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**Diversity and Relative Abundance of Birds at Entoto  
Mariam Church Groves**

*MSc thesis submitted in Partial Fulfillment of the Requirements for the Degree of  
Master of Science in Biology*

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## **LIST OF ACRONYMS**

EARO	Ethiopian Agricultural Research Organization
EBA	Endemic Bird Area
EOTC	Ethiopian Orthodox Tewahido Churches
EWCA	Ethiopian Wildlife Conservation Authority
EWNHS	Ethiopian Wildlife and Natural History Society
IBA	Important Bird Area
ICBP	International Council for Bird Protection
PES	Payments for Ecosystem Services
NDVI	Normalized Difference Vegetation Index
GIS	Geographic Information System

## ABSTRACT

Relative abundance and diversity of birds at the Entoto Mariam Church Groves was studied between February to August 2016, covering both dry and wet seasons. Point count method was used to investigate the relative abundance of birds in the sacred groves to provide current information. A total of 48 bird species belonging to 8 orders and 21 families were recorded. Only one species, Spot-breasted plover (*Vanellus melanocephalus*) was endemic to Ethiopia and White-collared pigeon (*Columba albitorques*), White-backed black tit (*Melaniparus leuconotus*) and white-winged cliff-chat (*Monticola semirufus*) were the three endemic species to both Ethiopia and Eritrea in the study area. The Crowned eagle (*Strephanoaetus coronatus*) is near threatened species and the white-headed vulture (*Necrosyrtes monachus*) is the only critically endangered species and the Spot-breasted plover (*Vanellus melanocephalus*), white-collared pigeon and white-winged cliff-chat are least concern species. The mouse colored penduline tit (*Anthscopus musculus*) was the most abundant species with a total sighting of 703 followed by Tacazze Sunbird (*Nectarina tacazze*) with 294 sightings. Moorland chat (*Cercomela sordida*), Willow warbler (*Phylloscopu strochilus*), Wood warbler (*Wood warbler*) and Common Bulbul (*Motacilla clara*) were the least abundant species with less than seven sighting records. Diversity and evenness indices during the dry and wet seasons were 2.33, and 0.75; and 2.83 and 0.82, respectively. The lowest species diversity ( $H'=2.27$ ), species evenness ( $E=0.76$ ) and species richness (20) were observed in April. The highest species diversity ( $H'=2.82$ ), species evenness ( $E=0.84$ ) and species richness (29) were observed in the August. Variation in diversity of bird species was statistically insignificant between months ( $df=3$ ,  $p=0.94$ ). Most birds (45.83 %) had scored *Abundant* in the ordinal scale while there were no species with *Rare* and *Uncommon* ranks.

**Keywords:** Birds, distribution, Entoto Church, relative abundance, species diversity

## **1. INTRODUCTION**

Ethiopia is one of the most physically and biologically diverse countries due to variations in altitude with the highest peak at Ras Dashen (4620 m asl) and the lowest at the Afar depression (116 m asl). The physiographic, climatic and edaphic diversity resulted in a variety of vegetation from high altitude alpine to semi-desert plant communities (Gebremarkos Woldelessie, 1998). Vegetation in various parts of the country supports several fauna including those that are endemic to the country (Yonas Yemshaw, 2002). The presence of five diversified climatic zones defined by different altitudes, rainfalls and temperatures (Saavedra,2009) helped to create isolated and varied ecological situations in the country.

Ethiopia's major land feature is a massive highland complex of mountains and plateaus bisected by the Great Rift Valley and surrounded by lowlands along much of the edge (Hillman, 1993; Viveropol, 2001). The Great Rift Valley bisects this mountainous plateau, dividing it into northwestern and southeastern highland regions (Gillespie, 2003). These made Ethiopia to have various wildlife and wildlife habitat.

The biological resources including birds are distributed or grouped in different biomes mainly the Afrotropical highlands, the Sudan-Guinean, the Sahel-Transitional Zone and the Somali-Masai Biome (Yalden et al., 1996). Ethiopia has 50% of all the afrotropical land above 2,000 m and 80% of all the land above 3,000 m asl (Yalden, 1983). Most of the country comprises highland plateaus and mountain ranges that are dissected by numerous streams and rivers. The highlands gradually descend to lowland areas in the east, west and south of the country (EWNHS, 1996; EPA, 1998). So the country is rich in its fauna diversity. The biodiversity is not evenly distributed in the country. The larger mammals are mainly concentrated in the south and southwest border and adjacent areas of the country. There are also plain game animals along the stretch of the Great Rift Valley System. Mountain massifs in the north are also home to many endemic species. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, which constitute about 12 per cent endemic (Tewolde Brehan Gebre Egziabher, 1991).

Out of the 865 bird species listed for the country, one is introduced species (Rock Pigeon, *Columba livia*), 596 are residents, 224 are seasonal migrants, 176 are Palearctic migrants, 19 are endemic and 31 are globally threatened species (Bird Life International, 2011; Lepage, 2017). The data released from different sources concerning to faunal diversity in the country vary in different times. For example, Biodiversity Analysis and Technical Support Team (2008) revealed that there are 861 with 28 endemic birds in Ethiopia. In contrast, Leykun Abune (2008) reported that Ethiopia has over 861 species with 32 endemic (Some of which are shared with Eritrea). But Lepage (2006) showed that Ethiopia has about 926 with 23 endemic and 19 globally threatened bird species out of 1850 bird species of Africa.

There are more than 35,000 church forests in Ethiopia that are protected as recreations of the Garden of Eden (Sengupta and Dalwani, 2008). Entoto church forest is one of them and plays a role in preserving biodiversity such as avian diversity. These birds are very visible and integral part of the ecosystem occupying many trophic levels in a food chain ranging from consumers to predators. Their occurrences have been helpful as environmental health indicators, plant pollinators and seed dispersal as well as pest control (Hadley et al., 2012; Ramchandra, 2013). Furthermore, they have been particularly important to the cultural, religious and aesthetic sides of human life from time immemorial. They do add enjoyment to our lives because of their distinctive colors, behavioral displays and also distinctive songs and calls (Houlihan, 1986).

Many of the regions of Ethiopia were covered with thick natural forest and woodland with varieties of trees and wild animals. The forest cover of Ethiopia declined due to anthropogenic effect and natural catastrophes (Hillman, 1993; Gill, 1995). Much of the Ethiopian landscape from sea level up to 4,000 m is altered by agricultural activities, deforestation and over-grazing. The vegetation has been used for fuel wood, construction and other purposes. As a result, wildlife resources of the country are now largely restricted to a few protected areas in about 22,829 km<sup>2</sup>, which is approximately 2.9% of the country's land area (Hilman, 1993).

Ecological studies on birds are important to determine the biodiversity importance of the site, habitat requirements of the species, determine the population size and to understand the population dynamics (Gibbons et al., 1996). There is a need to know and study more about birds in order to protect them because currently many species of birds are in danger of extinction. This

problem is associated with human activities such as destruction or fragmentation of bird habitats for agricultural expansion (ICBP, 1990).

The present study is an attempt to document the species diversity, and relative abundance of birds in the sacred grove of Entoto Mariam Church to provide current information of birds in the area.

## **2. LITRATURE REVIEW**

### **2.1 Ethiopian Orthodox Tewahido Church Forests and Bird Diversity**

The Ethiopian Orthodox Church has long history of planting, protecting and preserving trees around churches (Colwell, 2010). It is forbidden by the religion for anyone to cut the trees around churches as a result of which old aged indigenous trees which have been totally removed from many places in the country are still standing. This in turn results in the formation of patchy forests around the churches (Feoli, 1996, cited in Leul et al., 2010). Owing to this the Ethiopian Orthodox Church forests have attracted the attention of biologists since they are acting as biodiversity “hot spots”. Several animal species including birds and mammals, in addition to plants, inhabit these patchy habitats. The patchy habitats are attracting several animals from areas where severe deforestation and land degradations have occurred.

