ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Diversity and Distribution of the Avian fauna of Duguma Jaldeso Forest East Wollega, Limu Woreda, Western Ethiopia

A Thesis Presented to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the MSc in General Biology

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AUGUST, 2016

ADDIS ABABA, ETHIOPIA

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ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to Dr. Habte Jebessa for his inspiring guidance, advice and useful comments starting from proposal writing up to the completion of this work. My special thanks also go to Negash Ayana and Fikadu Shifera for their contribution in field data collection. I gratefully acknowledge Addis Ababa University for facilitating my research work and financial support of this work. I would like to thank the National Metrological Service Agency for their genuine response in delivering weather data of the study area. Finally, I thank my brothers, sisters and all my friends for their moral support and encouragement throughout the study.

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LIST OF ACRONYMS

EARO	Ethiopian Agricultural Research Organization
EBA	Endemic Bird Area
EWNHS	Wildlife and Natural History Society
GPS	Geographical Positioning Systems
IBA	Important Bird Area
ICBP	International Council for Bird Protection
LSD	Least Significant Difference

Abstract

The study was carried out to estimate diversity, distribution and abundance of avian species in Duguma Jaldeso Forest east Wollega Zone, Limu Woreda area covering wet and dry seasons from September 2015 to July 2016. Duguma Jaldeso forest is found 493 km a way from Addis Ababa. Forest, Bushland, Grassland and Farmland habitats were identified. Each vegetation type was used as sample site. Data were collected using point count and line transect method. The data were collected in the morning and afternoon. A total of 124 species of birds were identified during the whole study period. Out of the total, 48 species were observed during the wet season; 32 during dry and 44 species in both seasons. During the wet season, the highest species diversity was recorded in the forest habitat (H'=2.881) followed by the bushland (H'= 2.795). During the dry season, avian diversity was highest in bushland (H'=3.305) followed by forest (H'=3.267). During the wet season, high species similarity was seen between forest and bushland (SI=0.304) followed by grassland and farmland (SI= 0.27) and the lowest species similarity was observed between forest and farmland (SI= 0.1). Awareness creation to the local community to reduce human induced factors such as overgrazing, clear cutting and agricultural expansion within the area are recommended.

1. INTRODUCTION

According to the Ethiopian Wildlife and Natural History Society (EWNHS) (1996), Ethiopia is one of the Mega-diversity countries consisting of various types of living organisms with variations in species composition. It is endowed with great ecological diversity. Moreover, it is one of the few countries in the world with relatively high number of endemic species (EARO, 2002). The physiographic, climatic and edaphic diversity resulted in a variety of vegetation from high altitude alpine to semi-desert plant communities (Gebremarkos Woldeselassie, 1998). Vegetation in various parts of the country supports several fauna including those that are endemic to the country (Yonas Yemshaw, 2002). The faunal diversity of Ethiopia is very high. There are 288 known terrestrial mammal species, of which 31 are endemic (Sewnet Mengistu, 2012). The country is also one of Africa leading birding destinations. Its avifauna represents an interesting mixture of East and West African, Palearctic and some strikingly unusual endemic components (EWNHS, 1996).

Ethiopia is one of the most significant countries in Africa in terms of biodiversity (Urban and Brown, 1971). The highlands and Horn of Africa are major parts of conservation international's Eastern Afromontane hotspot. This is due to the diverse and isolated ecosystems with a large number of endemic species. These hotspot areas are among the world's most important biodiversity areas. However, they are the most degraded and disturbed ecosystems. This includes the entire eastern area below 1,100m and higher altitudes including all highland areas (Mckee, 2007).

Among 2100 bird species so far recorded in Africa (Sinclair and Ryan, 2003), Ethiopia harbors 926 species (Lepage, 2006) of which 21 species are endemic and 19 species are globally

threatened (Redman et al., 2009). Out of the threated bird species of the country, two species are critically endangered, five species endangered, and 12 species vulnerable (Collar et al., 1994).

In Ethiopia, a total of 73 hotspots have been identified as important Bird Area (IBAS). Nationally, Ethiopia IBA sites have been grouped into three conservation categories: 19 critical sites, 23 Urgent sites and 31 highly sited areas (Mengistu Wondefrash, 2003). IBSAs are internationally important for the conservation of bird biodiversity. EWNHS has identifies three globally recognized endemic Bird area (EBAS) (Bird Life International, 2007).

Many of the regions of Ethiopia were covered with thick natural forest and woodland with varieties of trees and wild animals. 40% of the country's landscape was covered with natural forest and wood land but, due to serious human pressure, at present, it is left with less than 2.7% of the original plant cover. This has also brought relative decline in wild animal species. Destruction of habitat, excessive human predation, introduction of toxic chemicals and natural uncontrolled events have threatened about 1,000 species worldwide (Gill, 1995).

Currently many species of birds are in danger of extinctions. This problem is associated with human activities such as destruction or fragmentation of bird habitats for agricultural expansion are the main threats for the bird species. There is a need to know more about birds and their habitat requirements in order to protect them (ICBP, 1990).

The present study is an attempt to document the species composition, distribution, relative abundance of birds in the Duguma Jaldeso Forest.

1.1. Objectives

1.1.1. General Objectives

The general objective of the study was to determine the current diversity, distribution and relative abundance of avian fauna in Duguma Jaldeso Forest.

1.1.2. Specific Objectives

The specific objectives of the study are:

- To determine the species composition and distribution of Avifauna in the study area.
- To compare diversity of bird species among different habitats of study area.
- To study abundance of birds at study area.
- To determine the impact of season in the habitat preference of birds.
- To recommend appropriate management plan of better protection and sustainable use of the habitat.

2. LITERATUREREVIEW

Birds are numerically the most successful terrestrial vertebrates (Welty, 1975). According to Kotpal (1985), the world population of birds is nearly 100 billion. Birds make up less than half a percent of global animal species diversity (Jews, 2004). The power of flight is a means of quick direct access to almost any spot on earth. They can feed on variety of food items and build homes on infinite variety of sites (Welty, 1975). They are the only animals that have feathers and the only living vertebrates apart from bats that have evolved wings and powered flight (Birdlife International, 2007).

The current classification of extant birds is a hierarchical arrangement of roughly 29 Orders, 201 Families, over 2000 Genera and 10,010 species that live in diverse habitats (Wessells and Hopson, 1988; Cofre et al., 2007). More than 50% of the living species of birds are belonging to the order Passeriformes (Gill, 1995).

Birds are one of the most important components of biodiversity. This can be indicated by their ecological, economical and aesthetic values. From the earliest times, birds have captured the imagination of people the world over. Their flight, songs, colour displays and migrations are among the world's most compelling natural wonders (ICBP, 1990). Birds are conspicuous and possess diagnostic calls or songs that are necessary to identify them in the field (Walace and Maham, 1975). Birds are associated with mankind. They also serve as game animals, pest control agents and means of cleaning the environment (Kotpal, 1985). One economic importance of birds is their contribution in seed and fruit dispersal. It is well known that many fruit producing plants and bird species are co-evolved to disperse the plants both in tropics and temperate region (Wilkinson, 1997).

Birds appear to be quite variable. They differ considerably in size, body proportion, colour, song, behavior and ability to fly. They were able to become flying machines largely through evolutionary gifts of feather, powerful wings, hollow bones, endothermism, remarkable respiratory system and large strong heart. These adaptations all fulfill two prime requirements for birds, high power and low weight (Welty, 1975; Birdlife International, 2007). Birds have evolved constant body temperature (endothermism) like mammals that make energetic activity possible in all habitats (Welty, 1975; Feduccia, 1996). Birds are varied in body size and shape of the bill in relation to the type of food consumed; leg length changes according to the habit of perching and wing shapes change in relation to patterns of flight (Gill, 1995). The size of the bird ranges from 29 gram (Humming bird) up to 150kg (Ostrich). Variation in the size of bird is related to a balance between such factors as the amount of food ingested, heat loss from the body and the demand for flight (Lonyon, 1963; Hickman et al., 2001). Birds occurance is related to food availability in various habitats such as forests, mountain, grassland scrub and cities (Mesay Digafe, 2008).

Birds are adapted for flight, which is an important mechanism to escape from terrestrial enemies. However, the best method of escaping from sudden attack is by concealing coloration with their habitat (Lanyon, 1963). Their skeleton, lung and heart have adaptation mechanisms for flight. Some of them can fly continuously for over 2500km or even greater distance. Some can reach speeds of more than 90km/hr (King and Mcleeland, 1975).

The ranging and breeding ecology of many bird species in a given ecosystem are the result of food availability and suitability of vegetation cover (Sodhi, 2002). For example majority of birds use specific parts of the forest canopy for food, nesting and travel routes (Enger and Smith, 2000). They can consume a variety of food items including plants, insects and even mammals of

the same size in addition to the food that is inaccessible to other organism. Many are omnivorous and show limited specialization. Others, however, depend on a particular food source, with unique structures and different techniques of acquiring and storing (Mesay Digafe, 2008).

Species of birds increase or decrease based on complexity of the habitat. As the vegetation component increases the number of bird species in a terrestrial environment increases (MacArthur and MacArthur, 1961). For terrestrial communities the number of bird species as well as their diversity is strongly positively correlated with aspects of the structural complexity of vegetation (MacArthur, 1964; Recher, 1969; Karr and Roth, 1971). Species diversity increase with vertical foliage height complex the structure or composition of the vegetation, the more diverse the species of birds present in the habitat. Lowest bird species diversity occurs in even aged monoculture plantation without under growth. In such dense forests, the canopy suppresses the under story by shading, as a result species richness is minimized (Urban and Smith 1989).

Species richness increases as climatic variation decreases. Unpredictable climatic variation is a form of disturbance for bird species. Environmental factors influence species richness (Oindo et al., 2001). Seasonal irregularities lead birds to migration in order to search for alternative food source available and breeding sites (Alerstam, 1990). Various bird migration systems have evolved in response to particular temporal and spatial changes in the environment, and most of the aspects of these migratory systems for shaped by evolutionary selective pressure associated with change in time and space (Bauchinger and Klaosen, 2005). Birds performs long range movements or migrations. Traveling alone or in flocks, they navigate with precision, dividing their habitats between places that are far apart. Unlike many other animals, birds need abundant food all the year round migration allows them to exploit seasonal changes and to breed where the food supply is best (Birdlife international, 2007).

