ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

OFFICE OF GRADUATE STUDIES

ASSESSMENT OF SPECIES DIVERSITY OF LARGE MAMMALS IN CHILALO GALEMA MOUNTAIN, ARSI ZONE, ETHIOPIA

A THESIS

SUBMITTED TO THE DEPARTMENT OF APPLIED BIOLOGY

SCHOOL OF APPLIED NATURAL SCIENCE
IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER'S IN BIOLOGY

BY

GIRMA LEMMA

Adama

December, 2017

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ADVISOR: Dr. MESELE ADMASSU

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December, 2017

Declaration

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all source of materials used for this thesis/ dissertation have been duly acknowledged.

Name: Girma Lemma

Signature: _____

This MSc Thesis has been submitted for examination with my approval as thesis advisor/supervisor.

Name: Dr. Mesele Admassu

Signature:_____

Date of submission: _____

Supervisor's/ Advisor's Approval Sheet

To Biology Department

Subject: Thesis Submission

This is to certify that the thesis / dissertation entitled:

"Assessment of Species Diversity of large mammals in Chilalo Galema Mountain, Arsi Zone, Ethiopia" submitted in partial fulfillment of the requirements for the degree of Master's of Philosophy in Biology, the Graduate program of the department of Biology, and has been carried out by Girma Lemma Id. No GSU/0406/ 06, under my supervision. Therefore, I/ We recommend that the student has fulfilled the requirements and hence hereby he can submit the thesis/ dissertation to the department.

Name of major Advisor/ Supervisor: Dr Mesele Admassu

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Date: _____

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ACRONOMY

ABRDP	Arsi-Bale Rural Development Project
APEDO	Arsi zone Planning and Economic Development Office
EWCA	Ethiopian Wildlife Conservation Authority
GPS	Global Positioning System
HWC	Human Wildlife Conflict
IUCN	International Union for Conservation of Nature
masl	meter above sea level
mbsl	metre below sea level
SPSS	Statistical Package for Social Science

Abstract

A study on the assessment of species diversity of large mammals was conducted in Chilalo Galema Mountain in east Arsi administrative zone from February 2017 to July 2017. The main objective of this study was to assess large mammalian species diversity and human-wildlife conflict in Chilalo-Galema Mountain National Park block.Line transects method and observation was used to collect data for the study. Twenty six transect lines were laid, which based on topography of the study site varied in length from 1.41km to 4.34km established to observe large mammal species. Transect width ranged from 200m to 400m depending on vegetation cover and topography of the study site. In this study both primary and secondary data sources were used to conduct the research. To assess mammalian species diversity, direct observation, body parts and vocalization, and indirect evidences such as footprints, burrowing and droppings were used. Observation and direct count of animals were made during 6:00-10:00 a.m. in the morning and 3:00-6:00 p.m. in the late afternoon when most mammals were active in the study area. Species diversity of large mammals were calculated using the Shannon-Weaver index of diversity. The evenness of mammalian species was calculated as J= H'/H'max where H'max= ln(s) and s is the number of species. A total of 28 species that belong to seven Orders (Primates, Artiodactyla, Carnivora, Hyracoidea,Tubulidentata, Rodentia and Lagomorpha) were recorded during this assessment. Out of the 252 recorded mammals in this study 26 (10.08%) were order primates, 50 (19.38%) were order carnivora, 1 (0.39%) were order hyracoidea, 6 (2.33%) were order tubulidentata, 164 (63.57%) were artiodactyla, 8 (3.10%) were rodentia and 2 (0.78%) were lagomorpha. The data presented here indicate that the mammalian fauna of the Chilalo Galema Mountain (ChGM) was dominated by two groups of mammalian orders (the most abundant orders); namely, order artiodactyla and order carnivora, composed of 164 (63.57%) and 50 (19.38%) recorded mammals, respectively. The least abundant was order hyracoidean 1 (0.39%) recorded mammal. Therefore, Chilalo Galema Mountains can serve as important center for conservation of the country's wildlife and tourist attraction area in the future. The present study confirms that the Chilalo Galema Mountain forest contains rich diversity of mammals and hence, its conservation measure should be given a clue attention to save the species in the park.

Key words: Artiodactyla, Carnivore, Chilalo Galema, Large mammals, Species diversity.

1. INTRODUCTION

1.1. Background of the Study

About 1,150 species of mammals were described and listed from the continent of Africa (Kingdon, 1971). East Africa is rich in mammalian fauna. Ethiopia is widely acknowledged as having high rates of endemism across all taxa including mammals. There are over 861 species of birds, 284 species of mammals, 201 species of reptiles, 63 species of amphibians and 150 species of fish in Ethiopia (Yalden and Largen, 1992). Among these, 31 species of mammals, 16 species of birds, 24 species of amphibians, 9 species of reptiles and 40 species of fish are believed to be endemic. Out of 31 species of endemic mammals, five species are larger mammals and the rest are smaller ones including 2, 9 and 15 species of bats, insectivores and rodents, respectively (Admassu *et al*.,2011).However, these vary from place to place and season to season due to climatic and environmental factors (Hillman, 1993).

Ethiopia is often known as 'the roof of Africa' due to its mountainous nature. It is endowed with extensive and unique environmental conditions, ranging from Ras Dejen at altitude of 4620-masl to Dallol, 100 mbsl at Kobar sink in Afar depressions (Tekalign, 2006).The wide variety of habitats in Ethiopia, ranging from arid desert, open grassland, and semi-arid savannas to highland diversity of cultures and ecology is further reflecting by forests and Afro-alpine moorlands, supports an exceptionally diverse fauna and flora. Ethiopia's uneven topography and the varied climatic conditions have endowed it with impressive wildlife species. Ethiopia is the home to various endemic, endangered, vulnerable and rare species (Yosef*et al.,* 2012).Ethiopia is one of the biodiversity hotspot areas of Africa. Ethiopia is among the world's best biodiversity area in terms of richness and endemism of mammalian species. Ethiopia and Tanzania are among the top 25 endemic rich countries of the world in terms of higher vertebrate species whereas Ethiopia, Kenya, Uganda and Tanzania are individually among the world leaders in terms of richness and endemic of mammals. In Ethiopia 40 protected areas (national parks, sanctuaries, wildlife reserves and an enclosures) cover roughly 16.4% of the country's geographic area (186000 km^2). Those areas face many challenges due to growing population, borders conflict and drought. Mammals are often the first taxa to be listed for a site. Ethiopia does contain largest concentration of large mammals

within the national parks. However, complete inventory does not exist and endemism not well illustrated the species diversity for better management of biodiversity. The study of the species richness, endemism and rarity across geographical areas is essential to select the best places for conserving biodiversity (Melaku , 2011).

The wildlife population has been declining throughout the world at an alarming rate. This is mainly due to habitat destruction and expansion of agriculture (Idris *el, al.,* 2001: Maan and Chaudhry, 2001: Gabol *et al.,* 2005; Gundogdu, 2011). This destruction is mainly pronounced in developing countries like Ethiopia. Ethiopia's increasing human population has substantially fragmented the wildlife habitat as settlement and agriculture extends into the mountain leading to habitat destruction due to overgrazing by livestock.

The Ethiopian high lands are at present among the most densely populated agricultural areas in Africa (Evangelista *et al.,* 2007). With expansion of human habitation, many wildlife populations have become restricted to and are isolated in National Parks. Small fragment of habitats exist outside protected areas; however, their significance in maintaining diverse groups of species in Ethiopia is poorly understood. Therefore, accurate population estimate of these diverse wildlife forms is an essential requirement for conservation efforts.

An assessment of the conservation status of all known mammals was conducted by the International Union for Conservation of Nature (IUCN, 1996). These IUCN Red List classifications of extinction risk have been used in numerous studies, including the identification of traits associated with high extinction risk (Purvis *et al.* 2000, Cardillo *et al*.,2005), prediction of future species' losses (Cardillo *et al.*,2006), and prioritization of species for conservation action. Although, the 1996 assessment was a remarkable feat at the time, it provided very little supporting data to justify the status attributed to each species, and was based on categories and criteria that have now been supersede. Furthermore, IUCN Red List assessments are officially outdated after 10 years, and about 3,300 mammals assessed in 1996 had fallen into this category by 2006 (Isaac *et al*., 2007). The ecological roles, or niches, filled by the nearly 5000 mammal species are quite diverse. There are predators and prey, carnivores, omnivores, and herbivores, species that create or greatly modify their habitat and thus, the habitat and structure of their communities e.g., beavers damming streams, large populations of ungulates (Artiodactyla and Perissodactyla) grazing in grasslands, moles

digging in the earth. In part because of their high metabolic rates, mammals often play an ecological role that is disproportionately large compared to their numerical abundance. Thus, many mammals may be keystone predators in their communities or play important roles in seed dispersal or pollination. The ecosystem roles that mammals play are so diverse that it is difficult to generalize across the group. Despite their low species diversity, compared to other animal groups, mammals have a substantial impact on global biodiversity (Vaughan, *et al.,* 2000).

Production of agricultural crops is affected both by drought and severe loss of crops due to wild vertebrate animals. The impact of crop damage inflicts by wildlife creates a negative attitude on the community toward wildlife and undermine effort of support for conservation. Crop raiding by wildlife is increasing problem around protected areas and forest area (Mussa, 2009). Destruction of forests, occupation original habitat of wildlife for purpose of investment increases the conflict of human-wildlife (Mesele, 2006; Addis *et al.,* 2012). Due to the availability of food resources in agricultural crop field's wildlife population is increasing outside of protected areas and their crop raiding activities is affecting life of poor rural farmers (Demeke and Verma, 2013).

1.2. Statement of the Problem

In developing countries like Ethiopia where rich and unique wildlife species occur; however, shortage of resources (expertise and funding) hampered sustainable management and use of their wildlife resources for the socio-economic development of their nations. Consequently, due to such poor management, many of the wildlife species are facing a great risk of extinction by direct (factors such as poaching) and indirect (such as destruction of wildlife habitats) by human activities (Stephens *et al*., 2000; Williams *et al*., 2004; Struhsaker, Struhsaker & Siex, 2005; Yosef, Afework & Girma, 2012a).Thus, the current study would focus on mammalian species type, their abundance and human-wildlife conflict in Chilalo Galema Mountains National Park block.

Research questions

1. What are the abundances of mammalian species in Chilalo-Galema Mountain National Park block?

2. Is there human wildlife conflict in surrounding areas of Chilalo-Galema Mountain National Park block?

3. Which species of mammals are largely abundant in the area?

4. Which habitat has more diverse comunity?

5. What is possible solution to minimize human-wildlife conflict in the National Park block?

1.3. Significance of the Study

The result of this study would help to take conservation actions in the area. It is used as feedback for researchers. It will give an idea about the current status of mammalian species in Chilalo-Galama Mountain National Park block. It is used as feedback for conservation measures by governmental and non-governmental organizations.

1.4. Objectives of the study

1.4.1. General Objective

The main objective of this study was to assess large mammalian species diversity and human-wildlife conflict in Chilalo-Galema Mountain National Park block.

1.4.2. Specific Objectives

- To assess the diversity of mammalian species found in Chilalo-Galema Mountain National Park block.
- To identify the main causes of human-wildlife conflict in Chilalo-Galema Mountain National Park block.
- To investigate the most dominant species in the Park.
- To indicate which habitat has more diverse community.
- To suggest possible solutions to minimize the impact of human–wildlife conflict.
- To estimate the species of large mammals in Chilalo Galema Mountain National Park block.

