

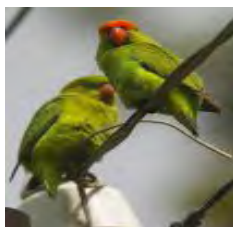


**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF SCIENCE
DEPARTMENT OF BIOLOGY
ECOLOGICAL AND SYSTEMATIC ZOOLOGY STREAM**

**SPECIES COMPOSITION, RELATIVE ABUNDANCE AND
DISTRIBUTION OF AVIAN FAUNA OF
ENTOTO NATURAL PARK AND ESCARPMENT**

BY: KALKIDAN ESAYAS

ADVISOR: PROF. AFEWORK BEKELE



June, 2010

*Addis Ababa
University*



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**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN
BIOLOGY**

BY: KALKIDAN ESAYAS

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ABSTRACT

The present study was carried out to investigate avian species composition, relative abundance and distribution in Entoto Natural Park and escarpment. It was conducted from July 2009 to March 2010 during wet and dry seasons. The study area was stratified based on vegetation. Four habitat types: forest, farmland, church and eucalypts plantation were considered. Point count method was employed for forest habitat and eucalypts plantation, line transect method was employed for farmland and total count method was used for church areas. Data were collected in the morning (6:30-10:00 a.m.) and late afternoon (3:30-6:00 p.m.) T-test and ANOVA were applied for analysis of the effect of season and habitats on abundance of species. A total of 124 avian species belonging to 14 orders and 44 families were identified in the study area during the wet and dry season surveys. During the dry season, highest avian diversity was observed in farmland ($H' = 3.73$) followed by the forest ($H' = 2.92$) whereas during the wet season highest avian diversity was observed in forest ($H' = 3.98$) followed by church areas ($H' = 3.25$). Highest number of species was recorded on farmland and forest during the dry and wet seasons, respectively. Simpson's Similarity Index showed the highest species similarity between forest and farmland during both wet and dry seasons. The mean abundance of species between habitats and seasons showed that between dry and

wet seasons, forest ($t=0.137$, $P>0.05$), farmland ($t=-0.70$, $P>0.05$) and church ($t=0.662$, $P>0.05$) did not show significant difference in the avian abundance. However, season had an effect on the avian abundance in eucalypts plantation ($t=2.952$, $P<0.05$). Eucalypts plantation, soil erosion, deforestation, habitat fragmentation and land degradation were the main threats for avian in the study area. Awareness creation, conservation, rehabilitation and active community participation are essential for maintaining the habitats and avian fauna of the area.

Keywords/Phrases: Avian diversity, Entoto Natural Park and escarpment, Species similarity

1. Introduction

Ethiopia is located in the northeast of Africa between $03^{\circ} 40'$ and 15°N latitude and 33° and 48°E longitude. It has diverse sets of ecosystems, ranging from humid forest and extensive wetlands to deserts like Afar depression, supporting a wide variety of life forms (Hillman, 1993; Ethiopian Wildlife and Natural History Society (EWNHS), 1996; Viveropol, 2001). The high and rugged mountains, deep gorges and vast rolling plains of the country show its topographic diversity (Yalden, 1983). The altitudinal difference with the highest peak at Ras Dashen (4620 m above sea level) and the minimum 116 m below sea level in the Afar depression is the main reason that makes Ethiopia as one of the very few countries that is rich in biodiversity (Hillman, 1993; Shibru Tedla, 1995; EWNHS, 1996).

The climate of Ethiopia varies mainly due to elevation. These wide ranges of altitudes have given the country a variety of ecologically distinct areas with three climatic zones (the tropical zone, the subtropical zone and the temperate zone) that led to the diversification of endemic species as a result of ecological isolation (EWNHS, 1996). Topographical variability and temperature are identified as the most important global predictors of avian species richness (Karr, 1976, 1980; Davies *et al.*, 2007).

There are over 1850 avian species in Africa, of these 926 are found in Ethiopia, of which 16 are endemic (Redman *et al.*, 2009). Including the endemics, 665 species are residents. 30 are migratory breeding in the Palearctic region, 37 are residents and 69 are mainly African (south of the Sahara Desert) or tropical species which also occur in the Palearctic region. There are 199 Palearctic winter visitors, including 21 passage migrants. Of these, 169 are only visitors with no resident forms. There are 47 species which migrate within the African continent, with few Palearctic migrant forms (Urban and Brown, 1971).

Although many of these avian are known, their habitat is not investigated. In terms of its avian fauna, Ethiopia is one of the most significant countries in the mainland of Africa (World Conservation Monitoring Centre (WCMC), 1991; 1995). Since Ethiopia contains a wide variety of habitats including high mountains, grasslands, deserts and lowlands, the distribution of avian in the country is quite complex (Urban, 1980).

Most of the avian species occur in Important Bird Areas (IBAs). IBAs are selected based on categories. Some of the categories are: globally threatened, restricted range and biome assemblages, and congregation. A total of 1228 IBAs are distributed among 58 countries or territories in Africa and its associated islands (Collar and Stuart, 1985). IBAs cover 7% of the land area of the African continent. Out Of 1228 IBAs, 597 are found in Africa (47%) (BirdLife International (BLI), 2001). In Ethiopia, IBAs cover an area of about 47,757 km² (5%) of the country's area. There are 69 IBAs. Out of these, 39 are unprotected and three are globally recognized endemic bird areas (EBAs) (Francis and Shirihai, 1991, 1999). EBAs are effective in identifying areas, which are important for the maintenance of avian diversity and the diversity of other flora and fauna (EWNHS, 1996).

One of the IBAs in the country is Entoto Natural Park and escarpment, which borders Addis Ababa and Oromiya (BLI, 2009). Entoto area and its surrounding

have high elevation with a diverse flora and fauna. The area is covered with eucalypts plantation and cultivation of barley and grazing. Over the years, the diversity is being affected due to various natural and anthropogenic threats (Davison, 2009). This increases the threat for avian species as well as the whole biodiversity in the area from time to time. The present study is therefore; to gather information on ecological study, determine the current species composition, relative abundance and distribution of avian of Entoto Natural Park and escarpment.

2. Literature Review

Avian are remarkably similar in basic body plan and biology. They show considerable variation in relation to the demand imposed by their habitat and ways of life. These variations include overall size, shape, size of the bill, leg, egg, flying ability and longevity (Gill, 1995). Basically they are creatures built for flight and the way that their bodies are constructed and operate reflects unifying features (Raven and Jonson, 1999).

Avian are not only creatures that can fly, but they are unique in being covered with feathers. The ability to fly is an important survival mechanism affording escape from terrestrial enemies (Tinberger, 1954). Some avian like penguins, ostriches, emus, cassowaries and rhea are unable to fly due to their small wings (Frank, 1995). Feathers serve different purposes such as providing efficient streamlining while being windproof, maintaining body temperature, providing stability and assist wings in steering during flight and help in barking during landing (Serkioglu, 2006).

The fossil record of avian is not extensive. The light hollow bones of avian do not survive as fossils. However, unusually well preserved fossil avian have contributed more to understand the evolution of avian (Mayr *et al.*, 2007). The late Jurassic *Archaeopteryx lithographica* is well-known as one of the first transitional fossils to be found and it provided support for the theory of evolution in the late 19th century.

Archaeopteryx has clearly reptilian characteristics like teeth, clawed fingers, a long, lizard-like tail and the size of a long-tailed pigeon. The forerunners of the avian were active, lizard like animals which probably ran rapidly on their large hind legs. Smaller forelegs were held off the ground and long tails used for balance but it has finely preserved wings with flight feathers identical to those of modern avian. *Archaeopteryx* is not considered a direct ancestor of modern avian, but is the oldest and most primitive known member of aves and it is probably closely related to the real ancestor. Most of the avian appeared 35 million years ago. Avian have radiated over the earth displaying wide range of size, form, color, habits and habitats. Understanding of the avian evolution is constantly changing as more fossils are excavated. They were once established as a new group of vertebrates because of the diversity in form and function. One of the greatest difficulties in the classification of avian is that their structure is very homogeneous. They are classified by their external forms. Recently, DNA structure and biochemical methods have been employed to reassess certain relationships (Clarke, 2004).

The class aves contain more species distributed over nearly the entire earth than other class of vertebrates (Harrison and Greensmith, 1993). There are 10,000 avian species numbering 100 billion. More than 50% of the extant species of avian belong to the order Passeriformes (Avibase, 2010). In addition, the process of speciation and evolutionary changes that result in new species continues all the time.

Currently, avian are the most successful and highly diverse of all terrestrial vertebrates because they can consume almost all types of animal and plant materials and their distribution patterns are closely related to the availability of food. Each species has its own ecological preference. It is largely a product of the interaction between existing ecological conditions and the species evolutionary history (Cody, 1968). However, many species share broadly similar distribution patterns. Areas with varied topography and climatic conditions support more species than uniform ones (Wallace, 1955; Pomeroy, 1992). Terrestrial avian diversity increases as one moves from the poles towards the equator. Habitat complexity is greater in the tropics. It

provides opportunity for ecological specialization of species (Roth, 1976). Competition, predation and parasitism are more intense in the tropics permitting more species to co-exist using diverse resources (Frank, 1995).

The distribution of a species is determined by climate, availability of suitable resources, barriers of dispersal and inter-specific interaction with those organisms sharing the same area (Smith, 1992). On the other hand, home range, territories and microhabitats are indicators of the distribution of individuals within an area of convenient habitats (Robert, 1992). These are governed by access to important resources. Furthermore, the range of species fluctuates depending on habitat change, competition, predation and climatic change (MacArthur, 1964). Some species have limited range because of narrow habitat or food requirement. Small geographical range is associated with habitat specialization. Species occupying disturbed or strongly seasonal habitat types may also have large area of distribution. Body size and abundance also affect range size. Large species usually occur at lower densities than small species if their range is very small (Allen, 1961).

Avian can exploit seasonal feeding and nesting opportunities. They respond to annual changes, which influence habitat and food availability by using a different set of habitats at different seasons (Recher, 1969). The migratory movement in response to seasonal climatic changes can result in short or long distances. For avian, rainfall regimes and associated environmental changes are of major importance in determining breeding seasons and annual cycles (Wiens, 1989). Avian have short breeding seasons at high latitudes and long breeding seasons at low latitudes. The seasonality of climatic variables must impose a long-term seasonal pattern on primary production and in turn there is a restricted period of the year during which most avian breed (MacArthur *et al.*, 1962). Avian generally produce young when and where there is ample food (MacArthur and MacArthur, 1961). Avian species that face seasonal irregularity in the availability of food resources shift to feeding on other resources or move to another area where preferred food resource is available. Where

there is no seasonal irregularity in food availability and other factors are held constant, species can maintain itself throughout the year (Karr, 1976).

Avian are excellent indicators of environmental degradation (Furness and Greenwood, 1993; Jarvis, 1993). Avian are taken as good indicators of biodiversity and they are monitors of environmental changes, like the level of contamination and environmental impacts (Chapman and Hall, 1993). Thus, although defined by its avian fauna, the conservation of important avian areas would ensure the survival of a correspondingly large number of other taxa (Stattersfield *et al.*, 1998). Communities of forest dwelling avian have been central in the development of geographical patterns of biodiversity (Power, 1993; Thiolly, 1994).

The role of avian in nature is quite significant owing to their diverse activities and very great number. Avian have been popular with naturalists, amateurs and professionals and are known than any other comparable group of animals with possible exception of the larger mammals.

The significance of avian is great in regulating the number of insects especially insectivorous avian (biological control) and small rodents by feeding upon them. Some nectar-feeding avian are important pollinators and many frugivorous avian play a key role in seed dispersal. Avian droppings contain a large amount of nitrogenous and phosphorous salts and are an excellent fertilizer. Avian occupy many levels of trophic webs, from mid-level consumers to top predators. As with other native organisms, avian help maintain sustainable population levels of their prey and predator species and after death, provide food for scavengers and decomposers. Avian are useful to humans by providing meat and eggs for food, feather for pillow and being domesticated for aesthetic purpose. Besides, avian appeal to people for their attractive, often wonderful colors, spectacular migration, social behavior (courtship display, mate selection, territorial behavior, incubation of eggs and caring the young) and excellent singers and can put one in a good spirit (Clout and Hay, 1989).