Species diversity is not determined by any single factor but the outcome of many contributing factors. Patterns of variation in species diversity are patters of variation in many biophysical factors as well as anthropogenic processes that could conceivably influence biological diversity (Diamond, 1988). Within sites, it is fairly evident that habitat is likely to be important determinant factor in the distribution and number of birds. Variations in habitats might be natural origin for instance by soil type, along a gradient of rain fall or by altitude. Important variation might have human origin such as the degree of deforestation (Bibby et al., 1998). Temporal diversity of birds during breeding season is the result of specific feeding difference together with temporal diversity in the availabilities of different food resources (Ricklefs, 1966).

Species composition and diversity of birds in a given area are the results of historical, evolutionary and ecological process. Their diversity reflects the evolution of species adapted in relation to their environmental factors. They are mostly described by historical factors such as dispersal events geographical isolation, and extinction due to past climatic and geological phenomena. However, ecological factors such as competition and predation are expressed to less extent (Barrantes and Sandoval, 2009). There are also several factors which influence bird species diversity within an ecosystem. These include the area of habitat patch in which the species nests; the amount of habitat within the landscape; degree of fragmentation and vegetation characteristics of the habitat (MacArthur and MacArthur, 1961).

The number of species in a given ecosystem is maintained through individual and interactive factors and it has been highly associated with vertical complexity of vegetation cover (MacArthur and MacArthur, 1961). Their difference among the localities in a landscape may be the result of species interactions among themselves of each species interaction with the physical environment (Veech and Crist, 2007). Habitat with a complex structural design can support more

number of species than habitats with a simple structural design, because they provide more resources and opportunities for microhabitats segregation (Vivkery et al., 2001). The abundance and distribution of birds in the habitats are affected by scale- dependents hierarchical processes that disturb the links between habitat suitability and their numbers (Tellera et al., 2009). Food and habitat quality and quantity loss have been identified as the most important limiting factors that influence their population and distribution (Jansen et al., 2001). For instance, the perturbation of forest habitats through modification of both the composition and configuration of landscapes result in the decline of forest bird abundance and distribution (Thinh, 2006).

The ecological and life history of birds in association with habitat loss due to climatic change and human impacts are explained by the narrow distribution of most bird species (Cofre et al., 2007). Narrow sized natural habitats are mostly disturbed through intensive human activities like deforestation, logging, subsistence farming, plantation and mining as the major threats for majority of birds (Francis and Shirihai, 1999; Fuentes, 1999). Livestock grazing, selective logging and agricultural intensification are contribution factors for the quality decline of the habitats and this inturn leads to the decline of grassland, forest and farmland bird (Whited et al., 2000; Janson et al., 2001). In line with this, when the natural habitats are disturbed, the species that have restricted ranges, particularly the endemic species, usually lack adaptability due to their relatively less ability to tolerate the modified conditions (Cofre et al., 2007).

Birds suffer more due to anthropogenic effect the destructive influence of human activities on bird populations is recognized only after substantial damage has been occurred (Klem, 1990). Almost human activities can affect bird populations either positively or negatively (Donnelly and Marzluff, 2004). This could especially be true for birds of prey, given their low densities, large home ranges and the resulting scale at which they operate (Berry et al., 1998).

Birds are economically important in various ways. They are vital in controlling insect pests (Ware, 1988). According to Otvos (1979), Insectivorous birds are also involved in feeding and dispersing the seeds of various forest trees and shrubs in the forest ecosystem. Most birds consume numerous grasshoppers, mosquitoes and other insect pests. Through these they make the environment more pleasant for humans (Jarvinen and Vaisanen, 1979). Birds are also beneficial to humans as source of food (Pomeroy, 1992).

3. STUDY AREA

The present study was conducted in Duguma Jaldeso Forest, Limu District, Wollega Zone of Oromia Regional State, Western Ethiopia (Figure 1). Duguma Jaldeso forest is located 493 km from Addis Ababa. It is situated between $09^0$50' N and $36^0$42' E. Duguma forest has altitudes ranging between 1892m-2100 m asl. The sizes of area coverage in the study area are 76, 58, 24, and 31.73 hectares for the forest, bushland, grassland and farmland respectively. The study area totally covers an area of about 189.73 hectares.

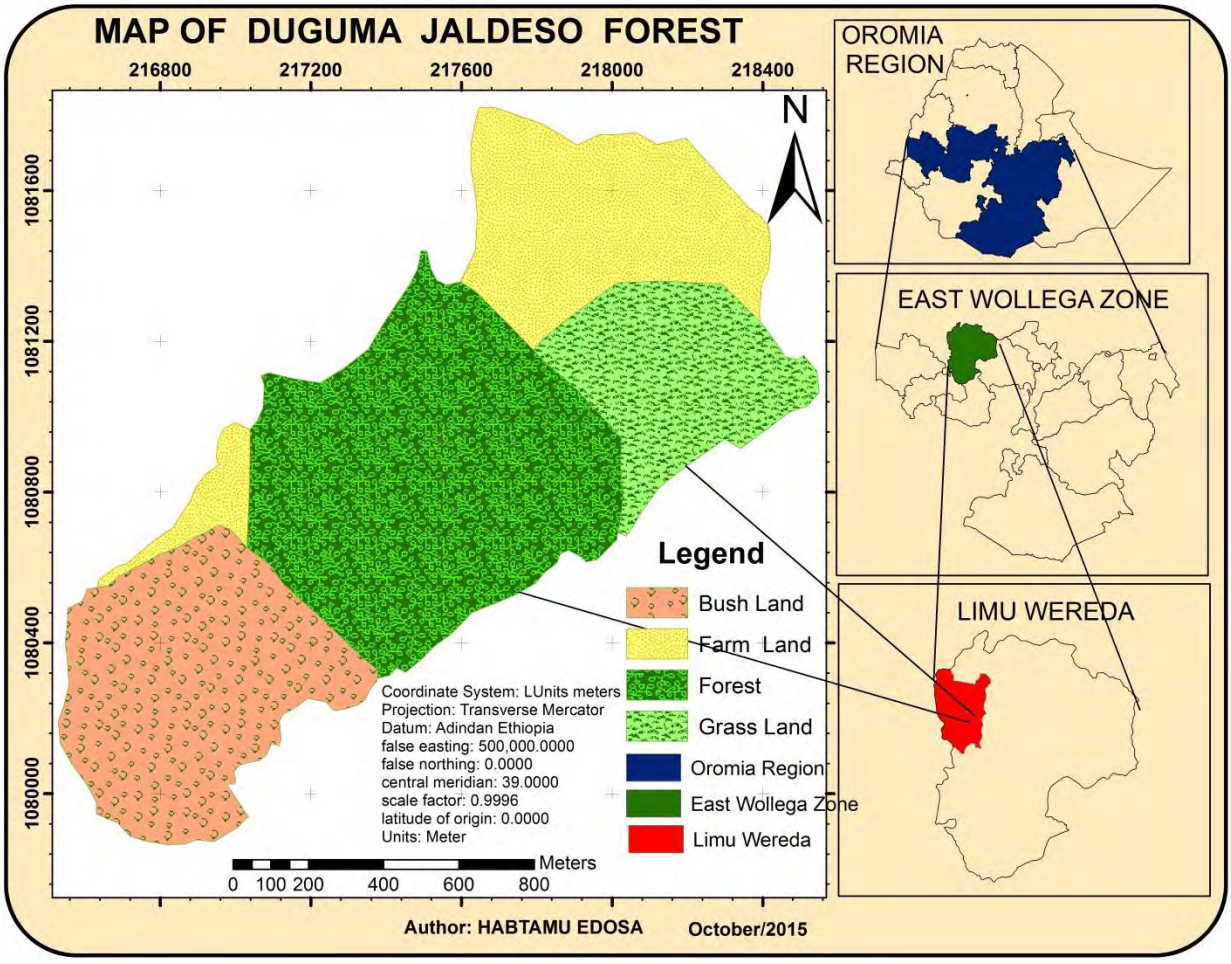

Figure1. Map of the study area with different habitats

3.1 Climate of the study area

Ten years (2006-2015) metrological data were collected from the study site. The mean monthly minimum temperature of the area is ranges from 13^{o}c in the month of January up to 15.65^{o}c. The maximum monthly mean temperature ranges from 20.69^{o}c in the month of August up to 28.36^{o}c in the month of March (Figure 2).The amount of annual rainfall ranges between 1397mm-1748mm. The mean maximum monthly rainfall record was registered in June (328.83 mm) while the minimum in January (5.32mm). It gradually increase between January to June and decrease from July to December (Figure 3).

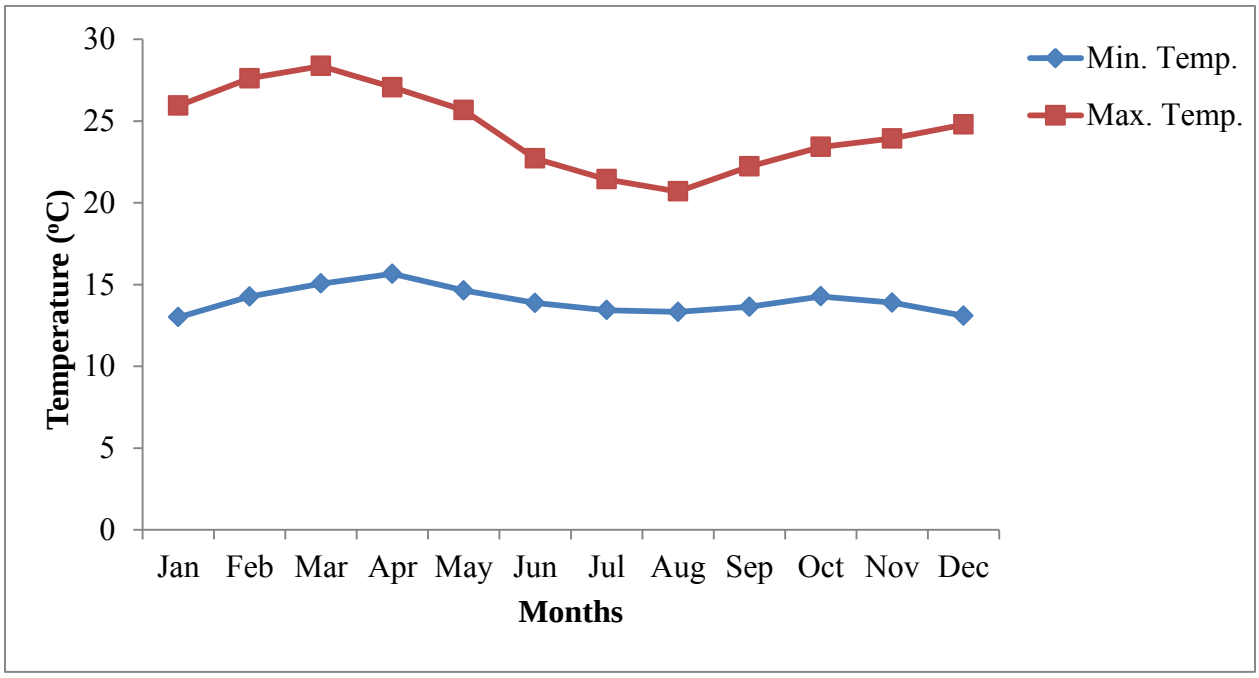

Figure 2. Mean monthly temperature (^{0}C) of the study area (2006-2015).

