COLLEGE OF NATURAL SCIENCE

DEPARTMENT OF BIOLOGY

SCHOOL OF GRATUATE STUDUIES

A STUDY ON THE DIVERSITY, DISTRIBUTION AND RELATIVE ABUNDANCE OF MEDIUM AND LARGE-SIZED MAMMALIAN SPECIES IN SHEKO FOREST PRIORITY AREA, BENCH MAJI ZONE, SOUTHWESTERN ETHIOPIA

A THESIS SUBMITTED TO THE DEPARTMENT OF BIOLOGY, COLLEGE OF NATURAL SCIENCES AND SCHOOL OF GRADUATE STUDIES, JIMMA UNIVERSITY IN PARTIAL FULFILMENT FOR THE REQUIREMENT OF THE DEGREE OF MASTER OF SCIENCE

By: Shibru Wega

Advisor: Tsegaye Gadisa (Ph D)

October, 2017

Jimma, Ethiopia

Approval form

Jimma University

School of Graduate Studies

Department of Biology

A Study on the Diversity, Distribution And Relative Abundance Of Medium And Large-sized Mammalian Species in Sheko Forest Priority Area, Bench Maji Zone Southwestern Ethiopia

By: Shibru Wega

Approved by the examining board

1. Chairperson, examination board (Jury)

Name_____ Signature _____ Date_____

2. Advisor

Name_____ Signature_____ Date_____

3. External Examiner

Name_____ Signature_____ Date_____

4. Internal Examiner

Name_____ Signature_____ Date_____

Place: Jimma University

Date of submission_____

This thesis has been submitted for examination with my approval as candidate' advisor

Name: Tsegaye Gadisa (Ph D)

Signature_____

Date _____

DECLARATION

I, here by, declare that this thesis is my original work and has not been presented for degree in any other University, and that all sources of material used for the thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirement for M.Sc. Degree at Jimma University and is deposited at the University library to be made available to borrowers under the rules of library. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgment of the source is made.

Name: Shibru Wega

Signature_____

Table of contents

List of Tables

List of figures

List of Acronyms

GPS - Global positioning system

IBC - Institute for Biodiversity Conversation

SPSS - Statistical package for social science

EWNHS - Ethiopian Wildlife and Natural History Society

SSC - Study site core

SSB - Study site buffer

SST - Study site transition

Acknowledgment

First of all, I would like to thank my God who helped me in many ways during this work. Next, I express my deep sense of gratitude and sincere to my adviser Dr. Tsegaye Gadisa, for giving me the opportunity to work guidance encouragement all through my thesis writing, I am grateful to Jimma University for the financial support and Bench Maji Bone Sheko Woreda agriculture office and Mizan Tepi University and Mizan Agricultural College is highly acknowledged for equipment support. I also express my sincere thanks to my best friend, Yosef Bekele, my family for their encouragement and moral support. I would like to acknowledge all my friends with whom I shared ideas during my work

Abstract

This study was conducted to assess the diversity, relative abundance and habitat association of medium and large-sized mammas in Sheko Forest priority Area, Bench Maji Zone South Nation and Nationalities People's Regional State. A two season data (from January to July) was collected using a transect line survey method. Representative transects were established in all the three zones of the forest; namely, core buffer and transition and transects for the actual study were selected randomly. Mammals were recorded by direct observation with naked eyes or aided by binoculars. The presence and absence of some species were also recorded by indirect method like finger print. Nine species of mammals were recorded from the present study area which belongs to four Orders and 6 families. Out of the three zones of the forest, transition zone was the most diversified (H= 1.62) during dry season while the Core zone was the most diversified Zone during the wet season (H =0.947). The most abundant mammal in the forest was Olive baboon (73.6 %) followed by Vervet monkey (21.15%), pig (5.2%). The highest species similarity was seen between the Core and Transition zones of the forest (SI= 0.42) during dry season and the least was between the Buffer and Transition zones (SI= 0.30). During wet season the highest similarity was seen between the Buffer and Transition zones (SI=0.375) of the forest and the least was seen between the Core and Transition as well as the Core and Buffer zones (SI=0.33).Among the mammalian species identified in the forest, 55.5% (4 species) were common, 33.3% (3 species) were uncommon and 22.2% (2 species) were rare based on how often they were sighted during the time of data collection. Despite the study area is home for different species of mammals, livestock grazing and human encroachments are evident in the area putting strain on the flora and fauna .hence, conservation measures should be taken to ensure long term conservation of the area .

***Key words**: abundance, diversity, habitat association, mammals, Sheko forest*

1. INTRODUCTION

1.1. Background

Ethiopia is situated in the Horn of Africa between 30N and 150N latitude and 330E and 480E Longitude (Ash and Atkins, 2009). Ethiopia's major land feature is a massive highland complex of mountains and plateaus bisected by the Great Rift Valley and surrounded by lowlands along much of the edge (Viveropol, 2001). The Great Rift Valley bisects this mountainous plateau, dividing it into northwestern and southeastern highland regions (Gillespie, 2003).The country is one of the most physically and biologically diverse countries primarily due to 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 (Yalden *et al.,* 1996). Ethiopia has an area of over 1,023,050 km2 and there are various wildlife and habitats types (Yalden, 1983**).**

The climate of Ethiopia is divided into five climatic zones, based on altitude and temperature. The hot, arid zone covers the desert lowlands below 500 m, where the average annual rainfall is less than 400 mm 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 altitude. Average annual rainfall is around 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 2,500 m 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 temperature is below 10°C and annual rainfall averages less than 800 mm (EPA, 1998; IBC, 2005). Ethiopia is rich in fanatic diversity, however, not evenly distributed. The larger mammals are mainly concentrated in the south and southwest border and adjacent areas of the country. There are also plain game animals along the stretch of the Great Rift Valley System. Mountain massifs in the north are also home to many

endemic species. The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7,000 species of higher plants, which constitute about 12 percent endemic (GebreEgziabher, 1991).

Commonly, mammals are divided into small, medium and large based on body weight. Medium-sized mammals are mammals between 2kg and 7kg such as small carnivores, small primates**,** large rodents, hyraxes, and pangolins while the species with more than 7kg are considered to be large size mammals these includes most diurnal primates, most carnivores larger than a fox or house cat, all Perissodactls and artiodactyls (Emmons and Feer, 1997). Ethiopia is among countries with rich faunal diversity there are 320 species of mammals, 861 species of birds, 240 species of reptiles, and 71 species of amphibians. Among these about 42 mammals, 19 birds, 16reptiles,and 28 amphibians are considered to be endemic to the country (http://lntreasures.com/ethiopia.html)). For several years, the natural ecosystems of Ethiopia have been altered due to anthropogenic effect and natural factors. Most of the highlands and some of the lowlands have been converted into agricultural and pastoral lands. The vegetation has been used for fuel wood, construction and other purposes. As a result, wildlife resources of the country are largely restricted to protected areas (Hilman, 1993).

To protect and conserve the diverse and important biological resources such as endemic animals, 21 National Parks, 11 Wildlife Reserves, 3 Sanctuaries, 22 Controlled Hunting Areas and 69 Important Bird Areas have been established as refuge in Ethiopia (Yong, 2010). Sheko forest priority area is subjected to severe deforestation due to human induced impacts. There is no scientific information about the faunal diversity particularly of the medium and large-sized mammalian species in the forest. Therefore, this study has been initiated to document the diversity, distribution and relative abundance of Medium and large sized mammalian species in Sheko forest, Southwestern Ethiopia.

