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Department of Biology

The Diversity, Abundance and Habitat Association of Diurnal Medium and Large sized Mammals in Gaysay, Bale Mountain National Park, Oromia National Regional state, Southeast Ethiopia Area

By: Abu Keweti

Advisor:Tsegaye Gadisa (PhD)

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List of Acronyms

AAU…….Addis Ababa University

EPA .....Environmental Protection Authority

EWCO …… Ethiopian Wildlife Conservation Organization

EWNHS..... Ethiopian Wildlife and Natural History Society

FAO …… Food and Agriculture organization of United Nation

GPS …… Global poising System

IBC..... Institute for Biodiversity Conversation

OARDB…….Oromia Agriculture and Rural Development Burea

Spp……..species

SPSS……Statistical Package for Social Sciences

Abstract

The study was conducted to assess the diversity, abundance and habitat association of medium and large sized mammals in Gaysay, Bale Mountain National Park from February, 2015 to August, 2015. Three habitat types; grassland, woodland and Erica forest were covered in the study. Inventory of the medium and large size mammalian species was made from representative transects randomly selected from each habitat. Indirect evidences including foot print, pug mark, burrows, quills and calls were also used to record the presence or absence of mammals. A total of 12 species of medium and large sized mammals belonging to four mammalian orders (Lagomorpha, Primate, Artiodactla and Carnivora) were recorded. Grassland had the highest diversity index (H'=1.333) during wet season. The most diversified habitat during dry season was woodland with (H'=1.504) while the least diversity was recorded in Erica forest in both dry (H'=0961) and wet (H'=0.827) seasons. Most common medium and large sized mammals in the study area were warthog (*Phacochoerus africanus),* olive baboon (*Papia Anubis),* menelik's bushbuck (*Traglaphus scriptus*) and grey duiker (*Sylvicapra grimmia).* In terms of abundance, Mountain nyala (*Traglaphus buxtoni*)(30.2%) and warthog (*Phacochoerus africanus)* (24.6) were the most abundant while the least abundant medium and large mammal species recorded from the study area were Klipspringer (*Oreotagus oreotagus*)(0.1%) and Spotted hyena (*Corcuta corcuta*)(0.1%). Among the three habitat types, the highest species similarity was obtained between the Woodland and Erica forest (SI=0.800) and the least species similarity was obtained between Grassland and Erica forest (SI=0.461) during wet season. The similarity of mammalian species between grassland and woodland was highest during dry season (SI=0.750). Mammals of the study area were classified in to common (41.67%), uncommon (41.67% %) and rare (16.66%) based on how often they were sighted. 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, Gaysay, habitat association, mammals, , similarity index, ,

1. INTRODUCTION

1.1. Background of the study

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 km^2 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 faunistic 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 perissodactyls 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,16 reptiles, 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). Gaysay is the northern part of Bale Mountain National Park. It has remnant biodiversity with important natural forest and high altitude and fauna, but with limited current biological information.

1.2. Statement of the problem

The Bale mountain national park was established to protect the mountain nyala, Ethiopian wolf and other endemic species found in Bale Mountains (Waltermire, 1975). Gaysay is the northern part of the park which is known for population of mountain nyala. Habitat fragmentation caused by human settlement and agricultural expansion has affected mammals' potential to inhabit their suitable range in Gaysay. Current resource exploitation is opportunistic and unregulated. Agricultural land is expanding rapidly, grazing areas are heavily degraded necessitating a continuous search for new pasture, forests are being cut and cleared, and water systems disrupted. There are no effective land use management plans, land use rights and ownership are confused, and there is no control of resource use.

Knowledge on mammalian diversity, abundance and habitat association is very essential for the development of sound management plan of Gaysay. Even though the mammals of the area were studied in the past for example Stephens *et al* (2001), there is no current information on diversity, abundance and habitat association of Medium and large sized mammals in the area. Thus the present study was aimed to fill the gap by gathering current information on the diversity, abundance and habitat association of medium and large sized mammalian in Gaysay of Bale Mountain National Park Bale Zone, Oromiya National Regional State, South east Ethiopia.

1.3. Objectives of the study

1.3.1. General Objective

The general objective of this study was to assess the diversity, abundance and habitat association of diurnal medium and large sized mammals in Gaysay, Bale Mountain National Park Bale Zone Oromiya Region, southeast Ethiopia.

1.3.2. Specific Objectives

The specific objectives of the study were:-

-To record the diurnal medium and large sized mammals species in the study area.

-To determine abundance of diurnal medium and large sized mammal species in various habitats of the study area.

-To assess habitat association of the mammalian fauna under stated category in the study category.

1.4. Significance of the study

The destruction of vegetation and environmental degradation have become issues of national and global concern in recent years. This is because of declining vegetation cover and depletion of natural resources are closely associated with drought and food shortages that have become major threat affecting the life of wild life.

Therefore; the result of the proposed research work will have a great importance in scientific documentation and provide the current detail information about the diversity, abundance and habitat association of diurnal medium and large sized mammals in Gaysay, Bale Mountain National Park, Bale Zone, Oromiya Regional state, Southeastern Ethiopia. This is important for the future development and sound management plan of Gaysay.

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 (Cox and Balick, 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 eggslaying 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 trophic 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 Importance of medium and large 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 trophic 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 trophic 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 (Serbek-Araujo and Chiarello, 2005). In addition to this terrestrial visual encounter survey is the core survey for medium and large sized mammals (Reif and Tornberg, 2006).