Source: Ethiopian Metrological Service Agency

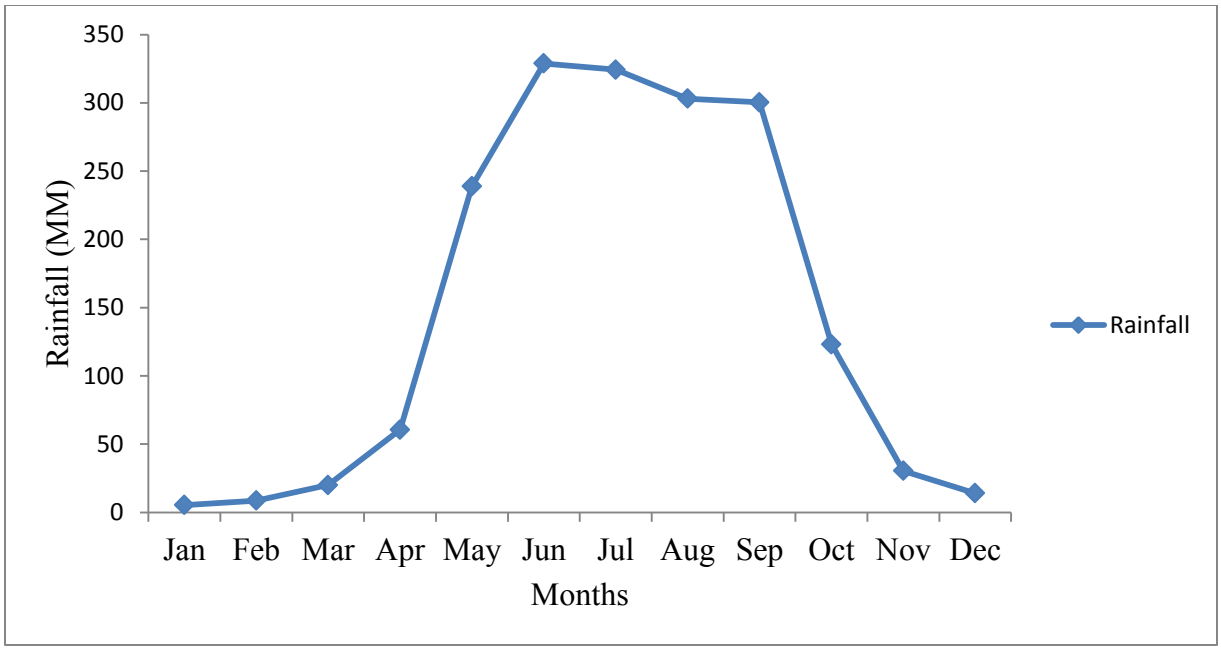

Figure 3. Mean monthly rainfall (mm) of the study area (2006-2015).

Source: Ethiopian Metrological Service Agency.

3.2 Flora and Fauna of the study area

The main plant species identified from different habitats were *Juniperus procera, Fiscus sur, Acacia abyssinica, Acacia etbaica, Prunus africana, Podocarpus falcatus, Albizia gummifera, Erica arborea and festuca* species.

Duguma Forest is a home of many species of wild animals including anubis baboon, colobus monkey, common jackal, spotted hyena and wild pig. It is hot spot of various bird species.

The study area is surrounded by agricultural land. The farmers that live near the forest area make threats to the forest and wild animals living there. The main agricultural productions are wheat, teff, maize, barley and beans. In addition to this farmers keep livestock and the forest is the source of timber, firewood and construction materials for many farmers. The habitats of the study area can be grouped in to four main parts (Figure4).

(a) (b)

(c) (d)

Figure 4. Vegetation types of the study area: a) Forest b) Bushland c) Grassland d) Farmland (photo: Habtamu Edosa, October, 2015)

4. MATERIALS AND METHODS

4.1. Materials

Materials used during the study period include digital camera, field guide books, binoculars, geographic positioning system (GPS), data sheet and note books.

4.2. Methods

4.2.1. Preliminary Survey

Preliminary survey was carried out in September 2015. In this survey, the study site and the habitats were identified. The habitats identified during the survey were classified into four. These are forest, bushland, grassland and farmland habitats. Random blocks were selected for the forest and bush habitats and transect for the grass land and farm land habitats (Krebs, 1999). The habitats were classified based on the vegetation types. Point count method was used to count birds in the forest and bush land habitats (Pomeroy, 1992; Bibby et al., 1992; Moffat and Minot, 1994).

4.2.2 Sample design

Based on the preliminary survey and vegetation structure of the habitats, point count sampling sites were randomly selected in forest and bushland habitats (Bibby et al, 1998). Point count sites were widely and evenly spread throughout the habitats. In each point a maximum of 10 minutes elapsed to count all birds seen or heard (Sutherland, 1996). GPS was used to locate the points in each block. During the first 3 minutes, the observer and his assistant stand quietly at the counting site just to allow birds to settle. The latter 7minutes were used to record all birds that were seen or heard (Bibby et al., 1992). After observation and recording in the data sheet, the observer and his assistant move to the next point to do similar activities. Line transect routes were lined in

farmland and grassland habitats randomly (Bibby et al., 1998) and allowed to carry out species count in both habitats.

4.2.3 Data collection

After the preliminary survey data collection was conducted for both wet and dry seasons. The data collection for the dry season was conducted from December 2015 to January 2016. The data for wet season was collected during the month of June 2016 and July 2016. The counting of birds was carried out using naked eyes, digital camera and binocular. For birds' identification, field guide books were used (Mack Worth-praed and Grant, 1955, Harrison and Smith, 1993; Perlo, 1995; Stevenson and Fanshawe, 2002; Sinclair and Ryan, 2003).

The survey was carried out by walking on foot through all the habitat types and random blocks form on vegetation types and transects in the field. Data were collected by observing the study area twice a day early in morning from 6:30-8:30 A.M and in the afternoon 2:30-4:30 P.M.

Three blocks were randomly identified for the forest habitat and three blocks for bushland habitat. Each block had an area of 1km x 1km and a total of $6km^2$area was covered in the forest and bushland habitats. The blocks were separated from each other by 250-300 meters. within each block, six random point counting sites were selected. The point count stations in a sample block were 150-200 meters apart to avoid under or over estimation during the counting process. The observer and his assistant stand at a particular point for a fixed time (10 minutes) and all birds that can been seen or heard are recorded with a fixed radius or arbitrary range of 25m (Pomeroy, 1992; Sutherland 1996; Bibby et al., 1998). Line transects sampling method were used for a large and relatively uniform areas of grass land and farmland habitats (Bibby et al., 1992). A total of four transects was designed each with 1 km distance. Transects were widely

spaced and are separated from each other by 500m. Counting of birds was carried out within a length of 25m at both sides by walking along the transect line. Species observed during the survey were identified and taxonomically classified following Sinclair and Ryan (2003), Avibase; Bird checklists of the world (Lepage, 2008). Photographs were taken for further confirmation of species.

4.2.4 Data Analysis

The species diversity of each habitat in the two seasons was analyzed using Shannon diversity Index (H') (Shannon and Wiener, 1949). Species evenness was evaluated using Shannon-Wiener evenness Index (E) (Southwood and Henderson, 2000). Simpson's similarity index (SI) was used to assess the similarity of species between two different habitat types. The relative abundance of avian species was determined using encounter rates that give crude ordinal scales of abundance as abundant, common, frequent, uncommon and rare (Bibby et al., 1998). Accordingly bird species with encounter rates <0.1, 0.1-2.0, 2.1-10.0, 10.1-40, >40 were classified as rare, uncommon, frequent, common and abundant respectively. One way analysis of variance (ANOVA) were used for habitat comparison in terms of bird abundance. The diversity and evenness are often calculated using Shannon diversity index. The Shannon diversity index normally varies between 1.5 and 3.5 and rarely exceeds 4.5 (Magurran, 1988; Kent and Coker, 1992). The idea of species diversity involved two quite distinct concepts: richness and evenness. Species richness refers to the total number of species in a community while evenness is the relative abundance of each species with in the sample community (Kent and Coker, 1992; Krebs, 1999).

Shannon-Wiener diversity index was calculated as follows:

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

Where, H' = Shannon diversity index

S = the number of species

Pi = the proportion of individuals or the abundance of the i^{th} species expressed as a proportion of the total

ln= Natural logarithm

Simpson's Index of Diversity (D) was used to evaluate the relative abundance of birds in each habitat for both seasons (Simpson, 1951). It was calculated as:

$D= 1- \sum Pi^2$, where

D= simpson index

Pi= proportion of individual species.

The evenness (pattern of distribution) of birds in the study area was calculated through Shannon-Wiener Evenness Index (E) (Shannon and Wiener, 1949).

E= H'/Hmax, where

E= Shannon wiener evenness index

H'= Shannon-Wiener diversity index

Hmax = LnS= Natural logarithm of the total number of species in each site (Southwood and Henderson, 2000).

The value of evenness index falls between 0 and 1. The higher the value of evenness index, the more even the species in their distribution with in a given area.

