Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Sciences

Diversity and Relative Abundance of Birds at Abune-Gebremenfeskdus Church Grove in Adwa, Northern Tigray

A thesis submitted to school of graduate studies of Addis Ababa University in partial fulfillment of the requirements for the degree of master science in biology

By

Guesh Hafte

Advisor

Dr Tilaye Wube

September, 2019

DECLARATION

ADDIS ABABA UNIVERSITY

School of Graduate students

This is to certify that thesis prepared by Guesh Hafte Tesfay entitled the distribution and relative abundance of birds in Abune-Gebremenfeskdus church grove in Woreda Adwa Tigray and submitted to partial fulfillment of requirement of degree of Masters of sciences with the regulation of University and meets the accepted standard with respect to originality and quality.

Signed by Examining Committee:

Advisor: Dr. Tilaye Wube Signature---------- Date----------

Examiner: ---------- Signature---------- Date----------

Examiner: ---------- Signature---------- Date----------

Chairman of department

ACKNOWLEDGEMENTS

First and foremost I would like to express my deepest gratitude from the bottom of my heart to my advisor Dr. Tilaye Wube for his initiation, encouragement, continuous assessment, giving critical and constructive comments, recommendations and suggestions from the beginning to the end of the thesis research and writing.

My gratitude also goes to Tesfaye Alemayoh a bird expert who gave me a short training on bird identification. Letebrhan Welehaweria is duly acknowledged for helping in identification of the local names of some of the birds. My thanks also go to Colonel Gebrezgiher Gebrelibanos for his cooperation by providing binoculars.

I gratefully acknowledge MoE and Addis Ababa University, Department of Zoological Sciences, for sponsoring and hosting the study respectively. Planning and Finance Office and Natural Resource and Agriculture Office of Adwa Town are acknowledged for provision of background information about the study area. I am also grateful for Ethiopian National Metrological Services Agency for climatic data of the study area.

My sincere love and respect goes to my wife W/ro Hanetsa Hagos who gave me true love and motivation to complete my work efficiently. I am indebted to my father Priest Hafte and my mother W/ro Hiwot Abraha for their financial and moral support during my study. My brother Engineer Negassi Hafte material support including PC, has been invaluable for completion of this study.

Last but not least, I would like to express my great gratitude to all my friends who supported me morally and also provided necessary material support including valuable references.

Table of Contents

LIST OF TABLES

LIST OF FIGURES Page

LIST OF APPENDECES

LIST OF ACRONYM

EARO	Ethiopian Agricultural Research Organization
EBA	Endemic Bird Area
ENMSA	Ethiopian National Meteorological Service Agency
EOTC	Ethiopian Orthodox Tewahido Churches
EWCA	Ethiopian Wildlife Conservation Authority
EWNHS	Ethiopian Wildlife and Natural History Society
GIS	Geographic Information System
IBA	Important Bird Area
ICBP	International Council for Bird Protection
MoE	Minister of Education
NRA	Natural Resource and Agriculture
WCMC	World Conservation Monitory Center

ABSTRACT

This study was aimed at investigating diversity and relative abundance of birds at Abune-Gebremenfeskdus Church Grove in Adwa, Northern Tigray. The study was conducted between September 2018 and March 2019. Point counting method was used to collect the intended data. Accordingly, each hour of data collection was divided into three scanning sessions of 10 minutes duration separated by 10 minutes of pause. The data collection days were subdivided as morning (7:00-10:00hr) and afternoon (15:00-18:00hr). A total of 67 bird species grouped in 12 Orders and 35 Families were recorded. Five species; White-Collared Pigeon (*Columba albitorques*), White-Billed Starlling (*Onychognathus albirostris*), Black Winged Love Bird (*Agapornis taranta*), Wattled Ibis (*Bostrychia Carunculata*) and Thick Billed Raven (*Corvus crassirostris*) were endemic to Ethiopia and Eritrea. Passeriformes was the dominant Order with the highest number of Families (n=19) and Species (n=34). Four species were Intra-African migrants, and another four species were Pale-arctic migrants. Eastern Red- Footed Falcon (*Falco amurensis*) was near threatened; Greater Spotted Eagle (*Adults clanga*) and Pied Kingfisher (*Corythornis*) species were endangered. Twenty eight species were recorded only in two seasons (14 species in the wet season and the remaining 14 in the dry season). Based on calculations of ordinal ranks of abundance, five species were categorized as common, 15 as frequent, 25 as uncommon, and 22 as rare. Red cheeked cordon blue (*Uraeginthus bengalus*) and Red billed fire finch (*Lagonosticta senegala*) were the most abundant birds with total sightings of 696 and 541 respectively. On the other hand, pied crow (*Corvus albus*) and White helmet shrike (*Prionops plumata*) were the least abundant species with respective sightings of three and six. There was slight difference in the diversity and evenness indices between seasons. Accordingly, the wet season had lower than that of dry diversity (H'=2.96 and 3.19); evenness (E=0.79 and 0.81). The overall diversity and evenness indices were 3.49 and 0.83 respectively. The similarity index for the wet and dry seasons was 0.72. It can be conclude that the Grove has good potential for bird watching tourism that can integrate economic gain with biodiversity conservation.

Keywords: Abune-Gebremenfeskdus Church, Aves, Relative abundance, Species diversity, Tigray

1. INTRODUCTION

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 (map reading) and lifting; toothless horny beak and skeleton exhibiting unique adaptations, mainly for flight and bipedal locomotion are characteristics of birds (Wallace and Maha, 1975).

Ethiopia is one of the few countries in the world that possesses a unique and characteristic fauna with a high level of endemism (WCMC, 1991). In Ethiopia, 69 Important Bird Areas (IBAs), which are also important for large number of other taxa, are identified by the Ethiopian Wildlife and Natural History Society (EWNHS), following quantitative criteria. These included the already existing protected areas and many other additional sites. In general, according to (EWNHS, 1996) the birds of Ethiopia are grouped into three biome assemblages: (1). The Afro Tropical Highland Biome Species: It holds about 48 species of birds including 7 endemic birds. Bale Mountains National Park is the richest site for this biome assemblage, representing over 80% of the species. (2). The Somali-Massai Biome Species, which is the richest in its species variety and holds over 97 bird species of which 6 are endemic (3). The Sudan-Guinea Savannah Biome Species, which is poorly known biologically, it holds about 16 species of birds. Gambella is the richest area for this biome (Lepage, 2011).

According to (Lepage, 2011), out of the 918 bird species listed for Ethiopia, 20 are endemic and 19 are globally threatened. The number of bird species varies from literature to literature and from time to time.

There are 13 species of birds restricted to the geographical region of Ethiopia and Eritrea (Viveropol, 2001). In Ethiopia 596 birds are resident and 224 are regular seasonal migrants, including 176 from the Palearctic (Viveropol, 2001). Thirty-one species are global conservation concern. Of these, five (*Sarothrura ayresii*, *Turaco ruspolii*, *Heteromirafra sidamoensis*, *Serinus flavigula and Serinus ankoberensis*) are classified as endangered and 12 as vulnerable. Some of the threatened species are non-

breeding migrants from the Palearctic while others are non-breeding visitors from elsewhere in the Afro-tropics. The remainders are residents (Collar et al., 1994; EWNHS, 1996).

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). Although they occupy most of the earth's surface, most species are found only in particular regions and habitats, whereas others are cosmopolitan (Van Tyne and Berger, 1959). 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 fits their requirements for successful reproduction and survival (Welty 1975; Estrella, 2007).

Diversity and extent of natural habitats will continue to decline as human populations increase and alter landscape for development (Petit et al., 1999). Such activities transformed natural areas by establishing towns, building houses, gardens and public parks, which create entirely artificial environments. Factors determining which species can coexist with human settlements include the presence and patch size of native vegetation as well as competition with exotic species and non-native predators. The structure and floristic attributes of planted vegetation as well as supplementary feeding by humans affect the level of such coexistence (Chace and Walsh, 2006).

The effective management of human activities in wildlife areas is an important conservation issue, as the footprint of human influence continues to expand and incidental impacts of human activities spread into more areas. Such expanding anthropogenic activity is widely perceived to lead to negative consequences for the wildlife beyond habitat loss alone. Understanding how animals respond to anthropogenic activities is fundamental to resolving potential conflicts between humans and animals. Distribution, abundance, reproductive success and behavior of animal species are often sensitive to habitat change caused by human activities (Chace and Walsh, 2006).

Birds have been particularly useful as indicators to evaluate effects of habitat change because they are easy to watch, and the populations of many decrease or increase when the landscape is modified by such activities. They are well-known indicator taxa due to their sensitivity to environmental perturbations, relevance to ecosystem functioning and relative ease in sampling (Posa and Sodhi, 2006).

They are indicators and useful models for studying variety of environmental changes Sutherland and Green (2004); Urfil et al. 2005; Estrella, 2007). Many of them have adapted with the changes that humans have inflicted on the ecosystem.

Birds are important for the ecosystem as they play various roles as bio-indicators of different kind of environmental changes like urbanization (Padmavathy et al., 2010). Urban environments provide birds with considerable quantities of food and roosting sites especially in gardens and parks (Dorst, 1974). Some species could be attracted to such areas since it introduces new exploitable resources such as water, ornamental plants and grasses (Posa and Sodhi, 2006).

Vegetation structure and rainfall played important roles in determining the species diversity and richness of birds Elizabeth (Yohannes, 1996). Avian studies are important to determine the importance of the site, habitat requirements of the species, size of a population species, and to understand the population dynamics (Gibbons et al., 1996).

There are more than 35,000 church forests in Ethiopia that are protected as recreations of the Garden of Eden (Sengupta and Dalwani, 2008,). 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).