2. LITERATURE REVIEW

2.1. Taxonomy of Mammals

There are three major groups of mammals; each is united by a major feature of embryonic development. Monotremes (Prototheria) lay eggs, which is the most primitive reproductive condition in mammals. Marsupials (Metatheria) give birth to highly antiracial young after a very short gestation period (8 to 43 days). The young are born at a relatively early stage of morphological development. They attach to the mother's nipple and spend a proportionally greater amount of time nursing as they develop. Gestation lasts much longer in placental mammals (Eutheria). During gestation, eutherian young interact with their mother through a placenta, a complex organ that connects the embryo with the uterus. Once born, all mammals are dependent upon their mothers for milk. Aside from these few generalities, mammals exhibit a diversity of developmental and life history patterns that vary among species and larger taxonomic groups (Vaughan *et al.*, 2000).

The traditional subdivision of the Chiropteran into megabats and microbats may not accurately reflect evolutionary history (Teeling *et al.*, 2002). Even more fundamentally, molecular evidence suggests that monotremes (Prototheria, egg laying mammals) and marsupials (Metatheria) may be more closely related to each other than to placental mammals (Eutheria) (Janke *et al*., 1997), and placental mammals may be organized into larger groups (Afrotheria, Laurasiatheria, Boreoeutheria, etc.) that are quite different from traditional ones (Murphy *et al.*, 2001).

Mammals are the highest evolved group of the animal kingdom (Ghose and Manna, 2003). Despite their remarkable success, mammals are much less diverse than are most invertebrate groups. This is probably attributable to their far greater individual size, to the high energy requirements of endothermic and thus, to the inability of mammals to exploit great numbers of restricted ecological niches. Wilson and Reeder (2005), recognized about 1, 229 genera and 5,416 species of living mammals. Among these, a total of 960 mammal species occur in sub-Sahara 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. Most species of extant mammals have already been

described, but approximately 10 to 12 new species continue to be named each year. Many of these are cryptic species, distinct generally but difficult or impossible to distinguish morphologically from already known species. When fossil mammals are considered, the numbers are more impressive. In the compendium of McKenna and Bell (1997), 5,162 genera of mammals in 425 families of which 4079 genera (79%) and 300 families (71%) are extinct had been named, with additional new fossil taxa named each year.

2.2. Habitat of Mammals

Different species of mammals have evolved to live in nearly all terrestrial and aquatic habitats on the planet. Mammals inhabit every terrestrial biome, from deserts to tropical rainforests to polar icecaps. Many species are arboreal, spending most or all of their time in the forest canopy. One group (bats) has even evolved powered flight, which represents only the third time that this ability has evolved in vertebrates (the other two groups being birds and extinct Pterosaurs). Many mammals are partially aquatic, living near lakes, streams, or the coastlines of oceans (e.g., seals, sea lions, walruses, otters, muskrats, and many others). Whales and dolphins (Cetacea) are fully aquatic, and can be found in all oceans of the world, and some rivers. Whales can be found in polar, temperate, and tropical waters, both near shore and in the open ocean, and from the water's surface to depths of over 1 kilometer (Nowak, 1991; Reichholf, 1990a; Vaughan, *et al.,* 2000).

Mammals are a land resource of cultural, ecological and economic significance. It is a renewable resource whose survival depends, on other factors, on the quality of habitats. The importance of habitats is derived from their ecological roles in provision of shelter, breeding places, dispersal and foraging grounds for a variety of wildlife species. They also allow free movement for animals to other geographical localities where access to critical resources for (mammals) survival and exchange of the genetic (material) occur. Mammal's habitats are, therefore, critical components for ecological integrity and the long-term survival of the ecosystem. Destruction or loss of wildlife habitats reduces their potential utility. There are three forms of habitat destruction. These are degradation, fragmentation and outright loss. While habitat degradation is "the process by which habitat quality for a given species is diminished", fragmentation "is the process by which a natural landscape is broken up into

small parcels of natural ecosystems, isolated from one another in a matrix of lands dominated by human activities". Outright loss of habitats occurs when habitat quality is so low such that the environment is no longer usable by a given species (Brooks *et al.*, 2002).

Animal and plant species often occur in many different habitats in the same region, where they may experience different development rates, life spans, and birth and death rates (Pulliam and Danielson, 1991). This habitat selection allows species to coexist (Orians and Wittenberg, 1991). It is in part a consequence of competition and predation, stabilizing both of them, and acting as an optimal-foraging process (Rosenzweig, 1991) or resource partitioning. In some cases, experience in a natal habitat affects habitat selection after the individual leaves its natal land and begins to search for new habitats (Stamps and Swaisgood, 2007). Among African countries, Ethiopia has diverse topographic features. Fifty percent of the African highlands above 2000 m and 80% of the land above 3000 masl occur in Ethiopia (Malcolm and Sillero-Zubiri, 1997).

The Bale Mountains have the first largest area of Afro-alpine habitat with high endemic mammalian species (Abunie, 2000). Using vegetation as the main distinguishing factor, there are 10 broadly recognized ecosystems in Ethiopia. These are Afro-alpine and sub afro-alpine ecosystems (3200 to 4620 masl), Montane grassland ecosystems (1500 to 3200 masl), dry evergreen montane forest and evergreen scrub ecosystems (1500 to 3200 masl), moist montane forest ecosystems (800 to 2500 masl), *Acacia -Commiphora* woodland ecosystem (900 to 1900 masl), *Combretum – Terminalia* woodland ecosystem (500 to 1900 masl), lowland tropical forest ecosystem (450 to 800 masl), desert and semi-desert scrubland ecosystems (>500 masl), wetland ecosystems and aquatic ecosystems. Ethiopia has the largest extent of afro-alpine and sub-afro-alpine habitats in Africa. These ecosystems are characterized by the giant herb, lobelia (*Lobelia rhynchopetalum*), the evergreen tree heather (*Erica arborea*) and shrubby and herbaceous everlasting flowers (*Helichrysum* spp) (Zerihun Woldu, 1999).

2.3. Behavior of Mammals

Mammalian behavior varies substantially among species. As endotherms, mammals require more energy intake than ectotherms of a similar size, and mammalian activity patterns reflect

their high energy demands. For example, thermoregulation plays an important role indictating mammalian behavior. Mammals that live in colder climates must keep warm, while mammals that live in hot, dry climates must keep cool and conserve water. Behavior is an important way for mammals to help maintain physiological balance. There are mammalian species that exhibit nearly every type of lifestyle, including fossorial, aquatic, terrestrial, and arboreal lifestyles. Locomotion styles are also diverse: mammals may swim, run, bound, fly, glide, burrow, or climb as a means of moving throughout their environment.

Social behavior varies considerably as well. Some mammals live in groups of tens, hundreds, thousands or 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 (Vaughan, *et al.,* 2000).All mammals share at least three charateristics not found in other animals: 3 middle ear bones, hair, and the production of milk by modified sweat glands called mammary glands. The three middle ear bones, the malleus, incus, and stapes (more commonly referred to as the hammer, anvil, and stirrup) function in the transmission of vibrations from the tympanic membrane (eardrum) to the inner ear. The malleus and incus are derived from bones present in the lower jaw of mammalian ancestors. Mammalian hair is present in all mammals at some point in their development. Hair has several functions, including insulation, color patterning, and aiding in the sense of touch. All female mammals produce milk from their mammary glands in order to nourish newborn offspring. Thus, female mammals invest a great deal of energy caring for each of their offspring, a situation which has important ramifications in many aspects of mammalian evolution, ecology, and behavior (Klima and Maier, 1990; Vaughan, *et al.,* 2000).

2.4. Reproduction of Mammals

Most mammalian species are either polygynous (one male mates with multiple females) or promiscuous (both males and females have multiple mates in a given reproductive season). The most common mating system in mammals is polygyny, with relatively few males fertilizing multiple females and many males fertilizing none. Many mammal groups are marked by sexual dimorphism as a result of selection for males that can better compete for

access to females. About 3% of mammalian species are monogamous, with males only mating with a single female each season. Mating systems may vary within species depending upon local environmental conditions. For example, when resources are low, males may mate with only a single female and provide care for the young. When resources are abundant, the mother may be able to care for young on her own and males will attempt to sire offspring with multiple females (Apfelbach, 1990; Vaughan, *et al.,* 2000).

Other mating systems such as polyandry can also be found among mammals. Some species like common marmosets and African lions display cooperative breeding, in which groups of females, and sometimes males, share the care of young from one or more females. Many mammals are seasonal breeders, with environmental stimuli such as day length, resource intake and temperature dictating when mating occurs. Females of some species store sperm until conditions are favorable, after which their eggs are fertilized. In other mammals, eggs may be fertilized shortly after copulation, but implantation of the embryo into the uterine lining may be delayed. A third form of delayed gestation is "delayed development", in which development of the embryo may be arrested for some time. Seasonal breeding and delays in fertilization, implantation, or development are all reproductive strategies that help mammals coordinate the birth of offspring with favorable environmental conditions to increase the chances of offspring survival (Vaughan *et al.,* 2000).

2.5. Importance of Mammals

Mammals play key roles throughout many of the world's ecosystems, including grazing, predation and seed dispersal. They also provide important human benefits such as food, recreation, and income. However, our understanding of mammals is surprisingly patchy, particularly for the smaller and more inconspicuous species, and in the least studied parts of the world. Indeed, the rate of species discovery among mammals is still high, and most of the recently described species occur in regions of high levels of endemism and threat. It is therefore possible that mammal species are being lost even before their existence has been documented (Reeder *et al.,* 2007).

Mammals are very important for the proper functioning of ecosystems. They are responsible for pollinating plants (Janson *et al.,* 1981), seed dispersal; balance populations via predator-

prey interaction (Nowak, 1991) and the absence and rarity of mammals in a given ecosystem have severe consequences in the structure, composition and diversity of forests. The loss of mammalian diversity could change ecosystems in ways that we do not recognize and understand the changes (Chapman and Onderdonk, 1998). They are experiencing greater population declines because of various reasons (IUCN, 1996). These include low reproductive rates, large body size, habitat fragmentation, over-exploitation and low rate of body growth, low generation time and requirement of large area (Vaughan, 2000; Cardillo *et al*., 2005).

Mammals are a vital economic resource for humans. Many mammals have been domesticated to provide products such as meat and milk (cows and goats) or fiber (sheep and alpacas). Many mammals are kept as service animals or pets (dogs, cats, ferrets). Mammals are important for the ecotourism industry as well. Consider many people who travel to zoos or to all corners of the world to see animals like elephants, lions, or whales. Mammals (bats) often help control populations of crop pests. Some species like Norway rats and domestic mice are vitally important in medical and other scientific research; because humans are mammals, other mammals can serve as models in human medicine and research (Vaughan, *et al.,* 2000).

2.6. Diversity of Mammalian species in Ethiopia

The Animal Diversity Web generally follows the arrangement used by Wilson and Reeder (2005). On a global scale, 5,416 mammalian species are recorded, of which more than 2,277 species are small mammals (rodents and insectivores). Over 1,150 species of mammals are currently listed from Africa, but more mammalian species, especially rodents, insectivores and bats await discovery (Kingdon, 1997: Wilson & Reeder, 2005). In line with global trends, of the 284 mammal species of Ethiopia, a large share (84, 29.6%) of species are rodents (Afework & Leirs, 1997). According to Olff *et al.*, (2002) large mammals are defined as having a body weight greater than 2 kg.

Ethiopia is located in the horn of Africa. It has long been recognized for its wealth of natural resources, endemic species, and high biodiversity (Yalden and Largen, 1992; Jacobs and Schloeder, 2001; IBC, 2007). Unlike other African countries, Ethiopia is a land of great

geographical diversity, characterized primarily by variations in altitude. This altitudinal variation makes Ethiopia a country of enormous climatic diversity and biodiversity (Ash and Atkins, 2009). It has diverse physiogeographic features with high rugged mountains, flat topped plateaus, deep gorges and incised river valleys. The altitudinal variation ranges from 116 m below sea level (mbsl) in the Dalol depression in the Afar region, to 4620 masl at Ras Dashen in the Smien Mountains. This altitudinal variation creates wide ranges of climatic conditions, which has positive effect on diversity of the country (Yalden and Largen, 1992; IBC, 2007).