Studies by Alemayehu Wassie et al. (2005) in North Gondar showed that churches have been places of refuge for many indigenous plants in the semi-arid highlands of Ethiopia. However, bird species residing in these forest patches is rarely investigated. Forests in churches are sanctuaries for different organisms ranging from microbes to large animals including birds. Studies on the diversity of plants have been conducted by Taye Bekele et al. (1998) in eight churches of south Gonder, Northern Ethiopia; however, very little is known about the bird community composition and abundance in those church forests of semi-arid high lands of the Tigray region. These church forests comprise local as well as global “hotspots” as critical conservation areas for a large portion of Ethiopia’s remaining biodiversity (Clout and Hay, 1989). Church forests provide important ecosystem services to local people, including fresh water, pollinators, honey, shade and spiritual value. An increase in complexity of vegetation structure, floristic composition and heterogeneity can increase niche diversity of birds and vice

versa (Leito et al., 2006). Both natural and human induced disturbances such as floods, drought, deforestation change in land use, natural resources and seasonal climatic changes affect vegetation and bird community structures.

## **2.2 Distribution of birds in different habitats**

Birds are commonly distributed in different habitats including the polar regions, the tropics, in forests and deserts, on mountains and prairie and the ocean and its islands (Wilson, 1980). Avian assemblage show latitudinal gradient. Tropical regions typically exhibit higher species richness than do those of temperate latitudes. Whether this higher avian species richness is associated with higher overall abundance of birds in an assemblage and/or with lower abundance of individual species is controversial. There are evidences for the higher numbers of specie in the tropics being supported by higher number of individuals (Karr, 1971: Poulser, 2002). On the other hand, some studies have reported that tropical forest bird assemblages have a higher biomass, but a more similar level of abundance to their temperate counterparts (Terborgh et al., 1990: Thiollay, 1990). In the tropics, greater levels of environmental factors may allow more species to co-exist through increased habitat heterogeneity and enhance niche specialization (Terborgh, 1980: Karr, 1989).

Although birds collectively occupy most of the earth's surface, most species are found only in particular regions and habitats, whereas others are cosmopolitan. Although there is much overlap in the resources that different habitats provide (e.g. insect food), some habitats are rich in certain resources. For example, heath lands are often rich in plant species belonging to the family Proteaceae, which tend to have bird-pollinated flowers that are rich in nectar. Heath lands are therefore good places to see honey eaters (Bird in Backyards, n.d.). Plants of rainforests often produce fleshy fruits and berries. Rainforests are therefore good places to find fruit-eating pigeons. Birds are commonly distributed in different habitats including the Polar Regions, the tropics, in forests and deserts, on mountains and prairie and the ocean and its islands (Wilson, 1980). Geographical distribution of species is a result of the action of both historical and ecological factors in time and space (Vulleumier and Simberloff, 1980). Nearly everyone associates penguins with Antarctica, emus with Australia, and hummingbirds for the most part with tropical or sub-tropical regions. Similarly, with respect to habitat, ducks are associated with water, woodpeckers with trees, and field birds with open spaces. Some species, particularly those

of recent origin and those handicapped by lack of mobility, may still be at or near their place of origin, never having succeeded in occupying new regions. Other species, with greater adaptability, better means of dispersal, or a higher reproductive or genetic potential, which creates population pressure and peripheral spreading, have successfully invaded new areas. Some of them, such as the hawks and owls, gulls and terns, swallow and swifts and many water birds are now virtually worldwide (Wallace and Mahan, 1975). Some species extend their range by “island hopping”. A recent example believed to be attributable to this mode of travel is the cattle Egret, which appeared in northern south America in the late 1930’s, presumably from Africa or Europe, and spread rapidly up the coast of North America to Newfoundland and sporadically into the interior, reaching California in 1964 (Crosby, 1972). Ecological changes, such as the development of a more favorable climate in a previously inhospitable region, encourage range expansion. On the other hand, unfavorable climatic change may restrict further spreading.

### **2.3 Seasonal migration**

The seasonal distribution of birds is affected by their migration patterns. Migration is not a voluntary one, but is one of necessity caused by climatic conditions such as the food supply and the length of the daylight (Lincoln, 1998). In Eastern Africa, the following three types of migration can be recognized : complete, trans-equatorial and local. Complete migration includes those species visit Eastern Africa during the non-breeding season from Europe or Asia. Trans-equatorial migration includes those species that move either to a more humid or to a drier area for breeding, and in so doing cross the equator. Local migration includes those species, which breed in Southern Africa and move northward in the non-breeding season (Mackworth-praed and Grant,1956).

Seasonal stability of the habitat affects species composition and abundance of birds. Bird species that face seasonal irregularities in the availability of food sources have two alternatives. A bird may shift to feeding on other resources, or it may move to another area where the original food resource is available. Where there is no seasonal irregularity in food availability and other factors are held constant, a species can maintain itself throughout the year (Karr, 1976). Seasonal variation in avian community structure decreases with increasing vegetation complexity. This is apparently due to the increased buffering of the physical environment by the more complex vegetation (Smythe, 1974). The impact of

seasonality varies among the subset of the avian fauna (Karr, 1975). Insectivorous species diversity and abundance generally vary more seasonally than do frugivorous species diversity and abundance in structurally mature habitats.

About 214 Palearctic migrants have been recorded from Ethiopia, and a large number of these have breeding populations in the country. Although tropical environments are sometimes assumed to be uniform throughout the year, seasonal changes in precipitation are common. For birds, rainfall regimes and associated environmental changes are of major importance in determining breeding seasons and annual cycles in many regions including Ethiopia (Beals, 1970). Seventy-two species of diurnal raptors occur in Ethiopia, 68 of which are believed to migrate at least in part of their ranges (Brown et al., 1982; Vittery, 1983). Furthermore, the extensive and unique conditions in the highlands of the country have contributed to the presence of the large number of endemic species.

The global population size of species varies by many orders of magnitude. Amongst the birds, the rarest comprise a handful of individuals (Birdlife International, 2000), whilst the most abundant ones have many hundreds of millions (Elliot, 1989). Numerous reasons can be suggested for these differences, including the influence of body size, life history, trophic group, phylogeny and history (Damuth, 1981; Pimm, 1991; Brown, 1995; Gaston and Blackburn, 1996; 2000). However, whether singly or in combination, these variables have been found to explain only small to moderate proportions of the variation in population size. Thus, body size, for example, has been widely quoted as an important correlate and perhaps determinant of abundance. With species of a similar size differing in abundance may be by several orders of magnitude (Nee et al., 1991; Blackburn et al., 1994; Gaston and Blackburn, 1996; 2000).

#### **2.4. Reproduction and feeding**

Birds reproduce sexually and carry out internal fertilization. Temperature may have a direct effect on timing of reproduction, but the correlation may also be indirect, for instance via food phenology. As climate change has led to substantial shifts in timing, it is essential to understand this causal relationship to predict future impacts of climate change (Visser et al., 2009).

Because of their high metabolic rates, birds must consume more food in proportion to their size than most animals. For example, a warbler might eat 80 % of its body weight in a day. As a group, birds consume just about any type of food you can imagine, including amphibians, ants, buds, carrion, crustaceans, fish, fruit, grass, insects, larvae, leaves, molluscs, nectar, other birds, pollen, reptiles, rodents, roots, sap, seeds, snails, wax, and worms. To meet their metabolic needs while remaining as light as possible (to be efficient flyers), the digestive system of birds has to be both as light as possible and as efficient as possible. Weight has been minimized by the loss of teeth &, in many birds, limited jaw musculature. The bill plays a critical role in food acquisition &, of course, bill morphology varies with food habits ( Ladyguin, 2000).