1.2. Statement of the Problem

According to Hundera (2009), majority of the Southwest land once covered by natural forest is shrinking in size due to increasing subsistence agriculture and investment for commercial farming .This may have a great impact on the diversity and ecological of mammals there in Sheko forest priority area is one of 58 national forest priority areas and is one of the four

nationally recognized wild coffee growing areas in Ethiopia. Rapid increase of population growth in Shako district has lead investment in forested area, deforestation and using of forest edge for coffee plantations and finally it may be major driving forces for land cover change which may result in the loss of many animal species found in the forest. To protect animal species in the forest, appropriate management practices should be carried out. To design and implement good management, key ecological information like diversity, abundance and habitat association of the species there in essential. To this end however, from the Sheko forest priority area there is little or no information on mammalian fauna diversity and knowledge of other Ecological aspects Therefore, the present study has been design to fill this information gap by documenting the diversity, distribution and relative abundance of medium and large sized mammalian species of the 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 Sheko forest priority area, South Nation Nationality People Regional State, South Western Ethiopia

1. 3. 2. Specific objectives

- Identify the species composition of medium and large sized mammals in the study area
- Estimate the relative abundance of medium and large-sized mammalian species at different seasons in the study area
- Examine the distribution of medium and large- sized mammalian species in the study area

1.4. Significance of the study

Baseline data on the diversity and distribution of fauna and flora are very important for conservation prioritization, proper management and sustainable use of biological resources. The present study focuses on the systematic documentation of the diversity, distribution, relative abundance and habitat association of mammals in Sheko Forest National Priority Area which

expected to serve as baseline data for better to document mammalian diversity and for recommending appropriate management (conservation) strategy for better conservation.

2. LITERATURE REVIEW

2.1 Biodiversity

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

Each community has a defined a set of animal and plant species living in it, a set that continues year after year with only minor change. Therefore, ecological community is an interactive grouping of species whose ecological role and energetic are in some way interdependent (Putman, 1994). Biodiversity has several values that benefit human being in different ways. Among the values of biodiversity, are ecological, economic, educational and scientific, recreational and aesthetic values are the principal ones.

The ecological services of biodiversity include enhancement of air and water quality, hydrological, gaseous and mineral nutrients circulation, manufacture of food by green plants to be used as food, waste disposal by organisms some of which act as decomposers, soil formation, support of parasite host, prey predator, symbiotic and other relationships among organisms (Tilman *et al*., 1999). Biological diversity is of fundamental importance to the functioning of all natural and human-engineered ecosystems and by extension to the ecosystem services that nature provides free of charge to human society. Living organisms play central roles in the cycles of major elements and Water in the environment and diversity specifically is important in that these cycles require numerous interacting species (Takacs, 1996).

Economic uses of biodiversity include its uses in the organization and utilization of biological wealth in satisfying human needs in different areas including agriculture, forestry, fisheries, wildlife and other industries (Balick and Cox, 1994).In spite of its values at the beginning of the 21st century scientists around the world are unaware of the rising threat that biodiversity is being

put under. Although naturally occurring phenomena such as fire, volcanic eruption and floods can adversely affect community structure and there by diversity, it is without question that human activity has far greater impact on the world biodiversity, primarily through habitat destruction (Kormondy, 1996). Human activities that affect biological diversity are various and vary significantly worldwide, but may include adjustment of ecological processes, change of forest to alternate land uses, hunting and fishing, introduction of non-native species, fuel wood gathering, subsistence agriculture and forest management practices that change habitat characteristics of the forests (FAO, 2001).). Ethiopia is known worldwide as one of the global centers of biodiversity and also has a high level of endemicity in its wild forest flora and fauna (NCS, 1994).

2.2. Mammalian Diversity

According to Dawud Yimer (2008) species diversity is high in areas where there is sufficient food and water source. Ojeda *et al*. (2000) indicated that mammals are one of the most important components of biodiversity in the world. 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).

Mammals are highly diverse. They range in size from African pigmy mice (*Musminutoides*) to whales (Mugatha, 2002).According to a Delnay and Happold (1979), one of the most interesting appearances of tropical Africa is the riches and diversity of its mammalian fauna. 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. Mammals inhabit every terrestrial biome, from deserts through tropical rainforests to polar icecaps. Many species are arboreal, spending most or all of their life time in the forest canopy. Many mammals are partially aquatic, living near lakes, streams or the coastlines of oceans. Locomotion styles 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 (Reichholf, 1990). Although mammals share several features in common, they also contain a vast diversity of forms. Mammals have evolved to exploit a large variety of ecological niches and have evolved numerous adaptations to take advantage of different lifestyles (Flynn *et al*., 2005). Among mammals living today, 0.1% of them are eggs lying and 99% are placental. They live on land, water bodies and air (Solomon Yirga, 2008).

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). In addition, both set of mammals greatly influence the environment beyond direct species interaction such as through cascading tropic effects (Berger *et al*., 2001).

2.3. Habitat and distribution of mammals

The distribution of species represents the sum of many local populations and the distribution of a particular species or group of populations. Distribution and habitat association of large mammals are determined in terms of their water and food requirements. Water and pasture conditions or the combinations of both are the major factors determining the distribution of wildlife populations in their natural habitats (Oubert, 1976). According to Balakrishinan and Easa (1986) habitats in terms of large mammals refer to the vegetation composition, floristic and structural of the area as a product of various factors such as climate, geology and soil. The habitat of the animals is therefore the area where the animal preferably occurs and where all its life necessities are fulfilled

Structurally complex habitats may provide more niches and diverse ways of exploiting environmental resources and thus increase species diversity (Bazzaz, 1975).Each mammalian species has an environmental tolerance for diverse environmental conditions they will occur over large areas, unless barriers intervene, and thus they may be said to be generalized in habit or to be adaptable. If their limits of tolerance are restricted their distribution is usually confined to relatively small local areas and they may be said to be specialized or no adaptable.

(UNESCO, 2008) . It is also important to know whether an organism prefers a certain habitat or is confined to a specific habitat, which in turn may localize species to crowded surroundings if habitat is reduced or degraded, increasing vulnerability to diseases, predation and competition (Christan, 2007). The distribution patterns of medium and large mammals are restricted habitats of protected area as they wander in search of preferred habitats. As a result, some of the rare and endangered mammalian species have shifted their original range and occur in a few habitats in some countries. But there is a lack of information on where they frequently occur and on their migratory corridor within the habitat (Patterson *et al*., 2003)

2.4 Ecological importance of mammals

Large and medium–sized mammals are particularly sensitive to habitat changes, and they are common victims of poaching and illegal trading (Laurance *et al*., 2006). The functional significance of these species lies in their ecological roles, such as seed dispersal and predation on numerous plant species. These functional roles may change the structure and composition of the ecosystem. Moreover, these species influence the community structure and complexity on the tropic levels in which they are involved, due to their regulatory role as preys and predators (Roemer *et al*., 2009) The loss of these organisms could have devastating effects because they contribute in many ways to the functioning of the natural ecosystem (Alonso *et al*., 2001). Given the importance of these species, studies identifying and predicting the environmental changes that may affect their diversity are essential, and in such studies, relative abundance and species diversity are usually used as indicators (Carrillo *et al*., 2000)

Large mammals are fundamental elements in many ecosystems (Berger *et al.,* 2001). Large carnivores frequently shape the number, distribution, and behavior of prey animals. Large herbivores function as ecological engineers by changing the structure and species composition of the surrounding vegetation (Dinerstein, 2003). Furthermore, both set of mammals profoundly influence the environment beyond direct species interaction such as through cascading tropic effects (Berger *et al.,* 2001).

Large sized mammals perform important ecological functions and are good indicators of the habitat value because they do not typically rely on specific single habitat as many small mammals do (NLFC, 2005). 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 come across 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 (Kingdon, 1997).

2.5 Monitoring of medium and large mammals

The diversity and abundance of medium and large 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 on 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. In addition to this terrestrial visual encounter survey is the core survey for medium and large sized mammals (Reif and Tornberg, 2006).