Although, Ethiopia is a tropical country with typically hot and dry lowland areas, it has varied macro and micro-climatic conditions (IBC, 2007). These varied climatic conditions have contributed to the formation of diverse ecosystems inhabited with a great diversity of life forms of both fauna and flora. The rainfall distribution is seasonal. The variations in the climate, topography and vegetation have contributed to the presence of a large number of endemic species. Ethiopia's high faunal biodiversity reflects the existence of a large number of species of mammals and other higher vertebrates (Yalden and Largen, 1992; Melaku Tefera, 2011). This in turn reflects a diversity of habitats, created by differing combination of elevation rainfall, geology, soil surface and ground water.

2.7. Communication and Perception of Mammals

Generally, olfaction, hearing, tactile perception, and vision are all important sensory modalities in mammals. Olfaction plays a key role in many aspects of mammalian ecology, including foraging, mating and social communication. Many mammals use pheromones and other olfactory cues to communicate information about their reproductive status, territory, or individual or group identity. Scent-marking is commonly used to communicate among mammals. They are often transmitted through urine, feces, or the secretions of specific glands. Some mammals even use odors as defense against mammalian predators (e.g. skunks), which are especially sensitive to foul-smelling chemical defenses (Apfelbach and Ganslosser, 1990; Vaughan, *et al*., 2000).

Typically, mammalian hearing is well developed. In some species, it is the primary form of perception. Echolocation, the ability to perceive objects in the external environment by

listening to echoes from sounds generated by an animal, has evolved in several groups. Echolocation is the main perception channel used in foraging and navigation in microchiropteran bats (Chiroptera) and many toothed whales and dolphins (Odontoceti), and has also evolved to a lesser degree in other species (e.g., some shrews) (Apfelbach and Ganslosser, 1990; Vaughan, *et al.*, 2000).

Many mammals are vocal, and communicate with one another or with heterospecifics using sound. Vocalizations are used in communication between mother and offspring, between potential mates, and in a variety of other social contexts. Vocalizations can communicate individual or group identity, alarm at the presence of a predator, aggression in dominance interactions, territorial defense, and reproductive state. Communication using vocalizations is quite complex in some groups, most notably in humans (Apfelbach and Ganslosser, 1990; Vaughan, *et al.*, 2000; Apfelbach and Ganslosser, 1990; Vaughan, *et al.*, 2000).

Mammals also perceive their environment through tactile input to the hair and skin. Specialized hairs (whiskers or "vibrissae") have a sensory function, letting an animal know when it is in contact with an object in its external environment. Vibrissae are often richly innervated and well-supplied with muscles that control their position. The skin is also an important sensory organ. Often, certain portions of the skin are especially sensitive to tactile stimuli, aiding in specific functions like foraging for instance the fingers of primates and the nasal tentacles of star nosed moles. Touch also serves many communication functions, and is often associated with social behavior like social grooming (Vaughan, *et al.*, 2000).

Vision is well-developed in a large number of mammals, although it is less important in many species that live underground or use echolocation. Many nocturnal animals have relatively large, well-developed eyes. Vision can be important in foraging, navigation, entraining biological rhythms today length or season, communication, and nearly all aspects of mammalian behavior and ecology (Apfelbach and Ganslosser, 1990; Vaughan, *et al.*, 2000).

2.8. Lifespan of Mammals

Lifespan, or longevity, is a fundamental life-history trait that exhibits considerable variation both within and among species. Just as mammals vary greatly in size; they also vary greatly

in lifespan. Generally, smaller mammals live short lives and larger mammals live longer lives. Bats (Chiroptera) are an exception to this pattern; they are relatively small mammals that can live for one or more decades in natural conditions, considerably longer than natural lifespan of significantly larger mammals. Maximum lifespan of Mammals range from one year or less to 70 or more years in the wild. Bowhead whales(*Balaena mysticetus)* may live more than 200 years and down to just eight weeks in the pygmy goby *(Eviota sigillata)*(Grzimek, 1990: Magalhaes *et al.*,2009 and Depcznski *et al*.,2005).Like most other life-history traits, lifespan varies strongly with body size such that large species tend to live longer than smaller species (Lindstedt *et al.,* 1981:Promislow,1993). However, many species have far longer, or indeed shorter, lives than expected given their body mass. Understanding the mechanisms underlying these deviations from predicted lifespan may reveal the secrets to treating and combating human ageing (Ricklefts.2010: Zhang *et al.,* 2013).

One explanation for species living longer than expected, given their body size, is that low extrinsic mortality (i.e. low risk of death owing to external causes such as disease, predation, food shortages or accidents) will, on average, select for longer lifespan than when extrinsic mortality is high (Steams.1992:Williams.1957). This is because when untimely death is more likely, investment in early and frequent reproduction is favored rather than investment in long-term maintenance and survival. Therefore, species with adaptations that reduce the risks of extrinsic mortality should live longer than expected, given their body mass. These ideas have led to myriad, taxon-specific hypotheses about traits that may reduce extrinsic mortality and result in increased lifespan. However, there is little consensus about the general drivers of increased lifespan across clades (Partridge *et al.,* 1993).

2.9. Conservation of Mammals

Overexploitation, habitat destruction and fragmentation, the introduction of exotic species, and other anthropogenic pressures threaten mammals worldwide. In the past five centuries at least 82 mammal species have gone extinct. Currently, the International Union for Conservation of Nature and Natural Resources (IUCN) has listed about 1000 species (roughly 25% of all known mammals), as being at some risk of extinction. Several factors contribute to a species' vulnerability to human-induced extinction. Species that are naturally rare

or require large home ranges are often at risk due to habitat loss and fragmentation. Species that are seen to threaten humans, livestock, or crops may be directly targeted for extirpation. Those species that are exploited by humans as a resource (e.g., for their meat or fur) but are not domesticated are often depleted to critically low levels. Finally, global climate change is adversely affecting many mammals. The geographic ranges of many mammals are shifting, and these shifts often correlate with changes in local temperatures and climate. As temperatures rise, which is especially pronounced in Polar regions, some mammals are unable to adjust and are consequently at risk of losing their environment (Reichholf, 1990b; Vaughan, *et al.*, 2000).

Habitat loss has emerged as the most severe threat to biodiversity worldwide (IUCN, 2004; Naeem *et al.*, 1999; Smith and Smith, 2003) threatening some 85% of all species classified as "threatened" and "endangered" in the IUCN's *Red Lists* (IUCN, 2004). It is the most pervasive to birds, mammals and amphibians. It affects 86% of all threatened birds, 86%of threatened mammals and 88% of threatened amphibians *(www.iucn.org/themes/ssc*). The effect of other threats is relatively lower. For instance, overexploitation affects only 30% of threatened birds, 33% mammals and 6% amphibians while introduction of alien species affects 30% and 11% of threatened birds and amphibians, respectively.

2.10. Human-Wildlife Conflict

According to IUCN, (2003), Human-wildlife Conflict (HWC) occurs when wildlife's requirements overlap with those of human populations, creating costs to residents and wild animals. Human–wildlife conflict is more intense in developing countries, where agriculture is important components of the livelihood and income of the rural populations (Boer and Baquete,1998). Direct contact with wildlife occurs in both urban and rural areas, but it is generally more common inside and around protected areas, where wildlife population density is higher and animals often stray into adjacent cultivated fields or grazing area. Rural Africans generally do not want to see wildlife or have wildlife nearby due to damage and lack of benefits from the sector (Newmark *et al*., 1994). Therefore, crop raid by wild animals is one of the major causes of human–wildlife conflict. Crop damage can mainly be caused by elephants, baboons, grivet monkeys, eland and kudu, together with elephant and bush-

pigs accounting about 80% of the total damage (Barnes, 1996). In Zambia, the main wild animalpests are monkeys, warthogs, baboons, elephants, and hippopotami. According to Kimega (2003), in Kenya, food items such as maize, cassava, beans, potatoes and fruit trees are the target of elephants, baboons, zebra, buffalo and wild pigs. The same is true in Ethiopia.

Human–predator conflict causes significant economic losses and can lead to retaliatory killing of predators and thus constitute a threat to both wildlife and human livelihoods (Hussain, 2003). Human-wildlife conflict has far reaching environmental impacts. Species most exposed to conflict are also shown to be more prone to extinction because of injury and death caused by humans; these can be either accidental, such as road traffic and railway accidents, capture in snares set for other species or from falling into farm wells, or intentional, caused by retaliatory shooting, poison or capture. Such human-induced mortality affects not only the population viability of some of the most endangered species, but also has broader environmental impacts on ecosystem equilibrium and biodiversity preservation Ogada *et al., (*2003).

Human-wildlife conflicts also undermine human welfare, health and safety, and have economic and social costs. Nuisance encounters with small animals, exposure to zoonotic diseases, physical injury or even death caused by large predators' attacks have high financial costs for individuals and society in the form of medical treatments to cure and prevent infections transmitted from animals through human contact (Ministry of water, land and air protection British Colombia, 2003). Humans can be economically affected through destruction and damage to property and infrastructure (e.g. agricultural crops, orchards, grain stores, water installation, fencing, and pipes), livestock depredation, transmission of domestic animal diseases, such as foot and mouth. Negative social impacts include missed school and work, additional labor costs, loss of sleep, fear, restriction of travel or loss of pets (Hoare, 1992).

Some mammal species are considered to have a detrimental impact on human interests. Many mammals that eat fruit, seeds, and other types of vegetation are crop pests. Carnivores are often considered to be a threat to livestock or even to human lives. Mammals that are

common in urban or suburban areas can become a problem if they cause damage to automobiles when they are struck on the road, or can become house-hold pests. A few species such as rats, house mice, pigs, cats, and dogs coexist exceptionally well with people, including some feral domesticated mammals. As a result of either intentional or unintentional introductions near human habitation, these animals have had considerable negative impacts on the local biota of many regions of the world, especially the endemic biota of oceanic islands. Many mammals can trans-mit diseases to humans or livestock. The bubonic plague is perhaps the most well-known example. Plague is spread via fleas that are carried by rodents. Rabies, which can be transmitted among mammalian species, is also a significant threat to livestock and can kill humans as well.

3. MATERIALS AND METHODS

3.1. Description of study area

Arsi Mountains National Park was established in 2011. This Park is found in eastern and western Arsi zones. The Park is subdivided in to 4 Blocks. These are Dera-Dilfekar, Chilalo-Galema, Kaka and Honkolo blocks. Due to the presence of these blocks, the park has different agro- ecological zones (kola, wayinadega and dega). It has a total area of 931 km^2. Arsi Mountains National Park is the nearest park to Addis Ababa than other protected areas.

Chilalo Galema Mountain block is found in the central part of the East Arsi Administrative Zone and lies between 7°28’ to 8°58’N latitude and 39°17’ to 39°28’E longitude (Fig.1).The block is located in the South Eastern part of Ethiopia. It is about 230 Km from Addis Ababa and 60 Km from Asella. Chilalo Galema block is surrounded by nine Woredas namely Hetosa and Lode Hetosa to the north, Tiyo to the north-east,Diksis to north-west, Shirka and Lemunabilbilo to south, Robe and Tena to east, Digelunatijo and Tiyo to west. The total area of the block is about 792 km^2 this is the largest block from the rest of the 3 blocks. Before the establishment of the park it was used as priority forest conservation and controlled hunting area. Mount Chilalo-Galema is part of the Arsi Mountains comprising the second highest afro-alpine habitat in Ethiopia (Gottelli and Sillero-Zubiri, 1992; Malcolm and Sillero-Zubiri, 1997).

