ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES

Diversity, Distribution and Relative Abundance of the Avian Fauna of Chebera Churchura National Park, Ethiopia

By

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A Thesis Presented to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Biology (Ecological and Systematic Zoology).

June, 2006

Acknowledgments

I would like to express my deepest gratitude to my advisor, Professor Afework Bekele, for his initiation, encouragement and unreserved help. His continuous assessment suggestions and critical comments from the beginning to the end of this research were appreciated.

I am also grateful to my instructors Dr. Gurja Belay, Professor M. Balakrishnan, Dr. Solomon Yirga, and Dr. Asefa Mebrate, who shared the basic knowledge required for carrying out the research. I am also indebted to the former SNNPR Bureau of Agriculture, Department of Wildlife, mainly W/O Almaz Beyero and Ato Fikadu Shifeta who allowed me to use a vehicle in many of the field trips. My appreciation also goes to the staff members of Omo National Park, Ato Gemedo Osolo and Belayneh Hassen, for their kindness and constructive ideas.

Appreciation and thanks should also be extended to the Ethiopian Wildlife and Natural History Society (EWNHS) that allowed free access to use the society's information center. Special thanks should be given to Ato Mengistu Wondafrash, staff member of EWNHS, for his professional advise. Thanks are also due to Ethiopian Wildlife Department, particularly to W/O Tiruworke Bekele, Librarian, for her patience, hospitality and dedication.

Appreciation and thanks should also be forwarded to Dawro zone and Konta Special Woreda Rural Developments who covered some field expenses. I am extremely grateful to the local people for their hospitality and willingness to share their indigenous knowledge.

I feel greatly indebted to Ato Girma Timer, for his initiation to conduct this research. He was also very close to me and gave advice and

material support. I also wish to thank all members of the stream who shared concrete ideas that were valuable assets to finalize the thesis.

I am also extremely grateful to my brothers and sisters, my father, Woldeyohannes Tanga, and my mother Bogalech Ayalew who always encouraged and supported me in any aspect of my life and in the work of the present study.

Lastly but not least, my thanks are to all my friends, who are numerous to mention, for the support they provided.

Dedication

This work is dedicated to my father W/Yohannes Tanga and my Mother Bogalech Ayalew.

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Abstract

The aim of this study is to investigate the diversity, relative abundance and habitat association of the avian species in Chebera Churchura Nation Park (CCNP). The study was carried out using the method of Timed-Species-Count technique (TSC) during August 2005-April 2006, covering both dry and wet seasons. The study area was stratified based on major vegetation types. Each vegetation type was used as a sampling site. Small crater lakes and farmland areas were also considered as sampling sites, to asses the species inhabiting water bodies and farmland areas. A total of 137 bird species was observed. The mean number of species per count was significantly correlated with the total number of species in each vegetation type both during the wet and dry seasons (r=0.84 and 0.78, respectively). Unusual relationship was observed between total vegetation cover and number of species in the montane forest (12 species and 15 species during the wet and dry seasons, respectively). The relative abundance of each species in different vegetation types of both seasons showed variation. During the wet season the relative abundance or the mean score value ranged between 0.2 and 5.75 and during the dry season it varied between 0.2 and 5.5. Shifting cultivation was considered to be the most significant threat of wildlife in the area.

Key words: - Birds, diversity, relative abundance, and habitat association, Chebera Churchura National Park.

1. INTRODUCTION

The biodiversity of Ethiopia deserves attention. The country has diverse ecosystem ranging from humid forest and extensive wetlands in the west and southwest to the desert of Afar depression in the northeast. The country's flora and fauna are scattered from the highest mountain peaks over 4000 m asl to one of the lowest and hottest places on earth in Dallol depression, 116 m below sea level (Ethiopian Mapping Authority, 1988). This has helped to contribute for the existence of various forms of life in Ethiopia.

Ethiopia is one of the few countries in the world that possesses a unique and characteristics fauna with a high level of endemism (WCMC, 1991). It is estimated that between 6,500 and 7,000 species of higher plants occur in Ethiopia, of which about 15% are endemic (WCMC, 1992). According to Brenan (1978), Ethiopia possesses the fifth largest floral composition in tropical Africa.

The faunastic diversity of Ethiopia is also very high. There are 277 species of terrestrial mammals known to occur in Ethiopia. Among this, 31 (11%) are endemic (Yalden *et al.*, 1996). Out of the 926 bird species listed for the country, 21 are endemic and 19 are globally threatened species (Avibase-Bird Checklists of the World, 2005).

To conserve these diverse and important biological resources, 9 National Parks, 11 Wildlife Reserves, 3 Sanctuaries and 18 Controlled Hunting Areas have been established as a refugia (Hillman, 1993). These protected areas represent only a small fraction of the total land mass and represent only a few of the diverse ecosystems of the country. The currently available protected areas represent only about 2% of the total area of the country (AFAP, 1999).

Because of its topographic diversity, Ethiopia is one of the most significant countries in Africa in terms of its avifauna. Three-biome assemblages of avifauna are known to occur in the country: the Afro-tropical Highland Biome, the Somali-Masai Biome and the Sudan and Guinea Savannah Biome (Mengistu Wondafrash, 2003). The Afro-tropical Highland Biome has 48 species of birds of which 7 are endemics. The Somali – Masai Biome is the richest in terms of diversity representing 97 species. It includes 6 endemic species, 3 of which are globally threatened. The Sudan-Guinea savannah Biome is represented in Ethiopia by 16 species (EWNHS, 1996).

In Ethiopia, 73 hot spots have been identified as Important Bird Areas (IBAs). 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 Wondafrash, 2003).

Chebera Churchura National Park (CCNP), which is the subject of the present study, is one of such places of conservation concern of the country with very little biological information. It is located between Dawro Zone and Konta Special Woreda. In Konta Special Woreda and Dawro Zone the forest cover has been declining at a very fast rate since 1991. This is mainly due to the expansion of human and livestock population, clearance for agriculture, settlement, increased demand for firewood and commercial timber production (Dawro Zone Rural Development, 2004). This habitat loss is likely to severely affect the avifauna and other wild animals inhabiting the area. However, nothing is known about the extent of destruction on the avifauna of the area. CCNP was initially designated for the conservation of significant wildlife resources as a Controlled Hunting Area. However, strict wildlife control hunting has never been practiced in this area.

CCNP is reported to harbor diverse types of mammalian and avian species (SNNPRS Bureau of Agriculture, 2002). Elephant, buffalo warthog, pig, waterbuck, primates, hyena and hippopotamus are some of the reported mammalian species inhabiting the area (Girma Timer, 2005). However, so far, research on the diversity of the avian fauna of the area has never been conducted.

Currently, the regional government is attempting to elevate the area into the status of a National Park. Some work and boundary delineation of the area has been completed in this connection. The Region has already declared the area as Chebera Churchura National Park. Realizing the destruction of wildlife due to human encroachment, it is mandatory to establish the area as a National Park for proper management and sustainable utilization of the resource (Almaz Beyero, 2004). CCNP provides a unique ecosystem with diverse wildlife resources in general and the avian fauna in particular. Systematic ecological study should be carried out in order to have information on the diversity, relative abundance, habitat association of the avian fauna and the existing human-bird conflict in and around the area.

This study, therefore, aims at obtaining primary information on the diversity, distribution, relative abundance and habitat association of the avian fauna of CCNP.

2. LITERATURE REVIEW

Biological diversity or biodiversity is the term given to the variety of life on earth and the natural pattern it forms. It provides a large number of goods and services to sustain life. During the 1992 Earth Summit in Rio de Janeiro, world leaders agreed on a comprehensive strategy for `sustainable development`-meeting our needs while ensuring that we leave a healthy and viable world for future generations. However, global biodiversity is being degraded at an alarming rate due to human activities (Skole and Tucker, 1993). The loss of biodiversity often reduces the productivity of ecosystems, thereby shrinking natural baskets of goods and services, from which we constantly draw (Wilson, 1989). It destabilizes ecosystems and weakens their ability to deal with natural disasters such as flood, droughts, and hurricanes, and with human–caused stress, such as pollution and climate changes.

One of the first steps towards national biodiversity strategy is to conduct survey in order to find out what exists and to analyze its value and importance, and what is endangered (Australia Biological Resource Study, 2001). On the basis of the survey results, governments can set measurable targets for conservation and sustainable use. National strategy programs need to be developed or adopted to meet this target. Biodiversity can be measured with quantitative indices of diversity based on richness, the number of elements of biodiversity (usually number of species), evenness and their relative abundance (Magurran, 1988).

An increasing amount of ecological research relies on measures of bird species richness to address a range of questions. Whether comparing vegetation plots of various ages and different habitats or remnants of

various areas, bird survey is a relatively straightforward and efficient method of estimating proportion of biodiversity. In addition to research-based projects, these methods are gaining widespread use among agencies and extension groups to measure baseline patterns of diversity and gauge the effectiveness of management practices (Freudenberger, 2001: Rosenstock *et al.*, 2002).

The most basic study of avifauna of a site is the preparation of a list of species. A list indicates the diversity of the site, and shows the presence of rare species if any. The number of rare and endemic species and the diversity of the species present at the site can be used as indicator of the importance of different sites or habitats for bird conservation (Bibby *et al.,* 1998: ICBP, 1992). In spite of the great diversity found among the many different kinds of birds, they are perhaps the most homogeneous and most easily recognized class of animals on earth (Wallace and Maham, 1975).

In size, living birds vary from the diminutive humming birds, many of which weigh less than 4 gm, to the bulky ostrich, which stands 2 m in height and weighs more than 150 kg (Bond, 1947). Generally, the size of the bird is directly proportional to its life span. Large birds like owls, eagles and pelicans survive more than 60 years of age in captivity (Wilson, 1980).

Birds are believed to be derived from reptiles. The exact point of departure is not clear from fossil records as obtaining fossil skeleton of birds is difficult. In fact, bird-like reptiles and reptile-like birds existed together during the Mesozoic geologic era, more than 100 million years ago. Modern birds continued to diversify through the Cenozoic. The Cenozoic bird fossil record consisted largely of isolated bones (although some nearly complete skeletons have been recovered

from certain localities). By the early Oligocene, 35 million years ago, most of the bird orders that we recognize today had appeared (Chatterjee, 1995). Compared to mammals and reptiles, fossil records of birds are scarce. Bird skeleton, because of their delicate structure, do not fossilize readily, and the living habits of birds are not conducive to preservation of specimens (Kurochkin, 1995: Chatterjee, 1995).

Wetmore (1960) divides the Class Aves into 27 orders of living birds, with 6 others known from extinct or fossil forms. About 170 families of living birds are listed in most classifications although much uncertainty exists about the status of some of them. An additional 41 fossil families have been listed by Wetmore (1960). Currently, the class Aves includes 29 orders, 201 families, 2073 genera and 10010 species (*http://www.hbw.com/ibc/phtml/families.phtml*, accessed on 06/01/2005).

Birds are commonly distributed in different habitats including the Polar Regions, the tropics, in forests and deserts, on mountains and prairie and the ocean and its islands (Wilson, 1980). Avian assemblage show latitudinal gradient. Tropical regions typically exhibit higher species richness than do those of temperate latitudes. Whether this higher avian species richness is associated with higher overall abundance of birds in an assemblage and/or with lower abundance of individual species is controversial. There are evidences for the higher numbers of specie in the tropics being supported by higher number of individuals (Karr, 1971: 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 (Telborgh, 1980: Karr, 1989).

