



Jimma University

College of Natural Sciences

School of Graduate Studies

Department of Biology

Diversity, distribution and relative abundance of medium and large sized mammals in two selected forests of Darimu district, Illuababor zone, Oromia regional state, south western of Ethiopia

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A Thesis Submitted to Department of Biology, College of Natural Science, Jimma University for the Partial fulfillment of the Requirements for the Degree of Master of Science in Biology.

June, 2019

Jimma, Ethiopia

Approval form

Jimma University

School of Graduate studies

Department of Biology

Title: species diversity, distribution and relative abundance of medium and large sized mammals in two selected forest of Darimu district Iluababorzone, Oromia region south west of Ethiopia.

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Acknowledgement

I would like to express my appreciation to my advisor: Gelaye G/michael for her unreserved cooperation, supervision, fruitful advice and appreciable encouragement in developing this thesis. I thank her again for her valuable comments and total assistance to accomplish this thesis and I would like to express my appreciation to my Co advisor GadisaNatea for his cooperation, supervision and advice in developing this thesis and express my great thanks to Jimma University in general and Biology department in particular for they have contributed in one or other ways to develop this research. Also I would like to thank the Oromia Regional state Education Bureau for giving me the Opportunity to study my MSc. Degree in Biology. Finally I want to thank everyone who was with me by documental and technical support.

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List of Acronyms

ASL: Above sea level.....	10
EBI: Ethiopian Biodiversity Institutes.....	2
EFAP: Ethiopian forestry Action Plan	4
GPS: Global positional system.....	13
ha: hectare.....	13
IBC:Institute of Biodiversity.....	1
SPSS: Statistical package for Social Science.....	15
USAID: United states Agency for International Development.....	7
WCMC: World conservation monitoring center.....	2

Abstract

The present study was carried out to determine diversity, distribution and relative abundances of medium and large sized mammals from September 2017 to October, 2018, in two selected forests of Darimu district, Iluababor zone, Oromia region, south western Ethiopia. The three fragmented forests in the study area were homogenous in vegetation type, disturbance level and topography, but different in area (hectare). Sombo forest was different from the rest, in vegetation type, disturbance level and in topography. Line transect method was employed for all the two forest types and species identification were made along each transect. In addition to direct observation, indirect method such as fecal dropping, footprint, scent marks, spine and sound were also used for identification of mammals. A total of 25 species of medium and large sized mammals grouped in 7 orders and 14 families were recorded from the study area during both dry and wet seasons. Among these mammals, only three species were medium sized, whereas the remaining 22 species were large sized mammals. Sombo forest had the highest mammalian diversity during both dry and wet seasons with the diversity index (H') 2.36. The relative abundant mammalian species in the study area were grivet monkeys (28.3%), Colobus monkey (22.5%), Olive baboon (6.34%). Whereas, Hippopotamus (0.5%) was the least abundant, followed by Lion and African buffalo (0.73%) of the total observation. The three fragmented forests (Furdo, Golol and Gololyabalo) were disturbed forests by residents for different purposes like agricultural expansion, logging for building material, cattle grazing, charcoal production and coffee cultivation, Whereas Sombo forest were relatively undisturbed.

Keywords: Chera Dambi, Darimu district, disturbance, diversity, mammals, Sombo

1. INTRODUCTION

1.1. Background of the study

Biological diversity is the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems. It includes the variety of living organisms, the genetic differences among them and the communities and ecosystems in which they occur (IBC, 2011). On global scale estimated some 5,416 mammalian species, from these large and small mammals comprises large numbers. Out of 5416 species, more than 1150 species of mammals were recorded from the African continent (Kingdom, 1997). In Eastern Africa, rodents account for 28% of the total mammalian fauna (Kingdom, 1997). The insectivore fauna, particularly of shrews, is also diverse having 140 species (Yalden, 1990). The population of many large and medium sized-mammalian species in the world is decreasing alarmingly due to natural and anthropogenic factors. The increment of population trend results encroachment over forest habitats (Ademasuet *et al.*, 2012).

Africa remains a continent whose fauna have been poorly studied was reflected in the continent description of new species (Delany.M.J, 1986). In Africa the majority of conservation areas sanction some sort of human activities within their borders but few of them are part of community-based conservation schemes. The effectiveness of these state-owned, partial protected areas in conserving mammalian fauna is largely unknown (Caro, 1999). The most suitable ecology for medium and large size mammals is which free from anthropogenic (Tadesse, 2003).

Many pastoral communities waiting wildlife for direct benefits from wildlife resources and wildlife-based ecotourism ventures will earn them direct revenue. However, for ecotourism, prerequisites such as tourist attractions (especially large mammals), community willingness and support, tourist and tourism investor opinions, support of conservation stakeholders, and economic viability need to be assessed (Okello, 2006). The ecological diversity of African forests have high large and medium sized population compared with other continents. Many large and medium sized species are found in the rain forests of Africa (Nowak, 1999; Harris and Chapman, 2007; Campbell *et al.*, 2011)

Ethiopia is among the few African countries with high species diversity. Currently 320 species of mammals (Afework and Yalden, 2014), 861 species of birds, 201 species of reptiles, 63 species of amphibians, 145 species of fresh water fish and 324 species of butterflies known from Ethiopia (Yalden and Largen, 1992; Leykun, 2000; Manyetal., 2006; Dewit and Afework, 2008). Among these about 31 mammals, 16 birds, 25 amphibians, and 19 reptiles are considered to be endemic to the country. The high level of endemism of mammals in Ethiopia is attributed to the large extent of high lands (above 3000m) isolated from the rest part of Africa and the variation in temperature and rain fall among different habitats (Yalden, 1992). The extensive high lands and plateaus are the most distinguishing features that make Ethiopia unique from the rest of the continent.

Out of 320 species of mammals in the country about 60% are medium and large sized mammals (Afework and Yalden, 2014). Medium sized mammals those weighing between 2 and 7 kg include mammals such as small carnivores, small primates, large rodents, hyraxes and pangolins while the species with more than 7kg are considered to be large sized mammals, these include most diurnal primate, most carnivores larger than a fox or house cat, all prosodactyls (horses, rhinos, tapirs) and artiodactyls (Emmons and Feer, 1997).

To protect and conserve these diverse and important biological resources such as endemic animals, the Ethiopian Wildlife Conservation Authority and regional governments allocated wildlife conservation areas under different categories (e.g. 21 National or regional Parks, 11 Wildlife Reserves, 3 Sanctuaries, 22 Controlled Hunting Areas and 69 Important Bird Areas yet many are left unrecognized (Young, J., 2010).

Management of agro ecosystems for biodiversity conservation is increasingly recognized. Agro forestry systems in particular provide a refuge for forest dwelling organisms (Dawson, *etal.*, 2013). Their suitability for biodiversity conservation is, however, affected by management intensity and canopy cover (Tejeda-Cruz and Sutherland, 2004), and there are tradeoffs between income, biodiversity and ecosystem functioning during agro forestry intensification (Steffan-Dewenter *etal.*, 2007; Philpott, 2010).

1.2. Statement of the problem

Information about mammalian distribution, abundance and composition is very essential to develop management plan for a given protected area (WCMC, 1994). Studies carried out by showed that many areas of the Afromontane forest and critical areas in Africa, including Ethiopia are subjected to ecological degradation and deterioration due to anthropogenic (human induced impact) (EFAP, 1994). Human activities have threatened the existence of wild life by destroying their habitat (Harrison and Bruna, 1999).

No information is available about mammalian species diversity, composition, conservation and threat in the Darimu district, there is an accelerated reduction on the number of mammalian species as the result of anthropogenic activities, such as hunting, by resident people, habitat destruction, fragmentation for agricultural expansion, logging for building material, Cattle grazing, coffee cultivation, pressure by domestic animals and heavy encroachment by human being. These activities have threatened the existence of wildlife including mammals through destroying their habitat, If not serious management interventions are taken, the condition will become very hazardous.

Therefore, the present study was designed to gather information about mammalian species, diversity, relative abundance and distribution of medium and large sized mammals in the four selected forest of Darimu district, Illuababor zone, and Oromia regional state of south western of Ethiopia.

1.3, Objective of the study

1.3.1 General objective

The general objective of this study was to assess species diversity, relative abundance and distribution of medium and large-sized mammalian species in four selected forest of Darimu district, Illuababor zone, Oromia regional state, South-West of Ethiopia.

1.3.2. Specific objectives

- ❖ Assess diversity and relative abundance of medium and large-sized mammals in the study area.
- ❖ Determine species distribution of large- and medium sized mammals in the study area.
- ❖ Assess age structure and sex ratio for the most abundant mammalian species of the Study area.
- ❖ Compare species diversity and relative abundance of medium and large sized mammals in the study area.