2.6 Threat of mammals

It is unfortunate that the survival of mammalian fauna is faced with natural and anthropogenic problems. They are threatened in most by many kinds of influences. The exact number of the species that are endangered is not known (Cuaron, 2008). However, the recent and seemingly sudden declines in many mammalian populations throughout world suggest that more species and populations are in precarious state (Cardillo *et al*., 2004).The abundance of organisms is influenced by the inter play of a biotic and biotic factors to varying degrees. This is because each species may get favorable site from the combination of environmental variables that most closely corresponds to its requirements (Brown, 1984). Different activities of humans have its own impacts on wildlife by the modifying the behavior of animals and their distribution. The disturbances of behavioral patterns can affect their social structure. Social structure is a key component in evolution and dynamics of species. Thus, its disruption by human disturbance can have major consequences on future populations even if the disturbance does not directly affect the survival and reproduction of mammals (Cardillo *et al*., 2004). Mammals face *various* threats

to their continued existence including habitat degradation and distraction, overexploitation, loss of genetic diversity, endangerment and extinction. The declines of mammals were dramatically accelerated by human activities that shoot, trap, and poison animals and burn forests (Miller *et al.,* 2000). All so factors like noise, disruption of the physical environment .This results in overgrazing, erosion, changes in predation pressure and breeding. Increasing human population and the associated impacts such as habitat loss and hunting are the underlying factors for the decline of mammalian species. They are considered as species threatening factors and vary in intensity across the surface of the earth. Species that inhabit more heavily impacted regions are expected to have a higher risk of extinction (Cardillo *et al*., 2004). 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 breed in the pet trade. The worldwide demand for pets and medicinal plants drives illegal trade of mammals, especially rare species. Sadly enough, wildlife trafficking is thought be one of the most profitable illegal trades in the world (Cardillo *et al*., 2004).

Humans have a long history of both deliberately and accidentally introducing exotic species. The long history of negative impacts that introduced exotics have on native species and habitats dictates that extreme caution should be exercised before any exotic species is introduced (Atkinson, 2001). There are many examples of negative impacts that exotics have on native species (Chane, 2010). Exotic species may contribute to the decline and extinction of native species in several ways. They may carry diseases to which native organisms have not evolved defenses. Exotics may also out compete native species for habitat, food and nesting sites, or may become predators on native species. Feeding activities of exotic herbivores may deplete food resources and otherwise disturb habitats to the extent that native species can no longer survive (Veitch, 2001)

3. STUDY AREA AND METHODOLOGY

3.1. Study area

Sheko district is located in Bench Maji Zone, Southern Nations and Nationalities People Regional State, Ethiopia. The major land covers of Sheko District was 12 smallest administrative unit forest, 12 smallest administrative unit farmland and 24 smallest administrative unit was human settlement The district lies between the coordinates of 6^0 58' N and 35^0 45'E and altitudinal range of 900 m to1850 m above sea level. It is located at 7^0 30' N and 35^0 45'E, Benchi Maji zone located 572 km from the center Addis Ababa, 872 regional center Hawsaa and 17 km zonal town Mizan Teferi According to the Sheko Woreda Culture and Tourism Office (2015) Description of sheko woreda. From unpublished

The average temperature range is 20°C -25°C. Annual rainfall range is 1500-1800 mm; elevation ranges 1,500- 1700m above sea level the wet seasons June to August and dry season January to march. The breeding tract receives maximum rain from June to September (Bench Maji Zone Agriculture Office) most parts of the study area fall in the tsetse belt of southwestern Ethiopia. Sheko cattle keepers practice crop-dominated mixed crop–livestock agriculture both in the lowland (<1,500m above sea level) and in the highland (>1,500m above sea level) agro ecological zones. Coffee is the main perennial crop with a mean area of 2.06 ha per household.

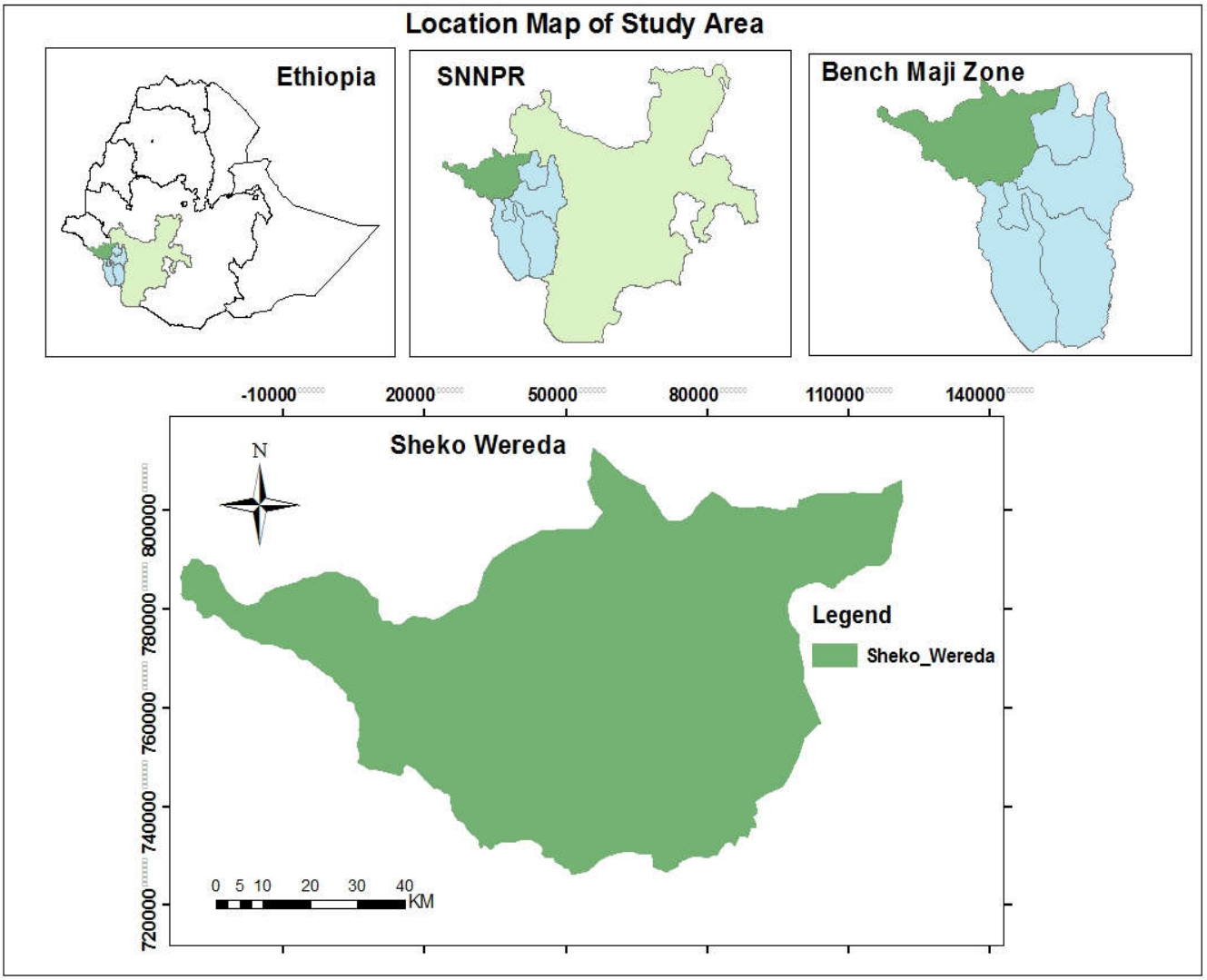

Figure 1 Map of the Sheko woreda with different forest zone

3.2. Preliminary Survey

Before starting the main research work, preliminary survey about the study area was conducted during February, 2017 in Sheko woreda for seven days. All the relevant information about study area such as the size of the study area, climatic condition, habitat types, and topography of the study site was gathered from observation and from the concerned bodies. The study area was divided into core, buffer and transition based on the nature of vegetation. The sampled areas were made to cover at least 20 to 25 %of the study area (Bibbyet al., 1992).All the available

information about the vegetation and land-use was collected from concerned governmental, non-governmental authorities and local people living around the study area.