Within sites, it is fairly evident that habitat is likely to be an important factor concerned with the distribution and number of birds. Habitat variations may be of natural origin, for instance by soil type, along a gradient of rainfall or by altitude. Important variations might also come as a result of factors of human origin, such as the degree of impact of logging on forest structure, from mature to selectively logged to clear-felled and regrowing secondary stands. Of all possible bird-habitat associations, elevation is the most commonly cited factor (Bibby *et al.*, 1998). However, it is not yet known whether a general relationship between species richness and elevation or even whether a universal explanation or model can be formulated (Colwell and Hurtt, 1994; Rahbek 1995; 1997).

Seasonal stability of the habitat affects species composition and abundance of birds. Bird species that face seasonal irregularities in the availability of food sources have two alternatives. A bird may shift to feeding on other resources, or it may move to another area where the original food resource is available. Where there is no seasonal irregularity in food availability and other factors are held constant, a species can maintain itself throughout the year (Karr, 1976). Seasonal variation in avian community structure decreases with increasing vegetation complexity. This is apparently due to the increased buffering of the physical environment by the more complex vegetation (Smythe, 1974). The impact of seasonality varies among the subset of the avian fauna (Karr, 1975). Insectivorous species diversity and abundance generally vary more seasonally than do frugivorous species diversity and abundance in structurally mature habitats.

The global population size of species varies by many orders of magnitude. Amongst the birds, the rarest comprise a handful of individuals (Birdlife International, 2000), whilst the most abundant ones have many hundreds of millions (Elliot, 1989). Numerous reasons can be suggested for these differences, including the influence

of body size, life history, trophic group, phylogeny and history (Damuth, 1981; Pimm, 1991; Brown, 1995; Gaston and Blackburn, 1996; 2000). However, whether singly or in combination, these variables have been found to explain only small to moderate proportions of the variation in population size. Thus, body size, for example, has been widely quoted as an important correlate and perhaps determinant of abundance. With species of a similar size differing in abundance may be by several orders of magnitude (Nee *et al.*, 1991; Blackburn *et al.*, 1994: Gaston and Blackburn, 1996; 2000).

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

Breeding season in birds shows variation. Local climatic conditions and local food supply are probably the main factors governing breeding period. Ground-breeding birds normally nest during the wet season and it may be due to the effect of annual burning of grass and open forest country during the dry season, but it is more likely that food is abundant at this season. Woodland and forest species may breed in any month. The breeding of a species in any one-year at a certain time is not a guarantee that it will breed at the same time the

next year, or even at all in that locality (Mackworth-praed and Grant, 1956).

Birds are one of the most important components of biodiversity. This is reflected by the ecological, economical and esthetic values. It is often asserted that birds are convenient indicators of biodiversity, at least at large scales and that they are useful for monitoring environmental changes. One reason is that birds have long been popular with naturalists, amateurs and professionals and consequently their 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 in wood (woodpeckers). Roughly 60% of the approximately 8600 species recognized by Mayr and Amadon (1951) are partly or largely insectivorous. Insect pest outbreaks can annually destroy hundreds of millions of dollars of agricultural and forest products. Birds can alter their diets to feed almost exclusively on an insect pest during an outbreak, if it becomes profitable for them to do so. They can develop a search image for this new prey and can learn how to hunt for it more efficiently. Factors that help to determine which type of insects are selected by birds of prey are; insect density, body size and nutritional content, ease of capture, palatability (presence of chemical defenses or parasites), and density of potential competitors (other birds, mammals, ants, spiders, and predacious insects) (Lack, 1954). In 1921, forest and agricultural pests were reduced to 78% by birds resulting in savings of $ 444 million crop and timber losses. The value of birds in terms of economy is beyond our imagination. Their value is not just in their actual consumption of

insect pests, but also in their role in keeping future outbreaks to a minimum (Holling, 1988).

Birds also serve other purposes in nature. Fruit-eating birds help in dispersal of seeds. Birds eat and digest the pulp of berries and other fruits, but pass the seeds unaffected through their droppings. The seeds may sprout wherever the droppings fall (Clout & Hay, 1989). Certain birds like hummingbirds and sunbirds pollinate certain flowers that produce nectar. Hummingbirds and sunbirds feed on 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 arguably the most universally celebrated form of nature, found in pictures, photographs, sculptures, word and song (Cliffordand and Beehler, 1998). At the same time, few species of birds like Quelea (*Quelea quelea*) cause major agricultural loss in some regions of the world.

Despite their importance, many species of birds are in danger of extinction due to human activities. These includes intensive farming, land reclamation, fertilizers, intensive meadow mowing/silage making during bird breeding season, drainage of formerly extensive wetlands, deforestation and widespread clearance of native forest and woodlands, intensive pine afforestation (at the expense of natural broadleaved woodlands), marine and coastal development encroaching on coastal and wetland areas (which are important for bird migration and breeding), intensive development encroaching natural conservation and heritage areas (roads, housing, golf courses, etc.) and pollution (Birdlife International, 2006).

So far, many researchers have dealt with the East African (mainly Kenya, Uganda and Tanzania) avian ecology. Few researchers have also conducted research on the diversity and ecology of avian species in some parts of Ethiopia (Urban and Brown, 1971; Ash, 1979; Ash and Gullick, 1989; EWNHS, 1996). Despite the availability of diverse ecosystems in different regions of Ethiopia, the ecology of most avian species is only little known.

Among the known wildlife area of Ethiopia, Chebera Churchura National Park (CCNP) is one of the conservation areas where the diversity, distribution and abundance of birds are very little known. The present study, therefore, attempts to fill this identified gap.

3. OBJECTIVES

3.1. General objectives

The general objective of the present study is to conduct ecological survey and determine the diversity, distribution, relative abundance and habitat association of the avifauna of Chebera Churchura National Park (CCNP) in SNNPR.

3.2. Specific objectives

The specific objectives of the present study are:

- To determine the species composition of avian fauna of CCNP.
- To determine the distribution of avifauna species in the study area.

- To provide biological information about the avifauna of the CCNP for the region to ensure sustainable conservation.
- To determine the habitat association of the avian fauna.
- To identify the seasonal habitat preference of representative species in the study area.
- To assess the impact of human activities on the avian fauna in the study area.

4. THE STUDY AREA

4.1. Location

The study area is Chebera Churchura National Park (CCNP) Ethiopia. It is in the southwestern part of Ethiopia, in the SNNP Administrative Region. It is partly located within Dawro zone and in Konta Special Woreda, about 300 km and 580 km southwest of Awassa and Addis Ababa, respectively. It covers an area of 1250 km^2 and lies between the coordinates $36^o27'00"$- $36^o57'14"$E and $6^o56'05"$-$7^o08'02"$N (Fig. 1). CCNP is bordered by Konta Special Woreda to the north, Omo River to the south, Dawro zone to the east and southeast, and Agare high mountains and Omo River to the west (Konta Special Woreda Report, 2004).

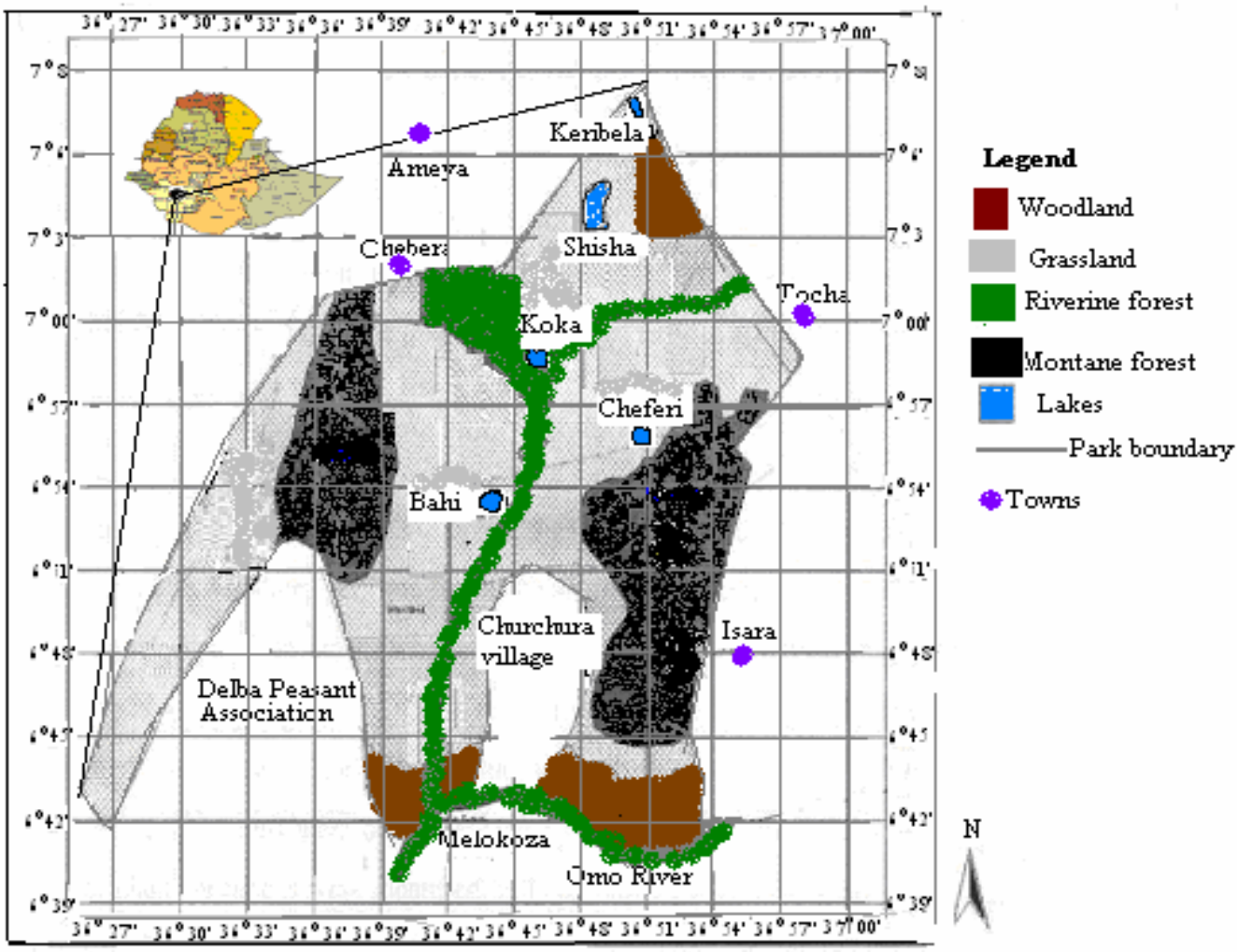
4.2. Topography

The study area lies at the center of Omo-Gibe River Basin. It contains both the highland and lowlands of the basin. The highlands are characterized by steep slopes. The lowlands, by contrast, are characterized by low altitude and relatively gentle slope (Woodroof and Associates, 1993). The general pattern of topographic feature of the study area, therefore, is one of the rolling to steep hills as interfluves between relatively narrow flat to undulating bottom land, which acts

as collecting sites for run-off water from the nearby uplands. There are about five smaller crater lakes that are distributed in different parts of the park area.

The altitude of the area ranges from 550–2000 m asl at the volcano peaks in the western boundary (Girma Timer, 2005). Few flat lands and highly undulating to rolling plains with incised river and perennial streams, valley and gorges, generally characterize the region. In the southern tip of the park close to the Omo River, there are relatively large plains that are savanna grassland in nature.