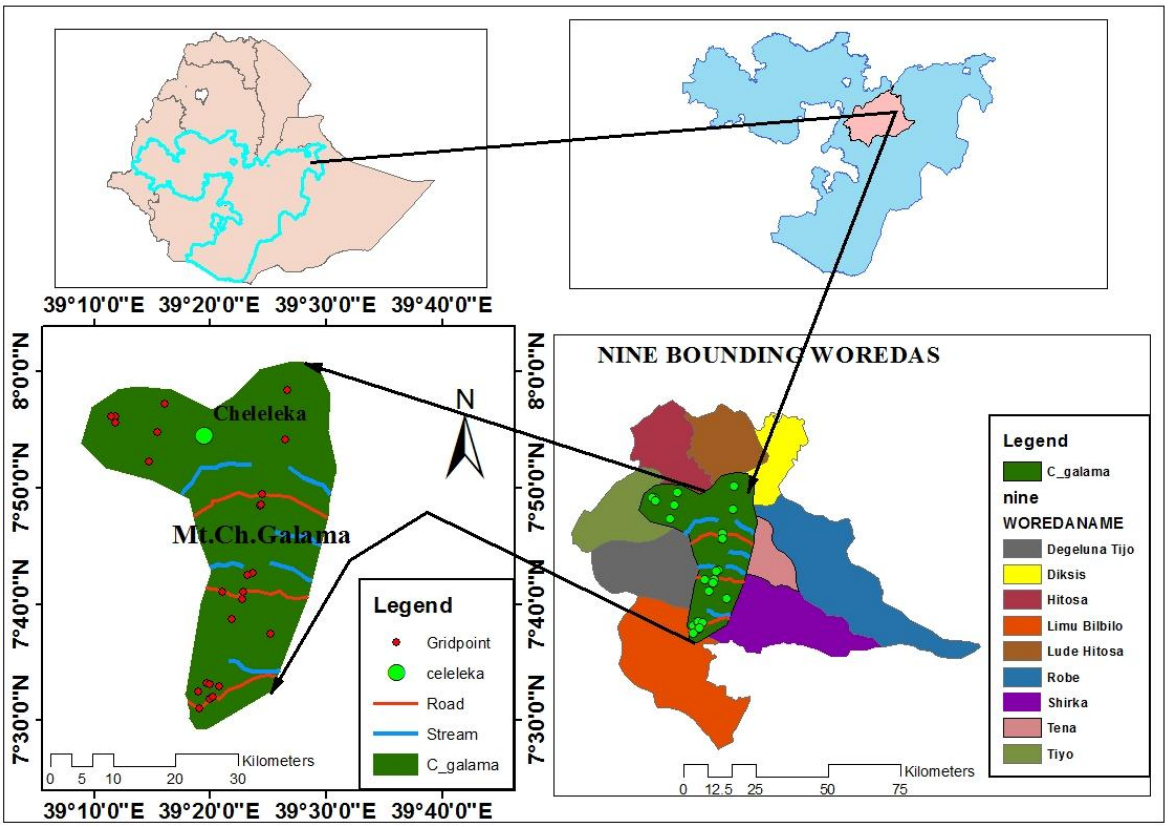

Figure1: Map of Chilalo Galema Mountain National Park block and its relative location

3.1.1. Soil Types

The area possesses different types of soils at different altitudes such as Pellic Vertisols (lower altitude), Orthic Luvisols (medium altitude), Chromic Luvisols (higher altitude) and Eutric Nitosols (on the moor land). The soil color along the western part of Mount Chilalo-Galema changes from darker to reddish brown between 2,500 and 3,000 masl and becomes dark above 3,000masl. It has acidic pH value ranging from 5 to 6. The lower altitude area is frequently cultivated (Kebrom Tekle, 1984).

3.1.2. Climate

The mean annual temperature and rainfall of Chilalo-Galema Mountain National Park block vary depending on altitude. Areas more than 3,300 masl have annual mean temperature less than 10°C while areas less than 3,300 masl shows ranges from 10°C to 15°C. During the dry season, diurnal temperature is high and at night, it is low (Alemayehu, 1975). The maximum

and minimum temperature of the study area is 25.96°C and 8.52°C.The hottest and coldest months of the year in the area are March and December respectively (Fig 2).

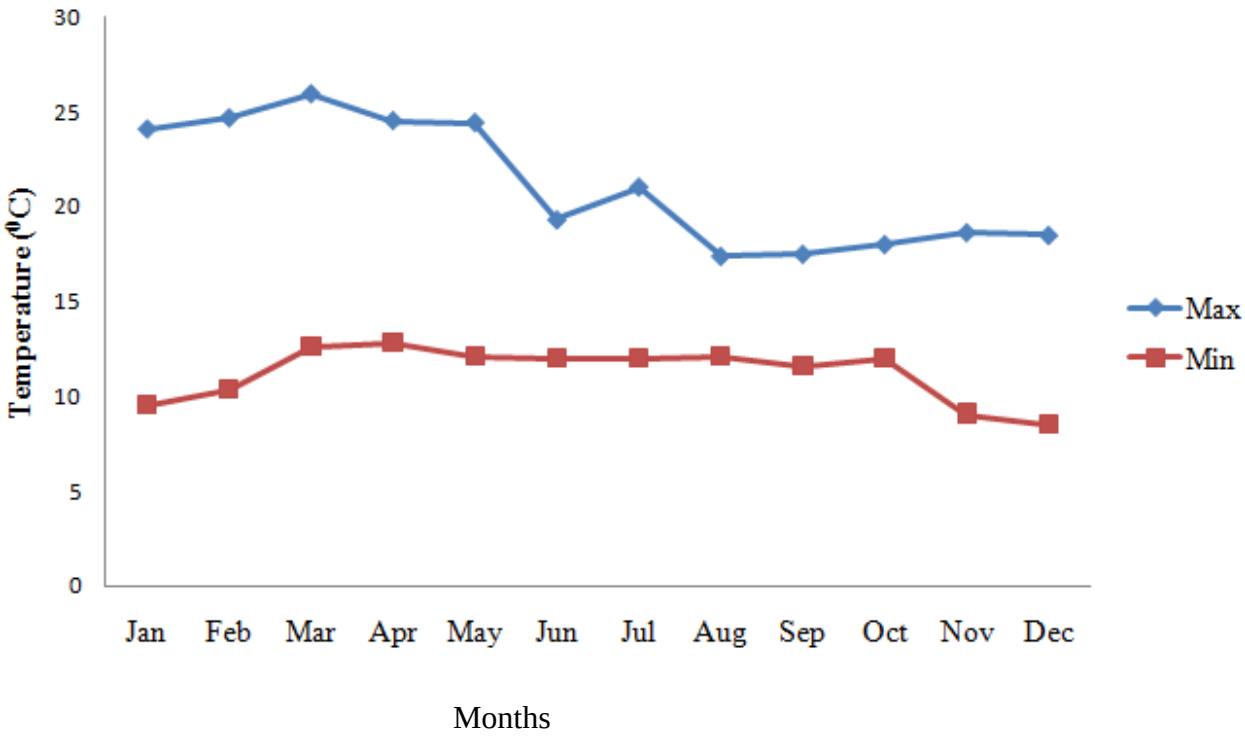

Figure 2: Monthly average maximum and minimum temperature of Chilalo-Galema Mountain National Park blocks (2012-2016).

Source: Data from kulumsa metrology station, 2009.

Chilalo-Galema Mountains National Park block experiences eight months of rainfall commencing from March and extending until October with the highest rainfall concentration during June to September (Fig.3). The annual rainfall ranges from 800mm to 2,000 mm (APEDO and ABRDP, 2004) (Fig.3).

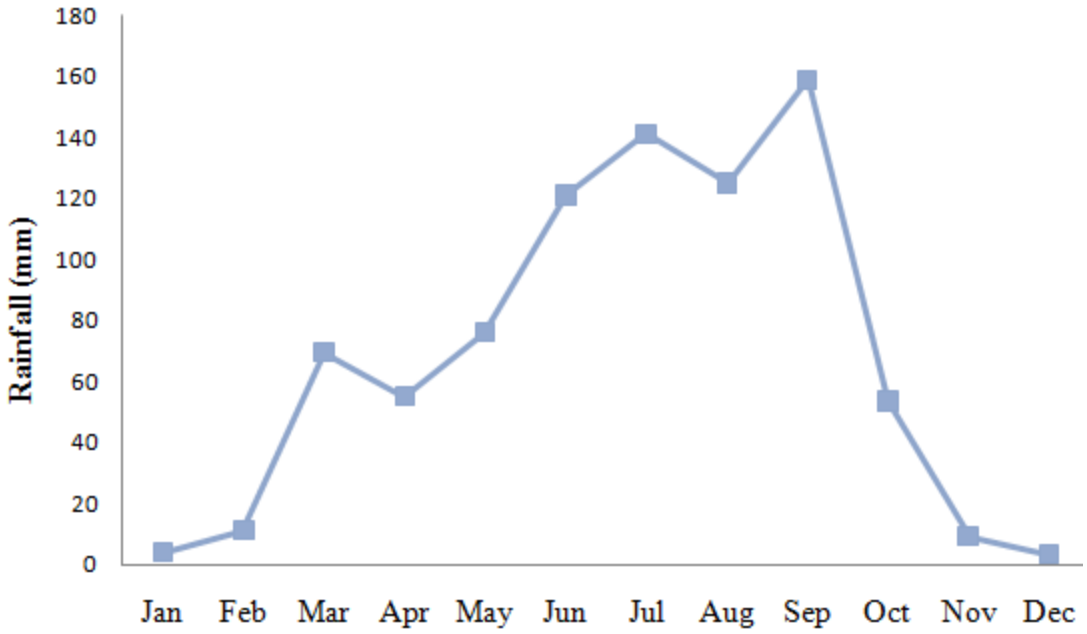

Figure 3: Monthly average rainfall of Chilalo-Galema Mountains National Park block (2012- 2016).

Source: Data from Kulumsa metrology station, 2009.

3.1.3. Vegetation

Chilalo Galema Mountains National Park block is characterized by three vegetation zones at different altitudes, although, it is dominated by Ericaceous (Asta) and Afro- alpine vegetation (Hedberg, 1951). The first is Afro-montan forest or mixed mountain forest (2,300 to 3,100 masl).The area has a mean annual rainfall varying from 500 mm to1100 mm. Characterized by *Hagenia abyssinica* dominates in the moist areas, *Podocarpus gracilior* forest at lower altitude and *Juniperus procera* at higher altitudes. The second zone is ericaceous forest (3100 to 3900 masl), characterized by *Erica arborea* with low mean annual temperature less than 10^0C and average annual precipitation from800 mm to 1600 mm. This low temperature inhibits tree growth, except low bushes, tuft grasses and lichens. The third is the Afro-alpine vegetation (3300 to 4200 masl) comprising largely Alchemilla helichrysum, Artimesia tri-mera and Lobelia rhynchopetalum species (Hedberg, 1951). The mountain is one of the Afro-tropical biodiversity hotspot areas. Most people who reside on

the slopes of Mount Chilalo Galema are engaged in mixed farming, although, farmers who live near ericaceous zone are more inclined to animal rearing than crop production (Alemayehu , 1975).

The dominant vegetation cover now is *Erica arborea* and Giant lobelia species. But some ruminant trees such as *Hagenia abyssinica*, *Podocarpus falcatus*, *Juniperus procera*, etc are dispersedly seen in the east part of the park. This shows that, in the past these species were the dominant vegetation cover in the middle and lower part of the park. An intimate and complex relationship can be observed between a given species of animal and its habitat with certain biotic and abiotic requirement for persistence. Ecological research has shown how key resources such as vegetation, water and shelter drive the distribution of herbivores (Illius and O'Connor, 2000). The broad-scale relationships between vegetation and animals have long been recognized. Important elements of the habitat of an animal are often provided by the vegetation of an area. Vegetation provides essential requirements for animals such as cover and food (Morrison *et al*., 1998).

