbis*), Defassa Waterbuck (*Kobus defassa*), Common Bushbuck (*Tragelaghus scriptus*), Lion (*Pantera leo)*, Leopard (*Pantera pardus*) and African Wild Dog (*Lycaon pictus*) (SZBCT, 2009).

MATERIALS AND METHODS

Materials used during the present study include: GPS (Garmin72), pair of binoculars (8x30 and 8x40), Field guides, Digital camera, and topographic map of LANP, data sheets, notebook, rulers and field tents. Motor cycles were used to travel through LANP.

Sampling design and Method

A preliminary survey was conducted from August 15 to 25, 2017. During this period, all available literature was reviewed concerning the accessibility, vegetation, fauna, topography and infrastructures of the park. The physical features of the overall landscapes of the study area were assessed. The type of each of the habitats of wild animals was observed and the coordinates of boundaries of each study site were also identified using GPS (Garmin 72).

Based on satellite images and preliminary survey, the study area was stratified into habitat types following Mengesha and Bekele (2008). Accordingly, three habitat types were identified for bird survey based on vegetation types: Wooded grassland (66.53%), Riverine forest (16.16%) and Wetland (6.17%) (Figure 2). In all the habitat types, a total of 46 blocks was established on the map of Loka Abaya National Park. Some of the blocks were 4 km × 4 km making a total of 16 km^2. The remaining blocks were at the periphery of the park area and are less than 16 km^2. The numbers of sampling blocks varied in each habitat type based on the size and the type of vegetation cover in the Park. To make sample representative 20% of blocks of each habitat type were considered (Bibby et al., 1992). Accordingly, 11 sampling blocks (6 from wooded grassland, 3 from riverine forest and 2 from wetland) were proportionally selected at random. Transect lines were laid out systematically in the selected blocks. The length and number of transect lines established was determined based on the size of selected grids of each habitat type. Thus, 68 transect lines in wooded grassland, 54 in riverine forest, and 2 in wetland were established on each of the selected sampling block. The length of transect lines was 1 km in riverine forest, 4 km in wooded grassland and wetland. The sighting distance (transect width) varied depending on the detection difficulties of birds in each habitat type due to size and nature of habitat. Thus, sighting distance (on either side of the transect line) was 100 m in wooded grassland and wetland and 75 m in riverine forest. Transect lines were 200 to 300 m apart from each other to reduce double counting.

Field data collection was carried out from August to October, 2017 (wet season) and from December to February, 2018 (dry season). Data were collected by walking along transect lines. The speed of walking on the transect lines depended on the number of birds present and difficulties to record them. In wooded grassland