1.4. Significance of the study

Human activities have dramatically disturbed natural environments throughout the world. Similarly Ethiopian protected areas are increasingly degraded by human activities. Land is being converted for subsistence and commercial agriculture, timber used for fuel wood and construction, protected grass lands used for livestock grazing. Therefore, the result of the proposed research work will have a great importance in scientific documentation and provide detail information about the diversity, relative abundance and distribution of medium and large sized mammalian in four selected forest of Darimu district, which is important for the future development of management plan for conserving fauna and flora diversity in the study area. In addition the information collected during this study will serve as a base line for other researchers interested to carry out additional studies in this area. Also this research serve as inputs for further scientific research, education purpose designing and implementation of the management of conservation areas. Furthermore, knowledge about the ecological impacts between human activities and wild life is highly important to alleviate the problems for the surrounding management and to make tourist attraction area in the future. The research information will assist base line for others researchers by giving the species diversity of medium and large sized mammals as well as the nature and the potential of the forest areas. Show emphasizes conservation for wild life and forest by both community and government. Therefore, the present study will be aimed to document the mammalian diversity of the area as base line information for better management of the resources.

1.5. Delimitation

This research emphasize species diversity, composition, relative abundance, distribution of medium and large sized mammals in two selected forests of Darimu district, Illuababor zone of Oromia regional state, south western of Ethiopia.

2. REVIEW LITERATURE

2.1. Biodiversity and its conservation in Ethiopia

Ethiopia is located at 3° 30'N and 15° 00' N latitude and 33°E and 48 ° E longitudes in the horn of Africa. The extensive central massifs in Ethiopian covers over 80% land area making it the largest continuous highland area in Africa. Ethiopia is one of the top 25 wildlife biodiversity rich countries in the world, and hosts two of the world's 34 biodiversity hotspots, namely: the Eastern Afromontane and the Horn of Africa hotspots (WCMC, 1994).

Ethiopia has very diverse climatic conditions varying from hot and dry deserts in the low land areas to cold and humid alpine habitats in the highlands. Such diverse climatic conditions and habitats contributed to the presence of high species diversity in plants and animals.

Management of agro ecosystems for biodiversity conservation is increasingly recognized. Agro forestry systems in particular provide a refuge for forest dwelling organisms (Dawson *et al.* 2013). Their suitability for biodiversity conservation is, however, affected by management intensity and canopy cover (Tejeda-Cruz and Sutherland 2004; Bhagwat *et al.* 2008), and there are tradeoffs between income, biodiversity and ecosystem functioning during agro forestry intensification (Steffan-Dewenter *et al.*, 2007; Philpott, 2010).

Wildlife resources of the country are now largely restricted to a few protected areas (Tewodros and Afework ,2008). So far the country established several protected areas for conservation of wildlife resources which include 21 national parks, four sanctuaries, three wildlife reserves, 20 controlled hunting areas, six open hunting areas, six community conservation areas and 58 national forest priority area of which 37 are protected (Young .J., 2012; IBC, 2012).

2.2 Mammalian species diversity

Mammals have evolved to exploit a large variety of ecological niches and have numerous adaptations to take advantage of different life styles (Flym *et al.*, 2005).As mammals vary greatly in size; they also vary greatly in life span. Generally,smaller mammals have short and large mammals' home long live span.Bats are an exception to this pattern;they are relatively

small mammals that can live for one or more decades under natural conditions, considerably longer than natural life span of some of the larger mammal (Grzimek, 1990).

Mammals comprise attractive class of animals that display tremendous morphological, physiological and reproductive diversity (Griffiths, 1984). They share several feature in common, and also contain a vast diversity of forms. The smallest mammal are found among the shrews and bats and weigh as little as less than 2kg. The larger mammals, and indeed the largest animal ever to inhabit the planet, is the blue whale which, weigh over 160 tones. On land the largest mammal is the African elephant which can be 3.2m tall at the shoulder and weighs 5.5 tones. Monotremes, marsupials, and eutherian mammals can be distinguished by variety of characteristics but they have different modes of reproduction that most clearly lead to their classification (Flynn, T. and Hii, J 1947).

Among mammals living to day, 0.1% of them are eggs laying and 99% are placental species of mammals are found on all continents, occurring from the arctic in the north hemisphere to the southern tips of the continents and large islands in the southern hemisphere (Nowak, 1991). According to Wilson and Reeder (2005), more than 5400 species of mammals exist today which are placed under 29 orders. However, systematists do not yet agree on the exact number or on how some orders and families are related to others. New information coming from phylogenies based on the molecular evidences and from new fossils does changing peoples' understand in many groups (Flynn, T. and Hii, J, 1947).

Locomotion styles of mammals are also diverse. Social behaviors vary considerably as well. Some mammals live in groups of tens, hundred, 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 maybe nocturnal, diurnal or crepuscular that means mammals that are active at dusk and dawn when the light level is low (Reichholf, 1990).

2.3 Distribution of medium and large size mammals

Mammals are biologically the most successful groups of animals with the possible exception of arthropods (Stanbury, 1972). There are 5416 extant mammal species on the globe. Among these, a total of 960 mammal species occur in sub-Saharan Africa (Wilson and Reeder, 1993). The

most diverse species of these mammals include bats, rodents, carnivores, primates and shrews. Some of these mammals are forest specialists and others are generalists. Mammals are very important for the proper functioning of ecosystems and are responsible for pollinating plants (Carthew and Goldingay, 1997), seed dispersal (Levey *et al.*, 1994), balance populations via predator-prey interaction (Nowak, 1991) and have enormous effects on the structure and composition of vegetation (McInnes *et al.*, 1992). Plant productivity and nutrient cycling (Pastor *et al.*, 1993). The absence and rarity of mammals in given ecosystem have severe consequence with its dramatic geological history and broad latitudinal and altitudinal range.

Ethiopia encompasses an extraordinary number of the world's broad ecological zones. With a high plateau and a central mountain range divided by Great Rift Valley, Ethiopia contains a huge altitudinal range from the depressions in the Afar (115 meters below sea level) to the mountain tops of RasDashens in the north (4,533 meters above sea level) and the Bale Mountains in the southeast (USAID, 2008). The Afro tropical Region (i.e. that part of the continent lying south of the Tropic of Cancer) has about 371,432 km² of land above 2000 m a.s.l., 50.4% of which is in Ethiopia, while of the 28,545 km² of land above 3000 m a.s.l., no less than 79.7% is in Ethiopia (Yalden, 1983). Ethiopia is one of the country where a major habitat block, having a high degree of endemism in both fauna and flora, is contained within political boundaries. (Yalden, 1983). Ethiopia's high faunal biodiversity reflects the existence of a large number of species of mammals and other higher vertebrates.

Medium and large-sized mammals are most vulnerable and intolerant for the slightest habitat changes, hence used as indicators for habitat quality and stability. The continual deteriorating trends of the status of wildlife in the protected areas are frightening, If not serious management interventions are taken, the condition becomes very hazard when it comes to the new habitat to protected area categories. In any cases fast recording of the biological resources of the areas needed and conservation measures. (Caro, 1999).

So, Ethiopia has one of the most diverse mammalian fauna in Africa, Traditionally, many people simply represented Ethiopia as “*Home of the Unique Seven*” which refers to seven distinctive and large endemic mammals found only in Ethiopia. Those seven large mammals are; the Ethiopian wolf (*Canis simensis*), Mountainnyala (*Tragelaphus buxtoni*), Walia ibex (*Capra waliae*), Menelik's bushbuck (*Tragelaphus scriptus meneliki*), Swayne's kudu (*Tragelaphus swaynei*)

celaphusbuseswaynei), Geladababon (*Theropithecusgelada*) and Bale monkey (*Chlorocebusdjamensis*) and the rest (83.9%) are smaller ones including 2, 9 and 15 species of bats, Insectivores and rodents, respectively. However, the country has more than seven large mammals (Amare, 2015). For example, Boutourlini's blue monkey (*Cercopithecus mitis*) which is an endemic sub species of blue monkey (Groves, 2005). Ethiopian Lion (*Pantheraleoabyssincum*), Starck's Hare (*Lepusstarcki*) and Giantmole rat (*Tachyoryctesmacrocephalus*) were some of endemic mammals of Ethiopia that are not included under unique endemic species.

The different mammalian species had different tolerance rate to different habitat factors and ecological amplitude (Aramdeet *al.*, 2011). There is likely to be a high incidence of direct disturbance, including hunting by people, and heavy grazing by livestock around the villages causing a shortage of preferred food (Bergstrom and Skarpe, 1999). As grazing can directly impact the structure, reproduction, and overall fitness of many plant species, knowing which type of grazer (wild vs. domestic) impacts different plant species can be critical to management and conservation decision-making (Wilkerson, 2013). Resource utilization (particularly plant and other vegetation resources) should be monitored to limit the negative impacts on wildlife habitats in the Corridor (Okello, 2005).