Agriculture is largely confined in the upland area with forest increasingly restricted to the steepest and most inaccessible slopes surrounding the reserve. This is mainly due to the demand for free space for teff cultivation. Teff cultivation needs relatively less fertile land, otherwise it will grow tall and can easily be damaged by wind. Shifting cultivation is common in the south and southwestern lowland on the undulating and rolling plains, by residents around the study area. Once farmed, the area is abandoned from three to five years without cultivation.



Source: Actual field survey and Girma 2005

Figure 1. Map of the study area

4.3. Climate

There is no temperature and rainfall record within the study area. The data used for the description of the climate (temperature and rainfall) was collected from the nearest metrological station to the study area. Data were obtained from the Ethiopian National Meteorological Service Agency (ENMSA) and Natural Resource and Agricultural office of the SNNPRS.

4.3.1. Rainfall

The 10 years rainfall data (1995-2004) of the area shows that the rainfall distribution is unimodal (having one long rainy season). Total amount of annual rainfall in the area varies between 1000 and 3500 mm. In the northern and northeast part of the area, the average annual rainfall distribution measures between 1200-2290 mm (Fig. 2). This part of the area has uniform and long rainfall season (between March and September and with a peak in July). The mean annual rainfall of the area is 2154 mm. The southern part of the area, which is closer to the Omo basin, receives the lowest amount of annual rainfall. Its average annual rainfall distribution ranges between 1000-1600 mm. The pattern, however, is almost similar.

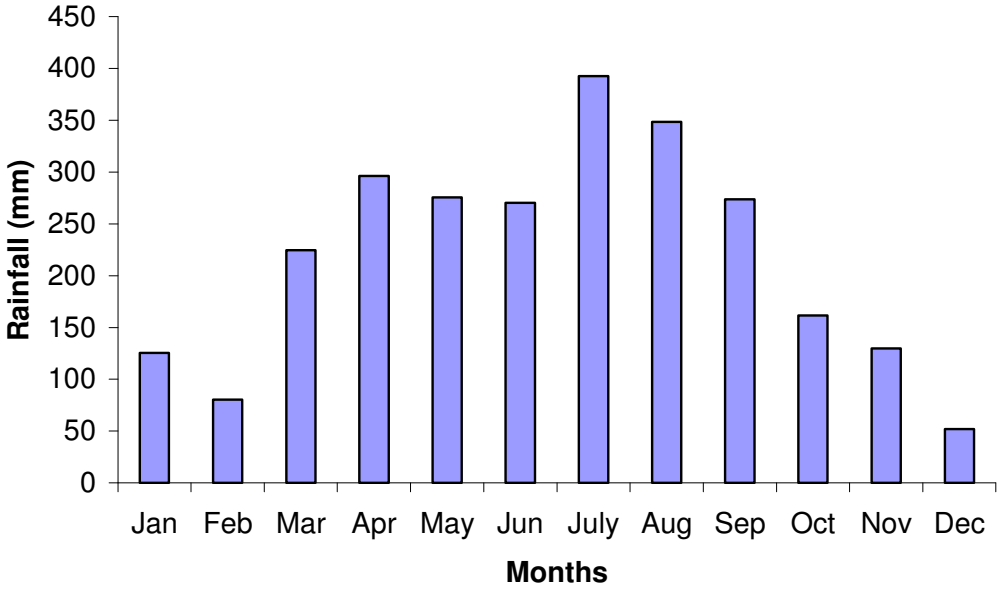


Figure 2. Average monthly rainfall in the study area

4.3.2. Temperature

The study area can be divided into two thermal zones, which broadly correspond to traditional agro-climatic zones. This includes `Weinadega` and `Kola` based on altitudinal and temperature variations. The `Weinadega` thermal zone has altitude varying between 1500-2500 m asl and temperature ranging between 16^{O}C and 20^{O}C (13 suns tours, 2003). The range of altitude of Kola thermal zone in the study area is between 500 and 1500 m asl with temperature varying between 20 and 28^{0}C. The dry season of the study area includes December, January and February with mean maximum temperature varying between 27 and 29^{o}C, respectively (Fig. 3). The absolute maximum temperature of the study area recorded was 32.1^{o}C in February 1994. The mean minimum temperature varying between 10 and 11.4^{o}C during the cooler months. The mean annual temperature of the area is 17^{o}C. The mean daily temperature of the warmest month is 25.4^{o}C and the coldest month is 10.2^{o}C. The daily

temperature range in the study area is widest during the dry season and narrowest during the wet season.

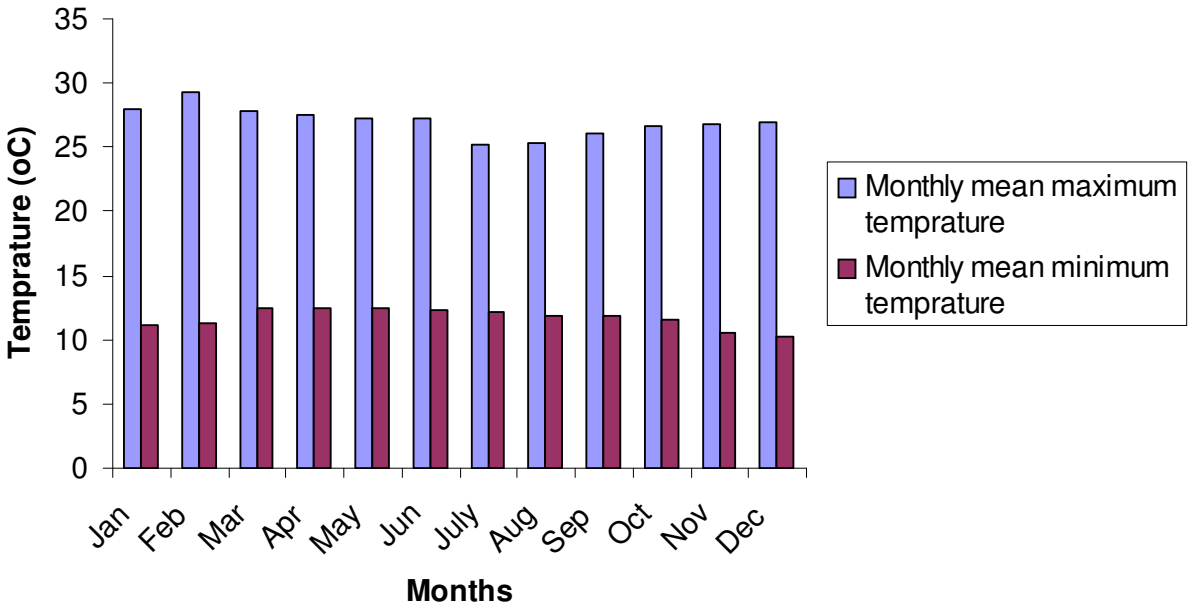


Figure 3. Monthly mean minimum and maximum temperature in the study area

4.4. Soils

The highland soils of the study area are characterized by deep, well-drained clay soils with moderate natural fertility. Soils of the highlands are divided into two groups. These are well-drained, red brown soils on slopes and heavy soils in the bottomlands. Well-drained soils on slopes are dominated by deep to very deep, red and reddish brown clay loams over clays. These soils are of moderate to low natural fertility. Poorly drained (bottom land) soils are predominantly vertisols. Soils of the lowlands are alluvial and very

young. These soils are primarily shallow and course textured (Woodroof and Associates, 1996).

4.5. Land-use and Land cover

4.5.1. Land-use and settlement

The principal ethnic groups living in and around the Park area are the indigenous Dawro and Konta Nationalities. The other ethnic groups, which have long been living together with the two principal ethnic groups, are the Bacha and Menja people. The Bacha and Menja people are few in number. They primarily live on fishing and wild honey collection. They are undermined and culturally discriminated by members of the Konta ethnic group.

The Dawro people inhabit primarily the eastern highlands and few areas of the southeastern lowlands. The people practice traditional agricultural system that combines perennial and annual crop cultivation with livestock rearing, simultaneously. They cultivate cereals, inset, coffee and root crops. According to the 1984 statistical data of the region, 26.1% of the total house heads produce coffee, and 56.26% produce inset. The average land size owned by an individual farmer is 3.8 hectare. It ranges from a maximum of 5.16 hectare to a minimum of 2.19 hectare (Dawro Zone Report, 2004). The people do not make extensive use of the lowlands except along the periphery. Other types of land-use practices include grazing, grass cutting for house making, wood collection for fire and construction, wild honey collection and traditional honey collection. In addition, the local people collect spices and wild coffee from the forests. Hence, forests are important economic sources for the local people besides their ecological value.

The Konta ethnic group occupies the north and northeast highlands and the southwest lowlands. The average land size of an individual farmer is smaller than Dawro. It is about 2 hectares per farmer. The people occupying the highlands have similar pattern of land-use system with the Dawro People. However, people who are living close to the study area of lower altitude, practice different types of land-use for the production of cereals, teff, fruit and vegetables.

The peasant associations that are very close to the study area are the Churchura, Delba, and Koisha. The Churchura Peasant Association inhabits the southern lowlands of the study area. Their total population is about 600 only. The Koisha and the Delba peasant associations occupy the southwestern lowland area. The total estimated population of the Konta ethnic group in the area is about 4000. Recently, there are people from Hadia and Wolaita ethnic groups who have inhabited the area through government resettlement program. The total estimated population of them is about 2000. The indigenous people of the Koisha and the Delba Peasant Associations live in lowland areas with a similar climatic condition. Hence, both people practice the same pattern of land-use systems, mainly shifting cultivation and livestock rearing. Sorghum, teff and fruits are the major food products of these areas.

4.5.2 Land cover

4.5.2.1. Vegetation

The vegetation types of the study area can be divided into four major natural types. Farmland area inside and at the boundary are also included as it also support appreciable number of bird species. These include:

1. Montane forest
2. Riverin forest

3. Woodland
4. Grassland with scattered trees
5. Farmland (modified vegetation)

1. Montane forest

This type of vegetation occurs in the eastern and northwestern highlands of the study area. It is dominated by tree species and characterized by the crown cover of 50%. The structure is multistoried (WBISPP, 2002). Climbers and saprophytes are important floristic components of the habitat. Under normal conditions, the distribution of trees through this forest area is relatively uniform. The dominant tree species are *Podocarpus*, *Juniperus* and broad- leaved tree species.

2. Riverine forest

This type of vegetation occurs along the course of the river of the study area. It covered about 40 km^2. The major rivers in the study area are Zigna, Shoshima, Wala, Tikurwuha, Mensa, Oma and other small seasonal rivers or streams. This habitat is characterized by mixed vegetation type composed of large trees and herbaceous species. The dominant plant species are *Ficus, Phonex, Costa, Albizia grandibracteata, Chionantus mildobradii, Grewia ferrugunea, Aspilia mosambicensis, Arundo donax* and *Ehretia cymosa.*

3. Woodland

Woodland covers 8% of the total study area. 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 southern part of the area, is characterized by the dominant species of *Combretum* and *Terminalia* species. It is also common in low-lying valley areas bellow 1100 m asl. This type of woodland has an

even distribution of trees, uniform canopy, almost no understory of bushes or shrubs, but typically with a well-developed grass cover. The other type of the habitat is mixed woodland, dominated by mixed species. It occurs in the northern upland area next to highland drainage and a break between highland and lowland. They are commonly burnt every year. Riparian woodland is found along many of the drainages in the lower or the southern part of the study area near to the Omo confluence. This vegetation type has a clear tree-grass formation without additional stories. Dominant plant species are *Acacia brevispica, Maytenus arbutifolia, Vitex doniana, Terminalia brownii, Combretum colinum* and *Combretum mole*.

