Jimma University

College Of Natural Sciences

Department Of Biology

The Diversity, Distribution and Relative Abundance of Medium and Large-Sized Mammals in Chukala Mountain Forest, East Shoa Zone, Oromia, Ethiopia

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Thesis Submitted to Department of Biology, College of Natural Sciences, Jimma University in Partial Fulfillment of the Requirement for the Degree of Master in Biology (Ecological and Systematic Zoology)

June, 2021

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Approval Sheet for Submitting Final Thesis

As a members of the Board of Examination the Final _____Thesis open defense, We certify that We have read and evaluated the thesis prepared by Nimona Alemu under the title "The Diversity, Distribution And Relative Abundance Of Medium And Large-Sized Mammals In Chukala Mountain Forest, East Shoa Zone, Oromia, Ethiopia" and recommend that thesis be accepted as fulfilling the thesis requirement for the degree of Masters of Science in Ecology and Systematic Zoology.

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Certification of the Final Thesis

I hereby certify the correction and recommendation suggested by the board of Examiners are incorporated into the final Thesis. Entitled_____

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List of Abbreviation and Acronyms

m.a.s.l…….....meter above sea level

SPSS……Statistical Package for Social Sciences

ETB……..Ethiopia Birr

IUCN……International Union for Conservation of Nature

FAO …… …Food and Agriculture organization of United Nation

GPS ……..Global poising System

Kg…….kilogram

Km…….kilometer

Mt……..Mountain

SI……Simpson's similarity index

Abstract

This study was conducted to assess the diversity, distribution, relative abundance of large and medium size mammals in Chukala mountain Forest from March 2020- August 2020. Preliminary survey was conducted and three habitat types: Montane Forest with grassland, woodland and Riverine Forest were identified. A line transect survey method was implemented to record the mammalian diversity. Representative Line transects were purposively selected and permanently surveyed for two seasons. Each transect was surveyed twice a month for two months per season. Data was collected in each line transect by direct and indirect method. A total of 12 species, 5 orders and 8 families were recorded from study area. Among them three (3) species;the Vervet monkey *(Chlorocebus aethiopis),* Rock hyrax *(Procavia capensis) and Ethiopian hare (Lepus fagani) were medium sized mammals while other nine (9) species were large sized mammals. From these species Olive baboon (Papio anubis) is the most abundant species while* Rock hyrax (*Procavia capensis*) *was the least abundant species in study area. The highest species diversity was recorded in woodland (H" =1.700) followed by Montane forest with grassland (H"=1.156) and the least diversified habitat was Riverine forest (H"=1.070) in the dry season. The similarity of mammalian species were recorded between the Montane forest with grassland and Riverine forest in both seasons (SI=1). This study identified and recorded medium and large sized mammalian species and provided current information about their existence in Chukala Mountain forest. Other researchers are recommended to find out additional mammalian species, plant, bird species and other, impact on and rehabilitation of Chukala mountain forest.*

Key words: Chukala Mountain forest, Mammals, Mammals 'distribution, mammals' diversity, Relative Abundance

1. Introduction

1.1 Background of the study

Mammals are an important ecological constituent of terrestrial ecosystem (Dirzo *et al*., 2009). They can be divided into small, medium and large based on body weight. Medium sized mammals are mammals whose body weight varies from 2kg to 7kg such as small carnivores, small primates, large rodents, hyraxes, and pangolins. While Species with more than 7kg are considered to be large sized mammals and these include most diurnal primates, most carnivores larger than a fox or house cat, all perissodactyls and artiodactyls (Emmons and Feer, 1997). Globally from the 5,487 mammalian species assessed, nearly one-quarter of species (22.2 %) are threatened or extinct, representing 1,219 species. Seventy-six of the 1,219 species are considered to be extinct. The other 3,432 species are not considered to be threatened at present, being classified in the IUCN red list categories of near threatened or least concern, while there was insufficient information available to assess the status of an additional 836 species (IUCN, 2018).

Over 1150 species of mammals are listed in Africa (Kingdon, 1997). Functional structures of medium and large-sized mammals are determined by the composition of functional traits (feeding type, body mass, activity patterns and gregariousness). Such structures often vary along environmental gradients such as disturbance and resource availability (Hashim and Mahgoub, 2007). Medium and large sized mammals are very important for the proper functioning of ecosystems. They are responsible for plant pollination, seed dispersal, nutrient recycling and balancing populations through predator-prey interaction (Janson *et al*., 1981). In addition, they have enormous effects on the structure and composition of vegetation (Sinclair and Arcese, 1995). Large mammals have long been recognized as animals that interact in particularly complex and powerful fashions with their habitat (Berger, 2001). They are also fundamental elements in many ecosystems. Large herbivores function as ecological engineers by changing the structure and species composition of the surrounding vegetation (Hashim *et al*., 2007). Furthermore, both set of mammals profoundly influence the environment beyond direct species interaction such as through cascading tropic effects (Mugatha, 2002). Large sized mammals perform important ecological functions and good indicators of the habitat value because they do not typically rely on specific single habitat as many small mammals do (NLFC, 2005).

Ethiopia is physically and biologically diverse country as the result of extensive altitudinal variation (Yalden *et al*., 1996). According to Yalden *et al*., (1996), the geographical position, range of altitude, rainfall pattern and soil variability of Ethiopia have resulted in an immense ecological diversity and huge wealth of biological resources. The altitudinal variations within Ethiopia produce a range of climate which affects every aspect of life in the country; plant and animal distribution and the concentration of people and the types of agriculture, while temperature, rainfall and vegetation play major roles in determining the distribution of fauna including that of endemic mammals (Ojeda *et al*., 2000). The flora of Ethiopia is very diverse with an estimated number between 6,500 and 7000 species of higher plants, of which 15 percent is endemic (Gebre Egziabher, 1991). Also Ethiopia is rich in its faunal diversity that reflects the existence of a large number of species of mammals and other higher vertebrates (Laykum, 2000). the fauna and flora in the Ethiopian highlands are unique that makes it one of the planets' diversity hotspots (Freilich et al., 2014). Of the over 300 species of mammals recorded from the country 31 are endemic (Largen, 2001) and the high level of endemicity is attributed to the large extent of highlands. Over sixty percent of the recorded mammals are medium and large sized (Bekele and Yalden, 2014).