3.1.4. Hydrology

The high land of Chilalo-Galema Mountains contribute drinking water for about 12 woredas of urban and rural populations. Earlier there were more than 50 rivers those flow out of the upper watershed in different directions. But now it is not more than 30 rivers. This is due to severe forest destruction both at upper and middle catchment. Even one of the main reasons for the establishment of the park was to maintain water source of Chilalo and Galema Mountains.

3.1.5. Topography

Chilalo-Galema Mountains have a great diversity of landscape with altitudes ranging from 2,000 to more than 4,000 masl. Many rivers and streams emanate from it in different directions forming different drainage basins. These massifs also have afro-alpine lakes and swamps on the top of the plateau.

3.2. Methods

Line transect method was used to collect data on the species of large mammals from the study area. Twenty six transect lines were laid, which varied in length from 1.41 km to 4.34 km established to observe large mammal species based on topography of the study site . Transect width ranged from 200 m to 400 m depending on vegetation cover and topography of the study site. Among 26 transect lines, ten transect lines were established for Ericaceous forest habitat, Six transect lines were for Afro-alpine forest habitat and ten transect lines were for afro-montane (woodland) forest habitat. Each transect line was set at a distance of 500 m (0.5 km) from other transects to avoid double counting. Two rounds of observations of large mammals during the late dry season and early wet season were carried out from February 2017 to July 2017. A totality of 67 km distance was covered. Observation was carried out along the line transect against the direction of wind to minimize disturbances (Yimer, 2008). Census (direct count) method was used to estimate number of large mammals in the park.

3.3. Data Collection

The present assessment was conducted during the late dry season and early wet season which might be relatively suitable to get the most likely data between the two seasons (Norton-Griffiths, 1978). To assess large mammal species diversity, direct evidences (direct observation or seeing, body parts and vocalization) and indirect evidences such as footprints, burrowing and droppings were used (Seber, 1982). During line transect survey, actual sightings of individual or group of animals or their signs such as droppings, footprints, vocalizations and dropped body structures (spines for porcupine) were recorded. Data collected from transect lines of similar habitats were pooled together for a particular habitat for analysis. Observation and direct counts of large mammals were made during 6:00 to10:00 a.m. in the morning and 3:00 to 6:00 p.m. in the afternoon when most mammals were active in the study area. 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). When traveled along the line transect, illegal activities, charcoal production, agricultural practices, grazing, fuel wood collecting and other human activities that might threaten wildlife and their habitats were recorded. To complement

information obtained about large mammals of the area and human-wildlife conflict, secondary data sources from Arsi Mountains National Park and interviews were conducted among people living adjacent to the forest in seven Kebele such as Lemunatijo, Tijolebu, Tulunegeso, Tite Waji, Shaldo jigesa, Digelu bora and Bura jale. Fourty nine adult male (seven from each Kebele) were selected for interview based on their extensive knowledge of the local fauna and who had lived adjacent to the area for many years. Interviews were mainly focused on human-wildlife conflict and the types of mammalian species existing in the forest.

3.4. Data Analysis

Encounter rate was computed as the total number of encounters for each species per total distance travelled. The relative abundance (Ar) was estimated as the total number of encounters of a species (calls, spoors and droppings) per distance of transects walked (encounter rate) at the study area (Lee *et al*., 2006 and Ofori *et al*., 2012).

Thus, Ar= Tse/Tlt where,

Tse = total number of species encountered and

Tlt = total length of transect walked

The Species diversity of large mammals in Chilalo Galema Mountains was calculated using the Shannon-Weaver index.

$$\text{Shannon Index (H)} = -\sum_{i=1}^{s} \text{PilnPi} = -\text{NPilnPi}$$

Where H= Shannon diversity index

Pi= is the proportion (n/N) of the i^{th} species in the habitat

S= Number of species encountered

Σ= sum for species 1 to species s

ln = is the natural log

N= Total number of individuals found and (n) = Number of one particular specie found

H is influenced both by number of species as well as by the evenness with which mammals are distributed with those species. Equal H values may thus be obtained if one habitat contains fewer and evenly distributed species of mammals (Shannon *et al*., 1949).

The evenness of mammalian species was calculated as J= H / H max

Where J= evenness of mammalian species

H= Shannon diversity index

H max= ln(s)

s =number of specie

n=number of individual

ln= is the natural log

This measure varies between 1(complete evenness) and 0 (complete unevenness). Chi-square ($\chi 2$) was used to compare differences in abundance of mammal species between habitats and the overall significant difference in abundance of large-sized mammal species in the study area. SPSS computer program was used for Chi-square analysis to test the association of large mammal species and their habitats (Flower *et al*, 1990). Simpson similarity index (SI) was also computed to assess the similarity among and between three habitats with reference to the composition of species.

SI= 3C/I+II+III

Where: SI= Simpson's similarity index

C= number of common species to all three habitat

I= the number of species in habitat one

II= the number of species in habitat two

III= the number of species in habitat three

4. RESULTS AND DISCUSION

4.1. Results

4.1.1. Line transect Observation

Information collected during each survey includes date, season, start time, end time, transect location. When large mammals were encountered, the following data were collected: time, coordinates, altitude, species/subspecies, and vegetation type. Large mammals transect line recording from Chilalo Galema Mountains during observation is indicated in (Table 1).

Table 1: Study sites within Chilalo Galema Mountains with their localities, altitude and habitat types

Habitat type		Study site	Date		Entry ID	Coordinates	Altitude (masl)
			late dry season	early wet season			
1	Afro-montane	Tulu negeso	20 / 02/ 2017	20-21 /06/ 2017	470	N. 0534816: E. 0833492	3348
		Ukamsa	21-24 /02/ 2017	14-18 /06/ 2017	500	N. 0539096: E.0834122	3277
		Chilalo	28-29 /02/ 2017	10-12 /06/ 2017	492	N. 0521782: E087622	3193
2	Afro-alpine forest	Bora Luku	25-27 /02/ 2017	4-7 /07/ 2017	484	N. 0544620: E. 0863096	3748
		Chefe Gedemsa	30-01 /03/ 2017	10-12 /07/ 2017	528	N. 0540161: E.0845095	3739
3	Ericaceous forest	Meraro	03-04 /03/ 2017	23-25 /06/ 2017	540	N. 0543473: E.0852357	3683
		Tulu saleni	02 /03/ 2017	27-28 /06/ 2017	524	N. 0538722: E.0849346	3266
		Merare chefe	05-06 /03/ 2017	29-30 /06/ 2017	470	N. 0536161: E0834795	3422

**Means of detection codes: - N= North E= East

4.1.2. Order and family of observed mammals

A total of 28 species that belongs to seven Orders (Primates, Artiodactyla, Carnivora, Hyracoidea,Tubulidentata, Rodentia and Lagomorpha) were recorded during this assessment. Order primates had two families (Cercopithecidae and Colobidae) and three species (*Papio anubis, Cercopithecus aethiops and Colobus guereza).*Order carnivore had six families (Canidae, Mustelidae, Viverridae, Herpestidae, Hyaenidae and Felidae) and 13 species (*Canis simensis, Canis mesomelas, Ictonyx striatus, Civettictis civetta, Herpestes sanguine, Crocuta crocuta, Panthera pardus, Caracal caracal, Herpestes inchneumon, Mellivoracapensis, Icneumia albicauda, Protelus cristatus, Canis aureus,* and *Felis serval).*Order Hyracoidea had one family *(procavidae) and one species (Procavia habessinica).*Order Tubulidentata had one family *(*Orycteropodidae) and one species (*Orycteropus afer).* Order Artiodactyla had two families (Suidae and Bovidae) and seven species (*Phacochoerus africanus, Sylvicapra grimmia, Oreotragus oreotragus, Redunca redunca, Tragelaphus scriptus, Tragelaphus scriptus meneliki* and *Tragelaphus buxtoni).* Order Rodentia had one family (Hystricidae) and one species (*Hystrix cristata).* Order Lagomorpha had one family (Leporidae) and two species (*Lepus capensis*and Lepus starki*).* Order Carnivora and Artiodactyla had the highest number of species with 13 and seven species respectively followed by Primates with three species.

Bohor reedbuck *(Redunca redunca)* the most abundant with the mean encounter rate of 1.04 followed by Warthog (*Phacochoerus africanus)* with 0.72 encounter rate. From the order Carnivora hyaena (*Crocuta crocuta)* relatively showed larger encounter rate (0.25) than Ethiopian wolf (*Canis simensis)* 0.21.Abyssinian Hare *(Lepuscapensis),* African civet (*Civettictis civetta),* Leopard (*Panthera pardus)*andBush buck *(Tragelaphus scriptus)* have registered the minimal encounter rate (0.03) in the study area. Secondary data source from Arsi Mountains National Park and Interviews made with the local people indicated the presence of nine species (Table 2).

Table 2: Mammals recorded and their encounter rate in Chilalo Galema Mountain

Order	Family	Common name	*Scientfic name*	*Total observed*	*Relative abundance*	*Encounter rate*
Primates	Cercopithecidae	Anubis baboon	*Papio Anubis*	13	*0.19*	*0.19*
		Grivet monkey	*Cercopithecus aethiops*	7	*0.10*	*0.10*
	Colobidae	Black-and-white colobus	*Colobus guereza*	6	*0.09*	*0.09*
Carnivora	Canidae	Ethiopian wolf	*Canis simensis*	14	*0.21*	*0.21*
		Black-back jackal	*Canis mesomelas*	4	*0.06*	*0.06*
		Common jackal	*Canis aureus*	*	*	*
	Mustelidae	Zorrilla	*Ictonyx striatus*	*	*	*
	Viverridae	African civet	*Civettictis civetta*	2	*0.03*	*0.03*
	Herpestidae	Slender-mongoose	*Herpestes sanguine*	4	*0.06*	*0.06*
		Honey badger	*Mellivoracapensis*	*	*	*
		Mongoose/Egyptia	*Herpestes inchneumon*	*	*	*
	Hyaenidae	Spotted hyaena	*Crocuta crocuta*	17	*0.25*	*0.25*
		Aard wolf	*Protelus cristatus*	*	*	*
	Felidae	Caracal	*Caracal caracal*	*	*	*
		Leopard	*Panthera pardus*	2	*0.03*	*0.03*
		Serval	*Felis serval*	*	*	*
Hyracoidea	Procaviidae	Ethiopian rock hyrax	*Procavia habessinica*	*	*	*
Tubulidentata	Orycteropodidae	Aardvark	*Orycteropus afer*	6	*0.09*	*0.09*
Artiodactyla	Suidae	Warthog	*Phacochoerus africanus*	48	*0.72*	*0.72*
	Bovidae	Bush duiker	*Sylvicapra grimmia*	3	*0.05*	*0.05*
		Klipspringer	*Oreotragus oreotragus*	12	*0.18*	*0.18*
		Bohor reedbuck	*Redunca redunca*	70	*1.04*	*1.04*
		Bush buck	*Tragelaphus scriptus*	2	*0.03*	*0.03*
		Menelik's bushbuck	*Tragelaphus scriptus meneliki*	6	*0.09*	*0.09*
		Monain nyala	*Tragelaphus buxtoni*	23	*0.34*	*0.34*
Rodentia	Hystricidae	Porcupine	*Hystrix cristata*	8	*0.12*	*0.12*
Lagomorpha	Leporidae	Abyssinian Hare	*Lepus capensis*	2	*0.03*	*0.03*
		Stark's hare	*Lepus starki*	*	*	*

*= indicate community information and secondary data from Arsi Mountain National Park for their existence.