Simpson's similarity index was used to investigate the similarity between different habitats in relation to the composition of species.

Simpson's Index (SI) = 2C/A+B, where

A= the number of species in habitat A

B= the number of species in habitat B

C= the number of common species for both habitat.

Relative abundance of birds in each habitat =Total individuals observed / 100 field hours

5. RESULTS

In the present study, a total of 124 avian species belonging to 49 families were identified from all study sites during both wet and dry seasons. The majority of bird species are of the family Accipitridae (13 species) followed by Muscicapidae (12 species). Among the total number 48 species were recorded during wet season, 32 species were recording during dry season and 44 were observed during both seasons (Table 1).

Table 1. Bird species recorded during wet and dry seasons from the study area.

No	Bird Species	Family	Dry Season	Wet Season	Both Seasons
1	Abyssinian Slaty-Flycatcher (*Melaenornisvariegates*)	Muscicapidae		+	
2	Black-Winged love Bird (*Agapornis taranta*)	Pasittacidae			+
3	Blue-breasted Bee-eater (*Merops variegates*)	Meropidae	+		
4	Abyssinian ground-Hornbill (*Bucorvus abyssinicus*)	Bucerotidae		+	
5	Black kite (*Milvus migrans*)	Accipitridae		+	
6	Hooded Vulture (*Necrosyrtes monachus*)	Accipitridae		+	
7	Europian Honey-buzzard (*Pernis apivours*)	Accipitridae	+		
8	Rupell's Vulture (*Gyps rueppellii*)	Accipitridae		+	
9	African Citril (*Serinuls citrinelloides*)	Fringillidae	+		
10	Black-headed Siskin (*Serinus negriceps*)	Fringillidae			+
11	Brown-rumped Seedeater (*serinus tristriatus*)	Fringillidae			+
12	African paradise Flycatcher (*Terpsiphone virdis*)	Monarchidae	+		
13	African Pipit (*Anthus cinnamomeus*)	Motacillidae			+
14	African Hill Babbler (*Pseudoalcippe abyssinia*)	Timaliidae	+		
15	Broad-ringed White eye (*Zosterops poliogastrus*)	Zosteropidae			+

16	Abyssinian Catbird (*Parophasma galinieri*)	Timaliidae			+
17	Brown Parisoma (*Parisoma lugens*)	Sylviidae		+	
18	Abyssinian long Claw (*Macronyx flavicollis*)	Oriolidae	+		
19	Bown-backed Wood pecker (*Dendropicos obsoletus*)	Picidae		+	
20	African Harrier-Hawk (*Ployboroides typus*)	Accipitridae	+		
21	African Fire finch (*Lagonostda rubricata*)	Estrildidae	+		
22	Black headed Oriole (*Oriolus monacha*)	Oriolidae			+
23	Black Headed Heron (*Ardea melanocephala*)	Ardeidae		+	
24	Black cuckoo Shrike (*Campeplaga flava*)	Campephagidae		+	
25	African stone Chat (*Saxicola torquatus*)	Muscicapidae		+	
26	Common Redstar (*Phoenicurus phoenicurus*)	Muscicapidae		+	
27	Beautiful Sunbird (*Cinnyris pulchellus*)	Nectariniidae		+	
28	Common bulbul (*Pycnonotus borbatus*)	Pycnonotidae	+		
29	Crested Francolin (*Francolimus sephaena*)	Phasianidae			+
30	Common chiffchaff (*Phylloscopus collybita*)	Phylloscopidae	+		
31	Cinnamon-Breasted Rock Bunting (*Emberizatahapisi*)	Emberizidae		+	
32	Common Fiscal (*Lanius collaris*)	Laniidae			+
33	Crowned Hawk-Eagle (*Stephanoaetus coronatus*)	Accipitridae		+	
34	Augur Buzzard (*Buteo augur*)	Accipitridae			+
35	Cape Crow (*Corvus capensis*)	Corvidae			+
36	Dusky Turtle-Dove (*Stroptopelia lugens'*)	Columbidae			+
37	Dusky crimson Wing (*Cryptospiza jacksoni*)	Estrildidae			+
38	Erlanger's Lark (*Clandrella erlangeri*)	Alaudidae			+
39	Erckel's Francolin (*Francolinus erckelii*)	Phasianidae		+	
40	Egyptian Gosse (*Alpochen aegyptiaca*)	Anatidae			+
41	Ethiopian Cisticola (*Cisticola lugubris*)	Cisticolidae	+		

42	Eastern Grey plantain-eater (*Crinfer zonurus*)	Musophagidae			+
43	Eurasian Hoope (*Upupa epop*)	Upupidae		+	
44	Fan-tailed Raven (*Corvus rhipidurus*)	Corvidae			+
45	Familiar Chat (*Cercomela sordida*)	Muscicapidae	+		
46	Foxy Cisticold (*Cisticola troglodytes*)	Cisticolidae		+	
47	Fischer's Sparrow Lark (*Eremopterix leucopareia*)	Alaudidae	+		
48	Fawn-breasted Waxbill (*Estrilda paludicola*)	Estrildidae		+	
49	Greater Blue-eared Glossy starling (*Lamprotornis chalbaeus*)	Sturnidae		+	
50	Ground scraper Thrush (*Psophocichla lirsipsirupa*)	Turdidae			+
51	Grey crowned – Crane (*Balearica regulorum*)	Gruidae			+
52	Green-Throated Sunbird (*Nectarinia rubescens*)	Nectariniidae		+	
53	Grey-Headed Batis (*Batis orientalis*)	Platysteiridae		+	
54	Hamerkop (*Scops umbretta*)	Scopidae			+
55	Hadada Ibis (*Bostrychia hagedash*)	Threskiornithidae			+
56	Isabellin Wheatear (*Oenanthe isabllina*)	Muscicapidae			+
57	Long-billed Pipit (*Anthis similes*)	Motacillidae	+		
58	Klaas' Cukoo (*Chrysococyx klaas'*)	Cuculidae	+		
59	Lemon Dove (*Columba larvata*)	Columbidae		+	
60	Lammergeier (*Gypaetus barbatus*)	Accipitridae			+
61	Nyanza Swift *(Apus niansae*)	Apodidae		+	
62	Lessoer Honey Guide (*Indicator minor*)	Indicatoridae			+
63	Masked Shrike (*Lanius nubicus*)	Lanidae	+		
64	Pale Flycatcher (*Bradornis pallidus*)	Muscicapidae		+	
65	Pied Wheatear (*Oenples chanka*)	Muscicapidae	+		
66	Moorland Alpine chat (*Cercomela sordida*)	Muscicapidae			+
67	Malachite Sunbird (*Nectarinia famosa*)	Nectariniidae			+

68	Nile valley Sunbird (Hedydipna metallica)	Nectariniidae		+	
69	Moore Land Francoin (*Francolinus psiloaemus*)	Phasianidae		+	
70	Olive Thrush (*Turdus olivaceus*)	Turdidae		+	
71	Little Rock-Thrush (*Monticola rufocinerus*)	Turdidae	+		
72	Pied Crown (*Corvus albus*)	Corvidae		+	
73	Olive pigeon (*Columba arquatrix*)	Columbidae			+
74	Pallid Swift (*Apus niansae*)	Apodidae			+
75	Pectoral-patch Cisticola (*Cisticola brunnescens*)	Cisticolidae	+		
76	Ruddly Shelduck (*Tadorna ferruginea*)	Anatidae		+	
77	Red-Necked Buzzard (*Buteo augur*)	Accipitridae		+	
78	Red-eyed Dove (*Streptopelia semitorquata*)	Columbidae		+	
79	Ring-necked Dove (*Streptopelia capicola*)	Columbidae			+
80	Red-checked Cordonblue (*Uraeguinthus bengalus*)	Estrildidae	+		
81	Red-backed Shrike (*Lanius collurio*)	Lanidae	+		
82	Red throated Pipit (*Anthus cervinvs*)	Motacillidae			+
83	Rupell's Robin-chat (*Cossypha semirufa*)	Muscicapidae			+
84	Rufous-tailed Scrub-Robin (*Cercotrichas galactotes*)	Muscicapidae	+		
85	Red – headed Weaver (*Anapllctes rubriceps*)	Ploceidae		+	
86	Red-billed Quelea (*Quelea quelea*)	Ploceidae			+
87	Rufous Chatterer (*Turdoides rubiginosa*)	Timaliidae	+		
88	Stout Cesticola (*Cisticola robustus*)	Cistcolidae		+	
89	Speckled pigeon (*Collumba guinea*)	Columbidae			+
90	Southern Gray Shrike (*Lanius meridionalis*)	Lanidae	+		
91	Spotted Flycatcher (*Muscicapa striata*)	Muscicapidae		+	
92	Scarlet chested Sunbird (*Chalcomitra senegalensis*)	Nectariniidae		+	
93	Shining Sunbird (*Cinnyris habessinicus*)	Nectariniidae		+	

94	Swainson's Sparrow (*Passer swainsonii*)	Passeridae			+
95	Scaly Francolin (*Francolinus squamatus*)	Phasianidae			+
96	Song Thrush (*Twidus philomelos*)	Turdidae	+		
97	Tawny Eagle (*Aguila rapax*)	Accipitridae			+
98	Tiny Cisticola (*Cisticola nana*)	Cisticolidae	+		
99	Tawny-flarked Prinia (*Prinia subflava*)	Cisticolidae			+
100	Thick-billed Raven (*Corvus crassiorostiris*)	Corvidae			+
101	Tropical Boubou (*Laniarius aethiopicus*)	Malaconotidae		+	
102	Tawny pipit (*Anthus campastris*)	Oriolidae	+		
103	Tree pipit (*Anthus trivialis*)	Oriolidae			+
104	Termminck's Stint (*Calidri's temminckii*)	Scolopacidae	+		
105	Verreaux's Eagle (*Aquila berreauxii*)	Accipitridae		+	
106	Wahlerg's Eagle (*Aquila wahbergi*)	Accipitridae		+	
107	White collared Pigeon (*Columba albitorgues*)	Columbidae		+	
108	White-winged Cliff-chat (*Thamnolaea semirufa*)	Muscicapidae	+		
109	White-cheecked Turaco (*Turaco leucotis*)	Musophagidae			+
110	White backed Black – Tit (*Melaniporus leucomelas*)	Paridae		+	
111	White – browed Sparrow Weaver (*plocepasser mahali*)	Ploceidae	+		
112	White billed Starling (*Onlychognathus albirostris*)	Sturnidae		+	
113	Wood Warbler (*Phylloscopes sibilatrix*)	Phylloscopidae		+	
114	Willow Warbler (*Phylloscopus trochilus*)	Phylloscopidae		+	
115	Wattled Ibis (*Bostrychia carunculata*)	Threskiornithidae			+
116	White-rumped Babbler (*Turdoides leucopygia*)	Timaliidae		+	
117	White breasted White eye (*Zosterops abyssinicus*)	Zosteropidae		+	
118	Yellow Billed kite (*Milvus aegypticus*)	Accipitride			+

