JIMMA UNIVERSITY

SCHOOL OF GRADUATE STDUDIES

COLLEGE OF NATURAL SCIENCES

DEPARTMENT OF BIOLOGY

THE DIVERSITY, RELATIVE ABUNDANCE AND DISTRIBUTION OF MEDIUM AND LARGE SIZE MAMMALS IN BAROYE CONTROLLED HUNTING AREA, ILLUBABOR ZONE, SOUTHWESTERN ETHIOPIA

BY

DEREJE NEGERI

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF JIMMA UNIVERSITY IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN BIOLOGY (ECOLOGICAL AND SYSTEMATIC ZOOLOGY)

DECEMBER, 2014

JIMMA, ETHIOPI

Acknowledgements

I would first like to express my deep gratitude and appreciation to my research advisor Dr. Tsegaye Gadisa, for his encouragement, constructive criticism and consistent academic guidance starting from proposal design up to the final production of this thesis and for his enthusiastic advice for the accomplishment of this research work. His punctuality, being concerned, patience, dedication, brotherly approach and immediate response are highly acknowledged. I am also grateful to Dr. Subhash Babu, my seminar paper advisor, for his constructive criticism and encouragement, mainly during proposal designing of the research work.

Various people contributed to the success of this work. I am grateful to all of them. I am deeply indebted to all the administrative staff members of the Oromia Forest and Wildlife Enterprise Metu branch, particularly, Ato Zeleke, Department of wildlife management and Ato Asfawu, finance officer for their valuable guidance and for allowing me to use the facilities and also to all scouts members for creating a homely working environment and their unlimited friendly relationship during the field investigations in the controlled hunting area, but especially to Ato Befikadu Tadesse for he supported me in giving 40km motorcycle transport service weekly to the study area.

I am grateful to Jimma University, Department of Biology for providing me financial support to carry out this research. I would like to extend my deepest appreciation to all Ecological and Systematic Zoology Stream postgraduate students, Department of Biology.

My special thank you goes to my beloved wife, W/r Abebech Diriba, for her encouragement, understanding and patience and loving care and sharing all my pains during my stay in the School of Graduate Studies.

Last but not least, I would like to acknowledge all my staff members of Metu TTC who provided me ideal and material support, especially to Ato Gizachew Mekonen who gave me all rounded support to complete this research work. Above all, I would like to thank my God, who helped me in all my up and downs throughout my study period.

Dereje Negeri

Table of Contents

Contents **Page**

List of Tables

List of Figures and Plates

List of Appendices

Lists of Acronyms

EWNHS - Ethiopian Wild life and Natural History Society

EPA - Environmental Protection Agency

IBC - Institute for Biodiversity Conservation

IUCN - International Union for Conservation of Nature

SPSS - Statistical Package for Social Science

NLFC - National Life Finance Cooperation

OFWE - Oromia Forest and Wildlife Enterprise

WCMC - World Conservation Monitoring Center

NRS - National Regional States of the country.

ONRS - Oromia National Regional State

Abstract

The present study was carried out to determine the diversity, relative abundance and distribution of medium and large sized mammals during dry and wet seasons from January, 2014 to July, 2014 in Baroye controlled hunting area, Illubabor Zone, Southwestern Ethiopia. The study area was classified into three habitat types (grassland, woodland and riverine forest) based on the vegetation type of the area. Representative sample blocks were taken from each habitat type. Line transect method was employed for all the three habitat types and species identification and counting of individuals were made along each transect. In addition to direct observation, indirect methods such as scat/dropping, spines and calls were also used for identification of mammals. A total of 23 species of medium and large sized mammals grouped into 7 orders and 13 families were recorded from the study area during both seasons. Among these mammals only five species were the medium sized, whereas the remaining 18 species were large sized mammals. Riverine forest and Woodland habitats had the highest mammalian species diversity during the dry season with the diversity index (H') 2.37and 2.23 respectively. The abundant mammal species in the study area were African buffalo (Syncerus caffer) (23.16%), Olive baboon (Papio anubis) (21.23%), Vervet monkey (Chlorocebus aethiopis) (14.76%) and Colobus monkey (Colobus abyssinicus) (9.56%), whereas leopard (Panthera pardus) and lion (Panthera leo) were fewer than 1% of the total observation. Among the three habitat types the highest Simpson's index (SI) similarity of mammalian species was obtained from woodland and riverine forest both during the dry (0.67) and wet season (0.66),while less similarity was obtained from species of grassland and riverine forest during dry (0.31). Despite the study area provided habitats for various species of mammals, the seasonal fire, illegal settlement, poaching and deforestation were very evident in the area, putting an extreme negative effect on the fauna and flora. Hence, there is a need for urgent conservation measures to save the biodiversity.

Key words: *Mammalian diversity, species distribution, relative abundance, habitat type, Controlled hunting*

1. Introduction

1.1 Background

The diverse habitats, variable topographic and climatic conditions of the African continent have contributed to harbor 25% of the global species of mammals (Chris and Stuart, 2000). Ethiopia is among those African countries with the most physically and biologically diverse due to primarily by variations in altitude. This diversity includes physiographic, climatic and edaphic, which resulted in unique and diverse sets of biotic zones ranging from afroalpine to desert communities (Hillman, 1993; Yalden *et al*., 1996).

The altitudinal variation and other factors are resulted in a very diverse set of ecosystems ranging from humid forest and extensive wetland to the desert (Shibru Tedla, 1995; Leykun Abune, 2000). Its topography varies from vast plains to high mountains having an altitudinal range of 116 m in Dallol depression below sea level and the highest peak of 4620 m above sea level on Mount Ras Dashen (Shibru Tedla, 1995).The country's unique topography and wide ranging climate making it the home for diversity of species and endemics (Yalden and Largen, 1992). Most of the country comprises highland plateaus and mountain ranges that are dissected by numerous streams and rivers. The highlands gradually descend to lowland areas in the east, west and south of the country (EWNHS, 1996; EPA, 1998).

Ethiopia has five climatic zones, defined by altitude and temperature. The hot, arid zone covers the desert lowlands below 500 m, where the average annual rainfall is less than 400mm and average annual temperatures range between 28°C and 34°C or higher. The warm to hot, semi-arid zone includes those areas with an altitude of 500–1,500 m Average annual rainfall is about 600 mm and the average annual temperature ranges from 20 to 28°C. The warm to cool, semi-humid zone covers the temperate highlands between 1,500 and 2,500m altitude. Average annual temperatures vary between 16°C and 20°C, and annual rainfall is generally around 1,200 mm, reaching 2,400 mm in the southwest. The cool to cold humid zone includes the temperate highlands between 2,500 and 3,200 m altitude, where average temperatures range between 10°C and 16°C, with an annual rainfall of 1,000 mm and up to 2,000 mm in higher areas. The cold, moist temperate zone covers the afro-alpine areas on the highest plateaus between 3,200 and 3,500 m; average temperatures are below 10°C and annual rainfall averages less than 800 mm (EWNHS, 1996; Saavedra, 2009; IBC, 2005; EPA, 1998).

Ethiopia is among the few African countries with high species diversity (Yalden *et al*., 1996). The country currently possesses 284 species of mammals, 861 species of birds, 201 species of reptiles, 63species of amphibians, 145 species of fresh water fish and 324 species of butterflies known from Ethiopia (Yalden and Largen, 1992; Leykun Abune, 2000; Manyingerew Shenkut *et al*., 2006; Dawit Kassa and Afework Bekele, 2008). Among these about 31 mammals, 16 birds, 25 amphibians, and 9 reptiles are considered to be endemic to the country (Largen, 2001). The high level of endemicity of mammals in Ethiopia is attributed to the large extent of highlands (above 3000m), isolated from the rest part of Africa and the variations in temperature and rainfall among different habitats (Yalden and Largen, 1992). The extensive highlands and plateaus are the most distinguishing features that make Ethiopia unique from the rest of the continent.

Out of 284 species of mammals in the country, about 60% are medium and large size mammals (Yalden and Largen, 1992). Medium-sized mammals are mammals those weighing between 2 and 7 kg such as small carnivores, small primates**,** large rodents, hyraxes, and pangolins while the species with more than 7 kg are considered to be of large size mammals these includes most diurnal primates, most carnivores larger than a fox or house cat, all perissodactyls (horses, rhinos, tapirs) and artiodactyls (Emmons and Feer, 1997). The Medium and Large mammalian species are usually found in and around the arid part of the country (Hillman, 1993).

To protect and conserve these diverse and important biological resources such as endemic animals, 12 National Parks, 11 Wildlife Reserves, 3 Sanctuaries, 18 Controlled Hunting Areas and 69 Important Bird Areas have been established as refuge in Ethiopia (Zewdu Belete and Yemesrach Assefa, 2005). These areas are not only act as biodiversity “banks” but also have a direct economic benefit; bringing in revenues from tourism. However, due to the expansion of human settlement and agriculture that lead to habitat destruction, the natural habitats range of many wildlife species have increasingly become smaller. As a result, wildlife resources of the country are largely restricted to a few protected areas. As Yalden and Largen (1992) reported, the restriction of wildlife habitats caused harsh struggle for natural resources between wild animals and the local communities which in turn resulted in wildlife human conflict.

The biological resources of Ethiopia are widely distributed in the different National Regional States (NRS) of the country. One of these NRS is the Oromia National Regional State (ONRS).

Baroye controlled hunting area is one of the recently established controlled hunting area in, Illubabor Zone, ONRS and Southwestern Ethiopia. One of the problems in biodiversity conservation is lack of information on the relative importance of habitats and ecosystems in terms of biological diversity (WCMC, 1994). Systematic studies have not been carried out on the diversity, distribution and relative abundance of medium and large sized mammals in Baroye controlled hunting area. Information from the local community and few preliminary surveys conducted by Oromia Forest and Wildlife Enterprise (OFWE) found in this zone however, suggested the presence of mammals, different species of birds and other forms of life. This study was aimed to identify the species of medium and large sized mammals, collect data on their diversity, distribution and relative abundance and suggest mechanisms for proper management and conservation in Baroye controlled hunting area.

1.2 Statement of the Problem

Baroye controlled hunting area is one of the newly established controlled hunting area in Oromia regional state, Illubabor zone, Metu Woreda to ensure conservation of wildlife resource by generating revenue from nonresident hunters based on the set quota through regulation by the Oromia Forest and Wildlife Enterprise (OFWE). Even though this area is believed to have higher mammalian diversity, there is an accelerated reduction on the number of mammalian species as result of anthropogenic activities, such as illegal hunting by natives, seasonal fire and habitat destruction for agricultural expansion, pressure by domestic animals and heavy encroachment by humans. Information about mammalian diversity, distribution and relative abundance is very essential to develop management plan for a given protected area (WCMC, 1994). However, no such information for the Baroye controlled hunting area. Therefore, the present study was aimed to fill the gap by gathering essential information on the diversity, distribution and relative abundance of medium and large sized mammals in the present study area.

1.3 Objectives of the study

1.3.1 General objective

- The general objective of this study was to assess the diversity, distribution and relative abundance of medium and large sized mammals in Baroye controlled hunting area, Western Ethiopia.

1.3.2 Specific objectives

The specific objectives of the study were:

- To assess the diversity of medium and large sized mammals in Baroye controlled hunting area.
- To determine habitat association and relative abundance of medium and large size mammals in the study area.
- To analyze distribution of medium and large sized mammals in the study area.
- To describe the biological and physical information of the area

1.4. Significance of the study

As IUCN (2005) has reported, 23% of mammal species 11% of all bird species and 14% of all plant species are threatened with extinction. As a result, many species will disappear before they have been described by science. Human activities have dramatically disturbed natural environments throughout the world. Similarly Ethiopia's protected area is increasingly degraded by human activities. Land is being converted for subsistence and commercial agriculture, protected grasslands used for livestock grazing (Young, 2012). The loss of biodiversity in the country is underpinned by population growth and food insecurity resulting in people moving into marginal and protected areas, unsustainable natural resource management and very low public awareness of the importance of biodiversity and ecosystems (Young, 2012). As result of human activities, such as uncontrolled hunting, habitat destruction and seasonal fire, the number of mammals is declining. The situation in Baroye controlled area cannot be in any case different from this. Therefore, this study would document and provide detail information about the diversity, distribution and relative of medium and large sized mammals in Baroye controlled hunting area, which is important for the future development of sound management plan for that controlled area. In addition the information collected will serve as a base line for other researchers interested to carry out additional studies in this area.