Even though avian have a number of significant roles, their life is threatened from time to time due to different factors (Fjeidsa, 1999). Some of the factors are deforestation, commercial logging, subsistent farming, plantation and mining. A decline in the quality of habitat through grazing by livestock and agricultural intensification leads to loss of habitats. In order to sustain the livelihood of avian, these habitats should be managed and protected.

3. Objectives

3.1. General Objective

The general objective of the present study is to conduct ecological survey and describe the current species diversity, relative abundance and distribution of the avian fauna of Entoto Natural Park and escarpment.

3.2. Specific Objectives

- ❖ To identify the species composition of the avian fauna of Entoto Natural Park and escarpment.
- ❖ To determine the effect of season and habitat on the abundance of avian species.
- ❖ To determine the distribution of avian species.
- ❖ To investigate the impact of human activities on the avian fauna and to recommend a management plan for better protection of the area under study.

4. The Study Area

Entoto Natural Park and escarpment is located between latitudes of $9^{\circ} 04'N$ to $9^{\circ} 06'N$ and longitudes of $38^{\circ} 44'E$ to $38^{\circ} 49'E$. It is located between 7.5 and 10 km north of Addis Ababa (Sululta Woreda Agriculture and Rural Development Office, (SWARDO), 2007). Entoto Natural Park covers an area of 1300 hectares on the southeast facing slopes of Mt. Entoto, between the northern limit of the city of Addis Ababa and the track along the mountain ridge. The ridge of which Entoto is a part, divides two large watersheds, that of the Abay (Blue Nile) to the north and Awash to the south. Entoto Park is intersected by rivers and streams flowing southwards through valleys and ravines, providing a variety of rock formations, vegetation and wildlife (EWNHS, 1996).

At the northern end of the area there is open moorland with many patches of bright green fresh grassland and numerous springs. On the eastern side, further down the mountain, two valleys form wide gorges known as “Neb-Gedel” (bee cliff) and “Jib Gedel” is observed with springs. One of them constitutes the well known “Maryam Tebel” (St.Marry’s spring) and rock formation. In the southwestern corner, there is a cliff with a waterfall and a cave named “Ye Abba Washa” or the hermit’s cave. The

small streams flow into two tributaries of “Kebena” River. Leading to Entoto “Maryam” church through the center of the area, there is a dry weather road. There could be four possible access points to the Park: from the vicinity of “Kuskuam” Church, where the number 17 city bus stops and the old Entoto “Maryam” from “Kidane Meheret” Church, or from “Fitawrari Sefer”, both points accessible by taxi via Shiromeda (Fig. 1).

There are very good views observed from a number of vantage points both within and near the Park. On the north side, the view over the “Sululta” plain covers an extensive area of undulating shallow valleys and marshy meadows with suitable pasture land. To the south, one observes Addis Ababa towards the East African Rift valley where five mountains: Menagesha, Wechacha, Furi, Ziquala and Yerer are observed (EWNHS, 1996).

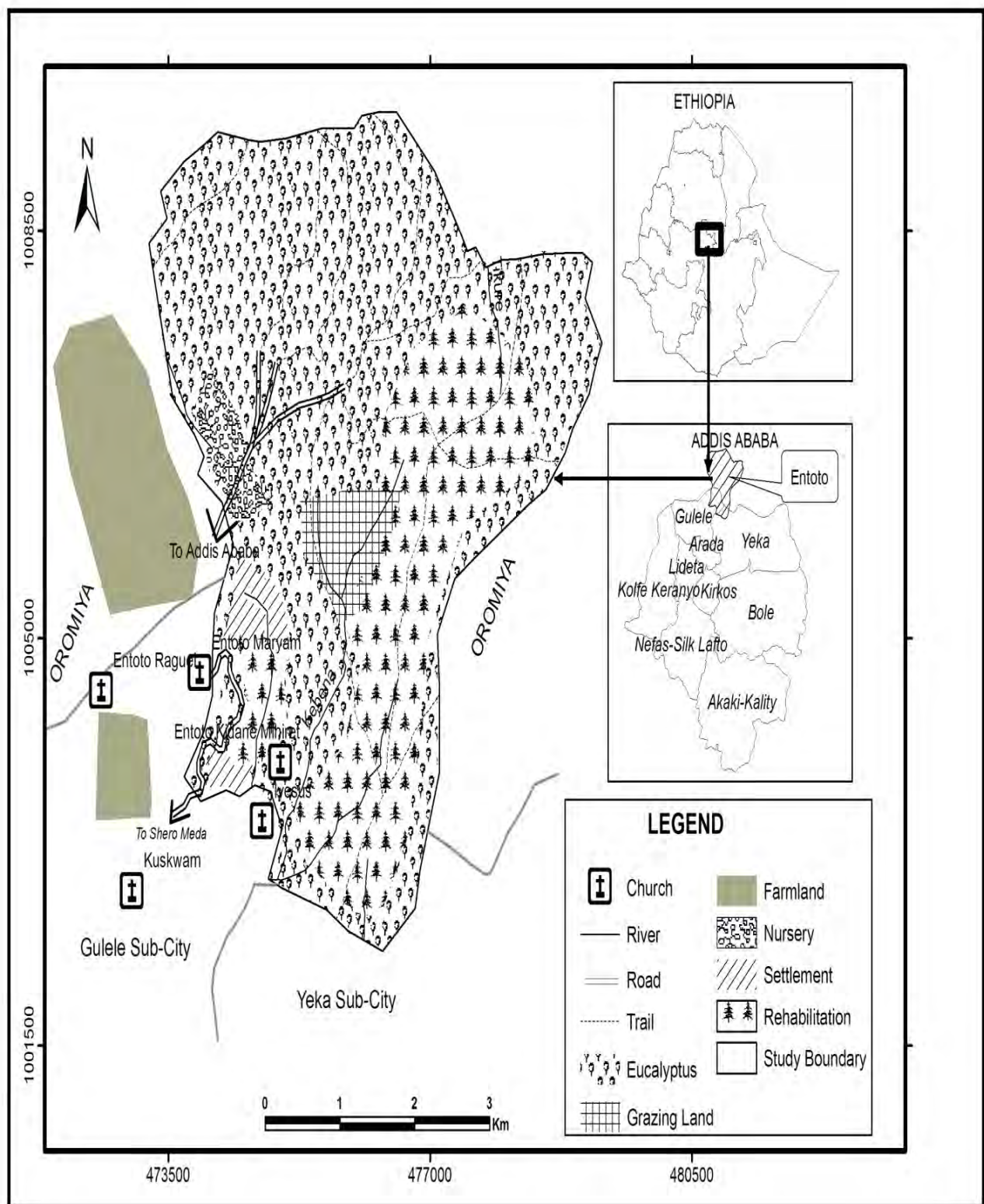


Figure1. Location map of the study area with different habitats (Source: Ethiopian Mapping Agency (1982), Toposheet 0938D4 and GPS Reading).

The topographic feature of the study area is made up of rolling terrain (a rugged topography) with the average elevations of 2800 m asl which ranges from 2500 m asl to 3100 m asl (SWARDO, 2007). The foothill of Entoto Mountain has a similar geologic makeup with that of the top of mountain and consists of volcanic rocks, reddish rhyolite, trachytes, ignimbrites, tuffs, welded tuffs and black glassy obsidian (Plate 1). The common soil type in the study area includes luvisols, lepthosols, nithosols, vertisols and cambisols (SWARDO, 2007).



Plate 1. Topography of the study area (March, 2010; Photo: Kalkidan Esayas)

The average maximum monthly temperature at the top of Entoto is recorded in February (20.3°C) and March (20.5°C) and the average minimum monthly temperature is in November (7.4°C) and December (7.5°C) (National Meteorological Service Agency, 2010) (Fig. 2).

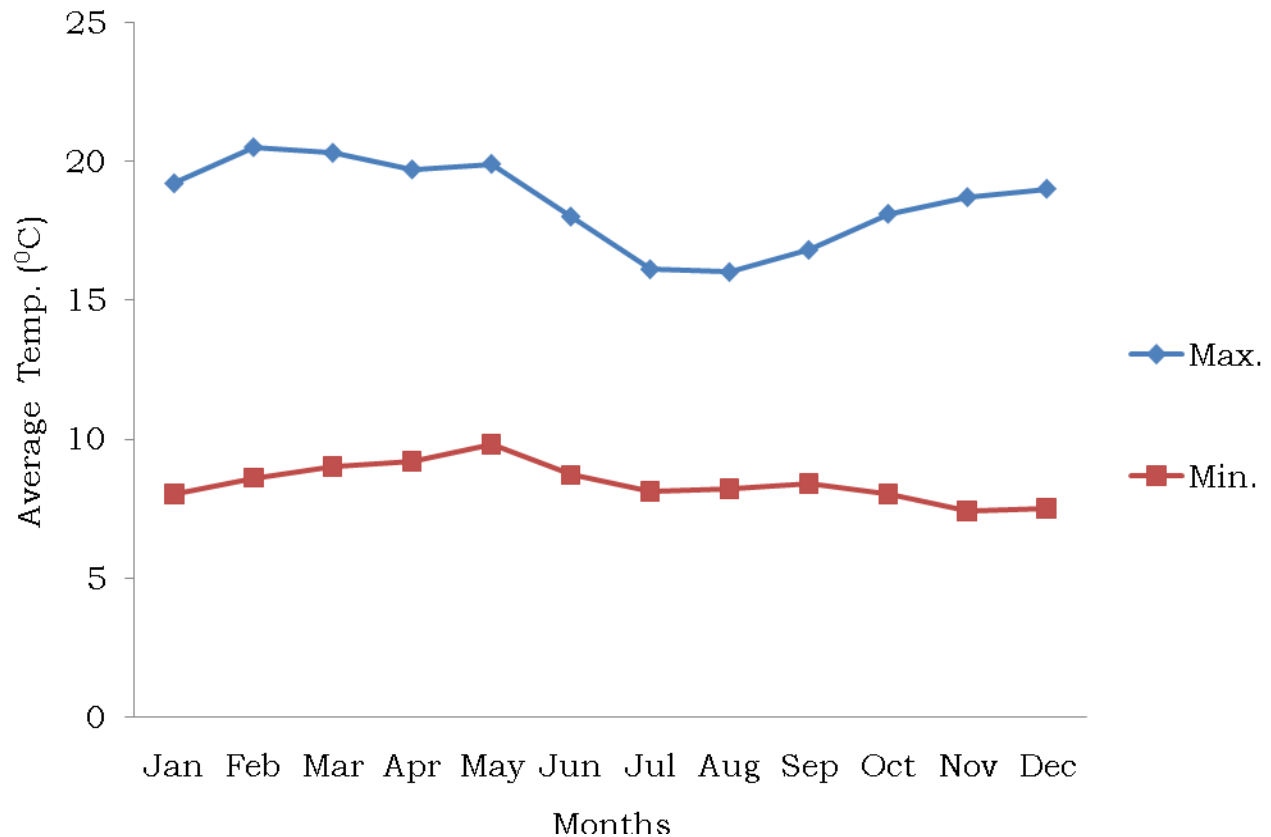


Figure 2. Monthly average maximum and minimum temperature (°C) of Entoto area during 1999-2009 (Source: National Meteorological Service Agency, 2010).

There are two rainy seasons in a year, the small rain from February/March to April/May and the big rain from July to September. The highest intensity occurs in July (305 mm) and August (326 mm) and the lowest in November (11 mm) and December (7 mm) (National Meteorological Service Agency, 2010) (Fig. 3). The wind is often strong and persistent. This makes the climate quite tough, especially during the rain and in the higher parts of the Park.