## **2.5 Importance of birds**

Birds are one of the most important components of biodiversity. This is reflected by the ecological, economical and esthetic values. It is often asserted that birds are convenient indicators of biodiversity, at least at large scales and that they are useful for monitoring environmental changes. One reason is that birds have long been popular with naturalists, amateurs and professionals and consequently their systematic and distributions are better known than any other comparable groups of animals, with the possible exception of larger mammals (Furness and Green wood, 1993). Birds are technologically advanced, highly motivated, extremely efficient and cost-effective insect pest controllers (Pschorn-Walker, 1977). As a group, insectivorous birds display a wide variety of feeding specializations, from hunting in the air (swifts and swallows) to excavating deeply in wood (woodpeckers). Roughly 60% of the approximately 8600 species recognized by Mayr and Amadon (1951) are partly or largely insectivorous. Insect pest outbreaks can annually destroy hundreds of millions of dollars of agricultural and forest products. Birds can alter their diets to feed almost exclusively on an insect pest during an outbreak, if it becomes profitable for them to do so. They can develop a search image for this new prey and can learn how to hunt for it more efficiently. Factors that help to determine which type of insects are selected by birds of prey are; insect density, body size and nutritional content, ease of capture, palatability (presence of chemical defenses or parasites), and density of potential competitors (other birds, mammals, ants, spiders, and predacious insects) (Lack, 1954). In 1921, forest and agricultural pests were reduced to 78% by birds resulting in savings of \$ 444 million crop and timber losses. The value of birds in terms of economy is beyond our

imagination. Their value is not just in their actual consumption of insect pests, but also in their role in keeping future outbreaks to a minimum (Holling, 1988).

Birds also serve other purposes in nature. Fruit-eating birds help in dispersal of seeds. Birds eat and digest the pulp of berries and other fruits, but pass the seeds unaffected through their droppings. The seeds may sprout wherever the droppings fall (Clout & Hay, 1989). Certain birds like hummingbirds and sunbirds pollinate certain flowers that produce nectar. Humming birds and sunbirds feed on nectar. As they visit flowers in search of it, they spread pollen from flower to flower.

The value of birds to human society is at present widely recognized and can be extensively traced beyond their immediate products. Wildlife tourism, large farming and sustainable utilization of natural resources are promoted as a source of foreign exchange for developing countries. In many industrialized countries, the revenue from bird watching and related “industries” can be counted in millions of dollars. However, many advantages of birds remain unexplored, for example, their enormous scientific value, which ranges from evolutionary, ecological and behavioral advances to biomedical research, where they are prominent in genetic studies, development of vaccines, and in the discovery and exploitation of retroviruses (Hiwot Hibste, 2007).

Birds can act as bio-indicators of environmental conditions (Gregory et al., 2003). Birds are often used as a biological model because they are good ecological indicators and they are easily observable (Clergeau et al., 2001). Some of the birds are sensitive and have capability of early warning for changes like heavy metal pollution (Furness, 1993; Jarvis, 1993). Marchant et al. (1990) and Baillie et al. (1997) showed that birds in agricultural land declined as chemicals and other input are applied for agricultural intensification to increase productivity, which at the same time leads to the collapse of many invertebrates and microorganisms. Similarly, many specialized invertebrates and plants to specific habitats declined by land use changes (Donald, 1998; Donald et al., 2001). Birds can be used to indicate the status of biodiversity as a whole where little information exists, and the key places for its conservation. Because of their diversity and mobility, birds can tell us much about overall changes to the environment (BLI, 2002).

## **2.6 Taxonomy and morphology**

According to Ehrlich et al. (1994), there are nearly 10,000 known species of modern or recently extinct birds. The living species of birds are grouped into 27 orders and these in turn have been grouped into 155 families (Peterson, 1963). Africa is home to two endemic bird Orders, ten endemic Families (with two more only reaching Madagascar or Arabia) (Sinclair and Ryan, 2003).

Birds are among the most easily defined and readily recognized categories of animals, due to the presence of feather, which is unique to them. In addition to feathers, the development of forelimbs as wings, mostly for flight; feathered tail that serves for balancing, steering and lifting; toothless horny beak and skeleton exhibiting unique adaptations, mainly for flight and bipedal locomotion are characteristics of birds (Wallace and Mahan, 1975; Padian and Chiappe, 1998). Birds are both visually and acoustically conspicuous organisms of most ecosystems. Because they are comparatively easy to identify, birds have received considerable attention of humans (McLay, 1974; Whelan et al., 2008). Patterns of abundance and distribution of birds are strongly related to environmental factors, which determine their presence and activity. The power of flight allows them to move easily through the air and yet they are perfectly adapted to every environment that fit their requirements for successful reproduction and survival (Welty, 1975; Estrella, 2007).

## **3. OBJECTIVES**

### **3.1. General Objective**

The general objective of the study was to document the diversity and relative abundance of birds at Entoto Mariam Church Groves.

### **3.2 Specific. Objectives**

The specific objectives of the study were to:

- produce species list of the groves
- compare diversity of bird species between wet and dry seasons
- determine the bird species with higher and lower number of sightings

## **4. THE STUDY AREA**

### **4.1. Location**

Entoto Mariam Church Grove is located at the northern limit of Addis Ababa. It is part of Gullele Sub city of Addis Ababa Administration and lies at  $09^{\circ} 05' 04''$  N and  $38^{\circ} 45' 06''$  E (Fig. 1). The Church is within the Entoto mountain chain, reaching 3,011 meters above sea level. The church was established in 1877(Gulal Haftu , 2015).The mountain 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. There is a park called Entoto Park which 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 mountain, 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” (Hyena cliff) are 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. 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 (EWNHS, 1996).

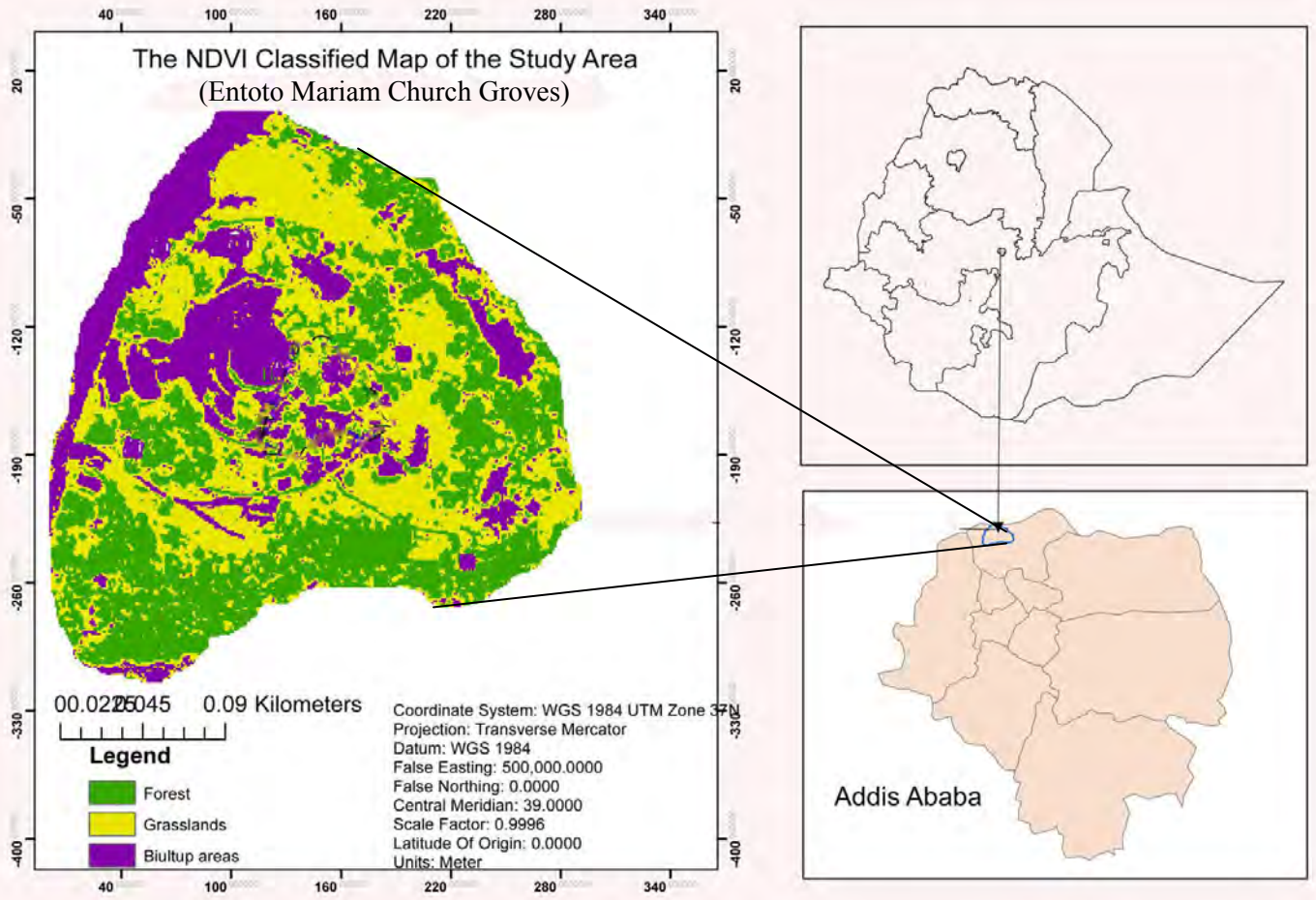
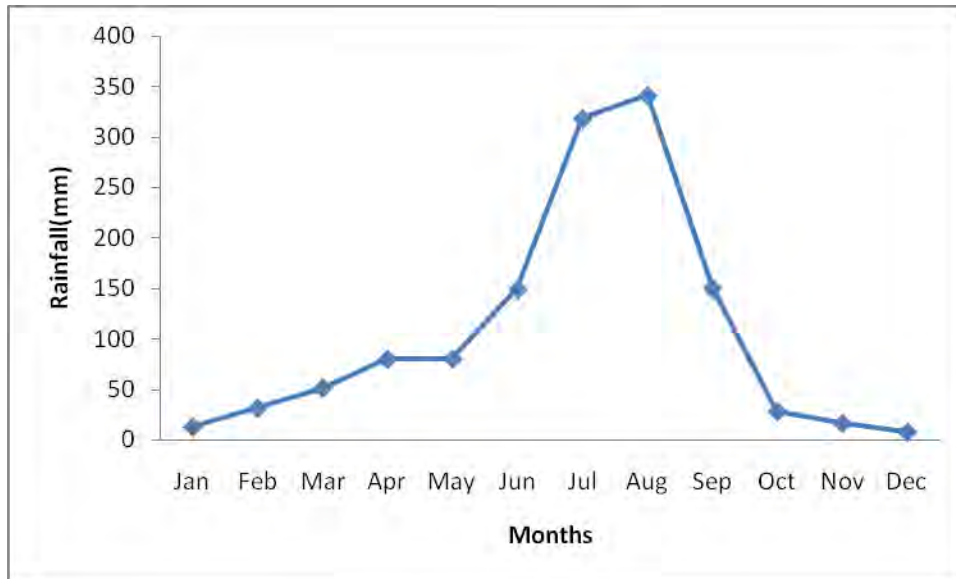