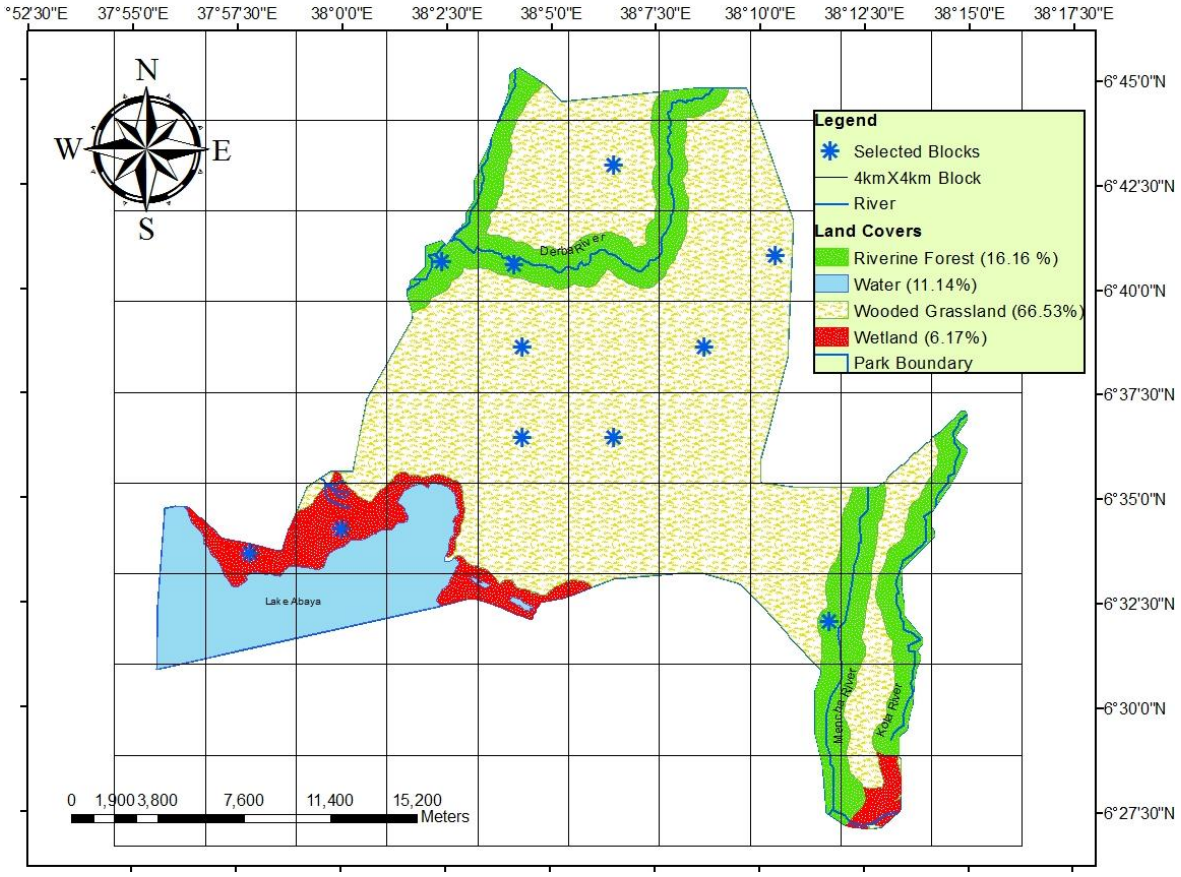

Figure 2. Map showing habitat types of the study area.

and wetland habitat type, a speed of about 2 km/h and riverine forest 1 km/h was followed (Bibby et al., 1992). GPS was used to find the position of each transect line. Each established transect line was surveyed eight times (four times during the wet and four times during the dry season). Data was collected early in the morning from 6:30 to 10:00 a.m. and the late afternoon 3:30 to 6:00 p.m. During the survey, name of bird species and number of individuals was recorded by direct observation. Estimated perpendicular distance from transect lines and time taken to accomplish each transect was recorded. Bird identification was aided by binoculars (8 × 30 and 8 × 40) and standard bird field guides (Redman et al., 2009). Photograph of birds was also taken using digital camera for further confirmation. Birds were also identified based on their calls.

Data analysis

Biodiversity indices were used to analyze the bird species diversity: the Shannon-Weiner diversity index (H') was used to compute the bird species diversity in different habitat types based on the abundance of the species recorded. The value of Shannon-Weiner index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species. Simpson's similarity index (SI) was used to determine the similarity of bird species between any two different habitat types. The relative abundance of avian species was calculated using encounter rates that give crude ordinal scales of abundance. Encounter rate incorporates field hours for each observer and the number of individuals of each species observed. The abundance categories (the number of individuals per 100 field hours) were: < 3.04, 3.04-6.08, 6.38-30.43, 30.70-122 and > 122. For each category, the following abundance score is given: 1 (rare), 2 (uncommon), 3 (frequent), 4 (common), and 5 (abundant), respectively. Hence, the relative abundance of each bird species was determined based on the ordinary scale of rare, uncommon, frequent, common and abundant based on the abundance categories. All calculations were performed using MINITAB 17 software. SPSS software (version 16) was also applied to analyze the data. Two-way ANOVA was used to analyze the effect of habitat type and season on abundance of birds. Means for variables whose F-values showed a significance difference were compared using Tukey's Multiple Comparison Test. Differences were considered statistically significant at 5 and 1% levels.