2.4 Threats of Mammals

Mammals face numerous threats to their continues existence including habitat degradation and destruction, overexploitations, loss of genetic diversity, endangerment and extinction. The main problem confronting not only mammals but also the earth's biodiversity is human population explosion (Vaughan *etal.*, 2000). Habitat loss and habitat fragmentation are the major threats of protected areas in developing countries including Ethiopian. Human induced habitat loss and associated forest fragmentation are the leading cause of mammalian extinction across the tropics (Wilkie, 2008). While illegal hunting represents the second most serious threat to mammals (Cullen *etal.*, 2000; Peres and Lake, 2001). Anthropogenic activities have their own impacts on wild life by modifying the behavior of animals and their distribution. The disturbance of behavioral patterns of animals can affect their social structures. social structures is a key components in the evolution and dynamic of species. Thus its disruption by human

disturbance can have a major consequences on future population even if the disturbance does not directly affect the survival and the reproduction of mammals (Cardillo *et al.*, 2004).

Growth of human population have been associated with extensive habitat disturbance related to changes in land cover ,expansion of agricultural practices, settlements, uncontrolled resources extraction (over exploitation) and extensive fragmentation of the remaining forests. Mammalian species diversity and abundances tend to decrease with increasing human disturbance of the landscapes (Chairello and Laurance; Lopes and Ferrir, 2008). Mammals are also directly or indirectly affected by environmental pollutants, aquatic pollution has adversely affected aquatic mammals either by direct toxicity or by reducing their food resources (Kathpal, 1994).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The district has an area of 1,387.97 km². Darimu district is bordered by Mettu district in the south direction, in south west and south east bordered by AlgeSach district, in east direction bordered by west Welega zone, in the direction of north west and north east by kelemwelega zone as illustrated in (fig.1).

The highest altitude/elevation in the district is at silase which about 1772m a.s.l and the lowest/elevation in the district is at Uche about 700 m.a.s.l. The minimum annual rainfall of the district is 1192mm and the maximum is 1749.9mm. The minimum temperature of the district is 18C⁰ and the maximum is 25C⁰ (Darimu district rural land and Environmental protection Office, 2018).

CheraDambi and Sombo forests are among the forests found in the Darimu district. CheraDambi lies from 08⁰37'231'' to 08⁰38'357''N and from 035⁰24'531'' to 35⁰30'842''E and it has an area of 2652ha. Furdo, Golol, and GololYabalo are fragmented that make CheraDambi forests (disturbed forest). Sombo forest lies from 08⁰34.707'' to 08⁰36'708''N and from 035⁰30'842'' to 035⁰31'84E (Table 1). Sombo forest is relatively undisturbed forest and its area covers is 1300ha. Furdo fragmented forest is a forest with different human activities like, hunting by resident people, habitat destruction for agricultural expansion, and pressure by domestic animals, firewood collection, and logging for building material, illegal activities (charcoal production), agricultural practices and other human activities. Golol fragmented forest is a forest where the major threats of the forest are anthropogenic such as clearing forest to plant agricultural crops is one of the main causes of deforestation. Farmers cut down the trees, or burn the forest to make space to plant their crops. As a direct result of population growth, there is a steady increase in the number of people who do not have land holdings. They clean the land, often on the edge of forests and settle there. GololYabalofragmented forest is a forest like the two above fragmented forests which different human activities take place like, expansion of Coffee plantation, cutting down trees for construction materials leads to deforestation, more trees are cut down to provide fuel to burn, generally the above three fragmented forests (CheraDambi) are forest disturbed by human activities for different purpose whereas Sombo forest is undisturbed

relatively compare to the others forest. The geographical location, elevations, and area of the three fragmented forests of CheraDambi and Sombo forests were showed (table1).

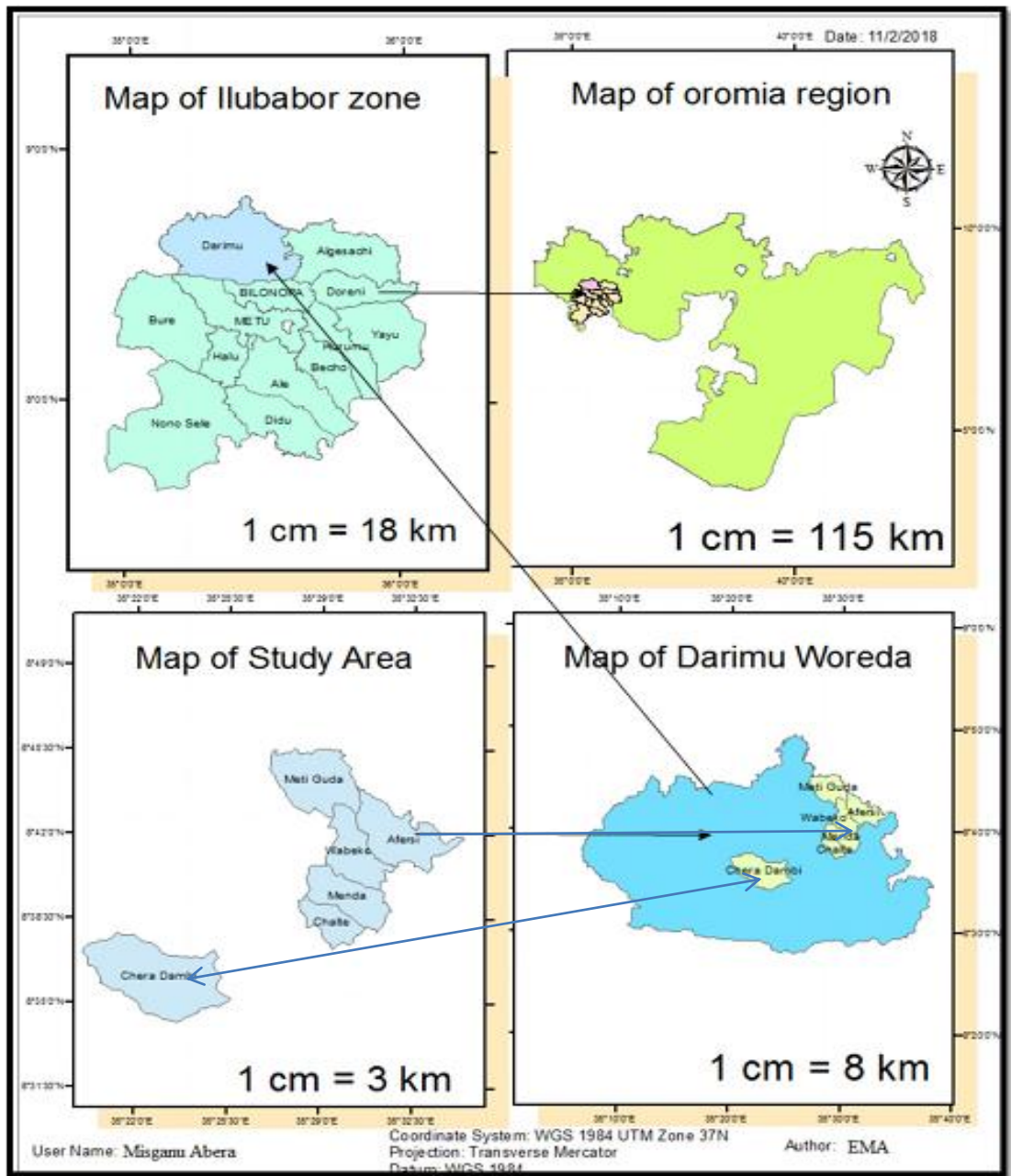


Fig. 1: Map of study areas

Table 1 Geographical location, elevation and area of Cheradambi and Sombo forest of Darimudistrict.

Name of forests	Fragmented forests	Geographic coordinates	Elevation	Disturbance level	Area (ha)
CheraDambi forest	Furdo	08 ⁰ 36'360' to 08 ⁰ 37.231''N and 035 ⁰ 22'600'' to 035 ⁰ 24'531''E	1590-1610m	Disturbed	915.34
	Golol	08 ⁰ 35'325'' to 08 ⁰ 35.347''N and 035 ⁰ 20'30'' to 035 ⁰ 24.57''E	1598—1617m	Disturbed	710.76
	GololYabalo	08 ⁰ 37.357'' to 08 ⁰ 37'390'' N and 035 ⁰ 24'531' to 035 ⁰ 21.609''E	1520m—1540m	Disturbed	1023.44
Somboforest		08 ⁰ 34.707'' to 08 ⁰ 36'708''N and 035 ⁰ 30'842'' to 035 ⁰ 31'84E	1670—1695m	Undisturbed	1300.45

3.2. Materials used

The following equipment and materials were used during the present study: geographical positional system (GPS), digital camera, data sheets, Binocular with 10*25 magnification, scissors, paints, and meter. Other printed materials (colour printed photo for comparison of species and certain morphological characteristics).

