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Diversity, distribution and abundance of the avian fauna of Dhati-Walel National Park, Western Ethiopia

A thesis submitted to the Department of Biology, College of Natural Sciences, School of Graduate Studies, Jimma University in Partial Fulfillment of the requirements for the Degree of Master of Science in Biology (Ecological and Systematic Zoology)

By: Megersa Tsegaye

Advisor: Tsegaye Gadissa (PhD, Asst.Prof)

Co-advisor: Gelaye G/Michael (PhD. candidate)

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Table of contents

List of Tables

Page

List of Figures

List of Plates

List of Appendices

List of Acronyms

BLI	BirdLife International.
DhWNP	Dhati-Walel National Park.
EWNHS	Ethiopian Wildlife and Natural History Society.
EMAKS	Ethiopian Metrological Agency at Kebe station.
GKAO	Gawo Kebe Agricultural Office.
IBA	Important Bird Area.
IBC	Institute for Biodiversity Conversation
IUCN	International Union for Conservation of Nature and Natural Resources.
OFWE	Oromia Forest and Wildlife Enterprise.
SPSS	Statistical Package for Social Science
WCMC	World Conservation Monitoring Centre.

Abstract

The present study aimed to investigate bird diversity, distribution and abundance in Dhati-Walel National Park, western Ethiopia. After reconnaissance survey, detailed data collections were carried out from June to September 2013 and March to May 2014 for the wet season and from November 2013 to February 2014 for the dry season. The study area was stratified based on vegetation. Three habitats types: wetland, woodland, and riverine forest, were identified for counting birds. The habitat type was classified into blocks. Representative samples were taken from each habitat type. Line transect method was employed for wetland and woodland habitat and point count method was employed for riverine forest. A total of 124 avian species belonging to 18 orders and 50 families were identified during the study period. During the wet season, highest avian diversity was observed in woodland ($H' = 3.96$) *followed by riverine forest* ($H' = 3.087$) *. The least diversity of avian species was observed in the riverine forest* ($H' = 2.928$) *whereas during thedry season, highest avian diversity was observed in woodland* ($H' = 3.709$) *followed by riverine forest* ($H' = 3.146$) *. The least diversity of avian species was observed in the wetland* ($H' = 3.068$). *During the wet season, more similarity of bird species was obtained from woodland and riverine forest (SI=0.44) followed by woodland and wetland (SI= 0.11). During the dry season, more similarity of bird species was obtained from woodland and riverine forest (SI=0.31) followed by wetland and riverine forest (SI= 0.15). Mean abundance of species composition among the three habitats showed significant difference at 0.05 level of significance (F= 15.810, p < 0.05). But insignificant difference was shown during wet and dry seasons at 0.05 level of significance (F= 0.632 = 0.658, p > 0.05). Awareness creation, conservation, and active community participation are essential for maintaining the habitats and avian fauna of the area.*

Key words: *- Abundance, Birds, Dhati-Walel National Park, Distribution*

1. Introduction

1.1. Background

Topographical variability and temperature are identified as the most important global predictors of richness of avian species (Karr, 1976, 1980; Davies *et al*., 2007). Environmental heterogeneity in the form of spatial variation in habitat and local climate can affect species distribution (Veech and Crist, 2007). The abundance and distribution of bird species are also affected by scale-dependent hierarchical processes that disturb the links between habitat suitability and their numbers (Telleria *et al.*, 2009). The divergent seasonality of rainfall and seasonal variation in the availability of food resources end result in seasonal changes in the species abundance of birds (Karr and Roth, 1971; Gaston *et al*., 2000). The allocation and abundance of numerous bird species are determined by the composition of the vegetation that forms a major element of their habitats. As vegetation changes along multifaceted biological and environmental gradients, a particular bird species can appear, increase or decrease in number, and vanish as the habitat changes (Lee and Rotenberry, 2005).

Ethiopia is both physically and biologically one of the most diverse countries of the world. This is believed to be as a result of the large diversity of ecological conditions determined by a topography ranging from 110 meters below sea level at Kobar sink in the Afar depression to a peak of 4620 meters above sea level at Ras Dejen in the Simen Mountains (Shibiru, 1995). Three-biome assemblages of avifauna are known to occur in the country: namely, the Afro-tropical Highland Biome, the Somali-Masai Biome and the Sudan and Guinea Savannah Biome (Mengistu, 2003). The Afro tropical Highland Biome has 48 species of birds of which 7 species are endemic. The Somali-Mosai Biome is the richest in terms of diversity representing 97 species. It includes 6 endemic species,3 of which are globally threatened. The Sudan-Guine savannah Biome is represented in Ethiopia by 16 species (EWNHS, 1996).

Most of the avian species occur in Important Bird Areas (IBAs). IBAs are selected based on categories. Some of the categories are: globally threatened, restricted range and biome assemblages, and congregation. A total of 1228 IBAs are distributed among 58 countries or territories in Africa and its associated islands (Collar and Stuart, 1985). IBAs cover 7% of the

land area of the African continent. Out 0f 1228 IBAs, 597 are found in Africa (47%) (BirdLife International (BLI), 2001).

Many bird populations are declining worldwide, with 1,227 species listed as threatened (Fuller, 2000). The threatened bird fauna of Ethiopia are categorized as critically endangered (2 species), Endangered (5 species), Varnerable (12 species) and Near-Threatened (14 species) (Collar *et al*., 1994; EWNHS, 1996).

To conserve the biodiversity of the country and enhance economic growth through tourism and associated activities about 73 important bird areas (IBAs) are identified within the country (Shimelis and Afework, 2008). Of these 30 sites (41% of the total) comprise wetlands, while the rest are representatives of other types of ecosystems. Nationally, Ethiopian IBA sites have been grouped into three conservation categories based on distribution and abundance as critical (19), urgent (23) and high (31) (Mengistu , 2003).

Among the known wildlife area of Ethiopia, Dhati-Walel National Park is one of the conservation areas which contain the largest extent of wetland habitat in Ethiopia. Wetlands provide suitable habitats for innumerable organisms including birds (Shimelis and Afework, 2008). The distribution of wetlands in Ethiopia can be described by classifying them in to three major biomes, which also describe broadly the Ethiopian climatic features, namely, the Afro-Tropical highlands, the Somali-Masai, and the Sudan-Guinea and the Sahelian-Transition biome groups (Leykun, 2003). The wetlands of the Dhati-Walel National Park previously called Dabus swamp (Conway, 1997; Sutcliffe and Parks, 1999) are included in the Sudan-Guinea biome, which is found in the western Ethiopia (Mohammednur, 2012).

In order to sustain the livelihood of avian species of the area, basic ecological information should be available. So far, many researchers have dealt with the East Africa (Kenya, Uganda, and Tanzania) avian ecology and some studies have also been conducted on the diversity and ecology of avian species in some parts of Ethiopia (EWNHS, 1996; Ash and Gullick, 1989). Despite the availability of diverse ecosystems in different regions of Ethiopia, the ecology of most avian species is only little known. Dhati-Walel National Park is a recently established Park in the upper stream of Blue Nile, western part of Ethiopia, Oromia Regional State. There is no attempt to assess the existing information on bird diversity, distribution and relative abundance in this study

area. Therefore, this study aims at obtaining primary information on the diversity, distribution and relative abundance of the avian fauna of Dhati-Walel National Park to fill this identified gap.

1.2. Statement of the problem

Dhati-Walel is a newly established National Park in Ethiopia. This area is known to have higher avian diversity (*http://www.oromiyaa.com*). However, there is an accelerated reduction on the number of avian species as a result of man-made pressure and activities, such as uncontrolled hunting, habitat destruction for agricultural expansion, pressure by domestic animals and heavy encroachment by humans *(http://www.feg-consulting.com).* Knowledge about avian diversity, distribution and relative abundance is very essential for the development of sound management plan for a given protected area. In Dhati-Walel National Park, no research is carried out to investigate the diversity, distribution and relative abundance of avian species. Thus this study is designed to gather essential information on the diversity, distribution and abundance of the avian fauna of Dhati-Walel National Park.

1.3. Objective of the study

1.3.1. General objective

- To assess the species diversity, distribution and abundance of the avian fauna of Dhati-Walel National Park.

1.3.2. Specific objectives

- To determine species diversity of birds in the study site.
- To determine the distribution of avian species.
- To estimate abundance of birds.

1.4. Significance of the study

The destruction of vegetation and environmental degradation of natural habitat has become issues of national and global concern in recent years. Declining vegetation cover and depletion of natural resources are closely associated with drought and food shortages that have become major threat affecting the life of wildlife. As a result of these problems, the number of bird species is declining. Therefore, the findings of this study is expected to show the current diversity, distribution and abundance of the avian fauna of Dhati-Walel National Park which is important for the future development of sound management plan for this Park. The information collected during this study will serve as a baseline for other researchers interested to carry out additional studies in this National Park. In addition, the results of the study will serve as a source of information for ecotourism development in the area.

2. Literature review

Biodiversity describes the sum total variety and variation of life forms across all levels of organization, which ranges from genes to ecosystems. It also includes the variety and abundance of species, genetic composition, and the communities, ecosystems, and regions in which they occur (Burley, 2002). Ecological processes have structural and functional relationships. This process includes energy flow and minerals and nutrient cycles through individual organisms that are members of species whose populations are assembled into ecological communities (Wilson, 1992; Kormondy, 1996). None of these ecological processes occurs in isolation for each is marked by particular by groupings of different species or populations in particular physiochemical environments (Grime, 1997).

Birds are the most successful and highly diverse of all terrestrial vertebrates because they can consume almost all types of animal and plant materials. Each species has its own ecological preference. Birds have long been popular with amateurs and professionals and consequently their systematic position and distribution patterns are better known than any other comparable groups of animals, with the possible exception of large mammals (Furness and Greenwood, 1993).Every year, more bird species are discovered. A taxonomic revision of the mouse-colored *Tapaculo syctalopusspeluncae* complex was identified as new species and suggested more species are waiting to be described (Dias, 2006). Close comparison of the birds from museum specimens have confirmed as a new species.Observations of new and/or endangered species are costly and time consuming as it requires intensive efforts.

The class Aves includes 29 orders, 201 families, 2073 genera and 10,000 species (Lepage, 2009). Africa is home to two endemic bird Orders, ten endemic Families (with two more only reaching Madagascar or Arabia) (Sinclair and Ryan, 2003). One of the 120 species endemic to Madagascar, Sakalava Rail, has only been seen by a handful of ornithologists since its rediscovery in 1995, 30 years after the last previous sighting (Pitches, 2005). Africa is second only to South America in terms of numbers of bird species, and offers more rewarding birding than other tropical regions. The continent supports more than 2100 of the world's bird species, out of which almost 1400 are endemic species in a diversity of habitats (Sinclairand Ryan, 2003).

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). Areas with varied topography and climatic conditions are believed to support more species than uniform ones (Wallace, 1955; Pomeroy, 1992). Terrestrial avian diversity increases as one moves from the poles towards the equator. Habitat complexity is greater in the tropics. This provides opportunity for ecological specialization of species (Roth, 1976).

Birds are among the widely studied groups, with enough information on their distribution and status (Canterbury *et al*., 2000). 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.The distribution of any species can be influenced by many factors which are mainly categorized under abiotic and biotic factors (Loreau, 2010). Approximately 30% of the world's species of birds are restricted to tropical forests (either for winter or year-round habitat) that they would disappear if all tropical forests were lost (Myers, 1992). 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 fit their requirements for successful reproduction and survival (Welty, 1975).

Birds were categorized into three distribution patterns: resident birds (birds observed during the whole study period), regular birds (birds observed for a considerable part of the year or in different months), and irregular birds (birds observed only once or a few times during the study period) (Karr, 1976).