RESULTS

Species composition and relative abundance

A total of 134 species of birds belonging to 99 genera, 53 families and 18 orders were recorded during this study (Table 1). Of these, one endemic species to both Ethiopia and Eritrea (Wattled Ibis), one near-threatened species (Black-winged Pratincole), three critically endangered species (Hooded Vulture, Rüppell's Griffon and White-backed Vulture), and one rare species (Siberian Stonechat) were recorded. Migratory species including

Table 1. Relative abundance of the recorded bird species in Loka Abaya National Park.

Common name	Scientific name	Number of individuals per 100 field hours	Abundance score	Relative abundance
Abyssinian Ground-Hornbill	*Bucorvus abyssinicus*	18.29	3	Frequent
*Abyssinian Roller	*Coracias abyssinicus*	1.03	1	Rare
African Black-headed Oriole	*Oriolus larvatus*	16.49	3	Frequent
African Darter	*Anhinga rufa*	1.54	1	Rare
African Fish-Eagle	*Haliaeetus vocifer*	10.31	3	Frequent
African Gray Hornbill	*Lophoceros nasutus*	31.44	4	Common
African Jacana	*Actophilornis africanus*	18.04	3	Frequent
♣African Openbill	*Anastomus lamelligerus*	1.03	1	Rare
♣African Paradise-Flycatcher	*Terpsiphone viridis*	1.54	1	Rare
♣African Pipit	*Anthus cinnamomeus*	3.61	2	Uncommon
♣African Spoonbill	*Platalea alba*	0.26	1	Rare
Bare-faced Go-away-bird	*Corythaixoides personatus*	6.44	3	Frequent
Beautiful Sunbird	*Cinnyris pulchellus*	10.31	3	Frequent
Black Crake	*Zapornia flavirostra*	6.03	2	Uncommon
*Black Goshawk	*Accipiter melanoleucus*	0.52	1	Rare
Black Kite	*Milvus migrans*	4.64	2	Uncommon
Black-billed Woodhoopoe	*Phoeniculus somaliensis*	6.02	2	Uncommon
Black-crowned Tchagra	*Tchagra senegalus*	7.22	3	Frequent
Black-headed Batis	*Batis minor*	17.53	3	Frequent
Black-headed Heron	*Ardeamela nocephala*	3.61	2	Uncommon
*Black-winged Pratincole	*Glareola nordmanni*	22.16	3	Frequent
Black-winged Stilt	*Himantopus himantopus*	6.01	2	Uncommon
♣Blue-breasted Bee-eater	*Merops variegates*	3.61	2	Uncommon
*Blue-cheeked Bee-eater	*Merops persicus*	9.79	3	Frequent
Blue-headed Coucal	*Centropus monachus*	6.96	3	Frequent
*Blue-spotted Wood-Dove	*Turtur afer*	4.12	2	Uncommon
♣Bruce's Green-Pigeon	*Treron waalia*	3.09	2	Uncommon
♣Cardinal Woodpecker	*Dendropicos fuscescens*	1.55	1	Rare
Cattle Egret	*Bubulcus ibis*	44.33	4	Common
Common Bulbul	*Pycnonotus barbatus*	54.38	4	Common
♣Common Sandpiper	*Actitis hypoleucos*	2.58	1	Rare
Crested Francolin	*Dendroperdix sephaena*	446.65	5	Abundant
Crowned Lapwing	*Vanellus coronatus*	52.32	4	Common
Double-toothed Barbet	*Lybius bidentatus*	5.41	2	Uncommon
Dusky Turtle-Dove	*Streptope lialugens*	7.21	3	Frequent
Eastern Plantain-eater	*Crinifer zonurus*	4.12	2	Uncommon
Egyptian Goose	*Alopochen aegyptiaca*	13.40	3	Frequent
Emerald-spotted Wood-Dove	*Turturchal cospilos*	171.63	5	Abundant
Eurasian Hoopoe	*Upupa epops*	5.67	2	Uncommon
Fan-tailed Raven	*Corvus rhipidurus*	6.01	2	Uncommon
Fawn-breasted Waxbill	*Estrilda paludicola*	8.25	3	Frequent
Fork-tailed Drongo	*Dicrurus adsimilis*	57.47	4	Common
*Gabar Goshawk	*Micronisus gabar*	0.56	1	Rare
Giant Kingfisher	*Megaceryle maxima*	1.03	1	Rare
Goliath Heron	*Ardea goliath*	2.58	1	Rare
Gray Heron	*Ardea cinerea*	4.38	2	Uncommon
*Gray Kestrel	*Falco ardosiaceus*	0.26	1	Rare
*Gray Wagtail	*Motacilla cinerea*	4.12	2	Uncommon
Gray-backed Fiscal	*Lanius excubitoroides*	39.18	4	Common
Great Egret	*Ardea alba*	1.55	1	Rare