3.3 Methods

3.3.1. Preliminary Survey

Preliminary survey was conducted in November 2017. For gathering relevant information about the study area. The three fragmented forest in CheraDembi are homogenous in vegetation type coverage and topography but, different in area (hectare). The physical features of the study area were assessed using ground survey and the coordinates of each study site was taken and their boundaries was defined. The sampling unit within the forest was determined and assigned on the basis of size of the forest (area in hectare).

3.3.2 Sampling Design

The study area is homogenous in vegetation type; disturbance level and topography in three fragmented of the CheraDambiforest. Therefore, Line transect method was used to the size of forest are available. If species relatively large and medium (conspicuous), one of the best methods is e line transect for estimating abundances of mammal species inthe study site. The importance of the line transect is that one walks along a straight line and records the individual seen and their perpendicular distance from transect line (Buck land *et al.*, 2001).

A total of 32 transect lines were laid , 6 in Furdo forest, 5 in Golol forest, 8 in the GololYabal forest .These forests are relatively disturbed, that means a large forest tract is converted into several smaller, increasing isolated patches and recurrent habitat disturbance including canopy damage by logging and fires (Fahrig ,2003;Michalsik and Peres ,2006). Whereas, in Sombo forest relatively undisturbed, not divided in to several smaller patches. SomboForestalsohomogenous in vegetation type and the average topography different five meters. The distance between line transectin Sombo was different from the disturbed forestdue to their disturbance level were different. Therefore, 13 line transect were laid in Somboforest separately and parallel. To avoid double counting, line transects were laid 1.5km apart from each otherinFurdo, Golol and GololYabalo fragmented forests, whereas in Somboforest, line transects was 1 kmapart from each other. The number of line transect in each forest was based on their size of forest (Table 1).Data collection was carried out walking along each transect and directly counting all at once for one forest using field assistants to avoid double counting. During the survey, the investigator walked along the transect lines and count any mammal species encountered right and left from the center of the transectline.

When an unknown species was observed, the field assistants were consulted for the local name and the scientific name was determined later with the help of the field guide book (Alden *et al.*, 1995).

3.3.3. Data collection

The datacollected mammalian species diversity,distribution and relative abundance of medium-and largesized mammals in the study area. TheCheraDambi forest was divided in tothree fragmented (Furdo, Gololand Gololyabalo). Sample was collected through direct

observation from the established transect lines in each site of the Chera Dambiforest and Sombo forests. Each transect line was surveyed each season. From January to March, 2018 for dry season and from May to July, 2018 for wet season. All the transect lines were surveyed six days per month twice a day at the same time. There were two individuals per each transect line to be surveyed.

3.3.4. Direct observation of medium- and large sized mammals

Assesses mammalian species composition, diversity, relative abundance and distribution; direct observation (actual sightings) of individual or group animals of along transect line was made with naked eye or an aid of Nikon binocular (10*25) while observer traveling against the direction of wind to minimize disturbances (Kingdom, 2003). Mammalian counts were made from 07:00-11:00 AM, in the morning and 03:00-5:00 PM in the afternoon. Kingdom (2003) and Yirga (2008), field guide was used for identification of the mammalian species in study area. After data were collected from the study area, would group species occurrence for all forests as common, uncommon and rare. During identification, observed mammalian species, sex and age structure of mammalian species were recorded. For the most abundant species sex ratio and age was determined by body size, body structure (presence and absence of breast, tests), coloration, horn and dominant behavior was used to group sex and age of the observed mammals. Identification of sex and age categories was carried out in the field by using relative body size and external genitalia (Agetsuma, 2001).

3.3.5. Indirect survey for medium and large sized mammals

During each transect line survey, indirect evidence for the presence of mammalian species in the study area sign marks were collected such as body structure (spines for porcupine), footprints, burrows, fecal dropping, vocalizations, and scats/pellets were among the things that were used for the indirect evidences for the presence of mammalian species (Sutherland, 2007).

3.3.6. Data analysis and Interpretation

The data analysis was based on the pooled data of both seasons and data of each season separately. Data from all line transects of each sampling sites with similar disturbance level were pooled together for particular analysis. Species richness and diversity of large- and medium

sized mammals in the study area were computed using past program software, whereby each transects lines was considered as a sample. Variation in sex ratio, age structure and variation in abundance between seasons and between forests type (disturbed vs. undisturbed) were computed using ANOVA in SPSS. Then, MS Excel was used to draw figures. Species diversity and species richness of mammals was estimated using Shannon-Weaver diversity Index (Elliott and Hewitt, 1997), as follows:

$$H' = - \sum_{i=1}^S p_i \ln p_i \quad \text{Where,}$$

$i=1$

Σ = Summation symbol;

H' = Shannon-Weaver diversity Index,

S = the number of species

P_i =the proportion of individuals or the abundance of the i^{th} species expressed as proportion of total sample

\ln = natural logarithm

The Evenness of species distribution (J) = H'/H_{max} , of mammalian species was calculated from the ratio of observed diversity to maximum diversity using the equation $J = H' / H'_{\text{max}}$, or where $H_{\text{max}} = \ln(S)$ and S is the number of species. $J = H' / \ln S$, Equitability assumes a value between 0 and 1 with 1 being complete evenness (Kent and Cooker, 1992).

The higher the value of evenness index, the more even the species is in their distribution within the given area. Relative abundance of each mammalian species of each forest was computed by the formula of

$$\text{Relative abundance} = \frac{\text{total number of individual species}}{\text{total number of individual sampled}} \times 100$$

4. RESULT

4.1. Result

4.1.1 Species Composition

During the study period, a total of 25 species of mammals were recorded belonging to seven Orders and fourteen families. The order Carnivores was represented by the largest number of families (six) species (nine) followed by order Artiodactyl was represented by three family and eight species. Order Primates was represented by one family and four species. The remaining, Order Hyracoidean, Rodentia, Tubulidentata and Lagomorpha, were represented by one family and one species each. Among the identified species, three species (*Bush hyrax*, *Crested porcupine*, *stark's hare*) were medium –sized mammals while the remaining were large sized mammals (Table 2).

Table 2. Mammalian species identified in the study area.

Order	Family	common name of species	Scientific name	Local name
Carnivora	Felidae	Lion	<i>Pantheraleo</i>	Leenca
		Leopard	<i>Pantherapardus</i>	Qeeransa
		African wild cat	<i>Felisservestris</i>	Adala
	Hyaenidae	Spotted hyena	<i>Crocutacrocuta</i>	Waraabessa
	Canidae	Black-backed jackal	<i>Canismesamolas</i>	Jeedala
		Common jackal	<i>Canis aureus</i>	Wangoo
	Hyrpestidae	Slender mongoose	<i>Galerellaflavescens</i>	Focii
	Mustelidae	Honeybadger	<i>Mellivoracapensis</i>	Hamaa
	Viverridae	African civet	<i>Civettictiscivetta</i>	Xirinyii
	Artiodactyla	Bovidae	African buffalo	<i>Synceruscaffer</i>
Common bushbuck			<i>Traglyphusscritus</i>	Bosonuu
Common duiker klipspringer			<i>Sylvicapragrimmias</i> <i>Oretagusoretagus</i>	Kuruphee Qennejje
Hippopotamidae		Common reedbuck	<i>Reduncaarundinum</i>	Warabboo
		Hippopotamus	<i>Hippopotamusamphibus</i>	Roobii
Suidae		Bush-pig	<i>Potamochoeruslarvatus</i>	Boye
		Common warthog	<i>Phacochoerusafricanus</i>	Karkarroo
Primate	Cercopithecii	Grivet monkey	<i>Chlorocebusaethiops</i>	Qamalee
		Colobus monkey	<i>Colobusabyssinicus</i>	Weennii
		Blue monkey	<i>Cercopithecusmitis</i>	Canaa
Hyracoidea	Procaviidae	Olive baboon	<i>PapioAnubis</i>	Jaldeessas
		Bush hyrax	<i>Hetrohraxbracei</i>	Osoleholqaa
Rodentia	Hystriidae	Crested porcupine	<i>Hystrixcristata</i>	Xaddee
Tubulidentata	Oryctestidae	Aardvark	<i>Orycteropusaffer</i>	Waldiigessa
Lagamorpha	Leporidae	Stark's hare	<i>Lepus starck</i>	Hilleent

During the study period 197 and 213 individual of medium and large sized mammals were counted in dry and wet season respectively from the two selected forests of Darimu district. Seasonal variations were observed in species composition and individual number of mammal among different forest (Table 3). The highest number of mammalian species was counted in the Sombo forest during both dry and wet seasons. But also the highest number individuals of mammalian species were counted in Chera Dembi forest.