2. Literature Review

2.1 Mammalian Diversity

Mammalian comprises attractive class of animals that display tremendous morphological, physiological and reproductive diversity (Griffiths, 1984). Although mammals share several features in common, they also contain a vast diversity of forms. Mammals range in size from those that are very small to the largest animals known to have existed (Mugatha, 2002). The smallest mammals are found among the shrews and bats and weigh as little as less than 2g. The largest mammal, and indeed the largest animal to ever inhabit the planet, is the blue whale which, weigh over 160 tones. On land the largest mammal is the African elephant which can be 3.2m tall at the shoulder and weight 5.5 tons. Monotremes, Marsupial, and Eutherian mammals can be distinguished by variety of characteristics but they have different modes of reproduction that most clearly lead to their classification (Flynn and Hill, 1947)

Among mammals living today 0.1% of them are eggs laying and 99% are placental. Species of mammals are found on all continents, occurring from the arctic in the north hemisphere to the southern tips of the continents and large islands in the southern hemisphere (Nowak, 1991). According to Wilson and Reeder (2005), there are more than 5,400 species of mammals exist today which are placed under 29 orders. However, Systematists do not yet agree on the exact number or on how some orders and families are related to others. New information coming from phylogenies based on molecular evidences and from new fossils is changing peoples' understanding of many groups (Flynn *et al*., 2005).

Mammals have evolved to exploit a large variety of ecological niches and have evolved numerous adaptations to take advantage of different life styles (Flynn *et al*., 2005). As mammals vary greatly in size, they also vary greatly in lifespan. Generally, smaller mammals have short and larger mammal live long life span. Bats are an exception to this pattern; they are relatively small mammals that can live for one or more decades in natural conditions, considerably longer than natural lifespan of some of the larger mammals (Grzimek, 1990).

Locomotion styles of mammals are also diverse. Social behavior varies considerably as well. Some mammals live in groups of tens, hundreds, thousands or even more individuals. Other mammals are generally solitary except when mating or raising young. Activity patterns among

mammals also cover the full range of possibilities. Mammals may be nocturnal, diurnal or crepuscular i.e. mammals that are active at dusk and dawn when the light level is low (Reichholf, 1990).

Mammals are one of the most important components of biodiversity in the world (Ojeda *et al*., 2000). Functional structures of mammals are determined by the composition of useful traits (feeding type, body mass, activity patterns and gregariousness). Such structures often vary along environmental gradients such as disorder and resource availability (Hashim and Mahgoub, 2007).

One of the most interesting appearances of tropical Africa is the diversity of its mammalian fauna (Delny and Happold, 1979). This fauna holds species as varied as enormous elephants, tiny pygmy mice, scaly pangolins, amphibious hippopotamuses, flying squirrels, naked burrowing rodents, and termite-eating aardvarks. Over 1,150 species of mammals are recorded from Africa, belonging to 13 Orders and 50 Families. Among them, small mammals are the most ubiquitous and numerous, both in species and individual members (Kingdon, 1974).

Large mammals have long been recognized as animals that interact in particularly complex and powerful fashions with their habitat (Laws, 1970). They are also basic elements in many ecosystems. Large carnivores regularly shape the quantity distribution, and behavior of prey animals (Berger *et al*., 2001). Large herbivores function as ecological engineers by altering the structure and species composition of the surrounding vegetation (Dinerstein, 2003).

2.2 Habitat and distribution of Mammals

Mammals inhabit every terrestrial biome, from deserts to tropical rainforests to polar icecaps. Many species are arboreal, spending most or all of their time in the forest canopy. Many mammals are partially aquatic, living near lakes, streams, or the coastlines of oceans (McCoy and Bell, 1991). Distribution of mammals occurs in two levels namely geographical distribution and the local distribution. The distribution of species represents the sum of many local populations and the distribution of a particular species or group of populations (Vaughan *et al.*, 2000). Structurally complex habitats may provide more niches and divers ways of exploiting environmental resources and thus increase species diversity (Bazzaz, 1975). In most habitats, plant communities determine the physical structure of environment and therefore have a

considerable influence on the distribution and interactions of animal species (McCoy and Bell, 1991).

According to Kingdon (1997) large mammals, particularly those in well-protected National Parks are generally easy to observe, sometimes on foot, but usually from a vehicle or hide. Outside protected areas, they can only be seen at some distance. Many mammals are observed indirectly, most commonly by their tracks, diggings, excreta and feeding site. Mammals are mobile and often choose specific habitats and supply to ecological processes such as seed dispersal, predation and pollination.

According to Reid (1997), the population densities of mammal communities and their responses to ecosystem processes potentially provide much expensive information to the encouragement of conservation through increasing community interest and financial support opportunities.

2.3 Threats of Mammals

Mammals face numerous threats to their continued existence including habitat degradation and destruction, overexploitation, loss of genetic diversity, endangerment and extinction. The main problem confronting not only mammals but also the earth's biodiversity is human population explosion (Vaughan *et al.,* 2000). Habitat loss and habitat fragmentations are the major threats of protected areas in developing countries including Ethiopian. Human induced habitat loss and associated forest fragmentation are the leading cause of mammalian extinctions across the tropics (Wilkie *et al*. 2011), while illegal hunting represents the second most serious threat to mammals (Cullen *et al*. 2000, Peres and Lake 2001, Mockrin *et al*. 2011).

Anthropogenic activities have its own impacts on wildlife by modifying the behavior of animals and their distribution. The disturbance of behavioral patterns of animals can affect their social structure. Social structure is a key component in the evolution and dynamics of species. Thus, its disruption by human disturbance can have a major consequences on future populations even if the disturbance does not directly affect the survival and reproduction of mammals (Manor and Saltz, 2003; Cardillo *et al.*, 2004).

Growth of human population have been associated with extensive habitat disturbances related to changes in land cover, expansion of agricultural practices, settlement, uncontrolled resource

extraction (over exploitation), and extensive fragmentation of the remaining forests. Habitat loss and modification are also considered among the leading threats to mammals (Miller *et al.,* 2000). Mammalian species diversity and abundance tend to decrease with increasing human disturbances of the landscape (Chiarello, 2008; Laurance *et al*., 2008; Lopes and Ferrari, 2008). Mammals are also directly or indirectly affected by environmental pollutants. Aquatic pollution has adversely affected aquatic mammals either by direct toxicity or by reducing their food resources (Kathpal, 1994). .

In addition, illegal or traditional exploitation of wildlife within conservation areas for both subsistence and economic gain is common. For example, as reported by Leader-Williams *et al*. (1990), the decline of black rhinos and elephants in many African countries is due to overexploitation. If this trend continues, one can expect the complete collapse of the core wildlife area. Besides indirect negative effects of human activities through habitat disturbances, humans in many poor areas of the world rely to an ever increasing extent on hunting and poaching of mammals for food or trade. For example, the multibillion-dollar trade in bush meat, i.e., the meat of terrestrial wild animals, hunted and for subsistence or for commercial purposes, is an important contribution to the economy of the developing Country. Hunting for bush meat is considered as one of the most important threats to the survival of tropical mammals (Brashares *et al.,* 2004). Similarly, poaching has been shown to reduce substantially the abundance of mammal populations in high demand (Wright *et al.,* 2001).

Similarly illegal trapping and other demands for wild mammals are problems throughout the world. Many species are sought for their use as valuable products, for example, elephants for their ivory (Cardillo *et al.,* 2004). Mammals are also trapped or taken from wild populations to be sold or bred in the pet trade (Brashares *et al.,* 2004). The worldwide demand for pets and medicinal products drives illegal trade of mammals, especially rare species.

2.4 Medium and large sized mammalian monitoring

Larger and Medium size mammals consist of a wide variety of species from different trophic levels, ranging from herbivores (e.g., lagomorphs), to mid-level carnivores (e.g., skunks), to top carnivores (e.g., weasels, mountain lions, bears). The density of medium to large mammals is lower than lower trophic level species, and therefore the species detected per unit effort is relatively low. However, carnivores play a significant role in structuring populations and communities, and their status has implications for many aspects of sustainability (Murphy *et al.*, 2001). Medium and large size mammal species are relatively easy to identify and monitor, hence among the vertebrate groups, the taxonomy, behavior and biogeography of mammals are comparatively well known (Wilson and Reeder, 2005).

The diversity and abundance of medium and large sized mammals can be monitored by different techniques. Among these techniques, the oldest method used to survey medium and large sized mammals are the identification of foot print in the ground (Martin *et al.*, 2000). Two of the most commonly applied methods to survey medium and large sized mammals are track plot recording and camera trapping (Scheibe *et al.*, 2008). Both methods permit the estimation of the presence and /or abundance of mammals in an area (Srbek-Araujo and Chiarello, 2005).

3. The study Area and Methods

3.1 The study area

Baroye controlled hunting area is found in Oromia regional state, Ilubabora Zone, Metu woreda, Baroye Gebisa kebele administration. It is found 641kms to Southwest of Addis Ababa, 41kms northwest from zonal capital Metu town. Baroye controlled hunting area is located within 36 P740000 to 770000 east and 36 P928000 to 942000 north. The controlled hunting area covers 355 km^2 (35500 ha) and the altitude ranges from 1350m to 1811m above sea level. It is bounded by Darimu Woreda to the north, Hawa Gelan Woreda to northwest, BureWoreda to the Southwest, Bilo Nopha to the east and Halu Woreda to the south (Fig1).

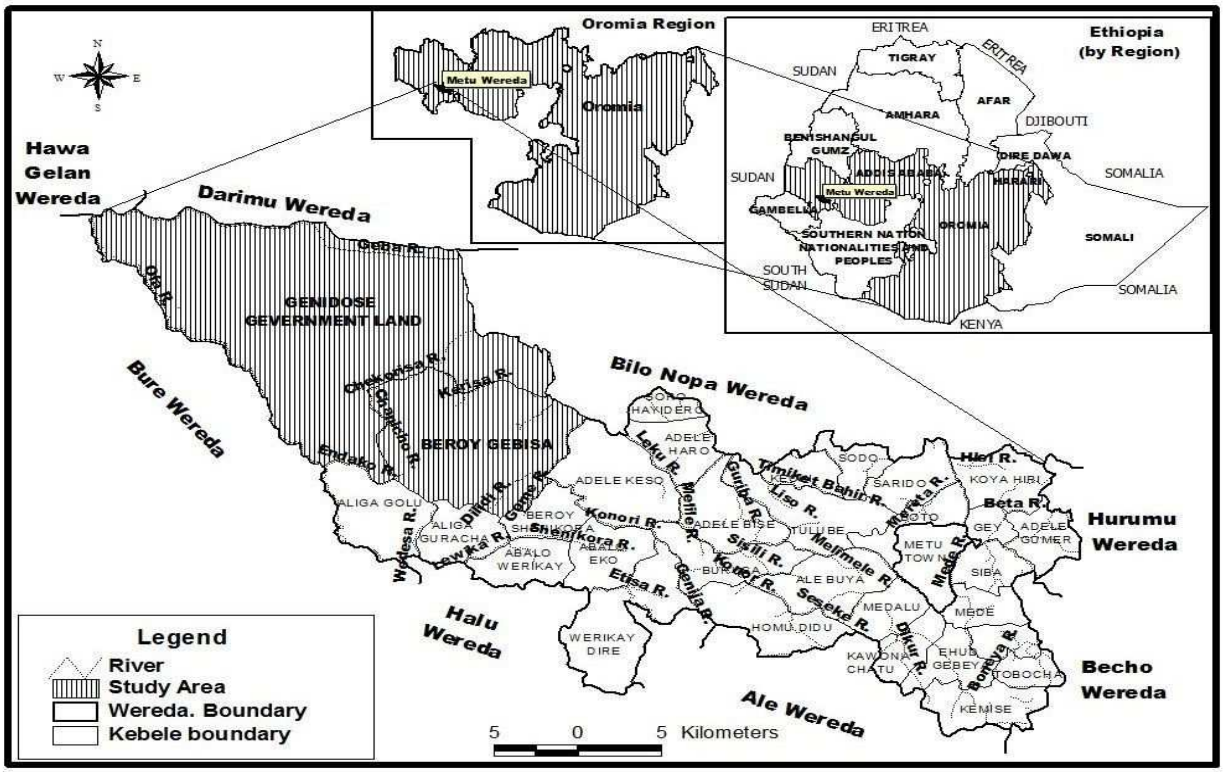

Figure 1. Map of the study area (CSA, 2012)