Wetlands provide suitable habitats for innumerable organisms including birds (Shimelis and Afework, 2008). Water birds are also categorized as; wetland specialists and generalists. Specialists are those that nest, feed and roost in wetlands. Wetland specialists are wholly dependent on aquatic habitats, and cannot survive in other habitats. Generalists are those birds that frequently visit wetlands, but are seen in other habitats as well. Birds are the most abundant

vertebrates next to fish. They are widespread due to their adaptability and the feasibility of movements. Some birds even invade deep water to a depth of up to 200 m (Kress, 2000).

Ethiopia has a diverse set of ecosystems ranging from humid forest and extensive wetlands to the desert of the Afar depression. Because of its geographic position, range of altitude, rainfall pattern and soil variability, the country possesses ecological diversity and a huge wealth of biological resources. The geographical location of Ethiopia, particularly the plateau, makes it a bio-geographical island surrounded by expanse of drylands. This complex topography coupled with environmental heterogeneity offers suitable environments for a wide range of life-forms. 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).

Birds are one of the most important components of biodiversity. This is reflected by the ecological, economical and esthetic values. Ongoing reductions in bird abundance and species richness are likely to have far-reaching ecological consequences, with diverse societal impacts ranging from the spread of disease and loss of agricultural pest control to plant extinctions and trophic cascades (Gaston *et al.*, 2003). It is often asserted that birds are convenient indicators of biodiversity, atleast 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 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 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 from 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, 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 and Hay, 1989). Certain birds like humming birds and sunbirds pollinate certain flowers that produce nectar. As they visit flowers in search of it, they spread pollen from flower to flower.

Birds through the ages have been the source of considerable fascination and folklore, and have been used as symbols. They are the most universally celebrated form of nature, found in pictures, photographs, sculptures, word and song (Clifford and Beehler, 1998). At the same time, few species of birds like Quelea (*Quelea quelea*) cause major agricultural loss in some regions of theworld (Elliott, 1989).

Birds are found across the world in all major habitat types. Worldwide, tropical forests are being logged and degraded because of an increasing demand for forest resources, or are converted into farmland and plantations (Laube *et al*., 2008). In the tropics, habitat loss and habitat degradation, in particular in forests, are causing rapid declines in bird species, which in turn may cause reductions in ecosystem processes, services and benefits (Sekercioglu *et al*., 2012). Agriculture which puts 1,065 threatened birds (87%) at risk, logging and wood harvesting impacting 668 species (55%) and invasive species which threaten 625 (51%) of threatened species (BirdLife International, 2008).

According to BirdLife International (2008), most threatened birds show a clear preference for certain types of habitat, with 26% occurring in just one major type (e.g. forest) and 51% in one or two. As with all birds, forests are the most important habitat for threatened birds, supporting 77% of the species, with 27% in shrubland, 16% in inland wetlands and 16% in grasslands. Marine habitats support a higher than expected proportion of threatened birds (13%), while savannas are of lower importance (8%). Only 31% of threatened species use an artificial habitat

(compared with 50% of all birds), which suggests that threatened species may be less tolerant of habitat modification (BirdLife International, 2008).

Bird species will not have evolved entirely in the presence of agriculture on the scale seen today and will select for aspects of the land which resemble the savanna, grassland, forest or wetland they have evolved to exploit (Gill, 2006). In the tropics, habitat losses and habitat degradation, in particular in forests, are causing rapid declines in bird species, which in turn may cause reductions in ecosystem processes, services and benefits (Sekercioglu *et al*., 2012). Alterations in species richness and composition can also affect the functional diversity of the community (Gray *et al*., 2007) and changes in provided ecosystem services can, in turn, have an effect on humans again (Clough *et al*., 2009).

In Ethiopia particularly in the Afromontane rainforests, habitat destruction and degradation due to anthropogenic activities are reducing the forest cover and the associated biodiversity (Yeshitila, 2001). A new threat, which is expected to intensify in the next century, is global climate change (Dessler and Parson, 2003). As the earth warms, birds respond in a number of ways, there is evidence that some species are laying eggs earlier and others may be changing their range and migratory behavior in response to climate-driven habitat changes. The species is tied to its breeding sites and their genetic programming may not allow the birds to move to other viable nesting habitat (Schutkowski, 2006).Threatened birds are found in all forest types. Tropical/subtropical lowland and montane moist forest are the most important habitats supporting 45% and 37% of species, respectively, with tropical/subtropical dry forest supporting 13% (Hilton-Taylor, 2000).

3. Study area and Methods

3.1. Study area

3.1.1. Location of the study area

Dhati-Walel National Park is established in 2010. The Park is located along the western lowlands of Ethiopia, about 647 km from Addis Ababa, the capital city of Ethiopia and 116 km south and southwest of the zonal capital of Kelam Wollega (Dembidollo) town(Mohammednur, 2012). It lies between the coordinates of 67^0 55' 49" to 72^0 45' 03" east and 10^0 05' 25" to 10^0 51' 01" north, covering an area of about 1035 km^2 (Mohammednur, 2012). The name of this National Park is derived from two prominent features in the area called Dhati River and the Walel Mountain. The elevation of the Park ranges from1390 m around Dhati River to 1500 m at the peak of Walel. The Park is located midway between two zones; Kelem Wollega zone to southeast, south and southwest, and west Wollega zone from northeast, north and northwest (Fig.1). It is bordered by six Woredas namely Gawo Kebe, Jima Horo, and Gidami in Kelem Wollega zone, and Begi, Kondala, and Babo Gambel woredas in West Wollega zone. The largest portion of the Park is in GawoKebe Woreda (Mohammednur, 2012).

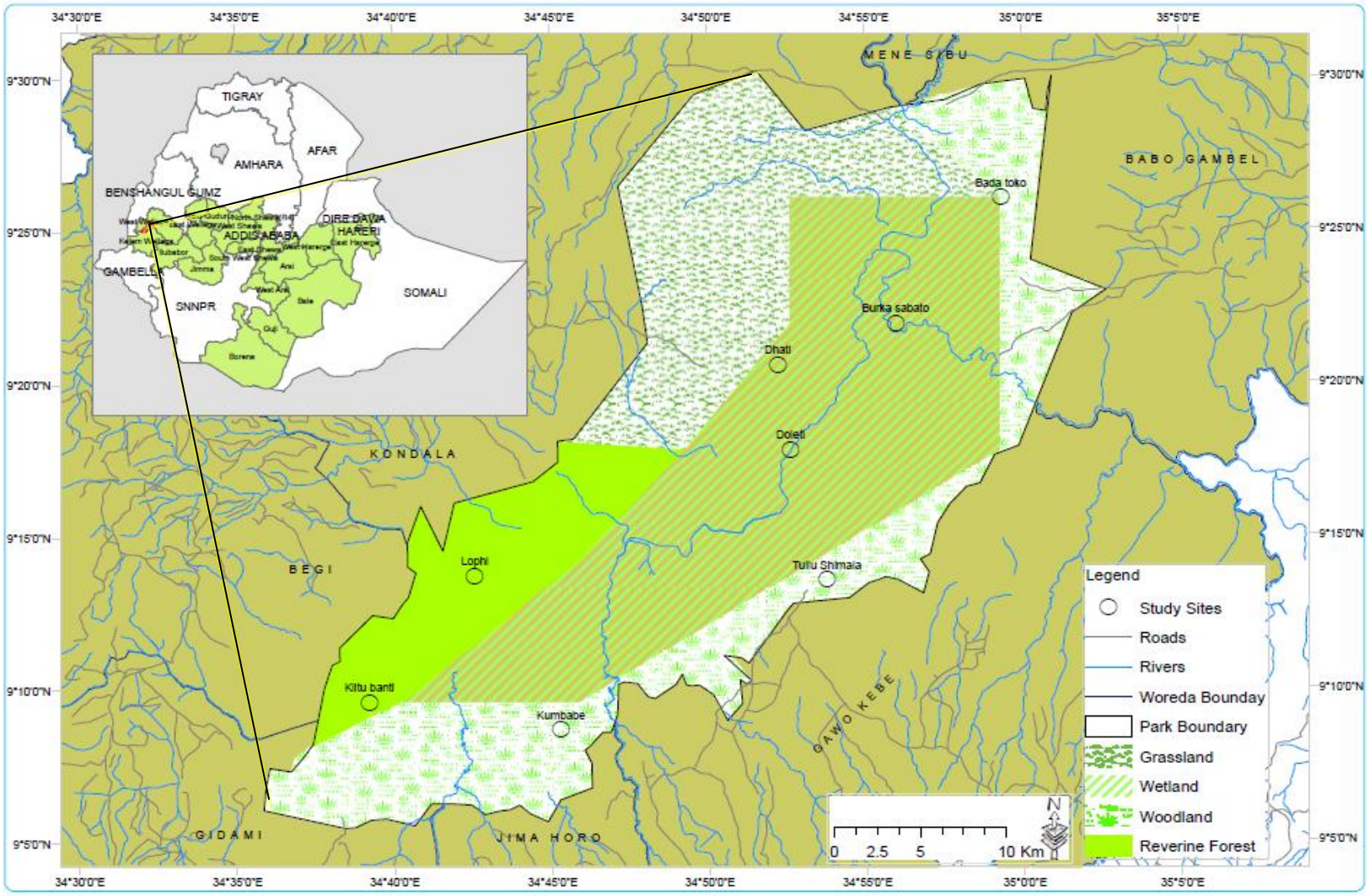

Figure 1. Location map of the study area (Dhati-Walel National Park)

(Map by: Dassaleny Gurmessa , 2014)

3.1. 2. Habitats

The park encompasses four different habitat types. These are wetland, woodland, riverine forest and grassland.

3.1. 2.1. Wetland

The wetland is composed of the two major rivers of Dhati and Dabus that drain to the Blue Nile. It is the largest portion of the study area which covers a total area of 900 km^2 andoften with high water table and sub-surface water within the root zone (Mohammednur, 2012). In most cases, these flood plains are conspicuous features of the landscape in contrast with the surrounding vegetation. As a result, this habitat attracts wildlife. Papyrus plant (*Cyperus papyrus*) and *Typha latifolia* are important floristic components of this habitat. The wetland bird habitats during the dry and wet seasons are shown in plate 1.

a b

Plate 1.Views of wetland, dry season (a)(February, 2014) and Wet season (b) (July, 2014)

(Photo by: Megersa Tsegaye)

3.1. 2.2. Woodland

Woodland is the second largest habitat covering an area of 100 km^2 next to wetland (Mohammednur, 2012). It is characterized by small to moderate-sized tree species with broad leaves, often deciduous, such as *Boswellia papyrifera, Anogeissus leiocarpa, Stereospermum kunthianum* and *Terminalia species,* and *Combretum* species *(*Plate 2). Based on the types of dominant species the woodland area can be characterized as mixed and *Combretum* woodlands. The *Combretum* woodland which is found at the border of the park is characterized by dominant species of *Combretum* and *Terminalia* species (Mohammednur, 2012). This habitat is typically covered with a well-developed grass which is commonly burnt every year. This vegetation type has a clear tree grass species. The dominant species are *Maytenus arbutifolia*, *Terminalia brownie, Combretum colinum*and *Combretum mole* (http://www.feg-consulting.com).

a b

Plate 2.Views of woodland, dry season (a) (February, 2014) and wet season (b)(July, 2014).

(Photo by: Megersa Tsegaye)

3.1. 2.3. Riverine forest

Riverine forest is the third largest site which covers an estimated area of 30 km^2(Mohammednur, 2012). It occurs along the narrow strip of the river banks in the study area. The major rivers in the study area are Dhati, Kumbabe, Dilla, Jirma, Sadeka and Burar (Mohammednur, 2012). In addition, small seasonal streams also form the riverine forest. This habitat is characterized by mixed vegetation type composed of large tree and herbaceous species (Plate 3). The dominant plant species in this study site are *Phonex*, *Ficus*, *Podocarpus falcatus*, *Syzygium guineense* and *Costa*. (*http://www.feg-consulting.com*).

a b

Plate 3.Views of riverine forest, dry season (a) (February, 2014) and wet season (b) (July, 2014) (Photo: Megersa Tsegaye)

3.1. 2.4. Grassland

Savannah grassland covers only a small portion of the study area (Mohammednur, 2012). The dominant grass species in most distributional range of this habitat is the elephant grass (*Pennisetum sp*.) Local people deliberately set fire to it in search of grazing land (*http://www.feg-consulting.com*).