Table3.Distribution and method of identification of mammalian species in the study areas

Common name of Species	Furdo fragmented		Golol fragmented		GololYabal fragmented		Somboforest		Method of identification
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	
Lion	0	0	0	0	0	0	1	2	Sound
Leopard	0	0	0	2	1	1	1	1	Sound
African wild cat	1	3	0	0	2	0	0	0	Seen
Spotted hyena	0	0	4	2	1	1	1	1	Sound/footprint
Black-backed jackal	0	4	1	1	2	0	1	3	Seen
Common jackal	0	0	1	3	0	2	1	1	Seen
Slender mongoose	1	3	0	0	1	1	1	3	Seen
Honey badger	2	0	2	0	3	1	8	0	Seen
African civet	0	0	0	2	0	0	0	4	Scent marks
African buffalo	0	0	0	0	0	0	1	2	Footprint
Common bushbuck	1	3	2	0	2	0	4	2	Seen
Common duiker	0	4	1	3	0	0	1	1	Seen
klipspringer	0	0	0	0	0	0	0	4	Seen
Common reedbuck	0	0	0	0	0	0	1	3	Seen
Hippopotamus	0	0	0	0	0	0	0	2	Seen
Bush-pig	0	4	1	1	1	1	0	4	Seen
Common warthog	1	1	0	0	1	1	1	1	Seen
Grivet monkey	12	8	18	18	1	7	19	21	Seen
Colobus monkey	9	11	10	6	2	16	8	12	Seen
Blue monkey	1	3	0	2	1	3	1	1	Seen
Olive baboon	3	5	2	0	4	2	3	7	Seen
Bush hyrax	0	0	0	0	1	3	3	3	Seen
Crested porcupine	4	2	2	0	0	0	1	1	Spine/pellet
Aardvark	0	0	0	0	1	1	4	2	Burrow
Stark's hare	0	0	3	1	0	0	0	0	Seen
Total No. of individual per forest , per season and spp rich	35	51	47	41	5	40	61	81	
	10	12	12	11	1	13	19	22	

The seasonal variation in the number of individuals of Furdo fragmented forest (dry=35 and wet=51),df=1, $p > 0.05$,of Golol fragmented forest(dry=47andwet=41),df=1,p $> ,0.08$ of Gololoyabalo fragmented forest(dry=54 and wet= 50),df=1, $p >0.05$ and of Sombo forest (dry= 61andwet=81),df=1,p > 0.05 were not statically significant. For the two forest Chera Dambi forest (dry=136 and wet =132),df=1.p > 0.06 and Sombo(dry= 61and wet=81),df=1, $p > 0.05$ were not statically significant .The seasonal variation in the number of individuals of furdo fragmented forest (dry=35 and wet=51),df=1, $p > 0.05$,of Golol fragmented forest(dry=47andwet=41),df=1,p $> ,0.08$ of Gololyabalo fragmented forest (dry=54 and wet= 50),df=1, $p >0.05$ and of Sombo forest (dry= 61andwet=81),df=1,p > 0.05 were not statically significant. For the two forest CheraDambiforest (dry=136 and wet =132), df=1.p > 0.06 and Sombo (dry= 61and wet=81),df=1, $p > 0.05$ were not statically significant.

The number of medium and large mammal species varied between fragmented forests as well as between disturbed and undisturbed forest of the study area. Higher numbers of large sized mammalian species were found in undisturbed forest and higher number of medium sized mammalian species relatively found in disturbed forest, Seventeen large mammalian species and three medium mammalian species were found in disturbed forest, twenty one large sized mammal species and two medium mammal species found in undisturbed forest (fig.2).

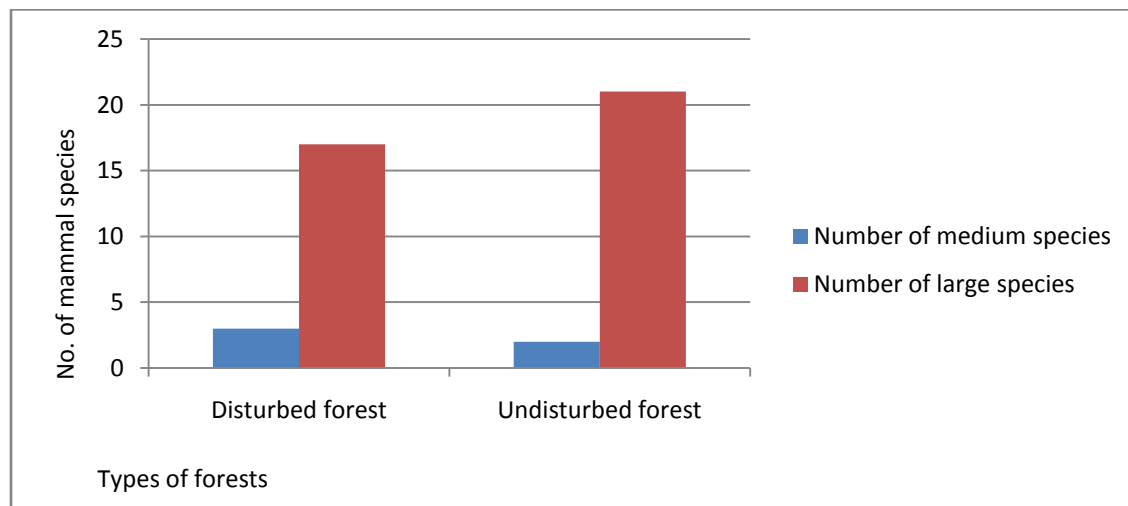


Fig 2.Comparison of large and medium sized mammal species of Disturbed and undisturbed forests

The least number of species richness was observed in CheraDembiforest. Highest number of mammal species was counted from Sombo forest (23 species) and the least number of mammalian species was recorded in ChoraDambi forest (20 species). The highest number of individual was recorded in disturbed forest and the highest number of mammals' species was counted in undisturbed forest (in Sombo). (Fig.3)

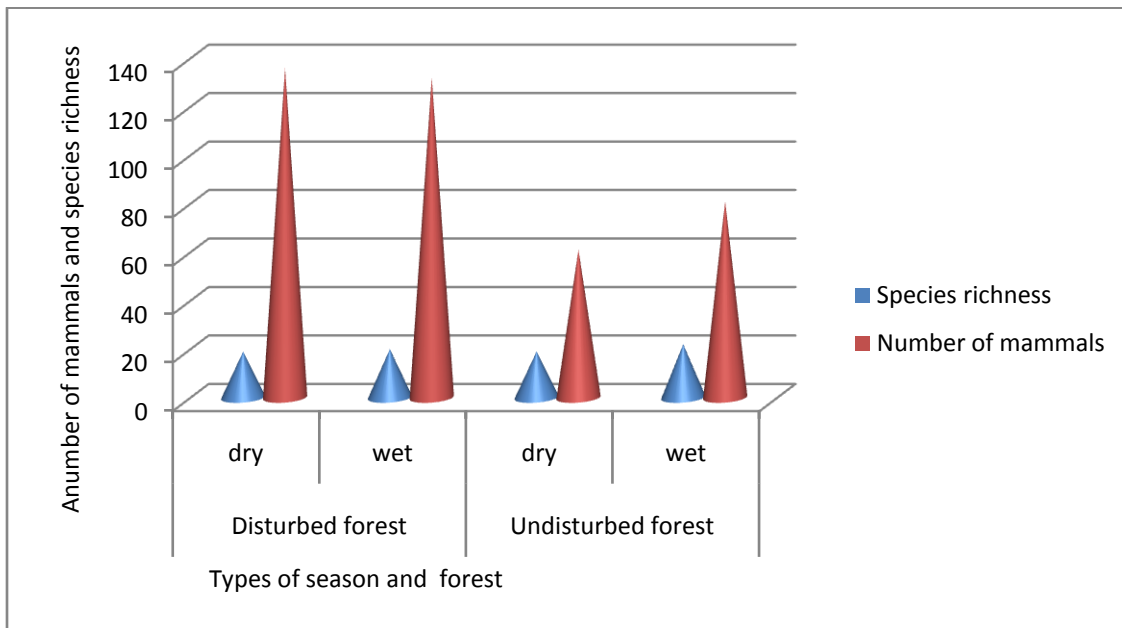


Fig. 3. Species richness and number of mammals in Disturbed and undisturbed (Sombo) forest

The highest number of individual of large and medium sized mammal counted from Sombo forest (61 individuals), Gololyabalofragmented forest (54 individuals) during the dry season. During wet season more number of individuals were counted also from Sombo forest (81 individuals) this might due to the large area of the forest comparing to the others, Furdo fragmented forest (51 individuals) this might due to the season variation.