3.1.1 Topography and drainage

The controlled hunting area is characterized by rugged landscape exhibiting undulated topography and embedded with lots of hills, which is highly dissected by major Rivers including Sor, Geba, Offa and other small streams. The Sor River flows through the controlled hunting area and joins another river Geba. The major River Geba flows through the controlled hunting

area and joins the major river Birbir which is permanently flowing to the greater Baro River which is one of the main tributaries to the Nile, and drains most areas of the forested areas in the southwestern part of the country. Birbir River is the major River separating Illubabor Zone from West Wolega zone. Another rivers Offa and Chokorsa are flowing through the controlled hunting area and join the major Geba River.

3.1.2 Geology and Soil

As the data collected from the agricultural office of Metu Woreda indicates that the Precambrian basement complex consisting of rocks and boulders dominate the geology of the study area. The steeply dissected to hilly physiographic units consist of basalt with predominantly nitosols and vertisols. The dominating soil cover of the study area is characterized by red brown to black with a very shallow to moderately deep, loamy fertile in organic matter and are well drained soil. However, due to slight to moderate erosion surface stoniness and soil with shallow depth has been observed in different parts of the study area.

3.1.3 Socioeconomic Conditions

The socioeconomic conditions of the people living around the Baroye controlled hunting area rely on cereal crops cultivation, livestock rearing, fruit production and traditional bee keeping for their subsistence economic survival. The settlement of the people living around the controlled hunting area is scattered and there is some illegal settlement within controlled hunting area.

3.1.4 Climatic Conditions of the Area

Temperature and rainfall condition of the study area was inferred based on the climatic conditions of the Woreda. Data concerning temperature and rainfall condition were collected from Institute of Agricultural Research (IAR) Metu sub-branch.

3.1.4.1 Rainfall

The ten years rainfall data (EMA, 2014) revealed that the study area receives an average annual rainfall of 1705 mm ranging between 1527 and 2015 mm. The Woreda experiences a uni-modal type of rainfall, With the exception of unexpected climatic change, rainfall starts in April and reaches its peak in between June-September and stops in late October or early November. The area receives highest rainfall during the wet season June to September and lowest rainfall during

the dry season in months of January, February and March. The driest month is January with 27 mm. Most precipitation falls in August, with an average of 282 mm (Fig 2).

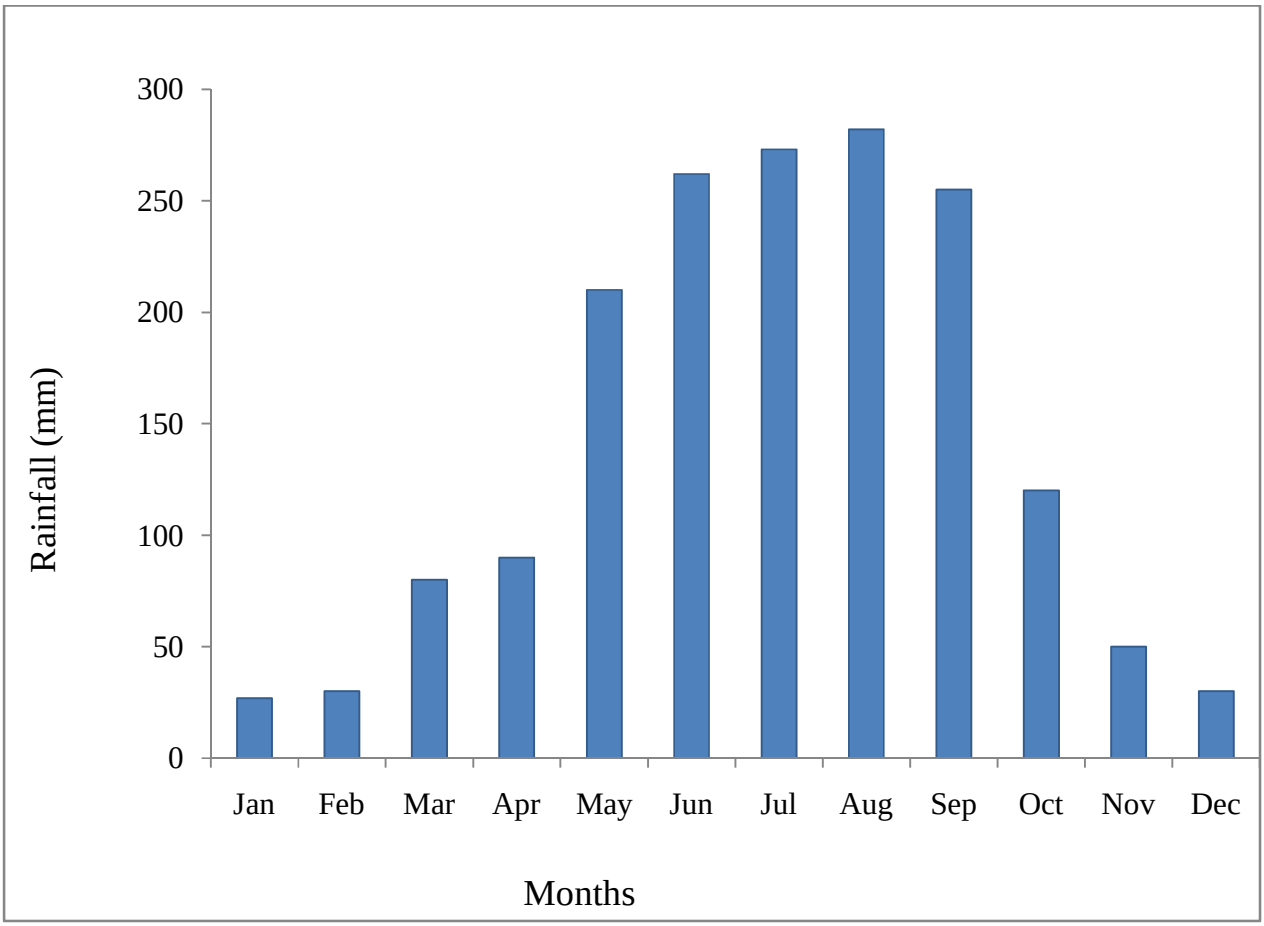

Figure 2. Rainfall data of the study area (EMA, 2014)

3.1.4.2 Temperature

The average annual temperature of the area is 19.9 °C with the average minimum temperature of 13.1°C and average maximum temperature of 26.7 °C. The warmest month of the year is March with an average temperature of 21.6 °C. In August the average temperature is 18.7 °C. It is the lowest average temperature of the whole year (Fig 3).

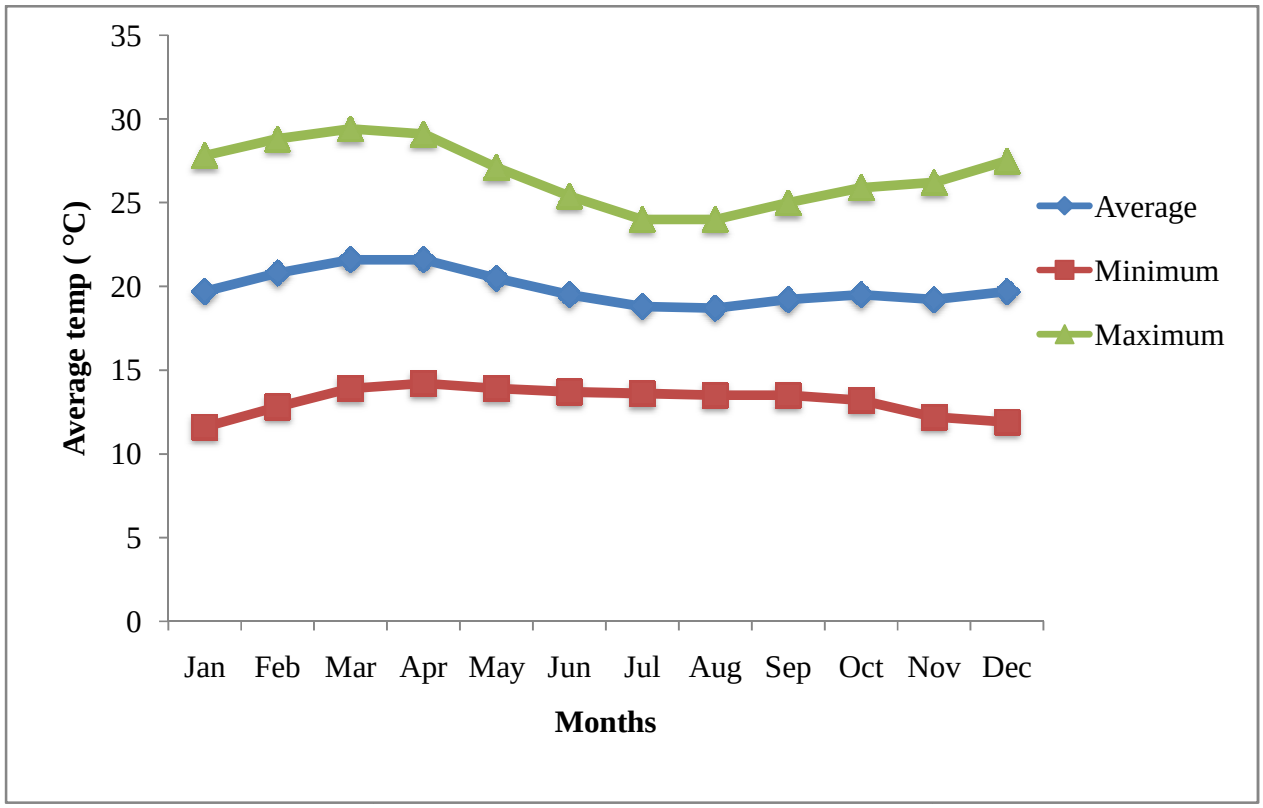

Figure 3. Mean minimum and maximum temperature of the study area (EMA, 2014))

3.1.5 Vegetation

Based on preliminary survey the vegetation types of the study area were divided in to three major natural types as grassland, woodland and riverine forest.

3.1.5.1 Grassland

This habitat covers the largest portion of the study area (60%). The dominant grass species covering the grassland habitat is the giant elephant grass (*Pennisetum purpureum*). Small portion of this habitat is covered by savanna grassland. Scattered trees that have thick bark, broad leaves and shrubs occur in this habitat (Plate 1).

Plate1. Grassland habitat (Dereje Negeri, February, 2014)

3.1.5.2 Woodland

This habitat covers the second largest portion of the study area next to grassland (25%). It is characterized by small to moderate-sized tree species. Based on the types of dominant species the Woodland area can be characterized by small to moderate sized tree species with broad leaves, often deciduous. This habitat is typically covered with grass which is commonly burnt every year. The dominant plant species found are *Albiza gummifera, Acacia* spp., *Cordia africana, and Croton macrostachys* (Plate 2).