2.6. Threats of medium and large 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 interplay of abiotic 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 including migration, alteration of the chemical environment and introduction of exotic species are responsible for disturbing the regularity of wildlife. The ecological impacts of losses of habitat and redistribution of animals away from development areas may affect the foraging success or survival in areas beyond the initial zone of disturbance. This results in

overgrazing, erosion, changes in predation pressure and breeding (Anonymous, 2001). 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 (Brashares *et al*.,2004). 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

3.1.1. Geographic location of the study area

Gaysay derives the name from the little Gaysay river that flows into Web near Dinsho(http://www.selemta.net/). It is located in the Dinsho Woreda, Bale zone, Oromiya National Regional State, SouthEast Ethiopia. It is located at 400 kms, from capital of the country (Addis Ababa) and 30 Kms from Zonal capital Robe town. It is bounded by Gofingra Kebele to the north, Gojera Kebele to the south, Horasoba Kebele to the Northwest and Dinsho town to the east (Bale Mountain National park Management Office).

The study area is located in the northern parts of BMNP, between $6^{o}\,20'$ to $7^{o}\,40'$ N latitudes and $39^{o}\,30'$ to $39^{o}\,58'$ E longitudes in the southeastern highlands of Ethiopia (Fig: 1). The Gaysay Valley is ($34.4km^2$), covering about 1.6% of the park's area and the elevations varies from 3200 to 3500 m asl (OARDB, 2007).

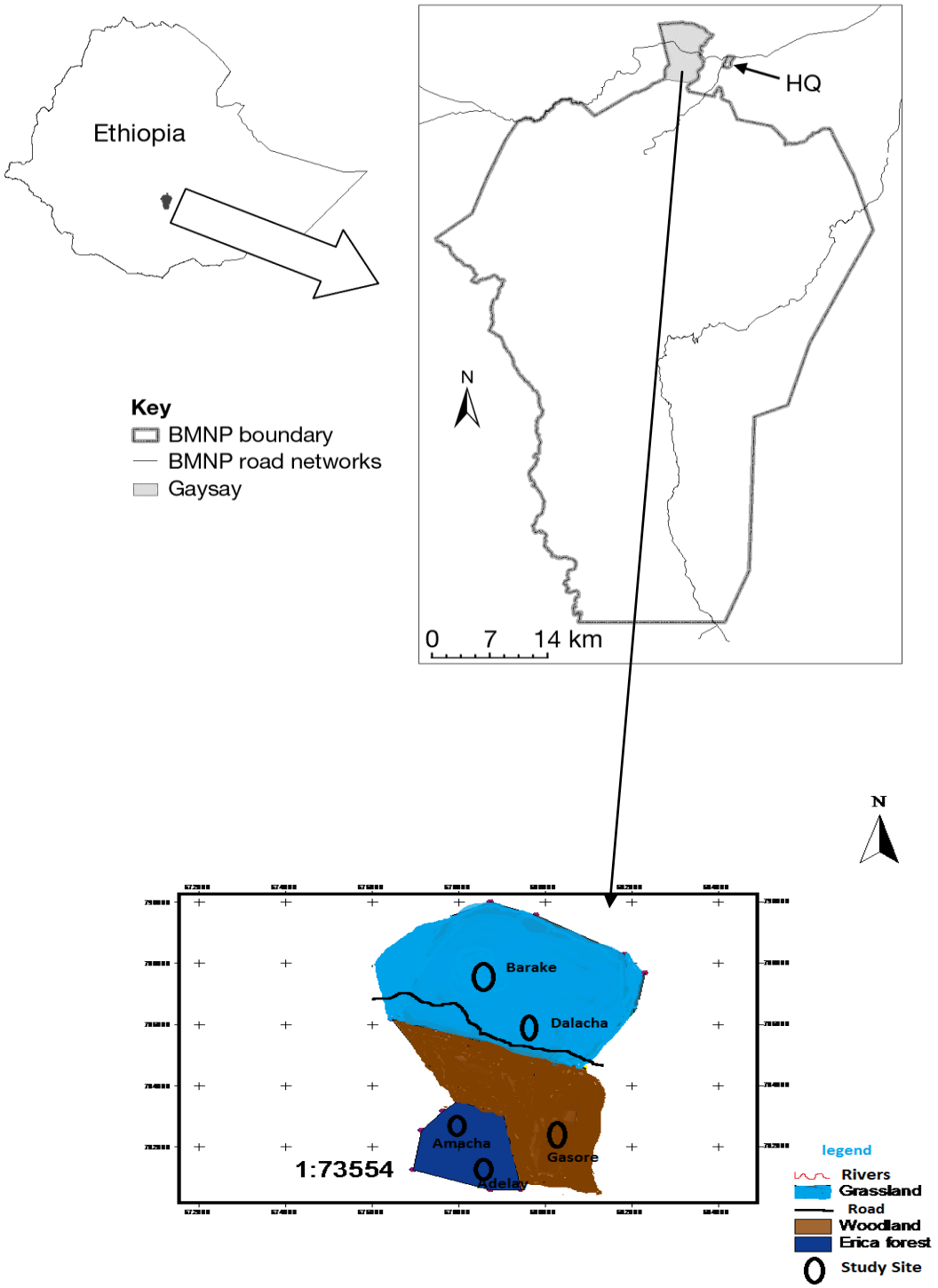

Figure 1. Map of the study area

3.1.2. Vegetation

The vegetation of the study area can be divided in to three main types; Grassland, woodland, and Erica forest.

3.1.2.1. Grassland

Grassland covers the largest portion of the study area. This habitat approximately covers more than 50% of the study area. The grassland, which is part of the northern projection of the BMNP boundary, is dominated by *Artemisia afra*, *Ferula communis, Kniphofia foliosa*, grasses and sedges (Teshome *et al*., 2011).