Abune-Gebremenfeskdus church grove is one of such forests and plays a role in preserving biodiversity such as avian diversity. The present study was aimed at generating field data on the species diversity, and

abundance of birds, and their seasonal variation at Abune-Gebremenfeskdus Church Grove in Adwa Woreda, Tigray.

2. OBJECTIVES

2.1. General Objective

The general objective of the study was to assess the diversity and relative abundance of birds and their seasonal variations in wet and dry at Abune-Gebremenfeskdus Church Grove

2.2. Specific Objectives

The specific objectives of the study were to:

- ✓ determine the relative abundance and diversity of bird species
- ✓ understand seasonal variations in bird diversity and abundance
- ✓ determine the abundance rank of bird species in the study area

3. LITRATURE REVIEW

3.1. Ethiopian Orthodox Tewahido Church forests and bird diversity

The Ethiopian Orthodox Church has long history of planting, protecting and preserving trees around churches (Colwell2, 010). 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 absent 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.

A study 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 are 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 in eight churches of South Gondar, 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; because they disperse seeds when they fly from place to place, honey, shade and spiritual value.

3.2. Distribution pattern of birds

Birds are commonly distributed in different habitats including the Polar Regions, the tropics, in forests and deserts, on mountains and prairie and the oceans and their 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 species in the tropics being supported by higher number of individuals (Karr 1971: Poulsel, 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 Plants of rainforests often produce fleshy fruits and berries. Rainforests are therefore good places to find fruit-eating birds (Wilson, 1980).

3.3. Migration of birds

The seasonal distribution of birds is affected by their migration patterns. Migration is long-distance movement of individuals, often seasonally, for a variety of reasons. Sometimes many individuals of a single species migrate together in groups. There are also a few common paths that multiple species use to migrate to similar places. Temperature change is the most common reason to migrate. If a bird's habitat gets too cold in the winter or too warm in the summer it will fly south or north, respectively for the season (Http://www.allaboutbirds.org/Page.aspx?pid=1189). Food availability, often determined by seasonal temperature variation, is another incentive to leave one's habitat temporarily. Some birds change diets as they migrate, picking places to rest along the way based on where they found good food the years before.

Migration is a voluntary activity, 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 visiting 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).

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 large number of endemic species.

Breeding is the final most common reason birds migrate. Many species have certain locations that adults go to raise young year after year. Breeding grounds normally have favorable temperatures, plentiful food in breeding months, and a low predator population. Some birds will reuse the same breeding nest year after year. 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 penology. 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).

3.4. Feeding

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, 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 (Fuller et al., 2008).

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 and, in many birds, limited jaw musculature. The bill plays a critical role in food acquisition and, of its morphology varies with food habits (Ladyguin, 2000).

3.5. 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, and they are useful for monitoring environmental changes. One reason is that birds have long been popular with naturalists, amateurs and professionals and consequently their systematics 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 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.

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. 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 and Hay, 1989).

Certain birds like humming birds and sunbirds pollinate certain flowers that produce nectar. They feed on nectar and 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 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 inputs 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 also 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).

4. STUDY AREA

4.1. Location and general description

Abune-Gebremenfeskdus Church Grove is found in Adwa Woreda previously called Soloda church that is located North of Soloda Mountain. Adwa is located 223km and 946km North of Mekelle and Addis Ababa, respectively. The coordinates lie between, 38^0 53' 55" E - $38^0$57' 30"E and 14 ^{0} 08' 43"N - 14^0 11' 7"N. The altitude of the area ranges from 1850-2540m above sea level Planning and Finances Adwa Town (2009). The study area is located at Kebelle (Tabia) Abnet, 5km away from Adwa City close to the Geraa River, reaching 2029 meters above sea level. The church is surrounded by Soloda Mountain and intersected by streams Planning and Finances Adwa Town (2009). It is also surrounded by Mereb-leke Woreda in the North, Were-leke Woreda in the South, Ahferom Woreda in the East and Laelay-may Chew in the West. At the end of the north-western tip of the mountain, there is open moorland with several patches of bright green trees and grasslands with numerous springs. *Geraa River* located in the eastern side and another church, Abune-Teklehaimanot, is found on the west. One of the streams constitutes the well-known"Kidane-Mihret Tebel (St.Marry's Holly springs), Teklehaimanot Tsebel (Abune-Teklehaimanot Holly springs) and Abune- Gebremenfeskdus Tsebel (Abune-Gebremenfeskdus Holly springs). (Fig.1)

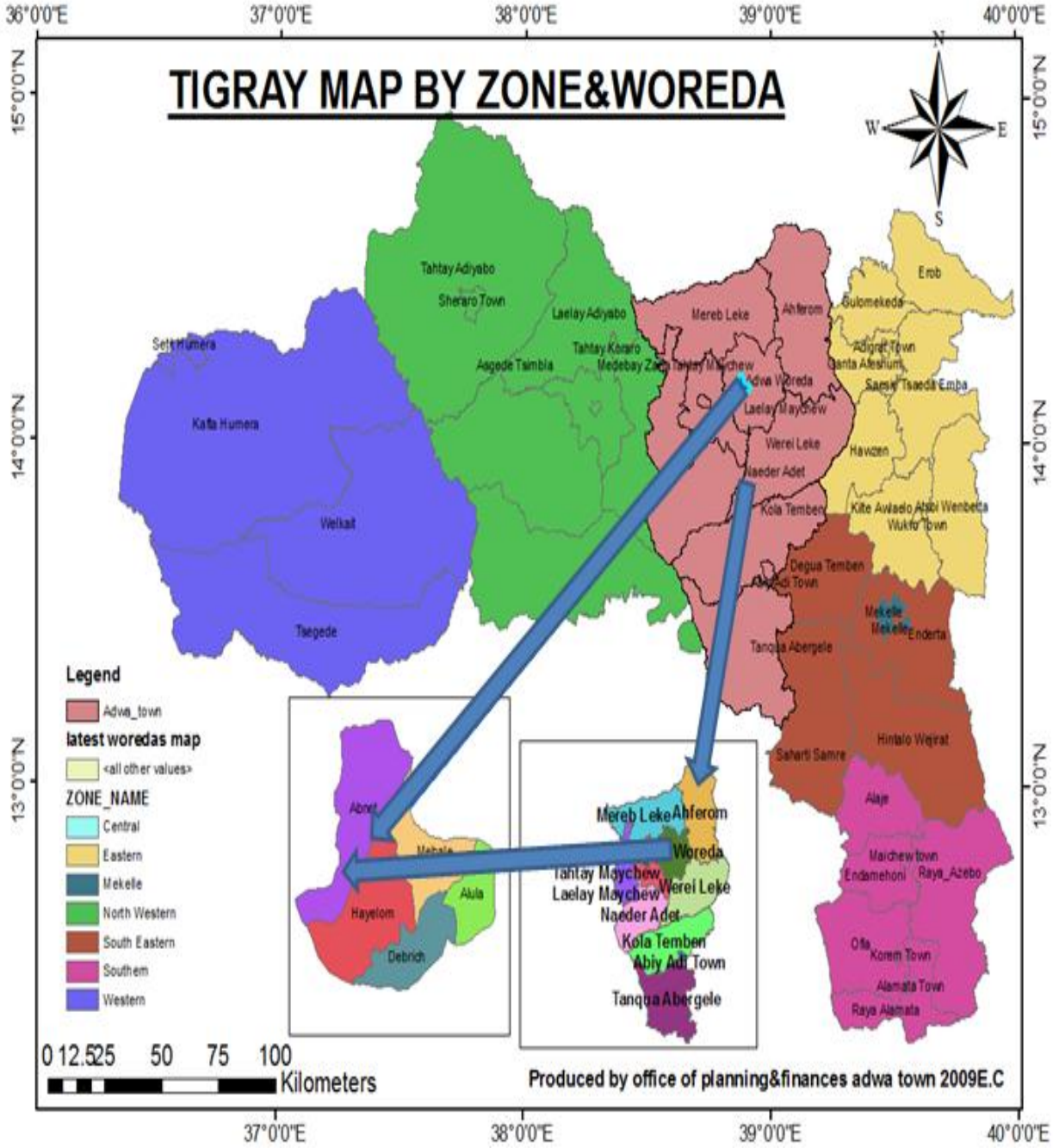
TIGRAY MAP BY ZONE&WOREDA
36°0'0"E
37°0'0"E
38°0'0"E
39°0'0"E
40°0'0"E
15°0'0"N
14°0'0"N
13°0'0"N
N
S
W
E
Tahtay Adiyabo
Sheraro Town
Laelay Adiyabo
Asgede Tsimbla
Tahtay Koraro
Medebay Zana
Tahtay Maychew
Mereb Leke
Ahferom
Gulomekeda
Erob
Adigrat Town
Saesie Tsaeda Emba
Adwa Woreda
Laelay Maychew
Werei Leke
Naeder Adet
Kola Temben
Hawzien
Kilte Awlaelo
Abiy Wenberta
Wukro Town
Degua Temben
Abi Town
Mekele
Mekele
Enderta
Tanqua Abergele
Saharti Samre
Hintalo Wejirat
Alaje
Maichew town
Endamehoni
Raya_Azebo
Ofla
Korem Town
Alamata Town
Raya Alamata
Seta Humera
Kafta Humera
Welkait
Tsegede
Legend
Adwa_town
latest woredas map
<all other values>
ZONE_NAME
Central
Eastern
Mekelle
North Western
South Eastern
Southern
Western
Abiret
Mehale
Hayelom
Alula
Debrich
Mereb Leke
Ahferom
Woreda
Tahtay Maychew
Laelay Maychew
Werei Leke
Naeder Adet
Kola Temben
Abiy Adi Town
Tanqua Abergele
0 12.525 50 75 100
Kilometers
Produced by office of planning&finances adwa town 2009E.C

Figure 1. Map of Tigray and Adwa (Kebele Abnet)

4.2. Climate

The climate of Adwa is considered as a tropical summer-rain climate described (Walter, 1973). The study area includes `Dega` and `Weinadega` agro-climatic zones based on altitudinal and temperature variations. The rainfall is variable both spatially and temporarily as it is inflated by the inner tropical convergent Zone and the rain shadow of Tekeze River. The annual rainfall recorded in eleven years (1998-2008 E.C), varies between 600mm and 849mm and the annual mean temperature is 19^0C. But, between September 2018 and March 2019 rainfall and temperature varied by 204mm and 5.1^0C between the driest and wettest months; and the hottest and coldest months respectively. Climate diagram water deficiency is expected from December to June and water surplus from August to October (Egziabher et al. ,1998).