4.1.3. Large mammalian species of Chilalo Galema Mountains National Park

Twenty- eight mammalian species were encountered during this assessment. A total of 16 species of large mammals of the 28 mammalian species recorded were detected through direct observation, where as three species were detected through indirect observation based on sign marks, including burrow, spine and scent marks and nine species were reported by scouts, staff worker of Arsi Mountains National Park, local people and secondary data source from Arsi Mountain national Park (report July 2008).The total number of species recorded for each habitat is presented in (Table 3).

Warthog *(Phacochoerus africanus)*, mountain nyala (*Tragelaphus buxtoni*) and spotted hyena (*Crocuta crocuta)* were the most common mammals which were recorded in all the habitat types and Ethiopian wolf (*Canis simensis),*klipspringer (*Oreotragus oreotragus)*, bohor reedbuck (*Redunca redunca*), mongoose and common jackal (*Canis aureus)* were recorded in two habitat types while aardvark (*Orycteropus afer)*,menelik bushbuck (*Tragelaphus scriptus meneliki)*, porcupine (*Hystrix cristata),),* leopard (*Panthera pardus),* bushbuck (*Tragelaphus scriptus),* serval cat (*Felis serval),* stark's hare (*Lepus starki),* honey badger (*Mellivora capensis),* anubis baboon (*Papio anubis),* monkey (*Cercopithecus aethiops),* guereza (*Colobus guereza percivali),* Ethiopian rock hyrax (*Procavia habessinicia),* caracal *(Caracal caracal*) and were recorded in one habitat type each.

Afro-montane habitat had highest species number records of 20 followed by ercaceous habitat species number records 13 while afro-alpine habitat had the least number of records which is nine (Table 3). Out of 28 mammalian species the presence of 19 (67.86%) species were confirmed through direct and indirect evidence while 9 (32.14%) species were recorded from secondary data sources of Arsi Mountains National Park.

Table 1: Large mammalian species of Chilalo Galema Mountains National Park.

No	Common name	Local name	Scientfic name	Methods of identification	Habitat types		
					Erc	Af-al	Af-mo
1	Mountai nyala	Gadamsa baddaa	*Tragelaphus buxtoni*	Observation	1	1	1
2	Bohor reedbuck	Godaa	*Redunca redunca*	Observation	1	0	1
3	Red duiker	Kuruphee	*Cephalophus natelensis*	Observation	1	0	1
4	Ethiopian wolf	Jeedala Dimtuu	*Canis simensis*	Observation	1	1	0
5	Porcupine	Xaddee	*Hystrix cristata*	Spine,Burrow &footprint	0	0	1
6	Anubis baboon	Jaldeessa	*Papio anubis*	Observation	0	0	1
7	Warthog	Goljaa	*Phacochoerus africanus*	Observation	1	1	1
8	Leopard	Qeeransa	*Panthera pardus*	Observation	0	0	1
9	Menelik's bush	Borofa gurracha	*Tragelaphus scriptus meneliki*	Observation	0	0	1
10	Black-back jackal	Sardiida dugda gurrraacha	*Canis mesomelas*	Observation	1	1	0
11	Monkey	Qamalee	*Cercopithecus aethiops*	Observation	0	0	1
12	Abyssinian Hare	Illeetti	*Lepus capensis*	Observation	0	1	0
13	Aardvark	Awwaaldigessa	*Orycteropus afer*	Burrow & R	0	0	1
14	Bushbuck	Bosoonu	*Tragelaphus scriptus*	Observation	0	0	1
15	Guerza	Weennii	*Colobus guereza percivali*	Observation	0	0	1
16	Spotted hyena	Waraabessa	*Crocuta crocuta*	Observation	1	1	1
17	Klipspringer	Gicii	*Oreotragus oreotragus*	Observation	1	1	0
18	Ethiopian Rock hyrax	Osolee	*Procavia habessinicia*	Secondary data source	0	1	0
19	Mongoose	Amaa	*Herpestes sanguine*	Observation	1	0	1
20	Serval cat	Deeroo	*Felis serval*	Secondary data source	0	0	1
21	Zorilla		*Ictonyx striatus*	Secondary data source	1	0	0
22	Civet cat	Moor'ee	*Civettictis civetta*	Scent mark	1	0	1
23	Caracal	Warbaa	*Caracal caracal*	Secondary data source	1	0	0
24	Common jackal	Jeedala bakka maraa	*Canis aureus*	Secondary data source	1	0	1
25	Honey badger	Amaa gaaguraa	*Mellivoracapensis*	Secondary data source	0	0	1
26	Mongoose/Egyptian	Amaa	*Herpestes inchneumon*	Secondary data source	0	0	1
27	Aard wolf		*Protelus cristatus*	Secondary data source	0	0	1
28	Stark's hare	Illeettii	*Lepus starki*	Secondary data source	0	1	0
	Total				13	9	20

Means of detection codes:-Erc**=Ericaceous habitat, Af-al= Afro-alpine habitat, **Af-mo**= Afro-Montane habitat **1-** Present and **0-**Absent

4.1.4. Large mammalian species recorded through direct and indirect observation in Chilalo Galema Mountains National Park block.

A total of 19 large mammalian species were observed and recorded in Chilalo Galema Mountains National Park block through direct and indirect observations (Table 4). In Chilalo Galema mountains Bohor reedbuck was the most dominant species about 27.8% and followed by warthog about 19.1%. Overall, 252 large mammals belongings to 28 species were recorded from three vegetation types of habitats (eight study sites). About 28.97% mammals, belongings to 28 species were recorded from ericaceous forest (Tulu saleni, Meraro and Merare cheffe study site), 10.32% from afro-alpine forest (Bora luku and Cheffe Gedemsa study site) and 60.32% from afro-montane (Woodland) forest (Chilalo, Ukamsa and Tulu negesso study site) were recorded (Table 4).

Table 2: Large mammalian species recorded through direct and indirect observation in eight study site of Chilalo Galema Mountains National Park block.

Site	Mountain Nyala	Bohor reedbuck	Duiker	Ethiopian wolf	Porcupine	Baboon	Warthog	Leopard	Menelic bush	Jackal	Klipspringer	Monkey	Hare	Aardvark	Bushbuck common	Colobus black And white	Civet cat	Mongoose	Hyena	Total (N)
Tulu Negeso	0	10	2	0	4	0	3	1	2	2	0	0	0	2	0	0	1	0	2	29
Bora luku	0	0	0	7	0	0	2	0	0	0	2	0	1	0	0	0	0	0	1	13
Chilalo	0	0	0	0	4	13	2	1	2	0	0	7	0	2	1	6	0	0	4	42
Ukamsa	9	28	0	0	0	0	30	0	2	0	0	0	0	2	1	0	1	4	5	82
Chefé Gedemsa	2	0	0	1	0	0	5	0	0	1	0	0	1	0	0	0	0	0	3	13
Tulu saleni	0	0	1	5	0	0	2	0	0	0	7	0	0	0	0	0	0	0	1	16
Merar	0	0	0	2	0	0	2	0	0	0	3	0	0	0	0	0	0	2	1	10
Merar Chefe	12	32	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	47
Total	23	70	3	15	8	13	48	2	6	3	12	7	2	6	2	6	2	6	18	252
%	9.1%	27.8%	1.2%	6.0%	3.2%	5.2%	19.1%%	0.8%	2.4%	1.2%	4.8%	2.8%	0.8%	2.4%	0.8%	2.4%	0.8%	2.4%	7.1%	100%

4.1.5. Species distribution and abundance of large mammalian species recorded through direct and indirect observation in different study sites in ChGMNP block.

The three habitat types (eight study sites) with their species type, number of individuals species (n), Total number of all species (N), Pi, $Pi,^2$ LnPi & PiLnPi are shown in Table 5.

Table 3: Species type, number of each species (n), and Total number of all species (N) recorded through direct and indirect observation in three habitat types.

Habitat type	Study site	Species type	n	N	n/N	Pi	Pi^2	lnPi	PilnPi	H'(Index of diversity)
Afro-montane	**Chilalo, Ukamsa and Tulu negesso**	Bohor reedbuck	38	152	38/152	0.25	0.063	-1.386	-0.347	1.904
		Red duiker	2	152	2/152	0.013	0.000	-4.343	-0.056	
		Porcupine	8	152	8/152	0.053	0.003	-2.937	-0.156	
		Warthog	35	152	35/152	0.230	0.053	-1.469	-0.338	
		Leopard	2	152	2/152	0.013	0.000	-4.343	-0.056	
		Menelik's bush buck	6	152	6/152	0.039	0.001	-3.244	-0.127	
		Jackal	2	152	2/152	0.013	0.000	-4.343	-0.056	
		Aardvark	6	152	6/152	0.039	0.001	-3.244	-0.127	
		Civet cat	2	152	2/152	0.013	0.000	-4.343	-0.056	
		Mountain nyala	9	152	9/152	0.059	0.004	-2.830	-0.167	
		Mongoose	4	152	4/152	0.026	0.001	-1.347	-0.035	
		Bush buck	2	152	2/152	0.013	0.000	-4.343	-0.056	
		Hyaena	10	152	10/152	0.066	0.004	-2.718	-0.179	
		Baboon	13	152	13/152	0.086	0.007	-2.453	-0.211	
		Monkey	7	152	7/152	0.046	0.002	-3.219	-0.148	
		Guereza	6	152	6/152	0.039	0.001	-3.244	-0.127	
Ericaceous	**Tulu saleni, Meraro**	Red duiker	1	73	1/73	0.014	0.000	-4.269	-0.059	1.57
		Ethiopian wolf	7	73	7/73	0.068	0.005	-2.688	-0.182	

		Hyaena	3	73	3/73	0.027	0.001	-3.612	-0.097	
		Klipspringer	10	73	10/73	0.137	0.019	-1.988	-0.272	
		Warthog	6	73	6/73	0.082	0.007	-2.501	-0.205	
		Mountain nyala	12	73	12/73	0.164	0.027	-1.808	-0.296	
		Bohor reed buck	32	73	32/73	0.438	0.192	-0.826	-0.361	
		Mongoose	2	73	2/73	0.027	0.001	-3.612	-0.098	
Afro-alpine	**Bora luku and Cheffe gedemsa**	Mountain nyala	2	27	2/27	0.074	0.005	-2.603	-0.192	1.809
		Warthog	7	27	7/27	0.259	0.067	-1.350	-0.349	
		Jackal	1	27	1/27	0.037	0.001	-3.296	-0.121	
		Abyssinia hare	2	27	2/27	0.074	0.005	-2.603	-0.192	
		Ethiopian wolf	8	27	8/27	0.296	0.087	-1.217	-0.360	
		Hyaena	5	27	4/27	0.185	0.034	-1.687	-0.312	
		Klipspringer	2	27	2/27	0.074	0.005	-2.603	-0.192	

4.1.6. Diversity indices of large mammalian species in Chilalo Galema Mountains National Park block.

A total of 28 large mammalian species were identified and recorded. Three habitat types Ericaceous forest, Afro-montane (Woodland) forest and Afro-alpine forest were represented by 8,16, and 8 species respectively. Diversity indices (H') and evenness (J) of large mammal species along the three habitat types were shown in (Table 6). Afro-montane (Woodland) forest had the highest diversity index (1.904) and evenness (0.686), thus afro-montane forest had more diverse community and species are evenly distributed, whereas the lowest diversity index (1.57) and evenness (0.755) was recorded in ericaceous habitat this showed that ericaceous habitat had less diverse community and evenly distributed species (Table 6).

Table 4: Diversity indices (H') and evenness (J) of mammals found in Chilalo Galema Mountains National Park block.