The diverse and important biological resources of Ethiopia need to be protected and managed. To safeguard the under studied wildlife resources of the country, the Ethiopian Wildlife Conservation Authority and regional governments allocated wildlife conservation areas under different categories including 12 National Parks, 11 Wildlife Reserves, 3 Sanctuaries, 18 Controlled Hunting Areas and 69 Important Bird Areas have been established as refuge in Ethiopia (Yong, 2010). But many are unrecognized. Mammals of Ethiopia are under progressive studies, But the diversity and conservation status of mammalian species outside protected area are poorly known (Gonfa *et al*.,2015, Atnafu *et al*.,2018). However, the study mammals in unprotected area are equally important even more because of huge anthropogenic pressure they absorb from their surrounding environments. Chukala mountain forest is unprotected area that has heavy exploited and in virtue of total destruction if conservation action is not takes place. The area has many diversity of medium and large sized mammals but like most unprotected area of the country there is scarce of information about mammalian species diversity, distribution and relative abundance of medium and large sized mammals. Therefore the aim of this study is to document species composition of medium and large sized mammals in Chukala mountain Forest.

1.2 Statement of problem

Due to the expansion of human settlement, deforestation of forestlands for cultivation purposes had intensified the degradation of forests; loss of vegetation has increased the depletion of soils and loss of wild mammals. As a result, the wildlife populations are forced to occupy isolated habitat areas that are often found in national parks (Girma, 2012).The Ethiopian highlands are among the most densely populated agricultural areas in Africa. This in turn has led to formation of many forest fragments in most parts of Ethiopia. However, the significance of small fragments of wildlife habitats that exist outside protected areas in maintaining diverse groups of wildlife species in Ethiopia is poorly understood. In Mountain Chukala Forest and its surrounding, the devastation of the natural forests on the mountain has been going on for some time. Charcoal production and illegal burning of trees are also occurred in the area (Forest genetic resources conservation project, 2004).These are caused by rapid population and inhabitation of people increase in and around Chukala Mountain. These human activities impact on faunal diversity by losing of the habitat, exposing them for hunting, increasing human wildlife conflict, reduce their reproduction and faunal population and also cause of mammalian extinction. Unless serious management interventions are taken by the concerned body, condition can become very worse and the forest will be eliminated in nearest time together with the faunal resources. Knowledge on diversity, distribution and relative abundance of mammals is very essential for the development of effective land management plan (Stephens *et al.*, 2001). However, there is scarce information on diversity, distribution and relative abundance of medium and large mammals in the study area. Systematically record the mammalian faunal diversity is crucial for management (for assigning appropriate mammals for controlled hunting) (Wihart, 2004), or to document the faunal resource to recommend appropriate conservation strategies (Varman and Sukumar, 1995). Therefore, the present study is proposed to fill this gap by collecting current information on the diversity, distribution and relative abundance of medium and large sized mammals in Chukala mountain Forest, Liban Chukala District, East Shoa, Oromia, Ethiopia.

1.3 Objectives

1.3.1 General objectives

To assess the diversity, distribution, relative abundance of large and medium size mammals in Chukala mountain Forest.

1.3.2 Specific objectives

- ✓ To determine the species composition of large and medium size mammals in the study area.
- ✓ To record distribution of large and medium size mammals in the study area.
- ✓ To assess seasonal distribution patterns of medium and large sized mammals in the Chukala mountain forest.
- ✓ To identify the relative abundance of medium and large sized mammals in the study area.

1.4 Significance of Study

The destruction of vegetation and environmental degradation has become issues of national and global concern in recent years. This is because of declining vegetation cover and depletion of natural resources are closely associated with drought and food shortages that have become major threat affecting the life of wild life. Identifying the diversity, distribution and the relative abundance of mammalian species is very important to conserve and manage properly for sustainable use of mammals. However there is the lack scientific documentation of mammalian species in Chukala mountain Forest. Therefore, the result of the proposed research work will have great importance for the scientific documentation and provide the current information about the diversity, distribution and relative abundance of medium and large sized mammals and conservation of wildlife in Chukala mountain Forest in East shoa Zone, Oromia regional state, Ethiopia. This is important for the future development, management plan and conservation strategy of Chukala Mountain Forest.

2. Literature Review

2.1. Biodiversity

Biodiversity describes the sum total variation of life forms across all levels of organization which ranges from genes to ecosystems. Accelerating rates of biodiversity loss and the signing of international agreements, such as the convention on biological diversity and agenda 21, have called for the world biodiversity to be inventoried and monitored (Stork and Samways, 1995). The convention requires each signatory nation to provide and identify biodiversity components that are important for conservation and sustainable use. Biodiversity inventorying and monitoring provide fundamental and essential biological information used by many basic scientific disciplines (e.g. systematic, population biology, behavior, ecology and other comparative fields of biology) and applied science. Thus, it helps biological conservation to have a scientific basis from which we can gain knowledge about species, habitat and ecosystem. The more we know about species, habitats and ecosystem and about how these entities function, the more likely we are able to be successful at conserving biodiversity. Spellerberg and Steven, (1995) suggested that, before adequate conservation measures can be undertaken, it is necessary to conduct an accurate survey on identification, distribution and abundance of the species harbored in an area.

Biodiversity also includes the variety and abundance of species, their genetic composition, and the communities, ecosystems, and regions in which they occur (Burley, 2002). Ecological processes have the totality of structural and functional relationships. Energy flows and minerals cycle through individual organisms that are members of species whose populations are assembled in to ecological communities (Kormondy, 1996). None of these ecological processes occurs in isolation for each is marked by particular groupings of different species or populations in particular physio-chemical environments (Grime, 1997). Each community has a defined a set of animal and plant species living in it, a set that continues year after year with only minor change. Therefore, ecological community is an interactive grouping of species whose ecological role and energetic are in some way interdependent (Putman, 1994).

Biodiversity has several values that benefit human being in different ways. Among the values of biodiversity, are ecological, economic, educational and scientific, recreational and aesthetic values are the principal ones. The ecological services of biodiversity include enhancement of air and water quality, hydrological, gaseous and mineral nutrients circulation, manufacture of food by green plants to be used as food, waste disposal by organisms some of which act as decomposers, soil formation, support of parasite host, prey, predator, symbiotic and other relationships among organisms (Tilman *et al*., 1999).