3.3. Sampling Design

Based on the preliminary survey, study sites were established on the basis of management system of different land-use forms of forest protected area. Hence, sampling site in the present study was categorized in to three groups such as Core, Buffer and Transition Zone, Sheko Woreda Office of Agriculture Surface Area) 33843.56 ha from total Core area covers 15416.05 ha while the Buffer and Transition areas cover 13456.05 ha and 5071 ha respectively.

3.3.1 Description of the three forest zones

Core area: The core zone was covers an area of 15416.05 ha composed of intact natural high forest cultural forests (Gizmeret), sacred forests, and wetlands. As the core zone is devoted to long-term protection, its location and boundaries are also determined in such a way that minimizes human disturbance and hence ensure sustainability. This was approached by maintaining appropriate distances from settlement areas, cultivated areas, roads and towns that are thought to trigger anthropogenic pressure. The majority of the core areas are at higher altitudes

Figure 2 Partial view of the Core zone of Sheko forest priority area (photo by Shibru Wega September 2017)

3.3.2 Buffer zone

Buffer zone: the buffer zone covers an area of 13 456 ha include bamboo thickets, and managed forests for production including coffee, honey and spices, wetlands, river in forests and the like. Though the buffer zone serves as a shield for the core zone, it should simultaneously render economic use on a sustainable basis and has estimated the value of the forest in economic terms. It estimated that direct use value of the natural forest for house construction, furniture, utensils, farm implements and for fencing purposes. Among the non-timber forest products are honey, forest coffee, spices, bamboo, fuel wood and charcoal, and others such as palm and wild fruits. But, honey is the main source of cash for most of the rural households. It has also estimated that, on average, the sampled households generate 44% of their income from forest and forest products. This indicated that there is high dependence on forest resource by the community for livelihood purpose. Hence, sufficient size of the forest that the community can utilize for livelihood purpose should remain in the buffer zone. The society use to the invasion of coffee plantation instead of the previous forest can make cannot stability of habitat. The majority of the buffer zone areas are at lower altitude where coffee performs well and within accessible distances from settlement areas and roads that can allow the community to utilize the direct use values and collect non-timber forest products.

Figure 3 Partial view of partial view of Buffer zone Sheko forest priority area (photo by Shibru Wega September 2017)

3.3.3 Transition Zone

The transition zone of the forest represents an area of the biosphere reserve where sustainable development is promoted for the improvement of the livelihoods of the local community. The transition zone in the proposed biosphere reserve includes agricultural land, grazing Land, settlement areas, coffee and tree plantation, small-holder coffee plantations and some semi-forest coffee production areas. These areas are under intensive human use and therefore demand the promotion of sustainable resource use, which is the major objective to be attained in the transition zone. The agricultural lands are dominated by perennial crops like Ensete and the main consumption crops are sorghum.

Figure 4 Partial view Transition zone Sheko forest priority area (Shibru Wega September 2017)

Based on information obtained from experts of the Sheko district Natural Resources and Agricultural Office, 16 Kebles had protected for forest conservation from a total of 24 Kebles. But, now only 12 kebeles have core, buffer and transitions zone, for forest conservation. Namely:Gizmeret, Ayibera, Jenjeka, Bergi, Bardeka, Shimi, Bonki, Jemdes, Sanka, Gufika, Worgu, Fajeka. The reaming 4, kebeles lost their core zone due to population: namely M/ sheko, Bajeka,Muruns, and Shayita.

Sample size was determined proportionally to make results representatives of the whole study area (Bibby *et al.*, 1998 Sutherland, 1996:).Sampling sites in the present study was 4, Core 4, buffer and 2, transition from a total of 16 kebels of protected forest areas. Therefore, a total of ten (10) transect lines were designed to gather information regarding to species diversity, distribution and relative abundance of medium and large- sized mammals in Sheko forest. According to the present study sites in each group's whether in core 4, buffer 4 and transition 2 transect lines represent the entire area. The selection of the transect lines may depend on different factors such as topography, area coverage, habitat type etc. During data collection the study sites named in considering their categorized zone so that core zone has four sites SSC-1, SSC-2, SSC-3 and SSC-4 similarly, in Buffer zone named SSB-1, SSB-2, SSB-3 and SSB-4 and in study site transition zone named SST-1 and SST-2. In core zone transect length of 2 km and width 50 m, in buffer zone transect length of 3 km and width 100 m and in transition zone 3 km and width 200m width varied based on the favorability and visibility of each habitat type. Each transect line was at a distance of 0.5 km from other transects to avoid double counting (Sukumar and Varman, 1995; Sutherland, 2007).

3.4. Data collection

Data collection was carried out between February, 2017 and July , 2017 for both dry and wet seasons. The dry season data was collected between February, 2017 and April, 2017. The wet seasons are between May and July 2017. During this study, body weight is a parameter to categorize mammals in to medium and large-sized. Accordingly Emmons and Feer, (1997), mammals weighing between 2 and 7 kg are considering medium and all above categorized large sized.

Data to study the diversity, distribution and relative abundance of medium and large-sized mammals was collected through direct and indirect observation by line transect method in ten (10) study sites. To survey medium and large mammals walking along a transect line, slow speed 1 km/h was carried out. All transects line in each zone was surveyed two times a day (early in the morning between 06:00 and 10:00 am and late afternoon between16:00 and 18:00 pm) for three consecutive days in two Season.

Direct observation was conducted with naked eyes or aided by binoculars (7x50 mm). During observation, the number of individuals of each species was identified, sexed and age was categorized, time and habitat type also recorded. Body size, pelage color, presence or absences of horn was used to determine sex and age (Bekele and Yalden, Kingdon, 1997, 2014 Yirga,

2008). Indirect observation also using indirect evidences such as fecal droppings, calls, track survey, marks and prints, quills, holes, feeding signs will be also recorded to the presence or absence of mammals in established transect lines (Wilson , 1996). For the species identification of mammals, field guides and indigenous people also consulted for vernacular name, call and sign identifications according to Sutherland

(2007). All the observed (direct or indirect) mammals was identified to species level by using the taxonomic characters listed in Kingdon (2004) Yalden and Largen (1992),

3.5. Methods of data analysis

The analysis of the obtained data was carried out using appropriate statistical test methods. Species diversity of medium and large size mammals was calculated using the Shannon-Wiener Index (H‟) index of diversity (Shannon and Weaver, 1949), = -Σ [() × In ()] Where nI= number of individuals of each species (the $\mathbf{1}^{st}$ species) and N = total number of individuals for the site, and ln = the natural log of the number. The evenness of Mammalian species refers how close in numbers each in a habitat and was

Calculated as J= $\frac{H'}{H\ mas}$ Where, J = evenness H' = is Shannon-Wiener index of diversity H maximum = is maximum diversity index Hmax= ln(s) and s is the number of species.

Relative abundance= $\frac{\textbf{\textit{Total number of individual of species}}}{\textbf{\textit{Sampled habitat}}}$

The Chi square ($x^{2)}$ was used to compare habitat association of the mammalian species in the different zones of the forest at 0.05 level of significance SPSS computer software used for chi-square analysis test the association of mammal species and their habitats (Flower and Cohen, 1990*)*

Simpson similarity index (SI) was also computed to assess the similarity between the habitats with reference to the composition of species as: SI=$\frac{\textbf{\textit{nc}}}{\textbf{1+2}}$

Where, SI= Simpson's similarity index, C= the number of common species to, n = the number of habitat, 1= the number of species in habitat one, 2= the number of species in habitat two

Abundance of medium and large sized mammals was calculated as, Abundance= total number of individual species/sample zone (Brown, 1984).

The occurrence of a species was grouped as common if the probability of seeing is 100% in every time of the fieldwork, uncommon, if the probability of seeing is more than 50% and rare if the probability of seeing is less than 50% (Hillman, 1993).