The data used for the description of the climate (temperature and rainfall) were collected from the nearest metrological station 5km away to the study area. Data were obtained from the Ethiopian National Meteorological Service Agency, Natural Resource and Agricultural office of Adwa (2009)**.**

4.3. Vegetation

The vegetation types of the study area can be categorized as, montane forest, riparian forest, woodland and grassland with dense trees. The list of trees and shrubs species found in the study area is given in Appendix 1.

5. MATERIALS AND METHODS

5.1. Sampling method

5.1.1. Sampling area

The total extent of the Church grove (1218 m^2) was used as the sampling area which is located at the Northern limit of the City of Adwa.

5.1.2. Data collection

Data on bird diversity and abundance was collected using the point scanning method (Bibby and Jones, 1999). Data collection days were divided in to morning (7:00 - 10:00hr) and afternoon (15:00 -18:00hr). Each hour was divided in to three scanning sessions of 10 minutes duration followed by10 minutes pause. During each scanning, the observer stands at a random point and recorded bird species and their abundance (number of birds observed for a given species). At the end of a scanning session, the observer quietly moved to a different spot and started new scanning session after 10 minutes since the last scan. In this manner it was attempted to cover all potential bird areas of the Grove. The observer was trained for two weeks by a bird expert before starting the study and was aided by a bird guide book "Birds of Eastern Africa" (Van Perlo, 2009) to correctly identify bird species.

5.1.3. Study period

Data collection was conducted between September 2018 and March 2019. Four days were used in each month with a total of six hours of data collection per day, there were a total of 168 hours of data collection (504 scanning sessions). September–November were considered as wet season where as December–March were considered as dry season. Binocular (612-1NACO781) were used to clearly

observe birds from a distance (>20m). Pictures of bird that could not be identified on the field were taken using camera model (Sony-LensG.16X optical Zoom).

5.2. Data analysis

5.2.1. Diversity Index

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

$$H' = -\sum_{i=1} Pi \, Ln \, Pi$$

Where:

H' = Shannon- Wiener diversity index

Pi = Proportion of the i^{th} species

Ln =Natural Logarithm of total number of species

5.2.2. Evenness Index (Equitability)

The evenness or equitability index was calculated as:

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

Where:

E= Evenness index

H' = Shannon Wiener Diversity index

H_{max} = Natural log of total number of species

5.2.3. Species similarity

Simpson's similarity index was used to assess similarity of species between wet and dry seasons (Simpson et al., 1949).

$$SI = 2C / A + B$$

Where,

SI = Simpson's similarity index

A = Number of species recorded in the wet season

B = Number of species recorded in the dry season

C = Number of species recorded in both seasons

5.2.4. Abundance

The ordinal rank of abundance of each species was calculated as:

Encounter Rate $(ER) = n_i / N*168$ hours

Where:

$\mathbf{n_i}$ = total sightings of the i^{th} species

N = total sightings of all species

Based on the calculated values, the ordinal rank category was determined using the table below (Bibby and Jones, 1999).

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

Relative abundance = (***n*** **/ N*168**)	Ordinal rank
<0.1	Rare
0.1-2.0	Uncommon
2.1-10.0	Frequent
10.01-40	Common
40+	Abundant

Collected data was analysis using excel word to analysis the effect of variable on seasons comparison among bird communities were analyzed using the similarity indices. Community structures were described in terms of Shannon-Weaver Diversity index (H') Shannon and Weaver (1949).

6. RESULTS

6.1. Species composition

A total of 67 species of birds belonging to 12 Orders and 35 Families were recorded during the study period. Five species were endemic to both Ethiopia and Eritrea these were; White-Collared Pigeon (*Columba albitorques*), White-Billed Starlling **(***Onychognathus albirostris*), Black Winged Love Bird (*Agapornis taranta*), Wattled Ibis (*Bostrychia carunculata*) and Thick Billed Raven (*Corvus crassirostris*). The Passeriformes was the most dominant and largest Order with the highest number of Families (n =19) and species (n =34), the second largest Order was Accipitriformes with Families (n =1), Species, (n =8) and the third largest Order was Columbiformes with Families (n =1) and species (n=5). Among the recorded species, four species; Black Storck (*Ciconia nigra*), Buffy Pipit (*Anthus vaalensis*), Hoopoe (*Upupa epops*) and Narrow Tailed Starling (*Poeoptera lugubris*) were Intra-African migrants. Four species; Black kite (*Milvus migrants*), Greater Spotted Eagle (*Adults clanga*), Little Ringed Plover (*Charadrius dubius*) and Pied Wagtail (*Motacilla alba*) were Palearctic migrants. Eastern Red-footed falcon (*Falco amurensis*) was the other migrant. The Greater Spotted Eagle (*Adults clanga*) and Pied Kingfisher (*Corythornis leucogaster*) were the only endangered species. While the rest 50 species were residents (Table 2).

Table 2. List of bird species and seasonal occurrence

No	Order	Family	Common Name	Scientific Name	Season		
					D	W	B
1	Accipitriformes	Accipitridae	African white backed vulture	*Gyps africanus*			√
			Augur Buzzard	*Buteo rufofuscus*			√
			Black Kite	*Milvus migrans*	√		
			Common Stilt	*Himantopus himantopus*			√
			Greater Spotted Eagle	*Adults clanga*			√
			Lammer Geier	*Gypaetus barbatus*			√
			Long Creasted Eagle	*Lophaetus occipitalis*			√
			Pallied Swift	*Apus niansae*	√		
2	Bucerotiformes	Buceerotide	African Grey Horn Bill	*Tockus nasutus*			√
			Hemprichs Horn Bill	*Tockus hemprichii*			√
		Upupidae	Hoopoe	*Upupa epops*			√
3	Charadriiformes	Charadriidae	African wattled Lapwing	*Vanellus senegallus*			√
			Three Banded Plover	*Charadrius tricollaris*	√		
4	Colliformes	Coliidae	Blue Naped Mouse Bird	*Urocolius macrourus*	√		
		Coliidae	Speckled Mouse Bird	*Colius striatus*		√	
		Charadriidae	Little Ringed Plover	*Charadrius dubius*			√
5	Columbiformes	Columbidae	Loughing Dove	*Streptopelia senegalensis*			√
			Speckled Pigeon	*Columba guinea*			√
			Vinaceous Dove	*Streptopelia vinacea*		√	
			White Collared Pigeon	*Columba albitorques*		√	

6	Coraciiformes	Meropidae	Little Bee-Eater	*Merops pusillus*		√	
7	Falconiformes	Falconidae	Eastern Red -footed falcon	*Falco amurensis*			√
8	Passeriformes	Monarchidae	African Paradise monarch	*Terpsiphone viridis*	√		
		Motociliidae	African Pied Wagtail	*Motacilla aguimp*			√
			Buffy Pipit	*Anthus vaalensis*	√		
			Pied Wagtail	*Motacilla alba*			√
		Viduidae	Bar Breasted Fire Finch	*Lagonosticta rufopicta*		√	
			Pin Tailed Whydah	*Vidua macroura*		√	
		Ploceidae	Black headed Weaver	*Ploceus cucullatus*			√
			Blue Billed Malimbe	*Malimbus nitens*	√		
			Chest Nut-Crowned Sparrow-Weaver	*Plocepasser superciliosus*	√		
			Fox's Weaver	*Ploceus cucullatus*		√	
			White Headed Buffalo Weaver	*Dinemellia dinemelli*	√		
		Muscicapidae	Black Red Start	*Phoenicurus ochruros*		√	
			Mocking Clift Chat	*Myrmecocichla cinnamomeiventris*			√
		Ciconidae	Black Storck	*Ciconia nigra*	√		
		Pycnonotidae	Common Bulbul	*Pycnonotus barbatus*			√
		Lantidae	Common Fiscal	*Lanius collaris*			√
			Thick Billed Raven	*Corvus crassirostris*			√
		Hirundinidae	Ethiopian Swallow	*Hurundoa ethiopica*			√
		Cisticolidae	Green Capped Eremomela	*Eremomela scotops*			√
			pied fly catcher	*Ficedula hypoleuca*	√		
			Southern Black Fly Catcher	*Melaenormis pammelaina*			√
			Trilling Cisticola	*Cisticola woosnami*		√	
			YellowBrowed Camaroptera	*Camaroptera superciliaris*		√	
		Nectarinidae	Green Sun Bird	*Anthreptes rectirostris*		√	
		Malaconotidae	Grey Green Bush Shrike	*Malaconotus bacagi*			√
		Fringillidae	White Rumped Serin	*Serinus leucopygius*		√	
			Yellow crowneic Canary	*Serinus canicollis*			√
		Vangidae	White Helmetshrike	*Prionops plumata*			√

		Sturnidae	Narrow Tailed Starling	*Poeoptera lugubris*			√
			White Billed Starlling	*Onychogathus albirostris*	√		
		Turdidae	Rueppells Robin Chat	*Cossypha semirufa*			√
		Corvidae	Pied Crow	*Corvus albus*			√
		Alcedinidae	Pied King Fisher	*Corythornis leucogaster*		√	
		Estrildidae	Red Billed Fire Finch	*Lagonosticta senegala*			√
9	Pelecaniforms		Red Cheeked Cordon Bleu	*Uraeginthus bengalus*			√
		Scopidae	Hamerkop	*Scopusumbretta*			√
			Wattled Ibis	*Bostrychia carunculata*			√
10	Piciformes	Capttonidae	Black Billed Barbet	*Lybius guifsobalito*			√
11	Procellariiformes	Diomedeidae	Black Browed Albatross	*Diomedea melanophrys*	√		
		Procellaridae	Mascarene Petrel	*Pterodroma aterrima*	√		
12	Psittaciformes	Psittaciae	Black winged Loved Bird	*Agapornis tarana*			√
		Psittaculidae	Red Headed Love Bird	*Agapornis pullaria*		√	

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

6.2. Ordinal Rank abundance of species

During the study period few bird species 5(7.46%) were found within the ordinal rank of "*Common*" while 15(22.39%) were "*Frequent*", 25(*37.31)* "Uncommon" and 22(32.84%) "Rare". There were no bird species with the rank of "Abundant" (Table 4).