Biological diversity is a fundamental importance to the functioning of all natural and human engineered ecosystems and by extension to the ecosystem services that nature provides free of charge to human society. Living organisms play central roles in the cycles of major elements and water in the environment and diversity specifically is important in that these cycles require numerous interacting species (Takacs, 1996). Economic uses of biodiversity include its uses in the organization and utilization of biological wealth in satisfying human needs in different areas including agriculture, forestry, fisheries, wildlife and other industries (Cox and Balick, 1994).In spite of its values at the beginning of the 21st century scientists around the world are unaware of the rising threat that biodiversity is being put under.

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

2.2. Mammalian diversity

Mammals are highly diverse. Mammaliogists commonly group mammals as small or large based on body weight or size. The extant land placental mammals range from the six ton elephant to mice, shrews and bats weighting a few grams (Nowak, 1991; Wirminghaus and Perrin, 1993).

The body size of mammals, generally, correlates with territory, amount of food intake and reproductive potential. Large mammals in general require larger territory, consume large quantity of food per individual and have relatively lower reproductive potential as compared to the smaller mammals.

Happoled (1991), grouped mammals based on their body weight and size and in relation to the general response to human influences. Thus, according to Happoled and Happoled(1991), large sized mammals (elephant, rhino, ungulates, carnivores and most primates) have low reproductive rates and compete directly with humans for resources. Most medium sized mammals have variable size, moderate reproductive rate and limited competition with humans for resources. Smaller mammals (rodents, shrews and bats) have high metabolic and reproductive rates, and are difficult to hunt compared to large mammals. They show positive response (population increment) to most human influences, unlike large mammals. They range in size from African pigmy mice (Musminutoides) to whales (Mugatha, 2002).

According to a Delnay and Happold (1979), one of the most interesting appearances of tropical Africa is the riches and diversity of its mammalian fauna. This fauna holds species as varied as enormous elephants, tiny pygmy mice, scaly pangolins, amphibious hippopotamuses, flying squirrels, naked burrowing rodents, and termite-eating aardvarks. Over 1,150 species of mammals are recorded from Africa, belonging to 13 Orders and 50 Families.

Out of the 900 genera of placental mammals in the world, 20% occur in East Africa (Kingdon, 1971). Simpson (1945) classified 26 orders of placental mammals, ten of which have become extinct. Out of the remaining 14 orders of placental mammals, 12 are represented in East Africa in 47 families with over 360species. Mammals inhabit every terrestrial biome from deserts through tropical rainforests to polar icecaps. Many species are arboreal, spending most or all of their life time in the forest canopy. Many mammals are partially aquatic, living near lakes, streams or the coastlines of oceans. Locomotion styles are also diverse. Social behavior varies considerably as well. Some mammals live in groups of tens, hundreds, thousands or even more individuals. Other mammals are generally solitary except when mating or raising young.

Activity patterns among mammals also cover the full range of possibilities. Mammals may be nocturnal, diurnal or crepuscular (Reichholf, 1990). Although mammals share several features in

common, they also contain a vast diversity of forms. Mammals have evolved to exploit a large variety of ecological niches and have evolved numerous adaptations to take advantage of different lifestyles (Flynn *et al.*, 2005). Among mammals living today, 0.1% of them are egg laying and 99% are placental. They live on land, water bodies and air (Solomon, 2008).

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

2.3. Distribution of Mammals

The geographical distribution of mammals is world-wide. They occupy all continents, from far beyond the Arctic Circle in the north to the southern most parts of continents and large islands in the south covering most habitats of the earth (Walker, 1975). Some orders and families that are absent in one continent occur in the other. Family Leporidae, Mustllidae, Cotiedae and Felidae are native to all continents except Antarctica and Australia. Aardvark occurs only in Africa. Insectivores are absent from Australia and South America (Prasad and Kashyap, 1995).Since the distribution and abundance of animal population is the result of their past colonization history and ongoing interactions with their respective environment, the reason for restricted or wider distribution of any given species needs to be viewed accordingly.

Ethiopia has high level of biodiversity and endemism because of the diverse habitats, altitude and climate that vary from desert to tropical and Afroalpine habitats (Marino, 2003). Ethiopian high faunal biodiversity reflects the existence of a large number of species of mammals and other higher vertebrates. The expansion of human settlement and agriculture causes many wildlife species to become smaller in population. In the face of global change and ensuing modifications of biodiversity patterns, research on species distribution is a prime focus in ecology and conservation. Large scale land conversion, resource exploitation, industrial, agricultural and climate change are posing considerable pressure on species (Foley *et al.*, 2005). The question of

how this impact will modify community assemblages, species interactions and eventually ecosystems and their services requires first and foremost a solid understanding of the mechanisms determining species distribution and biodiversity patterns (Gaston, 2000). The distribution of species and biodiversity is determined by a large number of abiotic and biotic factors, of which usually only a few are well established for any given species (Guisan, 2006). Much research effort has been devoted to identifying the factors for individual species and patterns of biodiversity including geophysical conditions, geographical features, the productivity, quality and heterogeneity of habitats, predation, disease, demographic effects, human impact and species interactions (Guisan, 2006).

Consequently, depending on the taxa of interest these effects then lead to both positive and negative relationships between biodiversity and human impact (Luck, 2007). The habitat of the animals is the area where the animal preferably occurs and where all its life necessities are fulfilled. Wildlife resources including mammals of the country are now largely restricted to a few protected areas (Tewodros and Afework, 2008).

2.4 Importance of Mammals in an Ecosystem

The use of animals by humans for food (Alves *et al.*, 2010; Alves, 2012), tools manufacturing, medicines production and magical-religious practices dates to the early history of human (Frazier, 2007). Mammals and birds are the preferred groups of animals selected by hunters for food. Mammals have long been recognized as animals that interact in particularly complex and powerful fashions with their habitat (Laws, 1970). Large herbivores function as ecological engineers by changing the structure and species composition of the surrounding vegetation.