Figure 2. Grassland
(Photo by:Abu Keweti July, 2015)

3.1.2.2. Woodland

Woodland covers the large portion of the study area next to grassland. The lower altitudes are dominated either by *Juniperus procera* or *Hagenia abyssinica* with the two species sometimes co-dominating on slopes. Other species that are not dominant but of significance include, *Hypericum revolutum*, *Myrsinemelanophloeos* and *Discopodium eremanthum.*The higher altitudes are dominated by *Hypericum revolutum*, *Helichrysum citrispinum* and *H. splendidum* moorland (Teshome *et al*., 2011).

Figure 3. Woodland

(Photo by:Abu Keweti Feburary, 2015)

3.1.2.3. Erica forest

The Erica forest covers the smallest portion of the study area. *Erica* spp. may grow to be 10 m tall and may take the form of a small tree. It is the dense forest dominated by *Erica arborea* and *Erica trimera* (Teshome *et al*., 2011)

Figure4. Erica forest

(Photo by: Abu Keweti Feburary, 2015)

3.1.3. Rivers

The rivers in the area are web, Dalacha and Gaysay and their tributaries such as Guracha, Huluka-Borena, Lenchencha and handida whose source is from forested mountain of the area.

3.1.4. Soil

There are two types of soil in the area. These are chromic luvisol and eutric cambisol (OARDB, 2007).

3.1.5. Climate

The description of the climate was collected from the Robe metrological station, 30 kms far from the study site.

3.1.5.1. Temperature

According to the temperature data obtained from Robe Metrological Station the mean monthly maximum temperature of the area ranged between 15.0 to 17.2 °c and the mean minimum temperature of the area ranged between 2.3 to 6.4°c (Fig 5)

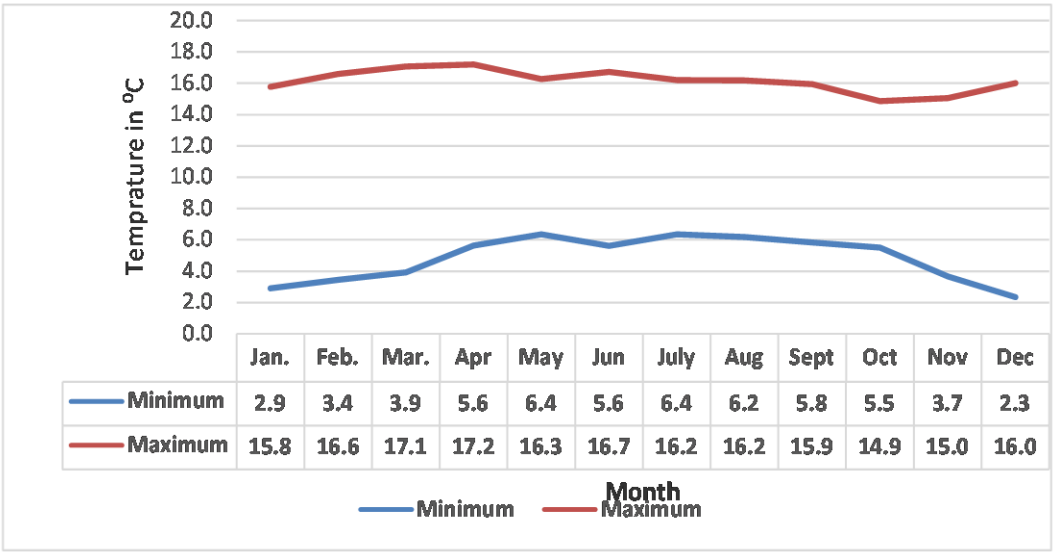

Figure 5.Monthly mean maximum and minimum temperature in study area (2005-2014).

3.1.5.2. Rainfall

The total amount of annual rainfall in the study area varies between 2713.7mm to 2937.6mm and the mean annual rainfall of the area is 2825.65mm. The area receives the high rainfall during wet season from September to October and the lowest during the dry season from November to February (Fig 6).