Plate 2. Woodland Habitat (Dereje Negeri, February, 2014)

3.1.5.3 Riverine forest

Riverine forest is found along the narrow strips of the river banks in the study area. The major rivers found in the study area are Sor, Geba, Offa and Chebel. In addition to these small seasonal streams are also found within riverine forest. The habitat is characterized by mixed vegetation type composed of large trees and herbaceous species. The dominant plant species in this habitat include *Ficus vasta, Millettia forrugenen, Phoenix abyssinica, Croton macrostachys, Entadoppsis abyssinicus, and Cordia africana* (Pale 3).

Plate 3. Riverine forest (Dereje Negeri, February, 2014)

3.2. Methods and Materials

3.2.1 Materials

The materials used during this study were binoculars (7x50mm), Geographic Positioning System (GPS), digital camera, rulers, field guides for identification of medium and large sized mammals (Kingdon, 1997; Peres, 1999; Solomon Yirga, 2008), stationary materials and marking tape.

3.2.2 Methods

A preliminary survey was conducted in January, 2014. To have a good survey of mammalian species in a particular area at least two season cycles are recommended (Norton-Griffith, 1978). The actual field work for the dry season was conducted between February to April (2014) and wet season from May to July (2014). During the preliminary survey all the available and relevant information regarding to the temperature, rainfall, topography, Soil, approximate size and boundaries of the study area, and habitat types were gathered from OFWE Metu branch and Agricultural office of the woreda. Further, transect sites, vegetation types, areas where high mammalian diversity found were observed and identified with the help of scouts and from

previous records. Habitats of the study area were classified into Grassland, Woodland and Riverine forest. Habitat classification was made depending on the vegetation types, occurrence of unique habitats e.g, near water (Jensen and Friis, 2001). The survey revealed that the vegetation cover and topography of the area was no more homogenous. For the purpose of this study, the entire study area was divided into blocks. A total of 7 study blocks were selected from the three habitat types. Survey was conducted along the transect line in the selected blocks. There were 3 blocks from grassland (Deti, Gobicha and Chokorsa), 2 blocks from woodland (Kasso and Leman) and 2 from riverine forest (Sor and Konor).

The selected blocks covered about 21% of the total study area. In surveying medium and large sized mammals the randomly selected blocks for actual study should cover at least 20 to 25% of the study area (Bibby *et al.*, 1992). To study the diversity, abundance and habitat association of the mammals in the study area transect count method was implemented (Tobler *et al*., 2008). A total of 38 line transect were established representing each habitat. Eighteen line transect for grassland habitats (Deti, Gobicha and Chokorsa, six line transect each). Ten line transects were established for the woodland (Kasso and Leman, with 5 line transect each) and ten for the riverine forest (Sor and Konor, each with 5 line transect). The number of line transect in each habitat type was determined based on the size of the blocks. The distance between transects varied based on the Visibility of the habitat. As the result, in grassland transect length was 3 km with width of 200 m, woodland 2.5 km length and100 m width and for the riverine forest, the length of transect was 3.5 km length with 50 m width .The minimum distance between any two transects was 2 km.

Identification and recording of mammals were carried out by direct observation with naked eye or aided by binoculars (7x50mm). Indirect evidences such as animal droppings, feeding marks, digging, animal parts and calls of mammals were used to confirm the presence of mammals (Wilson *et al*., 1996). Data collection was carried out walking along each transects and directly counting all the individuals of every species sighted. In the study block all transects were counted all at once using experienced scouts to avoid double counting. During the survey, the investigators walked along the transect lines and record any mammal species encountered right and left from the center of the transect line. Species identification was based on the Kingdon field guide to African Mammals (Kingdon, 1997) and *"Atibiwochu" (*Solomon Yirga, 2008).

Local people were asked for vernacular names. While walking quietly along each transects, species type and number of individuals of medium and large sized mammals were recorded. As much as possible, the observer traveled against the direction of wind to minimize disturbances (Dawud Yimer, 2008).Survey of medium and large sized mammals was carried out in the morning (6:00-11:00 a.m.) and late in the afternoon (15:00-18:00 p.m.). Each transect was visited 12 days per season to estimate the distribution and relative abundance of medium and large sized mammals.

Mammals can be grouped as common (if probability of seeing is 100% every time of the visit or evidence recorded once a day), uncommon (if probability of seeing is more than 50% and/or evidence recorded once a week), and rare (if probability of seeing is less than 50% or single recorded during the whole survey periods) (Hillman, 1993). The mammalian species in the present study were categorized based on this criterion.

3.2.3 Data Analysis

Shannon-Wiener diversity Index (H') was used for the calculation of the diversity of medium and large sized mammals in the study area. $H' = -\sum P_i \ln P_i$, where H' is Shannon index of diversity, P_i is the proportion of individuals of species in a sample (Krebs, 1999). The evenness (J) of medium and large sized mammalian species was calculated using Begon *et al*. (1996) procedure, J = H'/ H' max, where H' is observed index of diversity and H' max =ln(S), where S is the number of species in a sample (Krebs, 1999). Evenness is used to quantify the unique representation of a given species against a given hypothetical community in which all species are equally common, such that when all species have equal abundance in the community and hence evenness is maximal (Krebs, 1999). The higher the value of evenness index, the more even the species is in their distribution within the given habitats. Species similarity among the different habitats was determined using Simpson's similarity index (SI), which is SI= 2C/A+B, where C is common species in the habitats A and B. A is the number of species observed in habitat A and B is the number of species observed in habitat B (Simpson, 1949). Abundance of medium and large size mammals was calculated as, Abundance = total number of individual species/ sample blocks (Brown, 1984). Pearson's Chi-square ($\chi 2$) test was also used to determine seasonal variations in number of individuals and species composition of medium and large sized mammals among different habitats.

4. Results

4.1 The Diversity of mammalian species

A total of 23 species of medium and large size wild mammals grouped into seven orders and thirteen families were identified in the study area during both seasons (Table 1). Among these mammalian species five species such as Crested Porcupine (*Hystrix cristata*), Vervet monkey (*Chlorocebus aethiopis)*, Stark's hare (*Lepus starcki)*, Rock hyrax (*Procavia capensis*) and white tailed mongoose *(Icheumia albicauda)* were the medium sized mammals, whereas the remaining 18 species observed were large sized mammals.

Out of the 23 species of mammals recorded from the present study area, African civet *(Civetticitis civetta*) was identified by indirect evidence. The Presence of this species was identified by their scat. The presence of seven mammalian species such as crested porcupine *(Hystrix cristata)*, aardvark (*Orycteropus afer)*, bush pig (*Potamochoerus larvatus)*, African buffalo (*Syncerus caffer)*, striped hyena **(***Hynae hynae)***,** leopard (*Panthera pardus*) and lion (*Panthera leo)* were identified both by direct and indirect evidences of identification and the remaining 15 mammalian species were identified by direct observations (Table 1).

Among all the families of mammals recorded in the study area the family Bovidae outnumbered all other by comprising five species followed by Cercopitheci that contained four species and Felidae which contained three species. The remaining families were represented by single species (Table 1).

Table 1. The mammalian species recorded from Baroye controlled hunting area, 2014

Order	Family	Scientific Name	Common Name	Identification Methods
Primate	Cercopitheci	*Colobus abyssinicus*	Colobus monkey	Visual
Primate	Cercopitheci	*Cercopithecus neglectus*	De brazza's monkey	Visual
Primate	Cercopitheci	*Chlorocebus aethiopis*	Vervet monkey	Visual
Primate	Cercopitheci	*Papio anubis*	Olive baboon	Visual
Rodentia	Hystricidae	*Hystrix cristata*	Crested porcupine	Visual/spine
Lagomorpha	Leporidae	*Lepus starcki*	Stark's hare	Visual
Hyracoidea	Procaviidae	*Procavia capensis*	Rock hyrax	Visual
Tubulidentata	Oryctestidae	*Orycteropus afer*	Aardvark	Visual/hole
Artidactyla	Bovidae	*Traglaphus scriptus*	Common bushbuck	Visual
Artidactyla	Bovidae	*Redunca arundinum*	Common reedbuck	Visual
Artiodactyla	Bovidae	*Sylvicapra grimmia*	Grey Duiker	Visual
Artidactyla	Suidae	*Potamochoerus larvatus*	Bush pig	Visual/faeces
Artidactyla	Suidae	*Phacochoerus africanus*	Warthog	Visual
Artidactyla	Bovidae	*Syncerus caffer*	African buffalo	Visual/faeces
Artidactyla	Bovidae	*Alcelaphus buselaphus*	Tora harte beest	Visual
Carnivora	Hyaenidae	*Hynae hynae*	Striped hyena	Visual/faeces
Carnivora	Felidae	*Felis servestris*	African wild cat	Visual
Carnivora	Canidae	*Canis mesamolas*	Black backed jackal	Visual
Carnivora	Hyrpestidae	*Icheumia albicauda*	White tailed mongoose	Visual
Carnivora	Mustelidae	*Mellivora capensis*	Honey badger	Visual
Carnivora	Viverridae	*Civetticitis civetta*	African civet	Scat
Carnivora	Felidae	*Panthera pardus*	Leopard	Visual/scat
Carnivora	Felidae	*Panthera leo*	Lion	Visual /sound

Photographs of some mammals in the study Area

Plate4. African buffalo (*Syncerus caffer)* (Dereje Negeri, April, 2014)

Plate5. Warthog (*Phacochoerus africanus)* (Dereje Negeri, April, 2014)

Plate6. Grey Duiker (*Sylvicapra grimmia)* (Dereje Negeri, April, 2014)

Plate7. Common bushbuck (*Traglaphus scriptus)* (Dereje Negeri, February, 2014)

During the study period 965 and 755 individuals of medium and large sized mammals were recorded in dry and wet seasons respectively from Baroye controlled hunting area (Table 2) Seasonal variations were observed in species composition and individual number of mammals among different habitats (Table 2). The highest number of species was recorded in the riverine forest during the dry season. Woodland had also considerably high number of species during both dry and wet season, whereas grassland contains the least number of species during the dry season.

Table 2. Seasonal abundance and distribution of mammals among different habitats in the study area

Common Name	Grassland		woodland		Riverine forest	
	Dry	Wet	Dry	Wet	Dry	Wet
Colobus monkey	0	0	45	20	50	50
De brazza's monkey	0	0	3	5	15	11
Vervet monkey	0	15	46	38	102	54
Olive baboon	34	68	84	44	82	52
Crested porcupine	0	8	4	0	12	7
Stark's hare	0	7	8	7	8	0
Rock hyrax	0	0	14	9	14	7
Aardvark	6	10	5	6	0	5
Common bushbuck	11	9	16	4	0	0
Common reed buck	9	11	6	0	0	0
Grey Duiker	6	6	9	5	0	0
Bush pig	0	9	12	12	12	7
Warthog	0	0	0	0	18	13
African buffalo	47	95	80	50	86	38
Tora hartebeest	11	14	7	0	0	0
Striped hyena	0	0	0	0	13	7
African wild cat	5	3	9	0	10	8
Blacked back jackal	0	0	7	4	14	5
White tailed mongoose	0	0	0	7	10	6

Honey badger	0	0	0	0	14	8
African civet	0	0	0	8	12	0
Leopard	2	1	0	0	3	0
Lion	4	2	0	0	0	0
Total No. Of individuals per habitat per season	135	258	355	219	475	278
Total No. Of species per habitat per season	10	14	16	14	17	15

Variations in abundance (number) of individuals between seasons in grassland (Dry = 135 and Wet = 258) ($\chi 2 = 34.8$, $P<0.05$), Woodland (Dry = 355 and Wet =219) ($\chi 2 = 51.80$, $P<0.05$) and riverine forest (Dry = 475 and Wet =278) ($\chi 2 = 42.71$, $P<0.05$) were statistically significant. The seasonal variations in abundance of individual mammals among the habitats types was significantly different ($\chi 2 = 98.09$, $P<0.05$). However, the seasonal variation in species composition (number) mammals among the habitat was not significantly different ($\chi 2 = 9.25$, $P > 0.05$). All the 23 species of medium and large sized mammals recorded in the study area were occurred both during dry and wet seasons.