Even though the habitats of the study area were classified into wetland, woodland, riverine forest and grassland, due to time constraints and shortage of money sampling sites were selected

purposively based on habitat types, the area it covers and availability of birds (wetland, riverine forest, and woodland) from the available habitats.

3.1.3. Climate

Temperature and rainfall record within the study area are lacking. The data used for the description of the climate (temperature and rainfall data) were collected from the Kebe metrological station, 26 km far from the study site.

3.1.3.1. Temperature

The data of temperature for the present study was collected from Ethiopia Metrological Agency at Kebe station and the result is presented in figure 2. The mean monthly maximum temperature of the area ranged between 27^0 C and 29^0C and the mean minimum temperature between15^0 C and 17^0C (Fig.2).

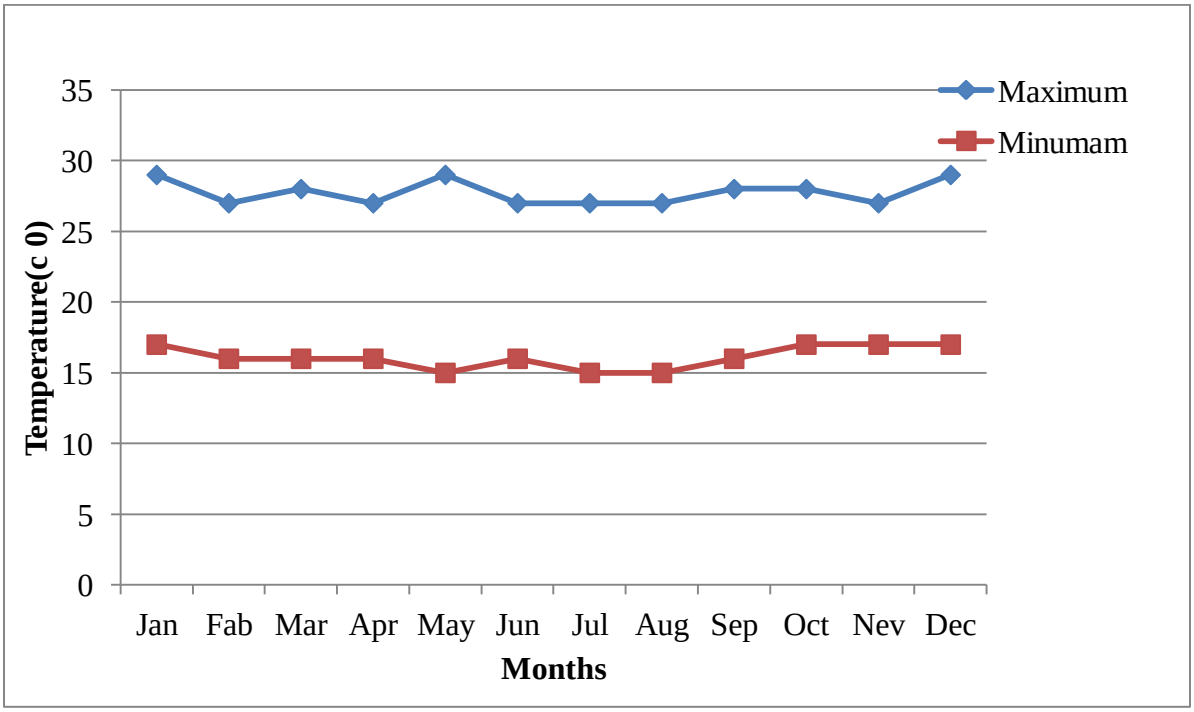

Figure 2. Monthly mean maximum and minimum temperature in Dhati-Walel National park (2007-2012).

3.1.3.2. Rainfall

The rainfall distribution in this area is bimodal with one long rainy season; June to September and the short rainy season March to May. The total amount of annual rainfall in the study area varies between 1200 and 1500 mm (Fig. 3) and the mean annual rainfall of the area is 1350 mm .The area receives the highest rainfall during the wet season during, June to September and the lowest rainfall during the dry season, November to February (EMAKS, 2013).

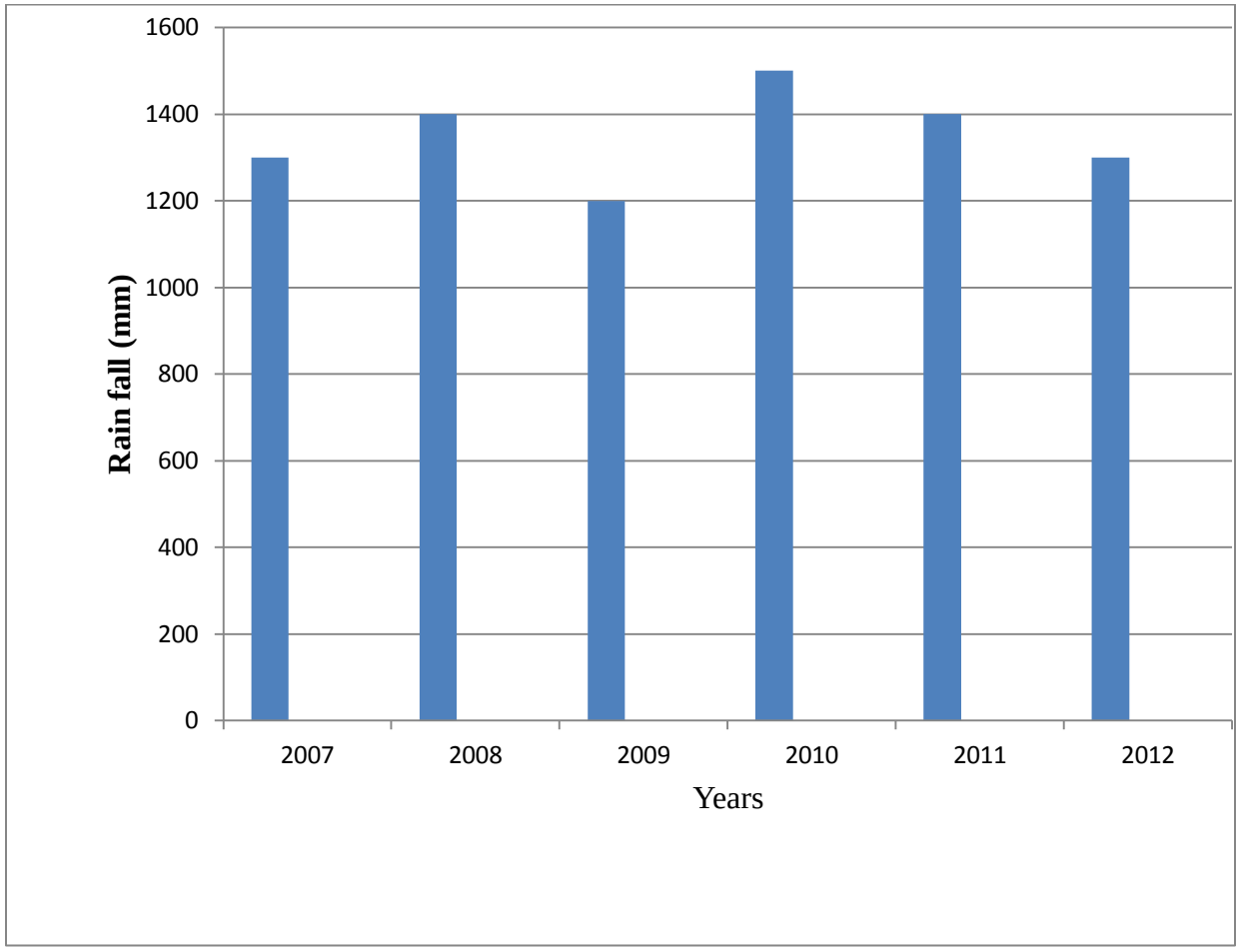

Figure 3.Annual average rainfall in Dhati-Walel National Park (2007-2012).

3.2.Materials and Methods

3.2.1. Materials

In this study, binoculars (PENTAX 8x40 6.3°), digital camera, Global Positioning System (GPS-72), field data sheet, Notebooks, pen, pencils, and field guide book (Sinclair and Ryan, 2003) were used.

3.2.2. Methods

3. 2.2.1. Preliminary survey

Initially a preliminary survey was conducted in the study area for five days. The actual field work was carried out between June, 2013 to May, 2014to cover both wet and dry seasons.

During the preliminary survey, information about the study area (climatic condition, topography), and approximate size of the study area was gathered from relevant governmental authorities (Kellem Wollega Cultural and Tourism Office,Gawo Kebe Agricultural office, Kebe Metrological Station,Oromia Regional State Park Development Office and Dhati-Walel National Park warden) and the local people living around study area. Different habitat types and representative habitat sites were observed. Habitats of the study area were classified into wetland, woodland, riverine forest and grassland habitat types. From these habitat types wetland, woodland and riverine forest were selected purposively, based on vegetation types, the area it covers and availability of birds. At least 20 to 25% of the study area was covered in each sample units (Bibby *et al*., 1992). During the study, each habitat type was classified into blocks. Although,14 blocks were selected from habitat types of the study area, representative blocks were selected for actual survey among the habitat types at random to make sure that the results are generally representatives of the whole study area. There were five blocks from wetland, five blocks from woodland and four blocks from riverine forest.

3.2.2.2. Sampling methods in wetland and woodland.

Line-transect methods were used for wetlands and woodland sampling units (Buckland *et al.*, 2001). For the five blocks of wetland randomly selected, a total of 20 line transects, seven transect lines each for Burka Sabato and Doleti, six transect lines for Dhati were laid. For thefive

blocks from woodland randomly selected, a total of 20 line transects were laid. Eight transect lines for Bada Toko, nine transect line for Tullu Shimala and three transect lines for Kumbabe were laid. The length of transect varied based on the visibility of habitat and accessibility. Accordingly, for wetland habitat transects length of 2 km and in the woodland habitat transects length of 1.5 km, were located randomly in the study area using Global Positioning System (GPS). Avian seen were recorded, early in the morning from 6:30 to 10:00 a.m. and 3:30 to 6:00 p. from within 25 m on either side of the transect line making a total width of 50 m. Transact lines were 250-300 m apart from each other to avoid double counting (Hostler and Martin, 2006). Transect line were placed by random sampling approach in which transect placement is proportional to the area of the habitat type (Bibby *et al*., 1998; Manley *et al*., 2006, Lambert *et al*., 2009). Due to the inaccessibility of the sampling site censuses were conducted twice during wet season and dry season each on foot by the researcher and a well-trained field assistant of the Park and trained scouts who are familiar with the area. The number of assistances varied depending on the number of line transect in the study site.

3.2.2.3. Sampling methods in riverine forest.

Point count sampling methods were used in the riverine forest. For each four blocks of riverine forest , a total of, 30 point count stations were laid. Fifteen point count station each for Kiltu Banti, and Lophi were laid. All thirty point count stations were surveyed four times during the study period. The point count within the sample unit were 200 m far from each other, and had a radius of 25 m to avoid double counting (Ralph *et al*. 1995).

3.2.3. Data collection

After reconnaissance survey, detailed data collections were carried out from June to September, 2013 and March to May, 2014 to accommodate the wet season and from November, 2013 to February, 2014 to accommodate the dry season. Two field surveys for wet season were carried out from July to September, 2013 for first session, and March to May, 2014 for second session to collect data. First session of the dry season data collection was carried out from November to December 2013 and from January to February2014 for the second session of the dry season.