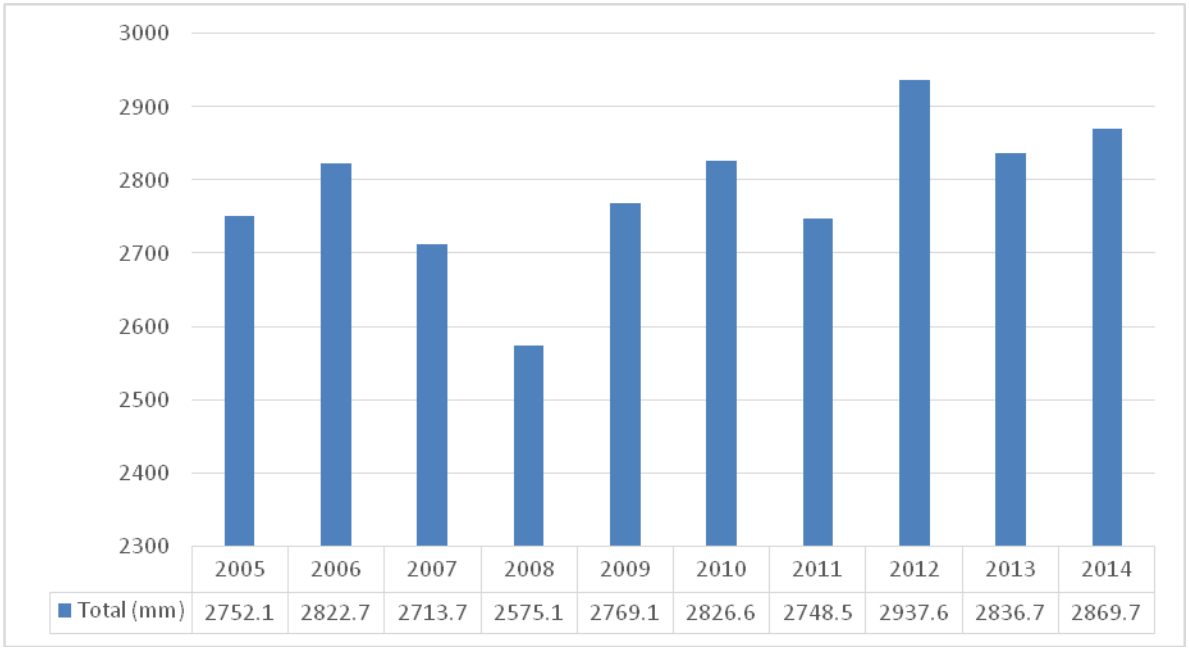

Figure6. Annual average rainfalls in the study area (2005-2014)

3.2. Methodology

3.2.1. Preliminary Survey

Before starting the main research work, preliminary survey about the study area was conducted during February, 2015 in Gaysay 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 grassland, woodland and Erica forest based on the nature of vegetation. The sampled areas were made to cover at least 20 to 25 %of the study area (Bibby*et al.,* 1992).

Among the established habitats; permanent transect lines were established (Sutherland, 1996). During this period permanent transect lines were established and the locations were marked using Global Positioning System (GPS). The number of transect line and the distance between each transect line was determined by size of the habitat and vegetation.

3.2.2. Mammalian survey

Survey of the medium and large size mammalian species in the study area was conducted on foot along randomly selected transect lines. The data for dry season was collected in February and March 2015 and the wet season data was collected in July and August/2015. The data was collected twice for each season. Classification of the study area was based on the vegetation of the area. A total of 10 transect lines were established in the study area. Four transect lines for grassland, 3 transect lines each for woodland and Erica forest were established. Three transect lines for Barake and one for Dalacha in grassland, two transect lines for Adelay and one for Amacha in Erica forest and one transect each for Gasore, Adelay and Dalacha in woodland were established. In the grassland habitat transects length of 2.5 km with a width of 250 m, in woodland transects length of 2 km with a width of 200m and in the Erica forest transects length of 1 km with a width of 100 m were used. Data from one habitat was collected at once to avoid

double count. The species in the study site was recorded through direct observation by using roof prism binocular or naked eyes. Indirect evidences including foot print, pug mark, burrows, quills and calls were also used to record the presence or absence of mammals (Wemmer *et al.*, 1996). Field observations were carried out during (7:00-11:00) in the morning and (15:00-18:00) in the afternoon when most mammals in the study were active.

When an individual animal or group of animals is sighted, movement was stopped and Species, habitat type, geographical location, and number of individual in a group were recorded at each transect line and species identification was based on the Kingdon Field Guide to African Mammals (Kingdon, 1997) and "Atibiwochu" (Yirga, 2008).

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 a rare (if probabilty of seeing is less than 50% or single recorded during the whole survey periods) (Hillman, 1993). In the present study, mammalian species were classified based on the above

3.2.3. 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 (Shanno and Weaver, 1949), $H' = -\sum [(\frac{ni}{N}) \times \ln (\frac{ni}{N})]$ Where ni= number of individuals of each species (the ith 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 $J = \frac{H'}{Hmax}$ 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.

Chi-square (x^2) was used to calculate habitat association of the species in the study area.

Relative abundance=$\frac{\text{Total number of individuals of species}}{\text{sampled } habitat}$

SPSS computer Program was used for Chi- square analysis to test the association of mammal species and their habitats.

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

4. Results

4.1 Species Composition

A total of 950 and 914 individuals of medium and large-sized mammals were observed and recorded in the Gaysay of Bale Mountains National Park in the wet and dry season rspectively. During this investigation, 12 species of medium and large-sized mammals were observed. Among these mammalian species only whitetailed mongoose (*Icheumia albicauda*) and stark's hare (*Lepus starcki*) were the medium sized mammals observed, whereas the remaining 10 were large sized mammals. The mammalian species recorded from this study area belong to four mammalian orders (Lagomorpha, Primate, Artidactla and Carnivora) and 7 families. The highest number of mammalian species was recorded for the family of Bovidae which contained five species and followed by Cercopitheci which contained two species. Each of the rest five families contained only one species.

Table1. Medium and large sized mammalian species recorded from Gaysay

Afan Oromo	Common Name	Scientific Name	Order	Family
Hileti	Stark's hare	*Lepus starcki*	*Lagomorpha*	*Leporidae*
Wenu	Colobus monkey	*Colobus abys sinicus*	*Primate*	*Cercopitheci*
Jaldesa	Olive baboon	*Papio anubis*	*Primate*	*Cercopitheci*
Borofa	Menelik's bushbuck	*Traglaphus scriptus*	*Artidactyla*	*Bovidae*
Borte	Klipspringer	*Oreotagus oreotagus*	*Artidactyia*	*Bovidae*
Goda	Bohor reed buck	*Redunca redunca*	*Artidactyla*	*Bovidae*
Karkaro	Warthog	*Phacochoerus africanus*	*Artidactyia*	*Suidae*
Warabesa	Spotted hyena	*Corcuta carcuta*	*Carnivora*	*HYaenidae*
Fochi	Whitetailed mongoose	*Cheumia albicauda*	*Carnivora*	*Hyrpestidae*
Jedala	Common jackal	*Canis aureus*	*Carnivore*	*Canidae*
Kurupe	Grey duiker	*Sylvicapra grimmia*	*Artidactyla*	*Bovidae*
Gadamsa bada	Mountain nyala	*Traglaphus buxtoni*	*Artidactyla*	*Bovidae*