119	Yellow rumped Seed eater (*Serinus xanthopygius*)	Fringillidae	+		
120	Yellow wagtail (*Motacclla flava*)	Motacillidae	+		
121	Yellow Bishop (Euplectes capensis)	Ploceidae		+	
122	Red-billed Oxpecker (*Buphagus erythrorhynchus*)	Sturnidae			+
123	Yellow-fronted Parot (*Poicephalus flavifrons*)	Psittacidae		+	
124	White winged Black-Tit (*Melamiparus leucomelas*)	Paridae			+

5.1 Species Diversity and Evenness

Variations were observed in Species diversity among the different habitats during the wet and dry seasons. Species diversity was higher during the dry season in all the habitats compared to the wet season (Table 2). During the wet season, the highest diversity of bird species was recorded in the forest habitat (H'=2.881) followed by the bushland (H'=2.795) and the lowest diversity of species was found in the grassland (H'=2.539) followed by farmland (H'=2.571). During the dry season, the bushland habitat (H'=3.305) supported the highest diversity and followed by forest habitat (H'=3.267). The least diversity of birds was recorded in the grassland habitat (H'=2.964) during dry season. The highest evenness was observed in the farmland (E=0.974) and the lowest evenness was observed in the forest habitat (E=0.884) both during the wet season (Table 2).

Table 2.Bird species diversity, evenness and diversity index in different habitat types during wet and dry season.

Habitat	Season	Species richness	Abundance	H’	H_{max}	H'/H_{max}	$D=1-\sum pi^2$
Forest	Wet	26	550	2.881	3.258	0.884	0.963
	Dry	33	710	3.267	3.497	0.934	0.941
	Both	47	1260	3.424	3.850	0.889	0.953
Bushland	Wet	20	330	2.795	2.996	0.933	0.955
	Dry	38	661	3.305	3.638	0.908	0.939
	Both	45	991	3.401	3.807	0.983	0.957
Grassland	Wet	16	55	2.539	2.773	0.916	0.912
	Dry	23	96	2.964	3.135	0.945	0.928
	Both	31	151	3.098	3.434	0.902	0.918
Farmland	Wet	14	40	2.571	2.639	0.974	0.916
	Dry	26	112	3.164	3.258	0.971	0.929
	Both	38	152	3.126	3.638	0.859	0.955

Note: H’= Shannon-Weiner Index; H/H’max = Evenness; D= Diversity Index; H’max=ln(S)

5.2. Species Richness

Variation in the number of species was observed among the four different habitats and between seasons in the same habitat. The highest species number during the wet season was recorded in the forest habitat (26) and in the bushland (38) during the dry season. The least species number was recorded in the farmland habitat (14) during the wet season and in the Grassland (23) during the dry season. During both seasons, the highest number of bird species was recorded from forest followed by bushland (Fig.5)

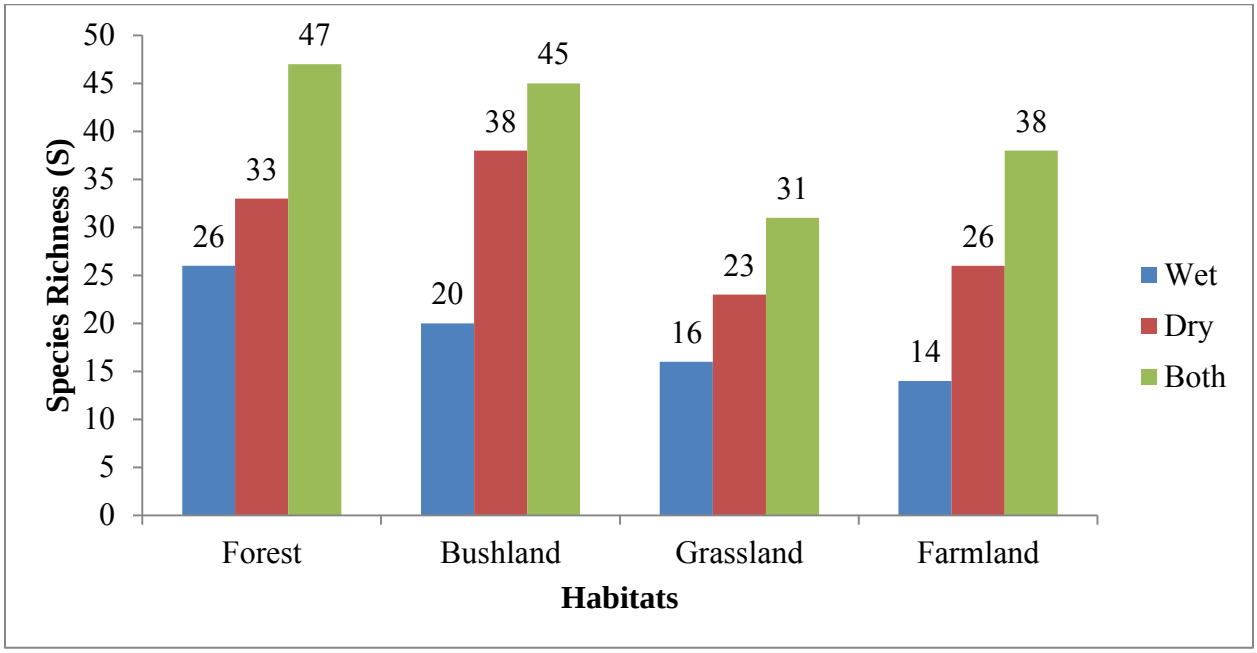

Figure 5. Species richness of birds in the four different habitats

5.3 Species Similarity

Bird species similarity between different habitats showed variations between seasons. During the wet season more species similarity was seen between species of forest and bushland (SI=0.304). Least similarity was observed between forest and farmland (SI=0.1). During the dry season the highest similarity was observed between forest and bushland (SI=0.28) and least similarity was

between forest and grassland (SI=0.14). Species similarity was high between bird species of forest and bushland in both seasons (SI=0.35). The lowest species similarity was seen between bushland and farmland (SI=0.22) (Table 3).

Table 3. Bird species similarity between the four habitat types in different seasons

Habitats	Season	Simpson's Similarity Index (SI)			
		Forest	Bushland	Grassland	Farmland
Forest	Wet	_	0.304	0.143	0.1
	Dry	_	0.28	0.14	0.24
	Both	_	0.35	0.31	0.24
Bushland	Wet	_	_	0.22	0.24
	Dry	_	_	0.23	0.25
	Both	_	_	0.29	0.22
Grassland	Wet	_	_	_	0.27
	Dry	_	_	_	0.24
	Both	_	_	_	0.23
Farmland	Wet	_	_	_	_
	Dry	_	_	_	_
	Both	_	_	_	_

Note: Simpson's Similarity Index (SI) = 2C/A+B Where,

A=the number of species in habitat A

B= the number of species in habitat B

C= the number of common species for both habitats.

Within the same habitat, the percentage comparison of species similarity during wet and dry seasons showed the highest species similarity in the farmland habitat (45%). The least similarity was obtained in the bushland habitat (10%) (Table 4)

Table 4. Seasonal species similarity within the same habitat

Habitats	Wet season	Dry season	Common species	SI	Species similarity between seasons (%)
Forest	26	33	11	0.37	37%
Bushland	20	38	3	0.1	10%
Grassland	16	23	6	0.24	24%
Farmland	14	26	9	0.45	45%

Note: Similarity Index (SI) = 2C/A+B

5.4 Distribution

During the present study, bird species were distributed differently through the vegetation types. Among the observed bird species 47 species were recorded from the forest,45 species were recorded from bushland, 31 species recorded from grass land and 38 species were recorded from farmland habitat (Appendix 1)

5.5 Abundance

Bird species abundance varied among the vegetation types. The highest abundance was recorded in forest habitat (550) followed by bushland (330) during the wet season. The least abundance was recorded in farmland habitat (40) followed by grassland (55) during the wet season. The highest abundance was recorded in forest (710) followed by bushland (661) and the least abundance was recorded in grassland habitat (96) during dry season (Figure 6).