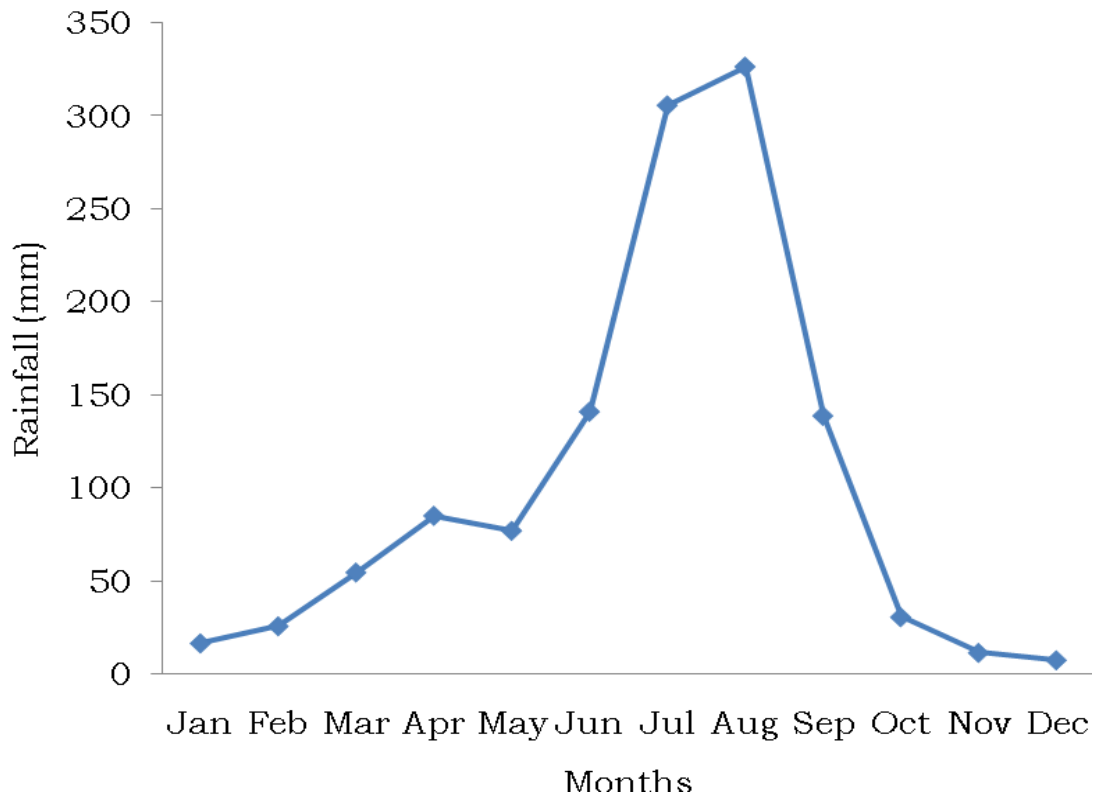


Figure 3. Average monthly rainfall of Entoto area (mm) (1999-2009) (Source: National Meteorological Service Agency, 2010).

The natural vegetation is Afro-montane forest and, where drainage is impeded, woodland with open meadows. The forest would have been dominated by *Juniperous excelsa* with groves of *Olea europaea Subsp.cuspidata*, scattered *Hagenia abyssinica*, *Hyericum revolutum*, *Podocarpus falcatus*, *Ficus species*, *Acacia abyssinica*, *Rosa abyssinica* and *Erythrina brucei* had there not been anthropogenic effect. However, at present, most of the area is covered with *Eucalyptus globulus* trees which are widely used for fuel consumption (Davison, 2009). The eucalypts plantations are dense, especially on the northern and western side. Under the eucalypts, the soil is shallow, with poor ground vegetation and there are widespread scars from soil erosion. Farmers cultivate barley and raise cattle

and sheep. Despite the close proximity to the city, the system of farming has hardly been affected by modern inputs (EWNHS, 1996).

In the study area spotted hyenas, dik diks, grey duikers, Common Jackals, leopard, small antelopes, baboons, white tailed mongoose, vervet monkeys, mole rat, porcupines, civets, wild cats, anteaters, squirrels and different species of rodents are the major wild mammals (EWNHS, 1996).

The population of the study area consists of 8789 individuals, of which 4361 are males and 4428 are females. Economically active groups (15-64) were 44% of the total population. Children below 15 years were 48%, while the elderly (65 years and above) were only 8 % (SWARDO, 2007).

5. Materials and Methods

5.1. Materials

In this study area, binoculars (7X50; Model No.781), digital camera, Global Positioning System (GPS 72), walkman size tape recorder, field data sheet (Appendix 10 and 11), thermometer, notebooks, pen, pencils, plastic tag, tape measure, topographic map (Toposheet 0938D4) and field guides (Williams and Peterson, 1963; Richards, 2000; Stevenon and Fanashawe, 2002) were used.

5.2. Methods

5.2.1. Preliminary Survey

Ecological survey of avian in and around the Entoto Natural Park and escarpment was carried out during July 2009 to gather relevant information about the area. In this survey, an overall view of the avian fauna of the area was conducted. Topographical features and vegetation cover of the area were assessed. Additional information was collected from concerned governmental, non-governmental authorities and local people living around the study area.

5.2.2. Sampling Design

Random sample sites were based on the types of habitats in the study area. A number of sampling units representing each habitat type was selected based on stratified random sampling method. The technique involves dividing the study area into blocks by choosing the location of each habitat with random numbers (Sutherland, 1996). Sample blocks were selected at random to make sure that the results were generally representatives of the whole study area. At least 20 to 25% of the study area was covered in each sample site (Bibby *et al.*, 1992). Based on the vegetation structure, the study area is grouped into four habitats. These are forest habitat (rehabilitated and nursery area), farmland, eucalypts plantation and church areas (Entoto St. Marry and Entoto St. Raguel Church) (Plate 2-5).

Forest: forest occurs in some parts of the Park and the nursery area. It is dominated by *Juniperous excelsa*, *Olea europaea subsp.cuspidata*, *Hagenia abyssinica*. There are also other trees and climbers present in the forest and nursery area (Appendix 1). The forest area is surrounded by eucalypts plantation.



Wet season (July, 2009)



Dry season (December, 2009)

Plate 2. Forest Habitat during wet and dry seasons (Photo: Kalkidan Esayas)

Farmland: In the farmland, barley and wheat are the principal crops grown in the area. It is also conducive to livestock production which depends on grazing land.



Wet season (July, 2009)



Dry season (December, 2009)

Plate 3. Farmland during wet and dry seasons (Photo: Kalkidan Esayas)

Church Areas: The church areas include Entoto St. Marry and Entoto St. Raguel Church. They are found adjacent to the Park. The dominant vegetation in the area includes *Juniperus excelsa*, *Acacia abyssinica*, *Olea europaea* Subsp. *cuspidata*, *Podocarpus falcatus* and *Erythrina brucei* (Appendix 1).



Wet season (July, 2009)



Dry season (December, 2009)

Plate 4. Church areas during wet and dry seasons (Photo: Kalkidan Esayas)

Eucalypts Plantation: In this area *Eucalyptus globulus* is the most dominant tree. The fast-growing eucalypts trees suppress the growth of nearly all the indigenous woody and herbaceous plants and severely reduce the biodiversity of any area when they are planted in dense stands.



Wet season (July, 2009)



Dry season (December, 2009)

Plate 5. Eucalypts plantation during both seasons (Photo: Kalkidan Esayas)

Point count method was employed for forest habitat and eucalypts plantation, line transect method was employed for farmland and total count method was used for church areas. Stratified random sampling method was employed for point count and line transect methods.

Point count method was undertaken from a fixed location within the sample unit of radius 15 to 20 m with a fixed time interval consisting of 5 to 10 minutes. Point count can be imagined as transect zero length conducted at zero speed. To minimize disturbance during count, a waiting period of 3 to 5 minutes prior to counting was applied. Where point count technique is employed, the radial distance from which the avian occurred was estimated and the type and group number of species were recorded using binoculars. Large number of point count locations (more than 20) was identified from each study plot. There are 9 grids in both forest and eucalypts plantation. In each block, a total of 35 point count stations were identified. In each point count station, a minimum distance of 150-200 m was employed using GPS to avoid double counting (Sutherland, 1996).

In the farmland, a total of six grids each with 1km² area were sampled. In each grid, a total of 4 transect lines with a length of 1km were located. Avian heard and seen were recorded within 25 m on either side of the transect line making a total width of 50 m. Transect lines within a grid were 250-300 m apart from each other to avoid double counting (Bibby *et al.*, 1992, 1998; Hostler and Martin, 2006).

In church areas, two churches were taken for the study. These are Entoto St. Marry church and Entoto Raguel church. Each is approximately 1km apart from the other. As the areas were manageable, total count method was employed (Lack, 1966).

5.3. Data collection

Based on the information collected and the sites selected during the preliminary survey, field work was carried out in July and August 2009 to collect data for the first session of the wet season. In October 2010, data were collected for the second session of the wet season. First session of the dry season data collection was carried out from December 2009 to January 2010 and from February and March, 2010 for the second session of the dry season.

A common study design, therefore, is to begin data collection about 30 minutes after dawn and continue to mid-morning until the avian activity declines (Bibby *et al.*, 1998). Data were taken on weekly basis for five days per week depending on weather conditions and time of the day when most of the avian species are active. Data were collected early in the morning from 6:30 a.m to 10:00 a.m and late in the afternoon from 3:30 p.m. to 6:00 p.m. (Spencer, 1963; Centerbury *et al.*, 2000).

For identification of species present in the study area, plumage pattern, size, shape, color, songs and calls were important parameters (Afework Bekele and Shimelis Aynalem, 2009). Binoculars as well as naked eye were used for observation. Field data sheet was used to record the identified species. In addition, photographs were taken to confirm the identification of avian. Avian calls were recorded whenever possible using tape recorder (Peterson, 1949; 1963). The location of the observed avian was recorded with the help of GPS in the study area. Avian species were identified and their taxonomic groups were properly categorized based on field guides (Williams and Peterson, 1963; Urban and Brown, 1971; Van Perlo, 1995; Williams and Arlott, 1996; Stevenson and Fanashawe, 2002; Sinclair and Ryan, 2003; Redman *et al.*, 2009).

5.4. Data Analysis

Data collected during the wet and dry seasons were organized and the diversity and relative abundance were compared between different communities of avian in the study site by using the similarity indices measures. The community structure of avian of each habitat was described in terms of Shannon-Wiener diversity Index (H') (Shannon and Wiener, 1949). Shannon-Wiener diversity Index is evaluated as:

$$H' = -\sum (p_i \ln p_i) \text{ where,}$$

H' = Shannon-Wiener Index

P_i = Proportion of the ith species

ln = Natural logarithm

Simpson's index of diversity (D') was used to evaluate the relative abundance of avian in each habitat for both wet and dry seasons by using the formula:

$$D' = 1 / \sum p_i^2 \text{ where,}$$

D' = Simpson's Index

P_i = Proportion of individual species (Simpson, 1949).

To see the evenness (the pattern of distribution) of avian in the study area, Shannon-Wiener evenness Index (E) was calculated using the equation:

$$E = H' / H_{\max} \text{ Where,}$$

E = Shannon-Wiener Evenness Index

H' = Shannon-Wiener diversity Index

H_{max} = ln S = natural logarithm of the total number of species (S) in each site (Southwood and Henderson, 2000).

The richness index (RI) of each species was determined using the formula:

$$RI = \frac{S-1}{\ln S} \text{ where,}$$

S = Number of species in each habitat

ln = Natural logarithm

I= Number of individuals or species in each habitat

In reference to the composition of species, Simpson's similarity index (SI) was used to assess the similarity of species between two different sites by using the formula:

SI = $\frac{2C}{A+B}$ where,

SI = Simpson's similarity index

A = Number of species that occur in site A

B = Number of species that occur in site B

C = Number of common species that occur in site A and B

Excel computer program was also employed to draw graphs. Data obtained during the survey were analyzed using SPSS (2006) statistical package to employ one way analysis of variance (ANOVA) to see the effect of habitat composition on abundance of avian in a given season and chi-square test was employed in order to evaluate the habitat preference of avian in each study site.

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).

Encounter rate = $\frac{\text{Total number of individual Avian observed}}{\text{Period of observation in hour}} \times 100$

Encounter rate was calculated for each species by dividing the number of hours spent searching, in order to get a figure of Avian per hour for each species. The abundance category (the number of individuals per 100 field hr) was :< 0.1, 0.1-2.0, 2.1-10.0, 10.1-40.0 and 40+, the following abundance score was given as 1 (Rare), 2 (Uncommon), 3 (Frequent), 4 (Common) and 5 (Abundant), respectively.

6. Results

6.1. Species Composition

A total of 124 avian species belonging to 14 orders and 44 families were identified in the study area during the wet and dry seasons. Of the recorded species in Entoto Natural Park and escarpment, 5 were endemic to Ethiopia and 11 were shared between Ethiopia and Eritrea. The highest number of species was recorded for the family Turdidae (11) and Accipitridae (8) followed by Nectariidae (6) and the rest of the families ranged between 1 and 5. Among the recorded avian species, the order Passeriformes is the most dominant and largest order with the highest number of families (18) and species (62). Among the recorded species, 4 species were Intra-African migrants, 13 species were palearctic migrants and 81 were residents. Among 124 avian species, 11 and 33 were recorded exclusively during the dry and wet seasons, respectively (Table 1).