4.1.1. Diversity indices of medium and large sized mammals

Among the three habitats, Woodland was the most diversified habitat (H'=1.504) and with high evenness (J=0.773) as well the second diversified habitat was grassland with (H'=1.392) and (J=0.633) while the least diversity was recorded in Erica forest with (H'=0.961) and (J=0.693) during the dry season. During the wet season, grassland had the highest diversity index with Shannon-Weiner index (H'=1.333) and evenness (J=0.606) the second diversified habitat was woodland with (H'=1.319) and (J=0.736) while the least diversity was recorded in Erica forest with (H'=0.827) and (J=0.596) Table 2.

Table 2. Diversity indices (H'), evenness (J) and abundance for medium and large mammalian species in the three different habitat types in the study area during wet and dry seasons.

Habitat type	**Number of species**		**Abundance**		**Diversity**		**Evenness**	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Grassland	9	9	593	552	1.333	1.392	0.606	0.633
Woodland	6	7	277	279	1.319	1.504	.736	0.773
Erica forest	4	4	80	83	0.827	0.961	0.596	0.693

For combined seasons, grassland had the highest diversity index with Shannon-Weiner index (H'=1.437) and evenness (J=0.599) the second diversified habitat was woodland with (H'=1.424) and (J=0.731) while the least diversity was recorded in Erica forest with (H'=0.823) and (J=0.593) for both seasons Table 3.

Table 3. Diversity indices (H'), evenness (J) and abundance for medium and large sized mammalian species in the three different habitat types in the study area during both seasons.

Habitat type	Number of species	Abundance	Diversity	Evenness
Grassland	11	1145	1.437	0.599
Woodland	7	556	1.424	0.731
Erica forest	4	163	0.823	0.593

4.1.2. Distribution of Mammals observed in the different habitat types

All 12 species of mammals recorded from the present study area were identified by direct observation. Distribution of these mammalian species is shown in Table 4.

Table 4.Distribution of medium and large sized mammals along the study habitats observed in the study area.

Species	Species Identification method	Habitat type					
		Grassland		Woodland		Erica forest	
		Wet	Dry	Wet	Dry	Wet	Dry
Stark's hare (*L.starcki*)	Visual	√	-	-	-	-	-
Colobus monkey(*C.abyssinicus*)	Visual	√	-	-	-	-	-
Olive baboon (*P.anubis*)	Visual	√	√	√	√	√	√
Menelik's bushbuck(*T.scriptus*)	Visual	√		√	√	√	√
Klipspringer(*O.oreotagus*)	Visual	-	-	-	√	-	-
Warthog(*P.africanus*)	Visual	√	√	√	√	√	√
Spotted hyena(*C.carcuta*)	Visual	√	-	-	-	-	-
Whitetailed mongoose(*C.albicauda*)	Visual	√	√	-	-	-	-
Common jackal(*C.aures*)	Visual	√	√	-	-	-	-
Grey duiker(*S.grimmia*)	Visual	√	√	√	√	√	√
Mountain nyala(*T.buxtoni*)	Visual	√	√	√	√	-	-
Bohor reed buck(*R.redunca*)	Visual	√	√	√	√	-	-

√ stands for the presence of animal in a habitat - stands for the absence of animal in a habitat

4.1.3. Occurrences of mammals

Based on occurrence in the study area, the medium and large sized mammals were grouped in to common, uncommon and rare (Table 5). Out of the 12 mammalian species recorded in the study area, 41.67% was uncommon, 41.67% were common and 16.66% were rare.

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

Common	Uncommon	Rare
Mountain nyala	Grey duicker	Spotted hyena
Warthog	Whitetailed mongoose	Klipspringer
Bohor reed buck		Colobus monkey
Olive baboon		Common jackal
Menelik's bush buck		Stark's hare

4.2 .Species Richness and Abundance

4.2.1. Number of mammalian species in the four habitat types of the study area

During the study period of the dry season the highest number of mammalian species was recorded in Grassland (9 species), followed by Woodland which contained 7 species. The least number of mammalian species was recorded in Erica forest with 4 species. During wet season, the highest number of mammalian species was recorded in Grassland (9 species), followed by Woodland which contained 6 species while Erica forest contained 4 species. For combined seasons, Grassland contained 11 species followed by Woodland which contained 7 species. The least number of species was observed in Erica forest with 4 species (Table 6).

Table 6.Number of mammalian species in different habitat types in both seasons

	Habitat type		
	Grassland	Woodland	Erica forest
Number of mammalian species	11	7	4

4.2.2. Abundance

Among the 950 individuals of medium and large sized mammals recorded in the wet season, the most abundant species was mountain nyala (*Traglaphus buxtoni*) 345(36.4%) followed by Olive baboon 240(*Papio anubis*)(25.3) and warthog 227 (*Phacochoerus africanus*)(23.8%) was the thired most abundant species in the study area. Whitetailed mongoose 2 (*Cheumia albicauda)* (0.2%) and common jackal 2 (*Canis aureus*)(0.2) were the least abundant species in the study area during wet season(Table 7).