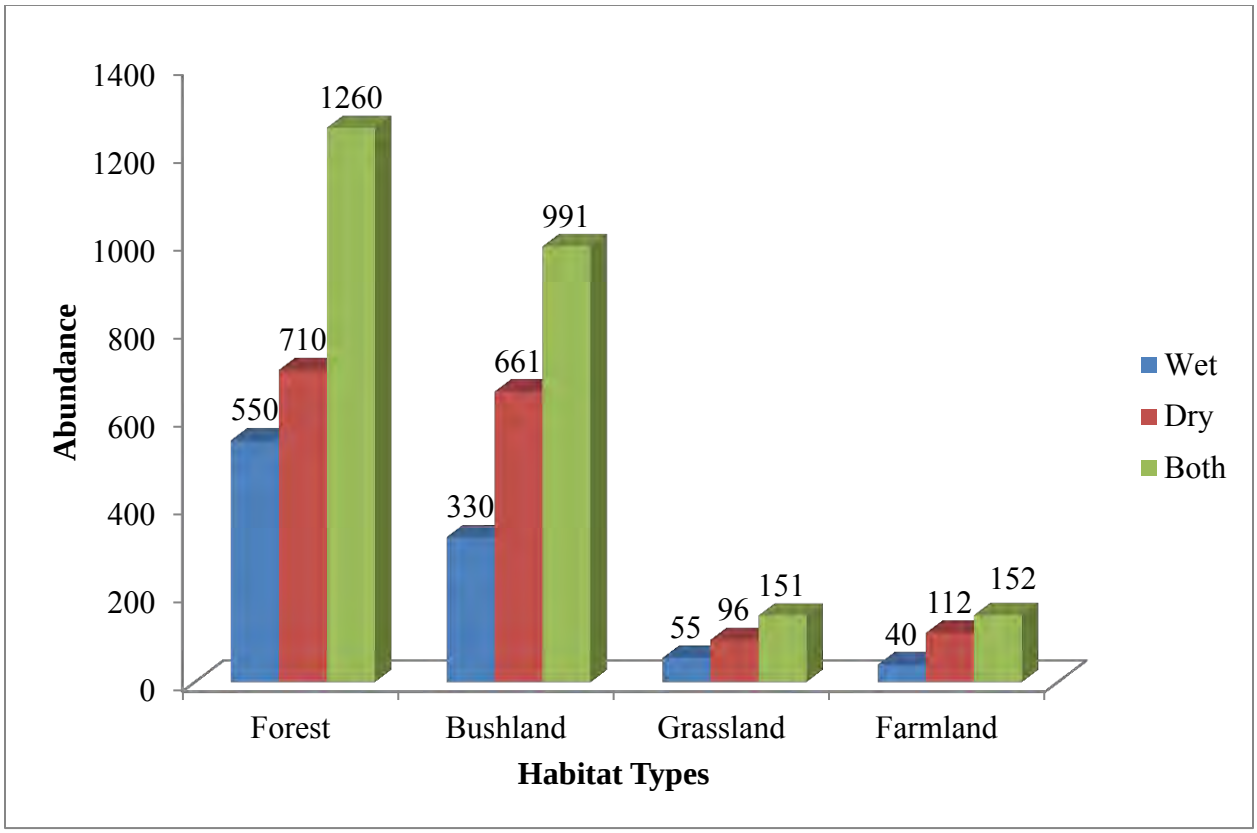

Figure 6: Abundance of bird species during wet, dry and both seasons for all habitats

During the wet season, the numbers of individuals of species recorded were 550, 330, 55, 40 in forest, bushland, grassland and farmland habitats respectively. During dry season, there were 710, 661, 96, 112 individuals in the forest, bushland, grassland and farmland habitats respectively. The mean number of individuals observed varied between habitats and it was statistically significant (df=3, F=9.246, p=0.029<0.05). This indicates that the difference in habitat had a significant effect on the abundance of birds.

Table 5. Multiple pair-wise comparisons of mean difference in species abundance in different habitat using LSD

(I)Habitat	(J)Habitat	Mean Difference (I-J)	Sig.
Forest	Bushland	134.500	0.370
	Grassland	554.000*	0.014
	Farmland	554.000*	0.014
Bushland	Forest	-134.500	0.370
	Grassland	419.500*	0.035
	Farmland	420.000*	0.034
Grassland	Forest	-554.000*	0.014
	Bushland	-419.500*	0.035
	Farmland	.500	0.997
Farmland	Forest	-554.500*	0.014
	Bushland	-420.000*	0.034
	grassland	-0.500	0.997

*The mean difference is significant at the 0.05 level

The relative abundance score and rank of each species in different habitats and seasons was determined using encounter rate data. The relative abundance score and rank of each species in different seasons and habitats are shown in (Appendix 2-9). The relative abundance of bird species during the wet and dry season is shown in Table 6.

Table 6. Relative abundance of avian species during the wet and dry season using encounter rates

Habitat	Season	Rank				
		Rare	Uncommon	Frequent	Common	Abundant
Forest	Wet	-	1	15	10	-
	Dry	-	2	19	10	2
Bushland	Wet	-	2	10	8	-
	Dry	-	6	22	10	-
Grassland	Wet	-	3	5	7	1
	Dry	1	5	11	6	-
Farmland	Wet	-	3	6	5	-
	Dry	-	7	13	6	-

6. DISCUSSION

A total of 124 species of birds were recorded from the study area, this indicates that the area is rich in avian diversity. The floristic composition of the four habitats is different. Due to this there was difference in the diversity of birds. Differences in habitat characteristics and feeding habits of bird species in the study area are responsible for variation in species diversity and number of individuals of bird species among different habitats as suggested by (Smith, 1992).

In all habitats dry season recorded highest species diversity compared to wet season. The high diversity indices of birds during the dry season might be related to the presence of enough food sources in the habitat that meet the requirement. It could also be associated with abundance of seeds, fruits and crops food for the birds in the habitat during dry season. During the wet season, the highest diversity of bird species was recorded in the forest habitat. The reason for high diversity of bird species in forest habitat during the wet season could be the availability of variety of food sources for bird. Sodhi (2002) and Martin and Possingham (2005) have stated that habitat structure and food resources are the major determinant of bird species diversity. The difference in species diversity in the forest and bushland habitats was very small due to the complexity of vegetation in both habitats. Grassland & farmland habitats have near similar number of species of birds during wet season but the diversity of species in farmland habitat during dry season increased. This might due to increased food availability in farmland habitat during dry season compared to the wet season. During dry season, the diversity of bird species of bushland habitat is high and low in grassland habitat.

The study showed that the diversity of species of birds was small during wet in the farmland and grassland compared to the other habitat types. This finding is in line with Rana (2005), who

reported that in natural habitats where the intervention of humans is less and minimum, the diversity of species is higher than habitats where intensive farming is apparent. As the number of vegetation layer increase, the number of available niches for birds also increases and so does the diversity of avian species. This is due to the different feeding habit of avian birds to niche separation (MacArthur, 1964). Structural change in the vegetation of farmland as a result of removal of plants might have forced birds to migrate to nearby habitats. The increase and decrease of species diversity at different habitats and seasons might be due to local migration of birds from one habitat to the other in search of food (MacArthur, 1964; Adeyemo and Ayodele, 2005).

During wet season the highest species richness was seen in the forest and in the bush land habitats. This might be due to high structural complexity of vegetation structure of the forest and bushland. The difference in species richness might be due to the influences of climatic variation such as topography, vertical and horizontal vegetation structure (Karr, 1980; Cueto and deCasenava, 1999; Oindo et al., 2001). The highest evenness value was seen in the farmland habitat which had the smallest species richness. This agrees with the idea of Krebs (1999), which states that evenness is independent of species richness.

The analysis of bird species similarity among the four habitat types shows highest similarity of bird species was observed between the forest and bushland both during wet (SI=0.304) and dry (SI=0.28) season. This similarity might be due to the presence of stable bird niches and similarity in vegetation composition in the two habitats. This coincides with the idea of Karr (1980), which states that faunas under similar ecological conditions are more or less similar to each other in species richness and topographic structure than faunas under different ecological conditions. The least similarity was between forest and farm land habitats. This might be due to the difference in

the resources and breeding area requirement among the bird species. The distribution of birds within the four habitats varied. The highest numbers were observed in the forest habitat followed by bushland habitat. This might be due to the higher vegetation complexity in the forest than other habitats. This finding is in line with MacArthur (1964), who reported that the complexity of vegetation structure for avian can provide stable source of food, nesting and cover from predator.

The difference in relative abundance of birds recorded at the present study areas might be due to the availability of food, habitat condition and breeding nature of the species. The distinct seasonality of rainfall and seasonal variation in the abundance of food resource result in seasonal changes in species abundance of birds (Karr and Roth, 1971). The relative abundance of bird species in the study areas was grouped as rare, uncommon, common, frequent, and abundant. The rare and uncommon species may be related to the breeding nature, large home range and niche of the species. In addition, degradation of the habitat might be a reason for the species to be uncommon.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

The Duguma forest supports diverse species of birds in the different habitat types. During the survey, a total of 124 species of birds belonging to 49 families were identified from the study area. The highest numbers of bird species were recorded from family Accipitridae. Species diversity and richness were high in both forest and bush land habitats may be associated with the presence of sufficient amount of food, habitat condition and breading nature of species. There was high a significant variation in species both by habitats difference and seasonal variation. The seasonal variation depends up on climatic condition, while the variation in the habitats depends up on the types of vegetation of the area.

The forest is shrinking in size in all direction from time to time due to the expansion of farmland, clear cutting of trees for fire food, charcoal and construction materials. The farmland are expected to the local people for cultivating and cutting of vegetation as compared to others habitats, which have negative impact on birds population. If these threats continue the bird species diversity in the area declines.

7.2 Recommendations

The Duguma Jaldeso forest is suitable for the survival of various types of bird species and other wild animals. In order to conserve the avian fauna and other wild animals the vegetation coverage of the area should be maintained. Based on the present study, the following recommendations are forwarded:

- Awareness creation to the local community to reduce human induced factors such as overgrazing, clear cutting and agricultural expansion within the area.
- Detailed study of the diversity and other ecological aspects of forest bird species should be conducted.
- The habitat of birds should be protected and the local people should have to participate in the conservation program.
- Recognition should be given for developing and maintaining the area as historical site and center of biodiversity.
- Land management through controlled grazing and appropriate stocking density of cattle in the grassland habitat should be practiced.

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9. APPENDICES

Appendix 1: Distribution of different bird species in the four habitats.