4. Grassland with Scattered trees

This habitat covers the largest part of the study area and belongs to the Sudanian-Biome regional center of endemism. It covers 62.5% of the total area and is widely distributed in parts of the Park area. It is characterized by extensive grass species with few dominant scattered trees. The dominant grass species in most distributional range of this habitat is elephant grass (*Pennisetum* sp.). The scattered trees that occur in this habitat are resistant to fire. They have thick and gnarled bark. The dominant tree species are broad-leaved *Combretum* species in association with *Terminalia albiza*. The local people in search of grazing land and clear site deliberately set fire. The tree species composition varies in relation to altitude. This may be due to the variability in soil type and/or soil moisture.

5. Farmland

In this vegetation types the dominant plant species were cereal crops like maize, teff and other root crops and vegetables.

5. METHODS

5.1. Description of the vegetation types

Description of the vegetation type was made following White (1983). The area coverage of each vegetation type is calculated from the vegetation map of the area. Few plant specimens were collected to determine the dominant plant species in each vegetation types. The collected plant specimens were pressed properly and identified by the professionals in the National Herbarium, Addis Ababa University. The local names of the specimens were labeled based on the information obtained from the local guides. Vegetation description of Girma Timer (2005) was used as a base line with some modifications. All the available information about the vegetation and land-use of the study area were further verified through ground survey during the present study.

5.2. Subdivision of the Study Area

The first step prior to the actual fieldwork was reconnaissance survey. It was conducted by vehicle and on foot in August 2005. The aim of this survey was to collect the necessary information about the study area. The study area was not homogenous in vegetation type coverage, human settlement and land-use, topography and rainfall distribution.

The study area was categorized into two broad types, as terrestrial and water bodies. The terrestrial part of the study area was stratified based on the vegetation types. Each of the vegetation types was grouped as a sampling unit or a census zone. Stratification was made possible by using aerial photography (scale 1: 30,000), satellite imagery information and EMA topography maps (scale 1: 50,000).

Each census zone was then divided into 1 km^2 blocks or grids. (Table 1, Fig. 4). The census zones of the terrestrial part are:

1. Grassland with scattered trees (census zone 1). This is the largest part within the study area. It covered a total area of 750 km^2. A total of 10 grids were marked in this habitat.

2. Woodland (census zone 2). It is the third largest zone covering an estimated area of 100 km^2. Six grids were demarcated in.

3. Montane forest (census zone 3). This is the second largest zone next to census zone 1. It covered an estimated area of 350 km^2. Eight grids were marked in this habitat.

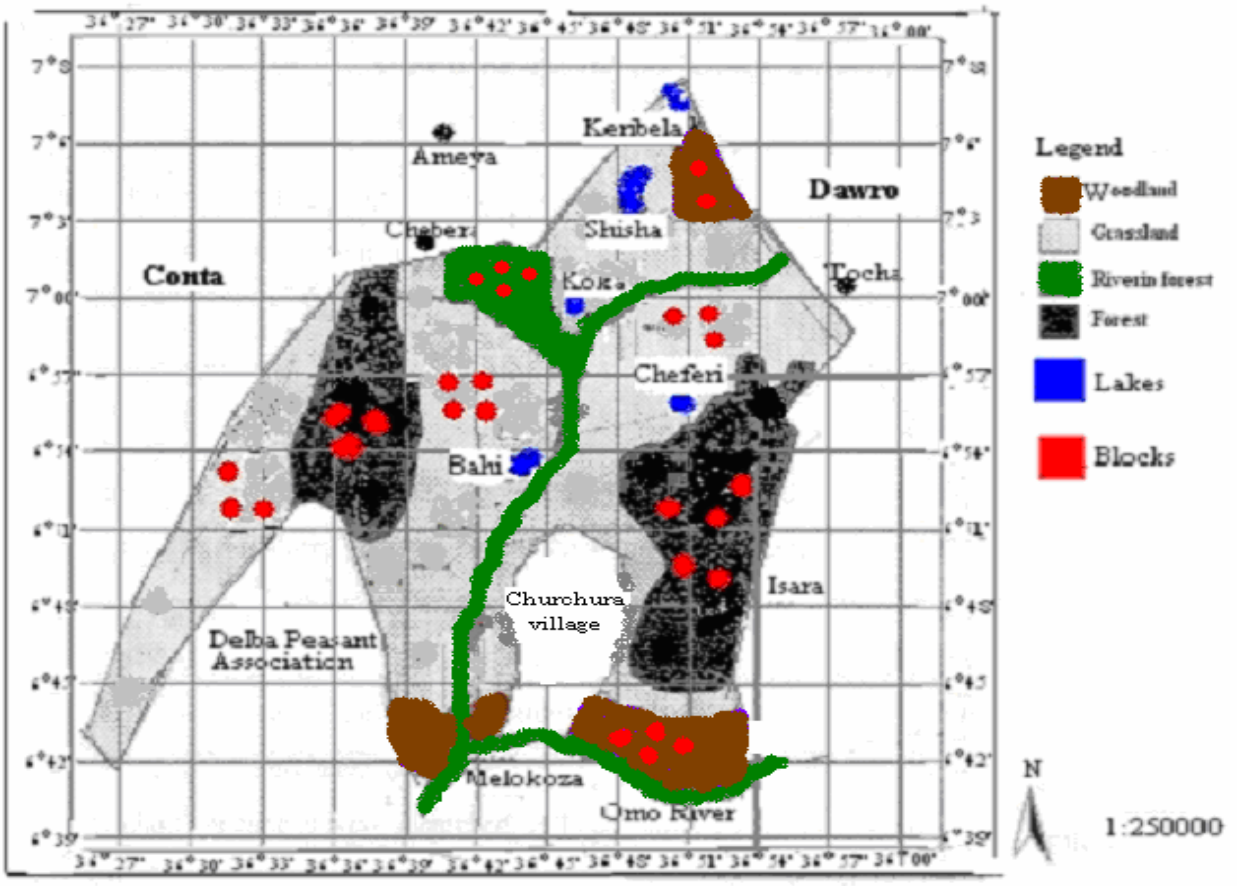
4. Riverine forest (census zone 4). This was the smallest census zone of the natural vegetation with an area of about 40 km^2. In this vegetation type four grids were marked.

5. Farmland (census zone 5). This is a modified vegetation inside and at the boundaries of the Park area. The total area and percentage proportion of this modified vegetation was not possible to estimate from satellite imagery and actual field survey. This is mainly because of its sparse distribution. Compared to the other natural vegetation of the study area, the modified vegetation (farmland) has smaller area coverage. Four census grids were marked in this habitat.

   The water bodies refer to the five smaller crater lakes distributed in the northern and northeastern part of the study area. Each smaller crater lake is taken as a grid or a block. Characteristic features of some habitats are shown in plates 1 to 3.

Table 1. Estimated area and number of census blocks.

Census zone/sampling unit	Area (km^2)	Proportion/ percentage to total area	Number of Census block	Census block area ($km^{2)}$
Grassland with scattered Trees (CZ 1)	750	0.6 (60%)	10	10
Woodland (CZ 2)	100	0.08 (8%)	6	6
Montane forest (CZ 3)	350	0.29 (29%)	8	8
Riverine forest (CZ 4)	50	0.03 (3%)	4	4
Farmland (CZ 5)	-	-	4	4
Total	1250	1.00 (100%)	32	32



Source: Actual field survey and Ginna Timer, 2005

Figure 4. Census blocks in each vegetation types without farmland

Plate 1. Riverine forest

Plate 2. Picture of Lake Keribela

Plate 3. Woodland

5.3. Sampling design

The study area was stratified using major vegetation types during a reconnaissance survey. A total number of 32 blocks among the diverse vegetation covers were chosen for the study using stratified random technique. The technique involved dividing up the census zones with grids on a map, and then using random numbers to position the blocks/grids within each sampling units (Sutherland, 1996: Bibby *et al.*, 1998). Some blocks were also chosen depending on the accessibility and bird diversity of the area. Within each block, the researcher was allowed to move freely in any direction. Birds that fly over the block were also recorded during the survey. These features of

Timed-Species Count differs from transect count. Survey of wetland birds was conducted on two of the five smaller lakes in the study area. Total count was made using a binoculars. In this study, as the technique employed is TSC, only less than 20% of the total area was assed.

5.4. Data collection

Identification and recording of avian species was conducted by direct observations using binoculars. The survey was conducted on foot along the randomly established 1-km2 blocks within the census zone. Indirect observations using bird calls were made in the forests.

Survey of the avian species was carried out in the sampled blocks of the survey zone early in the morning (06:00-11: 00 h) and late in the afternoon (15:00-19:00 h), when most of the avian species were active.

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Data were collected through Timed-Species Count System (TSCS) technique developed by Pomeroy and Tangecho (1986). It provided methods for comparing the avifauna of extensive area by sampling representative habitats through stratified random sampling technique. A minimum of 10 surveys were carried out in each of the census zones, covering all seasons (Pomeroy, 1992).

Data on wetland birds were collected through Point Count Technique. The water bodies are small crater lakes that could be surveyed from a given area. One point count in each of the two lakes was conducted during the dry season due to the inaccessibility of the lakes. The data were not sufficient to analyze, however, it was important to know the total species number of the Park area. The observation was aided by

binoculars. Bird field guides were used for identification. Video and photographic pictures were also taken for further confirmation.

The associated vegetation types were described. Location of the observed birds were determined and recorded in each census zone using GPS.

5.5. Duration of the study

Avian field survey in the CCNP was conducted from August 2005 to March 2006 to cover both wet and dry seasons. The diversity, distribution, relative abundance and habitat associations of avian fauna of the CCNP were studied along the randomly selected blocks established in the randomly selected sampling units of each vegetation types and wetlands of the study area. The study was conducted for one and half months each during the wet and dry seasons. A total of three months of fieldwork, comprising wet and dry seasons was conducted. Two field surveys for each season were conducted to compare the avian diversity and abundance within the seasons (peak and beginning of the seasons).

5.6. Data analyses

The data collected by TSCS technique helped to analyze, measure and compare the different magnitudes of avian diversity in the study area. Species observed during the survey activity were properly identified and taxonomically classified following Urban and Brown (1971), Avibase Checklist of the World (2005) and taxonomy and classification of Ethiopian birds. The data were used to assess the species richness, distribution and relative abundance indices of each vegetation type.

In analyzing the TSCS data, each species was given a score depending on the 10-minute period in which it was first recorded, such that

species recorded in the first ten minutes were given a score of six, species first recorded in the second ten minutes given a score of five and so on, with species recorded in the final ten minutes being given a score of one for that survey. An index of a relative abundance of species recorded from repeated survey was calculated as the mean of scores from each survey and, therefore, varied between a maximum value of six and a minimum value of 1/n (where n is the number of repeated surveys) (Bibby *et al,* 1998). This index helped to compare the relative abundance of species among different vegetation types of the study area and within the same habitat type. Simpson's similarity index (SI) was adopted to compare the similarity of different habitat types in terms of avian species diversity. The data obtained during the survey were analyzed using SPSS software. Chi- square test, one-way ANOVA and simple correlation were employed to see the effects of different variables on the ecology of birds. Excel computer program was also used to draw graphs.

5.7. Threats to avifauna in the study area

During the study period, observation and discussion with local community were made to assess human activities around the study area, which were potential threats to the diversity and abundance of the avian fauna. The current human activities including livestock incursion, habitat exploitation and wildlife utilization were closely examined along with the field survey of the avian species. Comparison was made to show the extent and distribution of threats in different parts within and around the study area. The history of consumptive avian and other wildlife utilizations was also assessed.