Table 1. Contd.

*Great White Pelican	*Pelecanus onocrotalus*	1.55	1	Rare
Greater Blue-eared Starling	*Lamprotornis chalybaeus*	81.44	4	Common
♣Greater Honeyguide	*Indicator indicator*	2.32	1	Rare
Grosbeak Weaver	*Amblyospiza albifrons*	13.66	3	Frequent
Hadada Ibis	*Bostryc hiahagedash*	16.49	3	Frequent
Hamerkop	*Scopus umbretta*	9.78	3	Frequent
Helmeted Guinea fowl	*Numida meleagris*	494.59	5	Abundant
Hemprich's Hornbill	*Lophoceros hemprichii*	18.04	3	Frequent
Hooded Vulture	*Necrosyrtes monachus*	6.03	2	Uncommon
Kittlitz's Plover	*Charadrius pecuarius*	6.70	3	Frequent
Laughing Dove	*Streptopelia senegalensis*	56.19	4	Common
Lesser Jacana	*Microparra capensis*	7.22	3	Frequent
*Lilac-breasted Roller	*Coracias caudatus*	2.06	1	Rare
♣Little Bee-eater	*Merops pusillus*	2.06	1	Rare
Little Ringed Plover	*Chara driusdubius*	5.15	2	Uncommon
*Little Stint	*Calidris minuta*	6.70	3	Frequent
Little Weaver	*Ploceus luteolus*	28.35	3	Frequent
Long-crested Eagle	*Lophaetus occipitalis*	5.67	2	Uncommon
Marabou Stork	*Leptoptilos crumenifer*	44.84	4	Common
Mariqua Sunbird	*Cinnyris mariquensis*	18.04	3	Frequent
Marsh Sandpiper	*Tringa stagnatilis*	8.25	3	Frequent
Mountain Wagtail	*Motacilla clara*	4.12	2	Uncommon
Mourning Collared-Dove	*Streptopelia decipiens*	22.16	3	Frequent
Namaqua Dove	*Oena capensis*	8.50	3	Frequent
Northern Black-Flycatcher	*Melaenornis edolioides*	255.15	5	Abundant
Northern Carmine Bee-eater	*Merops nubicus*	48.45	4	Common
Nubian Woodpecker	*Campethera nubica*	4.12	2	Uncommon
Pied Kingfisher	*Ceryle rudis*	2.57	2	Uncommon
*Pied Wheatear	*Oenanthe pleschanka*	5.67	2	Uncommon
Pin-tailed Whydah	*Vidua macroura*	2.06	1	Rare
♣Rameron Pigeon	*Columba arquatrix*	4.12	2	Uncommon
Red-and-yellow Barbet	*Trachyphonus erythrocephalus*	5.41	2	Uncommon
*Red-bellied Parrot	*Poicephalus rufiventris*	2.84	1	Rare
Red-billed Buffalo-Weaver	*Bubalornis niger*	18.04	3	Frequent
Red-billed Firefinch	*Lagonosticta senegala*	13.40	3	Frequent
Red-billed Oxpecker	*Buphagus erythrorhynchus*	7.21	3	Frequent
Red-cheeked Cordonbleu	*Uraeginthus bengalus*	55.67	4	Common
Red-eyed Dove	*Streptopelia semitorquata*	103.61	4	Common
Red-headed Weaver	*Anaplectes rubriceps*	10.31	3	Frequent
*Red-shouldered Cuckooshrike	*Malaconotus blanchoti*	1.55	1	Rare
Red-winged Starling	*Onychognathus morio*	32.47	4	Common
Ring-necked Dove	*Streptopelia capicola*	25.00	3	Frequent
*Rock Kestrel	*Falco rupicolus*	0.51	1	Rare
Rufous-crowned Roller	*Coracias naevius*	12.88	3	Frequent
Rüppell's Griffon	*Gyps rueppelli*	8.25	3	Frequent
Rüppell's Starling	*Lamprotornis purpuroptera*	17.26	3	Frequent
Rüppell's Weaver	*Ploceus galbula*	12.88	3	Frequent
Sacred Ibis	*Threskiornis aethiopicus*	15.46	3	Frequent
♣Saddle-billed Stork	*Ephippiorhynchus senegalensis*	0.52	1	Rare
♣Scaly-throated Honeyguide	*Indicator variegates*	1.55	1	Rare
Senegal Thick-knee	*Burhinus senegalensis*	41.75	4	Common
*Siberian Stonechat	*Saxicola maurus*	5.93	2	Uncommon