From 914 individuals of medium and large sized mammals observed in the dry season, the most abundant species was warthog (*Phacochoerus africanus*) 232(25.4%) followed by mountain nyala (Traglaphus buxtoni) 218 (23.9%) and Bohor reedbuck (*Redunca redunca)* 216*(*23.7%) was the thired most abundant species in the study area. Whitetailed mongoose 1(*Cheumia albicauda)* (0.2%) and common jackal 2 (*Canis aureus*)(0.2) were the least abundant species in the study area (Table 7).

Table7. Total number of medium and large sized mammal species recorded in the study area and their relative abundance during wet and dry season.

Species	Total recorded		Relative abundance **(%)**	
	Wet	Dry	Wet	Dry
Stark's hare(*L.starcki*)	3	-	0.3	-
Colobus monkey(*C.abyssinicus*)	5	-	0.5	-
Olive baboon (*P.anubis*)	240	212	25.3	23.2
Menelik's bushbuck (*T.scriptus*)	19	23	2	2.5
Klipspringer(*O.oreotagus*)	-	2	-	0.2
Bohor reed buck(*R.redunca*)	99	216	10.5	23.7
Warthog(*P.africanus*)	227	232	23.8	25.4
Spotted hyena(*C.carcuta*)		1	-	0.1
Whitetailed mongoose(*C.albicauda*)	2	1	0.2	0.1
Common jackal (*C.aures*)	2	2	0.2	0.2
Grey duiker (*S.grimmia*)	8	7	0.8	0.7
Mountain nyala(*T.buxtoni*)	345	218	36.4	23.9
Total (12)	950	914	100	100

The highest number of individuals of medium and large sized mammals were recorded from Grassland habitat (593), followed by Woodland habitat (277) and Erica forest with 80 during wet season (Table 8). More number of individuals is also observed in Grassland (552) than woodland (279) and Erica forest (83) during dry season (Table 8). Seasonal variations in abundance (number) of individuals between seasons in grassland habitat (wet=593 and dry=552) (x^2=1.468, df=1, P >0.05), woodland (wet=277, dry=279) (x^2 =0.007, df=1, P>0.05) and Erica forest (wet=80, dry=83) (x^2=0.055, df=1, P>0.05) were not significant. Their abundance significantly varies among habitats of the study area (=7.863, df=2, P<0.05).

Table8. Numbers of medium and large sized mammalian species in each habitat type during wet and dry seasons.

Species	Habitat type					
	Grassland		Woodland		Erica forest	
	Wet	Dry	Wet	Dry	Wet	Dry
Mountain nyala (*T.buxtoni*)	234	134	111	84	-	-
Warthog(*P.africanus*)	127	130	89	82	11	20
Bohor reed buck(*R.redunca*)	92	190	7	26	-	-
Olive baboon (*P.anubis*)	126	91	55	68	59	53
Menelik's bush buck(*T.scriptus)*	-	2	12	15	7	6
Grey duiker(*S.grimmia*)	2	1	3	2	3	4
Colobus monkey (*C.abyssinicus*)	5	-	-	-	-	-
White tailed mongoose(*C.albicauda*)	2	1	-	-	-	-
Klipspringer(*O.oreotagus*)	-	-	-	2	-	-
Common jackal (*C.aures*)	2	2	-	-	-	-
Stark's hare(*L.starcki*)	3	-	-	-	-	-
Spotted hyena(*C.carcuta*)	-	1	-	-	-	-
Total 12	593	552	277	279	80	83

4.3 Habitat association

4.3.1. Species similarity based on habitat type

During the wet season, mammal species were more similar between woodland and Erica forest habitat (SI=0.800), followed by grassland and woodland habitats (SI=0.666) (Table 9) where as low species similarity was observed between grassland and Erica forest (SI=0.461). However during dry season, highest similarity index was observed between grassland and woodland (SI=0.75), followed by woodland and Erica forest (SI=0.727) (Table 9).Mammal species were least similar between grassland and Erica forest (SI=0.615).

Table9.Similarity of medium and large sized mammal species between habitats during wet and dry seasons.

	Habitat types					
	Grassland		Woodland		Erica forest	
	Wet	Dry	Wet	Dry	Wet	Dry
Grassland			0.666	0.750	0.461	0.615
Woodland					0.800	0.727

Among the three habitat types for combined seasons, more similarity of mammalian species was obtained from woodland and Erica forest (SI=0.727) followed by grassland and woodland (SI=0.666). Less similarity was obtained from species of grassland and Erica forest (SI=0.533) (Table 10).

Table10. Similarity of medium and large sized mammal species between habitats during combined seasons

	Habitat types		
	Grassland	Woodland	Erica forest
Grassland		0.666	0.533
Woodland			0.727
Erica forest			

Habitat association of medium and large sized mammals among the three different habitats of the study area during wet season is statistically significant at $P< 0.05$ level of significance (x^2 =4.230, df=2, P=0.001 for wet, x^2 =3.642, df=2, P=0.001 during dry).

Habitat association of medium and large sized mammals among the three different habitats of during combined seasons in the study area is also statistically significant $P< 0.05$ level of significance(x^2 =4.286, df=22, P=0.001).

5. Discussion

A total of twelve species of medium and large sized mammals were observed during the study. The mammalian species recorded from Gaysay cannot be compared with similar studies in different parts of Ethiopia (for example Chane and Yirga, 2014; Gonfa *et al*., 2015).This may be due to the lack of sufficient survey in this study. Ten of them were large sized while two of them were medium sized mammals. Mountain nyala, starck's hare and menelik's bush buck were endemic mammals of Ethiopia recorded from the study area. This shows how the area is important in terms of keeping unique world biota .This may not represent all the species present in the study area, but it gives update accounts of some of the medium and large sized mammal species in the study sites. If exhaustive survey is made increasing the study period and the sampling area, the number of mammalian species identified in the study area may be more.