Table 1. Avian species observed in Entoto Natural Park and escarpment (♠ Endemic, ☼ Endemic to Ethiopia and Eritrea, ♥ Palearctic Migrant, ♦ Intra-African Migrant, **D** Dry season, **W** Wet season, unmarked species are resident avian).

Family	Common Name	Scientific Name
Accipitridae	Augur Buzzard	<i>Buteo augur</i>
	Lizard Buzzard	<i>Kaupifalco monogrammicus</i>
	African Harrier Hawk	<i>Polyboroides typus</i>
	Crowned eagle ^D	<i>Strephanoaetus coronatus</i>
	African fish eagle ^D	<i>Haliacetus vocifer</i>
	Black Kite [♦]	<i>Milvus migrans</i>
	White-headed Vulture ^D	<i>Necrosyrets monachus</i>
	Red-Thighed Sparrow hawk	<i>Accipiter erythropus</i>

Cont'd...

Alaudidae	Rufous-naped Lark	<i>Mirafraga africana</i>
	Thekla Lark	<i>Galerida thekla</i>
	Crested Lark	<i>Galerida cristata</i>
	Obbia Lark	<i>Spizocorys obbiensis</i>
Anatidae	Blue-winged goose ☼	<i>Cyanochen cyanoptera</i>
	Egyptian goose	<i>Alopochen aegyptica</i>
Apodidae	African palm Swift	<i>Cypsiurus parvus</i>
	Nyaza Swift	<i>Apus niansae</i>
	Alpine Swift	<i>Apus melba</i>
	Common Swift ♥	<i>Apus apus</i>
	White-rumped Swift	<i>Apus caffer</i>
Capitonidae	Banded barbet ♣ ^W	<i>Lybius undatus</i>
	Black-billed Barbet ^W	<i>Lybius guifsohalito</i>
Caprimulgidae	Mountain Nightjar	<i>Caprimulgus poliocephalus</i>
Charadriidae	White Fronted Sand Plover	<i>Charadrius marginatus</i>
	Spot-breasted plover	<i>Vanellus melanoccephalus</i>
Ciconiidae	Yellow-billed stork ^D	<i>Mycteria ibis</i>
Cisticolidae	Singing Cisticola ^D	<i>Turdus olivaceus</i>
	Stout Cisticola	<i>Cisticola galactotes</i>
Coliidae	Speckled Mouse bird	<i>Colius striatus</i>
Columbidae	Dusky Turtle Dove	<i>Streptopelia turtus</i>
	Red- eyed Dove	<i>Streptopelia lugens</i>
	Speckled Pigeon	<i>Columba guinea</i>
	White-collared Pigeon ♣	<i>Columba albitorques</i>
Corvidae	Thick Billed Raven ♣	<i>Corvus crassirostris</i>
	Pied Crow	<i>Corvus capensis</i>
	Fan-tailed Raven	<i>Corvus rhipidurus</i>

Cont'd...

Cuculidae	Jacobin Cuckoo ♦ ^W	<i>Camator jacobinus</i>
Estridide	Red Winged Pytilia	<i>Pytilia phoenicoptera</i>
	Yellow-bellied Waxbill	<i>Estrilda paludicola</i>
	Red-rumped Waxbill	<i>Estrilda chamosyna</i>
	Red-billed firefinch	<i>Lagonossticta senegala</i>
Fringillidae	Yellow Fronted Canary	<i>Serinus mozambicus</i>
	Brown-rumped Seed eater ^W	<i>Serinus tristraitus</i>
	Streaky Seedeater	<i>Serinus striolatus</i>
	Black-headed Siskin ♦	<i>Serinus nigriceps</i>
Hirundindae	African Citril	<i>Serinus citrinelloides</i>
	Wire-tailed swallow	<i>Hirundo smithi</i>
	Rock martin ^W	<i>Hirundo fuligula</i>
	Blue swallow ^W	<i>Hirundo atrocaerulea</i>
	Common house martin♥ ^W	<i>Delichon urbicum</i>
Indicatoridae	Ethiopian Swallow ^W	<i>Hirudino aethiopica</i>
	Greater Honey Guide	<i>Indicator indicator</i>
	Lesser Honey Guide	<i>Indicator minor</i>
	Wahlberg's honey bird	<i>Prodotiscus regulus</i>
Laniidae	Common Fiscal	<i>Lanius collaris</i>
Laridae	Slender-billed Gull ♥	<i>Larus genei</i>
Meropidae	Blue-breasted Bee-eater	<i>Merops variegates</i>
	Little Bee- eater	<i>Merops pusillus</i>
Monarchidae	African paradise flycatcher	<i>Terpsiphone viridis</i>
Motacillidae	Abyssinian Long Claw ♦	<i>Macronyx flavicollis</i>
	Yellow wagtail ♥	<i>Motacilla flava</i>
Muscicapidae	Abyssinian Flycatcher ☼	<i>Melaenoris chocaltina</i>
	Semi-collared flycatcher♥ ^D	<i>Ficedula semitorquata</i>

Cont'd...

Musophagidae	Princeruspoli's Turaco	<i>Turaco ruspolii</i>
	White-cheeked Turaco	<i>Turaco leucotis</i>
Nectariniidae	Olive Sun bird	<i>Nectarinia olivacea</i>
	Tacazze Sun bird	<i>Nectarina tacazze</i>
	Variable Sun bird	<i>Cinnyris vanuatu</i>
	Bronze Sun bird	<i>Nectarinia kilimensis</i>
	Collared Sun bird	<i>Anthreptes collaris</i>
	Scarlet-chested Sun bird	<i>Chalcomaitra senegalensis</i>
Oriolidae	African Black headed oriole	<i>Oriolus larvatus</i>
	African golden oriole♦	<i>Oriolus auratus</i>
	Ethiopian oriole✧	<i>Oriolus monacha</i>
	Black headed forest oriole	<i>Oriolus monacha</i>
Pandionidae	Osprey ♥ W	<i>Pandion haliaetus</i>
Paridae	White-backed black tit✧D	<i>Parus leuconotus</i>
	Dusky tit D	<i>Parus funeruse</i>
Passeridae	Chestnut Sparrow W	<i>Passer eminibey</i>
	Swainson's Sparrow W	<i>Passer swainsonii</i>
Phasianidae	Moorland FrancolinW	<i>Francolinus psilolaemus</i>
	Erckel's Francolin✧	<i>Francolinus erckelii</i>
	Common Quail ♥	<i>Coturnix coturnix</i>
Phoeniculidae	Abyssinian Scimitarbil	<i>Rhinopomastus minor</i>
	Violet-wood-hoopoe	<i>Phoeniculus damarensis</i>
Picidae	Abyssinian woodpecker♠ W	<i>Dendropicus abyssinicus</i>
Ploceidae	Spectacled weaver	<i>Ploceus ocularis</i>
	Rupell's weaver	<i>Ploceus galbula</i>
	Baglafech Weaver	<i>Ploceus baglafecht</i>
	Yellow-mantled widow birdW	<i>Euplectes macrourus</i>

Cont'd...

	Fan-tailed widow bird ^W	<i>Euplectes axillaris</i>
Psittacidae	Rose ringed parakeet	<i>Psittacula krameri</i>
	Red headed love bird ♣	<i>Agapornis pullarius</i>
	Yellow-fronted parrot ♠ ^D	<i>Poicephalus flavifrons</i>
	Black winged love bird	<i>Agapornis taranta</i>
Pycnonotidae	Northern Brownbul ^D	<i>Phyllastrephus strepitans</i>
	Common Bulbul ^W	<i>Mptacilla clara</i>
	Slender billed Greenbul ♥	<i>Andropadus gracilirostris</i>
Ramizidae	Mouse colored penduline tit	<i>Anthscopus musculus</i>
Sternidae	Black tern♥ ^W	<i>Chlidonias niger</i>
Sturnidae	Sharpe's Starling ^W	<i>Cinnyricinclus femoralis</i>
	Common Starling ^W	<i>Sturnus vulgaris</i>
	Chestnut winged Starling ^W	<i>Onychognathus swalleri</i>
Sylviidae	Willow warbler ♥ ^W	<i>Phylloscopus trochilus</i>
	Brown warbler ^W	<i>Sylvia borin</i>
	Brown woodland warbler ^W	<i>Phylloscopus umbrovirens</i>
	Wood warbler♥ ^W	<i>Phylloscopus sibilatrix</i>
Threskiornithidae	Wattled Ibis ♣	<i>Bostrychia carunculata</i>
	Hadada Ibis	<i>Bostrychia hadegash</i>
	Sacred Ibis ♦ ^W	<i>Threskiornis aethiopicus</i>
Timaliidae	Abyssinian cat bird♠	<i>Parophasma galinieri</i>
	African hill barbler	<i>Pseudoalcippe abyssinica</i>
Trogonidae	Narina Trogon ^W	<i>Apaloderma naria</i>
Turdidae	Olive Thrush	<i>Turdus philomelos</i>
	Abyssinian Ground Thrush	<i>Zoothera piaggiae</i>
	Mountain Thrush ^W	<i>Turdus abyssinicus</i>
	Blue-rock Thrush♥ ^W	<i>Monticola solitarius</i>

Cont'd...

	Spoted palm Thrush ^W	<i>Cichladusa guttata</i>
	Groundscraper Thrush	<i>Psophocichla litsipsirupa</i>
	Rupell's Robin Chat	<i>Cossypha semirufa</i>
	White crowned Robin Chat ^W	<i>Cossypha albicapilla</i>
	Moorland chat ^W	<i>Cercomela sordida</i>
	White-winged cliff-chat ^W	<i>Myrmecocichl semirufa</i>
	Pied Wheater ^W	<i>Cossypha semirufa</i>
Zosteropidae	Montane White Eye ^D	<i>Zosterops poliogaster</i>

6.2. Species Diversity

During the dry season, highest avian diversity was observed in farmland ($H'=3.73$) followed by the forest ($H'=2.92$) and church areas ($H'=2.86$) (Table 2). The least diversity of avian species was observed in the eucalypts plantation ($H'=2.74$). The highest and the lowest even distribution was observed in farmland and eucalypts ($E=0.97$) and forest ($E=0.80$), respectively.

Table 2. Species diversity among habitats during the dry season.

Habitat	Species Richness	Abundance	H'	$H'_{\max}$	E	D'
Forest	39	2623	2.92	3.664	0.80	0.92
Farmland	46	2305	3.73	3.829	0.97	0.96
Church	25	2147	2.86	3.219	0.89	0.93
Eucalypts	17	233	2.74	2.833	0.97	0.93

During the wet season, highest avian diversity was observed in forest ($H'=3.98$) followed by church areas ($H'=3.25$) (Table 3). The least diversity of avian species was observed in farmland ($H'=2.82$). The highest and the lowest even distribution was observed in forest ($E=0.99$) and farmland ($E=0.75$), respectively.

Table 3. Species diversity among habitats during the wet season.

Habitat	Species Richness	Abundance	H'	$H'_{\max}$	E	D'
Forest	56	2723	3.98	4.03	0.99	0.97
Farmland	42	2718	2.82	3.74	0.75	0.95
Church	34	1782	3.25	3.53	0.92	0.95
Eucalypts	27	406	3.2	3.30	0.97	0.96

During both seasons, highest avian diversity was observed in forest ($H'=3.96$) followed by church areas ($H'=3.91$) (Table 4). The least diversity of avian species was observed in the eucalypts plantation ($H'=3.59$). The highest and the lowest even distribution was observed in eucalypts ($E=1.0$) and farmland ($E=0.96$), respectively.

Table 4. Species diversity among habitats during wet and dry seasons.