Table 1. Contd.

*Slate-colored Boubou	*Laniarius funebris*	1.55	1	Rare
*Slender-billed Starling	*Onychognathus tenuirostris*	3.61	2	Uncommon
Speckled Mousebird	*Colius striatus*	82.21	4	Common
Speckled Pigeon	*Columba guinea*	7.23	3	Frequent
*Spur-winged Goose	*Plectropterus gambensis*	3.61	2	Uncommon
Spur-winged Lapwing	*Vanellus spinosus*	136.08	5	Abundant
Squacco Heron	*Ardeola ralloides*	53.61	4	Common
Superb Starling	*Lamprotornis superbus*	51.80	4	Common
Swainson's Sparrow	*Passer swainsonii*	12.37	3	Frequent
Three-banded Courser	*Rhinoptilus cinctus*	3.61	2	Uncommon
Three-banded Plover	*Charadrius tricollaris*	6.05	2	Uncommon
Village Indigobird	*Vidua chalybeate*	10.82	3	Frequent
Village Weaver	*Ploceus cucullatus*	12.11	3	Frequent
Von der Decken's Hornbill	*Tockus deckeni*	25.26	3	Frequent
*Wattled Ibis	*Bostrychia carunculata*	1.03	1	Rare
Wattled Lapwing	*Vanellus senegallus*	18.29	3	Frequent
*Wattled Starling	*Creatophora cinerea*	19.07	3	Frequent
Western Yellow Wagtail	*Motacilla flava*	32.21	4	Common
*White Helmetshrike	*Prionops plumatus*	2.32	1	Rare
White-backed Vulture	*Gyps africanus*	37.63	4	Common
White-bellied Bustard	*Eupodotis senegalensis*	5.67	2	Uncommon
White-bellied Go-away-bird	*Corythaixoides leucogaster*	129.64	5	Abundant
*White-browed Coucal	*Centropus superciliosus*	1.03	1	Rare
White-browed Sparrow-Weaver	*Plocepasser mahali*	280.15	5	Abundant
*White-cheeked Turaco	*Tauraco leucotis*	0.26	1	Rare
♣White-faced Whistling-Duck	*Dendrocygna viduata*	1.55	1	Rare
White-headed Buffalo-Weaver	*Dinemellia dinemelli*	25.77	3	Frequent
White-rumped Shrike	*Eurocephalu sruppelli*	17.78	3	Frequent
*Woodchat Shrike	*Lanius senator*	2.06	1	Rare
Woodland Kingfisher	*Halcyon senegalensis*	2.84	1	Rare
Woolly-necked Stork	*Ciconia episcopus*	2.58	1	Rare
Yellow-necked Francolin	*Pternistis leucoscepus*	106.70	4	Common