Table 3. Abundance rank of species based on total encounter rates per 168 hours of scanning

No	Species of birds	Session with number of sightings			Ordinal relative abundance value per 168 hrs	Ordinal rank of abundance
		Morning	Afternoon	Total		
1	Red Cheeked Cordon Blue	284	412	696	14.36	Common
2	Red Billed Fire Finch	265	276	541	11.16	Common
3	White Collared Pigeon	315	206	521	10.75	Common
4	Little Bee-Eater	218	291	509	10.50	Common
5	Speckled Pigeon	124	312	436	10.01	Common
6	Vinaceous Dove	186	238	424	8.75	Frequent
7	Black Winged Loved Bird	93	299	392	8.10	Frequent
8	Olive Thrush	265	106	371	7.65	Frequent
9	Blue Billed Malimbe	165	134	299	6.17	Frequent
10	Bar Breasted Fire Finch	135	143	278	5.74	Frequent
11	Red Headed Loved Bird	107	168	275	5.67	Frequent
12	White Rumped Serin	28	223	251	5.18	Frequent
13	Buffy Pipit	101	87	188	3.88	Frequent
14	Black Browed Albatross	84	51	135	2.79	Frequent
15	White Billed Starlling	72	61	133	2.74	Frequent
16	Loughing Dove	41	70	111	2.29%	Frequent
17	Pied fly Catcher	61	43	104	2.15%	Frequent
18	Augur Buzzard	50	51	101	2.08%	Frequent
19	Black Kite	61	38	99	2.04	Frequent
20	Yellow Crowneic Canary	41	58	99	2.04	Frequent
21	Black Storck	62	32	94	1.94	Uncommon

22	Hamerkop	34	60	94	1.93	Uncommon
23	Hemprich's Horn Bill	36	55	91	1.88	Uncommon
24	Three Banded Plover	49	43	91	1.88	Uncommon
25	Hoopoe	51	38	89	1.84	Uncommon
26	Fox's Weaver	20	65	85	1.75	Uncommon
27	African Pied Wagtail	45	39	84	1.73	Uncommon
28	Black Headed Weaver	28	51	79	1.63	Uncommon
29	Narrow Tailled Starlling	36	37	73	1.51	Uncommon
30	Mocking Clift Chat	39	27	66	1.36	Uncommon
31	Pied Wagetail	23	42	65	1.34	Uncommon
32	Black Billed Barbet	33	31	64	1.32	Uncommon
33	Greater Spotted Eagle	27	37	64	1.32	Uncommon
34	Trilling Cisticola	14	50	64	1.32	Uncommon
35	Mascarene Petrel	34	29	63	1.30	Uncommon
36	African Wattled Lapwing	23	39	62	1.28	Uncommon
37	Chest nut-Crowned Sparrow	35	25	60	1.24	Uncommon
38	African Grey Horn Bill	31	28	59	1.22	Uncommon
39	White Headed Buffalo Weaver	35	22	57	1.18	Uncommon
40	Southern Black Fly Catcher	25	29	54	1.11	Uncommon
41	Long Creasted Eagle	24	29	53	1.10	Uncommon
42	Northern Red Bishop	22	31	53	1.10	Uncommon
43	Blue Napped Mouse Bird	31	19	50	1.03	Uncommon
44	Common Bulbul	21	27	48	1.00	Uncommon
45	Wattled Ibis	18	30	48	1.00	Uncommon
46	GreenCapped Eremomela	15	30	45	0.93	Rare
47	YellowBrowed Camaroptera	4	38	42	0.87	Rare
48	Black Red Start	10	28	38	0.80	Rare
49	Pallied Swift	22	16	38	0.80	Rare
50	Little Ringed Plover	13	21	34	0.70	Rare
51	AfricanParadise Monarch	19	11	30	0.62	Rare
52	AfricanWhiteBacked Vulture	20	9	29	0.60	Rare
53	Lammer Geier	13	15	28	0.58	Rare

54	Common Fiscal	11	14	25	0.52	Rare
55	Grey Green Bush Shirke	11	13	24	0.50	Rare
56	Eastern Red Footed Falcon	12	11	23	0.47	Rare
57	Pied King Fisher	11	12	23	0.47	Rare
58	Pin Tailed whydah	11	12	23	0.47	Rare
59	Rueppell's Robin Chat	9	11	20	0.41	Rare
60	Common Stilt	13	5	18	0.37	Rare
61	Thick Billed Raven	4	13	17	0.35	Rare
62	Green Sun Bird	5	11	16	0.33	Rare
63	Speckled Mouse Bird	5	10	15	0.31	Rare
64	Easter Chanting Goshawk	2	12	14	0.29	Rare
65	Ethiopian Swallow	4	5	9	0.19	Rare
66	White Helmetshrike	1	5	6	0.12	Rare
67	Pied Crow	-	3	3	0.06	Rare

6.3. Seasonal abundance

6.3.1. Three bird species with high and low number of sightings

Red Checked Cordon Blue (*Uraeginthus bengalus*) was the first species with the highest number of sightings (n= 696; 14.36%) in the study area followed by Red Billed Fire Finch (*Lagonosticta senegala*) (n=541; 11.16 %) and the third White Collared Pigeon (*Columba albitorques*) (n=521; 10.75). Pied Crow (*Corvus albus*) was the species with the lowest number of sightings (n=3; 0.06%) in the study area followed by White Helmet Shrike (*Prionops plumata*), (n=6; 0.12%) and Ethiopian Swallow (*Hurundoa ethiopica*) (n=9; 0.19%) %) (Table 4).

Table 4. Seasonal abundance three bird species with high and low number of sightings

No	Bird species	Wet season	Dry season	Total
Three high number of sightings				
1	Red Cheeked Cordon Blue	348	348	696 (14.36%)
2	Red Billed Fire Finch	265	276	541(11.16%)

3	White Collared Pigeon	315	206	521(10.75%)
Three low number of sightings				
1	Pied Crow	-	3	3 (0.06%)
2	White Helmet Shrike	-	6	6 (0.12%)
3	Ethiopian Swallow	-	9	9 (0.19%)

6.4. Diversity, evenness, similarity and richness indices

The wet season diversity index (H'=2.96) was slightly lower than that of dry season (H'=3.19). Similarly the wet season had lower than dry by evenness (E=0.79) values than the dry season (E=0.81). The overall values for the combined data for both sesaons were; diversity index H'=3.49; Evenness E = 0.83 and Richness S= 67. The similarity index of species between the wet and dry season was 0.72 (Table 5).

Table 5. Diversity, evenness and richness indices of birds

Seasons	**Diversity Index (H')**	**Evenness (E)**	**Richness (S)**	**Similarity (SI) index (Wet vs. Dry season)**
Wet	2.96	0.79	53	0.72
Dry	3.19	0.81	55	
Over all	3.49	0.83	67	

6.5. Monthly distribution of species

An attempt to analyze the monthly occurrence of the top five most and least abundant birds revealed that, the most abundant species showed occurrence in all months of the study period while the least abundant ones had occurrence records only in two months of the study period (Table 6).

Table 6. Monthly occurrence of the top five most and least abundant species

No	Name of species		Months	Total

		Wet season			Dry season				months recorded in
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
Five most abundant									
1	Black Winged Loved Bird	√	√	√	√	√	√	√	7
2	Red Billed Fire Finch	√	√	√	√	√	√	√	7
3	Red Checked Cordon Blue	√	√	√	√	√	√	√	7
4	Speckled Pigeon	√	√	√	√	√	√	√	7
5	White Collared Pigeon	√	√	√	√	√	√	√	7
Five least abundant									
1	Black Stork	-	-	-	-	-	√	√	2
2	Ethiopian Swallow	√	√	-	-	-	-	-	2
3	Pied Crow	-	-	-	√	√	-	-	2
4	Three Banded Plover	-	-	-	-	-	√	√	2
5	White Helmetshrike	-	-	√	-	-	-	√	2

7. DISCUSION

A total of 67 bird species belonging to 12 Orders and 35 Families were recorded in Abune-Gebremenfeskdus Church Grove at Adwa which was similar to the study of Hailemariam Areaya et al. (2013) in the Church of Tigray which reported a total number of 65 species. On the other hand, Megersa Tsegay et al. (2016) and Kalkidan Esayas (2010) recorded 124 species each from Dhati Walel National Park and Entoto National Parks and Escarpment including church grove respectively. This shows that, the number of species recorded in the present study was much lower than these previous studies. The observed difference can be partly explained by the smaller size of the area sampled in the present study than the above mentioned studies. The study by Kalkidan Esayas (2010) covered additional areas outside of the Church grove. Similarly, the study area maintains lesser species composition when compared with previous studies from various localities. For example, the number of bird species was 102 reported by Elizabeth Girma (2007) at Recreational Parks of Addis Ababa. 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). However, Abune-Gebremenfeskdus church grove supports greater bird diversity when compared to other studies.