The highest species diversity was recorded from the riverine forest during the dry season (H'= 2.37) followed by Woodland with diversity index of (H'=2.24), while grassland had the lowest diversity in dry season (H'= 1.87). The highest species evenness was obtained from woodland during wet season (J =0.85) followed by riverine forest during dry season (J =0.84), but the lowest species evenness was obtained from grassland habitat (J= 0.73) (Table 3).

Table 3. Diversity indices of mammals in different habitat types

Habitat type	No. of Species		No. of individuals		SWI (H')		H 'max		H'/ H 'max	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Grassland	10	14	135	258	1.87	1.92	2.30	2.63	0.81	0.73
Woodland	16	14	355	219	2.23	2.25	2.78	2.63	0.81	0.85
Riverine forest	17	15	475	278	2.37	2.16	2.83	2.70	0.84	0.80

4.2. Relative Abundance of mammalian species

From the total individuals of mammals recorded, African buffalo (*Syncerus caffer*) was the most abundant species in the study area (23.16%), Olive baboon (*Papio anubis*) was the second most abundant species (21.23%), Vervet monkey (*Chlorocebus aethiopis*) and Colobus monkey (*Colobus abyssinicus*) were the third and fourth most abundant species in the study area with relative abundance of 14.76% and 9.56% respectively (Table 4). Leopard (*Panthera pardus*) and Lions (*Panthera leo*) were the least abundant species that each contributed less than 1% of the total record.

Table 4. Relative abundance of mammalian species recorded in the study area

Common Name	Total No. of individuals recorded		Relative Abundance (%)	
	Dry	Wet	Dry	Wet
Colobus monkey	95	70	9.84	9.27
De brazza's monkey	18	16	1.87	2.12
Vervet monkey	148	107	15.34	14.17
Olive baboon	200	164	20.73	21.72
Crested porcupine	16	15	1.66	1.99
Stark's hare	16	14	1.66	1.85
Rock hyrax	28	16	2.90	2.12
Aardvark	11	21	1.14	2.78
Common bushbuck	27	13	2.80	1.72

Common reed buck	15	11	1.55	1.46
Grey Duiker	15	11	1.55	1.46
Bush pig	24	28	2.49	3.71
Warthog	18	13	1.87	1.72
African buffalo	213	183	22.07	24.24
Tora hartebeest	18	14	1.87	1.85
Striped hyena	13	7	1.35	0.93
African wild cat	24	11	2.49	1.46
Black backed jackal	21	9	2.18	1.19
White tailed mongoose	10	13	1.04	1.72
Honey badger	14	8	1.45	1.06
African civet	12	8	1.24	1.06
Leopard	5	1	0.52	0.13
Lion	4	2	0.41	0.26
Total	965	755	100%	100%

4.3 Occurrence of medium and large sized Mammals.

Based on Hillman (1993) procedure mammalian species in the study area were categorized into common, uncommon and rare. Accordingly, out of 23 species of mammals identified in the study area nine (39.13%) species were common, nine (39.13%) species were uncommon and five (21.74%) species were rare (Table 5). Some of the mammalian species occurred commonly in the study area were African buffalo (*Syncerus caffer*) (Plate 4), Grey diker *(Sylvicapra grimmia*) (Plate 6), Common bush *(Traglaphus scriptus*) (Plate7), *Olive baboon (Papio anibus)*, Vervet monkey *(Chlorocebus aethiopis)* and the like.

Table 5. Occurrence of medium and large sized Mammals in the study area**.**

Common	Uncommon	Rare
Colobus monkey	De brazza's monkey	Black backed jackal
Vervet monkey	Crested porcupine	Honey badger
Olive baboon	Stark's hare	African civet
Rock hyrax	Aardvark	Leopard
Common bushbuck	Common reedbuck	Lion
Grey Duiker	Warthog	
Bush pig	Tora hartebeest	
African buffalo	African wild cat	
Striped hyena	White tailed mongoose	

4.4 Habitat Association of medium and large sized mammals

4.4.1 Species Similarity among the study blocks within each habitat

Seasonally within grassland the three blocks had nearly similar species compositions. However, relatively the highest similarity of medium and large sized mammalian species was obtained from Deti site (84.2%) followed by Gobicha (83.3%) and the less similarity of mammal species was recorded for Chokorsa (80.0%) (Table 6).

Table 6. Seasonal species similarity of medium and large size mammals within grassland

Sites	No. Of species		Common Species	Species similarity between seasons (%)
	Dry	Wet		
Deti	8	11	8	84.2
Gobicha	10	14	10	83.3
Chokorsa	8	12	8	80.0

Regarding seasonal species similarity within woodland from the two sites, more species similarity was observed in Kasso (80.0%) than Leman (70.9%) sites (Table 7).

Table7. Seasonal species similarity of mammals within woodland

Sites	No. Of species		Common Species	Species similarity between seasons (%)
	Dry	Wet		
Kasso	16	14	12	80.0
Leman	17	14	11	70.9

The two sites of riverine forest habitats Sor and Konor had similar species compositions in both seasons (96.5%) (Table 8).

Table8. Seasonal species similarity of mammals within Riverine forest

Sites	No. Of species		Common Species	Species similarity between seasons (%)
	Dry	Wet		
Sor	15	14	14	96.5
Konor	14	15	14	96.5

4.4.2 Species Similarity among different habitats

Habitat association of medium and large sized mammals in the study area is indicated in Table 9. The Simpson's similarity index (SI) of mammals among the three habitats of the study area during dry season was (SI = 0.19) and wet (SI = 0.18). This indicated that 19% of the species during the dry season and 18% during the wet season were common for the three habitats. Among the three habitat types the highest Simpson's index similarity of mammalian species was obtained from woodland and riverine forest both during the dry (SI = 0.67) and wet seasons (SI = 0.66) followed by grassland and woodland in both dry (SI = 0.65) and wet (SI = 0.64) seasons. However, less similarity was obtained from species of grassland and riverine forest during dry (SI=0.31) and wet (SI =0.46) respectively

Table 9. Seasonal species Similarity of mammals between different habitats

	Habitat types					
	Grassland		Woodland		Riverine forest	
	Dry	Wet	Dry	Wet	Dry	Wet
Grassland	-	-	0.65	0.64	0.31	0.46
Woodland	-	-	-	-	0.67	0.66
Riverine forest	-	-	-	-	-	-

4.5. Threats challenging the controlled hunting Area

4.5.1 Bush fire

Information obtained from the local people indicated that before the start of the wet season peoples are traditionally setting fire deliberately every year in some parts of the controlled hunting area to get fresh grass growth and to make open the giant grass. Sometimes fire unintentionally escapes during honey collection, charcoal production and fire that escape from surrounding farmers during land preparation for agriculture. This practice greatly affects the proper functioning of the ecosystems and could destroy a lot of wild fauna and flora of the controlled hunting area.

Plate 8. Burning practice inside the controlled hunting (Dereje Negeri, February, 2014)

4.5.2 Poaching

Poaching was among the major threats creating unfavorable situation to the wellbeing of the wildlife of the area. Discussion held with local communities indicated that, peoples from bordering Woredas were hunting buffalo, common bushbuck, bush pig, common duiker and Common reedbuck illegally for their meat. This was witnessed during the study period, we directly observed three poachers with bushbuck meat. Subsistence hunting and habitat degradation due to fire and agriculture may have decreased the number of bushbuck, reedbuck, bush pigs and common duiker in these areas.

4.5.3 Encroachment for land Expansion

As witnessed during the study period illegal land expansion for agriculture and settlement was observed. The main activity of the illegal settlers inside the controlled hunting area was agriculture mainly cereal production and to some extent honey. They also depend on fire wood, making charcoal and timber production for subsistence and commercial purpose as a source of alternative livelihood. Timber and charcoal production by Chopping down of giant trees for commercial purpose was not only done by illegal settlers but also by some local communities surrounding the controlled hunting. Deforestation and change in land for agricultural use in general affect the biodiversity resources of an area.

Plate 9. Illegal settlement inside the controlled hunting (Photo by Dereje Negeri, February, 2014)

5. Discussion

During the study period, a total of 23 species of medium and large sized mammals grouped into seven orders and thirteen families were identified in the study area. Among the identified mammalian species five species were medium sized mammals whereas the remaining eighteen species were large sized mammals.

Though, the size of the protected areas were different, similar studies have been carried out in different parts of Ethiopia that have used similar line transect techniques. For example, Girma Mengesh and Afework Bekele (2008) recorded 20 species of large mammals in Alatish National Park, Meseret Chane (2010) recorded 23 species of mammals in Borena-Sayint national park, Gebrecherkos Woldegeorgis (2010) identified 16 species of large mammas from Yayo coffee forest biosphere reserve, Zerihun Girma *et al*. (2012) identified 19 species of large mammals in and around Wondo Genet forest patch and in Dati Wolel National Park, Rabira Gonfa (2013) recorded 28 species of medium and large sized mammals.

The number of medium and large sized mammals recorded in Baroye controlled hunting area was relatively smaller than some well-known wildlife protected areas of Ethiopia. For example, in Dati Wolel National Park 28 species were identified (Rabira Gonfa, 2013), Nechisar National Park 37species, Mago National Park 38 species and Omo National Park 40 species of mammals were recorded (Gebrecherkos Woldegeorgis, 2010). This indicate the need for a long term surveying of the area by extending the study period and the sampling area to find out if there are additional mammal species.

The diversity results shows that the highest mammal species diversity was recorded from riverine forests (Sor and Konor) during the dry season followed by woodland (Kasso and Leman) that had considerably similar species diversity during both seasons The highest species evenness was obtained in woodland during wet season and riverine forest during dry season. However, among the three habitats the lowest species diversity and evenness were obtained from grassland habitats (Deti, Gobicha and Chokorsa). The highest mammalian species diversity in the riverine forests and woodland during the dry season in the study area might be because of the availability of food, water and cover for protection from predation and high temperature compared to grassland. Studies by Shiferaw Ayele (2008) and Dawud Yimer (2008) revealed that species diversity often high in areas where there are sufficient food and water sources. The

presence of bigger rivers within riverine forest, small rivers and streams in the woodland that flow throughout the year might be preferred by mammals. During the dry season, the riverine forests and woodland were relatively less disturbed by human activities such as burning practice and harvesting of grass compared to grassland. This could also have contributed to the higher mammal species diversity during the dry season in both habitats. There is shortage of water and food in the grassland in the study area during the dry season. Shortage of food and water during the dry season reduced the diversity and evenness of mammalian species in the grassland. Bailey (1984), Balakrishnan and Easa (1986) noted that the extent to which a given species possesses a preferred habitat is based on the requirement for resources. Shortage of food was indicated by few number of plant species collected by herbivores during the dry season as compared to the wet season (Sebsebe Demissew *et al*. 2005).

Therefore, the availability of different plant species, water and cover in riverine forest and woodland habitats in the study area could be the main reason for higher mammalian diversity in the study area. Homogenous conditions yield lower diversity while heterogeneous condition yields higher diversity (Tariku Mekonen *et al.*, 2011).

In addition to the availability of adequate food and water sources during the dry season the differences in diversity of mammal species in three the study area might be due to stress imposed by the environmental factors such as variation in temperature. Climate can affect the distribution of wildlife and their habitat condition. Bailey (1984) point out that mammals respond to climate induced nutritional and structural change in vegetation by the selection of appropriate habitat for survival and reproduction.