Habitat type	Study site	Number of species (s)	Total number of all species in habitat (N)	-ΣPilnPi i=1	H'_{max}= ln(s)	H'(Index of diversity)	J (evenness)
Afro-montane	Tullu Negeso, Ukamsa and chilalo	16	152	-1.904	2.772	1.904	0.686
Ericaceous forest	Tulu saleni Merarie chefe and Meraro	8	73	-1.57	2.079	1.57	0.755
Afro-alpine and Ericaceous forest	Bora luku and Cheffe gedemsa	8	27	- 1.809	2.079	1.809	0.870

There were 16 species in Afro-montane habitat, eight species in ericaceous and 8 species in afro-alpine habitat. Between three habitats they have 3 species in common.

Simpson's similarity index =3*3/16+8+8= 9/32 = 0.281

Simpson similarity index (SI) of large mammalian species among three habitats (eight study site area) was 0.281. This indicated that 28.1% of the species were common for all three habitats. The highest similarity occurrence between ericaceous against afro-alpine (0.625) and followed by ericaceous against afro-montane (woodland) (0.5).Whereas the lowest similarity occurrence (0.333) was between afro-alpine against afro-montane (woodland). The simpson's similarity index of large mammals for three habitat types is given in (Table 7).

Table 5: Simpson similarity index (SI) of large mammalian species among three habitat types.

Habitat (vegetation type)	Species number	Common species	Simpson's similarity
Ericaceous against afro-montane e	8 and 16	6	0.5
Ericaceous against afro-alpine	8 and 8	5	0.625
Afro-montane against afro-alpine	16 and 8	4	0.333

4.1.7. Human wildlife conflict

During line transect survey and observation; it was observed that the people practice mixed traditional agricultural system that combines annual cultivation with livestock rearing. This land use system is more serious especially in and around forest reserves close to human settlements. Interviews conducted with local people confirmed that permanent crops harvested in the area include barely, beans, wheat, pea, vegetables like potatoes, carrot and cabbage. Barely is the major staple crop in the area. Increasing land scarcity, wildlife attacking and killing livestock, damage caused by wildlife to crops and wildlife causes threats on human increased human wildlife conflict. This forced large and mobile animals to disappear from the area. Mostly human wild animals' conflict was with warthog, porcupine, anubis baboon, monkey, hyena and leopard. These large mammals (warthog, porcupine, anubis baboon and monkey) in the locality severely damage agricultural crops. As a result crop yield decline and the livelihoods of the farmers could be highly affected (Admasu *et al*., 2011). Farmers utilized various methods to keep their farms against pest animals in the study area. These are physical barriers (fence, walls) and guarding (watching, dog).

4.2. Discussion

Large mammal's distribution and diversity in the present study area was highly associated with habitat types. Afro-montane habitat has supported the highest number of mammalian species (16 species). Ericaceous habitat has supported eight species and afro-alpine habitat has 8 species from a total of twenty eight species. The possible reason for this distribution and diversity of large mammalian species might be due to the presence of food and water.

The mammalian species diversity recorded during the present study in the Chilalo Galema Mountains range is comparable with several other studies conducted in Ethiopia and African countries. This study agrees with the findings of other investigators such as Njoroge *et al*. (2009) recorded 23 species in Arawale National Reserve, Kenya; Bene *et al*. (2013) recorded 23 species in Sime Darby, Liberia; Zerhun Girma *et al*., (2012) recorded 19 species in Wendo Genet, Ethiopia, Afework Bekele (1988), recorded 25 species in Harena forest, Ethiopia, and Ofori *et al*. (2012) recorded 23 species in the moist semi-deciduous forest of Ghana.

A total of 16 species of large mammals of the 28 mammalian species recorded were detected through direct observation such as Mountain nyala (*Tragelaphus buxtoni),* Bohor reedbuck (*Redunca redunca),*Red duiker*(Cephalophus natelensis),* Ethiopian wolf (*Canis simensis),* Anubis baboon(*Papio anubis),* Warthog (*Phacochoerus africanus),* Menelik's bushback(*Tragelaphus scriptus meneliki),* Black-back jackal *(Canis mesomelas),* Monkey(*Cercopithecus aethiops),* Abyssinian hare *(Lepus capensis),* Bushbuck common (*Tragelaphus scriptus),* Guereza (*Colobus guereza percivali),* Spotted Hyena(*Crocuta crocuta),* Leopard *(Panthera pardus),* Mongoose (*Herpestes sanguine*) and Klipspringer (*Oreotragus oreotragus).*

Whereas three nocturnal species such as civet cat *(Civettictis civetta*), aardvark (*Orycteropus afer*) and porcupine *(Hystric crista*) were detected through indirect observation based on sign marks including foot print, burrow, spine and scent marks. Secondary data source from Arsi Mountains National Park indicated the presence of nine species such as serval cat (*Felis serval*), zorilla (*Ictonyx striatus*), caracal (*Caracal caracal),* scrub hare (*Lepus fagani),* common jackal (*Canis aureus),* honey badger (*Mellivoracapensis),* mongoose/egyptian (*Herpestes inchneumon),* aard wolf (*Protelus cristatus)* and Ethiopian rock hyrax (*Procavia habessinicia)* in the Chilalo Galema Mountains though the presence of the nine species were not confirmed both by direct and indirect evidences.

A total of three species of Order Primates belonging to the Family Cercopithecidae and Colobidae were recorded in the edge of woodland mixed with ericaceous forest of Chilalo Mountains through direct observation. Vervet monkey (*Cercopithecus aethiops*) and anubis baboon (*Papio anubis*) were seen at the edge of the forest closer to human dwelling areas and at the centre of the natural forest. The location of the species at the edge of the forest might be associated with a system of feeding on crops from shorter distance and easier sheltering when back off. This is similar to Yalden *et al*., (1976). Colobus black and white (*Colobus guereza*) was seen on long trees in the afro-mountain forest (mixed mountain forest) of Chilalo Mountains. This might be associated with the large number of fruits used as food and the height of trees might secure them from danger. This is the same as Aramde Fetene *et al*., (2011) said that *C.guereza* selected riverine and large trees as their preferred habitat.

A total of 252 recorded mammals in Chilalo Galema Mountains 26 (10.10%) were order primates. Interviews conducted with the local people revealed that the population of primates is declining in the area due to woodland was completely transformed by agricultural activities, deforestation. Order Carnivora had the highest number of family and species with six and 13 respectively. A total of 252 recorded mammals 50 (19.38%) were order Carnivora. Among the recorded carnivores, 18 (36%) was spotted hyena. Hyena (*Crocuta crocuta) was* the most common mammals of order carnivora which was recorded in all habitat types such as afro-montane forest, ericaceous forest and afro-alpine forest. The present study agrees with Sillero-Zubiri, (1996) that stated, spotted hyenas observed in the Bale Mountains, at more than 4,000 m of height.

From the order carnivora the presence of as serval cat (*Felis serval*), zorilla (*Ictonyx striatus*), caracal (*Caracal caracal),* common jackal (*Canis aureus),* honey badger (*Mellivoracapensis),* mongoose/Egyptian (*Herpestes inchneumon)* and Aard wolf (*Protelus cristatus)* were recorded from secondary data source of Arsi Mountains National Park and interview made with local people, scout and staff worker of Arsi Mountains National Park. Due to their nocturnal behavior could not be easily confirmed by direct observation. The presence of Jackal and Leopard were confirmed by direct observation in Ericaceous mixed with plantation forest and woodland mixed with Ericaceous forest. This study agrees with Hunter and Yonzon (1993) describes that most carnivore species are solitary, nocturnal and crepuscular so that their presence could not be easily documented. Ethiopian wolf was recorded through direct observation in Afro-alpine forest of the Chilalo Galema Mountains, endemic and feed mainly on rodents. This study agree with Malcolm &Sillero-Zubiri,(1997) Chilalo–Galama Mountain range has the second largest population of the Ethiopian wolf next to the Bale Mountains with 572 km^2 of suitable habitat.

Order artiodactyla had two families (Suidae and Bovidae) and seven species warthog (*Phacochoerus africanus),* red duiker *(Sylvicapra grimmia),* klipspringer *(Oreotragus oreotragus),* bohor reedbuck *(Redunca redunca),* bush buck *(Tragelaphus scriptus),* menelik's bush *(Tragelaphus scriptus meneliki)* and mountain nyala (*Tragelaphus buxtoni).* Out of the 252 recorded mammals in this study 26 (10.08%) were order primates, 50 (19.38%) were order carnivora, 1 (0.39%) were order hyracoidea, 6 (2.33%) were order

tubulidentata, 164 (63.57%) were artiodactyla, 8 (3.10%) were rodentia and 2 (0.78%) were lagomorpha. The data presented here indicate that the mammalian fauna of the Chilalo Galema Mountain (ChGM) was dominated by two groups of mammalian orders (the most abundant orders); namely, order artiodactyla and order carnivora, composed of 164 (63.57%) and 50 (19.38%) recorded mammals, respectively. The least abundant was order hyracoidean 1 (0.39%) recorded mammal. Endemic species belong to order artiodactyla two species (Mountain nyala *(Tragelaphus buxtoni*) and Menelik's bushbuck (*Tragelaphus scriptus meneliki*)) and order carnivora one species, Ethipian wolf (*Canis simensis*) were also found in Chilalo Galema Mountains.

From recorded 164 mammals of Order artiodactyla family Bovidae had 6 species that is 70 (42.68%) were bohor reedbucks (*Redunca redunca),* 23 (14.02%) were Mountain nyala *(Tragelaphus buxtoni*), 12 (7.32%) were Klipspringer (*Oreotragus oreotragus),* 6 (3.66%) were Menelik's bush (*Tragelaphus scriptus meneliki),*3 (1.83%) were Red duiker (*Sylvicapra grimmia)* and 2 (1.22%) were common bush buck (*Tragelaphus scriptus meneliki*), family Suidae had one species which is 48 (29.27%) were warthogs (*Phacochoerus africanus).*This showed that the most dominant and abundant species in Chilalo Galema mountains range was bohor reedbucks (*Redunca redunca)* and followed by warthogs (*Phacochoerus africanus).* Bohor reedbuck was recorded through direct observation. This species appeared to be more concentrated in ericaceous forest, afro-montane (plantation) forest habitat. The species was more frequently seen during the day and late afternoon. This might prevent the species from nocturnal predators. Among Order artiodactyla Mountain nyala and Menelik's bushbuck were endemic species in Chilalo Galema Mountain. Menelik's bushbuck, duiker, warthog, klipspringer, bush buck and montain nyalawere recorded through direct observation.

Order tubulidentata had one family (Orycteropodidae) and one species (*Orycteropus afer)* of which mammal's species recorded in Chilalo Galema Mountains. Aardvark (*Orycteropus afer)* was the only representatives of the Order Tubulidentata detected in the study area. It was recorded by indirect observation including burrows, spade-like scratches and foot prints found in woodlands, plantation, ericaceous forest and farmlands near forest. Aardvark was a nocturnal animal and shelters during the day in deep burrows. The current study agrees with

Yalden *et al.,* (1986) that aardvark has been overlooked in Ethiopia due to its nocturnal habits and its shelters during the day in deep burrows. Order Rodentia had one family (Hystricida) and one species (*Hystrix cristata)* in this study area. Porcupine (*Hystrix cristata)* was a nocturnal mammal of order rodentia.

The presence of porcupine (*Hystrix cristata)* was recorded by indirect observation including sign marks such as black and white spines, foot prints and burrows. It was classified in the IUCN list of least concern (Grubb *et al.,* 2008). Order hyracoidea had one family (Procaviidae) and one species Ethiopian rock hyrax (*Procavia habessinica)* which was recorded in Chilalo Galema Mountains during this study from secondary data source of Arsi Mountain National Park. Order lagomorpha had one family (leporidae) and two species abyssinian hare (*Lepus capensis)* and scrub hare (*Lepus fagani)* recorded during this study in Chilalo Galema Mountains through direct observation and secondary data source from Arsi Mountains National Park.