For example, the number of bird species was only 21 in the study by Kalayu Mesfin and Gebremedhin Teklu (2014) at Debla Church, Eastern Tigray. Similarly, Hailu Uregessa (2016) recorded only 48 species at Entoto Church. Such variations may not be explained until comparative ecological studies are conducted between the present study area and the previous study sites.

The present study area consists of five endemic bird species shared with Eritrea. Previous study by Kalayu Mesfin and Gebremedhin Teklu (2014) at church forest in Eastern Tigray reported seven endemic species shared with Eritrea of which four were also recorded in the present study. Similarly, Hailemariam Areaya et al. (2013) reported four endemic species shared with Eritrea, with two species also recorded in the present study area.

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 three birds with high number of sightings; Red Checked Cordon Blue, Red Billed Fire Finch and White-collared Pigeon accounted for 43.09% 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 dominance was seasonal and may be they migrated to survive. 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.

In contrast, the last three bird species with lower number of sightings*;* Pied Crow, White Helmet Shrike and Ethiopian Swallow constituted only 0.42 % of the total sightings. The observed low sighting records

for the Pied Crow could be due to its perching behavior which in turn makes it less detectable. Similarly, it arise problem in the feeding site while it is flying here and there.

The result of species on diversity index showed that the species declined slightly during the wet season while it increased during dry season. 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.

Bird species richness and abundance are influenced by local resource availability and vegetation composition, in addition to the size of habitat patches. This is because abiotic factors affecting species distribution and interspecies interaction as well as the resources that are essential for a species or a group of species have a non-uniform distribution in space (Nabaneeta and Gupta, 2010). 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, Red Billed Fire Finch feed on fresh seed. 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).

Species richness of birds in the study area for each month showed wide variations. The highest species richness was recorded in December. This could be due to the arrival of migrant species such as Black kites and Mouse Birds observed at this time of the study period. The least species richness was recorded in February, which was due to the less favorability of the weather for most birds. There was large fluctuation in species richness even between consecutive months which was hard to explain.

8. CONCLUSION AND RECOMMENDATION

8.1. Conclusion

Ornithological importance of Abune-Gebremenfeskdus Church Grove is unquestionable as it holds range restricted and globally threatened species. This study area is the home of some globally threatened species as well as endemic birds of Ethiopia. The study area supports diverse species of birds in the same habitat types. The high diversity and richness of birds in the study area indicate the importance of this site as an important refugee for birds. The results are yet another confirmation that Ethiopian Orthodox Churches have played important role in preserving nature including bird diversity. It can be concluded that the grove has good potential for bird watching tourism that can integrate economic gain with biodiversity conservation.

8.2. Recommendations

- Protection of the grove is mandatory for wildlife conservation especially for birds to enrich their diversity, abundance and to maintain the natural ecological balance of the area.
- The status of the endemic birds that occur in the grove should be studied in detail. This is important to know whether the species is endangered and to take appropriate conservation measures.
- The grove should be carefully controlled over a long period on reproductive potential and behavior of birds that might be helpful to understand the effect of managed habitat on birds.
- Management action should be supported by research followed by monitoring scheme to obtain information on the bird species and threats.

9. REFERENCES

Adeyemo, A. I. and Ayodele, I. A. (2005). Food and feeding ecology of rock fowl picatthartes Oredsin old Oyo National Park, Nigeria. *African Journal of Ecology* **43**:1-6.

Alemayehu Wassie, Demel Teketay and Powell, N. (2005). Church forests in North Gondar Administrative Zone, Northern Ethiopia. *Forests trees livelihoods* **15:** Pp. 349-53.

Baillie, H.S., Pacey, A.A., Warren, MA. Scudamore, IW., and Barratt, C.L. (1997).Greater numbers of Human spermatozoa associate with endosalpingeal cells derived from the isthmus Compared with those from the ampulla. *Human Reproduction***12**:1985-1992.

Beals, E.W. (1970). Birds of Euphorbia-Acacia wood land in Ethiopia: habitat and seasonal changes. *Journal of Animal Ecology* **39**: Pp. 277-297.

Bibby, C. and Jones, B. (1999). Bird Census Techniques. Academic Press, London, Pp 239-241

Birds in Backyards (n.d.). Natural Habitats of Birds. Retrieved on December 9, 2016, from http://www.birdsinbackyards.net/birds/Natural-Habitats-BirdLife

International (2000). Threatened Birds of the World. Lynx Editions and Bird Life International. .Barcelona and Cambridge, UK.

BLI (2002). Globally Threatened Birds indicating priorities for action. Cambridge, UK: BirdLife

Brown, L. H.; Urban, E. K. and Newman, K. (1982). The Birds of Africa. Vol. 1. Academic Press, London.

Chace, J. F., and Walsh, J. J. (2006). Urban effects on native avifauna: a review. Landsc. and Urban Plan. **74**: 46–69.

Clergeau, P. G., Mennechez, A., Sauvage, and Lemoine. A. (2001). Human perception and appreciation of birds: A motivation for wildlife conservation in urban environments

Clout, M. N. and Hay, J.R. (1989). The importance of birds as browser, pollinator and seed dispersers in New Zealand Forests. *New Zealand Journal of Ecology* **12**: 23-29.

Collar, N. J., Crosby, M. J. and Stattersfield, A. J (1994). Birds to Watch 2: The World List of Threatened Bird. Bird Life International, Cambridge, 407 pp.

Colwell, R. K. (2010). Estimates. Version 8.2: Statistical estimation of species richness and Shared species from samples. available at :http://viceroy.eeb.uconn.edu/EstimateS.

Currier, D.J. and Fritz, J.T. (1999). Global patterns of animal abundance and species energy use. *Oikos* **67**: 56-68

Donald, P. F. (1998). Changes in the abundance of invertebrates and plants on British Farm land. *British Wildlife* **9**:279-289.

Donald, P. F., Green R. E. A., and M. F. Heath, M. F. (2001). Agricultural intensification and the collapse of Europe's farmland bird populations. *Proceedings of the Royal Society of Lond. B.* **268**: 25-29.

Dorst, J. (1974). The Life of Birds. Columbia University Press, New York. pp. 498.

Egziabher Gebreab. Lee-smith, D. Maxwell, D.G. memon, P.A and Samo, M.C (1998) cites feeding people: An Examination of Urban Agriculture in East Africa. Insternational Development Research Centre Ottawa.

Elizabeth Girma (2007).Species composition and diversity of avian fauna of Beheretsigie, central and ferencye recreational parks in Addis Ababa, Ethiopia. M.Sc.Thesis (unpublished). Addis Ababa University,Faculty of Education,Addis Ababa.

Elizabeth Yohannes. (1996). Ecological study of the avifauna and bird strike problem at Addis Ababa Bole International Airport. Masters thesis. Addis Ababa University.

Estrella, R. R. (2007). Land use changes affect distributional patterns of desert birds in the Baja California Peninsula, Mexico. *Journal of Conservation Biogeography* **13**: 877–889.

Ethiopian National Metrological Service Agency (ENMSA) and Natural Resource and Agricultural office of Adwa, (2009).

Ethiopian Wildlife and Natural History Society (EWNHS) (1996). Important Bird Areas of Ethiopia: A First Inventory. Ethiopian Wildlife and Natural History Society, Addis Ababa, 300 pp.

Feoli A., Lambiase G., Nesterenko V. V., Scarpetta G., (1999). *Regularizing property of the Maximal Acceleration Principle in Quantum Field Theory, to appear on Phys. Rev*. D (hep-th /9812130).

Fuller, R.A., Warren, P.H. ,Armsworth, P.R . , Barboasa, O, and Gaston, K.J.2008. Garden bird feeding predicts the structure of urban avian assemblages. Doiversity and Distribution 14, 131-137.

Furness, R.W and Green Wood, J.J.D (1993). Birds as monitor of environmental change. Chapman and Hall, London.

Gebrecherkos Woldegeorgis and Tilaye Wube, (2012). A Survey on Mammals of the Yayu Forest in Southwest Ethiopia. *SINET: Ethiopian Journal of sciences* **35**(2):135–138.

Gibbons, D.W., Hill, D.A. and Sutherland, W. J. (1996). Birds In: Ecological

Census Techniques: A Handbook, Pp. 81-95, (Sutherland, W. J., ed). Cambridge University Press, New York.

Gregory, R. D., Noble, D., Field, R., Marchant, J. H., Raven, M. and Gibbons, D. W. (2003). Using birds as indicators of biodiversity. *Ornis Hungarica*. **12**: 11–24.

Hailemariam Areaya, Meheretu Yonas and Tsegazeabe Hadush (2013). Community Composition and abundance of residential birds in selected church forests, Tigray region, Northern Ethiopia.*Acadamic Journal* **8** (22), pp. 1038-1047.

Hailu Uregerssa (2016). Diversity and, relative abundance of bird species at Entoto Church grove. MSc.Thesis (unpublished), Addis Ababa University, Addis Ababa.

Hiwot Hibste (2007). Species composition, abundance and activity pattern of birds Addis Abeba Abattoirs enterprise, Ethiopia. M.Sc. Thesis (unpublished), Addis Ababa University, 99pp.

Holling, C.S. (1988). Temperate forest insect outbreak, tropical deforestation and Migratory birds. *Memoirs of the Entomological Society of Canada***146**: 21-32.

Http://www.birds.cornell.edu/birdsleuth/top-10-tips-for-birding-with-kids.

ICBP (1990). The Illustrated Encyclopaedia of Birds. The Definitive Reference to birds of the world. Prentice Hall, New York, 420 pp.

Kalayu Mesfin and Gebremedhin Teklu (2014). Diversity and Abundance of Birds in Dbla Church Forest, Eastern Tigray, North Ethiopia. M.Sc. Thesis (unpublished) , Addis Ababa University, 89pp.