Variation in the relative abundance of medium and large sized mammal species in the present study area was observed between species to species. African buffalo (*Syncerus caffer*) was the most abundant species in the study area. This mammal species was widely spread in all selected habitat types of the study area. The highest abundance of *S. caffer* was observed in grassland during the wet season. This may be explained by the regeneration and growth of dried and burned grass which is improved by the presence of excessive rain in the area. However, the lower abundance during the dry season in this habitat might be associated with shortage of fresh grass and water leading to movement of mammals to riverine forests and woodland of the study area or outside of the protected area such as Nopha, Sago and Agelo worke areas where

sufficient fresh grass and water sources are available. Hence, during the dry season highest abundance of *S. caffer* was obtained in and around peripheral area of riverine forest and woodland of the study areas which were rich in resources and provide them protection from local poachers. Redfern *et al.* (2003) and Rabira Gonfa (2013) pointed out that buffalo selects areas close to water sources for survival.

Olive baboon (*Papio anubis*) was the second most abundant species in the study area during both seasons. The species was known to be widely distributed to a variety of habitats in the study area. This might be associated to the foraging behavior that it is to feed on different food items (Johnson *et al*., 2012). From the three habitat types the highest density of *P. anubis* was observed in riverine forests and woodland of the study area during the dry season. The increased density during the dry season might be due to slight increase in visibility of the area. During wet season because of the presence of rain growth of vegetation might have provided tick cover for the animals which makes observing of them difficult. In addition to the presence of variety of food in these habitats like other primates *P. Anubis* requires forested areas with tall trees as suitable habitat. In riverine forest and woodland habitats of the study area there are tall trees such as *Millettia forrugenen, Ficus spp., Acacia species, Cordia africana* which serve as living home for this animals. Kingdon (2003) noted that primate particularly families of colobidae and cercopithecidae need forested areas with tall trees.

Vervet monkey (*Chlorocebus aethiopis)* and Colobus monkey (*Colobus abyssinicus)* were the third and fourth abundant species of the study area. Both species were restricted to the riverine forests and woodland during both seasons and *C. abyssinicus* was totally absent in the grassland. Studies by Girma Mengesha and Afework Bekele (2008) have revealed that higher number of *C. aethiopis* was found from riverine woodland of Alatish National Park and Gebrecherkos Woldegeorgis (2010) observed more number of *C. abyssinicus* in riverine forest of Yayo coffee forest biosphere reserve area. The higher abundance of these species from riverine forest and woodland was probably associated to the availability of sufficient fruits and leaves and the need of forests with tall trees that serve as cover and their best habitat. Since forest habitat was relatively less disturbed, it might have also contributed as refuge for the shy behavior of Colobus monkey. Aramde Fetene *et al.* (2011) have noted that Colobus monkey selected riverine and large trees as their best habitats. Higher density of *C. aethiopis* and *C. abyssinicus* were observed during dry season than wet season in the study area. The possible explanation for this might be similar to *P. anubis*

which is associated to vegetation outgrowth which made sighting of them difficult during the wet season.

The least abundant medium and large sized mammal species recorded from the study area were Leopard *(P. pardus)*, Lion (*P.leo)*, African civet (*C. civetta)*, honey badger (*M. capensis)* and black backed Jackal *(C. mesamolas).* Different factors might be attributed to the lower number of these mammalian species in the study area. For example as information obtained from the local people indicated that there were more individual number of lion and leopard in the study area before few years. Even the lions occasionally came in groups to the resident area and disturb the local community by killing their livestocks. Because of livestock damage posed by lions a majority of local community had hostile attitudes toward this animal. The consequence of this condition resulted in human-lion conflict in the area and many lions were killed by the local community from time to time. Lions were destroyed intentionally by either direct or indirect methods. The commonly used include shooting them on a carcass and luring lions to poisoned bait. The remaining individual lion left the reserved area and migrate to other places where sufficient food is available. Similar observations were made in different parts of Africa that lions were killed by peoples in relation for attacks on livestocks. Conflict with humans over livestock depredation is the single most important factor causing the decline in African lion populations (Packer *et al*. 2005). Ogutu *et al.* (2005) reported that 87 lions were killed in South east Kenya by Masai morans (warriors) since 1998 in attack on their livestocks. In Mozambique lion-human conflict and lion mortality is observed because of the attack of livestocks by lions (Anderson and Pariela, 2005). In Tanzania, Packer *et al*. (2005) documented over 125 lion killings between 2000-2005 by the local people using poison or spears. The leopards' density is low as it is mainly hunted for its skin both for commercial and cultural purposes. It is also listed as threatened species in the IUCN Conservation Monitoring Centre 1990 and1988 Red data classification list. The other reason for the reduced individual number of lions and leopard might be associated to the presence of few individual numbers of natural preys such as bushbuck, reedbuck and Tora Harte beest in the present study area that served as source food for these animals.

The lowest number of individuals of *C. civetta* and *M. capensis* could be due to their nocturnal behavior and need for densely forested habitat cover for breeding that could make the sighting of the animals difficult. Nocturnal mammals need densely forested habitats and cover that could

make the sighting of them difficult (Zerihun Girma *et al*., 2012). The reduced number of *C. mesamolas* was related to their vermin habits that harm livestock of the resident people and persecution by humans was the main threat. The abundance of honey badger (*M. capensis*) was persecuted by beekeepers throughout their range. Studies by Meseret Chane (2010) shows least number of *C. mesamolas* and *M. capensis* were recorded in Borena-Sayint National Park and Rabira Gonfa (2013) also recorded few numbers of these species in Dati Wolel National Park.

Human activities such as burning of grass during dry season every year, harvesting of grass, cutting of trees for construction, illegal settlement, livestock encroachment and illegal hunting activities could limit the individual number mammalian species in the study area. The abundance of mammalian species in ecosystems is closely related to the physical stability of the habitat (Ananthakrishnan, 1988). Habitat modification and destruction by human activity affects the essential requirements of mammals which in turn affected mammalian diversity and makes the area to have fewer mammals.

The habitat association of medium and large sized mammals among the different habitats of the study area during both seasons shows significant difference. Habitat association is determined in terms of their food, water cover requirement. Similarly, studies carried out in different parts of Ethiopia have also noted that mammalian distribution and their habitat association are often correlated mainly with the availability of water, food and protection (Mohamed Yaba *et al.,* 2011; Zerihun Girma *et al.,* 2012).

Seasonal variations were observed in species number of medium and large sized mammals among different habitats in the study area based on the preferences for habitats that provide sufficient resources for survival. The highest number of mammalian species was recorded in the riverine forest during the dry season followed by woodland during the same season, but the least number of mammalian species was recorded in grassland during the dry season. The explanation for the highest species number recorded in the riverine forest and woodland during the dry season was might be due to movement of mammals from grassland toward those habitats which are relatively protected part of the area in search of food and cover. During the dry season the grassland was relatively dry, as a result water and palatable grasses were reduced in the area. Hence mammals could be forced to move towards riverine forests and woodland were sufficient

food and water sources area available. Studies by Zerihun Girma *et al*. (2012) have shown similar observations.

The distributions of mammalian species were not consistent throughout its geographical ranges. This is governed primarily by the presence or absence of suitable habitats for species. Mammalian species like African buffalo, Olive baboon, Vervet monkey and bush pig were relatively observed and recorded in all habitats of the study area. Their distribution in all habitat types indicates their adaptation to a variety of habitat types. The ecological preference and evolutionary adaptation of mammalian species play a role in their distribution in different habitat types (Bailey, 1984). Some primates like Colobus monkey and Dabraza monkey because of their arboreal life and the availability of a variety of plant species used for food and water they were largely associated to the riverine forest and woodland habitats. This finding was in line with Meseret Chane (2010) who reported high number of primate species in riverine forest of Borena-Sayint National park.

Regarding species similarity among the habitats types of the study area, the highest species similarity was obtained from woodland and riverine forest during both dry and wet seasons, followed by grassland and woodland in both seasons. However, less similarity was obtained from species of grassland and riverine forest during both seasons. The highest species similarity from woodland and riverine forest might be due to the presence of similar resource suitable for mammals in both habitats and the presence of cover for protection. This result is different from the findings of Girma Mengesha and Afework Bekele (2008) and Rabira Gonfa (2013) who have recorded high mammalian species similarity in woodland and grassland habitat.

6. Conclusion and Recommendations

6.1 Conclusion

Baroye controlled hunting area has potential to provide habitats to a number of medium and large sized mammalian species. During the present study 23 species of medium and large sized mammalian species belong to 7 orders and 13 families were identified. Among these mammalian species 5 species such as Crested Porcupine Vervet monkey Stark's hare (*Lepus starcki),* Rock hyrax and white tailed mongoose were the medium sized mammals, whereas the remaining 18 species observed were large sized mammals.

Direct and indirect evidences were employed to identify mammalian species. The mammalian fauna in Baroye controlled hunting area were identified and documented in this study so that interested bodies can have base-line information on diversity, distribution and relative abundance of medium and large sized mammalian species for future conservation and management plane. Diversity, distribution and relative abundance of mammalian species in the study area showed marked difference among habitat types in relation to the difference in habitat preference of the species on the availability of food, water and cover. African buffalo, Olive baboon, Colobus monkey and Vervet monkey were the most abundant mammalian species in Baroye controlled hunting.

Regardless of its potential to various species of fauna and flora, the negative impacts of various human induced activities are the major threats for future development of the wildlife resources in Baroye controlled hunting area. The major threats to biodiversity were poaching, burning, deforestation and logging of tree, livestock encroachment, expansion for agriculture and settlement and honey production. Fire is set by the local people deliberately during dry season to make open the giant grass and when they produce charcoal or unintentionally during collection of wild honey. There is chopping down of giant trees for timber production, for commercial purpose. Poaching also is a serious threat to the wildlife of the protected area. Buffalo, Bush buck, bush pig, common duiker and warthog are poached for their meat by the local community.

6.2 Recommendations

As mentioned above Baroye controlled hunting area has potential to provide suitable habitats to a number of wild mammals and a various species of birds. However, regardless of its potential to various species of fauna and flora its management system is poor. Therefore, in order to ensure effective conservation of biodiversity and management practices in the controlled hunting area the following recommendations are suggested:

- Establishing broad-based wildlife conservation education program. Awareness creation at all levels about the benefits of the reserved area should provide to the local community to maintain its biodiversity in general and mammal species in particular.
- The absence of similar studies in the area was a major gap to fill in addressing the assessment of medium and large sized mammalian diversity. Further research should be conducted to get detailed information about the mammalian diversity of the area.
- The regional Government should look forward to scale up conservation efforts of the reserved area together with the other stake holders.
- Implementing and strengthening proper law enforcement actions. Extensive conservation measures have to be implemented through continual support of the regional, zone and woreda administration and other concerned stake holders.
- Clear demarcation and natural buffer zones are essential to minimize the exploration of wildlife of the area.
- Illegal settlement and illegal activities of the local community in the controlled hunting should be controlled.
- The reserved area is far from the main road to implement day to day wildlife conservation activities. Therefore, roads and camps should be constructed by concerned bodies.

Reference

Ananthakrishnan, T. (1988). Dynamics of litter ecosystem in natural and interfered forests. *J. Int. Ecol. and Env. Sci.* **14**: 61−66.

Anderson, J. and Pariela, F.(2005). *Strategies to mitigate human-wildlife conflict in Mocambique*. Mozambique National Directorate of Forest and wildlife.