The functional significance of medium and large mammals relies on the ecosystem roles they play, such as seed dispersal and predation on numerous plant species. These functional roles may change the structure and composition of ecosystems. Moreover, these species influence the community structure and complexity on the tropic levels in which they are involved, due to their regulatory role as preys and predators (Roemer, 2009). The loss of these organisms could have devastating effects because they contribute in many ways to the functioning of the natural ecosystem (Alonso *et al.*, 2001). Given the importance of these species, studies identifying and predicting the environmental changes that may affect their diversity are essential and in such

studies, relative abundance and species diversity are usually used as indicators (Carrillo *et al*., 2000).

2.5. Threats to Mammals

2.5.1 Habitat Fragmentation

Habitat fragmentation is splitting of natural habitats and ecosystems into smaller, more isolated patches driven by many different factors like disturbance, pollution, settlement, infrastructure, and deforestation. It is the main process responsible for biodiversity loss and threat in tropical forests leading to isolation (Olifiers *et al*., 2005). Conversion to agricultural land use results in a loss of habitat, reduction in patch size, and an increase in distance between patches and new habitat formation. Habitat loss has pervasive and disruptive impacts on the biodiversity and its magnitude of the ecological impacts can be exacerbated by habitat fragmentation.

The impacts can also occur in introduction of exotic species, invasion by competitors, alteration of microclimatic conditions, crop cultivation, pasture and human residence near the fragmented forest habitat also highly determine the species composition and abundance of mammals (Olifiers *et al*., 2005). Species composition and abundance change as fragmentation occurs in landscapes by losing those species that require large areas. This increases the probability of extinction. The rate of species extinction in an isolated patch is inversely related to the size because it less likely provides food, cover, and other resources necessary to support the native wildlife community. The physical changes in the extent and connectivity of suitable habitat conditions affect many processes that influence the behavior and spatial habitat use patterns and intra and inter specific interactions that influence population persistence and community structure and dynamics (Wilson, 1996).

2.5.2 Deforestation

Deforestation and the resulting land degradation are the global threats for many wild animals with its natural habitat and affect the wild animal's life style in their preferred habitats. Habitat loss due to expanding human settlements, agriculture and increasing livestock grazing pressure contributed to the decline of mountain Nyala across its range. The human population around most protected areas over the years has been changing in terms of its size, density and livelihood

strategies Uncontrolled logging, illegal charcoal production and fuel wood collection are some of the major causes of deforestation that directly influence large mammal's habitat. Moreover, such activities cause the decline of the diversity of mammals of the protected area (Masanja, 2014).

2.5.3. Human Wildlife Conflict

Human wildlife conflicts are a perpetual problem. The problem is growing by the day as more and more land is brought under cultivation. Human settlements are on the increase, thus reducing areas available to wildlife and increasing chances of interaction between people and dangerous animals (Magin and Taylor, 2002).The factors could be migration of prey leaving the predators behind, prey number decline due to poaching and land use changes. The same also occurs due to livestock incursion into protected areas, where they become easy prey. In some instances the encounters between wildlife and humans turn fatal, while in other instances nonfatal injuries occur to either the people or the wildlife. Human death caused by wildlife is always a big issue, irrespective of the circumstances that lead to it.

Conflicts over natural resources between the communities living adjacent to protected area and tourism development have increased because of changes in land use and accompanying new ideas about wildlife resource management and utilization (Wolff, 1961). The varieties of large animals in Ethiopia are many and their distributions are dependent on the protected areas with insufficient protection (Amare, 2015). Human-wildlife conflict is a major concern of most people living next to protected areas in developing countries due to their subsistent live. It arises when growing human population's overlap with protected areas and result in scrambling for resource. As the human population increases, there is an increasing demand for space and resource utilization and affects wild animals habitat on the protected areas as a result various mammals are disturbed.

2.5.4 Demographic Factors

One of the problems of high population in close proximity to the borders of protected areas is growing pressure from local people to open protected lands for community use (Hackel, 1999). This had implication on land requirements for livestock. Expansion of arable land and settlements around national parks had led to shrinkage of the grazing land for livestock, which is increasing simultaneously with human populations. The confinement of livestock into small

areas causes overgrazing, soil erosion and siltation of water bodies (Kideghesho, 2005). The villagers are continuing to use the areas illegally on the basis of violation of law in order to survive. This causes habitat destruction and loss of wildlife from the ecosystems.

2.5.5. Poverty

Poverty is defined as "a state of deprivation associated with lack of incomes and assets, physical weakness, isolation, vulnerability and powerlessness" (Chambers, 1987). It is considered a rural phenomenon over the world where more population live below the food poverty line and basic needs poverty line (UNDP, 2003). Expansion into new lands - including sensitive areas for wildlife becomes the most feasible strategy to this end. Essentially, land shortage around national parks can be ascribed to poor agricultural practices. Fuel wood is the main source of energy for cooking and heating in Ethiopia. Fuel wood demand expands exponentially with population growth (Mwalyosi, 1992). This demand exacerbates destruction of the critical wildlife habitats. While electricity could serve as an alternative source of energy, until recently most areas lacked access to this service. Further, even in areas with the service high installation and service costs render its affordability practically impossible to majority of the households (Wako, 2009).

2.6 Factors that affect the distribution and abundance of mammals

The distribution of species and biodiversity is determined by a large number of biotic and abiotic factors. Distribution and habitat association of large mammals are determined in terms of their water, food, cover and space requirements. Water and pasture conditions or the combinations of both are the major factors determining the distribution of wildlife populations in their natural habitats (Balakrishinan and Easa, 1986). Habitats in terms of large mammals refer to the vegetation composition, floristic and structure of the area as a product of various factors such as climate, geology and soil. The habitat of the animals is therefore, the area where the animal preferably occurs and where all its life necessities are fulfilled. Consequently, medium and large-sized mammal distribution and their diversity were highly associated with habitat types. Meseret Chane and Solomon Yirga (2014) reported that woodland has found to support the highest number of mammalian species, followed by riverine forest. The possible reason for this distribution and diversity of medium and large-sized mammal species might be due to the presence of food, water and stability of the area from disturbances.