Note: (+) presence of species, (-) absence of species

No	Name of Bird species	Habitat Types			
		Forest	Bush land	Grassland	Farmland
1	Abyssinian Slaty-Flycatcher (*Melaenornis variegates*)	+	+	_	_
2	Black-Winged love bird (*Agapornis taranta*)	+	_	_	_
3	Blue-breasted Bee-eater (*Merops variegates*)	+	_	_	_
4	Abyssinian ground-Hornbill (*Bucorvus abyssinicus*)	+	_	_	_
5	Black Kite (*Milvus migrans*)	+	_	_	_
6	Hooded Vulture (*Necrosyrtesmonachus*)	+	_	_	_
7	Europian Honey-buzzard (*Pernis apivours*)	+	_	_	_
8	Rupell's Vulture (*Gyps rueppellii*)	+	_	_	_
9	African Citril (*Serinuls citrinelloides*)	+	+	_	+
10	Black-headed Siskin (*Serinus negriceps*)	+	+	+	_
11	Brown-rumped Seedeater (*Serinus tristriatus*)	+	_	_	+
12	African Paradise Flycatcher (*Terpsiphone virdis*)	_	+	_	_
13	African Pipit (*Anthus cinnamomeus*)	_	+	+	_
14	African Hill Babbler (*Pseudoalcippe abyssinia*)	_	+	_	_
15	Broad-ringed White eye (*Zosterops poliogastrus*)	_	+	_	_
16	Abyssinian Catbird (*Parophasma galinieri*)	+	_	_	_
17	Brown Parisoma (*Parisoma lugens*)	+	_	_	+
18	Abyssinian long Claw (*Macronyx flavicollis*)	_	_	+	_
19	Bown-backed Wood pecker (*Dendropicos obsoletus*)	+	_	_	_

20	African Harrier-Hawk (*Ployboroides typus*)	+	_	_	_
21	African Fire finch (*Lagonostda rubricata*)	_	+	+	+
22	Black headed Oriole (*Oriolus monacha*)	+	+	_	_
23	Black Headed Heron (*Ardea melanocephala*)	+	+	+	_
24	Black cuckoo Shrike (*Campeplaga flava*)	+	+	_	_
25	African Stone chat (*Saxicola torquatus*)	_	_	_	+
26	Common Redstar (*Phoenicurus phoenicurus*)	+	_	_	_
27	Beautiful Sunbird (*Cinnyris pulchellus*)	+	_	_	_
28	Common Bulbul (*Pycnonotus borbatus*)	+	+	_	_
29	Crested Francolin (*Francolimus sephaena*)	_	+	_	_
30	Common Chiffchaff (*Phylloscopus collybita*)	+	+	_	_
31	Cinnamon-Breasted Rock Bunting (*Emberizatalapisi)*	_	_	_	+
32	Common Fiscal (*Lanius collaris*)	+	+	_	+
33	Crowned Hawk-Eagle (*Stephanoaetus coronatus*)	_	+	+	+
34	Augur Buzzard (*Buteo augur*)	+	+	+	_
35	Cape Crow (*Corvus capensis*)	_	_	_	+
36	Dusky Turtle-Dove (*Stroptopelia Lugens'*)	+	+	_	+
37	Dusky crimson Wing (*Cryptospiza jacksoni)*	_	+	_	_
38	Erlanger's Lark (*Clandrella erlangeri*)	_	_	_	+
39	Erckel's Francolin (*Francolinus erckelii*)	+	+	_	_
40	Egyptian Gosse (*Alpochen aegyptiaca*)	+	_	+	+
41	Ethiopian cisticola (*Cisticola lugubris*)	_	+	_	_
42	Eastern Grey Plantain-eater (*Crinfer zonurus*)	_	+	_	_
43	Eurasian Hoope (*Upupa epop*)	_	_	_	+
44	Fan-tailed Raven (*Corvus rhipidurus*)	_	_	_	+

45	Familiar Chat (*Cercomela sordida*)	+	+	+	+
46	Foxy Cisticold (*Cisticola troglodytes*)	_	+	+	+
47	Fischer's Sparrow Lark (*Eremopterix leucopareia*)	_	+	_	_
48	Fawn-breasted Waxbill (*Estrilda paludicola*)	_	+	_	_
49	Greater Blue-eared Glossy starling *(Lamprotornis chalbaeus*)	_	+	_	_
50	Ground scraper Thrush (*Psophocichla lirsipsirupa*)	_	+	+	+
51	Grey crowned – Crane (*Balearica regulorum*)	_	_	+	+
52	Green-Throated Sunbird (*Nectarinia rubescens*)	_	_	_	+
53	Grey-Headed Batis (*Batis orientalis*)	_	_	_	+
54	Hamerkop (*Scops umbretta*)	_	_	+	+
55	Hadada Ibis (*Bostrychia hagedahs*)	_	_	+	_
56	Isabellin Wheatear (*Oenantheisabllina*)	_	_	+	+
57	Long-billed Pipit (*Anthis similes*)	_	_	+	_
58	Klaas' Cukoo (*Chrysococyx klaas'*)	_	+	_	_
59	Lemon Dove (*Columba larvata*)	_	_	_	+
60	Lammergeier (*Gypaetus barbatus*)	+	_	_	_
61	Nyanza Swift *(Apus niansae*)	_	_	_	+
62	Lessoer Honey Guide (*Indicator minor*)	_	+	_	_
63	Masked Shrike (*Lanivus nubicus*)	_	_	_	+
64	Pale Flycatcher (*Bradornis pallidus*)	_	+	+	_
65	Pied Wheatear (*Oenples chanka*)	_	_	+	+
66	Moorland Alpine chat (*Cercomela sordida*)	+	+	+	+
67	Malachite Sunbird (*Nectarinia famosa*)	_	+	+	_
68	Nile valley Sunbird (*Hedydipna metallica*)	_	+	_	_
69	Moore Land Francoin (*Francolinus psiloaemus*)	_	+	_	_
70	Olive Thrush (*Turdus olivaceus*)	_	+	_	+

71	Little Rock-Thrush (*Monticola rufocinerus*)	+	+	_	_
72	Pied Crown (*Corvus albus*)	_	_	+	+
73	Olive Pigeon (*Columba arquatrix*)	+	_	_	_
74	Pallid Swift (*Apus niansae*)	_	+	_	+
75	Pectoral-patch Cisticola *(Cisticola brunnescens*)	_	_	+	_
76	Ruddly shelduck (*Tadorna ferruginea*)	_	+	_	_
77	Red-Necked Buzzard (*Buteo augur*)	_	+	_	_
78	Red-eyed Dove (*Streptopelia semitorquata*)	_	+	_	_
79	Ring-necked Dove (*Streptopelia capicola*)	_	_	_	+
80	Red-checked Cordonblue (*Uraeguinthus bengalus*)	+	_	+	_
81	Red-backed Shrike (*Lanius collurio*)	_	_	+	_
82	Red throated Pipit (*Anthus cervinvs*)	_	_	+	_
83	Rupell's Robin-chat (*Cossypha semirufa*)	+	+	_	+
84	Rufous-tailed Scrub-Robin (*Cercotrichas galactotes*)	_	+	_	_
85	Red – headed Weaver (*Anapilctes rubriceps*)	_	_	+	_
86	Red-billed Quelea (*Queleaquelea*)	_	+	_	+
87	Rufous Chatterer (*Turdoides rubiginosa*)	_	+	_	_
88	Stout Cesticola (*Cisticola robustus*)	_	_	+	_
89	Speckled Pigeon (*Collumba guinea*)	_	+	_	+
90	Southern Gray Shrike (*Lanius meridionalis*)	_	_	+	_
91	Spotted Flycatcher (*Muscicapa striata*)	_	+	_	_
92	Scarlet chested Sunbird (*Chalcomitra senegalensis*)	_	_	+	_
93	Shining Sunbird (*Cinnyris habessinicus*)	+	_	_	_
94	Swainson's Sparrow (*Passer swainsonii*)	_	_	_	+
95	Scaly Francolin (*Francolinus squamatus*)	+	_	_	_
96	Song Thrush (*Twidus philomelos*)	_	_	_	+

97	Tawny Eagle (*Aguila rapax)*	_	+	_	_
98	Tiny Cisticola (*Cisticola nana*)	+	+	_	_
99	Tawny-flarked Prinia (*Prinia subflava*)	_	+	_	_
100	Thick-billed Raven (*Corvus crassiorostiris)*	_	+	+	_
101	Tropical Boubou (*Laniarius aethiopicus*)	+	_	_	_
102	Tawny Pipit (*Anthus campastris*)	_	+	+	_
103	Tree Pipit (*Anthus trivialis*)	_	+	_	_
104	Termminck's Stint (*Calidristemminckii*)	+	_	_	_
105	Verreaux's Eagle (*Aquila berreauxii*)	+	_	_	_
106	Wahlerg's Eagle (*Aguila wawbergi*)	+	_	_	_
107	White collared Pigeon (*Columba albitorgues*)	_	_	+	_
108	White-winged Cliff-chat (*Thamnolaea semirufa*)	_	_	+	_
109	White-cheecked Turaco (*Turaco leucotis*)	+	_	_	_
110	White backed Black – Tit (*Melaniporus leucomelas*)	+	_	_	_
111	White – browed Sparrow Weaver (*Plocepasser mahali*)	_	_	_	+
112	White billed Starling (*Onlychognathus albirostris*)	_	_	_	+
113	Wood Warbler (*Phylloscopes sibilatrix*)	+	_	_	_
114	Willow Warbler (*Phylloscopus trochilus*)	_	_	_	+
115	Wattled Ibis (*Bostrychia carunculata*)	+	_	+	+
116	White-rumped Babbler (*Turdoides leucopygia*)	+	_	_	_
117	White breasted White eye (*Zosterops abyssinicus*)	+	_	_	_
118	Yellow Billed Kite (*Milvus aegypticus*)	+	_	_	_
119	Yellow rumped Seed eater (*Serinus xanthopygius*)	_	_	_	+
120	Yellow Wagtail (*Motacclla flava*)	_	_	_	+
121	Yellow Bishop (Eupl*ectes capensis*)	_	_	_	+
122	Red-billed Oxpecker (*Buphagus erythrorhynchus*)	_	_	+	+

123	Yellow-fronted Parot (*Poicephalus flavifrons)*	_	_	+	_
124	White winged Black-Tit (*Melamiparus leucomelas*)	_	_	+	_

Appendix 2.Relative abundance score and rank of birds in the forest habitat during the wet season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
Abyssinian Slaty-Fly catcher	13.33	4	Common
Abyssinian ground-Hornbill	2.66	3	Frequent
Black Kite	7.06	3	Frequent
Hooded Vulture	5.32	3	Frequent
Rupell's Vulture	6.66	3	Frequent
Black-headed Siskin	12.5	4	Common
Brown-rumped Seedeater	14	4	Common
Brown Parisoma	11.4	4	Common
Bown-backed Wood pecker	6	3	Frequent
Black Headed Heron	14	4	Common
Black Cuckoo Shrike	10.3	4	Common
Common Redstar	6	3	Frequent
Black headed Oriole	16.2	4	Common
Beautiful Sunbird	6.6	3	Frequent
Erckel's Francolin	13	4	Common
Malachite Sunbird	3.18	3	Frequent
Moorland Alpine chat	2.6	2	Uncommon
Rupell's Robin-chat	14	3	Frequent
Shining Sunbird	4.72	3	Frequent
Tropical Boubou	7.44	3	Frequent
White backed Black – Tit	14.16	4	Common
White-cheecked Turaco	15.34	4	Common
Wood Warbler	6.4	3	Frequent
Wattled Ibis	4.72	3	Frequent