Aramde Fetene., Girma Mengesha and Tsegaye Bekele.(2011). Spatial distribution and habitat preference of selected large mammalian species in the Nech Sar National Park (NSNP), Ethiopia. *Nat. Sci*. **9**: 80-90

Bailey, J. A.(1984). *Principles of Wildlife management.* Academic press, New York: John Wiley, 1-366

Balakrishnan, M., Easa, PS.(1986). Habitat preference of larger mammals in the Parambikulam wildlife sanctuary, Kerala, India.*Biol.Cons*.**37:**191-200

Bazzaz, F. A. (1975). Plant species diversity in old-field successional ecosystems in southern Illinois.*Ecol*.**56**: 485–488.

Begon, M., Harper, J. and Townsend, C. (1996). *Ecology. Individual population and communities , 3rd ed*. Blackwell science Ltd, Cambridge.

Berger, J. Stacey, P. Bellies, L. and Johnson, P. (2001). A mammalian predator–prey imbalance: grizzly bear and wolf extinction affects avian Neotropical migrants. *Ecol. Appl*. **11**: 947–960

Bibby, C.J., Burgess, N.D. and Hill, D. (1992). *Bird census Techniques*. Academic Press, London, 239-241pp.

Brashares, J., Arcese, M., Sam, P., Coppolillo, A., Sinclair, E and. Balm ford A. (2004). Bush meat hunting, wildlife declines, and fish supply in West Africa. *Sci.* **306**: 1180-1183.

Brown, J. (1984). The relationship between Abundance and distribution of species. *Am. Nat*.**124**:255-279

Cardillo, M., Purvis, A., Sechrest, W., Gittleman, J., Bielby, J and Mace, G. (2004).Human Population Density and Extinction Risk in the World's Carnivores. *J. Prim. Biol*. **2**: 909-914.

Chiarello, A. **(**2008). Density and population size of mammals in remnants of Brazilian Atlantic forest. *Cons. Biol*. **14**: 1649-1657.

Chris T., Stuart T., (2000). *Field Guide to the larger mammals of Africa*. Cape Town: New Holland publishing

Cullen Jr., L., Bodmer, R., Padua, C., (2000). Effects of hunting in habitat fragments of the Atlantic forests, Brazil, *Biol. Cons*. **95**: 49-56.

Dawit Kassa and Afework Bekele (2008). Species composition, abundance, distribution and habitat association of rodents of Wondo Genet, Ethiopia. *SINET: Ethiop. J. Sci*. **31:** 141-146

Dawud Yimer (2008). *Mammalian diversity in Mazie national park, Ethiopia*. M.Sc. Thesis, Addis Ababa University, Addis Ababa.

Delany, M. and Happold, D. (1979). *Ecology of African Mammals.* Longman Inc, New York, 434pp.

Dinerstein, E. (2003). *The Return of the Unicorns*. Columbia University Press, New York.

Emmons, L. and Feer.F (1997). *Neotropical Rainforest Mammals, Chicago*. University of Chicago Press. 380pp.

Environmental Protection Authority.(1998). *Federal Democratic Republic of Ethiopia: National Action Programme to combat Desertification,* Addis Ababa, 158pp.

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

Flynn, T. and Hill, J. (1947). The development of monotrememata part IV. The later stages of cleavage and the formation of the primary germ layers. *Trans. Zool. Soc. Land*. 1-151

Flynn, J. Finarelli, J. Zehr, S. Hsu, J. and Nedbal, M. (2005). Molecular phylogeny of the Carnivora (Mammalia): assessing the impact of increased sampling on resolving enigmatic relationships. *Syst. Biol*. **54**: 317-337.

Gebrecherkos Woldegeorgis. (2010). *Reconnaissance study on bird and Large mammals in Yayu Forest, Oromia Regional state, South Western Ethiopia*. M.Sc. thesis, Addis Ababa University Addis Ababa.

Girma Mengesha and Afework Bekele (2008). Diversity, Distribution and habitat association of large mammals of Alatish, North Gonder Ethiopia. *Acta Zool sci*. **54** : 20-29.

Griffiths, M. (1984). Mammals: monotremes in Marshall's physiology of reproduction 4thed, Reproductive cycles of vertebrates. (Ed.G.Ecamming) **1**:351- 385 (Churchill living stone: ed in burgh UK).

Grzimek, B. (1990). *General Introduction*: Grzimek's Encyclopedia of Mammals. McGraw-Hill, New York.

Hashim, M. and Mahgoub, S. (2007). Abundance, habitat preference and distribution of small mammals in Dinder National Park, Sudan. *Afr. J. Ecol*.**46**:452–455

Hillman, J. (1993). *Ethiopia: Compendium of Wildlife Conservation Information*. **Vol.1**. Ethiopian Wildlife Conservation Organization, Addis Ababa, 454pp.

IBC (2005*). National Biodiversity Strategy and Action Plan*. Addis Ababa, 103pp.

IUCN (2005). Guidelines for using the IUCN Red list Categories and Criteria-April 2005, IUCN-SSC.(http://www.iucn.org/webfiles/doc/SSC/RedList/Redlist Guidlines.pdf).

Johnson, C.M., Swedell, L. and Rothman, J.M. (2012). Feeding ecology of Olive baboons (*Papio anubis*) in Kibale National Park, Uganda: Preliminary results on diet and food selection. *Afr. J. Ecol., (in press).*

Kathpal, T. (1994). *Magnitude of pesticidal contamination of animal products in India*. Symposium of environmentally related animal feeding strategies. 60 pp.

Kingdon, J. (1974). *East African Mammals*: An Atlas of Evolution in Africa**.** Vol. IIA. Hares and Rodents. Academic Press, London, 510pp.

Kingdon, J. (1997). *The Kingdom Field Guide to African Mammals*. Academic Press, London, 488pp.

Kingdon, J. (2003). *The kingdom Field Guide to African Mammals*. Christopher Helm A and C Black publisher Ltd., London, 475pp.

Krebs CJ, (1999). *Ecological methodology 2nd ed*. Melen park, California: Addison-Wellesley education publisher Inc., 1-85.

Largen M. (2001). Catalogue of the amphibians of Ethiopia, including a key for their identification. *Trop. Zool*. **14**:307- 402.

Laurance, W., Laurance, S and Hilbert, W**. (**2008). Long-term dynamics of a fragmented rainforest mammal assemblage. *Cons. Biol.* **22**: 1154-1164.

Laws, R. (1970). Elephant as agents of habitat and landscape change in East Africa. *Oikos*, **21**: 1-15.

Leader-Williams, N., Albon, S and Berry, P. (1990). Illegal Exploitation of Black Rhinoceros and Elephant Populations: Patterns of Decline, Law Enforcement and Patrol Effort in Lungwa Valley, Zambia. *J, Appl, Ecol.* **27**: 1055-1087.

Leykun Abune (2000). The Challenge of Conserving Ethiopian wildlife: Overview. *Walia*, **31**: 56-61

Lopes, M. and Ferrari, S.(2008). Effects of human colonization on the abundance and diversity of mammals in eastern Brazilian Amazonia. *Cons. Biol*. **14**: 1658-1665.

Manor, R. and Saltz, D.(2003). Impact of Human Nuisance Distribution on Vigilance and Group Size on a Social Ungulate. *Ecol. Appl.* **13**: 1830-1834.

Manyingerew Shenkut, Assefa Mebrate and Balakrishnan, M.(2006). Distribution and Abundance of rodents in farmlands: A case study in Alleltu Woreda, Ethiopia. *SINET: Ethiop. J. Sci*. **29:** 63-70.

Martin, R., Deblase, A. and Pine, R.(2000). *A manual of Mammalogy*. McGraw Hill, New York

McCoy, E. D. and Bell, S. S. (1991). Habitat structure: the evolution and diversification of a complex topic. **In**: *Habitat Structure: The Physical Arrangement of Objects in Space*, pp.3-27, (Bell, S. S., McCoy, E. D. and Mushin sky, H. R., eds). Chapman and Hall, London

Meseret Chane, (2010). *Mammalian diversity in Borena-Sayint National Park, South Wollo, Ethiopia*. M.Sc. Thesis, Addis Ababa University. Addis Ababa.

Miller, B., Reading, J., Hoogland, G., Ce-ballos, R., List, S., Forrest, L., Hanebur, P. Manzano, J. and Uresk, D. (2000). The role of prairie dogs a keystone species: response to stapp. *Cons. Biol.* **14**:318–321

Mohammed Yaba, Tariku Mekonen, Afework Bekele and Malcolm, J. (2011). Food selection and feeding behavior of Giant mole Rat (*Tachyoryctes macrocephalus*, Ruppell, 1842) from the Sanetti plateau of Bale Mountains National park Ethiopia, *J. Asia appl.sci*.**4**:735-740

Mockrin, M.H., Rockwell, R.F., Redford, K.H., Keuler, N.S. (2011). Effects of landscape features on the distribution and sustainability of ungulate hunting in northern Congo. *Cons. Biol*. **25**: 514-525.

Murphy, W.J., Eizirik, E., Johnson, W.E., Zhang, Y.P., Ryder, O.A. and O'Brien, S.J. (2001). Molecular phylogenetics and the origins of placental mammals. *Nature*, **409**: 614-618.

Mugatha, M. (2002). *Influences of Land-use Patterns on Diversity, Distribution and Abundance of Small Mammals in Gachoka Division, Mbeere Distrect, Kenya.Land-use Change,* Nairobi, 46pp.

Norton-Griffiths MN (1978). *Counting Animals.2nd edn*. Nairobi, Kenya: African Wildlife Foundation, 1-26.

Nowak, R. (1991). *Walker's Mammals of the World.5th edn*. Johns Hopkins University Press, Baltimor, Maryland

Ogutu, J., Bhola, N., and Reid, R. (2005). The effects of pastoralism and protection on the density and distribution of carnivores and their prey in the Mara ecosystem, Kenya. *J. Zool. Lond*. *Nature* **265**:281-293.

Ojeda, A., Blendinger, G. and Brandl, R.(2000). Mammals in South American drylands: faunal similarity and trophic structure. *Glob. Ecol. Biogeo.* **9:** 115-123.

Packer, C., Ikanda, D., Kissui, B. and Kushnir, H.(2005). Lion Attacks on Humans in Tanzania: understanding the timing and distribution of attacks on rural communities will help to prevent them. *Nature* **436**: 927-928.

Peres, C.A., Lake I.R.,(2001). Synergistic effects of subsistence hunting and habitat fragmentation on Amazonian forest vertebrates. *Cons. Biol*.**15**:1490-1505.

Peres, C.A. (1999). General guidelines for standardizing line-transect surveys of tropical forest primates. *Neotrop. Prim.* **7**: 11-16.

Rabira Gonfa (2013). *Diversity, Abundance and habitat association of medium and large sized mammals in Dati Wolel National Park, Western Ethiopia*, M.Sc. Thesis, Jimma University, Jimma.

Redfern, J., Grant, L., Biggs, H. and Getz, W. (2003). Surface water constraints on herbivore foraging in the Kruger National Park, South Africa. *Ecol*. **84**: 2092–2107.

Reichholf, J. (1990). *Mammals in the Balance of Nature*. Academic Press, New York.

Reid, F.A. (1997). *Mammals of Central America and Southeast Mexico.* Oxford University Press, New York.

Saavedra, D. (2009). *The Abune Yosef Massif. Birds and Mammals of a hidden jewel of Ethiopia.*(Saavedra, D.eds).Centre de Recursos de Biodiversitat Animal. Universitat de Barcelona, Barcelona.

Scheibe, K, Eichhorn, K, Wiesmayr, M, Schonert, B, Krone, O. (2008). Long-term automatic video recording as a tool for analyzing the time patterns of utilization of predefined locations by wild animals. *J. Eur. Wild.Rev*.**54**:53–59

Sebsebe Demissew, Noradl I, Herrmann C, Friis I, Awas T, Starbetrop O, (2005). Diversity and endemism of western Ethiopian escarpment: a preliminary comparison with other areas of Horn of Africa. *Biol. Skr*. **55**:315-330.