Data were collected early in the morning from 6:30 to 10:00 a.m. and late in the afternoon from 3:30 to 6:00 p. m (Spencer, 1963; Centerbury *et al*., 2000). To minimize disturbance during count, a waiting period of 3 to 5 minutes prior to counting was applied (Sutherland, 2000 ; Hosteler, 2001). Birds in the study sites were observed using naked eyes and binoculars for better identification. Birds flying over the area were also observed to identify the species. Photographs were taken for further confirmation of the bird species. For larger flocks and for rapidly moving flocks, members of individual species were recorded by estimation methods (Bibby *et al*., 1998). Common methods when estimating very large flock is to count, say 10, 20, 50, 100, or 500 birds and then estimate the proportion of the larger flock. Field data sheet were used to record the identified species. GPS coordinates were recorded for each study site. Species observed during the survey activity were properly identified and taxonomically classified following Sinclair and Ryan (2003), Avibase Checklist of the World (Lepage, 2013) and taxonomy and classification of Ethiopian birds.

3.2.4. Data analysis

3.2.4.1. Species diversity

The species diversity of each habitat of each seasons of the area was analyzed using Shannon-Wiener diversity Index (Shannon and Wiener, 1949). Shannon-Wiener diversity Index is calculated as:

H' = - Σ [($\frac{ni}{N}$) xln ($\frac{ni}{N}$))] where:

H' = Shannon-Wiener diversity Index

ni = number of individuals of each species (the i^{th} species) and

N = total number of individuals for the site, and

ln = the natural log of number.

The value of Shannon-Weiner diversity index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5 (Magurran , 1988). A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species (Bibi and Ali, 2013). In a community with only one species H' = 0. As H' increases, communities increase in diversity (Krebs, 1999).

3.2.4.2. Species evenness analysis

Species evenness, which measures the pattern of distribution of the bird populations that present in the area, were evaluated using Shannon-Wiener evenness Index (E) as follows:

$E = \frac{H'}{Hmax}$ Where:

E = Shannon-Wiener Evenness Index

H' = Shannon-Wiener diversity Index

H_{max} = ln S= natural logarithm of the total number of species (S) in each site

(Southwood and Henderson, 2000).

The richness index of each species was determined using the formula

$RI = \frac{S-1}{\ln I}$, Where,

S= number of species in each habitats

ln= Natural logarithm

I= Number of individuals or species in each habitat

3.2.4.3. Species similarity

Diversity indices measure the degree of uncertainty (if the diversity is high in a given habitat, the sureness of finding a particular species is low). In reference to the composition of species, Simpson's similarity index (SI) was used to assess the similarity of species between two different habitats, and season by using the formula:

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

SI = Simpson's similarity index

A = Number of species that occur in site A

B = Number of species that occur in site B

C = Number of species shared by A and B

3.2.4. 4. Species abundance analysis

The abundance of avian species were determined using encounter rates that give crude ordinal scales of abundance as abundant, common, frequent, uncommon and rare, which is calculated as follows (Bibby*et al*., 1998) :-

$$\text{Encounter rate} = \frac{\text{Total number of individual bird observed}}{\text{Period of observation in Hour}} \text{x}100$$

Encounter rates were used to give a crude ordinal scale of abundance (Bibby *et al*., 1998) as given in Table 1.

Table 1. Encounter rates used to give a crude ordinal scale of abundance

Abundance Category	Abundance score	Ordinal scale
<0.1	1	Rare
0.1–2.0	2	Uncommon
2.1–10.0	3	Frequent
10.1–40.0	4	Common
40.0+	5	Abundant

Data collected during the study period were analyzed using SPSS (version-16) statistical program. One-way ANOVA was used to determine if the differences in mean bird species diversity across sites were significant. Pearson's correlation was used to determine if there were significant associations between the mean number of species per count and total number of recorded bird species.

4. Results

A total of 124 species of birds belonging to 18 Orders and 50 Families were recorded during the study period (Table 2).Among them, two species, Wattled ibis (*Bostrychia carunculata*), and Thick-billed Raven are endemic to both Eritrea and Ethiopia. Banded Barbet (*Lybiusundatus*) and Erlanger's lark (*Calandr ellaerlangeri*) are endemic to Ethiopia. Sample photographs of avian were taken during the field study (Appendex 11). Passeriformes compossed the largest number of family and number. The highest number of bird species was recorded for the family Accipitridae which contained 14 species, followed by Columbidae, Nectariniidae and Ciconiidae that contained nine, six and five species, respectively. The result of the present investigation revealed seasonal variation in bird's species and abundance in different habitat types of the study area. Among 124 bird species recorded, 114 and 111 bird species were recorded during wet and dry seasons, respectively, 100 bird species were common to both season, but 14 and 11 species were exclusive to the wet and dry seasons, respectively (Table 3).

Table 2. Composition of bird orders in the study site.

Order	Number of family	Number of species
Passeriformes	23	49
Accipitriformes	2	15
Columbiiformes	1	9
Pelicaniiformes	3	9
Coraciiformes	3	9
Piciformes	3	6
Ciconiiformes	1	6
Charadriiformes	3	5
Galliformes	2	3
Coliiformes	1	2
Gruiformes	1	2
Anseriformes	1	2

Cont…

Psittaciformes	1	1
Carpimulgiformes	1	1
Cuculiformes	1	2
Falcaniformes	1	1
Suliformes	1	1
Trogoniformes	1	1
	50	124

Table 3. List of bird species recorded from Dhati-Walel National Park during both seasons in the three habitat types (D=dry season, W= wet season and B= both season).

Order	Family	Common Name	Scientific name
Accipitriformes	Accipitridae	African Harrier-Hawk [B]	*Polyboroides typus*
		African goshawk [B]	*Accipiter tachiro*
		African fish-eagle [B]	*Haliaeetus vocifer*
		Augur buzzard [B]	*Buteo augur*
		Black kite [B]	*Milvus migrans*
		Black sparrowhawk [B]	*Accipiter melanoleucus*
		European honey buzzard [B]	*Pernis apivorus*
		Hooded vulture [B]	*Necrosyrtes monachus*
		Lappet-faced vulture [B]	*Torgos tracheliotus*
		Long-crested eagle [B]	*Lophaetus occipitals*
		Ruppell's vulture [B]	*Gyps rueppellii*
		Shikra [B]	*Accipiter badius*
		Yellow- billed kite [B]	*Milvus aegyptius*
		White-backed vulture [B]	*Gyps africanus*
Apodiformes	Apodidae	Alpine swift [D]	*Tackymaroties melba*
Anseriformes	Anatidae	Egyptian goose [B]	*Alopochen aegyptiaca*
		Spur-winged goose [B]	*Plectropterus gambensis*
Carpimulgiformes	Caprimulgidae	Standard-winged nightjar [B]	*Macrodiptryx longipennis*
Charadriiformes	Charadriidae	Crowned lapwing [B]	*Venellus coronatus*
		Kentish plover [B]	*Charadrius alexandrines*
		Spur winged lapwing [B]	*Venellus spinosus*
	Jacanidae	African Jacana [B]	*Actophilornis africanus*
	Scolopacidae	Wood sandpiper [B]	*Tringa glareola*
	Ciconiidae	African Openbill [B]	*Anastomus lamelligerus*
Ciconiiformes		Black stork [B]	*Ciconia nigra*
		Marabou stork [B]	*Leptoptilos crumeniferus*
		Saddle-billed stork [B]	*Ephippiorhynchus senegalensis*

		Woolly-necked stork [B]	*Ciconia episcopus*
		White stork [D]	*Ciconia ciconia*
Coliiformes	Coliidae	Blue-naped mousebird [B]	*Urocolius macrourus*
		Speckled mousebird [B]	*Colius striatus*
Cuculiformes	Cuculidae	Black Cuckoo [B]	*Cuculus clamosus*
		Blue-headed Coucal [B]	*Centropus monachus*
Columbiformes	Columbidae	African collared-dove [W]	*Streptopelia roseogrisea*
		Cape turtle (ring nacked) dove [B]	*Streptopelia Capicola*
		Dusky (pink-breasted) turtle-dove [B]	*Streptopelia lugens*
		Lemon (cinnamon) dove [W]	*Aplopelia larvata*
		Lauphing dove [B]	*Streroptopelia senegalensis*
		Mourning collared-dove [B]	*Streptopelia decipiens*
		Speckled pigion [B]	*Columba guinea*
		Red-eyed dove [B]	*Streptopelia semitorquata*
		Tambourine dove [B]	*Turtur tympanistria*
Coraciiformes	Alcedinidae	Half-collared king fisher [W]	*Alcedo semitorquata*
		Hemprich's hornbill [B]	*Tockus hemprichii*
		Woodland Kingfisher [B]	*Halcyon senegalensis*
		African Pygmy-Kingfisher	*Ispidina picta*
	Bucerotidae	Crowned Hornbill [B]	*Tockus alboterminatus*
		Eastern yellow billed hornbill [B]	*Tockus flavirostris*
		Northern red billed horn bill [D]	*Tockus erythrorhynchus*
		Silvery-cheeked Hornbill [B]	*Ceratogymna brevis*
	Bucorvidae	Abyssinian ground-hornbill [D]	*Bucorvus abyssinicus*
Falconiformes	Falconidae	Sooty falcon [D]	*Falco concolor*
Galliformes	Numididae	Helmeted guineafowl [D]	*Numida meleagris*
	Phasionidae	Crested francolin [B]	*Francolinus sephaena*
		Common quail [B]	*Coturnix coturnix*
Gruiformes	Gruidae	Black (Northern) crowned crane [B]	*Balearica pavonina*
		Wattled crane [B]	*Bugeranus carunculatus*

	Acrocephalidae	Icterine warbler [B]	*Hippolais icterina*
Passeriformes		Great reed-warbler [D]	*Acrocephalus arundinaceus*
	Alaudidae	Erlanger's lark [D]	*Calandrella erlangeri*
	Buphagidae	Red-billed oxpecker [B]	*Buphagus erythrorhynchus*
	Campephagidae	Red-shouldered cuckooshrike [B]	*Campephaga phoenicea*
	Cisticolidae	Green backed eremomela [D]	*Eremomela canescens*
		Foxy cisticola [D]	*Cisticola troglodytes*
		Pectoral-patch Cisticola [B]	*Cisticola brunnescens*
		Tawny-flanked prinia [B]	*Prinia subflava*
	Corvidae	Fan-tailed raven [D]	Corvus rhipidurus
		Thick-billed raven [D]	*Corvus crassirostris*
	Dicruridae	Fork-tailed drongo [W]	*Dicrurus adsimilis*
	Estrildidae	Black-rumped waxbill [B]	*Estrilda troglodytes*
		Bronze manikin [B]	*Spermestes cucullatus*
		Yellow-bellied waxbill [B]	*Coccopygia quartinia*
	Fringillidae	African citril [B]	*Serinus citrinelloides*
		Yellow-fronted canary [W]	*Serinus mozambicus*
	Hirundinidae	Commen house martin [B]	*Delichon urbicum*
		Ethiopian swallow [D]	*Hirundo aethiopica*
		Sand martin (Bank swallow) [B]	*Riparia riparia*
	Laniidae	Commen fiscal [B]	*Lanius collaris*
		Lesser gray shrike [B]	*Lanius minors*
		Masked shrike [W]	*Lanius nubicus*
	Motacillidae	African pied wagtail [B]	*Motacilla aguimp*
	Monarchidae	African paradise-flycatcher [B]	*Terpsiphone viridis*
	Muscicapidae	Rueppell's robin-chat [B]	*Cossypha semirufa*
		Tacazze sunbird [B]	*Nectarinia tacazze*
		White-winged cliff-chat [W]	*Thamnolaea semirufa*
	Nectariniidae	Copper sunbird [B]	*Cinnyris cupreus*
		Beautiful sunbird [B]	*Cinnyris pulchellus*
		Olive sunbird [B]	*Cyanomitra olivacea*