Kalkidan Esayas (2010). Species composition, relative abundance and distribution of avian fauna of Entoto Natural Park and Escarpment. MSc. Thesis, Addis Ababa University, Addis Ababa.

Karr, J.R. and Roth, R.R (1971). Vegetation structure and avian diversity in several New World areas. *American Naturalist* **105**: 423-435.

Karr, J. (1976). Seasonality, resource availability and community diversity in tropical bird Communities. Am. Nat. **110**:973–994.

Karr, J.R. (1989). Birds. In: Tropical Rain forest ecosystems, Lieth, H. and Werger, M.J.A. (ed.) Elsevier, Amsterdam 23-37 pp.

Lack, D. (1954). The Natural Regulation of Animal Numbers. Oxford University press, Oxford.

Ladyguin, A. (2000). The morphology of the bill apparatus in the Steller's Sea Eagle 1-10pp in First Symposium on Steller's and White-tailed Sea Eagles in east Asia (M. Veta and M.J. McGrady,eds.). Wild Bird Society of Japan, Tokyo.

Lepage,D.(2011). Avibase-Birds Checklists of the World-Ethiopia.Retrieved on 16,07,2017, from http://www.bsc-eoc.org.

Leul Kidane, Tamrat Bekele, Sileshi Nemomissa (2010). Vegetation Composition in Hugumbirda- Gratkhassu National Forest Priority Area, South Tigray.*Momena Ethiopian Journal of Science* **2**:27-48.

Lincolin, C.; Fredrick, C.; Peterson, S. R. and Zimmerman, J. L. (1998). Migration of Birds. United States Fish and Wildlife Society, Washington, D.C.

Loreau, M., Naeem, S., Inchausti, P., Bengtsson, J., Grime, J. P., Hector, A., Hooper, D. U., (2001) Huston,

MacArthur, R.H, (1964). Environmental factors affecting bird species diversity. *American Naturalist* **98**: 387-397.

Mackworth-praed, C.W. and grant, C.C.H.B.(1956). Birds of Eastern and North Eastern Africa. Robert Maclehose and Co. Ltd., University press, Glagow.

Marchant, J. H., Hudson., Carter, S. P. and Whittington, P. (1990). Population Trends in British Breeding Birds. British Trust for Ornithology, Thetford.

Mayr, E., and D. Amadon. (1951). A classification of recent birds. *American Museum Novitates* **1946**: 453-473.

McLay, C.L. (1974). The species diversity of New Zealand forest birds: some possible Consequences of the modification of beech forests. *New Zealand Journal of Zool*.ogy **2**:179-96.

Nabaneeta, A. and Gupta, A. (2010). Avian Community Analysis in fragmented Lands capes of Cachar District. J. Sci. Technol. **5**: 75-84.

National Meteorological Service Agency (2016). The maximum and minimum monthly

Temperature and rainfall data (1991-2015) at Mountain Entoto, Ethiopia.

Oindo, B.O., De By, R.A. and Skidmore, A.K. (2001). Environmental factors influencing Bird species in Kenya. *African Journal of Ecology* **39**:295–302.

Padmavathy, A., Alexandar, R. and Anbarashan, M. (2010). Diversity of Birds in Ousteri Wetland, Puducherry, India. Our Nature **8**:247-253.

Perlo, B.V.(2009).Collins Field Guide on Birds of East Africa. HarperCollins Published Ltd

Petit, L. J., Petit, D. R., Christian. D. G. and Powell, H. D. W. (1999). Bird communities of natural and modified habitats in Panama. Ecography 22: 292304.

Posa, R. C. and Sodhi, N. S. (2006). Effects of anthropogenic land use on forest birds and butterflies in Subic Bay, Philippines. Biol. Conserve. **129**:256-270.

Planning and Finances of Adwa Town (2009).

Poulsen, B.O. (2002). A comparison of bird richness, abundance and trophic organization in Forests of Ecuador and Denmark: are high-altitude Andean forests temperate or tropical. *Journal of Tropical Ecology* **18**: 615–636.

Pschorn-Walker, H. (1977). Biological control of insect. *Annual Review of Entomology* **22**: 1-22.

Root, T. (1988). Environmental factor associated with avian distributional boundaries. *Journal Of Biogeography* **15**: 489-505.

Rosenzweig, M.L amd Abarmsky, Z. (1993). How are diversity and productivity related In: Species Diversity in Ecological Communities: Historical and Geographical Perspective, Richlifs, R.E and schluter, D . (ed.) University of Chicago Press, Chicago. Pp 75-93.

Sengupta, M. and Dalwani, R., (2008). Determination of water quality index and sustainability of an urban water body in Shimoga town, Kornataka, Proceedings of Taal 2007: The 12th World Lake Conference: 342-346.

Shannon, C. E and Weaver, N. (1949). The Mathematical Theory of Communication. The University of Illinios, Urbana, 117pp.

Simpson, E. H. (1949). Measurement of diversity. Nature **163**: 688.Sinclair, I. and Ryan, P. (2003). Birds of Africa. Princeton University Press, Princeton, New Jersey.

Smith, R. (1992). Elements of Ecology. 3rd ed. Harper Collins Publishers Ltd, London.

Sutherland, W.J., Newton, I. and Green, R.E. (2004). Bird Ecology and Conservation: A Hand book of Techniques. Oxford University Press Inc., New York, pp. 257.

Terborgh, J. (1980). Causes of tropical species diversity. Proc. 17 th int. *Ornithol. Congr*. **17**: 955-961.

Terborgh, J., Robinson, S.K., patker, T.A. III, Munn, C.A. and Pierpont N. (1990). Structure and organization of Amazonian bird community. *Ecological Monographs* **60**: 213- 238.

Tewolde Brehan Gebre Egziabher (1991). Diversity of Ethiopian Flora. In: Plant Genetic Resources of Ethiopia, pp. 75-81, (Engels, J.M.M., Hawkes, J.G. and Meleku Worede, eds.). Cambridge University Press, London.

Thiollay, J.M. (1990). Comparative study of temperate and tropical forest bird communities; the influence of habitat heterogeneity. *Actaoecologica* **11**: 887-907.

Tsegaye M., Gadisa T. and G/Micchael G. (2016). *Avian Diversity in Dhati Walel National Park of Western Ethiopia, International Journal of Molecular Evolution and Biodiversity*, 2016, 6(1), 1-12 (doi: 10.5376/ijmeb.2016.06.0001.

Urfil, A.J., Sen, M., Kalam, A. and Maganathan, T. (2005). Counting birds in India: methodologies and trends, initiatives, International Bird Strike Committee, Amsterdam. *Curr. Sci*. **89**: 25-27.

Van Perlo. B. (1995). Birds of Eastern Africa, Collins Illustrated Checklist Harper Collins Publishers, London, 301pp.

Van Tyne, J. and Berger, A.J. (1959). Fundamentals of Ornithology, 2nd ed. John Wiley

and Sons, Inc., New York. pp. 645.

Visser, M. E., L. J. M. Holleman, and S. P. Caro (2009). Temperature has a causal effect on cx zavian timing of reproduction. *Proceedings of the Royal Society B* 2076, 2323.

Vittery, A. (1983). Movements of Palaearctic raptors in the Ethiopian Rift Valley. *Scopus* **7**:1-9.

Viveropol, J.L. (2001). A guide to Endemic Birds of Ethiopia and Eritrea. Shama Books, Addis Ababa 78-80 pp.

Wallace, J.G and Mahan, H.D. (1975). An Introduction to ornithology. Third edition, Macmillan Publishing Co., Inc. Now York.

Walter, H, 1973.Vegetation zonen Undklima (2nd ed. Eugen Ulmer Verlag.Stuttgart,W. Germay).

WCMC (1991). Global Biodiversity Status of the Earth's Living Resource. World Conservation Monitoring Center. Chapman and Hall, London.

Welty, J. C. (1975). The Life of Birds.W. B. Saunders Company, Philadelphia, PA. 623pp.

Whelan, C. J., Wenny, D. G. and Marquis, R. J. (2008) Ecosystem services provided by birds, Ann. *New York Academy of Sciences* **1134**:25–60.

Wilson, B.W. (1980). Birds. W.H. freeman and Company, San Francisco.

Whittaker, R. H. (1975). Communities and Ecosystems. 2nd ed. Macmillan, London, 673 pp.

10. APPENDIXES

Appendix 1. The list of trees and shrub species found from the study area

No	Vernacular Name	Scientific Name	Floristic Category
1	Andel	*Capparis tomentosa lam*	Tree (shrub)
2	Argudi	*Maytenus senegalensis*	Tree (shrub)
3	Awhie	*Cordia africanalam*	Tree
4	Awlie	*Olea europaaea*	Tree

5	Bahrzaf	*Eucalyptus globules*	Tree
6	Chia	*Acacia Abyssinica*	Tree
7	Daero	*Ficus vasta*	Tree
8	Konteftefe	*Pterollobium stellatum*	Shrub
9	Korenet	*Solanum schimperianum*	Tree (shrub)
10	Lemin	*Citrus limon*	Tree
11	Liham	*Syzygium guineense*	Tree
12	Mebttie	*Acokanthera schimperi*	Tree
13	Metere	*Buddleja polystachya*	Tree
14	Qnchib	*Euphorbia tirucalli*	Tree (shrub)
15	Shibaka	*Pittosporum virgatum kirk*	Tree
16	Surbetri	*Clerodendrum myricoides*	Tree (shrub)
17	Tselimoy	*Psydrax schimperiana*	Tree (shrub)
18	Tsnquya	*Thespesia populnea*	Tree (shrub

(Natural Resource and Agriculture Office of Adwa).