4.1.2. Relative abundance of mammal species of disturbed and undisturbed forest

The numbers individuals of medium and large sized mammalian species counted in two selected forest or pooled together in to disturbed and undisturbed forest during dry and wet seasons were combined together and compared their relative abundance of disturbed and undisturbed forest and as a general relative abundance (Table 4). Among the 25 species of mammals Grivet monkey was the most species abundant comprising (28.3%), of the individuals counted and the second abundant species was Colobus monkey (22.44%) and the least abundant species

was Hippopotamus (0.49%), Lion and African buffalo each comprises (0.73%), the number of individual counted (Table 4)

Table 4 Relative abundances of mammalian species recorded in the study areas.

Common name of species	Disturbed forest		Undisturbed forest		all forests	
	Number of individuals counted	Relative abundance (%)	Number of individual counted	Relative abundance (%)	The general Abundance (%)	The general Abundance (%)
Lion	0	0	3	2.11	3	0.73
Leopard	4	1.49	2	1.41	6	1.46
African wild cat	6	2.24	0	0	6	1.46
Spotted hyena	8	2.98	2	1.41	10	2.44
Black-backed jackal	8	2.98	4	2.81	12	2.93
Common jackal	6	2.24	2	1.41	8	1.95
Slender mongoose	6	2.24	4	2.81	10	2.44
Honey badger	8	2.98	8	5.63	16	3.9
African civet	2	0.74	4	2.81	6	1.46
African buffalo	0	0	3	2.11	3	0.73
Common bushbuck	8	2.98	6	4.22	14	3.41
Common duiker	8	2.98	2	1.41	10	2.44
klipspringer	0	0	4	2.81	4	0.98
Common reedbuck	0	0	4	2.81	4	0.98
Hippopotamus	0	0	2	1.41	2	0.49
Bush-pig	8	2.98	4	2.81	12	2.93
Common warthog	4	1.49	2	1.41	6	1.46
Grivet monkey	76	28.36	40	28.16	116	28.29
Colobus monkey	72	26.86	20	14.08	92	22.44
Blue monkey	10	3.73	2	1.41	12	2.93
Olive baboon	16	5.97	10	7.04	26	6.34
Bush hyrax	4	2.98	6	4.22	10	2.44
Crested porcupine	8	2.98	2	1.41	10	2.44
Aardvark	2	0.74	6	4.22	8	1.95
Stark's hare	4	0.74	0	0	4	0.98
<i>Total</i>	268	100	142	100	410	100

With respect to forest among the 25 species of mammals Grivet monkey was the most abundant in Furdo, Golol fragmented forest and in Sombo and the second abundance was Colobus monkey.

However, Colobus monkey was the most abundant in GololYabalo fragmented forest and the second abundant was Grivet monkey (Table5)

Table5.Relative abundances of mammal species recorded from the three fragmented and sombo forest

Common name of Species	Furdo fragmented forest		Golol fragmented forest		GololYabalo fragmented forest		Sombo forest	
	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)	Number of individuals	Relative abundance (%)
Lion	0	0	0	0	0	0	3	2.11
Leopard	0	0	2	2.27	2	2.12	2	1.4
African wild cat	4	4.65	0	0	2	2.12	0	0
Spotted hyena	0	0	6	6.81	2	2.12	2	1.4
Black-backed jackal	4	4.65	2	2.27	2	2.12	4	2.81
Common jackal	0	0	4	4.54	2	2.12	2	1.4
Slender mongoose	4	4.65	0	0	2	2.12	4	2.81
Honey badger	2	2.33	2	2.27	4	4.25	8	5.63
African civet	0	0	2	2.27	0	0	4	2.81
African buffalo	0	0	0	0	0	0	3	2.11
Common bushbuck	4	4.65	2	2.27	2	2.12	6	4.22
Common duiker	4	4.65	4	4.54	0	0	2	1.4
Klipspringer	0	0	0	0	0	0	4	2.81
Common reedbuck	0	0	0	0	0	0	4	2.81
Hippopotamus	0	0	0	0	0	0	2	1.4
Bush-pig	4	4.65	2	2.27	2	2.12	4	2.81
Common warthog	2	2.33	0	0	2	2.12	2	1.4
Grivet monkey	20	23.25	36	40.9	20	21.27	40	28.16
Colobus monkey	20	23.25	16	18.18	36	38.29	20	14.08
Blue monkey	4	4.65	2	2.27	4	4.25	2	1.4
Olive baboon	8	9.3	2	2.27	6	6.38	10	7.04
Bush hyrax	0	0	0	0	4	4.25	6	4.22
Crested porcupine	6	6.97	2	2.27	0	0	2	1.4
Aardvark	0	0	0	0	2	2.12	6	4.22
Stark's hare	0	0	4	4.54	0	0	0	0
Total	86	100	88	100	94	100	142	100

4.1.3. Diversity indices and evenness of mammalian species in different forest

During dry season, the most diversified forest was Sombo forest ($H' = 2.358$) ($J = 0.5566$), while the second diversified site was Gololyabalo fragmented forest ($H' = 2.021$) ($J = 0.5032$). The least diversity during dry season was in Furdo fragmented forest ($H' = 1.846$) ($J = 0.6336$). During wet season the most diversified forest was of Sombo forest ($H' = 2.615$) ($J = 0.6213$), the second diversified was Furdo fragmented ($H' = 2.319$) ($J = 0.8469$). The least diversity during wet season was in Golol fragmented forest ($H' = 1.886$) ($J = 0.5996$) (Table 6).

Table 6. Diversity (H') and Evenness (J), of medium and large sized mammalian species in the three fragmented forests and Sombo forest during both dry and wet season.

Name of the two forests	The three fragmented	Numbers of mammalian species		Numbers of individuals		Diversity (H')		Evenness (J)	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
CheraDembi forest	Furdo fragmented	10	12	35	51	1.846	2.319	0.6336	0.8469
	Golol fragmented	12	11	47	41	1.947	1.886	0.5841	0.5996
	Gololyabalo fragmented	15	13	54	40	2.021	2.005	0.5032	0.5714
Sombo forest	—	19	22	61	81	2.358	2.615	0.5566	0.6213

Diversity indices (H'), Evenness (J), species richness and the abundance of medium and large sized mammalian species of the combined season of between the three fragmented forest and sombo forest were: Sombo forests was the most diversified ($H' = 2.63$) ($J = 0.6029$), The second diversified forest was Furdo fragmented ($H' = 2.259$) ($J = 0.7364$). The least diversity index was for Golol fragmented ($H' = 2.054$) ($J = 0.5201$) (Table 7).

Table 7 Diversity (H') and Evenness (J), of medium and large sized mammalian species in the three fragmented (CheraDembi forests) and sombo forest during both dry and wet seasons.

Name of the two forests	The three fragmented	Numbers of species	Numbers of individual s	Diversity	Evenness
	Furdo fragmented forest	13	86	2.259	0.7364
CheraDemb forest	Golol fragmented forest	15	88	2.054	0.5201
	Gololyabalo fragmented Forest	16	94	2.095	0.5077
Sombo forest		23	142	2.63	0.6029
Total		25	410	2.507	0.4905

Between the two forests (disturbed forest and un disturbed forest)the diversity index of Undisturbed forest during dry season was ($H'=2.36$) ($J=0.55$) and during wet season the diversity index was ($H'=2.62$) ($J=0.62$) and the combined diversity index was ($H=2.63$) ($J=0.61$).Disturbed forest diversity during dry season was ($H'=2.12$) ($J=0.44$) and wet season diversity was($H'=2.4$)($J=0.55$) and the two seasons result diversity was($H'=2.32$) ($J=0.51$)(Table8).

Table 8 Diversity (H') and Evenness (J), of medium and large sized mammalian species in the disturbed and undisturbed forest during each season and both seasons.