White-rumped Babbler	11	4	Common
White breasted White eye	8	3	Frequent

Appendix 3.Relative abundance score and rank of birds in the forest habitat during the dry season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
Blue-breasted Bee-eater	7.8	3	Frequent
African Citril	14.6	4	Common
Europian Honey-buzzard	5.8	3	Frequent
African Paradise Flycatcher	23	4	Common
Black-Winged loved bird	15.8	4	Common
Brown-rumped Seedeater	8.33	3	Frequent
Abyssinian Catbird	12	4	Frequent
African Harrier-Hawk	4.72	3	Frequent
Common Bulbul	22.28	4	Common
Common Chiffchaff	9.4	3	Frequent
Common Fiscal	7.8	3	Frequent
Augur Buzzard	2.36	3	Frequent
Dusky Turtle-Dove	44	5	Abundant
Egyptian Gosse	1.44	2	Uncommon
Familiar Chat	5.83	3	Frequent
Lammergeier	5	3	Frequent
Little Rock-Thrush	4.72	3	Frequnt
Red-checked Cordonblue	11.66	4	Common
Rupell's Robin-chat	43	5	Abundant
Scaly Francolin	3.33	3	Frequent
Tiny Cisticola	10.3	4	Common
Yellow Billed Kite	16.2	4	Common
Wattled Ibis	1.77	2	Uncommon
Abyssinian Slaty-Fly catcher	7.8	3	Frequent
Blue-breasted Bee-eater	12.52	4	Common
Black-headed Siskin	14.16	4	Common

Black Headed Heron	6.66	3	Frequent
Erckel's Francolin	2.36	3	Frequent
Termminck's Stint	2.75	3	Frequent
White backed Black – Tit	15.8	4	Common
Wood Warbler	9.46	3	Frequent
Wahlerg's Eagle	3.5	3	Frequent
Verreaux's Eagle	2.36	3	Frequent

Appendix 4. Relative abundance score and rank of birds in the bushland habitat during the wet season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
Abyssinian Slaty-Fly catcher	11.25	4	Common
Black-headed Siskin	12.75	4	Common
Black headed Oriole	6.4	3	Frequent
Black Headed Heron	1.18	2	Uncommon
Black cuckoo Shrike	4.72	3	Frequent
African collared Dove	5.44	3	Frequent
Crested Francolin	7.5	3	Frequent
Common Fiscal	14.16	4	Common
Crowned Hawk-Eagle	5	3	Frequent
Augur Buzzard	2.3	3	Frequent
Dusky Turtle-Dove	16.52	4	Common
Erckel's Francolin	8.85	3	Frequent
Foxy Cisticold	1.77	2	Uncommon
Greater Blue-eared Glossy starling	9.44	3	Frequent
Pale Flycatcher	13.25	4	Common
Moorland Alpine chat	22	4	Common
Olive Thrush	11.6	4	Common
Red-eyed Dove	27	4	Common
Speckled Pigeon	3.75	3	Frequent
Spotted Flycatcher	5	3	Frequent

Appendix 5.Relative abundance score and rank of birds in the bushland habitat during the dry season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
African Citril	4.6	3	Frequent
Common Bulbul	12.2	4	Common
Common Chiffchaff	2.75	3	Frequent
Common Fiscal	12.16	4	Common
African Paradise Flycatcher	11.52	4	Common
African Pipit	8.85	3	Frequent
African Hill Babbler	14.16	4	Common
Broad-ringed White eye	2.83	3	Frequent
African Fire finch	5.44	3	Frequent
Dusky crimson wing	2.2	3	Frequent
Ethiopian Cisticola	14.75	4	Common
Eastern Grey Plantain-eater	16.82	4	Common
Eastern Grey Plantain-eater	4.7	3	Frequent
Familiar Chat	7	3	Frequent
Ground scraper Thrush	2.36	3	Frequent
Klaas' Cukoo	3.54	3	Frequent
Lessoer Honey Guide	8.33	3	Frequent
Moorland Alpine chat	1.66	2	Uncommon
Malachite Sunbird	8.25	3	Frequent
Little Rock-Thrush	16.6	4	Common
Pectoral-patch cisticola	3.75	3	Frequent
Rupell's Robin-chat	6.25	3	Frequent
Rufous-tailed scrub-Robin	5	3	Frequent
Red-billed Quelea	23.4	4	Common
Rufous Chatterer	3.3	3	Frequent
Tawny Eagle	3.75	3	Frequent
Tiny cisticola	18	4	Common
Tawny-flarked prinia	3.75	3	Frequent

Thick-billed Raven	16	4	Common
Tawny Pipit	3	3	Frequent
Tree Pipit	6.25	3	Frequent
Pallid Swift	1.77	2	Uncommon
Fawn-breasted Waxbill	1.18	2	Uncommon
Nile valley Sunbird	1.44	2	Uncommon
Moore Land Francoin	5	3	Frequent
Olive Pigeon	3.75	3	Frequent
Ruddly shelduck	1.32	2	Uncommon
Red-checked Cordonblue	1.88	2	Uncommon

Appendix 6.Relative abundance score and rank of birds in the grassland habitat during the wet season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
Black-headed Siskin	7	3	Frequent
Black Headed Heron	15	4	Common
Augur Buzzard	12.33	4	Common
Ground scraper Thrush	5.9	3	Frequent
Egyptian Gosse	3.31	3	Frequent
Hamerkop	1.18	2	Uncommon
Pale Flycatcher	10.2	4	Common
Pied Crown	1.77	2	Uncommon
Red throated Pipit	1.24	2	Uncommon
Stout Cesticola	4.66	3	Frequent
Scarlet chested Sunbird	11.21	4	Common
Thick-billed Raven	18.5	4	Common
White collared Pigeon	14	4	Common
Wattled Ibis	42	5	Abundant
Red-billed Oxpecker	21	4	Common
Yellow-fronted Parot	11.8	4	Common

Appendix 7.Relative abundance score and rank of birds in the grassland habitat during the dry season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
African Pipit	4.83	3	Frequent
Abyssinian long Claw	6.66	3	Frequent
Augur Buzzard	0.09	1	Rare
Familiar Chat	5.2	3	Frequent
Ground scraper Thrush	3.36	3	Frequent
Grey crowned – Crane	1.18	2	Uncommon
Hadada Ibis	12	4	Common
Isabellin Wheatear	4.72	3	Frequent
Long-billed Pipit	3.12	3	Frequent
Moorland Alpine chat	19	4	Common
Malachite Sunbird	4	3	Frequent
Pectoral-patch Cisticola	1.16	2	Uncommon
Red-checked Cordonblue	11.8	4	Common
Red-backed Shrike	2.95	3	Frequent
Thick-billed Raven	7	3	Frequent
Tawny Pipit	5.6	3	Frequent
White-winged Cliff-chat	2.36	3	Frequent
Wattled Ibis	26	4	Common
Red-billed Oxpecker	14	4	Common
White winged Black-Tit	2.36	3	Frequent
Red – headed Weaver	1.66	2	Uncommon
Southern Gray Shrike	1.12	2	Uncommon
White collared Pigeon	1.18	2	Uncommon

Appendix 8.Relative abundance score and rank of birds in the farmland habitat during the wet season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
Brown Parisoma	11.5	4	Common
Cape Crow	3.3	3	Frequent
Dusky Turtle-Dove	4	3	Frequent
Erlanger's Lark	1.77	2	Uncommon
Egyptian Gosse	2.5	3	Frequent
Fan-tailed Raven	12	4	Common
Hamerkop	19	4	Common
Ground scraper Thrush	1.12	2	Uncommon
Moorland Alpine chat	18	4	Common
Olive Thrush	1.7	2	Uncommon
Pied Crown	3.25	3	Frequent
Speckled Pigeon	4.2	3	Frequent
Wattled Ibis	2.5	3	Frequent
Red-billed Oxpecker	13	4	Common

Appendix 9.Relative abundance score and rank of birds in the farmland habitat during the dry season.

Species	Number of individuals per 100 field hours	Abundance score	Rank
African Citril	5.31	3	Frequent
Brown-rumped Seedeater	7	3	Frequent
Common Fiscal	1.14	2	Uncommon
Cape Crow	12.1	4	Common
Erlanger's Lark	16.36	4	Common
Fan-tailed Raven	13	4	Common
Egyptian Gosse	2.2	3	Frequent
Familiar Chat	5	3	Frequent
Ground scraper Thrush	6.4	3	Frequent
Grey crowned – Crane	2.8	3	Frequent
Isabellin Wheatear	4	3	Frequent
Moorland Alpine chat	11.2	4	Common
Pallid Swift	16.7	4	Common
Ring-necked Dove	5	3	Frequent
Rupell's Robin-chat	4.75	3	Frequent
Red-billed Quelea	8	3	Frequent
Speckled Pigeon	1.77	2	Uncommon
Song Thrush	6	3	Frequent
Wattled Ibis	21	4	Common
Yellow Wagtail	5	3	Frequent
Yellow Bishop	3.33	3	Frequent
White billed Starling	1.77	2	Uncommon
Willow Warbler	1.36	2	Uncommon
Hamerkop	1.68	2	Uncommon
Yellow rumped Seed eater	2.5	3	Frequent
White – browed Sparrow Weaver	1.21	2	Uncommon

Appendix 10. Point Count Field Data sheet for bird survey

Habitat_____

Date_____

Starting time_____

Finishing time_____

Point station number	Bird species(Common Name)	Number of individuals

Appendix 11. Line Transect Count Field Data sheet for bird survey

Habitat_____

Date_____

Starting time_____

Finishing time_____

Transect number	Bird species(Common Name)	Number of individuals

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for seeking a degree in any other university and that all resources of the materials used for the thesis have been dully acknowledged.

Name: Habtamu Edosa

Signature: _____

Date: August, 2016

A thesis has been submitted with my approval as an advisor

Name: Habte Jebessa (PhD)

Signature: _____

Date: August, 2016