Appendix 2. List of bird species recorded in the study area

No	Local Name	Species of Bird	Scientific Name	Order	Family
1	*Afkerni*	African Grey Horn Bill	*Tockus nasutus*	Bucerotiformes	Buceerotide
2	*Ef meskel*	African Paradise monarch	*Terpsiphoneviridis*	Passeriformes	Monarchidae
3	*Wari*	African Pied Wagtail	*Motacilla aguimp*	Passeriformes	Motociliidae

4		African wattled Lapwing	*Vanellus senegallus*	Charadriformes	Charadriidae
5		African white backed vulture	*Gyps africanus*	Accipitriformes	Accipitridae
6	*Gedigeday*	Augur Buzzard	*Buteo rufofuscus*	Accipitriformes	Accipitridae
7	*Tito*	Bar Breasted Fire Finch	*Lagonosticta* rufopicta	Passeriformes	Viduidae
8	*Afkerni*	Black Billed Barbet	*Lybius guifsobalito*	Piciformes	Capttonidae
9	*Gedgedey*	Black Browed Albatross	*Diomedea melanophrys*	Procellariiformes	Diomedeidae
10	*Shemanit*	Black headed Weaver	*Ploceus cucullatus*	Passeriformes	Ploceidae
11	*Tskdim*	Black kite	*Milvus migrants*	Accipitriformes	Accipitridae
12		Black Red Start	*Phoenicurus ochruros*	Passeriformes	Muscicapidae
13	*Ybra*	Black Storck	*Ciconia nigra*	Passeriformes	Ciconidae
14	*Kulele*	Black winged Loved Bird	*Agapornis tarana*	Psittaciformes	Psittaciae
15		Blue Billed Malimbe	*Malimbus nitens*	Passeriformes	Ploceidae
16		Blue Naped Mouse Bird	*Urocolius macrourus*	Coliformes	Coliidae
17		Buffy Pipit	*Anthus Vaalensis*	Passeriformes	Motociliidae
18		Chest Nut-Crowned Sparrow-Weaver	*Plocepasser superciliosus*	Passeriformes	Ploceidae
19		Common Bulbul	*Pycnonotus barbatus*	Passeriformes	Pycnonotidae
20		Common Fiscal	*Lanius collaris*	Passeriformes	Lantidae
21		Common Stilt	*Himantopus himantopus*	Charadriformes	Accipitridae
22	*Tsikdim*	Eastern Chanting Goshawk	*Melierax canorus*	Accipitriformes	Accipitridae
23	*Merahti may*	Eastern Red -footed	*Falcoamurensis*	Falconiformes	Falconidae

		falcon			
24		Ethiopian Swallow	*Hurundoaethiopica*	Passeriformes	Hirundinidae
25	*Afkerni*	Foxs Weaver	*Ploceus cucullatus*	Passeriformes	Ploceidae
26	*Lil*	Greater Spotted Eagle	*Adults clanga*	Accipitriformes	Accipitridae
27		Green Capped Eremomela	*Eremomela scotops*	Passeriformes	Cisticolidae
28		Green Sun Bird	*Anthreptes rectirostris*	Passeriformes	Nectarinidae
29	*Afkerni*	Grey Green Bush Shrike	*Malaconotus bacagi*	Passeriformes	Malaconotidae
30	*Derhomay*	Hamerkop	*Scopusumbretta*	Pelecaniformes	Scopidae
31		Hemprichs Horn Bill	*Tockus hemprichii*	Bucerotiformes	Bucerotidae
32	*Kerhit*	Hoopoe	*Upupa epops*	Bucerotiformes	Upupidae
33	*Tsikidm*	Lammer Geier	*Gypaetus Barbatus*	Accipitriformes	Accipitridae
34	*Blaet nhbi*	Little Bee-Eater	*Merops pusillus*	Coraciiformes	Meropidae
35	*Ylefegn*	Little Ringed Plover	*Charadrius dubius*	Charadriiformes	Charadriidae
36	*Dabo*	Loughing Dove	*Streptopelia senegalensis*	Columbiformes	Columbidae
37	*Nesri*	Long Creasted Eagle	*Lophaetus occipitalis*	Accipitriformes	Accipitridae
38	*Belae derho*	Mascarene Petrel	*Pterodroma aterrima*	Procellariiformes	Procellaridae
39		Mocking Clift Chat	*Myrmecocichla cinnamomeiventris*	Passeriformes	Muscicapidae
40	*Wari*	Narrow Tailed Starling	*Poeoptera lugubris*	Passeriformes	Sturnidae
41		Northern Red Bishop	*Euplectes franciscanus*	Passeriformes	
42		Oliv e Thrush	*Turdus olivaceus*	Passeriformes	Turdidae
43		Pallied Swift	*Apus niansae*	Passeriformes	Accipittridae
44		Pied Crow	*Corvus albus*	Passeriformes	Corvidae
45		pied fly catcher	*Ficedula hypoleuca*	Passeriformes	Cisticolidae

46		Pied King Fisher	*Corythornis leucogaster*	Passeriformes	Alcedinidae
47	*Warri*	Pied Wagtail	*Motacilla alba*	Passeriformes	Motocillidae
48	*Tito*	Pin Tailed Whydah	*Vidua macroura*	Passeriformes	Viduidae
49		Red Billed Fire Finch	*Lagonosticta senegala*	Passeriformes	Estrildidae
50	*Dinbit*	Red Cheeked Cordon Bleu	*Uraeginthus bengalus*	Passeriformes	Estrildidae
51	*Hntse*	Red Headed Love Bird	*Agapornis pullaria*	Psittaciformes	Psittaculidae
52		Rueppells Robin Chat	*Cossypha Semirufa*	Passeriformes	Turdidae
53		Southern Black Fly Catcher	*Melaenormis pammelaina*	Passeriformes	Cisticolidae
54		Speckled Mouse Bird	*Colius striatus*	Colliformes	Coliidae
55	*Rgibit*	SpeKled Pigeon	*Columba guinea*	Columbiformes	Columbidae
56		Thick Billed Raven	*Corvus crassirostris*	Passeriformes	Lantidae
57	*Kelebet*	Three Banded Plover	*Charadrius tricollaris*	Charadriiformes	Charadriiidae
58		Trilling Cisticola	*Cisticola woosnami*	Passeriformes	Cisticolidae
59	*Barito*	Vinaceous Dove	*Streptopelia vinacea*	Columbiformes	Collumbidae
60	*Aaye*	Wattled Ibis	*Bostrychia carunculata*	Pelecaniformes	Thresktornithidae
61		White Billed Starlling	*Onychogathus albirostris*	Passeriformes	Sturnidae
62	*Rigbit*	White Collared Pigeon	Columba albitorques	Columbiformes	Collumbidae
63	*Shemanit*	White Headed Buffalo Weaver	Dinemellia dinemelli	Passeriformes	Ploceidae
64	*Abagunbah*	White Helmetshrike	Prionops plumata	Passeriformes	Vangidae
65		White Rumped Serin	Serinus	Passeriformes	Fringillides

			leucopygius		
66		Yellow Browed Camaroptera	Camaroptera superciliaris	Passeriformes	Cisticolidae
67		Yellow crowneic Canary	Serinus canicollis	Passeriformes	Fringillidae

Appendix 3. Bird species recorded in wet season

No	Species of birds	Session with number of sightings	Total number of	Pi	Piln	-Pilnpi

		Morning	Afternoon	Total	sightings/ 168hrs			
1	Little Bee-Eater	218	291	509	10.50	0.21	-1.56	0.33
2	Vinaceous Dove	186	238	424	8.75	0.18	-1.71	0.31
3	Olive Thresh	265	106	371	7.65	0.15	-1.89	0.28
4	Bar Breasted Fire Finch	135	143	278	5.74	0.12	-2.12	0.25
5	Red Headed Loved Bird	107	168	275	5.67	0.11	-2.21	0.24
6	White Rumped Serin	28	223	251	5.18	0.103	-2.27	0.23
7	Fox's Weaver	20	65	85	1.75	0.035	-3.35	0.12
8	Trilling Cisticola	14	50	64	1.32	0.026	-3.65	0.09
9	YellowBrowed Camaroptera	4	38	42	0.87	0.017	-4.075	0.07
10	Black Red Start	10	28	38	0.78	0.016	-4.14	0.066
11	Pied King Fisher	11	12	23	0.47	0.01	-4.61	0.05
12	Pin Tailed whydah	11	12	23	0.47	0.01	-4.61	0.05
13	Green Sun Bird	5	11	16	0.33	0.007	-4.96	0.035
14	Speckled Mouse Bird	5	10	15	0.31	0.006	-5.12	0.031

Appendix 4. Bird species in dry season

No	Species of birds	Session with number of sightings			Total number of sightings /168hrs	Pi	Piln	-Pilnpi
		Morning	Afternoon	Total				
1	Blue Billed Malimbe	165	134	299	6.17	0.23	-1.46	0.34
2	White Billed Starling	72	61	133	2.74	0.10	-2.26	0.24
3	Black Kite	61	38	99	2.04	0.08	-2.56	0.197
4	Black Storck	62	32	94	1.94	0.07	-2.62	0.19
5	Buffy Pipit	101	87	188	3.88	0.15	-1.92	0.28
6	Black Browed Albatross	84	51	135	2.79	0.11	-2.25	0.24
7	Augur Buzzard	50	51	101	2.08	0.023	-3.77	0.09
8	Blue Napped Mouse Bird	31	19	50	1.03	0.04	-3.24	0.13
9	Mascarene Petrel	34	29	63	1.30	0.05	-3.08	0.14
10	Chest Nut-Crowned Sparrow	35	25	60	1.24	0.05	-3.08	0.142
11	Three Banded Plover	49	43	91	1.88	0.08	-2.65	0.19
12	Pallied Swift	22	16	38	0.78	0.03	-3.54	0.103
13	African Paradise Monarch	19	11	30	0.62	0.02	-3.77	0.087
14	Ethiopian Swallow	4	5	9	0.19	0.002	-6.22	0.012
15	White Helimet shrike	1	5	6	0.12	0.001	-6.91	0.007
16	Pied Crow	--	3	3	0.06	0.001	-6.91	0.007