Figure1. Location map of the study area (Entoto Mariam Church Groves)

**4.2 Climate**

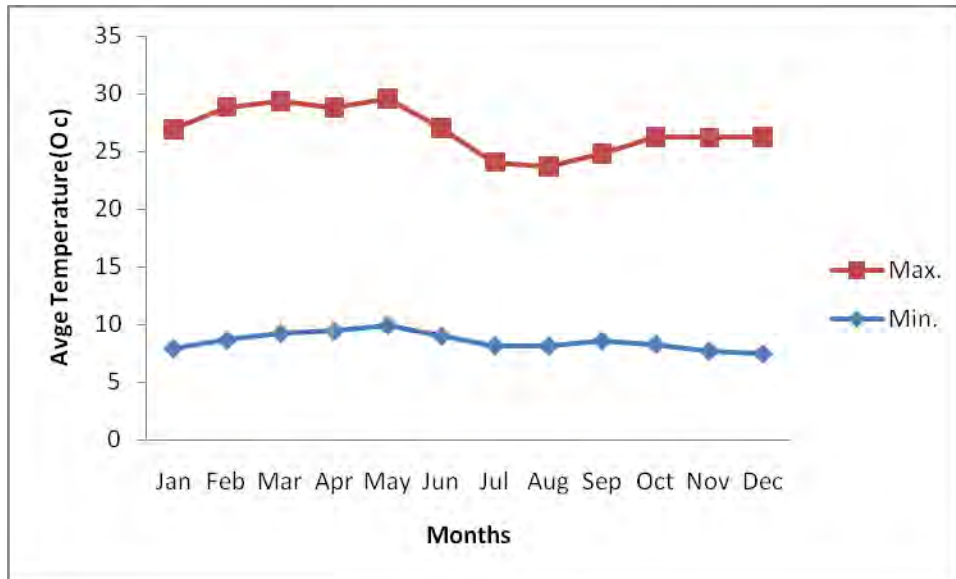
According to a 25 year climate data (1991-2015) provided by National Meteorological Service Agency(2016), the highest average maximum monthly rainfall at Mount Entoto was recorded in August (341.34 mm) and July (318.3 mm) and the lowest occurred in December (7.6 mm) and January (12.6mm) (Fig. 2).



**Figure 2. Average monthly rainfall at Entoto area (mm) (1991-2015)**

The wind is often strong and persistent. This makes the climate quite harsh, especially during the rain and in the higher parts of the Park (Kalkidan Esayas, 2010).

The average maximum monthly temperature was recorded in February ( $20.17^{\circ}\text{C}$ ) and March ( $20.1^{\circ}\text{C}$ ) and the average minimum monthly temperature in December ( $7.46^{\circ}\text{C}$ ) and January ( $7.92^{\circ}\text{C}$ ) (National Meteorological Service Agency, 2016) (Fig.3).



**Figure 3. Monthly average maximum and minimum temperature ( $^{\circ}\text{C}$ ) (1991-2015)**

#### 4.3 Vegetation

The natural vegetation is Afro-montane forest and woodland with open meadows. The dominant vegetation in the grove includes Tid (*Juniperus procera*), Girar (*Acacia abyssinica*), Weira (*Olea europaea*), Zigba (*Podocarpus falactus*) and Korch (*Erythrina brucei*). The area also supports Kulkual (*Euphorbia abyssinica*), Key Bahrzaf (*Eucalyptus Camaldulensis*), Tekur enchet (*Prunus Africana*), Kundo Berbere (*Schinus molle*) and Koso (*Hagenia abyssinnica*) (Appendix 8) (Gulal Haftu ,2015; Hiyab Gebretsadik, 2016 ).

#### 4.4 Fauna

The fauna is mainly composed of spotted hyena (*Hynea hyena*), dikdiks (*Madoqua kirkii*), grey duiker (*Cephalopus monticola*), common jackal (*Canis aureus*), leopard (*Panthera pardus*), vervet monkey (*Chlorocebus pygerythrus*), mole rat (*Heterocephalus glaber*), porcupine (*Hystrix cristata*), civet (*Civettictis civetta*), wild cat (*Felis silvestris*), squirrel(*Sciurus carolinensis*),) and Abyssinian hare (*Lepus habessinicus*) (EWNHS, 1996; Hiyab Gebretsadik, 2016).

## 5. MATERIALS AND METHODS

### 5.1. Sampling method

The study area of the Church grove covers an area of 950 m<sup>2</sup> on Mt. Entoto, between the northern limit of the city of Addis Ababa based on the data obtained from GIS. Point scanning method was used to collect the required data according to Bibby and Jones (1999). A total of 100 scanning hours were used to record birds. These were almost equally distributed in four months. In the first three months (February, April and June, 2016), 24 scanning hours/month were used and in the last month (August, 2016) 28 hrs/month were used. February and April were considered as the dry season months and June and August as wet season months. Data collection was conducted during the weekends of each month both on Saturday and Sunday. Each day was assigned a total of 4 hours of scanning equally distributed in the morning and afternoon. Morning data collection periods were between 7:00 – 9:00 hrs and that of the afternoon between 15:00 – 17:00 hrs. During each hour, the observer stands at a randomly selected point and records newly sighted species and the number of individuals for all sighted species for five minutes. Scanning was interrupted for 30 seconds and continued on a different point of observation which is randomly selected. In this manner the whole sampling area was scanned in two hours while subsequent scanning in the remaining time was used as duplicate scanning. New species were given a nominal code (Appendix 9) by the observer which was later used to identify them using Collins Field Guide Birds of Eastern Africa (Perlo, 2009). Binocular (8X20; 7.5<sup>0</sup> Japan) was used to view birds from a distance.