Habitat	Species Richness	Abundance	H'	$H'_{\max}$	E	D'
Forest	56	3913	3.96	4.03	0.98	0.97
Farmland	46	3719	3.68	3.83	0.96	0.96
Church	53	3292	3.91	3.97	0.98	0.97
Eucalypts	35	1141	3.59	3.56	1	0.97

6.3. Species Richness

Variation in the number of avian species was observed among the four habitats. During the dry season, farmland was the richest (46) and eucalypts plantation (17) had the lowest number of avian species. During the wet season, the number of avian species ranged from 56 to 27 recorded in forest habitat and eucalypts plantation (modified habitat), respectively. During both seasons, the number of avian species ranged from 56 to 35 in the forest habitat and eucalypts plantation, respectively (Table 4). The correlation factor for the dry season was less than the wet season. In both seasons, the mean number of species and the total number of species were weakly positively correlated ($R^2 = 0.032$ and $R^2 = 0.015$ for wet and dry seasons, respectively (Table 5).

Table 5. Species richness: Mean $\pm$ SE

		Habitats			
	Season	Forest	Farmland	Church	Eucalypts
Total species	Wet	56	42	34	27
Mean $\pm$ SE	Wet	49 $\pm$ 5.48	65 $\pm$ 11.27	52 $\pm$ 7.74	16 $\pm$ 1.5
Correlation factor ($R^2 = 0.032$)					
Total species	Dry	39	46	25	17
Mean $\pm$ SE	Dry	67 $\pm$ 16.22	50 $\pm$ 6.61	85 $\pm$ 15.78	14 $\pm$ 1.62
Correlation factor ($R^2 = 0.015$)					

Richness Index (RI)

During the dry season Mouse colored pendulin tit, Blue breasted bee-eater and Rose ringed parakeet were dominant in the four habitats (Table 6).

Table 6. Richness Index (RI) of the highest (H) and lowest (L) number of individuals in each habitat during the dry season.

Habitat	Species	Richness Index (RI)
Forest	Mouse colored penduline tit ^H	6.2
	Yellow-bellied Waxbill ^L	27.4
	(Mountain Thrush)	
Farmland	Blue-breasted Bee-eater ^H	8.5
	Obbia Lark ^L	18.8
Church	Mouse colored penduline tit ^H	4.2
	Red Winged Pytilia ^L	8.5
Eucalypts	Rose ringed parakeet ^H	4.8
	Erckel's Francolin ^L	11.5

If there are two or more species with the lowest number of individuals, it is indicated in a bracket.

During the wet season, Mountain thrush is dominant in both forest and eucalypts plantations whereas Bronze sun bird and White collared pigeon are dominant in farmland and church, respectively (Table 7).

Table 7. Richness Index (RI) of the highest (H) and lowest (L) number of individuals in each habitat during the wet season.

Habitat	Species	Richness Index (RI)
Forest	Mountain Thrush ^H	10.4
	Ethiopian Swallow ^L	20.8
Farmland	Bronze Sun bird ^H	7.02
	Red-rumped Waxbill ^L	17.1
	(Slender-billed Gull)	
Church	White-collared Pigeon ^H	6.2
	Black Kite ^L	12.5
	(Moorland Francolin)	
Eucalypts	Mountain Thrush ^H	7.5
	Red Winged Pytilia ^L	16.2

If there are two or more species with the lowest number of individuals, it is indicated in a bracket.

6.4. Species Similarity

6.4.1. Species Similarity Based on Habitat

In the farmland, 0.91 (91%) of avian species were common both during the wet and dry seasons with highest seasonal similarity. The least similarity was obtained in church areas, where 0.17 (17%) was recorded as common during both seasons (Table 8).

Table 8. Seasonal species similarity (SI) within habitats

Habitat	Wet	Dry	Common Species	SI	SI%
Forest	56	39	37	0.78	78
Farmland	42	46	40	0.91	91
Church	34	25	5	0.17	17
Eucalypts	27	17	9	0.41	41

6.4.2. Species Similarity Based on Season

During the dry season, avian species similarity was high between forest and farmland (SI=0.33), followed by farmland and church (SI=0.28). In contrast, the lowest avian species similarity was between church and eucalypts plantation (SI=0.05) (Table 9).

Table 9. Avian species similarity (proportion) of common species among habitats during the dry season.

Habitat	Forest	Farmland	Church	Eucalypts
Forest	-	14 (0.33)	16 (0.5)	6 (0.21)
Farmland		-	10 (0.28)	3 (0.10)
Church			-	1 (0.05)
Eucalypts				-

During the wet season, avian species similarity was high between forest and farmland (SI=0.43), followed by forest and eucalypts (SI=0.39). In contrast, the lowest avian species similarity was between church and farmland (SI=0.08) (Table 10).

Table 10. Avian species similarity (proportion) of common species among habitats during the wet season.

Habitat	Forest	Farmland	Church	Eucalypts
Forest	-	21 (0.43)	7 (0.16)	16 (0.39)
Farmland		-	3 (0.08)	6 (0.17)
Church			-	4 (0.13)
Eucalypts				-

During both seasons, high similarity was obtained between forest and farmland (SI=0.49) followed by forest and eucalypts (SI=0.42). In contrast, the lowest avian species similarity was obtained between farmland and eucalypts (SI=0.20) (Table 11) (Fig. 4).

Table 11. Species similarity (proportion) of common avian species among habitats during both seasons

Habitat	Forest	Farmland	Church	Eucalypts
Forest	-	25 (0.49)	20 (0.37)	19 (0.42)
Farmland		-	14 (0.28)	8 (0.20)
Church			-	13 (0.30)
Eucalypts				-

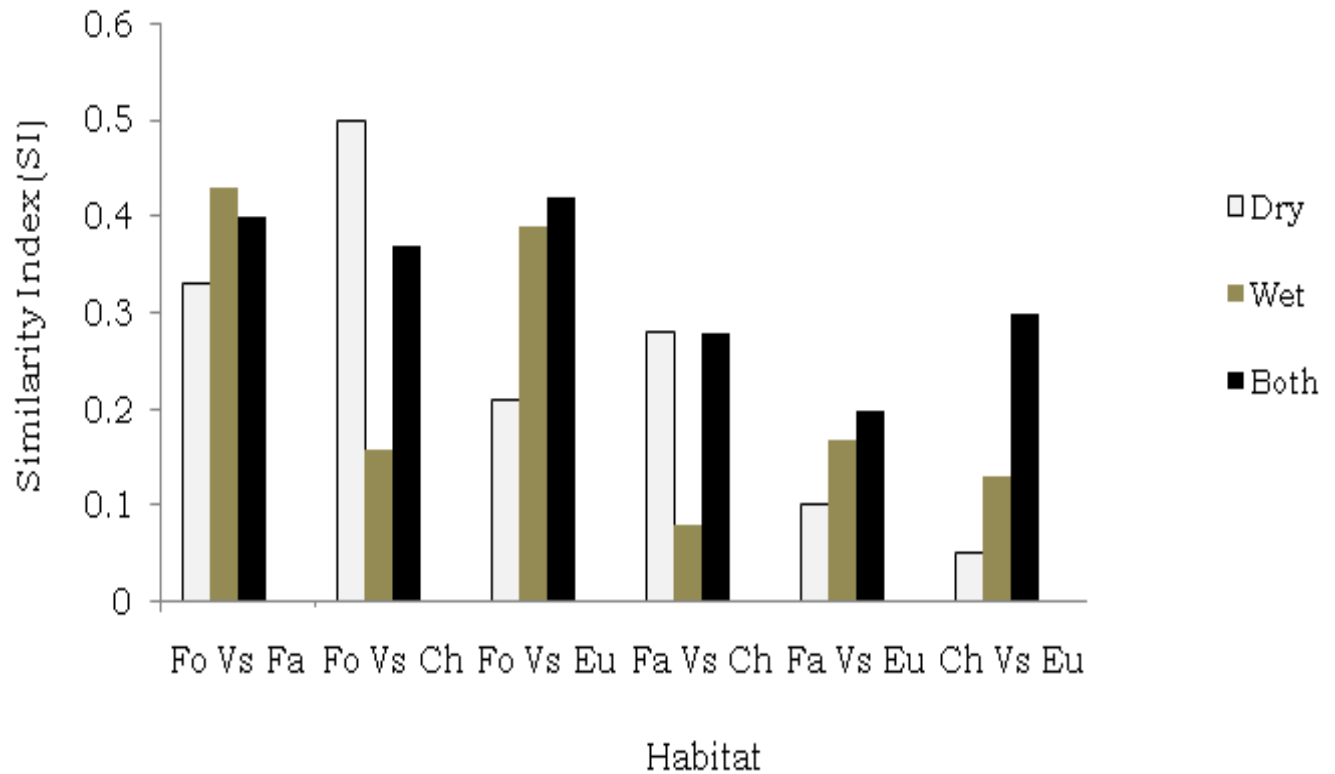


Figure 4. Avian species similarity among the habitat types (Fo=Forest, Fa=Farmland, Ch=Church and Eu=Eucalypts)

6.5. Avian Abundance

A total number of 2623, 2305, 2147 and 233 avian individuals were recorded in the forest, farmland, church and eucalypts plantation, respectively during the dry season (Table 2). A total number of 2723, 2718, 1782 and 406 individuals were recorded in the forest, farmland, church and eucalypts plantation, respectively during the wet season (Table 3). Using one way ANOVA and paired-wise T-test, these variations in abundance were statistically significant between seasons ($F=23.646$, $df=1$, $P<0.05$) (Table 12) and habitats ($F=30.260$, $df=3$, $P<0.05$) (Table 13).

Table 12. Differences in avian abundance between two seasons

	Sum of Squares	Df	F	Sig
Between Groups	44.993	1	23.646	.000
Within Groups	182.669	193		
Total	227.662	194		

Table 13. Differences in avian abundance among habitats

	Sum of Squares	Df	F	Sig
Between Groups	35.679	3	30.260	.000
Within Groups	75.069	191		
Total	110.748	194		

Between dry and wet seasons, forest ($t=0.137$, $P>0.05$), farmland ($t=-0.70$, $P>0.05$) and church ($t=0.662$, $P>0.05$) did not show significant difference in the avian abundance (Table 14). However, season had an effect on avian abundance in eucalypts plantation ($t=2.952$, $P<0.05$).

Table 14. Log-transformed abundance values of avian (Mean $\pm$ SE).

Habitat	Season	No. of Grids	M $\pm$ SE	Effect
Forest	Dry	9	291.4 $\pm$ 12	$t=0.137$, $P>0.05$
	Wet	9	302.6 $\pm$ 5.5	
Farmland	Dry	6	384.1 $\pm$ 6.61	$t=-0.70$, $P>0.05$
	Wet	6	453.0 $\pm$ 10.63	
Church	Dry	2	1073.0 $\pm$ 13.5	$t=0.662$, $P>0.05$
	Wet	2	891 $\pm$ 7.8	
Eucalypts	Dry	9	25.9 $\pm$ 1.64	$t=2.952$, $P<0.05$
	Wet	9	45.5 $\pm$ 1.34	

Relative abundance of avian species

Using encounter rate, abundance score and ordinal scale of avian recorded in the study period are shown as appendices (2-9). During the dry season, most avian were uncommon, but frequent in forest (18) whereas in church areas, relatively high numbers of abundant avian (2) were recorded. Most avian were frequent in the farmland habitat (Table 15).

Table 15. Summary of relative abundance of avian species during the dry season using encounter rates (Appendix 2, 4, 6 and 8).

Habitat	Rank				
	Rare	Uncommon	Frequent	Common	Abundant
Forest	-	18	18	3	-
Farmland	2	8	28	7	1
Church	1	4	14	4	2
Eucalypts	1	6	8	2	-

During the wet season, most frequent avian were obtained in the forest (30), whereas in the farmland, relatively high number of abundant avian (9) were recorded (Table 16).

Table 16. Summary of relative abundance of avian species during the wet season using encounter rates (Appendix 3, 5, 7 and 9).

Habitat	Rank				
	Rare	Uncommon	Frequent	Common	Abundant
Forest	-	22	30	1	3
Farmland	-	2	20	11	9
Church	-	6	18	4	6
Eucalypts	-	8	14	-	5

Relative abundance of the avian fauna among the four different habitats during wet and dry seasons indicated that 150 (52.4 %) species frequent, 32 (11.2%) species common, 26 (9.1%) species abundant, 74 (25.9 %) species uncommon and 4 (1.4%) species rare (Fig. 5).