4. RESULTS

4.1. Species composition

Generally 661 individual (349 wet seasons and 312, dry seasons medium and large sized mammals were recorded in the study area. From the recorded individuals of mammals nine species in four orders and seven 6 families were identified. Order primate and Artidactyla compose the largest number of species. Among the species recorded (Vervet monkey and Starks hare) were medium sized while seven species were large sized (Table 1)

Tables 1: Medium and large sized mammalian species recorded from Sheko forest priority area

Local name	Common name	Scientific name	Order	Family
Zinjero	Olive baboon	*Papio Anubis*	Primate	*Cercopitheci*
Tota	Vervet monkey	*Cercopithecus aethiops*	*Primate*	*Cercopitheci*
gureza	Colobus monkey	*colobus guereza*	Primate,	*Cercopitheci*
Kerkero	Warthog	*Phacochoerus africanus*	Artiodactyla	*Suidae*
Asama	Pig	*Sus scrofa*	Artiodactyla	Suidae
Midakwa	Grey duiker	*Syluicapra grimmia*	Artiodactyla	*Bovidae*
Yeminlik dikula	Menelik's bushbuck	*Traglaphus scriptus meliniki*	Artiodactyla	*Bovidae*
Jib	Spotted hyena	*Corcuta corcuta*	carnivora	hyaenidae
Tinchel	Stark's hare	*Lepus starki*	Lagomorpha	*Leporidae*

4 .2 Diversity indices of medium and large-sized mammals

From the three forest zones, Transition zone was the most diversified (H'= 1.62; J=0.9) and the second diversified zone was core (H'= 0.996; J= 0.48) during the dry season. The least diversified zone was the buffer (H'= 0.36, J= 0.92) in the same season. During the wet season, the core zone was the most diversified zone (H= 0.947; J = 0.45) and the Buffer zone was the second diversified zone (H'= 0.92; J =O.66) and the third was the transition zone (H'=0.71; J = 0.51) (Table 2)

Table 2: The abundance diversity indices (H ‘) and evenness (J) for the medium and large sized mammalian species in three forest zone of the study area during dry and wet seasons

Forest	No of species		Abundance		H’		J	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Core	8	8	8	8	0.996	0.947	0 .48	0.45
Buffer	4	4	4	4	0,36	0.92	0.26	0.66
Transition	6	4	6	4	1.62	0.71	0.9	0.51

For combined seasons transition zone had got the highest diversity index with Shannon weiner index (H’= 1.65; J =0.71) and the second diversified zone was the core (H’= 0 .991; J=0.465). The least diversified zone was buffer zone (H’ =0.64; J = 0.46) (Table 3)

Table 3 Number of species, abundance, diversity and evenness for combined seasons

Forest	No, species	Abundance	H’	J
Core	8	303	0.97	0.465
Buffer	4	182	0.64	0.46
Transition	5	176	1.65	0.71

4.3 Species Richness and Abundance

During the study period of the dry season the highest number of mammalian species was recorded in core (8 species), followed by transition which contained 6 species. The least number of mammalian species was recorded in buffer with 4 species.

During wet season, the highest number of mammalian species was recorded in core zone (8species), followed by buffer zone and transition zone 4 species was recorded in both. For combined seasons, core contained 8 species followed by transition which contained 5 species. The least number of species was observed in buffer with 4 species (Table 4)

Table 4: Number of mammalian species in different forest zone in both seasons

	Forest zone		
	Core	Buffer	Transition
Number of mammalian species	8	4	5

4.4 Distribution of mammals in the three habitats

By direct observation eight (8) species of mammals were observed from the three zones of the forest, while one (1) species was recorded by indirect evidences using foot print. The largest number of species (eight species) was recorded from the core zone while five and four species were recorded from the transition and buffer zones respectively (Table 5).

Table 5: The distribution and means of identification of mammals in the three zones of Sheko forest priority area during the dry and wet seasons; √ stands for the presence of animal in forest zone - stands for the absence of animal in forest zone

Common name	Scientific name	Means of identification	Forest zone					
			Core		Buffer		Transition	
			Dry	wet	Dry	Wet	Dry	Wet
Olive baboon	*Papio anubis*	Visual	√	√	√	√	√	√
Warthog	*Phacochoerus africanus*	Visual	√	√	–	–	–	–
Colobus monkey	*Colobus guereza*	Visual	√	√	–	√	√	√
Spotted hyena	*Corcuta corcuta*	Visual	√	√	–	–	–	√
Pig	*Sus scrofa*		√	√	–	–	√	–
Grey duiker	*Syluicapra grimmia*	Visual	√	√	–	√	√	–
Vervet monk	*Cercopithecus aethiops*	Visual	√	√	√	√	√	√
Menelik's bushbuc	*Traglaphus scriptus meliniki*	Visual	–	√	√	–	–	–
Stark's hare	*Lepus starki*	Foot print	√		√	-	–	–

4.5 Occurrence of mammals

Depending on their occurrence, mammals in the Sheko forest priority area were grouped into common (55.5%), uncommon (33.3%) and rare (22.2%) based on how often they were sighted (Table 6)

Table 6: The occurrence of the medium and large-sized mammals in Sheko forest priority area

Common name	Scientific name	Occurrence
Olive baboon	*Papio Anubis*	Common
Vervet money	*Cercopithecus aethiops*	Common
Pig	*Sus scrofa*	Common
Colobus monkey	*Colobus guereza*	Common
Warthog	*Phacochoerus africanus*	Uncommon
Grey duiker	*Syluicapra grimmia*	Uncommon
Starks hare	*Lepus stark*	Uncommon
Hyena	*Corcuta corcuta*	Rare
Menelik's bush buck	*Traglaphus scriptus meliniki*	Rare

4.6 Abundance

Among the 312 individual of medium and large sized mammals recorded during the wet season, the most abundant species was olive baboon, 220(76.3%) and the second was vervet monkey, 66 (21.15 %), The third abundant species was pig , 15 (5.2%) followed by colobus monkey, 3 (1.04%). The fifth was grey duiker, Minilik's bushbuck and warthog each with 0.69% (two individuals). During dry season, out of the total 366 mammals recorded, the most abundance was olive baboon 280(75.06%). The second was common monkey 32(8.73%) followed by pig, 18 (4.8%). and the fourth was warthog and grey duiker each with 6 (1.6%) individuals. The spotted hyena was the least abundant with 1(0.2%) individual (Table 7)

Table 7: Number of medium and large sized mammals and their relative abundance recorded in the Sheko forest priority area

	Number recorded		Relative abundance	
Species	Dry	Wet	Dry	Wet
Olive baboon	280	220	75 .06 %	76 .3%
Warthog	6	2	1.6 %	0.69 %
Colobus monkey	2	3	0.5 %	I.04 %
Spotted hyena	1	2	0.2 %	0.69 %
Pig	18	15	4.5%	5.2 %
Grey duiker	6	2	1.6 %	0.69 %
Vervet monkey	32	66	8.73 %	21.15 %
Stark's hare	-		-	-
Menilik's bushbuck	4	2	1%	0.69%
Total	349	312	100%	100%

The highest number of individuals of medium and large sized mammals were recorded from core zone (155), followed by buffer zone (104) and transition zone with (90) during dry season (Table 8). More number of individuals is also observed in core (148) than transition (86) and buffer (78) during wet season (Table 8). Seasonal variations in abundance (number) of individuals between seasons in core habitat (dry=155 and wet=148) ($\boldsymbol{x^2}$=0.28438, df=1, P< 0.05), buffer (dry=104 wet=78) ($\boldsymbol{x^2}$ =0.02782 df=1, P 0<.05) and transition (dry=90 wet=86) ($\boldsymbol{x^2}$=0.7070, df=1, P>0.05) Their variation in abundance is significantly varies among buffer and core habitats of the study area but the variation seen in the transition zone is not statically significant