Among the three habitats of the study area during dry season, the highest diversity index (H'=1.504) and evenness (J=0.773) of medium and large sized mammals were recorded in the woodland habitat, followed by grassland that contained diversity index of (H'=1.392) and evenness of (J=0.633). The grassland and woodland harbored different plant species which might have used as the source of food for different mammalian species, compared to Erica forest habitat. Bailey (1984) reported that Cover is also important as mammals interdependent for food sources as well as protection

Grassland had the highest diversity index ((H'=1.333) during the wet season. However, evenness is highest in woodland (0.736). This might be due to the presence of sufficient water and food in the area. Balakrishinan and Easa (1986) have noted that Water and pasture conditions or the

combinations of both are the major factors determining the distribution of wildlife populations in their natural habitats

Among the three habitats of the study area, the highest diversity index (H'=1.437) and evenness (J=0.599) of medium and large sized mammals were recorded in the grassland habitat, followed by woodland that contained diversity index of (H'=1.424) and evenness of (J=0.731) for combined seasons. The grassland and woodland contained different plant species which might have used as the source of food for different mammalian species, compared to Erica forest habitat. Diversity of mammalian species in an area depends on primarily on the availability of mixed plant species, which constitute their major food resources (Mathew and Rahamatthula, 1993).

The presence of different plant species in grassland and woodland in the study area might account for high species diversity index. Homogenous conditions yields lower diversity while heterogeneous condition yield higher diversity (Mekonnin *et al.,* 2001). In addition to this, cover is also important as mammals are interdependent for food sources as well as protection (Bailey, 1984). A pressure forced by environmental factors such as differences in temperature has resulted in declining mammalian diversity (Woldegeorgis, 2010).

The most abundant species in the study area was Mountain nyala (*Traglaphus buxtoni*)(30.2%). This mammal species was not recorded in the Erica forest. Huge number of this mammal was observed in the grassland and woodland habitats. This study is in line with the study of Evangelista *et al* (2007) who recorded more individuals in this study. The high abundance of this species might be due to suitability of habitat for food, cover and water. Mountain nyala are commonly reported to range between 2,700 m and 4,300 m and to prefer heathland and alpine

habitats (Brown, 1969b; Yalden & Largen, 1992). Mountain nyala are largely browsers that feed on a variety of trees, forbs, grasses and cultivars (Brown, 1969b; Hillman, 1985).

Warthog (*Phacochoerus africanus*)(24.6%) was the second most abundant and wide spread species in all three habitats of the study area. The high abundance of this species might be due to suitability of selected habitats for this animal. Common warthogs are associated with savanna, open woodlands, shorter grassland, flood plains, as well as open areas around waterholes and pans but mostly avoid densely wooded vegetation (Slotow 1985; Vercammen & Mason 1993).

Olive baboon (*P. anubis*)(24.2) was the third most abundant species in the study area. This might be attributed to the feeding behavior of the olive baboon. The species is known to be widely distributed in Africa in wide variety of habitats from savanna grass land to up land Afro-montane forest. It is adapted to feed on variety of food items (Johnson *et al*., 2012). Generally, it is known that primates (particularly families of Colobidae and Cercopithecidae) need forested areas with tall trees (Kingdon, 2003).

The least abundant medium and large mammal species recorded from the study area were Klipspringer (*Oreotagus oreotagus*)(0.1%) and Spotted hyena (*Corcuta carcuta*)(0.1%). The low abundance of klipspringer might be due to their territorial behavior. Monogamous species typically occur in low densities due to their marked territoriality, and it is highly sensitive to ecological disturbance (Nievergelt, 1998). The low number of spotted hyena in the study area could be due to it's nocturnal behavior. Mammals need densely forested habitats and cover that could make the sighting of them difficult. (Girma , 2006).

The low abundance of some of mammals in the study area was due to factors that are known to decrease mammal number in an area. Human population growth and development lead to the appropriation of extensive areas of land for settlement, agriculture, resource extraction and the

infrastructure to support these activities, which in turn are responsible for wildlife habitat loss and fragmentation (Foley *et al.* 2005). Similar to other anthropogenic pressures, live-stock grazing can have strong impacts on native wildlife, their habitat and overall ecosystem function and structure (Aagesen, 2000).

Water and food requirement of medium and large sized mammals might determine their distribution and habitat association in the natural habitats. Consequently, medium and large-sized mammal distribution and diversity in the present study area was highly associated with habitat types. Water and pasture conditions or the combinations of both are the major factors determining the distribution of wildlife populations in their natural habitats (Balakrishinan and Easa,1986).

The highest numbers of species were recorded in Woodland and Grassland habitat during combined seasons. The occurrence of more species of medium and large sized in Grassland is probably due to the availability of necessary resources that satisfy their need. This is in line with the study of Mengesha and Bekele (2008) who recorded high number of mammalian species from Grassland and Woodland from Alatish National Park. The high number of species in the Grassland is due to the presence of food, water and stability of the area from disturbances (Chane, 2010).

The highest species number recorded in the Woodland habitat was presumably due to the movement of these species from the peripheral part of the study area towards the inner and relatively protected part the (woodland) in search of food and cover. In addition to this, Woodland is less affected by anthropogenic pressures and live stock encroachments. Several studies in different localities have revealed the adverse effect of livestock and pack animals encroachments and human settlement on the abundance and distribution of wild mammals,

which in turn would reduced the sighting opportunities of the mammals (Busby, 2005, Hassani *et al*., 2008; Girma *et al*., 2012).