The varieties of large animals in Ethiopia and their distributions are dependent on the protected areas (national parks and sanctuaries) with insufficient protection. Currently, these protected areas are highly threatened by anthropogenic impacts. Human-wildlife conflict is a major concern of most people living next to protected areas in developing countries due to their subsistent live (Yihune Melaku *et al.,* 2008). According to Yihune Melaku *et al.*(2008), this arises when growing human populations needs overlap with protected areas and results scrambling for resource. As the Ethiopia's population increases, there is an increasing demand for space and resource utilization and affects wild animal's habitat on the protected areas.

3. Materials and Methods

3.1 Description of study Area

3.1.1. Location

The Chukala mountain forest is located in Liben Chukala Woreda, Eastern Shoa Zone, Oromia regional state. The mountain has been recognized from early times and its name is spelled and pronounced as Zuquala, Chukala and Zeqwala. The mountain is located specifically at 08°33' 0"N latitude - 38°51' 0"E longitude /8.550^0 N-38.867^{0}E. There are three Kebeles found in and around Chukala Mountain. The Woreda's capital is the small town called Adulala. On top of the mountain there is Abo Gedam or Monastery with a holy crater lake. The altitude of the mountain is recorded as 2989m.a.s.l on a topographic map specifically prepared for it. It is found 89 Km south east of Addis Ababa. The mountain is covered by afro-mountain forest. This area (land surrounding the Crater Lake) has densely wooded vegetation at the top. The natural forest area is about 100 hectares and has numerous species of plants growing together. The dominant tree stands is *Juniperous procera*. The forest also serves as a habitat for wildlife (Forest genetic resources conservation project, 2004). Physical infrastructures on the mountain and its surrounding are still at an insignificant scale of development. Considering the early date they had been constructed and the names of the area to the capital, such infrastructures are still very deprived by even Ethiopia's.

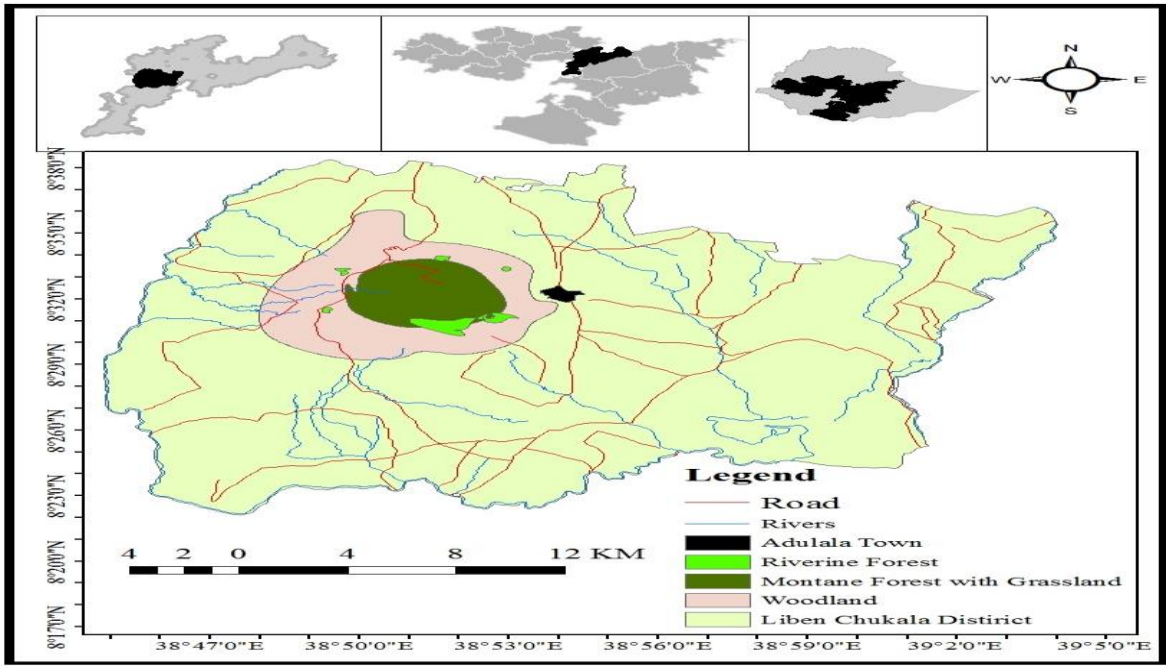

Figure 1 map of study Area

3.1.2Climate and Temperature

There are three traditional agro-climatic zones on the mountain. These are the Kola, Weyna Dega and the Dega agro-climatic zones. The plain surrounding the mountain is 1720m.a.s.l. Most of the mountain however, lies in the Weina Dega agro-climatic zone and only a small tip of the top of the mountain lays in the Dega agro-climatic zones(Forest genetic resources conservation project, 2004)

Since, the Kola agro- climatic zone ranges between 1000 and extends to l800m.a.s.l, the base of the mountain and its lower part is in the upper kola agro-climatic Zone. Most of the steep slope part of the mountain is lies in the Weina dega (1800m.a.s.1-2400m.a.s.l) agro climatic zones. One can observe stating from 2400m.a.s.l up to 3000m.a.s.l.

Temperature at the top of Mount Chukala is cold and receives a higher rainfall at some parts of the year. Rainfall is highly erratic but is relatively higher on mountain top. The annual average rainfall is 808 mm. The highest amount of rainfall occurs between the months of July and August. The forest area receives 731.3mm on average. The annual average maximum and minimum temperature is of 18°c and 6°c respectively(Forest genetic resources conservation

project, 2004) The current situation of deforested landscape had brought about excessive siltation in lands found below the slopes (Forest genetic resources conservation project, 2004). This happened since the rain that falls on top of the mountain fails to infiltrate due to the loss of a dense vegetation cover.

3.1.3 Physical Features

Chukala Mt. has height as well as immensity with a solid cone type structure. Its unique physical feature makes it the ideal extinct volcano for referencing by any geologist in the world. Such are the deep gorges the lava flow has created and observable even today. Lands found at the base are rolling plains with few low lying hills scattered on it. Mountain Chukala has also a well preserved crater lake being an extinct volcano cone of quaternary era. Its diameter is about 1 k.m. while its depth is about 60 meters (Solomon, 2005). The current situation of deforested landscape had brought about siltation and excessive flooding in lands found below the slopes.