Appendix 5 .Bird species recorded in both season

No	Species of birds	Session with number of sightings			Total number of sightings/ 168hrs	Pi	Piln	-Pilnpi
		Morning	Afternoon	Total				
1	Red Cheeked Cordon Blue	284	412	696	14.36	0.156	-1.86	0.289
2	Red Billed Fire Finch	265	276	541	11.16	0.12	-2.12	0.25
3	White Collared Pigeon	315	206	521	10.75	0.117	-2.15	0.25
4	Speckled Pigeon	124	312	436	9.01	0.098	-2.323	0.23
5	Black Winged Loved Bird	93	299	392	8.10	0.09	-2.41	0.22
6	Laughing Dove	41	70	111	2.29	0.025	-3.689	0.092
7	Yellow Crowneic Canary	41	58	99	2.04	0.022	-3.82	0.08
8	Pied fly Catcher	61	43	104	2.14	0.023	-3.772	0.087
9	Augur Buzzard	50	51	101	2.08	0.023	-3.77	0.09
10	Hamerkop	34	60	94	1.93	0.021	-3.86	0.082
11	Hemprich's Horn Bill	36	55	91	1.88	0.02	-3.91	0.078
12	Hoopoe	51	38	89	1.84	0.02	-3.91	0.078
13	African Pied Wagtail	45	39	84	1.73	0.019	-3.963	0.075
14	Black Headed Weaver	28	51	79	1.63	0.018	-4.017	0.072
15	Narrow Tailled Starlling	36	37	73	1.51	0.016	-4.135	0.066
16	Mocking Clift Chat	39	27	66	1.36	0.015	-4.199	0.063

17	Pied Wagetail	23	42	65	1.34	0.015	-4.199	0.063
18	Greater Spotted Eagle	27	37	64	1.32	0.014	-4.269	0.059
19	African Wattled Lapwing	23	39	62	1.28	0.014	-4.269	0.059
20	African Grey Horn Bill	31	28	59	1.22	0.013	-4.343	0.056
21	White Headed Buffalo Weaver	35	22	57	1.18	0.013	-4.343	0.056
22	Southern Black Fly Catcher	25	29	54	1.11	0.012	-4.422	0.053
23	Long Creasted Eagle	24	29	53	1.10	0.012	-4.423	0.053
24	Black Billed Barbet	33	31	64	1.32	0.014	-4.27	0.059
25	White Collared Pigeon	24	29	53	1.10	0.012	-4.423	0.053
26	Common Bulbul	21	27	48	0.99	0.011	-4.509	0.051
27	Wattled Ibis	18	30	48	0.99	0.011	-4.509	0.051
28	GreenCapped Eremomela	15	30	45	0.93	0.01	-4.605	0.046
29	Little Ringed Plover	13	21	34	0.70	0.008	-4.828	0.039
30	AfricanWhiteBacked Vulture	20	9	29	0.60	0.007	-4.962	0.035
31	Lammer Geier	13	15	28	0.58	0.006	-5.116	0.031
32	Common Fiscal	11	14	25	0.52	0.006	-5.116	0.031
33	Grey Green Bush Shirke	11	13	24	0.50	0.005	-5.299	0.026
34	Eastern Red	12	11	23	0.47	0.005	-5.299	0.026

	Footed Falcon							
35	Rueppell's Robin Chat	9	11	20	0.41	0.005	-5.298	0.026
36	Common Stilt	13	5	18	0.37	0.004	-5.521	0.022
37	Thick Billed Raven	4	13	17	0.35	0.004	-5.521	0.022
38	Easter Chanting Goshawk	2	12	14	0.29	0.003	-5.809	0.017
39	White Helmetshrike	1	5	6	0.12	0.001	-6.907	0.007

Appendix 6. Monthly distribution most and least common

No	Name of species of birds	Months							Total Months
		Wet season			Dry season				
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
1	African Grey Horn Bill	-	-	√	√	√	-	√	4
2	African Paradise monarch	-	-	-	√	√	√	-	3
3	African Pied Wagtail	√	√	√	√	√	-	√	6
4	African wattled Lapwing	-	√	-	√	√	√	√	5
5	African white backed vulture	-	-	√	√	-	√	√	4
6	Augur Buzzard	-	-	-	-	√	√	√	3
7	Bar Breasted Fire Finch	√	√	√	√	-	-	-	4
8	Black Billed Barbet	-	√	√	√	√	√	√	6
9	Black Browed Albatross	-	-	-	-	√	√	√	3
10	Black headed Weaver	√	√	√	√	√	√	-	6
11	Black kite	-	-	-	√	√	√	√	4
12	Black Red Start	-	√	√	√	-	-	-	3
13	Black Storck	-	-	-	-	-	√	√	2
14	Black winged Loved Bird	√	√	√	√	√	√	√	7
15	Blue Billed Malimbe	-	-	-	-	√	√	√	3
16	Blue Napped Mouse Bird	-	-	-	-	√	√	√	3
17	Buffy Pipit	-	-	-	√	√	√	√	4
18	Chest Nut-Crowned Sparrow-Weaver	-	-	-	-	√	√	√	3
19	Common Bulbul	√	√	√	√	-	-	√	5
20	Common Fiscal	√	-	√	√	√	√	√	6
21	Common Stilt	-	-	√	√	√	-	√	4
22	Eastern Chanting Goshawk		√	√	√	-	-	√	4

23	Eastern Red -footed falcon	√	√	√	-	-	√	√	5
24	Ethiopian Swallow	-	-	-	√	√	-	-	2
25	Fox's Weaver	√	√	√	-	-	-	-	3
26	Greater Spotted Eagle	√	√	√	√	-	√	√	6
27	Green Capped Eremomela	√	-	√	-	√	√	-	4
28	Green Sun Bird	√	√	√	-	-	-	-	3
29	Grey Green Bush Shrike	√	√	√	-	√	√	√	6
30	Hamerkop	-	√	√	√	√	√	√	6
31	Hemprichs Horn Bill	√	√	√	√	√	-	-	5
32	Hoopoe	√	√	√	√	-	√	-	5
33	Lammer Geier	-	-	√	√	√	-	√	4
34	Little Bee-Eater	√	√	√	-	-	-	-	3
35	Little Ringed Plover	√	√	√	-	√	√	-	5
36	Loughing Dove	√	√	√	√	-	√	√	5
37	Long Creasted Eagle	-	√	√	-	√	√	-	4
38	Mascarene Petrel	-	-	-	-	√	√	√	3
39	Mocking Clift Chat	√	√	√	√	√	-	√	6
40	Narrow Tailed Starling	√	√	√	-	√	-	√	5
41	Northern Red Bishop	√	√	√	-	√	-	-	4
42	Oliv e Thrush	√	√	√	-	-	-	-	3
43	Pallied Swift	-	-	-	-	√	√	√	3
44	Pied Crow	-	-	-	√	√	-	-	2
45	pied fly catcher	-	√	√	√	-	-	-	3
46	Pied King Fisher	√	√	√	-	-	-	-	3
47	Pied Wagtail	√	√	√	-	√	√	-	5
48	Pin Tailed Whydah	√	√	√	-	-	-	-	3
49	Red Billed Fire Finch	√	√	√	√	√	√	√	7
50	Red Cheeked Cordon Bleu	√	√	√	√	√	√	√	7
51	Red Headed Love Bird	√	√	√	-	-	-	-	3

52	Rueppells Robin Chat	-	√	√	-	√	-	√	4
53	Southern Black Fly Catcher	-	√	√	√	√	√	√	6
54	Speckled Mouse Bird	√	√	√	-	-	-	-	3
55	Speckled Pigeon	√	√	√	√	√	√	√	7
56	Thick Billed Raven	√	-	√	√	-	√	√	4
57	Three Banded Plover	-	-	-	-	√	√	-	2
58	Trilling Cisticola	√	√	√	-	-	-	-	3
59	Vinaceous Dove	√	√	√	-	-	-	-	3
60	Wattled Ibis	√	√	√	√	√	√	√	6
61	White Billed Starlling	-	-	-	-	√	√	√	3
62	White Collared Pigeon	√	√	√	√	√	√	√	7
63	WhiteHeaded Buffalo Weaver	√	-	-	√	√	√	√	5
64	White Helmetshrike	-	-	-	-	√	-	√	2
65	White Rumped Serin	√	√	√	-	-	-	-	3
66	Yellow Browed Camaroptera	√	√	√	-	-	-	√	3
67	Yellow crowneic Canary	-	-	√	√	√	√	√	5

Appendix 7. Sample photographs of birds taken during the field study

Speckled Pigeon

Hammerkop

Wattled Ibis

Laughing Dove

Yellow Crowneic Canary

Black Red Start

Hoopoe

Northern Red Bishop

African Pied Wagtail

Buffy Pipit

Narrow tailed Starling

Little Bee Eater

Red Cheeked Cordon Blue

Pied Crow

Hemprich Horn Bill

African Watteled Lapwing

Appendix 8. Part of the Grove at Abune-Gebremenfeskdus Church

Appendix 9. Point Count Field Data Sheet for Bird Survey

Date_____

Starting time_____

Finishing time_____

Code/ Name	Session						Scanning method			Recorded Bird species
	Morning			Afternoon			1st	2nd	3rd	
	7:00-8:00	8:00-9:00	9:00-10:00	15:00-16:00	16:00-17:00	17:00-18:00				

Supportive notes _____

_____

_____

_____

_____.

DECLARATION

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

Name: Guesh Hafte

Signature: _____

Date: September, 2019

The thesis has been submitted with my approval as a supervisor

Name: Tilaye Wube (PhD)

Signature: _____

Date: September, 2019