6. Results

6.1. Diversity

A total of 137 bird species belonging to 52 different families were identified during the wet and dry season surveys. Among them 5 species, namely Black-headed Forest Oriole (*Oriolus monacha*), Wattled Ibis (*Bostrychia carunculata*), Thick-billed Raven (*Corvus crassirostris*), Banded Barbet (*Lybius undatus*) and White-winged cliff-Chat (*Myrmecocichla cinnamomeiventris*) are endemic to Ethiopia. Some other bird species like black winged love bird (Agapornis taranta) are restricted only to Ethiopia and Eritrea. The number of species per family ranged between 1 and 11. The family Ploceidae was represented by 11species, which was the highest number of species per family. Many families were represented by a single species (Table 2).

The result of the present investigation revealed seasonal variation in species abundance in different vegetation types of the study area. During the wet season, a cumulative number of 94 species was recorded. Species abundance during the dry season was fewer than the wet season. A cumulative total of 85 bird species were recorded during the dry season survey.

Table 2. Species of birds recorded in both seasons (* indicate species observed during the wet season

Family	Common name	Scientific name
Phalacrocoracidae	Long-tailed Cormorant	*Phalacrocorax africanus*
Ardeidae	Gray Heron	*Ardea cinerea*
	Black-Headed Heron *	*Ardea melanocephala*
	Great Egret*	*Ardea alba*
	Intermediate Egret*	*Egretta intermedia*
	Little Egret *	*Egretta garzetta*
	Squacco Heron	*Ardeola ralloides*
Scopidae	Hamerkop*	*Scopus umbretta*
Ciconiidae	Saddle-billed Stork	*Ephippiorhynchus senegalensis*
Threskiornithidae	Sacred Ibis	*Threskiornis aethiopicus*
	Hadada Ibis *	*Bostrychia hagedash*
	Wattled Ibis *	*Bostrychia carunculata*
Anatidae	Egyptian Goose *	*Alopochen aegyptiacus*
Accipitridae	Bateleur	*Terathopius ecaudatus*
	Augur Buzzard *	*Buteo augur*
	Greater Spotted Eagle	*Aquila clanga*
	Tawny Eagle *	*Aquila rapax*
	African Hawk-Eagle *	*Aquila spilogaster*
	Long-Crested Eagle *	Lophaetus occipitalis
Numididae	Helmeted Guineafow *	*Umida meleagris*
	Vulturine Guineafowl	*Acryllium vulturinum*
Gruidae	Black crowned crane	*Balearica pavonina*

Jacanidae	African jacana *	*Actophilornis africanus*
Recurvirostridae	Black winged stilt *	*Himantopus himantopus*
Columbidae	Lemon dove *	*Columba larvata*
	African Mourning Dove *	*Streptopelia decipiens*
	Red-eyed Dove *	*Streptopelia semitorquata*
	Ring-necked Dove *	*Streptopelia capicola*
	Tambourine Dove *	*Turtur tympanistria*
	African Green Pigeon *	*Treron calva*
	Olive Pigeon	*Columba arquatrix*
	Speckled Pigeon	*Columba guinea*
Psittacidae	Red-headed Lovebird *	*Agapornis pullarius*
	Black-winged Lovebird *	*Agapornis taranta*
Musophagidae	White-bellied go-away bird	*Corythaixoides leucogaster*
	White-cheeked Turaco *	*Tauraco leucotis*
Cuculidae	Klaasa`s Cuckoo	*Chrysococcyx klaas*
	Senegal Coucal *	*Centropus senegalensis*
	Whte-browed Coucal *	*Centropu superciliosus*
	Blue-headed Coucal *	*Centropus monachus*
Strigidae	Cape-Eagle Owl *	*Bubo capensis*
Caprimulgidae	Standard-winged Night-jar	*Macrodipteryx longipennis*
Apodidae	White-rumped swift *	*Apus caffer*
Coliidae	Speckled Mousebird *	*Colius striatus*
Alcedinidae	Malachite Kingfisher *	*Alced cristata*
	Giant Kingfisher *	*Megaceryle maximus*
	Striped Kingfisher *	*Halcyon chelicuti*
	Gray-Headed kingfisher	*Halcyon leucocephala*

Meropidae	Little Bee-eater *	*Merops pusillus*
	White-throated Bee-eater *	*Merops albicollis*
	Cinnamon chested Bee-eater *	*Merops oreobates*
Upupidae	Hoopoe	*Upupa epops*
Bucerotidae	Crowned Hornbil *	*Tockus alboterminatus*
	Silver-cheeked Hornbil	*Ceratogymna brevis*
Capitonidae	Banded Barbet *	*Lybius undatus*
	Black-billed Barbet *	*Lybius guifsobalito*
	Double-toothed Barbet *	*Lybius bidentatus*
Indicatoridae	Greater Honeyguide *	*Indicator indicator*
Picidae	Cardinal Woodpecker *	*Dendropicos fuscescens*
	Beareded Woodpecker	*Dendropicos namaquus*
	Gray Woodpecker	*Dendropicos goertae*
Hirundinidae	Ethiopian Swallow *	*Hirundo aethiopica*
	Wire-tailed Swallow	*Hirundo smithii*
	Mosque Swallow	*Cecropis senegalensis*
Motacillidae	African pied Wagtail *	*Motacilla aguimp*
	Yellow wagtail	*Motacilla flava*
	Mountain Wagtail	*Motacilla clara*
Campephagidae	Gray Cuckoo-Shrike*	*Coracina caesia*
	Black Cuckoo-Shrike	*Campephaga flava*
	Red-shouldered Cuckoo-shrike	*Campephaga phoenicea*
Pycnonotidae	Common Bulbul *	*Pycnonotus barbatus*
Turdidae	OliveThrush *	*Turdus olivaceus*
Cisticolidae	Tawny-flanked Prinia	*Prinia subflava*
	Pale Prinia	*Prinia somalica*

Muscicapidae	Silverbird	*Empidornis semipartitus*
	Pale Flycatcher	*Bradornis pallidus*
	Northen black-Flycatcher*	*Melaenornis edolioides*
	Rueppell`s Robin-Chat *	*Cossypha semirufa*
	White-browed Robin-Chat *	*Cossypha heuglini*
	Snowy-crowned Robin-Chat *	*Cossypha niveicapilla*
	Black-eared Wheatear	*Oenanthe hispanica*
	Mocking Cliff-Chat *	*Thamnolaea cinnamomeiventris*
	White-winged Cliff-Chat*	*Thamnolaea semirufa*
	Pied Flycatcher	*Ficedula hypoleuca*
	Dusky Flycatcher *	*Muscicapa adusta*
Platysteiridae	Black-headed Batis *	*Batis minor*
Monarchidae	African Paradise-Flycatcher*	*Terpsiphone viridis*
Timaliidae	Scaly Babbler*	*Turdoides squamulatus*
Nectariniidae	Scarlet-chested Sunbird*	*Chalcomitra senegalensis*
	Hunter's Sunbird *	*Chalcomitra hunteri*
	Mariqua Sunbird *	*Cinnyris mariquensis*
	Bronze Sunbird *	*Nectarinia Kilimensis*
	Red-chested Sunbird	*Cinnyris erythrocerca*
Zosteropidae	White-breasted White-eye	*Zosterops abyssinicus*
Oriolidae	Dark-headed Oriole*	*Oriolus monacha*
Laniidae	Taita Fiscal	*Lanius dorsalis*
	Common Fiscal *	*Lanius collaris*
	White-rumped shrik	*Eurocephalus rueppelli*

Malaconotidae	Northern Puffback *	*Dryoscopus gambensis*
	Marsh Tchagra *	*Tchagra minuta*
	Black-crowned Tchagra *	*Tchagra senegala*
	Black-headed Bush-shrike	Laniarius erythrogaster
	Tropical Boubou *	*Laniarius aethiopicus*
Dicruridae	Fork-tailed Drongo *	*Dicrurus adsimilis*
Corvidae	House Crow *	*Corvus splendens*
	Cape Crow	*Corvus capensis*
	Brown-necked Raven *	*Corvus ruficollis*
	Thick-billed Raven	*Corvus crassirostris*
Sturnidae	Blue-eared Glossy-Starling*	*Lamprotornis chalybaeus*
	Violet-backed Starling	*Cinnyricinclus leucogaster*
	Red-billed Ox-Pecker*	*Buphagus erythrorhynchus*
	Goldon-breasted Starling*	*Cosmopsarus regius*
	Chust-net Bellied Starling*	*Spreo pulchera*
Ploceidae	Red-billed Buffalo-Weaver	*Bubalornis niger*
	Baglafech Weaver	*Ploceus baglafecht*
	Spectacled Weaver*	*Ploceus ocularis*
	Black-headed Weaver*	*Ploceus melanocephalus*
	Red-headed Weaver *	*Anaplectes rubriceps*
	Black Bishop *	*Euplectes gierowii*
	Red-collared Widowbird*	*Euplectes ardens*
	Grosbeak Weaver *	*Amblyospiza albifrons*
	White-billed Buffalo Weaver	Bubalornis albirostris
	Long-tailed Widow Bird*	*Euplectes progne*
	Northern-red Bishop *	*Euplectes nigroventris*

Estrildidae	Bar-breasted Firefinch *	*Lagonosticta rufopicta*
	Red-billed Firefinch *	*Lagonosticta senegala*
	Red-cheeked Cordonbleu *	*Uraeginthus bengalus*
	Fawn-breasted Waxbill *	*Estrilda paludicola*
	Bronze Mannikin *	*Spermestes cucullatus*
Viduidae	Village Indigobird *	*Vidua chalybeata*
	Steel-blue Whydah *	*Vidua hypocherina*
	Straw-tailed Whydah *	*Vidua fischeri*
	Pin-tailed Whydah *	*Vidua macroura*
Passeridae	Gray-headed Sparrow *	*Passer griseus*
Fringillidae	African Citril *	*Serinus citrineloides*
Phasianidae	Yellow-necked Spurfowl	*Francolinus leucocephalus*
Sylvidea	Buff-belied Warbler *	*Phyllolaispulchela*

Chi-square for seasonal number of species through the whole range of the study area had p-value greater than 0.05. So the number of species recorded during the dry and wet seasons showed insignificant variation at of 0.05 ($x^2 = 0.45$ (N=179, df=1).

6.2. Relative abundance

The total number of species in a given range of mean scores varied among seasons and vegetation types. The mean score (rank) of the wet season count varied between 0.2 and 5.75. The highest rank (mean score) was recorded from grassland vegetation with a value of 5.75, while the lowest was observed from forest vegetation type. For the grassland, it varied between 0.5 and 5.75. 56.25% of the species had mean score between 0 and 2. In the riverine forest, half of the species were in the range of mean score between 0 and 2. In the woodland vegetation, mean score varied between 0.49 and 5.7 and high

proportion of species lied between mean score of 1and 3. In forest vegetation, 58.4% of the species had a mean score between 0 and 2 (Appendix 1).

The mean score of dry season, even though had the same pattern of frequency distribution as the wet season count, differed basically in the number of species having the same mean score value. The highest mean score for the dry season count was 5.5 and the lowest 0.2. Woodland had the highest number of mean score and a total of 78.13% of species had mean score between 0 and 3. Forest vegetation had the lowest mean score value which is 0.2 and 60% of the total species had mean score between 0 and 2 (Appendix 1).