		Mariqua sunbird [B]	*Cinnyris mariquensis*
		Scarlet-chested sunbird [B]	*Chalcomitra senegalensis*
		Variable (yellow-billed) sunbird [B]	*Cinnyris venustus*
	Oriolidae	Eastern (black headed oriole) [B]	*Oriolus larvatus*
	Passeridae	Swainson's sparrow [B]	*Passer swainsonii*
	Phylloscopidae	Brown woodland-warbler [B]	Phylloscopus umbrovirens
		Wood warbler [B]	*Phylloscopus sibilatrix*
	Ploceidae	Little weaver [B]	*Ploceus luteolus*
		Red-billed buffalo-weaver [B]	*Bubalornis niger*
		Red-collared widowbird [B]	*Euplectes ardens*
		White-billed buffalo-weaver [W]	*Bubalornis albirostris*
	Pycnonotidae	Common bulbul [B]	*Pycnonotus barbatus*
	Sturnidae	Greater blue-eared starling [B]	*Lamprotornis chalybaeus*
		Ruppell's starling [B]	*Lamprotoris purpuropterus*
		Violet backed starling [W]	*Cinnyricinclus leucogaster*
	Turdidae	Abyssinian thrush [B]	*Turdus abyssinicus*
		Groundscraper Thrush [B]	*Psophocichla litsipsirupa*
	Viduidae	Eastern paradise-whyday [B]	*Vidua paradisaea*
Pelecaniformes		Black- crowned night-heron[B]	*Nycticorax nycticorax*
	Ardeidae	Black-headed heron [B]	*Ardea melanocephala*
		Cattle egret [B]	*Bubulcus ibis*
		Grey heron [B]	*Ardae cinerea*
		Squacco Heron [B]	*Ardeola ralloides*
	Scopidae	Hamerkop [B]	*Scopus umbretta*
	Threskiornithidae	Hadada ibis [B]	*Bostrychia hagedash*
		Glossy ibis [B]	*Plegadis falcinellus*
		Sacred ibis [B]	*Threskiornis aethiopicus*
Piciformes	Indicatoridae	Greater honey guide [W]	*Indicator indicator*
	Picidae	Bearded woodpecker [W]	*Dendropicos namaquus*
		Nubian wood peaker [B]	*Campethera nubica*
		Wattled ibis [B]	*Bostrychia Carunculata*

	Lybiidae	Double-toothed Barbet [B]	*Lybius bidenatus*
		Banded Barbet [B]	*Lybius undatus*
Psittaciformes	Psittacidae	Yellow-fronted Parrot [B]	*Poicephalus flavifrons*
Suliformes	Phalacrocoracidae	White breasted cormorant [B]	*Phalacrocorax lucidus*
Trogoniformes	Trogonidae	Narina Trogon [B]	*Apaloderma narina*

Variation in the number of bird species was observed among the three habitats. During the wet season, the highest number of species was recorded from woodland (67) followed by wetland (41)and riverine forest (33). During the dry season, the highest number of bird species was recorded from woodland (49) followed by wetland (48) and riverine forest (47). During both seasons, the highest number of bird species was recorded from woodland (87), followed by wetland (47) and riverine forest (53).

During wet seasons, the mean number of species per count and total number of recorded bird species were strongly positively correlated (r = 0.84). However, during the dry season, it was negatively correlated (r = -0.23). The minimum mean number of species per count was observed in wetland during both seasons (Table 4) (The raw data is given as appendix 4).

Table 4.Total count and mean abundance per count of bird species in Dhati-Walel National Park.

Wet season	Wetland	Woodland	Riverine forest
Total number of recorded bird species	41	67	33
Mean number of species per count	15.7(n=20)	51.6(n=20)	20.5(n=30)
Correlation factor(r) =0.84; n=number of sample			
Dry season	Wetland	Woodland	Riverine forest
Total number of recorded bird species	48	49	47
Mean number of species per count	17.6(n=20)	32.1(n=20)	19.5(n=30)
Correlation factor(r) =-0.23; n = number of sample			

Mean abundance of bird species among the three habitats showed statistical difference at 0.05 level of significance (F= 15.810, $p < 0.05$). But insignificant difference were shown during wet and dry seasons at 0.05 level of significance (F= 0.632 = 0.658, $p > 0.05$) (Tables 5and 6).

Table 5. Mean abundance of avian per count among the three habitats

Habitat	Mean	Std.Devation
Wetland	1.25	0.05
Woodland	2.72	0.17
Riverine forest	1.35	0.08

Table 6. Log transformed mean abundance of avian species per count at different seasons

Season	Mean	Std. Deviation
Wet	2.07	0.13
Dry	1.59	0.08

Variation was observed in species diversity among the different habitat types during the wet and dry seasons. During the wet season, highest bird diversity was observed in woodland ($H' = 3.96$) followed by riverine forest ($H' = 3.087$) . The least diversity of bird species was observed in the riverine forest($H' = 2.928$).The highest and the lowest even distribution were observed in woodland (E=0.94) and wetland habitats (E=0.79) during the wet season (Table 7).

Table 7. Species diversity among the three habitats during wet season in Dhati-Walel National Park.

Habitats	Species richness	Abundance	**H′**	**H′max**	E
Wetland	41	4540	2.928	3.71	0.79
Woodland	67	8993	3.960	4.20	0.94
Riverine forest	33	7601	3.087	3.49	0.88

H'= Shannon-Wiener Index, H max'= ln *S* = ln(total number of species), H'/H'max =Evenness (E)

During the dry season, highest birds diversity was observed in the woodland habitat ($H' = 3.709$) followed by riverine forest ($H' = 3.146$). The least diversity of avian species was observed in the Wetland habitat ($H' = 3.068$).The highest and the lowest even distribution was observed in woodland (E=0.95) and wetland habitats (E=79), respectively (Table 8).

Table 8. Species diversity among the three habitats during the dry season Dhati-Walel National Park.

Habitats	Species richness	Abundance	$\mathbf{H'}$	$\mathbf{H'max}$	E
Wetland	48	5408	3.068	3.87	0.79
Woodland	49	5067	3.709	3.89	0.95
Riverine forest	47	5448	3.146	3.85	0.82

H'= Shannon-Wiener Index, H max'= ln *S* = ln(total number of species), H'/H'max =Evenness (E)

During both seasons, highest diversity was observed in the woodland ($H' = 4.014$) followed by wetland ($H' = 3.71$) (Table 9).The least diversity of species was observed in riverine forest ($H' = 3.20$). The highest and lowest even distribution was observed in the wetland and riverine forest.

Table 9. Species diversity among the three habitats during both seasons Dhati-Walel National Park.

Habitats	Species richness	Abundance	$\mathbf{H'}$	$\mathbf{H'max}$	E
Wetland	47	4994	3.71	3.850	0.95
Woodland	87	10536	4.01	4.465	0.89
Riverine forest	53	8411	3.20	3.970	0.80

H'= Shannon-WienerIndex, H max'= ln *S* = ln(total number of species), H'/H'max =Evenness (E)

Among the three habitat types, maximum value of seasonal bird species similarity was observed in the wetland (SI=0.92) followed by riverine forest (SI=0.68). The minimum value of bird species similarity was observed in woodland (SI=0.5) (Table 10).

Table 4. Seasonal species similarity (SI) within the habitats type of Dhati-Walel National Park.

Habitat	Wet	Dry	No of common species during both seasons	SI	SI %
Wetland	41	48	41	0.92	92
Woodland	67	49	29	0.5	50
Riverine forest	33	47	27	0.68	68

Among the three habitat types, more similarity of birds species was obtained between woodland and riverine forest (SI=0.31), followed by wetland and riverine forest (SI= 0.15) during dry season. However, less similarity was obtained from species of wetland and woodland (SI= 0.15) (Table 11).

Table 5. Species similarity within the three habitats type during dry season Dhati-Walel National Park.

Simpson Similarity Index (SI)			
Habitat	Wetland	Woodland	Riverine forest
Wetland	-	7(0.14)	7 (0.15)
Woodland	-	-	15(0.31)
Riverine forest	-	-	-

Among the three habitat types, more similarity of birds species was obtained from woodland and riverine forest (SI=0.44) followed by woodland and wetland (SI= 0.11) during wet season. However, less similarity was obtained from species of wetland and reverine forest (SI= 0.08) (Table 12).

Table 6. Seasonal species similarity within the three habitats type during the wet season.

Simpson Similarity Index (SI)			
Habitat	Wetland	Woodland	Riverine forest
Wetland	-	9(0.44)	7(0.41)
Woodland	-		10(0.76)
Riverine forest	-	-	-

During both season, high similarity was obtained between woodland and riverine forest(SI=0.76) followed by wetland and woodland (SI= 0.44) (Table 13).

Table 7. Species similarity of common avian species among the three habitats type during both season.

Simpson Similarity Index (SI)			
Habitat	Wetland	Woodland	Riverine forest
Wetland	-	6(0.11)	3(0.08)
Woodland	-	-	22(0.44)
Riverine forest	-	-	-

The habitat of all the 124 species of birds recorded in the study area during the study period is indicated in appendix 4.

In the study area, birds showed variation in their distribution among the three habitats. Highest number of species was observed during both season in the woodland 67 and 49, respectively. Least number of species was recorded in the riverine forest (33) and wetlands (41) during the wet season.

During the dry season, 32, 25, 23 bird species were recorded only in one habitat type, wetland, woodland and riverine forest, respectively and 31 bird species were recorded in two habitat types and two bird species were recorded in all the three habitat types.

During the wet season, 36, 40, 9 bird species were recorded only in one habitat type, wetland, woodland and riverine forest, respectively and 29bird species were recorded in two habitat types and 1bird species were recorded in all the three habitat types.

In both seasons 29, 12, 5 bird species were recorded only in one habitat type, wetland, woodland and riverine forest, respectively 39 bird species were recorded in two habitat types and 1 bird species were recorded in all the three habitats types.

The abundance score and rank of each species from the encounter rate are shown in appendix 5-10. During the wet season, abundance of avian species showed that 38 were uncommon, 58 frequent, 43 common and 2 abundant (Table 14). In both season rare species were not registered.

Table 8. Abundance of avian species during the wet season using encounter rates

	Rank				
	Rare	Uncommon	Frequent	Common	Abundant
Wetland	-	20	16	5	-
Woodland	-	11	33	23	-
Riverine forest	-	7	9	15	2

During the dry season, the abundance score of avian species showed that 51 species were uncommon, 69 frequent, 22 common and 2 abundant (Table 15).

Table 9. Abundance of bird species during the dry season using encounter rates

	Rank				
	Rare	Uncommon	Frequent	Common	Abundant
Wetland	-	23	16	8	1
Woodland	-	8	38	3	-
Riverine forest	-	20	15	11	1

5. Discussion

In the present study, a total of 124 bird species belonging to 18 orders and 50 families were recorded. This may not represent all the avian species present in the study area, but it gives update accounts of some of the avian species present in the study area. If exhaustive survey is made by increasing the length of the study period and the sampling area, the number of species identified may be more. This underlines the area could be one of the areas with high diversity in Ethiopia. The study also revealed that, the bird species diversity, number of species and number of individuals of species differed in different habitats. This indicates habitat types influence the diversity and abundance of avian species diversity.

MacArthur (1964) stated that a large area could conceivably support many bird species in three rather different ways (vertical, horizontal and temporal). Within homogeneous habitat, the number of layers of vegetation is sufficient to account for the diversity of breeding bird species. When the area includes such major differences as those between patches of deciduous and coniferous forest, or sparse and dense vegetation, the number of layers of vegetation is no longer sufficient to account for bird species diversity. The area of the present study is not homogeneous; therefore, the diversity in bird species could be a result of vertical, horizontal and temporal as stated by MacArthur (1964).

Among the three habitats of the study area, the highest diversity index ($H' = 4.014$) and evenness (E=0.89) were recorded in the woodland habitat, followed by wetland. This variation observed in the study area could be due to differences in feeding habits and habitats could also increase diversity, evenness and species richness (Smith, 1992). The smallest size of the riverine forest might have contributed to the low evenness (E=0.8) and diversity (3.20) of species both during wet and dry seasons. The less food availability probably could lead to less richness and abundance of species (*Parrini et al.,* 2008).