The soil types of the mountain and the plain is black, red, brownish and gray in color. Each soil type is found in 63.7%, 3%, 9% and 24.3% out of the total respectively. The bed rock is a deposit from a volcanic ash and the lava flow had made the soil to be rich in nutrient content (Forest genetic resources conservation project, 2004).

3.1.4 Chukala's natural forest Ecology

The mountain used to be covered by mountain forest at the top and extending up to the limits of Weina Dega agro-climatic zone. However, the current situation shows only the presence of such forest at only the surrounding of the Crater Lake. The area covered by forest on the top is currently about 100 hectares. There is wide grassland that surrounds the lake. Even though, there used to be numerous springs in the past the current problems facing Mountain is a trend of drying up. The biodiversity of the natural forest shows the presence of many useful tree species and the presence of 217 tree species (Hylander, 1991).

3.1.4.1. Vegetation types

The vegetation of the study area can be categorized into three major habitat type's namely Montane forest with Grassland, Woodland and Riverine forest based on the type of vegetation and topography

1. Montane forest with Grassland

This habitat dominated by trees and characterized by the crown cover. The floristic composition of the forest is commonly rich with climbers and saprophyte. Under natural condition, the distribution of trees through this forest area is relatively uniform. Most of this area is dominated by *Juniperus procera, Podocrpus gracilior* and *Olea african* a tree species. This forest surrounds the amazing creater lake on the top of the mountain covered by grassland. Grassland exist on this habitat is found between Forest and creator water. It used as source of food for grass eater mammals. Generally, these habitats locate on the top of the mountain.

Figure 2 Partial view of grassland with Montane Forest (Photo by Nimona Alemu, March, 2020)

2. Woodland

In the study area, there are woodland habitats which include mixed woodland, dominated by mixed species. This habitat occurs on all side of the Chukala mountain forest.

Figure 3.Partial view of Woodland (Photo by Nimona Alemu, March and July, 2020)

3. Riverine forest

This occurs along the different small springs inside the study area and the different smaller perennial water courses. The forest in this habitat is covered with thorny tree, Acacia and other tree that have long leave. They are most of the time green due to the presence of water but no enough grass for the nutrition of mammals because the water flow by creating small groove and small. All of these water courses in almost all left in the study area. The floristic composition of these forests varies with altitude and edaphic conditions, but is always richer than the general area.

Figure 4.Partial view of Riverine(Photo by Nimona Alemu, July,2020)

3.2 Preliminary survey

Preliminary survey was conducted in Chukala mountain Forest before the actual study for 5 days, On March 1-5 in 2020. This pre-survey is important to classify the study area into different habitat types depending on the altitudinal and vegetation types. During that reconnaissance survey, the information concerning Chukala mountain Forest (climatic condition, vegetation variation, fauna types, topography and other crucial information) was gathered through direct observation from study area. Not only this, the sampling sites were selected and categorized into different habitat types based on the dominant vegetation covers and altitudinal variations. Generally, a preliminary survey was conducted in the study area to gather information that basic for the succession of study.

3.3The sampling design and Data collection

3.3.1 Sampling design

Transect lines were established purposively in each habitat type. Line transects are best used for visible mammals in open habitats and it can be used to estimate the abundance indices of mammal, such as dung piles and burrows (Sutherland, 2006). A total of six transect lines were established in study area from which each of three habitat types have two transect line. Each transect line was made about 0.5km far apart from each other to avoid double counting. The number and range of the transect width and length in each habitat type varied depending on vegetation cover, topography and the size (area) of the habitat types. In montane forest with

grassland transect length of 2km and 200m width while in woodland and Riverine forest length of 3km and 300m width were used.

3.3.2Data Collection

The investigations of medium and large-sized mammals in the study area were conducted by direct observation by naked eyes or using night vision binocular by walking along using transects lines survey. For nocturnal and naturally rare animals, indirect indicators such as animals' dropping, tracks, hair, vocal sound, quill, died animal and other indicators in the transect line was used for the presence of species(Meseret and Solomon, 2010).

The data collection was conducted for two seasons, dry and wet seasons to get relatively representative data. For the wet season, data was collected from July – August 2020 and for the dry from March - April, 2020. When mammals were sighted, the type of species, the number of individuals of each species and GPS location was recorded at each transect line and photograph of mammal was taken. Each transect in each habitat type was visited two times during every season. Two data collectors were assigned per transect, one walks along a straight path and records the individuals seen. All transects in a given habitat type was surveyed between 06:00and 10:00am in the morning and between 16:00 and 18:00 in late afternoon, when most mammals were active in the study area (Rebira *et al*., 2015).

The identification of medium and large sized mammal species was based on the Kingdom Field Guide to African Mammals (2003), comparison with other digital source and indigenous people were consulted for local names. Field identification of mammalian species were based on visible morphological characters of each of the mammalian species such as body size, coloration, proportion and structure of various organs like tail, ears and also from personal experiences. To have clear pictures of each mammalian species, observer noises was minimized to avoid being smelled by the animals, observation was made by moving against the direction of wind as far as possible. Other valuable data such as climate and human population in the study area was gathered from the concerned organizations.

3.5. Data analysis

Species diversity of medium and large size mammals was calculated using the Shannon-Wiener Index (H‟) index of diversity (Shannon and Wiener, 1949).

H'= -Σ [{ni/N} x ln[{ni/N}]

Where *ni*= number of individuals of each species (the i^{th}species) and

N = total number of individuals for the site, and

ln= the natural log of the number.

The Evenness of mammalian species refers how close in numbers each in the sampled site (Magurran, 2004) and was calculated as; $J = H'/Hmax$' where J= Pielou Evenness index, H'= observed index of diversity, Hmax=the maximum diversity index, Hmax=ln(S),‟S‟ is the number of species. It was computed to determine the number of individuals of the mammalian species between habitats and seasons (Krebs, 1999).

Species similarity between seasons and among the different habitats were determined using Simpson's similarity index (SI) (SI= 2C/A+B,) where C is common species in the habitats A and B. A is the number of species observed in habitat A and B is the number of species observed in habitat B (Simpson, 1949). Abundance of mammals was calculated as, Abundance = total number of individual species/ sample blocks (Brown, 1984). The chi-square ((χ2) statistical test method was used to carry out the analysis of seasonal abundance of mammals among different habitats. The mammalian species were classified as common if the probability of seeing is 100% in every time of the observation or evidence recorded once a day, uncommon if the probability of seeing is more than 50% and/or evidence recorded once a week and rare if the probability of seeing is less than 50% and/or single recorded during the whole survey periods (Hillman, 1993).