### 5.2. Data analysis

#### 5.2.1. Diversity Index

Shannon-Weiner diversity index was used to measure the avian diversity using:

$$H' = -\sum_{i=1} P_i \ln P_i$$

Where:

H' = Shannon- Wiener index

Pi = Proportion of the i<sup>th</sup> species

Ln =Natural Logarithm

### 5.2.2. Evenness Index

Equitability or evenness index was calculated using the ratio of observed diversity to maximum diversity using the equation.

$$E = H'/H_{\max}$$

Where:

E= Evenness index

H' = Shannon Wiener Diversity index

H<sub>max</sub> = Natural log of total number of species

### 5.2.3. Relative abundance

The relative abundance of each species was estimated from encounter rates (sightings) per 100 hours of scanning. This value was used to give each species an ordinal rank of abundance using the ranking scale of Bibby and Jones (1999) given below in Table 1.

**Table 1. Ordinal scale of abundance used to rank species**

<b>Abundance Category</b>	<b>Abundance score</b>	<b>Ordinal rank</b>
<0.1	1	Rare
0.1-2.0	2	Uncommon
2.1-10.0	3	Frequent
10.1-40	4	Common
40+	5	Abundant

Chi-square test was used to compare seasonal and monthly variations in diversity and evenness of birds at the 95 % level of significance. SPSS (version 20.0) statistical program was used for the analysis.

## 6. RESULTS

### 6.1. Species composition

A total of 48 avian species belonging to 8 orders and 21 families were recorded during the study period. Only one species, Spot-breasted lapwing (*Vanellus melanocephalus*), was endemic to Ethiopia. White-collared pigeon (*Columba albitorques*), White-backed black tit (*Melaniparus leuconotus*) and white-winged cliff-chat (*Monticola semirufus*) were the three endemic species to both Ethiopia and Eritrea. The highest number of species was recorded for the Family Turdidae (8 species) and Accipitridae (6 species) followed by Columbidae (4 species) and the rest of the families ranged between one to three species. Among the recorded bird species, the Order Passeriformes was the most dominant and largest order with the highest number of families (14) and species (32). Among the recorded species, 2 species, Jacobin Cuckoo (*Clamator jacobinus*) and black kite (*Milvus migrans*), were Intra-African migrants; three species, willow warbler (*Phylloscopus trochilus*), wood warbler (*Phylloscopus sibilatrix*) and blue-rock thrush (*Monticola solitaria*) were palearctic migrants. The Crowned eagle (*Strephanoaetus coronatus*) is near threatened species and the white-headed vulture (*Aegypius occipitalis*) is the only critically endangered species in the 2015 Red List category and the Spot-breasted plover (*Vanellus melanocephalus*), white-collared pigeon and white-winged cliff-chat were least concern species while twenty species were residents in the country (Table 2).

**Table 2. Bird species recorded from Entoto Kidest Mariam Church groves**

No	Order	Family	Scientific Name	Common Name	Status		
					D	W	B
1	Accipitriformes	Accipitridae	<i>Buteo rufofuscus</i>	Augur Buzzard	+	+	+
2			<i>Strephanoaetus coronatus</i>	Crowned eagle	+		

3			<i>Haliaeetus vocifer</i>	African fish eagle	+		
4			<i>Milvus migrans</i>	Black Kite	+	+	+
5			<i>Aegypius occipitalis</i>	White-headed Vulture	+		
6			<i>Accipiter erythropus</i>	Red-thighed Sparrowhawk	+		
7	Apodiformes	Apodidae	<i>Tachymarptis melba</i>	Alpine Swift	+	+	+
8	Caprimulgiformes	Caprimulgidae	<i>Caprimulgus poliocephalus</i>	Montane Nightjar	+		
9	Charadriiformes	Charadriidae	<i>Charadrius marginatus</i>	White Fronted Plover		+	
10			<i>Vanellus melanocephalus</i>	Spot-breasted lapwing/plover		+	
11	Columbiformes	Columbidae	<i>Streptopelia lugens</i>	Dusky Turtle Dove	+		
12			<i>Streptopelia semitorquata</i>	Red-eyed Dove	+	+	+
13			<i>Columba guinea</i>	Speckled Pigeon	+	+	+
14			<i>Columba albitorques</i>	White-collared Pigeon		+	
15	Cuculiformes	Cuculidae	<i>Clamator jacobinus</i>	Jacobin Cuckoo		+	
16	Passeriformes	Corvidae	<i>Corvus rhipidurus</i>	Fan-tailed Raven	+		

17		Estrildidae	<i>Pytilia phoenicoptera</i>	Red Winged Pytilia	+	+	+
18			<i>Estrilda chamosyna</i>	Red-rumped Waxbill	+		
19			<i>Lagonosticta senegala</i>	Red-billed firefinch	+		
20		Hirundinidae		Wire-tailed swallow		+	
21			<i>Hirundo smithii</i>			+	
22			<i>Hirundo atrocaerulea</i>	Blue swallow		+	
23		Monarchidae	<i>Terpsiphone viridis</i>	African paradise monarch	+		
24		Nectariniidae	<i>Nectarinia tacazze</i>	Tacazze Sun bird	+		
25		Paridae	<i>Parus leuconotus</i>	White-backed black tit	+		
26			<i>Parus funerus</i>	Dusky tit	+		
27		Passeridae	<i>Passer eminibey</i>	Chestnut Sparrow		+	
28			<i>Passer swainsonii</i>	Swainson's Sparrow		+	
29		Ploceidae	<i>Ploceus galbula</i>	Rueppell's weaver		+	
30			<i>Ploceus baglafaecht</i>	Baglafaecht Weaver		+	
31		Pycnonotidae	<i>Pycnonotus barbatus</i>	Common Bulbul	+		
32		Remizidae	<i>Anthscopus musculus</i>	Mouse colored penduline tit	+		
33		Sturnidae	<i>Cinnyricinclus sharpii</i>	Sharpe's Starling		+	
34			<i>Sturnus vulgaris</i>	Common Starling		+	

35			<i>Onychognathus fulgidus</i>	Chestnut-winged Starling		+	
36		Sylviidae	<i>Phylloscopus trochilus</i>	Willow warbler		+	
37			<i>Sylvia borin</i>	Garden warbler		+	
38			<i>Phylloscopus umbrovirens</i>	Brown warbler		+	
39			<i>Phylloscopus sibilatrix</i>	Wood warbler		+	
40		Timaliidae	<i>Illadopsis abyssinica</i>	African hill babbler		+	
41		Turdidae	<i>Turdus olivaceus</i>	Olive Thrush	+		
42			<i>Turdus abyssinicus</i>	Mountain Thrush	+		
43			<i>Monticola solitaria</i>	Blue-rock Thrush		+	
44			<i>Cichladusa guttata</i>	Spoted palm Thrush		+	
45			<i>Cossypha albicapilla</i>	White crowned Robin Chat		+	
46			<i>Cercomela sordida</i>	Alpine(Moorland) chat		+	
47			<i>Myrmecocichla semirufa</i>	White-winged cliff-chat		+	
48	Trogoniformes	Trogonidae	<i>Apaloderma narina</i>	Narina Trogon		+	

Key: D= observed only during the dry season, W= observed only during the wet season and B= observed during both seasons

## 6.2. Relative abundance of species

During the study period most avian species (45.83%) were found within the ordinal rank of “Abundant” while 37.5% were “Common” and 16.67% “Frequent”. “Uncommon” and “Rare” ranks were absent (Table 3).