6.3. Distribution and habitat association

6.3.1 Distribution

During the wet and dry seasons, the highest number of species was recorded in farmland habitats. A total of 49 and 44 bird species were observed in this vegetation during the wet and dry seasons, respectively. The second largest number of bird species during the wet season was observed in the riverine vegetation. However, the woodland vegetation encompassed the second largest number of bird species next to the farmland during the dry season (Table 4 and 5). Except the forest, in all the vegetation types, the number of observed bird species significantly decreased during the dry season compared to the wet season ($p<0.01$). Forest vegetation had larger number of bird species during the dry season (15) than the wet season (12). However, it is not statically significant ($p> 0.01$).

Data during wet season count showed that farmland and riverine sites had the highest number of species per 1 hour-count (20 species per count). Forest vegetation had the lowest mean number of species per count (6 species per count) (Table 3).

Data for the dry season count had smaller mean number of species per count than the wet season survey except for forest vegetation. The figure showed significant variation at 0.01 level of significance ($p<0.01$) except for grassland vegetation. The maximum mean number of species per count observed in farmland site was 16. The highest mean number of species per 1 hour-count was observed in farmland during this season. The mean number of species recorded for forest vegetation during the dry season was higher than the wet season figure. Grassland vegetation had the lowest mean number of 7 species per count, which is the smallest figure during the dry season (Table 3).

Table 3. Mean number of species per one-hour count with standard deviation.

Seasons	Vegetation type				
	Farmland	Riverine	Woodland	Grassland	Forest
Wet	19.93±1.40	19.87±1.92	10.8±1.94	8±1.46	6.13±1.19
Dry	16.07±1.13	9.80±1.08	8.93±1.10	7±1.13	7.93±1.28

The correlation factor for wet season is greater than the dry season. In both seasons, the mean number of species per count and total number of species are strongly positively correlated. The value of r for the wet season was 0.84 (Table 4) and for the dry season, it was 0.78 (Table 5).

Table 4. Total and mean number of species during the wet season.

	Vegetation type				
	Farmland	Riverine	Woodland	Grassland	Forest
Total no of species	49	46	43	32	12
Mean no of species per count	20	20	11	8	6
Correlation factor(r) = 0.84					

Table 5. Total and mean number of species during the dry season.

	Vegetation type				
	Farmland	Riverine	Woodland	Grassland	Forest
Total no of species	44	24	32	28	15
Mean no of species per count	16	10	9	7	8
Correlation factor(r) = 0.78					

6.3.2. Habitat association

Chi-square test revealed that the number of species during the wet season was strongly dependent on the type of vegetation at significance level of 0.01 ($p<0.005$) (Table 6). Chi-square test for the dry season species number indicated that the number of species was dependent on the type of vegetation. The p-value was highly significant at 0.01 ($P<0.01$). Mean number of species per count

showed significant variation between vegetation types during the wet season ($p<0.01$) and insignificant variation during the dry season ($p>0.05$).

Table 6. Chi-square for total and mean number of species per count.

Seasons	Total number of species	Mean number of species per count
Wet	$X^2 = 24.92$, df=4 P<0.01	$x^2 = 13.54$, df=4 p<0.01
Dry	$X^2 = 15.917$, df=4 P<0.01	$x^2 = 5$, df=4 p>0.05

Except the montane forest, all vegetation types showed significant variation in the number of species between dry and wet seasons ($p<0.01$). Forest vegetation showed insignificant variation of total number of species between seasons ($p>0.01$). In the riverine and woodland vegetations, the variation in the number of species between seasons was highly significant ($P<0.01$) (Table 7).

Table 7. ANOVA for total number of species between seasons of the same vegetation type.

	Sum of Squares	df	Mean Square	F	Significance
Grassland	32	1	32	24.00	.003
R. forest	968	1	968	726.00	.000
M. forest	18	1	18	13.50	.010
Farmland	50	1	50	37.50	.001
Woodland	312.5	1	312.5	375.00	.000

Grassland vegetation had p-value almost equivalent to 0.05. There was no significant variation in the mean number of species per count for grassland in both dry and wet seasons. The seasonal variation of mean number of species per count is significant for montane forest, farmland, woodland and riverine forest ($p<0.05$) (Table 8).

Table 8. ANOVA for mean number of species per count between seasons of the same vegetation type.

	Sum of Squares	df	Mean Square	F	Significance
Grassland	7.5	1	7.5	4.375	.046
Riverine	760.003	1	60.003	303.435	.000
Woodland	26.133	1	26.133	10.554	.003
Farmland	112.133	1	112.133	62.963	.003
Forest	24.3	1	24.3	15.947	.000

6.4. Community similarity

6.4.1. Seasonal bird species similarity

The data in Table 9 show that a maximum value of seasonal bird species similarity is observed in the farmland. Thirty-four bird species (73.12 % of the total) were common in both seasons in this vegetation type. The minimum value of bird species similarity was observed in forest vegetation. Only 3 bird species were common during dry and wet seasons. Grassland and riverine vegetations had closer value of percentage of dry and wet season bird species similarity (Table 9).

Table 9. Seasonal species similarity within the same vegetation type.

Vegetation type	No of common species in both seasons	% of species similarity between seasons
Grassland	13	43.34
Riverine	18	51.42
Farmland	34	73.12
Forest	3	22.22
Woodland	19	50.66

6.4.2. Bird species similarity among the vegetation types

Bird species similarity between different vegetation types showed variation between seasons. During the wet season, bird species similarity ranged from a minimum of 0.1 to a maximum of 0.5. The minimum value was recorded between forest and woodland, and grassland and forest. The value between farmland and grassland was the maximum.

Both the minimum and maximum values for bird species similarity between vegetation types during the dry season was different from the wet season record. The maximum value was observed between woodland and riverine (0.58), whereas the minimum was between farmland and forest with a value of 0.2.

The minimum value of bird species similarity between different vegetations for both seasons had a value of 0.1, and the maximum

was calculated during the dry season count with a value of 0.58 (Tables 10 and 11).

Table 10. Species similarity between different vegetation types during the dry season.

	Farmland	Riverine	Woodland	Grassland	Forest
Farmland	-	0.32	0.32	0.34	0.2
Riverine	0.32	-	0.58	0.46	0.3
Woodland	0.32	0.58	-	0.46	0.34
Grassland	0.34	0.46	0.46	-	0.42

Table 11. Species similarity between different vegetation types during the wet season.

	Farmland	Riverine	Woodland	Grass land	Forest
Farmland	-	0.48	0.48	0.50	0.14
Riverine	0.48	-	0.48	0.36	0.32
Woodland	0.48	0.48	-	0.46	0.10
Grassland	.50	0.36	0.46	-	0.10

6.5. Assessment of threats to avifauna

The result of the discussion with local people have revealed that the local communities and the government officials support the establishment of the area as a National Park, hoping that they will have benefits from the activities related to the development of the Park. During the study period the main wildlife threats identified were poaching, cultivation, fire and grazing.

Poaching

In the southeastern part of the study area, people of the Tsara ethnic group were involved in subsistence hunting of birds. They are not selective in bird species during hunting. People from other ethnic groups also hunt preferable bird species such as guinea fowl, francolin and Egyptian goose.

The local community has strong cultural and economic intimacy with the birds. The greater honey guide serves as important locator of wild honey for the local people. The local people also interpret the sound produced by different bird species. The locals relate the sound produced by different species of birds with natural events, such as the coming of rain, the nearby presence of snake, or death of a person.

Fire

Fire is one of the most recurrent threats of wildlife in the Park. It is set deliberately by the local people every year. Almost all woodland and grassland the Park are burnt during the dry season (Plate 4). They frequently set fire to find new foot track, for better visibility and to obtain young grass shoot for their livestock.

Plate 4. Fire to clear the vegetation for farming activities.

Grazing

The local people regularly bring their cattle into the Park area in search of grazing land and use of hot spring water. They believe that the water has medicinal properties and increases the appetite of their livestock, resulting in high yield of milk and meat.

Cultivation

Seri and ShewaKela Peasant Associations are permanently settled in the Park. These people experience shifting cultivation and also grow root crops and fruits (Plate 5). Others from nearby areas follow the same pattern of shifting cultivation in the Park area.

Plate 5. Farming inside the park area

7. Discussion

7.1. Diversity

Bird diversity data in each vegetation type is influenced by conspicuousness of birds, the skill of the researcher for identification and the technique employed during the survey. The outcome of the count should therefore be regarded as semi-quantitative. During the wet season, the count in grassland, woodland and riverine vegetation showed that the number of bird species increases with the amount of woody vegetation. This coincides with the result of Otim (1995). However, the number of bird species counted during this season was smaller in forest vegetation. Vuilleuemier (1972) described such unexpected pattern in bird communities in northern Patagonia in Argentina. He found less species in beech forests than in the structurally simpler scrub-steppe habitats. In the same area, Ralph (1985) found a significant inverse relationship between foliage

complexity and bird diversity in non-grassland site. This may probably be due to the effectiveness of the technique. Besides this, many tropical forest species are rare, secretive, live in dense vegetation or high canopy, have little known vocalization, short singing periods, separate breeding seasons, complex mating system, large home range and nomadic habit. Because of this multiple source of biases, the current census method does not reliably assess tropical forest birds (Waide and Naris, 1988). In addition to this, southwest Ethiopian forests are relatively poor in bird diversity than forests found in other parts of the country (EWNHS, 1996).

Increase in species number was associated with the increase in percentage of woody vegetation in grassland, woodland and riverine habitats. Vegetation structure and floristic composition are repeatedly stated habitat variables that determine the number of species in different vegetation types. Crow and Crow (1982) stated that vegetation diversity, rainfall and other environmental variables are significant prediction of Afro- tropical bird diversity, and they explain about 70% of the observed variation. Information about vegetation structure and composition will implicitly contain information about a broad range of ecological factors and their interrelationship. Erdelen (1984) showed that bird species diversity is significantly correlated with the vegetation structure and is also influenced by floristic composition. However, studies by Hanson (1997) found that the number of plant species was not clearly correlated with the number of bird species. He also found that the number of bird species was strongly correlated to site area but not to internal heterogeneity. The result of the present study was partially inagreement with Erdelen (1984) except for farmland and montane forest.

Which habitat variable is more important for species number than others remains unanswered. Many studies have come with different conclusions. According to some researchers, the distribution of animal diversity has often been explained in terms of simple environmental

factors. Temperature, energy supply and productivity have been alternatively considered as key factors in the determination of geographic variation of diversity (Root, 1988; Currier and Fritz, 1993; Rosenzweig and Abramsky, 1993). Telleria and Santos (1994) pointed out that habitat structures as well as climate affect the distribution of individual bird species in Iberian temperate. In the present study, the distribution of birds showed variation among vegetations. This is probably due to the difference in simple environmental factors as stated by the above authors.

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).

The importance of the availability of vegetation strata for the number of bird species is supported by many studies. Cueto and Csenave (1999) carried out research on the determinants of bird species richness and found a positive correlation between bird species richness and the availability of vegetation strata. Karr and Roth (1971) found a sigmoid relationship between bird species diversity and percentage vegetation cover, which is in agreement with the present result except for farmland and montane forest.

Moss (1978) explained the importance of vegetation layer. Each vegetation layer in a particular wood contains niches for a number of bird species. As the number of layers increase the number of available

niches also increase and so does the number of bird species. Estades (1997) inferred that foliage height diversity and total foliage volume might effectively describe different features of the habitat for certain bird species. This is probably due to the foraging behavior of birds. Insectivorous birds are influenced by foliage height diversity whereas other bird species that forage with the denser foliage of the understory are influenced by total foliage volume (Estades, 1997).

The higher number of species observed in farmland is probably due to the availability of food, which attracts birds that feed on fruits and seeds. Moris (1992) stated that the direction and magnitude of differences in bird community following habitat alteration is related primarily to species-specific adjustment to the structure and floristic characteristic of the habitat.