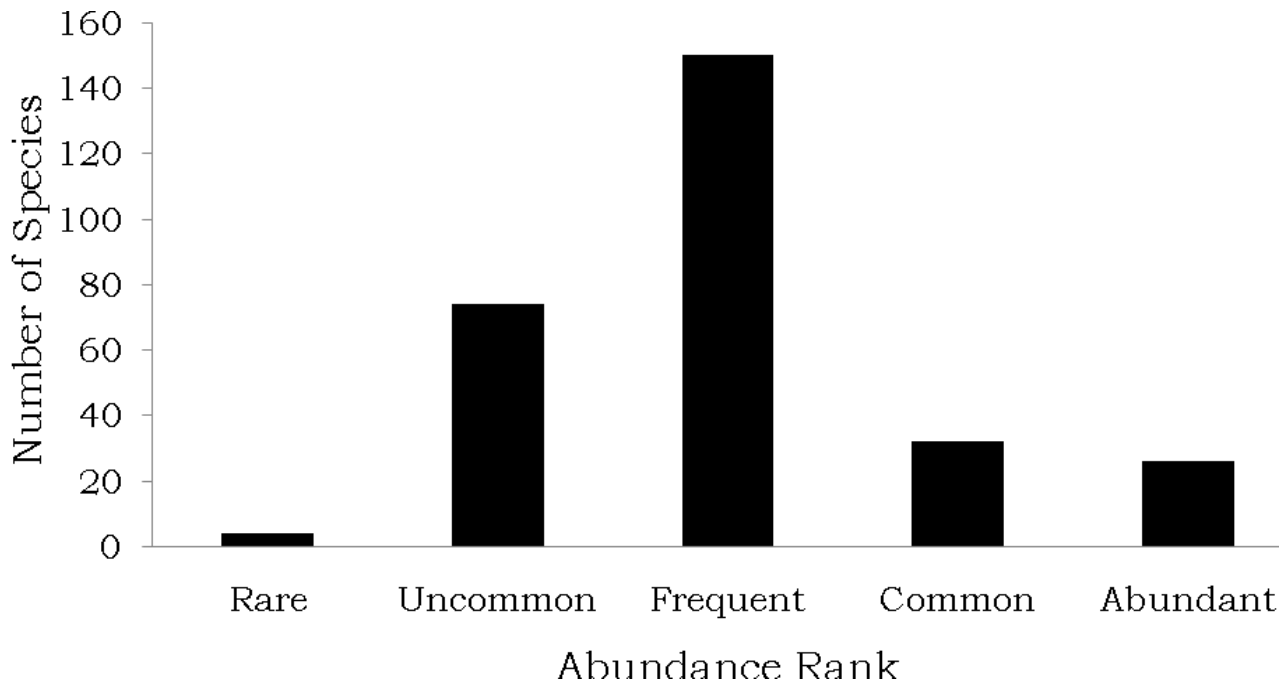


Figure 5. Abundance rank of avian species in the study area during both seasons.

6.6. Avian Distribution

Based on the family groups, avian showed variation in the distribution among the four habitats in the study area (Table 17). Columbidae, Estrildidae, Ploceidae and Turididae were the most abundant families in the present study area. Highest number of families were observed in the church area (26), followed by forest (25). Least number of families was recorded in the farmland habitat (18).

Table 17. Presence and absence of avian families in various habitat types within the study area (☐ shows presence and - absence of species)

Families	Habitats			
	Forest	Farmland	Church	Eucalypts
Accipitridae	☐	-	☐	☐
Alaudidae	☐	☐	☐	-
Anatidae	-	-	-	☐
Apodidae	☐	-	☐	☐
Capitonidae	☐	-	-	-
Caprimulgidae	☐	-	☐	☐
Charadriidae	☐	-	☐	-
Ciconiidae	-	☐	-	-
Cisticolidae	-	☐	-	-
Coliidae	-	☐	-	-
Columbidae	☐	☐	☐	☐
Corvidae	☐	-	☐	☐
Cuculidae	-	-	☐	-
Estridide	☐	☐	☐	☐
Fringillidae	☐	☐	-	-
Hirundindae	☐	-	☐	☐
Indicatoridae	☐	☐	-	-

Cont'd

Laniidae	☐	☐	-	-
Laridae	☐	☐	-	-
Meropidae	-	☐	-	-
Monarchidae	☐	-	☐	☐
Motacillidae	-	☐	☐	☐
Muscicapidae	-	-	-	☐
Musophagidae	-	☐	☐	-
Nectariniidae	☐	☐	☐	-
Oriolidae	-	☐	-	☐
Pandionidae	☐	-	-	-
Paridae	-	-	☐	-
Passeridae	-	-	☐	-
Phasianidae	-	-	☐	☐
Phoeniculidae	☐	-	-	☐
Picidae	☐	-	-	-
Ploceidae	☐	☐	☐	☐
Psittacidae	☐	-	-	☐
Pycnonotidae	-	-	☐	☐
Ramizidae	☐	-	☐	-
Sternidae	-	-	☐	-
Sturnidae	-	-	☐	-
Sylviidae	-	-	☐	-
Threskiornithidae	☐	-	-	☐
Timaliidae	☐	-	☐	☐
Trogonidae	-	-	☐	-
Turdidae	☐	☐	☐	☐
Zosteropidae	-	☐	-	-

7. Discussion

Entoto Natural Park and escarpment supports varieties of avian species. Most of these species are similar to the avian species of Menagesha-Suba State Forest. Menagesha-Suba State Forest, which is about 45 km from Addis, supports 27 highland biome species (Atkins and Harvey, 1992; 1994; 1996). The similarity of avian species with Menagesha-Suba State Forest is due to the nearness of geographical location, climatic conditions, local migration of avian from Menagesha to Entoto and the presence of indigenous and exotic plantation in the two areas. Even though the main concentration of wildlife in Ethiopia appears to be restricted in the south and western half of the country, Addis Ababa and its surrounding has quite a diverse flora, which is the home to different avian species, including a number of endemics.

The species composition, the number of species and number of individuals differed in different habitat within Entoto Natural Park and escarpment. Abundance of avian species in the study area was distributed differently among habitats because change in habitat characteristics influences the richness and avian diversity. The same is true in the outcome of the present study. The highest number of species observed in the farmland and forest habitat. This is probably due to the diversity of vegetation that provides heterogeneous habitat for different avian species and the availability of food where avian are attracted. The presence of ample resource, especially adequate food supply can increase the abundance of avian species at a given area. Chace and Walsh (2006) indicated that avian respond to changes in vegetation composition and structure, which in turn affects their food resources. Areas outside the Park can potentially provide suitable habitats, resource and food. In contrast, the lowest number of species was observed in eucalypts plantation. This is probably due to the allelopathic effect of the eucalypts to the surrounding habitat. This has negative effects on agricultural practices and other nearby woodlands causing significant decreases in crop output. This in turn affects the avian species that depend on it. This idea was agree with MacArthur and

MacArthur (1961) that the decline in the quality of habitat resulted in the loss of habitat leading to a decline in the resident avian fauna.

The highest number of individuals was recorded in the farmland during both seasons next to forest habitat. This is due to the adaptable nature of avian to live in human habitats. The openness of the sites compared to natural habitats with relatively dense vegetation cover might have also contributed for easy identification of the species. This explanation is similar to the work of Sisay Hailu (2008) that as open areas becomes easily accessible, sighting of avian for clear identification and counting gets better.

On the other hand the number of avian species during the wet season was high compared to the dry season. There is a significant variation in the number of avian species between seasons. In the study area, there was predictable seasonal change in temperature and rainfall. This is probably due to the positive relationship between habitat and season i.e. during the wet season the productivity and yield of habitat increase as a result, the species richness increases. These ideas agree with the work of Dawit Asmare (2009) where during the wet season additional avian species were observed. Besides, Onido *et al* (2001), and McPherson and Jetz (2007) stated that in a predictable seasonally changing environment, different species may be suited to conditions at different times of the year. Hence, more species might be expected to coexist in a seasonal environment than a constant one. This idea disagrees with the work of Shiferaw Ayele (2008) who concluded that season has no significant effect on avian species richness.

During both seasons, highest avian diversity was observed in the forest followed by church areas. This is probably due to the presence of high vegetation structure and volume that could be responsible for high avian diversity. As the number of vegetation layer increases, the number of available niches for avian also increases and so does the diversity of avian species. This is due to the different feeding habit of avian leading to niche separation (MacArthur, 1964). The least diversity of avian species was observed in the eucalypts plantation. In the case of church, because

the compound is a holy place, the vegetation that occurs is highly protected, free from anthropogenic effect and the vegetation structure is complex. Therefore, it can support diverse number of avian. This seems to disagree with the explanation of Dawit Asmare (2009) that avian are more diverse and abundant in lower stratum shrub communities than in complex forests.

Within habitats, seasonal avian species similarity was highest in the farmland, followed by forests. This might be due to higher vegetational complexity, stable source of food, nesting and cover from predator. Similarly, Karr (1976) noted that the more complex or denser habitats tend to contain more similar species because complex vegetation provides stable food supply and shelter during both seasons. The least similarity was obtained in church areas. This may be due to local migration of avian to the farmland as it had seeds and fruits.

Among habitats, avian species similarity was high between forest and farmland. Direct observation showed different fruit producing plants in the farmland and forest. This might contribute for avian species similarity between these habitats. Kikkawa (1982), and Tubelis and Cavaicanti (2001) noted that similarity of avian species composition between habitats indicates a tendency for similar habitats to have similar species composition. In addition, Marone (1991) noted that foraging modes of avian are important factors in avian habitat selection. Therefore, species of the same guild would select the same habitat features. In contrast, the lowest avian species similarity was between church and farmland during the dry season and between church and eucalypts plantation during the wet season. This is probably due to the differences in feeding adaptation of avian communities in each habitat.

The evenness of avian has revealed high value in the eucalypts plantation. This was because the vegetation cover of such habitat did not alter much but homogenous and the species depended on the same niche. In contrast, the evenness of avian has revealed small value in the farmland during the wet season. This might be due to the cultivation of the farmland and the removal of plants and some crops are at the

stage of germination. Probably, this caused shortage of food and structural change in the farmland habitat that forced avian to migrate to nearby habitats.

The relative abundance of avian species in the forest habitat showed that high number of avian species was grouped as uncommon. This might be due to vegetation complexity and inconspicuousness of small avian to observe avian species in this habitat. Thinh (2006) pointed out that each avian species in a given habitat such as forest has its own probability of being detected, which is usually less than 100%. Pomery and Dranzoa (1997) explained that many forest species are difficult to detect, especially those of understory. Besides, in eucalypts plantation, only two avian species was grouped as common. This might be due to the impact of eucalypts on the ecosystem like drying out of the surrounding habitat and the inhibitory effect minimizing the chance of other plant to grow. As a result, the availability of food resource declines. This has effects on the number of avian that depend on it. This explanation disagrees with the statement by Eshetu Yirdaw (2002) that forest plantations including eucalypts have a large potential for rehabilitating natural forest ecosystems at a comparatively low cost.

The distribution of avian within four habitats varied among each other at family level. Highest numbers of families were observed in the church area followed by forest. This might be due to higher vegetation complexity and floristic composition of the habitats. Least number of families was recorded in the farmland. This could be due to the less vegetation complexity and small size. Tellaria and Santos (1994) pointed out that habitat structure affects distribution of individual species. Besides, habitat size (Willis, 1979), foraging modes (Marone, 1991) and floristic composition (Wiens and Rotenberry, 1981) have influence in the distribution of Avian. Dawit Asmare (2009) concluded that avian species richness and distribution in the study area is influenced by vegetation structure, which is the principal determinant factor of avian species richness. Columbidae, Estrildidae, Ploceidae and Turididae were the most widely distributed families in the present study area. This might be due to the above factors.

8. Threats to the Study Area

The balance between the activity of people and their environment is being changed. Growing human population and increasing demands for resources are leading to the transformation and degradation of ecosystem resulting in the reduction of fauna and flora. Plants are central components of this threatened nature. The loss of plants is significant as they contribute the base of food webs and provide habitats for other organisms. It is generally accepted that conservation of all biodiversity should be our target, with sustainably utilizing natural habitats. Therefore, priority should be given to the conservation of the major centers of plant diversity which often lead to the conservation of many organisms. In forest areas of Ethiopia, human pressure is increasing with increasing need for both arable land and forest products. As the survival of local people is closely tied to the natural habitat around them, various threats continue to affect natural habitats in Entoto Natural Park and escarpment.