General their significant variation between season (dry=349 and wet=312)

$x^2 = 0.0380 \quad df = 1 \quad p < 0.05$

Table 8: Number of individual of medium and large sized mammalian species in the three zones of the forest

Species	Forest zone					
	Core		Buffer		Transition	
	Dry	Wet	Dry	Wet	Dry	Wet
Olive baboon	120	110	90	60	70	70
Warthog	2	4	-	-	-	-
Colobus monkey	1	1	-	1	1	1
Hyena	1	1	-	-	-	3
Pig	9	15	-	-	6	-
Grey duiker	4	1	-	1	2	-
vervet monkey	18	14	10	16	11	12
Stark's hare	-	-	-	-	-	-
Menelik's bushbuck	-	2	4	-	-	-
Total	155	148	104	78	90	86

4.7 Species similarity

During dry season, the highest similarity was seen between the core and transition zones (SI=0.42) and the second was between the core and buffer zones (Sl= 0.33). The least species similarity was seen between buffer and transition zones (Sl= 0.30). During wet season, the highest similarity was seen between the buffer and transition zones (Sl= 0.37) followed by the core and buffer zones as well as in between core transition zones (SI=0.33) (table 9)

Table 9: Species similarity among the three forest zones during the dry and wet seasons

	Forest zone					
	Core		Buffer		Transition	
Season	Dry	Wet	Dry	Wet	Dry	Wet
Core	−	−	0.33	0.33	0.42	0.33
Buffer			−	−	0.30	0.37
Transition						

During combined seasons, the highest similarity of species was seen between the core and the transition zones (SI=0.357). The next similarity was seen between the buffer and transition zones

(SI= 0.335) and the least similarity was seen between the transition and buffer zones (SI= 0.33) (table 10)

Table 10 Similarity of the medium and large-sized mammalian species during combined seasons

	Habitat type		
	Core	**Buffer**	**Transition**
Core	–	0.33	
Buffer			0.335
Transition	0.375		

5. DISCUSSION

The total number of mammalian species (nine species) recorded from Sheko Forest Priority area is less compared to the number of mammalian species recorded with similar studies in recently established protected areas in Ethiopia. For example, Gonfa *et al.,* (2015) recorded 28 mammalian species from Dati Wolel National park, western Ethiopia, while Negeri *et al*.(2015) recorded 23 mammalian species from Baroye controlled hunting area, Ilubabor Zone, south west Ethiopia. The number of species recorded from Sheko forest was even less than the total number of mammalian species recorded (12 species) from Bashata and Gunaye community forests (Alkadir 2016), Benishangul Gumuz national regional state, western Ethiopia. The small number of mammalian species recorded from Sheko forest priority area could be due to human impacts in and around the forest area.. The adverse effect of livestock and human settlement on the distribution of wild animals have been reported by different researchers

(Bonnington *et al.,* 2007; Gundogdu, 2011 ,Maan and Chaudhry, 2001)

However, the number of species recorded in this study may not represent all the species of medium and large-sized mammals in the forest. One of the reasons could be the short period of survey which may not be enough to make exhaustive record of all the mammalian species of the area. The second probable reason is that many medium and large-sized mammals could be, longer period of survey and methods should be devised for both diurnal and nocturnal mammals to record all the mammals of the forest.

Seasonal variations were observed in diversity and evenness of medium and large-sized mammals among the three zones of the forest. Among the three zones, the highest diversity (H`=1.62) and evenness (J= 0.9) of medium and large sized mammals was recorded in transition Zone of the forest during dry season. The second diversified (H`= 0.99) and more evenness (J= 0.48) was recorded in the core Zone of the forest. The least diversity was recorded in buffer zone (H`= 0.36, J= 0.26) during the season. During the wet season, the highest diversity (H`=0.947) and evenness (J= 0.45) in large and medium-sized mammalian species was recorded from the core zone of the forest. The next diversified was buffer zone (H`= 0.92, J= 0.66) and the least record was seen in transition zone of the forest (H`= 0.71, J= 0.51). These variations in diversity and evenness among the various zones of the forest during the wet and dry seasons may be due to variations in resource availability between the two seasons in the different zones of the forest.

For example, the highest diversity in the transition zone during the dry season could be due to the abundance of food particularly at the beginning of the dry as many of the fruits and crops planted ripen at this time.). In line with this, reports indicated that the distribution and habitat association of mammals are often correlated mainly with the availability of water, food and protection (Conroy and Nichols 1996; Girma *et al.,* 2012 Timer, 2005; Yaba *et al.,* 2011)

Relatively the core zone is with more diversity and evenness in both seasons. One of the major reasons could be less human disturbance as human activities are minimized in this zone of the forest. The other important reason might be the heterogeneous vegetation in the core zone compared the buffer and the transition zones of the forest. The availability of mixed plant species is known to be one of the major factors that determine the diversity of mammals in an area (Mathew and Rahamatthulla, 1993). Heterogeneous plant species available in the core zone of the forest might be the main reason for high diversity index of this zone of the forest. Various studies also have also showed that homogenous conditions yield lower diversity while heterogeneous conditions yield higher diversity
(Alatolo, 1981, Conroy and Nichols 1996, Mekonnin *et al.,* 2011)

The distribution and habitat association of mammals are often correlated mainly with the availability of water, food and protection (Conroy and Nichols 1996; Girma *et al.,* 2012 Timer, 2005; Yaba *et al.,* 2011) .The presence of high number of mammalian species in the core zone of the forest may be due to the availability of food and other resources to meet their requirements. The highest species similarity seen between the transition and core zones of the forest (SI=0.375) might be due to similarity in plant species found between the two zones of the forest.

The abundance of animals mainly correlates with the size of the available preferred habitat, presence or absence of natural enemies and the impact of human beings. The most abundant mammal was the olive baboon (76.3%). The high abundance of olive baboon in the study area might be associated with different species of fruit bearing trees in the forest and availability of water. Olive baboons are abundant in areas with sufficient food and water (Enstam and Isbell, 2007; McDougal *et al.,* 2010). The absence of the natural enemies for this species could be another reason for its abundance. A similar explanation can be given to the high abundance of

Vervet monkey next to olive baboon. The least abundant is *Corcuta corcuta* (0.40 %) in both dry and wet seasons in the study area can be given different explanations. One could be due to its nocturnal behavior. As the animals are nocturnal, their abundance could be seriously under estimated as no survey was conducted during the night time when this animal is active. The other probable reason could be due to human impacts. *Corcuta corcuta* is directly persecuted by livestock farmers due to its habit of preying on live stock. Among mammals observed in the Sheko forest priority area, Olive baboon, Vervet monkey and Colobus monkey were found distributed an all the three zones of the forest. The distribution of these mammals in all the three zones indicates their adaptation to a variety of habitat types.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

During the present study, the forest was divided in to three zones .Core, buffer and transition to investigate the diversity and abundance of the medium and large sized mammals Out of the nine species, eight species were observed directly and one was recorded indirectly. No previous research was conducted on the present title there were three habitats selected to investigate the diversity and abundance of the medium and large sized mammals in the area. However, the differences in the abundance of medium and large sized mammals showed among the habitat were high. The observed differences in diversity, abundance and distribution might be due to difference in resource availability and other biotic and a biotic factor. The present study area supports variety of medium and large sized mammals species therefore the value of conserving these environmental resources is not maintain the diversity and integrity of the biological resources but their benefit and services play important roles to sustain life and to meet the basic needs of all human kind

6.2. Recommendation

- ❖ Sheko forest national priority area is an important area in its fauna and floras, so the following recommendation are suggested to protect and ensure the area

- ➢ Awareness among the peoples should be created through exhibition; seminars and other media

- ➢ More effort should be channeled into preventing further habitat degradation

- ➢ Increasing the awareness of the society use to avoid the invasion of coffee plantation instead of the previous forest can make stability of habitat

- ➢ A full length exhaustive survey should be made in all habitats by increasing the sampling area.