Types of forest	Dry		Wet		Dry and wet		Diversity			Evenness		
	No. of species	No. of individuals	No. of species	No. of individuals	No. of species	No. of individuals	Dry	Wet	Dry and wet	Dry	Wet	Dry and wet
Disturbed forest	19	136	20	132	20	268	2.12	2.4	2.32	0.44	0.5	0.51
Undisturbed forest	19	61	22	81	23	142	2.36	2.62	2.63	0.56	0.6	0.61

4.1.4. Species Occurrences

The medium and large sized mammals were grouped in to common, uncommon and rare (unique), out of the 25 species recorded in the study area eight (32%) species were common, ten (40%) species were uncommon and seven (28%) species were rare (unique) .unique species to

Sombo forest were Lion, African buffalo, klipspringer, Common reedbuck and Hippopotamus and stark's hare (unique to Golol forest) in the study area. occurrence species listed in (Table9)

Table 9 Occurrence of medium and large sized mammals in the study areas

Common	Uncommon	Rare (unique to undisturbed forest)
Black-backed. Jackal	African wild cat	Lion
Haney badger	Spotted hyena	African buffalo
Common bushbuck	Common jackal	klipspringer
Bush-pig	Slender mongoose	Common reedbuck
Grivet monkey	African civet	Hippopotamus
Colobus monkey	Common duiker	stark's hare(unique to
Blue monkey	Common warthog	Gololforest)
Olive baboon	Bush hyrax	
	Crested porcupine	
	Aardvark	

4.1.5. Sex ratio

The numbers of counted female Grivet monkey were 70.68% and the remaining 29.32% were males. In both seasons the sex ratio of females was higher than males. The variation between sexes was statistically significant (df=1, $P < 0.05$). The numbers counted female of Colobus monkey comprised 65.21% and the remaining 34.78% were males in both seasons the number of females was higher than males. The variation in sex ratio was statistically significant (df=1, $P < 0.05$). The numbers of counted female Blue monkeys comprised 41.66% and the remaining 58.33% were males in both seasons. The number of females was less than males. The variation in sex ratio was not statistically significant between two sexes (df=1, $P < 0.62$). The numbers counted female Olive baboon comprises 57.69% and the remaining 42.3% were males in both seasons the number of females was higher than males. The variation in sex ratio was statistically significant between two sexes (df=1, $P < 0.05$). (Table 10)

Table 10 Number of individual and 1:1 sex ratio of the most abundant species

Common name of species	Sex ratio				
	Male	Female	Ratio	Df	P
Grivet monkey	34	82	1:2.4	1	P < 0.05
Colobus monkey	32	60	1:1.87	1	P < 0.05
Blue monkey	7	5	1.4:1	1	P < 0.62
Olive baboon	11	15	1:1.27	1	P < 0.05

4.1.6 Age structure

The population age structure and the proportion of various sex ratios of the most abundant mammals were show variation. For Grivet monkey adult males comprised 20.68% and adult females comprised 43.1%. A sub adult male was 6.03% and sub adult females 18.9%. juvenile males were 1.7% and juvenile female were 6.8%. The male neonate comprised 0.86% and the female were 1.7%. There was variation in age structure of Grivet monkey was statistically significant among different age structures (df=1, P < 0.05). Adult male Colobus monkey comprised 21.7% and 34.5 % was adult female. Sub adult male Colobus monkeys were 8.6% and sub adult female Colobus monkey 16.3%. Juvenile Colobus monkey male and female were 3.26% male neonate Colobus monkey were 1.08% and females were 2.17%. The adult females were higher than males. The variation was statistically significant between different age (df=1, P < 0.05). Adult male Blue monkeys were 30.76% and the adult females were 23.07%. Sub adult male Blue monkeys comprised 15.38% and the female were 7.6%. Neonates male Blue monkeys and female was 7.6%. The adult females were less than males. The variation was not statistically significant between different age (df=1, P < 0.06). Adult male Olive baboons comprised 26.96% and the 38.5% was for adult female. Sub adult male Olive baboons comprised 7.6% and female were 7.6% respectively. Juvenile male Olive baboons and female were 7.6% respectively. Neonate male Olive baboon 0% and female were 3.84%. The adult female was higher than males. The variation was statistically significant between different age (df=1, P < 0.05). (Table 11).

Table 11 Sex ratio and age structure of the most abundant mammalian species

Common name of species	Age structure											
	Adult			Sub-adult			Juvenile			Neonate		
	Male	Female	Ratio	Male	Female	Ratio	Male	Female	Ratio	Male	Female	Ratio
Grivet monkey	24	50	1:1.2	7	22	1:3.2	2	8	1:4	1	2	1:2
Colobus monkey	20	40	1:2	8	15	1:1.8	3	3	1:1	1	2	1:2
Blue monkey	4	3	1:67	2	1	2:1	1	1	1:1	0	0	0
Olive baboon	7	10	1:1.4	2	2	1:1	2	2	1:1	0	1	0:1

5. DISCUSSION

During the study period, a total of 25 species of medium and large sized mammals grouped in to seven Orders and fourteen families were identified in the study area. Among the identified mammalian species three mammal species were medium sized mammal species and the remaining twenty-two species were large sized mammals.

Although, the study areas were different forest, similar studies have been carried out in different parts of Ethiopia that have used similar number of line transect. For example, from survey conducted for the first time Rabira *et al.*, (2015), recorded 28 species and 3021 individuals of mammal from Dati Wolele National park, Western Ethiopia, Nechisar National Park 37 species, Mago National Park 38 species and Omo National Park 40 species of Mammals were recorded (Gebrecherkos and Tilaye, 2010). So, the number of medium and large sized mammalian species recorded in four selected forest of Darimu district was relatively smaller than the above well-known protected areas. This indicates natural resource including forest and wild animals need deliberate conservation from different concerned body (Hillman., 1993)

The diversity result shows that the highest mammal species diversity was recorded from Sombo forest during both seasons. This might be because of the human disturbance was minimized relatively in Sombo forest. The smallest mammal species diversity was recorded from Chera Dambi during all seasons. This might be due to anthropogenic (human activities) for different purpose like expansion of Coffee plantation, Clearing forest to plant agricultural crops, the more firewood collected, construction of roads to connect countryside, remove the timber from forests for building.

The highest mammal species diversity and evenness was recorded during wet season than dry season. This might be due to shortage of water and food during dry season reduced the diversity and evenness of mammal species in the study areas. Noted that the extent to which a given species possess a preferred habitat is based on the requirement for resource. Shortage of food was indicated by few number of plant species collected by herbivores during the dry season as compared to the wet season (Serkebrhan *et al.*, 2011). Therefore, the availability of different plant species, water, cover or shelter, and peace settlement are a major factor for mammalian species diversity and evenness Bailey (1984), Balakrishnan and Eesa (1986).

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

Variation in the relative abundance of medium and large sized mammal's species in the present study area was observed between mammalian species. Grivet monkey was the most abundant species in the study areas. This mammal species was widely spread in all selected forest of the study areas, followed by Colobus monkey in all selected forest of the study areas. The distribution and abundance of these mammal species in all forest is because of their adaptation to variety of human conflict. Olive baboon was the 3rd abundant mammal species of the study area. The 1st, the 2nd and the 3rd abundant species (Grivet monkey, Colobus monkey and Olive baboon) respectively were higher probably associated to the availability of sufficient fruit and leaves and the need of forest with tall trees that serve as cover and best habitat (Afework and Girma, 2008).

However, Hippopotamus were the least abundant among the recorded mammal species of the study area. It is unique to Sombo forest around Birbir river. This is because of its behavior that it prefers the site where water is present (Smith, 1992). The second and the third least abundant mammal species were African buffalo and Lion. Different factor might be attributed to the lower number of these mammalian species in the study areas. For example as information obtained from the local people indicated that there was more individuals' number of Lion from Sombo forest before few years. Particularly, in Metikebele, the Lion occasionally come in groups to the resident area and disturb the local community by killing their livestock's. Because of live stocks damaged posed by Lions majority of local community had hostile attitudes toward this mammal species. The result of this situation increase human-Lion conflict around Metikebele and many Lion were killed by the local community from time to time. Lion were destroyed intentionally by either direct or indirect methods. The commonly used including shooting them. The remaining individual Lion left the reserved area and migrate to Bibir river. Similar observations were made in different part of Africa that Lions were killed by people in relation for attacks on live stocks.

Conflict with humans over live stocks depredation in the single most important factor causing the decline in African Lion populations(Packer *etal.*,2005).Oguto*etal.*(2005) reported that 87 Lion were killed in south East Keny by MasaiMrans (Warriors) since 1998in attack on their Livestock. In Mozambique Lion Human conflict and lion mortality was observed because of the attack of livestock by lion (Anderson and Pariela, 2005).In Tanzania,Packer *etal.*, (2005) documented over 125 Lions killing between 2000-2005 by the local people using poison or spears.