7.2. Distribution and habitat association

The Chi-square test for wet season habitat association of species was significant. This is because for habitat preference, birds can use vegetation as selective criteria, thereby integrating a large number of biotic and abiotic factors (Hild`en, 1965). Many researchers have written differently on the relationship between bird diversity and vegetation types. MacArthur and his followers stated that vegetation structure is in general more closely connected to bird species diversity than is floristic composition (MacArthur and MacArthur, 1969). However, such biological conclusions are premature. This is because the method of a given study can influence the result. Chi-Square result showed that the wet and dry season bird species richness throughout the total range of the study area was insignificant. This may probably due to the presence of different vegetation types that allowed the birds to shift between different habitats in accordance with their biological need.

7.3. Seasonality of bird species

Although tropical environments are sometimes assumed to be uniform throughout the year, seasonal changes in precipitation are common (Fogden, 1972; Leck, 1972; Symth 1974). Bird species that face seasonal irregularity in the availability of food resources have two alternatives. A bird may shift from one resource to another, or it may move from one area to another, where the preffered 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). Seasonality in the number of bird species was observed in this study. It was revealed almost in all vegetation types except the forest. Many factors could account for this. For example, Karr (1976) related the seasonality in the number of bird species with the availability of resources such as food and vegetation strata and found that the number of bird species varied seasonally with peaks in the late dry and early wet seasons. This was also observed in the present study. The number of insect varied seasonally in the forest. The biomass peaked during the early rainy season (Smyth, 1974). Buskirk and Buskirk (1976) also found the same result on the seasonal abundance of arthropods in highland forest in Costa Rica. The insignificant seasonal difference in the number of bird species in the forest is in agreement with MacArthur (1972) and Symth (1974). It is based on the idea that structurally complex vegetation types buffer the effect of seasonality. In this complex vegetation type, there is a greater stability in resource availability and allows species to occur as residents throughout the year. Bird species also sometimes show a shift in feeding habit between different seasons (Ward, 1969). This may probably account for the insignificance of seasonal number of forest bird species in the present study. Seasonal variation in the number of

bird species in grassland probably related to the abundance of insect, which favors insectivores to colonize the area (Karr, 1976).

In woodland and riverine habitats, the increased number of bird species during the wet season can be accounted by the increase in number of high stratum species due to the influx of insectivores (Karr, 1976). The decrease in species number in riverine and woodland habitats during the dry season is probably due to the loss of vegetation strata, which is closely associated with the availability of resources. The major proportion of the canopy in these areas is composed of trees and shrubs that loss their leaves. In addition, fire during dry season burns many of the leaves on shrubs and trees that host a large number of insects.

Since the purpose of the present study is to asses the diversity of bird species in the area, the seasonal variation of population density was not analyzed in this study. However, studies like Karr (1976) showed the seasonality of the number of individuals varied independently of the number of species. The study also showed that the peak in bird density might not coincide with the peak in the number of bird species.

The mean number of species, which is a measure of diversity, showed significant seasonal variation in all vegetation types except grassland. This may probably due to the openness of the habitat that allows distant vision. The seasonal variation of the mean number of species in forest, riverine and woodland habitats can be accounted in the same way as a result of seasonal variation in the total number of species.

The percentage of seasonal species similarity within the same habitat has direct relation with the complexity of vegetation except in forest and farmland. In the farmland, such higher proportion of seasonal species similarity is probably due to the availability of agricultural

crops during different seasons. In the forest, such small proportion of seasonal species similarity probably arise from the secretive nature and the inadequacy of the technique to study tropical forest birds (Waide and Naris, 1988).

The seasonal similarity of bird species observed in the grassland, woodland and riverine habitats is closely associated with the complexity of the vegetation structure. The value increases with increase in vegetation complexity (MacArthur, 1972; Symth, 1974:). Species similarity among vegetation types of the same season show highest value in more similar vegetation types in both seasons. During the wet season, the highest value was observed between farmland and grassland, and during the dry season, it was between woodland and riverine. This is in agreement with Estade (1997). He found a positive correlation between the occurrence of certain tree species and bird species. Therefore, similarity in floristic composition may account for the similarity in bird species between different vegetation types.

7.4. Threats to aviafauna

During the study period, discussion with the local people helped to asses the view of the community and anthropogenic wildlife threats of the area. Unlike other parts of the conservation areas of the country, people living around the park area are cooperative and supportive of the activities concerning the establishment of the Park. This is mainly due to the development of awareness created by continuous provision of training and education for farmers by concerned governmental officials. The Park is relatively undisturbed compared to other Parks of the country. However, this does not mean that it is free of human intervention. Unless further measures are taken, similar problems are likely to occur as seen in other Parks.

Unlike large mammals, it is very difficult to assess the extent of poaching of birds in the area. Like any other wild animals, killing birds for different reasons has negative effect on the abundance of the species. Some bird species are rare and will rapidly respond to poaching. The effect varies among different species. Poaching will have insignificant short-term effect on abundant species responding slowly. This species will, however, respond to such threat later than rare species. Even though such effect is not clear on the study area, it will have a declining effect on the abundance of some species and will eventually result in the extermination of such species from the area.

Shifting cultivation is common in many parts of the study area. People living near to the park area also trespass the Park boundary to practice shifting cultivation. This activity is seen in every vegetation type of the Park area. They prefer less fertile sloppy areas for teff cultivation, which are more fragile and degradable. It is likely that some forest interior species, especially those that are rarely recorded in bird censuses, are sensitive to fragmentation caused by seasonal farming (Robbins *et al,* 1989). Population variability studies of forest interior species revealed that fragmented forests are characterized by `sink` population, where reproduction does not compensate for mortality (Porneluzi *et al*, 1993; Donovan *et al,* 1995; Robinson *et al,* 1995). There is a negative trend between forest decline and the number of species of canopy snatchers, canopy foliage gleaners, and shrub gleaners (Darveau *et al,* 1992). The deterioration of forest canopy will lead to some alteration of the physical environment (Klein and Perkins, 1988) as well as long term impact on the natural regeneration process (Houle, 1990).

The negative effect of establishing farm area is also observed in the grassland habitat. Studies have shown that farmland areas in grass habitats will affect the breeding ground of some bird species that inhabit the interior of the grassland habitat (Samson, 1980). The local

people in search of additional grazing land, for foot track and distant vision, frequently set wild fire. This activity has strong effect on the availability of food. Fire also seriously affects the population of ground nesting birds through the fatal effect on eggs and nestlings.

Grazing pressure in the study areas is currently not severe. However, in the future, due to the rapid increase of human pressure, the problem will be more prominent. Some bird species depending on their feeding habit can be influenced by grazing pressure. Karr (1976) revealed that the seasonality of bird species showed variation among grazed and unglazed grasslands.

8. Conclusion

The present ecological survey revealed that the Park supports a variety of bird species in different vegetation types of the area. Among these, five are endemic to the country. The number of individual species of the area shows seasonality. This seasonal variation is due to the cumulative effect of both biotic and abiotic factors. The distribution of avian species is also closely related to type of the habitat, which is influenced by environmental factors such as rainfall, soil, humidity, and temperature.

Specific conclusion might not be possible on the trends of avian species diversity, abundance and distribution in the study area in the absence of systematic ecological inventory prior to the present study.

The study area, CCNP being diverse in vegetation type, harbors large and small mammal species and other wild animals in addition to birds. Therefore it can serve as important center for tourist attraction. Besides its wild animal potential, the Park has impressive landscape and crater lakes. It could serve as a good source of income, if properly managed. In many parts of the country, the main problem of

conservation areas are associated with the local people. However, the local people of the study area are relatively supportive and cooperative to work for the development of the Park. However, cultivation, fire, poaching and grazing should be curtailed to minimize the effect on avian species diversity.

9. Recommendation

The people living inside the Park area should be removed to different site. However, this should be carried out in a well-coordinated manner by increasing the awareness of the community and by providing longlasting (sustainable) benefits.

The present threats of the area including poaching, cultivation, fire and grazing have negative impact on the diversity and abundance of the wild animals and on the biodiversity and ecosystem of the area in general. Therefore, it is necessary to take appropriate conservation and administrative measures to mitigate the expansion before large-scale destruction is made.

More budgets should be allocated from regional and federal governments for the construction of residence buildings, roads inside the Park and for the employment of additional staff members and other basic infrastructures to allow the Park to be practically functional.

During the employment of the Park staff, at least scouts should be from the local people. This helps to integrate the local people in conservation activities and develop awareness and belongingness towords the natural resources of the area.

The area has been declared as Chebera Churchura Nationaal Park by the regional government. However, it is not still approved by the

Federal Government of Ethiopia. Therefore, the regional government should make more for approval. Alternatively, mechanisms should be sought to approve it as a State Park.

Gazzetment of conservation area is important to avoid or minimize conflict between wildlife and local people. This has been witnessed in other areas after establishment of the Park. It is, therefore advisable to gazette such areas as early as possible.

In addition to the above measures, specific and detailed research on the different components of the biodiversity of the area is important for the proper and long-term management plan of the park. Therefore, based on the present study, the following studies should be carried out on priority basis:

- Floristic composition and distribution of plant species in different parts of the study area should be carried out. This is indispensable to relate faunal diversity with floristic composition of the area.
- Differences in the seasonality of insect population in different vegetation type should be studied to assess its impact on the seasonal distribution of insectivorous birds.
- Additional detailed study of long duration on the diversity and other ecological aspects of forest bird species should be conducted to get exhaustive data.
- 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.

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11. APPENDICES

Appendix 1. Relative abundance (mean score value)

A/Grassland habitat during the wet season

Species	Mean score value
Abbysinian white eye	1.17
African citril	3.25
African mourning dove	1.25
Bar breasted fire finch	4.58
Black bishope	1.83
Black headed batis	0.58
Bronze sunbird	3.08
Buff bellied warbler	1.67
Cardinal woodpecker	0.88
Common bulbul	4.33
Common fiscal	1.58
Crowned hornbill	0.75
Fawny breasred waxbill	5.75
Helmeted guineafowl	0.67
Northen red bishop	3.41
Pin tailed whydah	2.08
Purple indigo bird	2.08
Red billed firefinch	5.33
Red billed oxpecker	0.83
Red collared widow bird	1.92
Red headed weaver	1.25
Ring necked dove	0.8

Scaly babler	2.33
Scarlet chested sunbird	2.33
Senegal coucal	0.7
Speckled mouse bird	1.33
Steel blue whydah	2.5
Straw tailed whydah	2.58
Tambourine dove	1.5
Tawny flanked prinia	2.67
White rumped swift	1.67
White throated bee-eater	0.5

B/ Forest habitat during the wet season

Common name	Mean score value
African green pigeon	0.2
Black backed puff back	1.5
Black headed oriole	4.5
Black winged love bird	2.2
Chest net bellied starling	1.3
Double toothed barbet	4.9
LIttle bee eater	0.5
Red headed love bird	1.5
Scaly babler	3.5
Wattled ibis	2.3
White rumped swift	1.8
White winged cliff chat	1.7

C/ Woodland habitat during the wet season

Common name	Mean score value
Black bishop	3.7
African mourning dove	3.7
African paradise monarch	4.4
Banded barbet	5.7
Black crowned tchagra	1.4
Black flycatcher	1.3
Black headed batis	0.85
Black headed weaver	4.2
Black throated honey guide	1.5
Blue eared glossy starling	2.1
Bronze mannikin	1.1
Bronze sunbird	1.9
Brown hooded kingfisher	2.9
Cardinal woodpecker	3.1
Cinnamon chested bee eater	3.45
Common bulbul	5.3
Double toothed barbet	0.7
Dusky fly catcher	2.4
Fawny breasted waxbill	2.45
Golden breasted starling	2.2
Grey cuckoo shrike	0.92
Grey headed sparrow	1.8
Grosbeak weaver	0.68
Hunter`s sunbird	0.7
Long crested eagle	1.8
Long tailed widow bird	0.49