♣Refers to species recorded only during wet season; *Refers to species recorded only during dry season.

Black-winged Pratincole, Pied Wheatear and Wattled Starling were documented during the study. Of the recorded bird species, 109 species were recorded during the wet season, while 120 species during the dry season (Table 1). Ninety-five bird species were common to both seasons, but 14 and 25 species were exclusive to the wet and dry season, respectively. The Columbidae family consisted the highest (11 species) number of species followed by Accipitridae and Ploceidae, each with 8 species. The result showed that 7 species were abundant, 20 common, 45 frequent, 30 uncommon and 32 rare species (Table 1).

Species diversity

The highest number of species was recorded from riverine forest (87) and the lowest from wooded grassland (59) during both seasons (Table 2). The number of individuals of species during the wet and dry seasons was not significantly different ($F_{1,340} = 0.36$, $P > 0.05$), but there was a significant difference among habitat types ($F_{2,340} = 8.40$, $P < 0.05$). However, season and habitat interaction was not significant ($F_{2,340} = 1.29$, $P > 0.05$). Tukey Multiple Comparison Test showed that the mean number of individuals of species did not differ significantly between wetland (25.08±8.73, N = 111) and riverine forest (34.75±7.66, N = 142), but the mean in wooded grassland (75.10±9.49, N = 93) was significantly different between the two habitat types. Bird species diversity was highest in riverine forest during wet season (H' = 3.92) and dry (H' = 3.89) season (Table 2). During the wet season, the wetland habitat (H' = 3.19) and during the dry season, the wooded grassland (H' = 3.01) had the least bird species diversity. When both seasons' data was combined, highest and lowest diversity of birds was

Table 2. Avifaunal diversity among the three habitat types during the wet and dry seasons .

Habitat type	Season	Species richness	Abundance	H'	E
Wetland	Wet	48	1099	3.19	0.83
	Dry	63	1717	3.40	0.82
	Both	71	2816	3.43	0.80
Wooded grassland	Wet	51	4587	3.60	0.92
	Dry	42	2531	3.01	0.81
	Both	59	7118	3.44	0.84
Riverine forest	Wet	67	2087	3.92	0.93
	Dry	75	2876	3.89	0.90
	Both	87	4963	3.98	0.89

H' refers Shannon-Weiner diversity index and E refers to Shannon-Wiener evenness index.

Table 3. Species similarity of birds among the three habitat types during wet and dry seasons.

Habitat type	Season	Simpson's similarity index (SI)		
		Wetland	Wooded grassland	Riverine forest
Wetland	Wet	-	0.24	0.38
	Dry	-	0.36	0.43
	Both	-	0.37	0.49
Wooded grassland	Wet	-	-	0.61
	Dry	-	-	0.44
	Both	-	-	0.56

obtained in riverine forest (H' = 3.98) and wetland (H' = 3.43) during both seasons, respectively (Table 2).

Species similarity among habitat types

During the wet season, bird species similarity ranged from 0.24 Simpson similarity index to 0.61 (Table 3). The strongest similarity (0.61) was recorded in between wooded grassland and riverine forest while the lowest (0.24) was recorded between wetland and wooded grassland (Table 3). During the dry season, the strongest similarity was recorded between wooded grassland and riverine forest (0.44), whereas the lowest was between wetland and wooded grassland with a value of 0.36 (Table 3).