The species composition of birds recorded during the wet and dry seasons was not significantly different (P>0.05). This result agrees with Afework and Shimelis (2008) in which their finding at micro-geographic or local scale showed that the effect of season or the role of climate was negligible. Moreover, the extended time of inundation of the area during the wet and dry seasons could contribute to the insignificant effect of seasons on bird species composition in the studied

habitats. Bird species also shift their feeding habit between seasons in temperate areas (Ward 1969). This might account for the insignificant effect of seasons on bird species composition. Bird species that face seasonal irregularity in the availability of food resources has two alternatives. A bird may shift from one resource to another, or it may move from one area to another, where the preferred 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. For birds, rainfall regimes and other associated environmental changes are important in determining breeding seasons and annual cycles in many regions including Ethiopia (Beals, 1970). This study showed, Within habitats, maximum value of seasonal bird species similarity was observed in the wetland (SI=0.92) followed by riverine forest (SI=0.68). This might be due to higher vegetation complexity, stable source of food, nesting and cover from predators. Similarly, Karr (1976) noted that the more complex or denser habitats tend to contain more similar species because complex vegetation provides stable food supply and shelter during both seasons. The minimum value of bird species similarity was observed in the woodland habitat (SI=0.5).This may be due to local migration of birds to the riverine forest and wetland. Many bird species migrate to take advantage of global differences of seasonal temperatures, thereby optimizing availability of food sources and breeding habitat. The migration can vary among the different groups. Some bird species undertake shorter migrations, travelling only as far as is required to avoid bad weather or obtain food. This type of migration is normally associated with food availability (Wilson and Herbert, 1999).

Among the three habitat types, more similarity of birds species was obtained from woodland and riverine forest (SI=0.31) during the dry season and between woodland and riverine forest (SI=0.44) during wet season. However, less similarity was obtained between species of wetland and woodland (SI= 0.15) during the dry season and between species of wetland and reverine forest (SI= 0.08) during the wet season. This is probably due to the differences in feeding adaptation of bird communities in each habitat.

In the present study, the distribution of birds showed variation among habitats. Highest number of species was observed during wet and dry seasons in the woodland. Least number of species was recorded in the riverine forest and wetlands during both seasons. This might be due to higher vegetation complexity the woodland possesses than the riverine forest. Besides, habitat size has

influence in the distribution of avian (Willis, 1979). As pointed by Telleria and Santos (1994) the habitat structures as well as climate affect the distribution of individual bird species in the Iberian temperate. This finding in line with Dawit (2009), who reported that avian species richness and distribution is influenced by vegetation structure, which is the principal determinant factor of avian species richness.

In both season rare species were not registered. This variation might be related to the availability of food, habitat condition and breeding season of the species. The rarity of several species might be related to habitat conditions.

The seasonal variation in the abundance of food resources result in seasonal changes in species abundance (Karr and Roth 1971; Gaston *et al.*, 2000). The uncommon species may be related to the breeding nature, large home range and niche of the species. In addition, degradation of the habitat might be a reason for the species to be uncommon (Ryan and Owino, 2006). The abundance of many bird species are determined by the composition of the vegetation that forms a major element of their habitats. As vegetation changes along complex geographical and environmental gradients, a particular bird species may appear, increase or decrease in number, and disappear as the habitat changes (Lee and Rotenberry, 2005).

The presence of ample resource, especially adequate food supply can increase the abundance of avian species at a given area. Chace and Walsh (2006) indicated that avian respond to changes in vegetation composition and structure, which in turn affects their food resources.

6. Conclusion and Recommendations

6. 1. Conclusion

The present ecological survey revealed that the Park supports a variety of bird species in different habitat types of the area. The study area, Dhati-Walel National Park, being diverse in vegetation type, harbours large and small mammal species and other wild animals in addition to birds. The high diversity and richness of birds in the present study area indicate the importance of these sites for the conservation. Therefore, it can serve as important centre for tourist attraction if properly managed.

In addition, the value of similarity index may reflect the extent to which the habitats are similar. The seasonal variation in number of individual species and their distribution in the study area are directly related to the types of habitats.

6.2. Recommendations

Dhati-Walel National Park is like an island of highly modified environment. Therefore, to ensure the long-term conservation of wildlife of the Park, the following recommendations are suggested:

- Minimizing habitat alteration through enforcing conservation laws, controlling tree cutting, collection of other forest products and preventing forest fires should be practiced.

- The status of endemic birds that occur in the Park should be studied in detail. This is important to know whether the species is in danger and to take appropriate conservation measures.

- Education should be given to the public about the importance of birds and the need to protect and restore the habitats.
- Meteorological station should be set up at in or around the park to get accurate meteorological data of the Park.

- Additional detailed study of long duration on the diversity and other ecological aspects of the area should be conducted to get detailed information of the area.
- Actively protecting species through improving patrols, controlling illegal hunting and trapping, adopting special intensive anti- poaching measures.

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Appendices

Appendix 1.Data collection sheet for line transect.

No	Date and Time	Transact number	Bird species		Habitat types	Total number count	Remark
			Common name	Local name			

Appendix 2. Point count data sheet.

Survey area _____Date_____ Observer_____

Starting time _____ Finishing Time _____

Site description and habitat type _____

_____

_____

Weather condition _____

Station No	Station code	Bird species (common name)	Number of individuals	Remark

Appendix 3. Raw data to number of species recorded per count throughout the study period.

Habitat	Season	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Riverine forest	wet	22	22	23	26		
		23	21	21	19		
		20	15	13	23		
		21	24	24	19		
		21	25	19	19		
		23	24	24	19		
		20	18	14	17		
		17		19			
	Dry	23	31	29	27		
		27	23	18	16		
		13	20	24	14		
		17	15	13	20		
		21	16	19	18		
		15	19	23	18		
		21	17	18	20		
		16		15			
Woodland	Wet	59	41	59	42	50	
		53	52	55	52	50	
		51	53	49	47	50	
		57	55	57	51		
					50		
	Dry	41	25	30	30	33	
		41	31	33	34	35	
		33	36	33	31	31	
		37	26	28	28		
					25		
Wetland	Wet	12	15	16	22	15	26
		12	10	22	19	16	18
		10	10	8	15	13	15
				21			19
	Dry	26	23	19	18	16	11
		25	17	20	15	14	15
		20	18	11	12	12	15
		-	-	20	-	-	24

Appendix 4. Distribution of bird species in the study area.

Common Name	Scientific name	Season	Habitat type		
			wetland	woodland	Riverine forest
Abyssinian thrush	*Turdus abyssinicus*	Dry	-	✓	-
		Wet	-	✓	-
African fish eagle	*Heliaeetus vocifer*	Dry	✓	-	-
		Wet	✓	-	-
African goshawk	*Accipiter tachiro*	Dry	-	✓	-
		Wet	-	✓	-
African harrier hawk	*Polyboroides typus*	Dry	-	✓	-
		Wet	-	✓	-
African Jacana	*Actophilornis africanus*	Dry	✓	-	✓
		Wet	✓	-	-
African Openbill	*Anastomus lamelligerus*	Dry	✓	-	✓
		Wet	✓	-	-
African paradise-flycatcher	*Terpsiphone viridis*	Dry	-	✓	-
		Wet	-	✓	-
African pied wagtail	*Motacilla aguimp*	Dry	✓	-	-
		Wet	✓	-	-
Augur Buzzard	*Buteo augur*	Dry	✓	✓	-
		Wet	✓	✓	
Black (Northern) crowned crane	*Balearica pavonina*	Dry	✓	-	-
		Wet	✓	-	-
Black- crowned night-heron	*Nycticorax nycticorax*	Dry	✓	-	-
		Wet	✓	-	-

Black Cuckoo	*Cuculus clamosus*	Dry	-	✓	✓
		Wet	-	✓	✓
Black sparrowhawk	*Accipiter melanoleucus*	Dry	-	✓	✓
		Wet	-	✓	✓
Bronze manikin	*Spermestes cucullatus*	Dry	-	✓	✓
		Wet	-	✓	-
Cape turtle (ring nacked) dove	*Streptopelia Capicola*	Dry	-	✓	-
		Wet	-	✓	✓
Cattle egret	*Bubulcus ibis*	Dry	✓	-	-
		Wet	✓	-	-
Common bulbul	*Pycnonotus barbatus*	Dry	-	✓	✓
		Wet	-	✓	✓
Common fiscal	*Lanius collaris*	Dry	-	✓	✓
		Wet	-	✓	✓
Crested francolin	*Francolinus sephaena*	Dry	-	✓	-
		Wet	-	✓	-
Crowned Hornbill	*Tockus alboterminatus*	Dry	-	-	✓
		Wet	-	-	✓
Crowned lapwing	*Venellus coronatus*	Dry	✓	-	-
		Wet	✓	-	-
Dusky (pink-breasted) turtle-dove	*Streptopelia lugens*	Dry	-	✓	-
		Wet	-	✓	-
Eastern paradise-whyday	*Vidua paradisaea*	Dry	-	✓	-
		Wet	-	✓	✓
Eastern yellow billed hornbill	*Tockus flavirostris*	Dry	-	-	✓
		Wet	-	-	✓
Egyptian goose	*Alophochen aegyptiaca*	Dry	✓	-	-
		Wet	✓	-	-
European honey buzzard	*Pernis apivorus*	Dry	✓	✓	-
		Wet	✓	✓	-

Greater blue-eared starling	*Lamprotornis chalybaeus*	Dry	-	✓	✓
		Wet	-	✓	✓
Grey heron	*Ardae cinerea*	Dry	✓	-	-
		Wet	✓	-	-
Groundscraper thrush	*Psophocichla litsipsirupa*	Dry	-	✓	-
		Wet	-	✓	-
Hadada ibis	*Bostrychia hagedash*	Dry	✓	-	✓
		Wet	✓	-	✓
Hamerkop	*Scopus umbretta*	Dry	✓	-	-
		Wet	✓	-	-
Hemprich's hornbill	*Tockus hemprichii*	Dry	-	✓	✓
		Wet	-	✓	✓
Hooded vulture	*Necrosyrtes monachus*	Dry	✓	✓	-
		Wet	✓	-	-
Lappet-faced vulture	*Torgos tracheliotus*	Dry	✓	✓	✓
		Wet	✓	-	-
Lauphing dove	*Streroptopelia senegalensis*	Dry	-	✓	-
		Wet	-	✓	✓
Lesser gray shrike	*Lanius minors*	Dry	-	✓	✓
		Wet	-	-	✓
Marabou stork	*Leptoptilos crumeniferus*	Dry	✓	-	-
		Wet	✓	-	-
Mourning collared-dove	*Streptopelia decipiens*	Dry	-	✓	-
		Wet	-	✓	-
Northern red billed horn bill	*Tockus erythrorhynchus*	Dry	-	✓	✓
		Wet	-	-	-
Nubian wood peaker	*Campethera nubica*	Dry	-	✓	✓
		Wet	-	✓	✓
Red-billed buffalo-weaver	*Bubalornis niger*	Dry	✓	-	-
		Wet	✓	-	-

Red-billed oxpecker	*Buphagus erythrorhynchus*	Dry	✓	-	-
		Wet	✓	-	-
Red-collared widowbird	*Euplectes ardens*	Dry	✓	-	-
		Wet	✓	-	-
Red-eyed dove	*Streptopelia semitorquata*	Dry	-	✓	✓
		Wet	-	✓	-
Red-shouldered cuckooshrike	*Campephaga phoenicea*	Dry	-	-	✓
		Wet	-	✓	✓
Ruppell's starling	*Lamprotoris purpuropterus*	Dry	-	✓	-
		Wet		✓	-
Ruppell's vulture	*Gyps rueppellii*	Dry	✓	✓	✓
		Wet	✓	✓	✓
Ruppell's robin-chat	*Cossypha semirufa*	Dry	-	✓	✓
		Wet	-	✓	✓
Saddle-billed stork	*Ephippiorhynchus senegalensis*	Dry	✓	-	-
		Wet	✓	-	-
Shikra (little banded Goshawk)	*Accipiter badius*	Dry	✓	✓	-
		Wet	✓	✓	-
Silvery-cheeked Hornbill	*Ceratogymna brevis*	Dry	-	✓	✓
		Wet	-	✓	-
Spur winged goose	*Plectopterus gambensis*	Dry	✓	-	-
		Wet	✓	-	-
Spur winged lapwing (plover)	*Venellus spinosus*	Dry	✓	-	-
		Wet	✓	-	-
Squacco Heron	*Ardeola ralloides*	Dry	✓	-	-
		Wet	✓	-	-
Tambourine dove	*Turtur tympanistria*	Dry	-	✓	-
		Wet	-	✓	-
White-billed buffalo-weaver	*Bubalornis albirostris*	Dry	-	-	-
		Wet	-	✓	-