4. Results

4.1. Species composition

During the present study, a total of 794 (337 and 457 during the dry and wet seasons, respectively) individuals of mammals distributed in 12 species, 8 families and 5 orders were recorded from Chukala maintain Forest (Table 1). Among these, only three species: Vervet monkey (*Chlorocebus aethiopis*), Ethiopian hare (*Lepus fagani*) and Rock hyrax (*Procavia capensis*) were considered medium-sized and the remaining were large-sized mammals. From all the recorded families, Cercopithecidea contributed the highest (three species), followed by Bovidae (two species) and Suidea (two species) while, the remaining five families including Leporidae, Felidae, Procaviidae, Hyaenidae, Canidae, were represented by one species each (Table 1).

Table 1 Medium and large-sized mammalian species recorded from Chukala Mountain Forest, Oromia, Ethiopia.

Order	Family	Common name	Scientific name	Afan Oromo
Primate	Cercopithecidea	Colobus monkey	*Colobus guereza*	Weenni
		Vervet monkey	*Chlorocebus aethiopis*	Qamalee
		Olive baboon	*Papio Anubis*	Jaldeessa
Lagomorpha	Leporidae	Ethiopian hare	*Lepus fagani*	Illeetti
Hyracoidea	Procaviidae	Rock hyrax	*Procavia capensis*	Osolee
Artidactyla	Bovidae	Menelik's bushbuck	*Traglaphus scriptus*	Borofa
		Grey Duiker	*Sylvica pragrimmia*	Kuruphe
	Suidae	Bush pig	*Potamochoerus larvatus*	Booyyee
		Warthog	*Phacochoerus africanus*	Karkarro
Carnivora	Hyaenidae	Spotted hyena	*Corcuta carcuta*	Waraabessa
	Felidae	Leopard	*Panthera pardus*	Qeerransa

	Canidea	Common jackal	*Canis aereus*	Jeedala/sardiida

4.2 Diversity indices and Evenness of medium and large sized mammals

The highest diversity of mammals was recorded in the woodland (H‟ =1.700) during the dry season. The second diversified habitat was Montane forest &grassland (H‟=1.156) and the least diversified habitat was Riverine forest (H‟=1.070) in the same season. The calculated species evenness was J=0.709, J=0.646 and J=0.597) for Woodland, Montane Forest & Grassland and Riverine forest respectively during this season (Table-2).

During wet season the highest diversity was recorded in woodland (H‟=1.575). The second diversified habitat was Montane Forest with grassland (H‟=1.115) and the least diversified habitat was Riverine forest (H‟=1.105) in the same season. The calculated species evenness was J=0.622, J=0.634 and J=0.687) for grassland, woodland and Erica forest respectively during this season Table 2. .

Table 2.Diversity indices of medium and large sized mammals in different habitat types during dry and wet seasons

Habitat type	No.of Species		Number of individual		SWI (H'		H 'max		Eveness(J)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
MF with Grassland	6	6	90	127	1.156	1.115	1.792	1.79	0.646	0.622
Woodland	11	12	105	254	1.7	1.575	2.398	2.485	0.709	0.634
Reverine forest	6	5	133	74	1.07	1.105	1.79	1.609	0.597	0.687

For combined seasons, woodland had the highest diversity index with Shannon-Weiner index (H‟=1.375) and evenness (J=0.553) the second diversified habitat was Montane Forest with Grassland with (H‟=1.151) and (J=0.642) while the least diversity was recorded in Riverine forest with (H‟=1.093) and (J=0.610) for both seasons Table 3.

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

Habitat type	Number of species	Number of individuals counted	Diversity	Evenness
MF with Grassland	6	218	1.151	0.642
Woodland	12	359	1.375	0.553
Riverine forest	6	207	1.093	0.610

4.3. Distribution of Mammals observed in the different habitat types

All 12 species of mammals recorded from the present study area were identified by direct Observation and indirect method. The distribution of mammalian species in the three habitat types and seasons were different. Colobus monkey(*Colobus guereza*) and Leopard(*Panthera pardus)* were recorded in Montane forest with grassland habitat in both season and woodland in wet season. Vervet monkeys *(Chlorocebus aethiopis)* were distributed in woodland and Riverine forest habitat in both dry and wet season. Olive baboon (*Papio anubis*) were recorded in three habitat in both season and the major mammalian species in study area. Menelik's bushbuck(*Traglaphus scriptus*),Grey Duiker(*Sylvica grimmia) and* Spotted hyena(*Corcuta carcuta*) were recorded in all habitat in both dry and wet season. Ethiopian hare (*Lepus fagani),* Rock hyrax (*Procavia capensis),* Bush pig(*Potamochoerus larvatus*), and Warthog(*Phacochoerus africanus*) were recorded only in woodland habitat in both dry and wet season. Common jackal (*Canis aures*) was recorded in both woodland and riverine forest in dry and wet seasons (Table 4)

Mammalian species such as: Colobus monkey (*Colobus guereza),* Vervet monkey, Olive baboon, Ethiopian hare, Common jackal and Rock hyrax were recorded through direct observation in study area. The other species like Menelik's bushbuck, Grey Duiker, Spotted hyena, Bush pig

and Leopard were recorded through direct observation and indirect methods via feaces, foot printing (Table 4)

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

Species	Species Identification Method	Habitat Type					
		Montane forest with grassland		woodland		Riverine Forest	
		Dry	Wet	Dry	Wet	Dry	Wet
Colobus monkey(*Colobus guereza*)	Visual	√	√	-	√	-	-
Vervet monkey *(Chlorocebus aethiopis)*	Visual	-	-	√	√	√	√
Olive baboon (*Papio anubis*)	Visual	√	√	√	√	√	√
Ethiopian hare (*Lepus fagani)*	Visual	-	-	√	√	-	-
Rock hyrax (*Procavia capensis)*	Visual	-	-	√	√	-	-
Menelik'sbushbuck(*Traglaphus scriptus*)	Visual	√	√	√	√	√	√
Grey Duiker(*Sylvica grimmia*)	Visual	√	√	√	√	√	√
Bush pig(*Potamochoerus larvatus*)	Visual	-	-	√	√	-	-
Warthog(*Phacochoerus africanus*)	Visual/Feaces	-	-	√	√	-	-
Spotted hyena(*Corcuta carcuta*)	Visual	√	√	√	√	√	√
Leopard(*Panthera pardus)*	Visual	√	√	√	√	-	-
Common jackal(*Canis aures*)	Visual	-	-	√	√	√	√

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

4.4 Occurrences of mammals

Based on occurrence in the study area, the medium and large sized mammals were grouped in to common, uncommon and rare (Table 5). Out of the 12 mammalian species recorded in the study area, 29.2 were common, 29.2 were uncommon and 41.67% were rare.