DISCUSSION

A total of 134 species of birds were recorded in Loka Abaya National Park during the present study. The varied landscape and vegetation types of the park, presence of water bodies and other wetland habitat could be the reason for the existence of these different species of avian fauna in the park. This might have provided the bird species with a different array of foraging opportunities and nesting sites. Various studies indicated that diversity of vegetation within a habitat is one of the most important factors influencing the distribution of bird species (MacArthur and MacArthur, 1961; James, 1971; Cody; 1981; Radford et al., 2005; Soka et al., 2013). The park has a mosaic ecosystem that includes rivers, lake, forest, wetland and swampy areas as well as moist and wet savannas (SZBCT, 2009) that attracted various groups of birds. Temporary and permanent waters including ponds, burrowed pits, swamps, and lakes are important sites for many birds (Klem, 1990). These habitats of the park lead to occurrences of various species of birds.

The highest diversity of birds in riverine forest could be related to the presence of sufficient amount of food and availability of nesting materials owing to water availability in the habitat. Studies on birds indicated that bird species diversity is a factor of better foraging opportunities and nesting sites (Storch et al., 2003; Aynalem and Bekele, 2009; Mamo et al., 2016; Girma et al., 2017). Moreover, the highest avian diversity could be due to the diversity of vegetation strata that provides heterogeneous habitat for different avian species. The complexity of the riverine forest might be characterized by multiple vertical layers of

vegetation that provide dense understory, midstory and canopy strata (Jones, 2014). Structurally, complex habitats could harbor more species than sites with simple structure; because there are more niches providing different types of nesting and foraging resources (MacArthur and MacArthur, 1961; Radford et al., 2005; Thinh, 2006; Pennington and Blair, 2011; Soka et al., 2013). This could be the reason for the highest bird species in the riverine vegetation. Further other studies found that habitat structural complexity along riverine forest was a very important driver of bird distribution (Scott et al., 2003; Rumble and Gobeille, 2004; Fletcher and Hutto, 2008).

The decline in the diversity of birds in wooded grassland during dry season compared to wet season might be due to the decrease in vegetation productivity, reduction of food availability and sometimes low quality of nesting sites for birds. This may be due to non-availability of rain during this season, that is there was no availability of water for birds. Various studies indicated that seasonal changes results in seasonal variation in the availability of food and water resources, and as a result, birds shift between habitat types depending on their needs and availability of food and cover (Gaston et al., 2000; Chace and Walsh, 2006; Sua´rez-Seoane et al., 2008); in contrast, diversity of birds increased in wetland during the dry season. This could be related to the availability of moisture and then food resources for birds in the wetland during dry season. Lake Abaya is an important source of water for wild animals during the dry season. The lake could provide foraging ground for variety of bird species, with small fish, tadpoles, frogs, insect larvae and other invertebrates and edible aquatic plants.

The highest mean number of individuals in wooded grassland is due to high number of individuals of some species in this habitat type. Helmeted Guinea fowl (*Numida meleagris)*, White-browed Sparrow-Weaver (*Plocepasser mahali*), Crested Francolin (*Dendroperdix sephaena)*, Northern Black-flycatcher (*Melaenornis edolioides*) and Yellow-necked Francolin *(Pternistis leucoscepus*) were some of the species with high number of individuals in wooded grassland. The vegetation structure of wooded grassland could be important for these species to be dominant in the area. The tree species in wooded grassland is associated with a wide range of grasses, shrubs and herbs. The upper storey mainly contains different species of Acacia trees (SZDCT, 2009). Many birds are also habitat specific (Burgess et al., 2002). For example, Helmeted Guinea fowl prefers this kind of habitat since the species prefer open, dry grassland and savannah with scattered trees or shrubby cover and avoid thick forest, marshes and bare land (Smith, 1992). The highest mean number of individuals in wooded grassland could be also related to the more area coverage of wooded grassland compared to riverine forest and wetland. More number of individuals of species is likely to be recorded in large areas. This is probably because more space gives more room for birds and larger opportunities for foraging (Chamberlain et al., 2007). Studies have indicated that size of an area has a significant effect on the composition of bird species (Donnelly and Marzluff, 2004; Antos et al., 2006).