Woolly Necked Stork	*Ciconia episcopus*	Dry	✓	-	-
		Wet	✓	-	-
Yellow-billed kite	*Milvus aegyptius*	Dry	✓	✓	-
		Wet	-	✓	-
Yellow-fronted canary	*Serinus mozambicus*	Dry	-	-	-
		Wet	-	✓	-
Abyssinian ground-hornbill	*Bucorvus abyssinicus*	Dry	-	✓	-
		Wet	-	-	-
Alphine swift	*Tackymaroties melba*	Dry	-	✓	-
		Wet	-	-	-
Black kite	*Milvus migrans*	Dry	-	✓	-
		Wet	-	✓	-
Black stork	*Ciconia nigra*	Dry	✓	-	-
		Wet	✓	-	-
Blue napped mouse bird	*Urocolius macrourus*	Dry	-	-	✓
		Wet	-	✓	-
Common quail	*Coturnix coturnix*	Dry	✓	✓	-
		Wet	✓	-	-
Erlanger's lark	*Calandrella erlangeri*	Dry	-	✓	-
		Wet	-	-	-
Fan-tailed raven	Corvus rhipidurus	Dry	-	✓	-
		Wet	-	-	-
Foxy cisticola	*Cisticola troglodytes*	Dry	-	✓	-
		Wet	-	-	-
Glossy ibis	*Plegadis falcinellus*	Dry	✓	-	-
		Wet	✓	-	-
Great reed-warbler	*Acrocephalus arundinaceus*	Dry	-	✓	-
		Wet	-	-	-
Green backed eremomela	*Eremomela canescens*	Dry	-	✓	✓
		Wet	-	-	-

Cont…

Helmeted guineafowl	*Numida meleagris*	Dry	✓	✓	-
		Wet	-	-	-
Kentish plover	*Charadrius alexandrines*	Dry	✓	-	-
		Wet	✓	-	-
African Pygmy- Kingfisher	*Ispidina picta*	Dry	-	-	✓
		Wet	-	-	✓
Pectoral-patch Cisticola	*Cisticola brunnescens*	Dry	✓	-	-
		Wet	✓	-	-
Sacred ibis	*Threskiornis aethiopicus*	Dry	✓	-	-
		Wet	✓	-	-
Sooty falcon	*Falco concolor*	Dry	-	✓	-
		Wet	-	-	-
Thick-billed raven	*Corvus crassirostris*	Dry	-	✓	-
		Wet	-	-	-
Wattled crane	*Bugeranus carunculatus*	Dry	✓	-	-
		Wet	✓	-	-
Wattled ibis	*Bostrychia Carunculata*	Dry	✓	-	✓
		Wet	✓	-	✓
White stork	*Ciconia ciconia*	Dry	✓	-	-
		Wet	✓	-	-
White-ba*cked vulture*	*Gyps africanus*	Dry	✓	-	✓
		Wet	✓	-	-
Wood sandpiper	*Tringa glareola*	Dry	✓	-	-
		Wet	✓	-	-
African citril	*Serinus citrinelloides*	Dry	✓	-	-
		Wet	✓	-	-
African collared-dove	*Streptopelia roseogrisea*	Dry	-	-	-
		Wet	-	✓	-
Banded Barbet	*Lybius undatus*	Dry	-	-	✓
		Wet	-	✓	✓

Cont…

Bearded woodpecker	*Dendropicos namaquus*	Dry	-	-	-
		Wet	-	✓	-
Beautiful sunbird	*Cinnyris pulchellus*	Dry	-	✓	-
		Wet	-	✓	-
Black-headed heron	*Ardea melanocephala*	Dry	✓	-	-
		Wet	✓	-	-
Black-rumped waxbill	*Estrilda troglodytes*	Dry	✓	-	✓
		Wet	-	✓	-
Brown woodland-warbler	Phylloscopus umbrovirens	Dry	-	-	✓
		Wet	-	✓	-
Common house martin	*Delichon urbicum*	Dry	✓	-	-
		Wet	✓	✓	-
Copper sunbird	*Cinnyris cupreus*	Dry	-	-	✓
		Wet	-	✓	-
Double-toothed Barbet	*Lybius bidenatus*	Dry	-	-	✓
		Wet	-	✓	✓
Eastern (black headed oriole)	*Oriolus larvatus*	Dry	-	-	-
		Wet	-	✓	-
Ethiopian swallow	*Hirundo aethiopica*	Dry	-	✓	-
		Wet	-	-	✓
Fork-tailed drongo	*Dicrurus adsimilis*	Dry	-	-	-
		Wet	-	✓	-
Greater honey guide	*Indicator indicator*	Dry	-	-	-
		Wet	-	✓	-
Half-collared king fisher	*Alcedo semitorquata*	Dry	-	-	-
		Wet	-	✓	✓
Icterine warbler	*Hippolais icterina*	Dry	-	-	-
		Wet	-	✓	-
Lemon (cinnamon) dove	*Aplopelia larvata*	Dry	-	-	-
		Wet	-	✓	-

Little weaver	*Ploceus luteolus*	Dry	-	-	✓
		Wet	-	✓	-
Long crested Eagle	*Laphaetus occipitalis*	Dry	-	-	✓
		Wet	-	✓	✓
Mariqua sunbird	*Cinnyris mariquensis*	Dry	-	-	✓
		Wet	-	✓	-
Masked shrike	*Lanius nubicus*	Dry	-	-	-
		Wet	-	✓	-
Narina Trogon	*Apaloderma narina*	Dry	-	✓	-
		Wet	-	-	✓
Olive sunbird	*Cyanomitra olivacea*	Dry	-	✓	✓
		Wet	-	-	✓
Sand martin (Bank swallow)	*Riparia riparia*	Dry	✓	-	-
		Wet	✓	✓	-
Scarlet-chested sunbird	*Chalcomitra senegalensis*	Dry	-	-	✓
		Wet	-	✓	-
Speckled mouse bird	*Colius striatus*	Dry	✓	-	-
		Wet	-	✓	-
Speckled pigion	*Columba guinea*	Dry	-	-	✓
		Wet	-	✓	✓
Standard Winged Night jar	*Macrodiptryx longipennis*	Dry	-	-	✓
		Wet	-	✓	-
Swainson's sparrow	*Passer swainsonii*	Dry	-	-	✓
		Wet	-	✓	-
Tacazze sunbird	*Nectarinia tacazze*	Dry	-	-	✓
		Wet	-	✓	-
Tawny-flanked prinia	*Prinia subflava*	Dry	-	-	✓
		Wet	-	✓	✓
Variable (yellow-billed) sunbird	*Cinnyris venustus*	Dry	-	-	✓
		Wet	-	✓	-

Violet backed starling	*Cinnyricinclus leucogaster*	Dry	-	-	-
		Wet	-	✓	-
White breasted cormorant	*Phalacrocorax lucidus*	Dry	✓	-	-
		Wet	✓	-	-
White-winged cliff-chat	*Thamnolaea semirufa*	Dry	-	-	-
		Wet	-	✓	✓
Wood warbler	*Phylloscopus sibilatrix*	Dry	-	-	✓
		Wet	-	✓	✓
Woodland Kingfisher	*Halcyon senegalensis*	Dry	-	-	✓
		Wet	-	✓	✓
Yellow-bellied waxbill	*Coccopygia quartinia*	Dry	✓	-	✓
		Wet	-	✓	-
Blue-headed coucal	*Centropus monachus*	Dry	-	-	✓
		Wet	-	-	✓
Yellow-fronted parrot	*Poicephalus flavifrons*	Dry	-	-	✓
		Wet	-	-	✓

Appendix 5. Abundance of birds from in wetland habitat during the wet season.

Species Name	No of individuals per 100 field hours	Abundance score	Rank
African citril	0.95	2	Uncommon
African pied wagtail	0.4	2	Uncommon
African Sacred ibis	0.55	2	Uncommon
Augar buzzard	0.35	2	Uncommon
Black- crowned night-heron	0.75	2	Uncommon
Black stork	10.05	3	Frequent
Black-headed heron	3.6	3	Frequent
Common quail	0.9	2	Uncommon
Crowned lapwing	1.15	2	Uncommon
European honey buzzard	0.3	2	Uncommon
Glossy ibis	1.55	2	Uncommon
Grey heron	3.1	3	Frequent
Hadada ibis	1.8	2	Uncommon
Hamerkop	0.85	2	Uncommon
Kentish plover	2	2	Uncommon
Marabou stork	2.95	3	Frequent
Red billed oxpeaker	2.75	3	Frequent
Red-collared widowbird	0.5	2	Uncommon
Saddle-billed stork	0.45	2	Uncommon
Sand martin	8.65	3	Frequent
Shikra (little banded Goshawk)	0.3	2	Uncommon
Spur winged lapwing	1.15	2	Uncommon
Squacco Heron	0.35	2	Uncommon
Wattled crane	1.15	2	Uncommon
White breasted cormorant	1	2	Uncommon
Wood Sandpiper	1.95	2	Uncommon
Woolly-necked stork	2.15	3	Frequent

Black (Northern) crowned crane	2.45	3	Frequent
African fish-eagle	2.6	3	Frequent
Pectoral-patch cisticola	7.25	3	Frequent
African Jacana	2.75	3	Frequent
Hooded vulture	8.2	3	Frequent
Ruppell's vulture	9.4	3	Frequent
White-backed vulture	9.25	3	Frequent
Red-billed buffalo-weaver	5.4	3	Frequent
African open bill	2.4	3	Frequent
Egyptian goose	20.5	4	Common
Cattle egret	35.25	4	Common
Common house martin	36.75	4	Common
Lappet-faced vulture	15	4	Common
Spur winged goose	18.15	4	Common

Appendix 6. Abundance of birds from the wetland during the dry season.

Species Name	No of individuals per 100 field hours	Abundance score	Rank
African citril	0.5	2	Uncommon
African fish-eagle	2.35	3	Frequent
African Jacana	2.1	3	Frequent
African open bill	1.5	2	Uncommon
African pied wagtail	0.3	2	Uncommon
African Sacred ibis	0.55	2	Uncommon
Augar buzzard	0.25	2	Uncommon
Black (Northern) crowned crane	0.8	2	Uncommon
Black- crowned night-heron	1.15	2	Uncommon
Black stork	7.85	3	Frequent
Black-headed heron	2.7	3	Frequent
Cattle egret	26.5	4	Common
Common house martin	43	5	Abundant
Common quail	1.55	2	Uncommon
Crowned lapwing	0.85	2	Uncommon
Egyptian goose	22.8	4	Common
European honey buzzard	0.15	2	Uncommon
Glossy ibis	1.2	2	Uncommon
Grey heron	5.25	3	Frequent
Hadada ibis	2.75	3	Frequent
Hamerkop	5.15	3	Frequent
Helmeted guineafowl	2.2	3	Frequent
Hooded vulture	13.7	4	Common
Icterine warbler	3.3	3	Frequent
Kentish plover	0.9	2	Uncommon
Lappet-faced vulture	14.6	4	Common
Marabou stork	1.85	2	Uncommon

Pectoral-patch cisticola	8.75	3	Frequent
Red billed oxpeaker	3.1	3	Frequent
Red-billed buffalo-weaver	4.5	3	Frequent
Red-collared widowbird	0.35	2	Uncommon
Ruppell's vulture	10.2	4	Common
Saddle-billed stork	0.45	2	Uncommon
Sand martin	13.05	4	Common
Shikra (little banded Goshawk)	0.3	2	Uncommon
Speckled mouse bird	0.5	2	Uncommon
Spur winged goose	17.7	4	Common
Spur winged lapwing	24.6	4	Common
Squacco Heron	0.2	2	Uncommon
Wattled crane	0.4	2	Uncommon
Wattled ibis	0.4	2	Uncommon
White breasted cormorant	0.85	2	Uncommon
White stork	5.2	3	Frequent
White-backed vulture	8.15	3	Frequent
Wood Sandpiper	1.7	2	Uncommon
Woolly-necked stork	2.4	3	Frequent
Yellow-bellied waxbill	3.8	3	Frequent
Yellow-billed kite	0.25	2	Uncommon

Appendix 7. Abundance of birds from the woodland during the dry season.