There are different threats in the Entoto area. Some of them are eucalypts plantation, soil erosion, deforestation, habitat fragmentation and land degradation. The fast-growing eucalypts trees suppress the growth of nearly all the indigenous woody and herbaceous plants and severely reduce the biodiversity of the area where they are planted in dense stands. Eucalypts trees affect the depletion of soil nutrients. In contrast to commonly used agro-forestry species, eucalypts does not fix nitrogen, an essential element for soil health and sustainability. Surveys have indicated that eucalypts compete crops for water and nutrients, causing significant decrease in crop output. Eucalypts trees demand large quantities of water, and areas that were previously seasonally wet and supporting a distinctive flora and fauna has at present dried up. Streams that used to be perennial, at present only flow for a short period after the rains.

The most important factors which trigger soil erosion process in the study area are nature of rainfall, nature of topography, lack of vegetation cover, erodible nature of soil type, overcultivation and overgrazing. The nature of topography is accompanied

with rugged terrains and steep slopes, which are convex in nature. The soil types in the study area are poor in humus content with poor physical structure and low infiltration capacity. This leads to land degradation. Besides, heavy rainfall (intensity and duration) has a major role in soil erosion (Plate 6).



Plate 6. Soil Erosion (December, 2009; Photo: By Kalkidan Esayas)

There are several reasons for deforestation to occur: trees or derived charcoal are used and sold for fuel or a commodity to be used by humans. Entoto area has one of the lowest electricity per capita consumers and from the current trend in the prices of electricity and other commercial fuels, people remain highly dependent on fuel wood as the main source of energy. Removal of timber, twigs and leaves has left the soil in many areas of the Park greatly impoverished and vulnerable to erosion. Besides, cleared land is used by humans as pasture for livestock, plantations of commodities and settlements. Removal of trees by individuals without sufficient reforestation has resulted in damage to habitat, loss of biodiversity and aridity. It has adverse impact by increasing atmospheric carbon dioxide. Deforested regions typically lead to significant adverse soil erosion and frequently degraded into wasteland (Plate 7). Deforestation has many effects on organisms that depend upon forests. It affects avian species by interfering in their physical and physiological activities. To understand ecological impacts of forest management, information on

biological communities such as that of avian is highly needed (Serkioglu, 2006). Deforestation affects the distribution, abundance, migration, foraging behavior, flocking, breeding, succession and avian species diversity.



Plate 7. Deforestation (December, 2009; Photo: By Kalkidan Esayas)

Habitat fragmentation tends to result in the loss of species, affects migration and reducing population level. Avian species diversity follows the diversity of vegetation layers, when foliage is more evenly divided among different layers. These layers correspond roughly to herb, shrub and tree heights (MacArthur, 1964). The diversity of avian species depends on the number of habitat layers in foliage. As the habitat is diversified, the diversity of avian species will increase i.e. habitat diversity is directly proportional to species diversity.

9. Conclusion and Recommendations

The present survey revealed that Entoto Natural Park and escarpment supports variety of avian species in different types of habitats. The importance of different habitats for avian species by providing the necessary requirements like food, water and nesting is revealed. The seasonal variation in number of individual species and their distribution in the study area are directly related to the types of habitats.

Entoto Natural Park and escarpment harbours different animals as well. Thus it can serve as important centre of biodiversity and tourist attraction. However the area has a long history of eucalypts plantation, settlement, deforestation and erosion. The natural vegetation was reduced significantly due to population growth and expansion of the city. Since 1895, eucalypts have been introduced to satisfy the growing demand of firewood and construction material. This leads to scarcity of water and loss of biodiversity.

Removal of timber, twigs and leaves which is used for fuel, has left the soil in many areas of the Park greatly impoverished and vulnerable to erosion and causing severe degradation. Most of the individuals that collect firewood are poor vulnerable members of the society such as women household heads, landless farmers, widowed/divorced poor women and orphaned children who lack other opportunities to secure their livelihood. Besides, illegal settlements in the Park enable the people to have free access to entry and collect fuel wood.

Therefore protection of the area is mandatory for wildlife conservation especially for avian to have enough feeding, nesting, breeding sites and to maintain the natural ecological balance of the area. In order to conserve the Park and its surroundings, the following recommendations are made:

- ✓ Ethiopian Heritage Trust should strongly work on replacement of some of eucalypts plantation and rehabilitating the upper watersheds by promoting indigenous, multi-layer, uneven-aged forests and soil conservation measures. Besides, it should promote the Park as one of IBAs in the country.
- ✓ The government should be implement effective forest management and clear demarcation and delineation of the Park is essential.
- ✓ When the government and NGOs design plantation programs, they should practice participation of the local people.
- ✓ Environmental protection authority should work on active environmental impact assessment measure which highlights the importance of improved cross-sectored linkages and joint enforcement of environmental laws and standards.
- ✓ Agricultural office should work on capacity building for farmers on technical skills, materials and equipment of farming.
- ✓ Coordinated institutional framework and active involvement of stakeholders like NGOs, the Federal, Regional, Zonal bureau, Woreda and kebele level administrators should be practiced.
- ✓ Addis Ababa City Administration should take responsibility in displacing people who are living in the Park and giving other appropriate places to avoid their influence in the natural habitats.
- ✓ The organizations that support tree nurseries should supervise periodically.
- ✓ Agriculture office should support urban farmers in establishing woodlots and adopting agro-forestry and Soil Water Conservation (SWC) practices.
- ✓ Mineral and energy office should strongly promote improved stoves, efficient use of biomass energy and non-biomass energy sources.
- ✓ Ministry of education should design curriculum on environmental education to be given through schools.
- ✓ It is advisable for government to work on convincing elders, like religious leaders on environmental issue as they can play a critical role.
- ✓ The government should empower women that are depending on collecting fire wood by diversifying source of their income.

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Appendices

Appendix 1. Species of plants identified during the study period

Scientific Name	Amharic Name	Local Name (Oromiffa)
<i>Juniperous excelsa</i>	Tid	Gatirra
<i>Olea europaea Subsp. cuspidata</i>	Weira	Ejersa
<i>Hagenia abyssinica</i>	Kosso	Hetto
<i>Hyericum revolutum</i>	Amija	Riga ganzi
<i>Podocarpus falcatus</i>	Zigba	Birbirssa
<i>Ficus species</i>	Sholla	Qiltu
<i>Erythrina brucei</i>	Korch	Assta
<i>Rosa abyssinica</i>	Kega	Enqoto
<i>Acacia abyssinica</i>	Grar	Dedecca
<i>Eucalyptus globulus</i>	Baharzaf	Baharzaf

Appendix 2. Relative abundance of avian in the forest habitat during the dry season.

Species	No.of individuals Per 100 field hours	Abundance Score	Rank
Abyssinian cat bird	5.6	3	Frequent
Abyssinian Ground Thrush	1.78	2	Uncommon
Abyssinian Scimitarbil	2.68	3	Frequent
African Harrier Hawk	0.56	2	Uncommon
African paradise flycatcher	1.8	2	Uncommon
Alpine Swift	4.7	3	Frequent
Augur Buzzard	0.3	2	Uncommon
Common Bulbul	3.1	3	Frequent
Crested Lark	1.5	2	Uncommon
Dusky Turtle Dove	2.2	3	Frequent
Fan-tailed Raven	0.8	2	Uncommon
Ground scraper Thrush	3.5	3	Frequent
Hadada Ibis	1.6	2	Uncommon
Lizard Buzzard	4.1	3	Frequent
Mountain Thrush	0.2	2	Uncommon
Mountaine Nightjar	5.3	3	Frequent
Mouse colored penduline tit	27.2	4	Common
Nyaza Swift	8.5	3	Frequent
Olive Sun bird	2.4	3	Frequent
Olive Thrush	11	4	Common
Pied Crow	3.2	3	Frequent
Red- eyed Dove	1.4	2	Uncommon
Red headed love bird	1.8	2	Uncommon
Red Winged Pytilia	0.8	2	Uncommon

Cont'd....

Red-billed firefinch	4.1	3	Frequent
Red-rumped Waxbill	0.3	2	Uncommon
Rose ringed parakeet	1.6	2	Uncommon
Rupell's Robin Chat	15.5	4	Common
Slender billed Greenbul	3.8	3	Frequent
Spot-breasted plover	1.2	2	Uncommon
Tacazze Sun bird	3.2	3	Frequent
Thekla Lark	1.1	2	Uncommon
Thick Billed Raven	2.1	3	Frequent
Variable Sun bird	1.5	2	Uncommon
Violet-wood-hoopoe	0.8	2	Uncommon
Wattled Ibis	2.3	3	Frequent
White Fronted Sand Plover	2.8	3	Frequent
White-collared Pigeon	3.3	3	Frequent
Yellow-bellied Waxbill	0.2	2	Uncommon

Appendix 3. Relative abundance of avian in the forest habitat during the wet season.

Species	No.of individuals Per 100 field hours	Abundance Score	Rank
Abyssinian Ground Thrush	2.4	3	Frequent
Abyssinian Scimitarbil	2.5	3	Frequent
Abyssinian woodpecker	5	3	Frequent
African Harrier Hawk	1.6	2	Uncommon
African paradise flycatcher	2.5	3	Frequent
Alpine Swift	7.5	3	Frequent
Augur Buzzard	2	2	Uncommon
Banded barbet	5	3	Frequent
Black-billed Barbet	2.1	3	Frequent
Black-headed Siskin	0.8	2	Uncommon
Brown-rumped Seed Eater	1.4	2	Uncommon
Common Bulbul	3.3	3	Frequent
Common Fiscal	2.7	3	Frequent
Common house martin	3.1	3	Frequent
Crested Lark	1.3	2	Uncommon
Dusky Turtle Dove	10	3	Frequent
Ethiopian Swallow	0.2	2	Uncommon
Fan-tailed Raven	2.6	3	Frequent
Fan-tailed widow bird	5.5	3	Frequent
Greater Honey Guide	3.8	3	Frequent
Ground scraper Thrush	4.7	3	Frequent
Hadada Ibis	3.5	3	Frequent
Lesser Honey Guide	0.8	2	Uncommon
Lizard Buzzard	1.1	2	Uncommon

Cont'd....

Mountain Thrush	112.5	5	Abundant
Mountaine Nightjar	5.3	3	Frequent
Mouse colored penduline tit	9.4	3	Frequent
Nyaza Swift	8.5	3	Frequent
Olive Sun bird	4.2	3	Frequent
Olive Thrush	45	5	Abundant
Osprey	2.2	3	Frequent
Pied Crow	3.8	3	Frequent
Red- eyed Dove	7.4	3	Frequent
Red headed love bird	2.5	3	Frequent
Red Winged Pytilia	0.2	2	Uncommon
Red-billed firefinch	20	3	Frequent
Red-rumped Waxbill	2.2	3	Frequent
Rose ringed parakeet	0.8	2	Uncommon
Rufous-naped Lark	1.4	2	Uncommon
Rupell's Robin Chat	5.8	3	Frequent
Slender billed Greenbul	1.2	2	Uncommon
Speckled Pigeon	1.3	2	Uncommon
Spot-breasted plover	0.8	2	Uncommon
Streaky Seedeater	1.7	2	Uncommon
Tacazze Sun bird	33.4	3	Frequent
Thekla Lark	1.1	2	Uncommon
Thick Billed Raven	2.5	3	Frequent
Variable Sun bird	10.5	4	Common
Violet-wood-hoopoe	0.4	2	Uncommon
Wahlberg's honey bird	1.4	2	Uncommon
Wattled Ibis	15	3	Frequent
White Fronted Sand Plover	1.2	2	Uncommon

Cont'd

White-collared Pigeon	65	5	Abundant
Yellow Fronted Canary	1.7	2	Uncommon
Yellow-bellied Waxbill	0.5	2	Uncommon
Yellow-mantled widow bird	1.4	2	Uncommon

Appendix 4. Relative abundance of avian in the farmland habitat during the dry season.