Abundance of bird species during wet and dry season was not significantly different. This is probably due to negligible contrasting effect of season on number of individuals. The inundation of the area during different seasons may not be so severe. According to Aynalem and Bekele (2008), the extended time of inundation of the aera during wet and dry season could contribute to the negligeble effect of season on bird communities. Another possibility is the fact that, due to low habitat quality in the community neighborhoods, the birds simply could move from habitat to habitat rather than leaving the area year-round.

The strongest similarity of bird species between wooded grassland and riverine forest is probably due to the similarity of foraging opportunities and nesting sites between the two habitat types. In line with this, studies have indicated that vegetation cover has a strong influence on bird species diversity (Estades, 1997; Lee and Rotenberry, 2005; Fahrig et al., 2011). In addition, the adjacent occurrence of the two habitat types could be an important source of similarity. Habitat types that are close to one another can share the same number of species. According to Morand (2000), two areas may share the same number of species not because they are similar in area and/or in vegetation diversity, but because they are geographically close which allows individuals to move easily from one island to another.

Helmeted Guinea fowl (*Numida meleagris*) was the most abundant species using encounter rate which could be related with the social and gregarious behavior of the species during foraging, except during the breeding season when the species breaks large flocks (Smith, 1992). This is most likely to boost the species abundance relative to the effort made during the survey as compared to many other solitary species in the study area. According to the study conducted in South Africa, Helmeted Guinea fowl must live in a group so as to survive in the wild, specially where habitat disturbance is a common phenomenon and the number of predators is high (Van Niekerk, 2010).

The large number of rare and uncommon species than abundant and common species occurrence could be associated with habitat condition and behavior of bird species. Rarity of several species appeared to be related with habitat condition (Wilson and Comet, 1996). Moreover, species that are constantly rare have either large home range or patchily distributed (Thiollay, 1994). Breeding nature, large home range, niche of the species and degradation of habitat could be a reason for the species to be uncommon (Ryan and Owino, 2006). Aynalem and Bekele (2009) suggested that habitat

degradation might make most species of birds uncommon. According to SZBCT (2009), cutting trees for fire wood and charcoal production and livestock grazing were common in the present study area. These activities lead to disturbances of birds during reproductive and feeding activities and results in the decrease in individual bird species. As human disturbance increases, birds move away from the area (Blumstein et al., 2005). Human activities such as cutting trees for fire wood and charcoal production were also observed during the study period.

CONCLUSION AND RECOMMENDATION

The present study showed that Loka Abaya National Park is rich in avian fauna and supports high diversity of bird species including rare, uncommon and migratory species. This reveals that the park can be considered as one of the important bird areas in Ethiopia. In terms of avian richness and diversity, riverine forest is the most diversified area. The most abundance of birds that were recorded in wooded grassland, compared to riverine forest and wetland, implies the significance of this habitat in harboring birds. It is likely that riverine forest and wooded grassland are more important for bird species of the area. In general, the park is an area which is priority for bird conservation. Therefore, in the current face of habitat destruction by humans; here is an urgent need for conservation measures for the species and other long-term studies on bird communities of the park for better understanding of the situation in the area on the species and for building on the park's bird species checklist.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The author extends their thanks to NORALD project for financial support provided. They express their indebtedness to Loka Abaya National Park administrator Ato Bezabih Beyene, the park development expert Ato Gezahegn Terefe and all scout members for creating a homely working environment and their unlimited friendly relationship during the field investigations in the park. Finally, they also extend their thanks to Wondo Genet Collage of Forestry and Natural Resources for vehicle services provided.

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