Species Name	No of individuals per 100 field hours	Abundance score	Rank
Abyssinian ground-hornbill	2.25	3	Frequent
Abyssinian thrush	5.55	3	Frequent
African goshawk	5.8	3	Frequent
African harrier hawk	5	3	Frequent
African paradise-flycatcher	6.95	3	Frequent
Alphine swift	6.05	3	Frequent
Augur Buzzard	4.1	3	Frequent
Beautiful sunbird	7.45	3	Frequent
Black Cuckoo	1.15	2	Uncommon
Black kite	2.85	3	Frequent
Black sparrow hawk	6	3	Frequent
Bronze manikin	6.45	3	Frequent
Cape turtle (ring nacked) dove	6.55	3	Frequent
Common bulbul	5.8	3	Frequent
Common fiscal	6	3	Frequent
Common quail	6.5	3	Frequent
Crested francolin	4.8	3	Frequent
Dusky (pink-breasted) turtle- dove	5.5	3	Frequent
Eastern paradise-whyday	4	3	Frequent
Erlanger's lark	18.7	4	Common
Ethiopian swallow	10.95	4	Common
European honey buzzard	2	2	Uncommon
Fan-tailed raven	4.2	3	Frequent
Foxy cisticola	1.05	2	Uncommon
Great reed-warbler	8.9	3	Frequent

Greater blue-eared starling	7.15	3	Frequent
Green backed eremomela	2.65	3	Frequent
Groundscraper thrush	1.15	2	Uncommon
Helmeted guineafowl	8.2	3	Frequent
Hemprich's hornbill	5.5	3	Frequent
Hooded vulture	6.6	3	Frequent
Lappet-faced vulture	4.45	3	Frequent
Lauphing dove	3	3	Frequent
Lesser gray shrike	1.2	2	Uncommon
Mourning collared-dove	3.7	3	Frequent
Narina Trogon	0.35	2	Uncommon
Northern red billed horn bill	0.3	2	Uncommon
Nubian wood peaker	3.25	3	Frequent
Olive sunbird	8.2	3	Frequent
Red-eyed dove	6.3	3	Frequent
Ruppell’s starling	5.15	3	Frequent
Ruppell’s vulture	11.1	4	Common
Ruppell's robin-chat	6.85	3	Frequent
Shikra (little banded Goshawk)	2.6	3	Frequent
Silvery-cheeked Hornbill	4.35	3	Frequent
Sooty falcon	3.85	3	Frequent
Tambourine dove	7.4	3	Frequent
Thick-billed raven	1.75	2	Uncommon
Yellow-billed kite	3.7	3	Frequent

Appendix 8. Abundance of birds from the woodland during the wet season.

Species Name	No of individuals per 100 field hours	Abundance score	Rank
Abyssinian thrush	6.1	3	Frequent
African collared-dove	6.1	3	Frequent
African goshawk	7.25	3	Frequent
African harrier hawk	2.85	3	Frequent
African paradise-flycatcher	11	4	Common
Augur Buzzard	4.35	3	Frequent
Banded Barbet	7.6	3	Frequent
Bearded woodpecker	8	3	Frequent
Beautiful sunbird	11.45	4	Common
Black Cuckoo	2.2	3	Frequent
Black kite	7	3	Frequent
Black sparrowhawk	3.2	3	Frequent
Black-rumped waxbill	0.15	2	Uncommon
Blue napped mouse bird	1.65	2	Uncommon
Bronze manikin	7.3	3	Frequent
Brown woodland-warbler	10.85	4	Common
Cape turtle (ring nacked) dove	3.3	3	Frequent
Common bulbul	12.05	4	Common
Common fiscal	3	3	Frequent
Common house martin	14.85	4	Common
Copper sunbird	11.15	4	Common
Crested francolin	5.5	3	Frequent
Double-toothed Barbet	8.55	3	Frequent
Dusky(pink-breasted)turtle- dove	1.65	2	Uncommon
Eastern (black headed oriole)	11.2	4	Common
Eastern paradise-whydah	0.95	2	Uncommon
European honey buzzard	1.3	2	Uncommon

Fork-tailed drongo	11.7	4	Common
Greater blue-eared starling	6.65	3	Frequent
Greater honey guide	1.5	2	Uncommon
Groundscraper thrush	0.6	2	Uncommon
Half-collared king fisher	2.45	3	Frequent
Hemprich's hornbill	6.1	3	Frequent
Icterine warbler	8.9	3	Frequent
Lauphing dove	4.2	3	Frequent
Lemon (cinnamon) dove	3.3	3	Frequent
Little weaver	11.75	4	Common
Long crested Eagle	2.05	2	Uncommon
Maricua sunbird	13.4	4	Common
Masked shrike	2.5	3	Frequent
Mourning collared-dove	3.9	3	Frequent
Nubian wood peaker	2.95	3	Frequent
Red-eyed dove	10.65	4	Common
Red-shouldered cuckooshrike	4.4	3	Frequent
Ruppell’s starling	5.7	3	Frequent
Ruppell’s vulture	10.05	4	Common
Ruppell's robin-chat	10.1	4	Common
Sand martin (Bank swallow)	22.55	4	Common
Scarlet-chested sunbird	12.65	4	Common
Shikra (little banded Goshawk)	2.55	3	Frequent
Silvery-cheeked Hornbill	3.4	3	Frequent
Speckled mouse bird	2.4	3	Frequent
Speckled pigion	2.85	3	Frequent
Standard Winged Night jar	0.3	2	Uncommon
Swainson's sparrow	13.65	4	Common
Tacazze sunbird	10.7	4	Common
Tambourine dove	12.2	4	Common

Tawny-flanked prinia	10.55	4	Common
Variable (yellow-billed) sunbird	11.1	4	Common
Violet backed starling	9.45	3	Frequent
White-billed buffalo-weaver	1.05	2	Uncommon
White-winged cliff-chat	0.8	2	Uncommon
Wood warbler	11.6	4	Common
Woodland Kingfisher	2.7	3	Frequent
Yellow-bellied waxbill	10.55	4	Common
Yellow-billed kite	3.35	3	Frequent
Yellow-fronted canary	11.8	4	Common

Appendix 9. Abundance of birds from the riverine forest during the wet season.

Species name	No of individuals per 50 field hours	Abundance score	Rank
African Pygmy- Kingfisher	22.8	4	Common
Banded Barbet	17	4	Common
Black Cuckoo	14	4	Common
Black sparrowhawk	4.73	3	Frequent
Blue-headed Coucal	12.5	3	Frequent
Cape turtle (ring nacked) dove	18.7	4	Common
Common bulbul	29	4	Common
Common fiscal	2.6	3	Frequent
Crowned Hornbill	14.8	4	Common
Double-toothed Barbet	19.8	4	Common
Eastern yellow billed hornbill	15	4	Common
Greater Blue-eared Glossy-Starling	37.8	4	Common
Hadada ibis	1.23	2	Uncommon
Hemprich's hornbill	33.33	4	Common
Lesser gray shrike	58.67	5	Abundant
Narina Trogon	0.53	2	Uncommon
Nubian wood peaker	7.2	3	Frequent
Olive Sunbird	32	4	Common
Red-shouldered Cuckooshrike	23.1	4	Common
Ruppell’s vulture	21.3	4	Common
Ruppell's robin-chat	44.8	5	Abundant
Speckled pigion	9.4	3	Frequent
Tawny-flanked prinia	1.9	2	Uncommon
Wattled Ibis	1.33	2	Uncommon
Woodland Kingfisher	9.13	3	Frequent
Woodwarbler	35.8	4	Common
Yellow-fronted parrot	18	4	Common

Appendix 10. Abundance of birds from the riverine forest during the dry season.

Species name	No of individuals per 50 field hours	Abundance score	Rank
African open bill	0.9	2	Uncommon
African Pygmy- Kingfisher	0.67	2	Uncommon
Banded Barbet	1.53	2	Uncommon
Black Cuckoo	0.93	2	Uncommon
Black sparrowhawk	0.93	2	Uncommon
Black-rumped waxbill	0.27	2	Uncommon
Blue napped mouse bird	2.33	3	Frequent
Blue-headed Coucal	0.4	2	Uncommon
Bronze manikin	3.67	3	Frequent
Brown woodland-warbler	1.27	2	Uncommon
Common bulbul	4.27	3	Frequent
Common fiscal	0.6	2	Uncommon
Copper sunbird	2.13	3	Frequent
Crowned Hornbill	0.47	2	Uncommon
Double-toothed Barbet	1.73	2	Uncommon
Eastern (black headed oriole)	6.27	3	Frequent
Eastern yellow billed hornbill	3.6	3	Frequent
Greater Blue-eared Glossy-Starling	8.67	3	Frequent
Green backed eremomela	1.6	2	Uncommon
Hadada ibis	0.4	2	Uncommon
Hemprich's hornbill	2.4	3	Frequent
Lappet-faced vulture	3.33	3	Frequent
Lesser gray shrike	0.87	2	Uncommon
Little weaver	22.67	4	Common
Long crested Eagle	1.2	2	Uncommon
Maricua sunbird	16.67	4	Common
Northern red billed horn bill	1.47	2	Uncommon

Nubian wood peaker	3.47	3	Frequent
Olive Sunbird	21	4	Common
Red-eyed dove	8.73	3	Frequent
Red-shouldered Cuckooshrike	10.4	4	Common
Ruppell’s vulture	12.67	4	Common
Ruppell's robin-chat	24.67	4	Common
Scarlet-chested sunbird	11.73	4	Common
Silvery-cheeked Hornbill	4.47	3	Frequent
Speckled pigion	8.27	3	Common
Standard Winged Night jar	0.47	2	Uncommon
Swainson's sparrow	53.07	5	Abundant
Tacazze sunbird	34	4	Common
Tawny-flanked prinia	1.07	2	Uncommon
Variable (yellow-billed) sunbird	27.8	4	Common
Wattled Ibis	0.6	2	Uncommon
White-backed vulture	11.53	4	Common
Wood warbler	21.93	4	Common
Woodland Kingfisher	7.07	3	Frequent
Yellow-bellied waxbill	7.8	3	Frequent
Yellow-fronted parrot	1.27	2	Uncommon

Appendix 11. Sample photographs of avian taken during the field study (Photo by: Megersa Tsegaye)

Scopus umbretta

Gyps rueppellii

Plectropterus gambensis

Ardea melanocephala

Balearica pavonina

Tringa glareola

Bubulcus ibis

Alopochen aegyptiaca

Vanellus senegallus

Aredeola rolloides

Vanellus spinosus

Actophilornis africanus

Ciconia episcopus

Bostrychia carunculata

Mycteria ibis

Lanius collaris

Bucorvus abyssinicus

Cinnyricinclus leucogaster

Threskiornis aethiopicus

Tockus nasutus

Campethera nubica

Lybius bidenatus

Halcyon senegalensis

Poicephalus flavifrons

Centropus monachus

Apaloderma narina

Campephaga phoenicea

Isopidina picta

Haliaeetus vocifer

Lamprotornis chalybaeus