Species	No.of individuals Per 10 field hours	Abundance Score	Rank
Abyssinian Ground Thrush	4.7	3	Frequent
Abyssinian Long Claw	34	4	Common
African Black headed oriole	2.7	3	Frequent
African Citril	5.6	3	Frequent
African golden oriole	7.8	3	Frequent
Baglafech Weaver	3.3	3	Frequent
Black headed forest oriole	37. 5	3	Frequent
Black-headed Siskin	6.4	3	Frequent
Blue-breasted Bee-eater	61	5	Abundant
Bronze Sun bird	10.5	4	Common
Brown-rumped Seed Eater	8.5	3	Frequent
Collared Sun bird	3.5	3	Frequent
Common Fiscal	2.1	3	Frequent
Crested Lark	3.5	3	Frequent
Ethiopian oriole	2.6	3	Frequent
Greater Honey Guide	3.4	3	Frequent
Lesser Honey Guide	5.5	3	Frequent
Little Bee- eater	1.1	2	Uncommon
Montane White Eye	4.3	3	Frequent
Mountain Thrush	29	4	Common
Obbia Lark	0.05	1	Rare
Olive Sun bird	10.5	4	Common
Olive Thrush	18	4	Common
Princeruspoli's Turaco	1.1	2	Uncommon
Red- eyed Dove	3.6	3	Frequent

Cont'd....

Red Winged Pytilia	0.2	2	Uncommon
Red-billed firefinch	0.8	2	Uncommon
Red-rumped Waxbill	2.4	3	Frequent
Rufous-naped Lark	0.01	1	Rare
Rupell's weaver	5.4	3	Frequent
Scarlet-chested Sun Avian	1.7	2	Uncommon
Singing Cisticola	2.2	3	Frequent
Slender-billed Gull	2.2	3	Frequent
Speckled Pigeon	4.5	3	Frequent
Spectacled weaver	3.3	3	Frequent
Stout Cisticola	7.4	3	Frequent
Streaky Seedeater	16	4	Common
Tacazze Sun bird	8	3	Frequent
Thekla Lark	0.3	2	Uncommon
Variable Sun bird	9.5	3	Frequent
Wahlberg's honey bird	11.5	4	Common
White-cheeked Turaco	6.7	3	Frequent
White-collared Pigeon	4.2	3	Frequent
Yellow Fronted Canary	1.1	2	Uncommon
Yellow wagtail	2.5	3	Frequent
Yellow-bellied Waxbill	2	2	Uncommon

Appendix 5. Relative abundance of avian in the farmland habitat during the wet season.

Species	No.of individuals Per 10 field hours	Abundance Score	Rank
Abyssinian Long Claw	118.5	5	Abundant
African Black headed oriole	77.5	5	Abundant
African Citril	4.3	3	Frequent
African golden oriole	7.5	3	Frequent
Black headed forest oriole	12	4	Common
Black-headed Siskin	2.5	3	Frequent
Blue-breasted Bee-eater	3.6	3	Frequent
Bronze Sun bird	120.5	5	Abundant
Brown-rumped Seed Eater	15	4	Common
Collared Sun bird	20	4	Common
Crested Lark	44	5	Abundant
Ethiopian oriole	8.5	3	Frequent
Greater Honey Guide	65	5	Abundant
Lesser Honey Guide	22	4	Common
Little Bee- eater	18	4	Common
Mountain Thrush	3.6	3	Frequent
Obbia Lark	34	4	Common
Olive Sun bird	86	5	Abundant
Olive Thrush	63	5	Abundant
Princeruspoli's Turaco	2.1	3	Frequent
Red Winged Pytilia	3.3	3	Frequent
Red-billed firefinch	4.2	3	Frequent
Red-rumped Waxbill	1.1	2	Uncommon

Cont'd....

Rufous-naped Lark	3.3	3	Frequent
Rupell's weaver	5.5	3	Frequent
Scarlet-chested Sun bird	2.6	3	Frequent
Slender-billed Gull	1.1	2	Uncommon
Speckled Mouse bird	4.7	3	Frequent
Speckled Pigeon	10.5	4	Common
Spectacled weaver	3.5	3	Frequent
Stout Cisticola	4.2	3	Frequent
Streaky Seedeater	49	5	Abundant
Tacazze Sun bird	9.5	3	Frequent
Thekla Lark	2.4	3	Frequent
Variable Sun bird	52	5	Abundant
Wahlberg's honey bird	27	4	Common
White-cheeked Turaco	12	4	Common
White-collared Pigeon	36	4	Common
Yellow Fronted Canary	3.9	3	Frequent
Yellow wagtail	17	4	Common
Yellow-billed stork	3.3	3	Frequent
Yellow-bellied Waxbill	4.5	3	Frequent

Appendix 6. Relative abundance of avian in the church areas during the dry season.

Species	No.of individuals Per 10 field hours	Abundance Score	Rank
African fish eagle	4.3	3	Frequent
African paradise flycatcher	2.2	3	Frequent
Alpine Swift	1.1	2	Uncommon
Augur Buzzard	3.2	3	Frequent
Black Kite	4.5	3	Frequent
Common Bulbul	0.9	2	Uncommon
Crested Lark	0.4	2	Uncommon
Crowned eagle	15	3	Frequent
Dusky tit	3.3	3	Frequent
Dusky Turtle Dove	11.5	4	Common
Fan-tailed Raven	8.5	3	Frequent
Mountain Thrush	15	4	Common
Mountaine Nightjar	10.5	4	Common
Mouse colored penduline tit	100	5	Abundant
Olive Thrush	12	4	Common
Princeruspoli's Turaco	0.07	1	Rare
Red- eyed Dove	6.4	3	Frequent
Red Winged Pytilia	0.2	2	Uncommon
Red-billed firefinch	2.9	3	Frequent
Red-rumped Waxbill	3.4	3	Frequent
Red-Thighed Sparrow hawk	8.5	3	Frequent
Speckled Pigeon	5.5	3	Frequent
Tacazze Sun bird	42	5	Abundant
White-backed black tit	1.2	3	Frequent
White-headed Vulture	9.5	3	Frequent

Appendix 7. Relative abundance of avian in the church areas during the wet season.

Species	No.of individuals Per 10 field hours	Abundance Score	Rank
African hill barbbler	3	3	Frequent
Alpine Swift	67	5	Abundant
Augur Buzzard	1.3	2	Uncommon
Baglafech Weaver	4.2	3	Frequent
Black Kite	0.3	2	Uncommon
Black tern	0.8	2	Uncommon
Blue swallow	3.3	3	Frequent
Blue-rock Thrush	53	5	Abundant
Brown warbler	7.4	3	Frequent
Brownwoodlandwarbler	2.2	3	Frequent
Chestnet winged Starling	37	3	Frequent
Chestnut Sparrow	5.5	3	Frequent
Common starling	10.5	4	Common
Jacobin Cukoo	3.7	3	Frequent
Moorland chat	1.1	2	Uncommon
Moorland Francolin	0.3	2	Uncommon
Narina Trogon	4.7	3	Frequent
Pied Wheater	0.5	2	Uncommon
Red- eyed Dove	63	5	Abundant
Red Winged Pytilia	3.3	3	Frequent
Rock martin	27	3	Frequent
Rupell's weaver	14	3	Frequent
Sharpe's Starling	42	5	Abundant

Cont'd....

Speckled Pigeon	4.6	3	Frequent
Spot-breasted plover	3.7	3	Frequent
Spoted palm Thrush	11	4	Common
Swainson's Sparrow	10.5	4	Common
White crowned Robin Chat	51	5	Abundant
White Fronted Sand Plover	4.3	3	Frequent
White-collared Pigeon	73	5	Abundant
White-winged cliff-chat	25	4	Common
Willow warbler	2.1	3	Frequent
Wire-tailed swallow	23	3	Frequent
Wood warbler	2.3	3	Frequent

Appendix 8. Relative abundance of avian in the eucalypts plantation during the dry season.

Species	No.of individuals Per 10 field hours	Abundance Score	Rank
Abyssinian Flycatcher	2.5	3	Frequent
African Black headed oriole	3.4	3	Frequent
African golden oriole	1.2	2	Uncommon
Black winged love bird	4	3	Frequent
Blue-winged goose	0.8	2	Uncommon
Common Quail	2.2	3	Frequent
Egyptian goose	1.1	2	Uncommon
Erckel's Francolin	0.05	1	Rare
Northern Brownbul	6.5	3	Frequent
Red headed love bird	10.5	4	Common
Red-Thighed Sparrow hawk	0.1	2	Uncommon
Rose ringed parakeet	12	3	Frequent
Semi-collared flycatcher	3.3	3	Frequent
Spectacled weaver	2.8	3	Frequent
Violet-wood-hoopoe	0.3	2	Uncommon
Wire-tailed swallow	0.2	2	Uncommon
Yellow-fronted parrot	21	4	Common

Appendix 9. Relative abundance of avian in the eucalypts plantation during the wet season.

Species	No.of individuals Per 10 field hours	Abundance Score	Rank
Abyssinian cat bird	5.6	3	Frequent
African golden oriole	4.7	3	Frequent
African paradise flycatcher	3.3	3	Frequent
Alpine Swift	8.5	3	Frequent
Black winged love bird	10.5	4	Abundant
Blue-winged goose	2.2	3	Frequent
Common Bulbul	3.5	3	Frequent
Common Quail	4.5	3	Frequent
Egyptian goose	1.1	2	Uncommon
Erckel's Francolin	2.1	2	Uncommon
Fan-tailed Raven	0.8	2	Uncommon
Hadada Ibis	1.5	2	Uncommon
Lizard Buzzard	0.2	2	Uncommon
Mountain Thrush	27	4	Abundant
Mountaine Nightjar	15	4	Abundant
Olive Thrush	10.5	4	Abundant
Pied Crow	4.7	3	Frequent
Pied Wheater	1.7	2	Uncommon
Red- eyed Dove	8.4	3	Frequent
Red Winged Pytilia	0.1	2	Uncommon
Rose ringed parakeet	2.3	3	Frequent
Sacred Ibis	5.6	3	Frequent

Cont'd...

Speckled Pigeon	7.4	3	Frequent
Spectacled weaver	2.5	3	Frequent
Thick Billed Raven	15.5	4	Abundant
Violet-wood-hoopoe	0.2	2	Uncommon
Wattled Ibis	3.5	3	Frequent

Appendix 10. Field data sheet used for point count and total count methods

Date_____Point code_____Primary observer_____

Weather (wind direction and intensity)_____Temp._____Cloud cover_____

Time start:				
Time end:				
Species	Number of avian	Fly throughs	Fly overs	outside
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
Additional Notes:				

Appendix 11. Field data sheet used for transect method

Surveyor(s):		Field Sheet reference:		Date:
Survey Site:		Altitude:		
Latitude:	Longitude:		UTM (If available):	
Vegetation:		Human disturbance		
Season:		Weather:	Temperature:	
Transect Length:		Start Time:	End Time:	
Other:				
Time	Species	Number of avian in groups:		Additional observations:

Write a description on the back of the sheet (note things such as general size and color, beak color and shape, etc.) for any species you can identify with confidence. This can be used later for comparison with illustration and description in standard reference works.

Appendix 12. Sample Photographs of avian taken during the field study



Baglafech Weaver



African Golden oriole



Red-headed lovebird



PiedCrow



Abyssinian catbird



Speckled pigeon



Mousecolored Pendulin tit



Olive sun bird



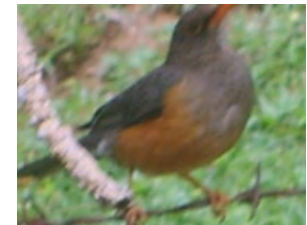
Dusky Turtle Dove



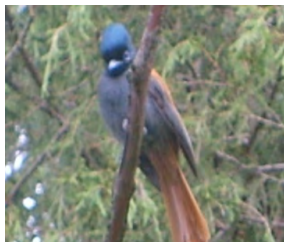
Ruppell's Robin Chat



Black Tern



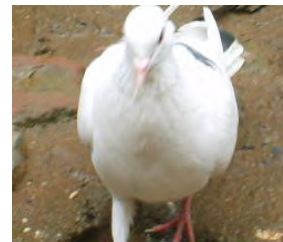
Olive Thrush



AfricanparadiseFlycatcher



Abyssinian longClaw



Slender billed Gull



Red-billed firefinch



Yellow white montane



Thick-billed Raven



Ground scraper Thrush



Wattled Ibis

DECLARATION

I undersigned, declare that this thesis is my original work. It has not been for a degree in this or any other univerisity and all the source materials used for this thesis have been properly acknowledged.

Name : Kalkidan Esayas

Signature: _____

Date : June, 2010

The thesis has been submitted with my approval as a supervisor

Name: Afework Bekele (Professor)

Signature: _____

Date: June, 2010