- ➢ The protected area do not have scouts so the biodiversity responsible people (or body) should prepare scouts for the area to conserve the mammalian diversity

REFERENCES

Alkadir, M (2016). The diversity abundance and habitat association of medium and large- sized mmals in Bashata and Gunaye community forests, Metekel zone, Benishangul Gumuz Region, western Ethiopia, MSc thesis, Jimma university, Jimma

Alonso, A., Dallameier, F. & Campbell, P. (2001).Urubamba: The biodiversity of Peruvia rainforest.Smithsonian Institution, Washington, D.C.

Ash, J.S. and Atkins, J. (2009).*Birds of Ethiopia and Eritrea, an Atlas of Distribution* Christopher Helm, London, 643 pp.

Atkinson, I. (2001). Introduced mammals and models for restoration.*Biological Conservation*, **99:81**-96

Balakrishinan and P.S. Easa.(1986). "Habitat preference of large mammals in the Parambikulam Wildlife Sanctuary.Karala, India." Biological Conservation, volume, **37**:191-200.

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

Bekele A , Yalden DW (2014) the mammals of the Ethiopia and Eritrea Addis Ababa University press Addis Ababa Ethiopia P 391

Berger,J. Stacey, P. Bellis, L. and Johnson, P. (2001). A mammalian predator–prey imbalance:grizzly bear and wolf extinction affect avian Neotropical migrants. Journal of applied Ecology, **11**: 947–960

Bibby,C. J., Burgess, N. D. and David, H. (1992).*Bird Census Techniques*. Academic Press, London, 299 pp

Bonnington, C., Weaver, D.and Fanning, E. (2007).Livestock and large wild mammals in the Kilomberovalley, in Southern Tanzania. *African Journal of Ecology***45** (4): 658-663

Brown J., 1984, The relationship between abundance and distribution of species, Am. Nat., 124: 255-279 Cambridge University Press, 1988, pp.36.

Brown, L. H. (1984). The status, habitat and behavior of the Mountain Nyala (*Tragelaphus buxtoni*). Natural Geographic Society Research Reports 1965 projects, pp 23-24

Burley,J. (2002). Forest Biological Diversity: an Overview. *Unasylva.***53**:3-9

Cardillo,M., Purvis, A., Securest, W., Gittleman, J.L., Bielby, J., and Mace, G.M. (2004).Human

Population Density and Extinction Risk in the World‟s Carnivores. *Journal of Primate Biology* **2**(7):909-914

Carrillo, E.,Wong , G. &Cuarón, A. D. (2000). Monitor- Monitoring mammal populations in Costa Rican protected areas under different hunting restrictions. Conservation Biology, **14**(6): 1580–1591

Chane, M. (2010).Mammalian diversity in Borena-Sayint National Park, South Wollo, Ethiopia. M.Sc. thesis,Addis Ababa University, Addis Ababa. 84p

Christian, A. (2007). Environment for survival.Green ForemConferrance Proceedings.**1**:38-323.

Conroy, M and Nichols,J.(1996).Designing a study to assess mammalian diversity. In: Wilson, D.Cole, F.,Nichols, J., Rudran, R., Foster, M. ed. Measuring and monitoring Biological diversity:Standardmeasure for mammals.Washington.D.C:Smithsonian institution press 41-49.

Cox, P. and Balick,J. (1994). The ethno botanical approach to drug discovery.*Scientific American* **270**(6):82−87.

Cuaron, A.(2008). A global persepectiveon a habitat disturbance and tropical rain forest mammals. *Conserve Biol*. **14**: 1574-1579

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

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

Emmons L and Feer F (1997). Neo tropical Rainforest Mammals. Chicago. University of

Chicago press.380p Erb.” Predator scent post survey and winter track indices,” In *Status of Wildlife Populations*

Enstam, K. and Isbell, L. (2007). The guenons (genus Cercopithecus) and their allies: behavioral ecology of poly specific associations. In: Campbell, C. Fuentes, K. MacKinnon, M. Panger, and Bearder, S.Eds. Primates in Perspective pp. 252-

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

FAO.(2001).State of the world‟s forests 2001. Food and Agricultural Organization of the United Nations.

Flower.J. and coher. L.(1990). Practical statics for field Biology. John Wiley and sons. Chi chester , munication. University of Illinois press, Chicago.

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.

GebreEgziabher,T.(1991). Diversity of Ethiopian Flora.**In:** *Plant Genetic Resource of Ethiopia*, pp. 75-81, (Engels, J.M.M., Hawkes, J.G. and MelekuWorede, eds.). Cambridge University Press, London

Gillespie, C.A. (2003). *Ethiopia*. Infobase Publishing, New York, 124 pp.

Girma, Z, Mamo Y and Ersado, M. (2012).Species composition, distribution, and relative abundance of Large mammals in and around Wondo Genet Forest patch, Southern Ethiopia. *Asian Journal of applied sciences* **5:**538-551.

Gonfa R., Gadisa T., and Habtamu, T.(2015). Diversity, Abundance and habitat association of medium and large sized mammals in Dati Wolel National Park, Western Ethiopia, International Journal of Biodiversity Consernation,7(2): 112-118

Grime, J. (1997). Biodiversity and ecosystem function: The debate deepens. *Science.* **277**:1260−1261

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

Hillman, J. C. (1993). Ethiopia: Compendium of Wildlife Conservation Information. Vol.1. Ethiopian Wildlife Conservation Organization, Addis Ababa, 454 pp. (http://lntreasures.com/ethiopia.html))

IBC (Institute for Biodiversity Conservation). (2005). *National Biodiversity Strategy and Action Plan.* Addis Ababa.

Kingdon, (2004) "The Kingdon Pocket Guide to African Mammals," Princeton University Press, Princeton, pp. 272,.

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

Kingdon, TheKingdon field guide to African mammals. Academic Press.London, pp. 476, 1997., pp.488.

Kormondy, E. (1996). Concepts of Ecology.4th Ed. Prentice−Hall, Inc., Upper Saddle River, New Jersey, USA

krebs, CJ(2006). Ecology: the experimental analysis of distribution and abundance, 2nd edition, Harper and row, New York

Laurance, W. F., Croes, B. M., Tchignoumba, L., Lahm, S., Alonso, A., Lee, M. E., Campbell, P. and Ondzeano, C.(2006) Impacts of roads and hunting en Central Africa Rainforest mammals. Conservation Biology, **20**(4): 1251−126

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

Maan, M. and Chaudhry, K. (2001) Wild life diversity in the Punjab (Pakistan), Online *Journal of Biological Sci*ences**1**(5):417-420

Martín H, et al. (2000) Regulatory mechanisms for modulation of signaling through the cell integrity Slt2-mediated pathway in Saccharomyces cerevisiae. *J Biol Chem* 275(2):1511-9

Mathew, G. and Rahamattulla, V. (1993). Studies on the butterflies of Silent Valley Natural Park. *Entomology*. **18**:185−192.

Mekonnin, T.,Yaba., M, Bekele, A, and Malcolm,J .(2011) .Food selection and habitat association of Starck's hare (Lepusstarcki petter,1963) in the Bale Mountains National park Ethiopia Asian *Journal of Applied sciences***4**:728-734.

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. Conservation Biology **14**:318–321.

Mugatha, M. (2002). Influences of Land-use Patterns on Diversity, Distribution and Abundance of Small Mammals in Gachoka Division, MbeereDistrect, Kenya.Land- use Change, Impacts and Dynamic Working Paper Series Number: 8, Nairobi. 46pp

NCS **Vol. I.** (1994).National Policy on the Resource base, its utilization and planning for Sustainability

Negeri, D., Gdisa, T. and Habtamu T., (2015). The diversity, distribution and relatibe abundance of medium and large-size mammals in Baroye controlled hunting area, Illubabor Zone, southwest Ethiopia. International journal of molecular evolution and biodiversity, 5(4): 1-9.