**Table 3. Ordinal abundance rank of species based on total encounter rates per 100 hours of scanning**

No	Species	Total number of sightings/100 hrs	Ordinal rank of abundance
1	Mouse colored penduline tit	703 (19.42%)	Abundant
2	Tacazze Sun bird	294 (8.12%)	Abundant
3	Red- eyed Dove	234 (6.42%)	Abundant
4	White-collared Pigeon	219 (6.05%)	Abundant
5	Alpine Swift	207 (5.72%)	Abundant
6	Blue-rock Thrush	159 (4.39%)	Abundant
7	White crowned Robin Chat	153 (4.23%)	Abundant
8	Sharpe’s Starling	126 (3.48%)	Abundant
9	Chestnut winged Starling	111 (3.07%)	Abundant
10	Mountain Thrush	105 (2.9%)	Abundant
11	Crowned eagle	105 (2.9%)	Abundant
12	Olive Thrush	84 (2.32%)	Abundant
13	Dusky Turtle Dove	81 (2.24%)	Abundant
14	Rock martin	81 (2.24%)	Abundant
15	White-winged cliff-chat	75 (2.07%)	Abundant
16	Montane Nightjar	74 (2.04%)	Abundant
17	White-headed Vulture	71 (1.97%)	Abundant
18	Wire-tailed swallow	69 (1.9%)	Abundant
19	Fan-tailed Raven	62 (1.71%)	Abundant

20	Red-thighed Sparrowhawk	61 (1.69%)	Abundant
21	Speckled Pigeon	53 (1.46%)	Abundant
22	Ruppell's weaver	42 (1.16%)	Abundant
23	Black Kite	38 (1.05%)	Common
24	Spotted palm Thrush	33 (0.91%)	Common
25	Common starling	32 (0.89%)	Common
26	Swainson's Sparrow	32 (0.89%)	Common
27	African fish eagle	31 (0.86%)	Common
28	Augur Buzzard	28 (0.77%)	Common
29	Red-rumped Waxbill	24 (0.66%)	Common
30	Dusky tit	23 (0.64%)	Common
31	Garden warble	22 (0.61%)	Common
32	Red-billed firefinch	21 (0.58%)	Common
33	Chestnut Sparrow	17 (0.47%)	Common
34	Red winged pytilia	16 (0.44%)	Common
35	African paradise monarch	15 (0.41%)	Common
36	Narina Trogon	14 (0.39%)	Common
37	Baglafaecht Weaver	13 (0.36%)	Common
38	White Fronted Plover	13 (0.36%)	Common
39	Jacobin Cukoo	11 (0.31%)	Common
40	Spot-breasted plover	11 (0.31%)	Common
41	Blue swallow	10 (0.28%)	Frequent
42	African hill barbler	9 (0.25%)	Frequent
43	White-backed black tit	8 (0.22%)	Frequent
44	Brown warbler	7 (0.2%)	Frequent
45	Common Bulbul	6 (0.17%)	Frequent
46	Willow warbler	6 (0.17%)	Frequent
47	Wood warbler	6 (0.17%)	Frequent
48	Moorland chat	5 (0.14%)	Frequent
	<b>Total</b>	<b>3620 (100%)</b>	

### 6.3. Seasonal abundance of bird species

#### 6.3.1. The first four bird species with high number of sightings

Mouse colored penduline tit (*Anthoscopus musculus*) was the first species with the highest number of sightings of 703 (19.42%) in the study area followed by Tacazze sun bird (*Nectarinia tacazze*) with the total sighting of 294 (8.12%) within the study period of time (Appendix 1,2,3 and 4). Dry season seems the more suitable season for Mouse colored penduline tit and Tacazze Sun bird but Wet season do too for White-collard Pigeon (*Columba albitorques*) with the total sighting of 219 (6.05%) (Table 4).

**Table 4. Seasonal abundance of the first four bird species with high number of sightings**

No	Species	Dry season	Wet season	Total
1	Mouse colored penduline tit	703	-	703
2	Tacazze Sun bird	294	-	294
3	Red- eyed Dove	45	189	234
4	White-collared Pigeon	-	219	219

#### 6.3.2. The last four bird species with lower number of sightings

Moorland chat (*Cercomela sordida*) was the species with the lowest number of sightings of 5 (0.14%) in the study area followed by Willow warbler (*Phylloscopu strochilus*), Wood warbler (*Phylloscopus sibilatrix*) and Common Bulbul (*Pycnonotus barbatus*) with the total sighting of 6 each (0.17 %) (Table5).

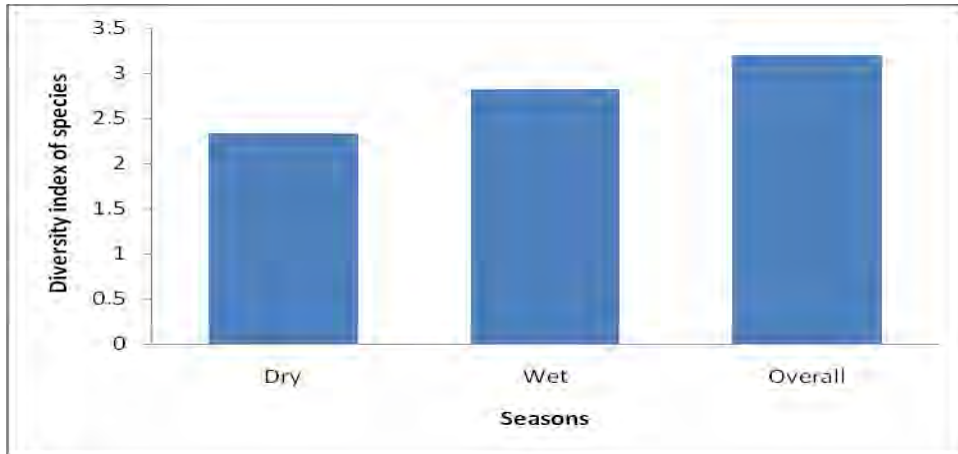
**Table 5. Seasonal abundance of the last four bird species with lower number of sightings**

No	Species	Dry season	Wet season	Total
1	Moorland chat	-	5	5
2	Willow warbler	-	6	6
3	Wood warbler	-	6	6
4	Common Bulbul	6	-	6

## 6.4. Diversity and Evenness Indices

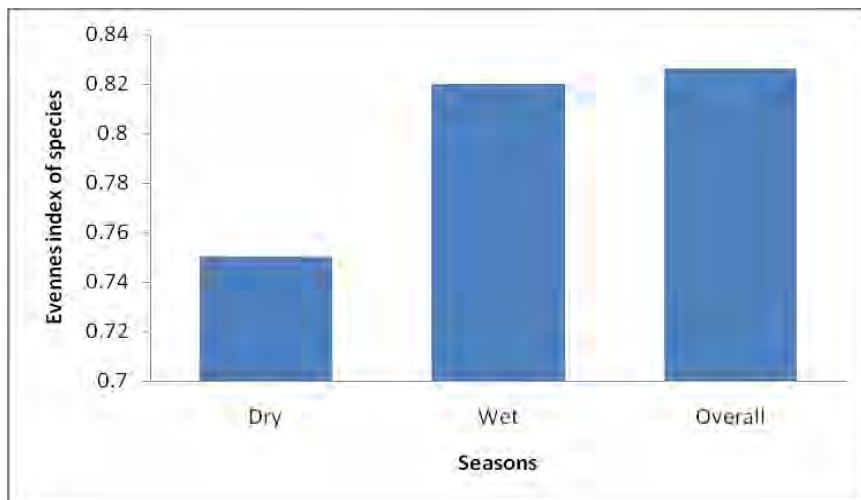
### 6.4.1 Seasonal Diversity and Evenness Indices

The wet season diversity index ( $H'=2.82$ ) was slightly higher than that of the dry season ( $H'=2.3$ ) while the overall diversity index was ( $H'=3.87$ ) (Fig. 4).



**Figure 4. Seasonal and overall diversity index of birds**

Evenness index was also higher during the wet season ( $E=0.82$ ) than the dry season ( $E=0.75$ ) and the overall evenness index was 0.826 (Fig.5).