Marsh tchagra	2.7
Pin tailed whydah	1.5
Ring necked dove	2.2
Ruppel`s robin chat	0.93
Scally babler	1.9
Scarlet chested sunbird	2.7
Senegal coucal	1.35
Snowy crowned robin chat	2.6
Speckeled mouse bird	1.5
Square tailed drongo	3.5
Steel blue whydah	1.45
Straw tailed whydah	0.78
Tambourine dove	1.7
Tropical boubou	2.8
White rumped swift	1.5
White throated bee eater	1.6
Yellow billed egret	0.92

D/ Riverine habitat during the wet season

Common name	Mean score value
African citril	2.73
African green pigeon	0.9
African hawk eagle	1.8
African mourning dove	3.8
Banded barbet	1.6
Black bishop	0.91
Black crowned tchagra	3.3
Black fly catcher	1.4
Black headed heron	0.89
Black winged love bird	1.4
Blue eared glossy starling	0.85
Bronze sunbird	3.6
Common bulbul	5.2
Crowned crane	0.6
Double toothed barbet	3.2
Egyptian goose	0.83
Fawny breasted waxbill	1.1
Giant kingfisher	0.95
Great blue turaco	3.7
Grey woodpecker	4.2
Hadada	1.7
Helmeted guinea owl	1.8
Hunter`s sunbird	2.3
Lemon dove	1.8
Little bee eater	2.2
Long tailed widow bird	1.2
Malachite kingfisher	2.3

Northen backed puff back	2.3
Olive thrush	2.6
Pied wagtail	0.8
Red eyed dove	4.4
Ring necked dove	3.3
Scaly babler	5.1
Scarlet chested sun bird	3.4
Speckeled mouse bird	2.4
Spectacled weaver	1.1
Striped kingfisher	0.87
Tambourine dove	4.1
Tawny eagle	1.7
Tawny flanked prinia	4.4
Wattled ibis	0.75
White browned robin chat	2.7
White rumped swift	3.1
White throated bee-eater	2.8
White winged cliff chat	1.3
Yellow billed egret	1.2

E/ Grassland habitat during the dry season

Common name	Mean score value
African citril	1.67
African hoopoe	1.25
African mourning dove	2.25
Banded barbet	1.42
Bangelafetch weaver	5.33
Black bishop	0.5
Black cuckoo shrike	0.92
Black fly catcher	4.17
Black throated honey guide	1.83
Bronze sunbird	4.56
Cinnamon chested bee eater	1.67
Common bulbul	4.08
Hunter`s sunbird	2.75
Marsh tchagra	1.83
Pied wheatear	2.5
Red billed fire finch	3.33
Ring necked dove	3.33
Scaly babler	5.17
Scarlet chested sunbird	5.4
Speckled mouse bird	3.4
Standard winged night jar	0.6
Tambourine dove	1.42
Tawny flanked prinia	2.58
Violet backed starling	1.92
White bellied go-away bird	0.92
White rumped swift	3.58
White winged cliff chat	0.83
Yellow necked spur fowl	2.5

F/ Montane forest during the dry season

Common name	Mean score value
African citril	0.2
African mourning dove	3.4
Banded barbet	1.5
Bearded woodpecker	1.5
Black winge love bird	1.5
Great blue turaco	5.1
Klaas` cuckoo	0.8
Little bee eater	2.5
Red shouldred cuckoo shrike	3.5
Ring necked dove	1.2
Scarlet chested sunbird	0.6
Speckled mouse bird	2.5
Tambourine dove	1.8
Violet backed starling	1.9
White rumped swift	4.1

G/ Riverine forest during the dry season

Common name	Mean score value
African mourning dove	1.5
African paradise fly catcher	2.7
Black flycatcher	1.5
Black headed bush shrike	0.8
Black winged love bird	2.6
Bronze sunbird	2.5
Common bulbul	3.2
Double toothed barbet	3.3
Hadad	2.9
Hunter`s sunbird	1.3
Long crested eagle	1.9
Pied wagtail	2.2
Saddle billed stork	0.7
Scaly babler	4.3
Scarlet chested sunbird	3.4
Speckeled mouse bird	4.3
Spectacled weaver	1.8
Tambourine dove	5.1
Tawny eagle	1.3
Tawny flanked prinia	3.5
Volutrine guinea fowl	1.1
White rumped swift	0.9
White throated bee eater	1.9
White winged cliff chat	0.9

H/ Farmland during the wet season

Common name	Mean score value
African citril	1.3
Augur buzzard	1.6
Banded barbet	0.76
Bangelafetch weaver	1.4
Black crowned tchagra	3.5
Black fly catcher	1.2
Black headed heron	1.3
Black headed weaver	5.5
Blue eared starling	3.3
Bronze mannikin	0.85
Bronze sun bird	4.4
Brown naked raven	2.9
Cardinal woodpecker	0.69
Common bulbul	5.2
Common fiscal	1.5
Fawny breasted wax bill	2.8
Greater spotted eagle	2.6
Grey headed sparrow	5.2
Helmeted guinea fowl	3.2
Lemon dove	0.85
Long crested eagle	1.3
Malachite kingfisher	2.3
Marsh tchagra	3.4
Mountain wagtail	1.6
Northen anteater chat	3.7
Olive thrush	2.4
Pin tailed whydah	2.2

Red billed buffalo weaver	1.5
Red billed fire finch	2.2
Red billed oxpecker	0.69
Red cheeked cordon blue	1.3
Red collared widow bird	2.5
Red eyed dove	2.3
Red headed weaver	1.9
Ring necked dove	3.7
Rufous breasted swallow	4.7
Scaly babler	4.5
Senegal coucal	0.75
Speckled mouse bird	2.4
Square tailed drongo	3.5
Tambourine dove	1.1
Tawny flanked prinia	4.9
Tawny eagle	2.1
Thick billed raven	0.95
Wattled ibis	2.7
White rumped swift	2.7
White winged cliff chat	0.78
Wire tailed swallow	3.5
Yellow billed egret	1.4

I/ Woodland habitat during the dry season

Common name	Mean score value
African mourning dove	2.67
African paradise monarch	1.52
Black flycatcher	3.5
Black throated honey guide	5.23
Black winged love bird	0.78
Blue eared glossy starling	1.92
Bronze mannikin	0.87
Bronze sunbird	2.54
Chest net bellied kingfisher	1.23
Cinnamon chested bee eater	1.46
Common bulbul	5.5
Crowned hornbill	2.75
Double toothed barbet	3.5
Hadada	1.86
Hunter`s sunbird	2.43
Lemon dove	0.76
Long crested eagle	1.94
Olive dove	0.98
Pallied fly catcher	4.5
Red shoulder cuckoo shrike	0.88
Ring necked dove	2.84
Scaly babler	5.25

Scarlet chested sunbird	2.73
Striped swallow	2.5
Tambourine dove	3.45
Tawny eagle	1.82
Violet backed starling	1.64
White bellied go-away bird	0.94
White rumped helmeted shrike	1.21
White rumped swift	2.73
White throated bee eater	1.43
Wire tailed swallow	2.5

J/ Farmland during the dry season

Common name	Mean score value
African citril	2.4
Augur buzzard	1.2
Bangelafetch weaver	2.6
Black crowned tchagra	2.6
Black headed heron	0.89
Black headed weaver	2.1
Blue cheeked cordon blue	2.4
Blue eared starling	5.4
Bronze sunbird	2.1
Brown naked raven	2.9
Cape rook	3.7
Common bulbul	3.8
Common fiscal	3.7
Greater spotted eagle	1.3
Grey headed sparrow	3.5
Hadada	2.2
Long crested eagle	0.75
Malachite kingfisher	0.77
Mariqua sunbird	0.85

Mountain wagtail	2.3
Olive thrush	1.3
Red billed buffalo weaver	0.93
Red billed fire finch	2.6
Red billed oxpecker	1.6
Red chested sunbird	1.9
Red eyed dove	1.1
Ring necked dove	1.9
Ruppel`s robin chat	0.87
Scaly babler	5.1
Senegal coucal	2.1
Speckled mouse bird	1.2
Speckled pigeon	2.1
Square tailed drongo	1.8
Taita fiscal	4.9
Tambourine dove	2.1
Tawny flanked prinia	1.2
Tawny eagle	3.8
Thick billed raven	2.6
Violet backed starling	1.2
Wattled ibis	4.9
White rumped wift	0.8
White winged cliff chat	1.3
Wire tailed swallow	2.7
Yellow wagtail	1.3

Appendix 2. Dominant plant specimens collected and identified during the study period

Familiy	Scientific name	Vernacular name (Konta)
Cotaceae	*Costas sp*	Gelesho Okashe
Moraceae	*Ficus Vasta*	Asa Gembela
Fabaceae	*Albizia grandibracteata*	Zamo
Acanthceae	*Acanthopale sp*	
Euphorbiaceae	*Bridelia scleroneura*	Gereche
Oleaceae	*Chionantus mildobradii*	Marike
Fabaceae	*Acacia brevispica*	Sisa
Celastraceae	*Maytenus arbutifolia*	Putare
Verbenaceae	*Vitex doniana*	*Dulo*
Bignoniaceae	*Terminalia brownii*	Gelesho Gembela
Combretaceae	*Combretum colinum*	Sobo
Euphorbiceae	*Combretum mole*	Digiso
Tiliaceae	*Grewia ferrugunea*	Lusha Gumre
Fabaceae	*Albizia lophantha*	
Moraceae	*Ficus ovata*	Maro
Asteracea	*Aspilia mossambicensis*	Kisho
Poaceae	Hyparrhenia cymbaria	Kalicho
Poaceae	*Arundo donax*	Woshlange
Poaceae	*Oplismenus hirtellus*	
Boraginaceae	*Ehretia cymosa*	Etrewanja
Poaceae	*Panicum maximum*	

Appendix 3. List of mammals observed during the study period

Common name	Scientific name
Bush baby	*Gelago senegalensis*
Savanna baboon	*Papio cynocephalus*
Gureza	*Colubus guereza*
Warthog	*Phacochoerus africanus*
Hippopotamus	*Hippopotamus amphibius*
African buffalo	*Syncerus caffer*
Bushbuck	*Tragelaphus scriptus*
Bushpig	*Potamocherus larvatus*
Waterbuck	*Kobus ellipsipprymus*
Common duiker	*Sylvicapra oreotragus*
Elephant	*Loxondata africana*
Golden jackal	Canis aureus
Honey badger	*Mellovora capensis*
African civet	*Civettictis civetta*
White tailed mongoose	*Ichneumia albicauda*
Spotted hyena	*Crocuta crocuta*
Leopard	*Panthera paradus*
Lion	*Panthera leo*
Aardvark	*Orycteropus afer*
Ground squirrel	*Xerus erythropus*
Porcupine	*Hystrix cristata*

Appendix 4. Data sheet of Timed-Species Count (TSC)

Place…… Date……. Sampling sight (block no.)…….. Start time…….. Stop time……..

GPS reading……..

Name of observer……

Time	Species	Sighting distance (m)	Activities	Score (rank)	Number of species per 1-hr count
0-10					
0-20					
20-30					
30-40					
40-50					
50-60					