The mammalian species like warthog (*Phacochoerus africanus),* olive baboon (*Papia Anubis),* menelik's bushbuck (*Traglaphus scriptus*) and grey duiker (*Sylvicapra grimmia)* were observed and recorded in all habitats in the present study area. The distribution of these mammals in all habitats is attributed to their adaptation to variety of habitat types. However, Mountain nyala and Bohor reed buck were common in Woodland and Grassland. This might be due to their behavior. This is in line with the idea of Smith (1992) who suggested that differences in the diversity and evenness of mammals are governed partly by differences in their feeding habits. The distribution of mammals in the different habitat types of the area might indicate habitat selection of the different species of mammals based on their ecological preferences as well as evolutionary adaptation (Bailey, 1984).

The distribution of mammals in the study area revealed that the mammalian fauna is not uniform across the three main types of habitats. Their distribution might depend on the presence or absence suitable habitats for mammal. In the present study area, Menelik's bush buck was largely associated to the Woodland and Erica forest. The relatively higher number of this species might be attributed to the relatively thick underground cover of the forest and grazing land that is assumed to be ideal for the species to secure cover and food. Similar studies have noted that the number of this subspecies was considerably high in most highland Afro-montane remnant forests of Ethiopia with thick underground cover (Bekele, 1988; Girma *et al*., 2012).

The highest species similarity for combined seasons of diurnal medium and large sized mammals was obtained from the Woodland and Erica forest (0.727). This might be due to the less disturbance of the two habitats by human and livestock. The least species similarity was obtained from Grassland and Erica forest (0.533). This might be due to dissimilarity of the two habitats in the availability of food, cover and other resources to meet their requirement.

6. Conclusion and recommendation

6.1. Conclusion

This study identified and recorded medium and large sized mammals of Gaysay and provided current information about their presence. Twelve species of medium and large sized mammals were identified. Fewer species were identified compared to previous study. Fourteen species were recorded in the past. The current observed mammalian species belonged to four orders seven families.

The differences in diversity, abundance and distribution might be due to difference in vegetation cover and other biotic and a biotic factor. Little variation in species diversity was observed among the three major habitat types in the present study area. However, the differences in the abundance of medium and large sized mammals showed among the habitat were high. This might be due to difference in vegetation cover in the habitats of the study area. The present study area supports variety of medium and large sized mammals in which some of them are endemic.

6.2. Recommendation

Gaysay is one of the important part of Bale Mountain National Park in terms of it's medium and large sized mammalian species composition. Hence, the following recommendations are suggested to ensure long term conservation of mammalian species in the study area.

-From diurnal medium and large sized mammals recorded in the study area, endemic mountain nyala was the most abundant species. However, other endemic mammals like menelik's bushbuck and stark hare need attention from the concerned body as were least abundant compared to mountain nyala.

-The present study was focused on diversity, abundance and habitat association of diurnal medium and large sized mammals. This does not give complete update number of large and medium mammals of the study area. Study for both diurnal and nocturnal should be conducted.

-Increasing the knowledge and competency of scouts through training should continue to obtain accurate scientific data for the study to be conducted on mammals in the study area.

-The effort of local communities, local and regional authorities and federal organization in conservation should continue uninterrupted.

Mountain nyala and bohor reedbuck were not recorded from the Erica forest habitat in the current study. Current detailed ecological study of these mammals should be conducted to have clear understanding of their habitat requirement.

-Exhaustive survey should be made by increasing the study period and the sampling area which can increase the number of individuals and mammalian species that can be recorded in the study area.

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Appendices

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

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

No	species	Number of individuals	Habitat type	Time	Method of identification

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

Species	Habitat				
	barake	Dalacha	Gasore	Adelay	Amacha
Mountain nyala	71	51	14	14	-
	28	22	3	15	-
	63	95	22	3	-
	78	29	35	20	-
Warthog	64	45	10	10	-
	44	17	12	23	7
	27	27	27	17	-
	69	24	8	28	-
Bohorreed buck	75	63	-	-	-
	48	24	-	6	-
	17	24	-	-	-
	27	24	-	7	-
Olive baboon	-	56	-	9	30
	57	30	16	14	-
	109	42	-	-	-
	-	15	-	74	-
Menelik's bush buck	1	3	2	5	-
	1	3	3	3	2
	-	2	1	3	3
	-	2	3	5	-
Grey duiker	1	1	1	2	1
	-	-	-	1	-
	-	1	-	2	-
	-	2	-	2	1
Colobus monkey	-	-	-	-	-
	-	-	-	-	-
	5	-	-	-	-
	-	-	-	-	-
Whitetailed mongoose	-	-	-	-	-
	1	-	-	-	-
	1	-	-	-	-
	1	-	-	-	-

Klipspringer	-	-	-	-	-
	-	-	-	-	-
	-	-	2	-	-
	-	-	-	-	-
Common jackal	2	-	-	-	-
	-	-	-	-	-
	2		-	-	-
	-	-	-	-	-
Stark’s hare	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
	3	-	-	-	-
Hyena	-	-	-	-	-
	-	1	-	-	-
	-	-	-	-	-
	-	-	-	-	-

Appendix3. Traglaphus buxtoni in the study area

(Photo by: Abu Keweti July, 2015)

Appendix 4. Phacochoerus *africanus* in the study area.

(Photo by Abu Keweti August, 2015)

DECLARATION

I, hereby, 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. I declare that this thesis is not submitted to any other institution anywhere for the award of any degree, diploma. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgment of the source is made.

Name: Abu Keweti

Signature_____

Date _____