Negussie G(2009).”study on insect diversity of Ankoricha forest and sheger puplic park in and Dry seasons in Ethiopia”, MSC thesis, Addis Ababa university ,Addis Ababa

NLFC (2005).Newhall Land and Farming Company.Assessment and Survey of Mammals within the Newhall Ranch SpecificPlaneArea. Impact Science, Inc., California. 57pp

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

Oubert, S.C.J. (1976). “The Population Ecology of the Roan Antelope Hippotraguseguinus eguinus (Desmera, 1804) in the Kruger National Park.” Ph D. Dissertation, University of retoria, Pretoria

Patterson, B. D., Ceballos, G., Sechrest, W.,Tognelli, M. F., Brooks, T., Luna, L., Ortega, P., Salazar, I. and Young B. E. (2003).Digital Distribution Maps of the Mammals of the Western Hemisphere.*Center for Applied boiscince, Conservation International* **1**:9pp.

Putman, R. (1994). *Community ecology*. London: Chapman and Hall

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

Reif, v, and Tornberg, R. (2006). Using time-lapse video recording for a nesting study of birds of prey. Eur. Wild 1. Res. **52**:251-

Roemer, G. W., Gompper, E. & Van Valkenburgh, B. (2009). The ecological role of the Mammalian meso carnivore. Biological Science, **59**(2): 165–173

Scheibe, K, Eichhorn, K, Wiesmayr, M, Schonert, B, Krone, O. (2008). Long-term automatic video recording as a too for analyzing the time patterns of utilization of predefined locations by wild animals. J, Eur. Wild 1, Re. **54**:53-59

Shanno. G. E and W. Weaver.(1949).The Mathematical Theory of Communication. Chicago: University of Illinois Press

Sutherland HM (2007). Ecological census techniques 2nd ed. Cambridge university press. pp450

Sutherland, W. (1996).*Ecological Census Techniques:* A Hand book. Cambridge University Press, Cambridge, pp. 332-336. Terborgh. "The big things that run the world."*Conserv. Biol.*, vol. 2, pp. 402-403, 1988.

Takacs, D. (1996). *The Idea of Biodiversity: Philosophies of Paradise*. The Johns Hopkins University Press, Baltimore

Tilman, D. Duvick, S. Brush, R. Cook, G. Daily, G. Heal, S. and Notter,D. (1999). *Benefits of biodiversity*. Ames, Ia.: Council for AgriculturalScience and Technology, 31.

Timer, G. (2005). Diversity, Abundance, Distribution and Habitat Association of large mammals in the CheberaChurchura National Park, Ethiopia.M.Sc.thesis, Addis Ababa University, Addis Ababa

UNESCO. (2008). Status and distribution of faunal diversity in Kafa Afromontane coffee forest faunal report doc. 46-47 pp.

Varman K.S., and Sukumar R., 1995, The line transect method for estimating densities of large mammals in a tropical deciduous forest:An evaluation of models and field experiments, Biosci., 20: 273-287 vol. M.H. Dexter, Ed. Minnesota: Division of Fish and Wildlife, Minnesota Department of Natural

Veitch, C. (2001). The eradication of feral cats (*Feliscatus*) from Little Barrier Island,.*J, New Zealand Zool*. **28**: 1-12.

Viveropol, J. L. (2001). *A Guide to Endemic Birds of Ethiopia and Eritrea*.Shama Books, Addis Ababa, 79pp.

Wilson, D. E. and Reeder, D M. (1996).*Mammal Species of the World Taxonomic and Geographic Reference,* 3rdedn,VolI Johns Hopkins University Press, Baltimore.pp.745─1945.

Yaba, M., Mekonin., T, Bekele, A. and. Malcolm, J. (2011). Food selection and Feeding behaviour of Giant mole Rat (Tachyoryctesmacrocephalus, Ruppell, 1842) from the Sanetti plateau of Bale Mountains National Park' Ethiopia.*Asian Journal of applied sciences***4**:735-740

Yalden, and M. J. Largen, "The endemic mammals of Ethiopia," Mammlian Reviews, vol. 22,

pp. 115-150, 1992.

Yalden, D.W. (1983). The extent of high ground in Ethiopia compared to the rest of Africa. *Sinet: Ethiop. J. Sci.* **6:** 35-39

Yalden, D.W., Largen, M.J., Kock, D., and Hilman, J.C. (1996). Catalogue of the Mammals of Ethiopia and Eritrea.Vol.7.Revised Checklist, Zoogeography and Conservation.*J. Trop. Zool.* **9**: 73 – 164

Yimer, D.(2008). Mammalian diversity in mazie national park, Ethiopia. M.Sc. Thesis, Addis Ababa University, Addis Ababa, Ethiopia.

Yirga, S.(2008). „Atibiwochu". Ethiopian Wildlife and Natural History Society, Addis Ababa

Young J., 2010, Ethiopian protected areas. A 'Snapshot'. A reference guide for future strategic and project fund, EWCA, Addis Ababa, pp.46

APPENDIX 1. Field data sheet used for surveying medium and large size mammals Study

Area----------Study site----------Date----------Observer----------

NO,	Species	No, of individual	Habitat type	Time	Method of identification

APPENDIX 2 .Row data of mammalian species recorded throughout the study period from different study site

No of species	***Forest types***					
	Core		***Transition***		***Buffer***	
	wet	*dry*	*wet*	*dry*	*wet*	*dry*
Olive baboon	*50*	*40*	*15*	*10*	*10*	*33*
	45	*55*	*35*	*20*	*18*	*23*
	15	*5*	*15*	*25*	*20*	*17*
	0	*20*	*5*	*15*	*22*	*17*
Warthog	*2*	*2*	*0*	*0*	*0*	*0*
	0	*0*	*0*	*0*	*0*	*0*
	2	*0*	*0*	*0*	*0*	*0*
	0	*0*	*0*	*0*	*0*	*0*
Colobus monkey	*0*	*0*	*0*	*0*	*0*	*0*
	1	*1*	*0*	*0*	*1*	*0*
	0	*0*	*1*	*1*	*0*	*0*
	0	*0*	*0*	*0*	*0*	*0*
Spotted hyena	*0*	*0*	*0*	*0*	*0*	*0*
	0	*0*	*0*	*0*	*1*	*0*
	1	*1*	*0*	*0*	*0*	*0*
	0	*0*	*0*	*0*	*2*	*0*
Pig	*5*	*0*	*0*	*0*	*0*	*0*
	6	*5*	*0*	*3*	*0*	*0*
	3	*4*	*0*	*3*	*0*	*0*
	1	*0*	*0*	*0*	*0*	*0*
Grey duikey	*0*	*0*	*0*	*0*	*0*	*0*
	1	*2*	*0*	*1*	*0*	*0*
	0	*2*	*0*	*1*	*1*	*0*
	0	*0*	*0*	*0*	*0*	*0*
Vervet monkey	*5*	*0*	*3*	*2*	*6*	*0*
	6	*5*	*2*	*3*	*4*	*2*
	3	*4*	*6*	*5*	*5*	*8*
	1	*9*	*1*	*1*	*2*	*0*
Starks hare	*0*	*5*	*0*	*0*	*0*	*0*
	0	*2*	*0*	*1*	*0*	*2*
	0	*4*	*0*	*0*	*0*	*2*
	0	*1*	*0*	*0*	*0*	*0*
Minilik bush buck	*0*	*0*	*0*	*0*	*0*	*0*
	1	*1*	*0*	*0*	*0*	*2*
	0	*2*	*0*	*0*	*0*	*0*
	1	*1*	*0*	*0*	*0*	*2*

APPENDIX 3 plates of some mammalian species recorded in the area

Oliv babbon

colobus monkey

Vervet monkey

Pig

Grey duiker

Warthog

Spotted hyena

Menelik bush back