During line transect observation interviews made with the local people indicated the presence of human-wildlife conflict. It was observed that surrounding Chilalo Galema Mountains in 9 districts (Woredos) and 45 Kebeles People leave in and nearby mountain practice mixed agricultural system. As interviews conducted with local people and reported the major causes of human-wildlife conflict in surrounding Chilalo Galema Mountains were increasing land scarcity, wildlife attacking and killing livestock, damage caused by wildlife to their crops and wildlife causes threats on human. The current study agrees with Admassu *et al*., (2011). Most Crop damage can be caused by baboon, monkey, warthog and porcupine. The current study agree with Admassu *et al*.,(2011). Predation can be caused by Hyena and Leopard. This study was similar to Barnes, (1996) about 80% of the total crop damage can mainly be caused by elephants, baboons, grivet monkeys, eland and kudu, together with elephant and bush-pigs. In Zambia, the main wild animal pests are monkeys, warthogs, baboons, elephants, and hippopotamus. According to Kimega (2003), in Kenya, food items such as maize, cassava, beans, potatoes and fruit trees are the target of elephants, baboons, zebra, buffalo and wild pigs. The same is true in Ethiopia and surrounding Chilalo Galema Mountain. Therefore, crop raid by wild animals is one of the major causes of human–wildlife conflicts.

Farmers utilized various methods to keep their farms against pest animals in the study area. These are physical barriers (fence, walls) and guarding (watching, dog), killing and hunting.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study has revealed that Chilalo Galema Mountains National Park is home for endangered and endemic mammals like critically endangered endemic Ethiopian wolf, endangered and endemic Mountain nyala and Menelik's bushbuck. The present study identified and documented mammalian species of Chilalo Galema Mountains National Park and gave base line information about their presence. The distribution and abundance of mammalian species in Park varied because of vegetation types and altitudinal differences. For example, guereza, anubis baboon, monkey, bushbuck, menelik's bush buck and leopard were frequently seen in woodland habitat. The numbers of large mammal species recorded during the present study from Chilalo Galema Mountains forest were comparable with several other studies conducted in Ethiopia and African countries. The area harbors many large mammalian species, birds and other wild animals. Therefore, it can serve as important center for conservation of the country's wildlife and tourist attraction area in the future.

The people practice mixed traditional agricultural system that combines annual cultivation with livestock rearing. Increased agricultural practice adjacent to the forest increased human wildlife conflict. This forced large and mobile animals to disappear from the area. Mostly human wildlife' conflict was with warthog, porcupine, anubis baboon, monkey, hyena and leopard. The result 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.

5.2. Recommendations

Based on the findings of the current study the following recommendations were suggested:

- The present study confirms that the Chilalo Galema Mountain forest contains rich diversity of mammals and hence its conservation and biodiversity documentation efforts should continue uninterrupted.
- Further study is required to reveal the amount of crop damaged and livestock attacking and killing by wild animals.

- To conserve the wildlife in the park, threats such as encroachment, livestock grazing, grass cutting, environmental degradation, poaching and deforestation should be minimized.
- To reduce human-wildlife conflict, physically separating the two by the use of barriers should be applied (buffer zones should be demarcated).
- Promote community-based solutions to prevent and manage human-wildlife conflicts.
- Increase public understanding and awareness about human-wildlife conflicts.
- Harmonized, multi-jurisdictional policies to reduce local human-wildlife conflicts with clear agency roles and responsibilities.

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APPENDICES

Appendix I: An interview with local people

Background information

1. Sex: Male_____ Female_____ 2. Age

<20	20-30	31-40	41-50	>50

3. Family size:

<2	2-4	4-6	6-9

4. marital status:

Married	Unmarried	Divorce	Widow

5. Education status:

Can't read and write	Grade 1-4	Grade 5-8	Grade 9-12	High level

6. Which types of large wild mammals do you know in Chilalo Galema Mountain currently live there?

NO	Mammals name	የእንሰሳውስም	Large wild mammals found in Chilalo-Galema mountain
1	Baboon	ዝንጅሮ	
2	Menelik bushbuck	የሚኒሊክድኩላ	
3	Buffalo	ጎሽ	
4	Lion	አንበሳ	
5	Colobus,black and white	ጉሬዛ	
6	Duiker	ሚዳቆ	
7	Commen Fox	ቀበሮ	
8	Hare	ጥንቸል	
9	Hartebeest,lelwel	ቆርኬ	
10	Giant forest (pig)	አሳማ	
11	Hippopotamus	ጉማሬ	
12	Hyaena	ጅብ	
13	Hyrax ,Rock	ሽኮኮ	
14	Klipspringer	ሰስ	
15	Mountain Nyala	ኣጋዘን	
16	Kudu,lesser	አምባራይሌ	

17	Leopard	ነብር	
18	Mongoose	ሸለምጥማጥ	
19	Monkey, blue	ጨኖ	
20	monkey	ጦጣ	
21	Oribi	ፌቆ	
22	Oryx	ሳላ	
23	Porcupine	ጃርት	
24	Bohar reedbuck	ብሆር	
25	Serval	ዬሮ	
26	Zorilla	ፋሮ	
27	Cheetah	አቦሸማኔ	
28	Zebra	የሜዳአህያ	
29	Aardvark	አዋልድጌሳ	
30	Hunting dog	ተኩላ	
31	Ibex,Walia	ዋልያ	
32	Ethiopian wolf (red fox)	ቀይቀበሮ	
33	Caracal	ዳልጋአንበሳ	
34	Warthog	ከርከሮ	
35	Elephant	ዝሆን	
36	African civet	ጥርኝ	
37	Bushbuck,commen	ድኩላ(ተራ)	
38	Dikdik,Guenther's	ኢንሹ(የጉንተር)	
39	Gazelle,Grant's	የሜዳፍየል(የግራንት)	
40	Genet,commen	ፉሮድመት(ተራ)	

7. Is there human-wildlife conflict in surrounding Chilalo Galema Mountain?

8. In your knowledge what are the main causes for human-wildlife conflict?

9. What are the different techniques you used to control (minimize) the human-wildlife conflict?

10. Which large wildlife mammals cause crop damage, predation, threats on human and diseases in surrounding Chilalo Galema Mountain?

Wildlife which cause crop damage	Wildlife which causes predation	Wildlife which causes threats on human	Wildlife which causes diseases

Appendix II: Interview that translated into Afan oromo

YUNIVERSIITII SAAYINSII FI TEKNOLOGII ADAMAA

ISKUULII APLAAYIDII SAAYINSII UMAMAA

MUMMEE APLAAYID BAAYOOLOJII

Af-gaaffii ummata naannoo gaara Chiilaaloo Gaalamaa waliin godhamu

Kabajamoo /ttu Deebisa/ ttu af-gaaffii kanaa kaayyoon af-gaaffii kanaa haala odeeffannoo gosa hosiftoota bineensota bosona gugguddoo gaara Chiilaaloo Gaalamaa keessaatti argaman beekuf.Kanaafu ,deebin isin kenitan galma gahiinsa qorannoo fi qu'annoo kanaaf eddo guddaa wan qabnuuf deebii keessan haala gaafatamtaniin akka naaf deebistan isin gaafadha.Deebiin isiin kennitan hundii hojii qo'annoo qofaa kan fayyaduu ta'uu isiinii ibsa.Yaada naaf kenitaniif galatooma

I. Odeffannoo waliigalaa gaafatamtootaa

1. Saala: dhi _____ dub_____

2. umrii waggaa:

<20	20-30	31-40	41-50	>50

3.Baay'nnaa maatii:

<2	2-4	4--6	6--9

4.Haala fudhaaf heerumaa

Kan fudhee/ heerumtee	Kan hin heerumnee/kan hin fudhinee	Kan hiiktee .kan hiikee	Window

5.Haala barumsa

Dubbisuu fi barreessu hin danda'u	Kutaa 1--4	Kutaa 5--8	Kutaa 9--12	Sadarkaa olii

6. Gaara Chiilaaloo Gaalamaa keessatti akaakuu hosiftoota gugguddoo kam fa'aa beektu? Gosa hosiiftoota guggudo beektu mallattoo 'X' barreesun agarsisii ..

Maqaa bineensa	የእንሰሳውስም	Hosiftoota gaara Ciilaaloo Gaalamaa keessatti argaman
1.Jaldeessa	ዝንጅሮ	
2.Borofa	ድኩላ	
3.Gafarsa	ጎሽ	
4. Leenca	አንበሳ	
5. Weennii	ጉሬዛ	
6.Kuruphee	ሚዳቆ	
7. Jeedela(sardiida)	ቀበሮ	
8. Illeetti	ጥንቸል	
9.korkee	ቆርኬ	
10.Booyyee	አሳማ	
11. Roobii	ጉማሬ	
12.Waraabeesa	ጅቡ	
13. Osolee (Shakokkoo)	ሸኮኮ	
14. Giccii	ሰስ	
15. Gadamsa baddaa	አጋዘን	
16.ambaaraaylee	አምባራይሌ	
17. qeeransa	ኑብር	
18. Amaa	ሽለምጥማጥ	
19. Cannoo	ጨኖ	
20. Qamalee	ጦጣ	
21. Feeqoo	ፌቆ	
22.Saalaa	ሳላ	
23. xaddee	ጃርት	
24. Goodaa (Bihoorii)	ብሆር	
25. Anarii (Iyyaa)	ዬሮ	
26. Faaroo	ፋሮ	
27. Aboo shamaanee	አቦሸማኔ	
28. Harree diidoo	የሜዳአህያ	
29. Awaaldiigeessaa	አዋልድጌሳ	
30. Yeeyyii	ተኩላ	
31. Waaliyaa	ዋልያ	
32. Jeedala diimtuu	ቀይቀበሮ	
33. Huutuu (Ayyubbee)	ዳልጋአንበሳ	
34.Karkaroo(goljaa)	ከርከሮ	
35.Arba	ዝሆን	
36.Xirinyi	ጥርኝ	
37. Bosonu	ድኩላ(ተራ)	
38.Ennishu	ኢንሹ(የጉንተር)	

7. Walitti bu’insi nama fi bineensota bosona giddu naannoo gaara Cilaaloo Gaalamaatti jira?

8. Sababoon gugguddon walitti bu’nsa nama fi bineensota bosona maalfa’a?

9. Tooftaaleen adda addaa walitti bu’insa nama bineensota bosona giddu jiru too’achuuf (hir’isuuf) fayadamtu maal?

10. .Hosiftoota bineensota bosona guggudoo keessa rakkoolee armaan gadi geessan issan kamfa’aa?

Kan miidhaan irraan badi gahaan.	**Kan beeladoota adamsaan(nyaatan)**	**Kan nama irraatti hubaati geessan.**	**Kan dhiibee fidan.**

Appendix III: Wildlife transect line recording form of Chilalo Galema block

Entry _____ Weather_____ Starting time_____

Category_____ Bearing_____ Altitude (start) _____

Ending (UTM)_____ Starting time_____ Altitude (end)_____

Final time_____ Transect length_____

Region=Oromia Observation_____

Park name AMNP Sample area_____

Block name Chilalo Galema Total area_____

No	Species observed	Sex			Age			. Location UTM	Dist. of observation	Altitude (masl)	Sight bear	Observation type	date	Time of observation	Tot. No of species	Remark
		male	female	Unknown	Calf	young	Adult									

Appendix IV: Plates

Bohor reedbuck

Monainten nyala

Klipspringer

Bohor reedbuck

Few large mammals of the Park (Photo by Girma Lemma and Muhamed Tifo AMNP Staff)

Pressure on the Chilalo Galema Mountains (grazing, fire wood collection, and unknown cause of Wildlife death (Photo by Girma Lemma and Muhammed Tifo AMNP staff).