Human activities such as burning of grass during dry season every year,harvesting of grass, cutting of trees for construction, illegalsettlement, cattlegrazing, and illegal hunting activities could limit the individuals' number of mammal species in the study area. For example Common reedbuck (*Reduncaarundinum*) was found in Gololyabalo site many years ago, but at present it is found only in Sombo forest. The reason was due to the over hunting disappear from the area (older resident of the area).The abundance of mammalian species in ecosystem is closely related to the physical stability of the habitat (Anderson., 2005).Habitat modification and destruction by human activities affects the essential requirements of mammals which in turn affected mammalian diversity and makes the area to have fewer mammals.

The distribution of mammalian species was not consistent throughout the forest. This is governed by the presence and absence of suitable condition in forest for species. Mammalian species like Grivet monkey, Colobus monkey,Olive baboon were relatively observed and recorded in all forests of study area. Theirdistribution in all forests indicates their adaptation to a variety of forests. The ecological preference and evolutionary adaptation of mammalian species play role in their distribution in different habitat types (Bailey, 1984).Some primates like Colobus monkey and Blue monkey because of their arboreal life and the availability of variety of plant species used for food and water they were largely associated to the natural forest (Meseret and Solomon,2014).

The loss of habitats is especially harmful to large mammals that require large home ranges to fulfill their nutritional requirements (Carthew,. 1997). Once forest fragmentation occurred, it continues with the formation of more fragmented habitats over time. This pattern gradually limits the size of the forests below which the species no longer able to survive.

Human activities that have threatened mammals and their habitat in the study area include encroachment habitat destruction and fragmentation (Appendix4, plate3-6). This resulted mainly due to the removal of tree for charcoal production ,agricultural expansion , cattle grazing ,wood fire collection, ,coffee cultivation, timber production clearing forests from adjacent crop lands to avoid large mammal pests. If deforestation continued, there might be no more chance to see the present floras and faunas of the study area. Once forest fragmentation starts, the process continues rapidly with few and less connected remaining fragmented over time (Chatelain *et al.*, 1996; Chapman *et al.*, 2007).

For the most abundant species numbers of adults were higher than sub-adult, sub-adults were higher juvenile and juvenile were higher than neonate. Regarding sex ratio for the most abundant species number of female were higher male except Blue monkey. This might be due to factors that affect the distribution of mammals' like predators, anthropogenic and food. Group size varies in relation to different external conditions. Data on grouping patterns of herbivores may be indicative of the effect of a changing environment (Leuthold, 1975), reproductive behavior (Jarman, 1973) Environmental disturbance resulting from heavy feeding, fire and other factors. Distribution of wild life population explained mainly in terms of water and food. The knowledge of sex ratio and age structure of individual mammals is vital for evaluating the viability of species because these variables reflect the structure and dynamics of population (Wilson *et al.*, 1996). *Sex and age structure of population at any given point of time is also an indicator of the status of the population (Woolf and harder 1979). .The high populations of female and fairly high population of young indicate healthy, increasing that species in the study area. Similar to the study carried out by (Yisehak et al., 2007).The an other factors on distribution and settlement of mammalian species determined by size or area of the forest, Golol Yabalo fragmented forest large area in hectare than the two fragmented forests (Furdo and Golol). No any variation between them therefore, more mammalian species and number of individuals were counted from Golol Yabalo fragmented forest relatively than the others fragmented forests.*

6.CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The number of medium and large size mammal species recorded from the two selected forests of Darimu district was small in number of species richness and in individuals. The investigation provides current information about their presence .No observation was conducted in the past. So this is the pioneer investigation for the area. Increase agricultural practice adjacent to the forest, increased human wild conflict. These forced large mammal and mobile animals to disappear from the area, mainly from the disturbed forest. In particular, the high number of livestock grazing inside the forest was causing overgrazing and depletion of resources for wild life. Besides this, coffee cultivation, the expansion and practice of farm lands in the forest and surrounding area have led to further forest degradation and fragmentation. The distribution and species richness of medium and large size mammals were higher in the study area of Sombo forest. This is might due to the fewer disturbances of human activities.

The results of this study will serve as a cue for further study on the biodiversity of the area and conservation activities to be implemented in the future .To minimize the impact of anthropogenic activities on wild life of the study area, community education, enforcement of law and rehabilitating the degraded area important for suitability of wild life in the study areas.

6.2. Recommendation

The present studies show that the presence of medium and large size mammals in the two forests(Choradambi and Sombo) selected forest of Darimu district. The two selected forests were ChoraDambi (disturbed) forest and Sombo (relatively undisturbed) forest; this was based on human activities on that forest. However the number of species and individuals during study period were fewer. This is might due to the presence of disturbance by resident people for different purpose. Like coffee cultivation, expansion of agriculture, cattle grazing, charcoal production, logging for building material. Conserving the forests as well as the species has great ecological, economical, and social values.

- Therefore, to maintain and conserve the mammals and their forests with other biodiversity were required by concerning bodies.

- The contribution of the society, the government and the concerned people (being) should be increased to protect forest and others animal species from different damaging activities.
- The conservation of mammals and their habitat plays a great role in providing environmental services like climate change mitigation, tourist attraction, and income generation, social and cultural heritages. The outlook of such provision services also contributed for positive attitude development and initiation in the protecting the area with its biodiversity.
- In addition, service giving facilities and others must be constructed in the way they do not disturb biodiversity and animals' habitat or forest.
- Implementing and strengthen proper law enforcement actions. Extensive conservation measures have to be implemented through continual support of the regional, Zone and woreda administration and other stake holders.

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Appendix-1- Data collection format

Name of the forest _____

Name of the researcher_____

Name of scout (coworker)_____

Season of collection time_____

Roll-on.	Local name of organism	Scientific name	No. Of line transect	Sex ratio		Age structure			
				Male	female	Adult	Sub, adult	juvenile	neonate
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Appendix-2-

Data collection format

Name of sampling site (forest)_____ .Name of season_____

Name	of	Linetransect	Lines	Line	Line	Line	Lines		
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Species	Furdo sampling site		Golol sampling site		GololYabalo sampling site		Sombo forest	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
<i>Pantheraleo</i>	-	-	-	-	-	-	1	2
<i>Panther pardus</i>	-	-	-	2	1	1	1	1
<i>Felisservestris</i>	1	3	-	-	2	-	-	-
<i>Crocutacrocuta</i>	-	-	4	2	1	1	1	1
<i>Canismesamolas</i>	-	4	1	1	2	-	1	3
<i>Canis aureus</i>	-	-	1	3	-	2	1	1
<i>Galerellaflavescens</i>	1	3	-	-	1	1	1	3
<i>Mellivoracapensis</i>	2	-	2	-	3	1	8	-
<i>Civettictiscivetta</i>	-	-	-	2	-	-	-	4
<i>Synceruscaffer</i>	-	-	-	-	-	-	1	2
<i>Traglyphusscritus</i>	1	3	2	-	2	-	4	2
<i>Sylvicapragrimias</i>	-	4	1	3	-	-	1	1
<i>Oretagusoretagus</i>	-	-	-	-	-	-	-	4
<i>Reduncaarundinum</i>	-	-	-	-	-	-	1	3
<i>Hippopotamusamphibus</i>	-	-	-	-	-	-	-	2
<i>Potamochoeruslarvatus</i>	-	4	1	1	1	1	-	4
<i>Phacochoerusafricanus</i>	1	1	-	-	1	1	1	1
<i>Chlorocebusaethiop</i>	12	8	18	18	13	7	19	21
<i>Colobusabyssinicus</i>	9	11	10	6	20	16	8	12
<i>Cercopithecusmitis</i>	1	3	-	2	1	3	1	1
<i>PapioAnubis</i>	3	5	2	-	4	2	3	7
<i>Hetrohraxbracei</i>	-	-	-	-	1	3	3	3
<i>Hystrixcristata</i>	4	2	2	-	-	-	1	1
<i>Orycteropusaffer</i>	-	-	-	-	1	1	4	2
<i>Lepusstarck</i>	-	-	3	1	-	-	-	-
Total	35	51	47	41	54	40	61	81

Appendix-4-photo of some direct observation and indirect evidences



plate 2 Some indirect evidences for the presence of porcupine and hyena in the study area, (photo by MisganuAbera, 2018).



plate 2Some indirect evidences for the presence of Aardvark in the study area, (photo by MisganuAbera, 2018)

Cont'





plate 4Furdo fragmented forest at different side view by(MisganuAbera,in April 20, 2018



photo of golol fragmented forest at different side

Plate 5 Golol fragmented forest at different side view by (MisganuAbera,in April 20, 2018



photo of golol yabalo fragmented forest at different side

Plate6 Gololyabalo fragmented at different side view by(MisganuAbera,in April 20, 2018



photo of sombo forest at different side

Plate7 Somboforest at different side view by (MisganuAbera,in April 20, 2018