Shibru Tedla (1995). "Protected areas management crisis in Ethiopia," *Walia*, **16**:17-30

Shiferaw Ayele (2008). *Species diversity, distribution, habitat association and similarity of bird and large mammal fauna in Kore community area, southern Ethiopia,* M.Sc. Thesis, Addis Ababa University, Addis Ababa.

Simpson EH, (1949). Measurement of diversity. Nature, 163:688

Smith, R. (1992). *Elements of ecology*. Harper Collins Publishers Inc, New York

Solomon Yirga. (2008). "*Atibiwochu*". Ethiopian Wildlife and Natural History Society, Addis Ababa. 55-61 pp

Srbek-Araujo, A. and Chiarello, A. (2005). Camera-trapping an efficient method to surveying mammals in neotropical forest, *J. Trop. Ecol*. **21**:121–125

Tobler, M., Carrillo-Percastegui, S., Leite Pitman R., Mares R. and Powell G. (2008). An evaluation of camera traps for inventorying large- and medium-sized terrestrial rainforest mammals. *Anim. Cons.* **11**:169-178.

Tariku Mekonen, Mohammed Yaba, Afework Bekele, and Malcolm, J. (2011). Food selection and habitat association of Starck's hare (Lepus starcki petter,1963) in the Bale Mountains National Park Ethiopia Asian *J. Appl, Sci*. **4**:728-734

Vaughan, A., Ryan, M., and Czaplewaki, N.(2000). *Mammalogy, 4thed*. Saunders College Publishing. New York, 565pp.

WCMC (1994). *Global Biodiversity: Status of the Earth's Living Resources.* Chapman and Hall, London.

Wright, S., Zeballos, I., Domínguez, M., Gallardo, M., Moreno, H and Ibanez, R. (2001). Poachers alter mammal abundance, seed dispersal, and seed predation in a Neotropical forest. *Cons. Biol.* **14**: 227-239.

Wilkie, D.S., Bennett, E.L., Peres, C.A., Cunningham, A.A., (2011). *The empty forest revisited*. Annals of the New York Academy of Sciences .**1223:** 120-128

Wilson, D. E., Cole, F. R., Nichols, J. D., Rudran, R. and Foster, M. S. (1996). *Measuring and Monitoring Biological Diversity*. Standard methods for mammals. Smithsonian Institute Press, Washington, DC.

Wilson, D. E. and Reeder, D. M. (2005). Mammal Species of the World. A taxonomic and Geographic Reference (3rded), Johns Hopkins University Press, **2**:142 pp

Yalden, D.W. and Largen, M.J. (1992).The endemic mammals of Ethiopia. *Mamm .Rev*. **22:**115-130.

Yalden, D. Largen, M. Kock, D. and Hillman, J. (1996). Catalogue of the Mammals of Ethiopia and Eritrea. Revised checklist, Zoogeography and Conservation, *J. Trop. Zool*. **9**: 73-164.

Young J. (2012). *Ethiopian Protected Areas a 'Snapsho*t', *a reference guide for future strategic planning and project funding*. Addis Ababa, Ethiopia

Zerihun Girma, Yosef Mamo and Mateos Ersado, (2012). Species composition, Distribution and Relative Abundance of large mammals in and around Wondo Genet Forest Patch, Southern Ethiopia. *Asian J. Appl. Sci*. **5(8)**: 538-551.

Zewdu Belete and Yemesrach Assefa (2005). *Willingness to Pay Protecting Endangered Environments: The Case of Nechsar National Park*. Nechisar National Park Report, Addis Ababa, 17pp.

Appendices

Appendix1. Field data sheet used for surveying medium and large size mammals

Study area----------Study site----------Date----------

Observer----------

No	Local name	Species	No. of individuals	Habitat type	Time of observation	Method of identification

Appendix2.Row Data of medium and large sized mammalian Species recorded from grassland during dry and wet seasons.

Common Name	Seasons	**Deti**						**Gobicha**						**Chokorsa**					
		LT1	LT2	LT3	LT4	LT5	LT6	LT1	LT2	LT3	LT4	LT5	LT6	LT1	LT2	LT3	LT4	LT5	LT6
Colobus monkey	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Debrazza's monkey	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vervet monkey	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	3	0	0	5	0	0	4	0	0	0	0	0	3	0	0	0	0
Olive baboon	D	0	12	0	0	6	0	0	0	11	0	0	0	5	0	0	0	0	0
	W	14	0	0	15	0	0	21	0	13	0	0	0	0	0	0	0	5	0
Crested porcupine	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	1	0	0	0	3	0	0	0	0	2	0	0	0	2	0
Stark's hare	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	2	0	0
Rock hyrax	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aardvark	D	0	0	0	2	1	0	1	0	0	0	1	0	0	1	0	0	0	0
	W	0	0	0	3	2	0	2	1	0	0	0	0	0	2	0	0	0	0
Common bushbuck	D	1	0	2	0	0	0	1	2	0	0	1	1	0	1	0	2	0	0
	W	0	0	0	2	2	0	0	0	1	0	0	3	0	0	0	1	0	0
Common reed buck	D	0	1	1	0	0	0	1	0	0	2	0	1	2	0	0	1	0	0
	W	0	2	1	0	0	0	3	0	0	1	0	2	0	0	0	2	0	0
Grey Duiker	D	0	0	1	0	0	0	2	0	1	1	0	0	1	0	0	0	0	0
	W	0	0	2	0	0	0	1	0	2	0	0	0	0	1	0	0	0	0
Bush pig	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	2	0	0	3	0	0	0	0	0	0	1	0	0	0	3	0	0
Warthog	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

African buffalo	D	0	8	0	10	0	13	0	0	0	6	0	0	0	0	6	0	4	0
	W	0	13	0	9	0	17	0	0	7	9	0	11	0	12	9	0	8	0
Tora hartebeest	D	0	0	3	0	1	0	2	0	0	0	2	0	0	0	0	3	0	0
	W	0	5	0	0	0	3	0	0	0	4	0	0	0	0	2	0	0	0
Striped hyena	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African wild cat	D	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0
	W	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0
Blacked back jackal	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White tailed mongoose	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Honey badger	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African civet	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leopard	D	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Lion	D	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0

Appendix3.Row Data of medium and large sized mammalian Species recorded from woodland during dry and wet seasons.

Spp common name	Seasons	**Kaso**					**Leman**				
		LT 1	LT 2	LT 3	LT 4	LT 5	LT 1	LT 2	LT 3	LT 4	LT 5
Colobus monkey	D	8	10	0	12	6	0	0	9	0	0
	W	0	0	5	0	7	0	4	0	4	0
Debrazza's monkey	D	0	2	0	0	1	0	0	0	0	0
	W		2	0	1	0	0	2	0	0	0
Vervet monkey	D	9	11	0	14	0	6	0	0	6	0
	W	10	0	7	0	8	0	5	0	3	5
Olive baboon	D	16	0	0	12	11	14	13	0	11	7
	W	10	0	0	20	0	6	0	0	8	0
Crested porcupine	D	0	0	1	1	0	1	0	0	1	0
	W	0	0	0	0	0	0	0	0	0	0
Stark's hare	D	2	0	2	0	0	2	0	1	0	1
	W	0	0	2	0	3	0	2	0	0	0
Rock hyrax	D	0	5	0	0	3	0	0	4	0	2
	W	0	3	0	0	4	0	0	0	0	2
Aardvark	D	0	1	0	1	0	1	2	0	0	0
	W	0	0	2	0	0	1	0	0	3	0
Common bushbuck	D	0	3	4	0	3	2	0	2	2	0
	W	0	2	0	0	1	0	0	0	0	1
Common reed buck	D	0	0	2	0	1	0	1	2	0	0
	W	0	0	0	0	0	0	0	0	0	0
Grey Duiker	D	0	2	1	1	0	1	2	1	0	1
	W	2	0	0	1	0	0	0	0	1	1
Bush pig	D	0	2	0	0	3	0	3	2	2	0
	W	0	0	3	0	3	0	4	0	2	0
Warthog	D	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0
	D	13	11	0	14	0	14	0	13	0	15

African buffalo	W	9	0	0	10	0	12	0	11	0	8
	D	0	0	2	1	0	0	3	1	0	0
Tora hartebeest	W	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0
Striped hyena	W	0	0	0	0	0	0	0	0	0	0
	D	0	3	0	0	2	0	0	0	0	4
African wild cat	W	0	0	0	0	0	0	0	0	0	0
	D	2	0	1	0	0	1	2	1	0	0
Blacked back jackal	W	1	0	0	0	2	0	0	1	0	0
	D	0	0	0	0	0	0	0	0	0	0
White tailed mongoose	W	2	0	2	0	0	0	2	0	0	1
	D	0	0	0	0	0	0	0	0	0	0
Honey badger	W	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0
African civet	W	0	0	3	0	2	0	0	2	0	1
	D	0	0	0	0	0	0	0	0	0	0
Leopard	W	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0
Lion	W	0	0	0	0	0	0	0	0	0	0

Appendix4.Row Data of medium and large sized mammalian Species recorded from Riverine forest during dry and wet seasons.

Common name	Seasons	**Sor**					**Konor**				
		LT 1	LT 2	LT 3	LT 4	LT 5	LT 1	LT 2	LT 3	LT 4	LT 5
Colobus monkey	D	6	0	10	13	11	0	0	8	2	0
	W	5	6	0	5	4	12	6	5	0	7
Debrazza's monkey	D	0	5	0	0	0	4	0	2	4	0
	W	3	3	0	2	0	3	0	0	0	0
Vervet monkey	D	15	10	14	12	8	0	9	16	10	10
	W	14	13	16	0	8	0	0	11	0	0
Olive baboon	D	16	13	0	13	12	0	14	0	14	0
	W	0	16	0	9	7	0	6	8	6	0
Crested porcupine	D	0	0	2	0	2	0	3	5	0	0
	W	2	0	2	0	0	0	2	0	1	0
Stark's hare	D	0	0	0	5	0	0	0	0	0	3
	W		0	0	0	0	0	0	0	0	0
Rock hyrax	D	0	2	0	0	4	3	0	3	0	2
	W	0	3	0	0	2	0	0	2	0	0
Aardvark	D	0	0	0	0	0	0	0	0	0	0
	W	0	2	0	1	0	0	0	2	0	0
Common bushbuck	D	0	0	0	0	0	0	0	0	0	
	W	0	0	0	0	0	0	0	0	0	0
Common reed buck	D	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0
Grey Duiker	D	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0
Bush pig	D	0	2	1	0	0	0	3	4	0	2
	W	0	2	0	0	0	0	3	0	2	0
Warthog	D	2	3	1	0	4	3	2	0	1	2
	W	0	0	0	4	2	0	3	4	0	0
	D	13	12	9	20	10	4	0	7	0	11

African buffalo	W	8	0	6	6	0	9	0	0	0	9
	D	0	0	0	0	0	0	0	0	0	0
Tora hartebeest	W	0	0	0	0	0	0	0	0	0	0
	D	0	2	0	2	2	0	3	2	0	2
Striped hyena	W	0	0	2	0	1	1	0	2	1	0
	D	1	0	1	2	2	0	1	0	1	2
African wild cat	W	1	0	0	2	0	1	0	2	1	1
	D	0	3	3	0	1	0	3	2	0	2
back Jackal	W	0	2	0	1	0	1	0	0	1	
	D	0	3	0	2	0	0	5	0	0	0
White tailed mongoose	W	1	0	1	0	2	0	0	2	0	0
	D	1	3	1	0	2	2	2	2	1	0
Honey badger	W	2	0	1	0	1	0	3	0	0	1
	D	3	0	2	2	0	0	3	0	0	2
African civet	W	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	1	2	0
Leopard	W	0	0	0	0	0	0	0	0	0	0
	D	1	0	0	0	0	1	0	0	0	0
Lion	W	0	0	0	0	0	0	0	0	0	0

NB: D– Dry Sea son, W –Wet Season, LT- Line Transect