**Figure 5. Seasonal and overall evenness index**

Using Chi-square test, variations in bird species diversity ( $df=1$ ,  $p=0.655$ ) and species evenness ( $df=1$ ,  $p=1.00$ ) were statistically insignificant between seasons (Table 6 and 7).

**Table 6 . Chi-square test for species diversity of birds between seasons**

	Observed H'	Expected H'	Residual	Chi square	Df	Sig.
Dry	2.337	2.5	-0.5	0.2	1	0.655
Wet	2.827	2.5	0.5			

**Table7 . Chi-square test for species evenness index of birds between seasons**

	Observed E'	Expected E'	Residual	Chi square	Df	Sig.
Dry	0.75	0.79	0.0	0.00	1	1.00
Wet	0.82	0.79	0.0			

Even if statistically insignificant differences in species diversity and evenness were observed between different seasons, only 12.5 % of the total species occurred during both seasons.

## **7. DISCUSSION**

The number of species recorded in the present study was much lower than what was reported by Kalkidan Esayas (2010) from the same area. She had recorded 124 species belonging to 14 orders and 44 families in different habitats (forest, farmland and eucalypts plantation) at Entoto. The difference was probably due to the variation in the size of the study areas used in the two studies. The study by Kalkidan covered additional areas outside of the Church groves. Also the study covered variable habitat types. These different habitats have their own different bird species due to the heterogeneity of vegetation composition and other food resources. Similarly, Donnelly and Marzluff (2004) and Antos et al. (2006) justified that as size of survey areas increase, the richness and composition of bird species also increased.

Similarly, the study area maintains lesser species composition when compared with previous studies from various localities. For example, the number of avian species was 65 and 102 reported by Hailemariam Areaya et al.(2013) at Church(Tigray) and Elizabeth Girma (2007) at Recreational Parks(Addis Ababa) respectively. This difference could be once again due to the restriction on the sampling area in the present study. Gaveriski (1976) and Davidar *et al.* (2001)

stressed the effect of size and habitat to be important determinants of species richness and diversity. The difference in habitat characteristics and feeding habits of bird species could also be the reason for variation in species diversity and number of individuals of bird species among different habitats as suggested by Smith (1992). The suitability of habitats for different bird species can be affected by food supply and shelter (Whittaker, 1975).

On the other hand, St.Marry church groves support greater avian biodiversity when compared to the studies reported by some authors in other study areas. For example, the number of avian species was 21 reported by Kalayu Mesfin (2014) at church (Aksum). Such variations may not be explained until comparative ecological studies are conducted between the present study area and the previous study sites.

The sacred place also supports varieties of birds since it is used as a refuge by several birds that forage elsewhere and come back to the sacred groves because they are less disturbed. This might also be due to higher vegetation complexity and floristic composition of the habitats which was also suggested by Wiens and Rotenberry (1981) and Marone (1991)).

The present study area contained only one endemic bird species (Spot-breasted plover, *Vanellus melanocephalus*), three endemic species shared with Eritrea (White-collared pigeon, *Columba albitorques*, White-backed black tit *Melaniparus leuconotus* and white-winged cliff-chat, *Monticola semirufus* ) and one critically endangered species (white-headed vulture, *Aegypius occipitalis*). There are some evidences that some of these avian species were recorded and others were unrecorded in different studies reported by different authors such as Kalayu Mesfin and Gebremedhin Teklu (2014) at church forest (Eastern Tigray), Hailemariam Areaya et al.(2013) at church forests(Tigray) and Elizabeth Girma( 2007) at recreational parks(Addis Ababa). Identifying situations of these birds in different study areas of the country help us to give more attention and take measures to protect them. As suggested by Gebrecherkos Woldegeorgis and Tilaye Wube (2012) the data documented on bird diversity is important in monitoring biodiversity changes and planning interventions. Also, the conservation focus on endemic and critically endangered species has been justified by the potential role that they may play in maintaining overall ecosystem functionality (Loreau et al., 2001).

The first four birds with high number of sightings; Mouse colored penduline tit, Tacazze Sun bird, Red- eyed Dove and White-collared Pigeon accounted for 40.01% of the total relative abundance. This might be due to more stable source of food for these species. Although they are the dominant birds, their dominancy was seasonal and may be they migrated to survive except the Red-eyed Dove. As some evidence justified that unless most birds should migrate, their food supplies in their ranges would be rapidly depleted and then they would starve and die. This evidence also indicated that breeding is other cause for migration of birds (Mayntz, 2017). For example, Mouse colored penduline tit was the most abundant, seasonal and found only in dry season in the study area. The reason might be related to its ecological adaptations. Because dry habitat favors this species ([https://en.wikipedia.org/wiki/Mouse-coloured\\_penduline\\_tit](https://en.wikipedia.org/wiki/Mouse-coloured_penduline_tit)). White collared pigeons were recorded in the wet seasons and this could be due to the availability of more food sources from flora production although their more suitable habitats are woodland and grassland or cultivated land above 1800 m (Baptista et al 2017). On the other hand the Red-eyed doves occurred in both seasons in the grove. This is probably because of their adaptation in different seasons and most habitats other than desert (Baptista et al, 2017). Baptista et al (2017) showed that red-eyed dove was recorded in all months in Nigeria, East Africa, Zimbabwe and South Africa.

In contrast the last four bird species with lower number of sightings; Moorland chat , Willow warbler , Wood warbler and Common Bulbul accounted for 0.64 % of the total species. This may be due to insufficient amount of their food in this area. For example, the moorland chats prefer shrub land and they feed on invertebrates such as insects, larvae, spiders, worms, possibly seeds and berries. But the moorland chat could be present in the month of August in the forest probably due to the availability of more food resources(existence of more invertebrates and green vegetation) at the study area. Then they could migrate in to the shrub land at the end of the wet season (Collar, 2017). Wood warbler breeds in moist and shady lowland deciduous woods (Clement, 2017 ). They were very small in number probably due to the nature of the groves (that is not shady lowland deciduous woods) and they were found in the month of August probably due to the moist habitat.

Erdelen (1984) showed that bird species diversity is significantly influenced by floristic composition. However, studies by Hanson (1997) found that the number of plant species was not

clearly correlated with the number of bird species. The result of the present study partially disagree with Hanson (1997). Because as Telleria and Santos (1994) pointed out habitat composition as well as climate affect the distribution of individual bird species. Some birds such as Augur Buzzard, Red- eyed Dove, and Speckled Pigeon occur in all of the study months and both seasons. But the rest bird species were recorded in some study months or even only in one month. For example, Moorland chat was recorded in August and Mouse colored penduline tit was recorded in February and April only. This might also be correlated with McPherson and Jetz (2007) who revealed that different species may be suited to conditions at different times of the year.

The Diversity index result showed that the species diversity declined during the dry season ( $H'=2.34$ ), while it increased during wet season ( $H'=2.83$ ). This might be due to the presence of immigrating species (MacArthur, 1964; Adeyemo and Ayodele, 2005). During the wet season the productivity and yield of habitat increases as many of the invertebrates breed and the vegetation becomes more productive on which the birds depend and as a result the diversity increases. This is supported by Gebrecherkos Woldegeorgis and Tilaye Wube (2012) who indicated that the Yayu forest food resources become plenty and attractive during the wet season resulting in higher avian species during wet seasons than dry season. This happens because of variation in environmental factors such as temperature and rainfall. This explanation is supported by the work of Root (1988), Currier and Fritz (1999) and Rosenzweig and Abramsky (1993) that animal diversity has often been explained in terms of environmental factors. These ideas also agree with the work of Oindo et al (2001), and McPherson and Jetz (2007) who 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 the non-seasonal one.

Variations in availability of animal and plant food resources that are suited for different bird species in the church forest can also result in different diversity index in different time intervals. Some groups of birds feed on insects, some on flowers, and others on seeds. For instance, Augur buzzards feed on flesh and white collard pigeons feed on seeds. So the increase and decrease of

species diversity at different seasons might be due to migration of birds from one habitat to the other in search of food (MacArthur, 1964; Adeyemo and Ayodele, 2005).

## **8. CONCLUSION AND RECOMMENDATION**

### **8.1 Conclusion**

The present study at Entoto St. Marry church revealed that the habitat supports a variety of bird species. Among these, one is endemic to the country. The findings are yet another confirmation that Ethiopian churches have played important role in preserving nature including bird diversity. The study area can serve as important center for tourist attraction with respect to wildlife tourism.

### **8.2 Recommendations**

- Specific and detailed research on the different components of the biodiversity of the area including the ecological needs of selected species such as endemic, most and least abundant birds could reveal key aspects of conservation planning.
- Differences in the seasonality of insect population in the habitat vegetation type should be studied to assess its impact on the seasonal distribution of insectivorous birds.
- The status of the endemic birds that occurs in the study area should be studied in detail. This is important to know whether the species is in danger and to take appropriate conservation measures.
- The area should be carefully monitored over a long period on reproductive potential and behavior of birds that might be helpful to understand the effect of managed habitat on birds.

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## 10. APPENDICES

### Appendix 1. Abundance proportions (pi) used in calculation of diversity index (Dry season)

N	Species	NO of individuals of each species	Pi	lnpi	-pilnpi
1	African fish eagle	31	0.0162	-4.12274	0.06679
2	African paradise monarch	15	0.0078	-4.85363	0.03786
3	Alpine Swift	6	0.0031	-5.77635	0.01791
4	Augur Buzzard	22	0.0115	-4.46541	0.05135
5	Black Kite	32	0.0167	-4.09235	0.06834
6	Common Bulbul	6	0.0031	-5.77635	0.01791
7	Crowned eagle	105	0.0547	-2.90589	0.15895
8	Dusky tit	23	0.012	-4.42285	0.05307
9	Dusky Turtle Dove	81	0.0422	-3.16534	0.13358
10	Fan-tailed Raven	62	0.0323	-3.43269	0.11088
11	Mountain Thrush	105	0.0547	-2.90589	0.15895
12	Montane Nightjar	74	0.0386	-3.2545	0.12562
13	Mouse colored penduline tit	703	0.3665	-1.00376	0.36788
14	Olive Thrush	84	0.0438	-3.12812	0.13701
15	Red- eyed Dove	45	0.0235	-3.75075	0.08814
16	Red winged pytilia	6	0.0031	-5.77635	0.01791
17	Red-billed firefinch	21	0.0109	-4.51899	0.04926
18	Red-rumped Waxbill	24	0.0125	-4.38203	0.05478
19	Red-Thighed Sparrowhawk	61	0.0318	-3.44829	0.10966
20	Speckled Pigeon	39	0.0203	-3.89713	0.07911
21	Tacazze Sun bird	294	0.1533	-1.87536	0.28749
22	White-backed black tit	8	0.0042	-5.47267	0.02299
23	White-headed Vulture	71	0.037	-3.29684	0.12198

**Appendix 2. Abundance proportions (pi) used in calculation of diversity index (Wet season)**

N Q	Species	NO of individuals of each species	Pi	lnpi	-pilnpi
1	African hill barbler	9	0.0053	-5.24005	0.02777
2	Alpine Swift	201	0.1181	-2.13622	0.25229
3	Augur Buzzard	6	0.0035	-5.65499	0.01979
4	Baglafecht Weaver	13	0.0076	-4.87961	0.03709
5	Black Kite	6	0.0035	-5.65499	0.01979
6	Blue swallow	10	0.0059	-5.1328	0.03028
7	Blue-rock Thrush	159	0.0934	-2.37086	0.22144
8	Garden warbler	22	0.013	-4.34281	0.05646
9	Brown warbler	7	0.0041	-5.49677	0.02254
10	Chestnet winged Starling	111	0.0652	-2.7303	0.17802
11	Chestnut Sparrow	17	0.01	-4.60517	0.04605
12	Common starling	32	0.0188	-3.9739	0.07471
13	Jacobin Cuckoo	11	0.0065	-5.03595	0.03273
14	Moorland chat	5	0.0029	-5.84304	0.01694
15	Narina Trogon	14	0.0082	-4.80362	0.03939
16	Red- eyed Dove	189	0.111	-2.19823	0.244
17	Red Winged Pytilia	10	0.0059	-5.1328	0.03028
18	Rock martin	81	0.0476	-3.04492	0.14494
19	Ruppell's weaver	42	0.0247	-3.70095	0.09141
20	Sharpe's Starling	126	0.074	-2.60369	0.19267
21	Speckled Pigeon	14	0.0082	-4.80362	0.03939
22	Spot-breasted plover	11	0.0065	-5.03595	0.03273
23	Spoted palm Thrush	33	0.0194	-3.94248	0.07648
24	Swainson's Sparrow	32	0.0188	-3.9739	0.07471
25	White crowned Robin Chat	153	0.0899	-2.40906	0.21657
26	White Fronted Plover	13	0.0076	-4.87961	0.03709
27	White-collared Pigeon	219	0.1287	-2.05027	0.26387
28	White-winged cliff-chat	75	0.0441	-3.1213	0.13765

29	Willow warbler	6	0.0035	-5.65499	0.01979
30	Wire-tailed swallow	69	0.0405	-3.20645	0.12986
31	Wood warbler	6	0.0035	-5.65499	0.01979

### Appendix 3: Ordinal Abundance rank of Species

Name of species	Encounter rate/100 field hours	Abundance score	Ordinal rank of abundance
African fish eagle	31	4	Common
African hill barbler	9	3	Frequent
African paradise monarch	15	4	Common
Alpine Swift	207	5	Abundant
Augur Buzzard	28	4	Common
Baglafecht Weaver	13	4	Common
Black Kite	38	4	Common
Blue swallow	10	3	Frequent
Blue-rock Thrush	159	5	Abundant
Garden warbler	22	4	Common
Brown warbler	7	3	Frequent
Chestnut winged Starling	111	5	Abundant
Chestnut Sparrow	17	4	Common
Common Bulbul	6	3	Frequent
Common starling	32	4	Common
Crowned eagle	105	5	Abundant
Dusky tit	23	4	Common
Dusky Turtle Dove	81	5	Abundant
Fan-tailed Raven	62	5	Abundant
Jacobin Cuckoo	11	4	Common
Moorland chat	5	3	Frequent
Mountain Thrush	105	5	Abundant
Montane Nightjar	74	5	Abundant

Mouse colored penduline tit	703	5	Abundant
Narina Trogon	14	4	Common
Olive Thrush	84	5	Abundant
Red- eyed Dove	234	5	Abundant
Red winged pytilia	16	4	Common
Red-billed firefinch	21	4	Common
Red-rumped Waxbill	24	4	Common
Red-Thighed Sparrowhawk	61	5	Abundant
Rock martin	81	5	Abundant
Ruppell's weaver	42	5	Abundant
Sharpe's Starling	126	5	Abundant
Speckled Pigeon	53	5	Abundant
Spot-breasted plover	11	4	Common
Spotted palm Thrush	33	4	Common
Swainson's Sparrow	32	4	Common
Tacazze Sun bird	294	5	Abundant
White-backed black tit	8	3	Frequent
White crowned Robin Chat	153	5	Abundant
White Fronted Plover	13	4	Common
White-collared Pigeon	219	5	Abundant
White-headed Vulture	71	5	Abundant
White-winged cliff-chat	75	5	Abundant
Willow warbler	6	3	Frequent
Wire-tailed swallow	69	5	Abundant
Wood warbler	6	3	Frequent

**Appendix 4. Part of the grove at Entoto Saint Marry Church**



**Appendix 5. Point Count Field Data Sheet for Bird Survey**

Date \_\_\_\_\_

Starting time \_\_\_\_\_

Finishing time \_\_\_\_\_

Code letter/ Common Name of Bird species	Unique feature	Number of individuals

Additional Notes: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## **Declaration**

I declare that the dissertation submitted here by for the Degree of Master of Science in Biology to Department of Zoological Sciences, Addis Ababa University is my original work. All materials obtained from other sources have been dually acknowledged in the thesis.

Candidate's Name: Hailu Urgessa

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