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

Common	Uncommon	Rare
Vervet monkey(*C aethiopis*)	Spotted hyena(*C.carcuta*)	Warthog(*P.africanus)*
Colobus monkey*(Colobus guereza*)	Grey Duiker(*S. grimmia*)	Leopard(*P.pardus)*
Olive baboon (*P.anubis)*	Ethiopian hare (*L. fagani)*	Spotted hyena(*C.carcuta*)
Common jackal(*C.aures)*	Menelik‟s bushbuck(*T.scriptus)*	Rock hyrax (*P. capensis)*
		Bush pig(*P. larvatus*)

4.5 Relative abundance of mammals

Among the 12 species of mammals recorded, Olive baboon (*P. anubis*) was the most abundant species contributing 53.64% and 56.46% during the dry and wet seasons, respectively. With 17.49% (during the dry) and 12.47% (wet season), Vervet monkey(*C. aethiopis)* was the second most abundant mammal, while Colobus monkey(*Colobus guereza*)(with 10.68% and 10.07%) and Spotted hyena(*C. carcuta*) (6.23% and 6.13%)during the wet and dry seasons, respectively, were the next abundant species and other species like Leopard(*P.pardus*) (0.89% and 0.656%), Ethiopian hare (*L. fagani)(* 0.89% and 0.22%) and Rock hyrax (*P. capensis)(* 0.593% and 0.22%*)* were the least diversified species in Chukala Mountain forest (Table 6)

Table 6 Relative abundance of medium and large sized mammalian species recorded in the study area during dry and wet seasons.

Number of Individual Species	Total no of individual Recorded		Relative abundance	
	Dry	Wet	Dry	Wet
Colobus monkey(*Colobus guereza*)	36	46	10.68	10.07
Vervet monkey*(Chlorocebus aethiopis*	60	57	17.8	12.47
Olive baboon (*Papio anubis*)	178	258	53.64	56.46
Ethiopian hare (*Lepus fagani)*	3	1	0.89	0.22
Rock hyrax (*Procavia capensis)*	2	1	0.593	0.22
Menelik's bushbuck(*Traglaphus scriptus*)	11	21	3.26	4.60
Grey Duiker(*Sylvica grimmia*)	8	17	2.37	3.72
Bush pig(*Potamochoerus larvatus*)	5	12	1.48	2.63
Warthog(*Phacochoerus africanus*)	4	7	1.19	1.53
Spotted hyena(*C.carcuta*)	21	28	6.23	6.13
Leopard(*Panthera pardus)*	3	3	0.89	0.656
Common jackal(*Canis aures*)	6	6	1.78	1.31
Total	337	457	100	100

Seasonal variations were observed in the mammalian species composition and number of individuals among habitats and between seasons. The highest number of individuals of medium and large sized mammals were recorded from Woodland habitat(254), followed by Montane Forest with Grass land habitat (128) and Riverine forest with 74 during wet season (Table 7). More number of individuals is also observed in Riverine forest (133) than woodland (105) and

Montane Forest with Grass land (90) during dry season (Table 7). Within habitat, the seasonal abundance of mammals was significantly vary for all habitats (Montane Forest with grassland: $\chi 2 = 10$, 1 df, $P<0.05$; Woodland: $\chi 2 = 1.33$, 1 df, $P<0.05$ and Riverine forest: $\chi 2 = 12.5$, 1 df, $P<0.05$).

Table 7.Seasonal abundance (number of individuals counted) and distribution of mammals among different habitats in Chukala mountain Forest, East Shoa Zone, Oromia, Ethiopia

Number of Individual Species	Habitat types					
	Montane forest with Grassland		Woodland		Revirine forest	
	Dry	Wet	Dry	Wet	Dry	Wet
Colobus monkey(*Colobus guereza*)	30	36	-	16	-	-
Vervet monkey *(Chlorocebus aethiopis)*	-	-	32	18	25	42
Olive baboon (*Papio anubis*)	78	42	142	60	38	60
Ethiopian hare (*Lepus fagani)*	-	-	-	1	3	-
Rock hyrax (*Procavia capensis)*	-	-	1	2	-	-
Menelik'sbushbuck(*Traglaphus scriptus*)	9	4	10	2	5	2
Grey Duiker(*Sylvica grimmia*)	3	1	12	4	1	3
Bush pig(*Potamochoerus larvatus*)	-	-	12	5	-	-
Warthog(*Phacochoerus africanus*)	-	-	7	4	-	-
Spotted hyena(*Corcuta carcuta*)	7	5	13	10	8	6
Leopard(*Panthera pardus)*	1	2	2	1	-	-
Common jackal(*Canis aures*)	-	-	6	6	-	-
Total	128	90	254	105	74	133

Table 8.Number of medium and large sized mammal species recorded in the study area in different habitat types (MF&G=Montane Forest with Grassland, W=Woodland and Riverine forest) and their relative abundance during wet and dry season.

Species	Habitat type											
	MF with Grassland				Woodland				Riverine Forest			
	Dry	RA(%)	Wet	RA(%)	Dry	RA(%)	Wet	RA(%)	Dry	RA(%)	Wet	RA(%)
Colobus monkey(*Colobus guereza*)	36	40	30	23.62	0	0	16	6.3	0	0	0	0
Vervet monkey(*C. aethiopis*)					18	17.14	32	12.6	42	31.58	25	33.78
Olive baboon (*P. anubis*)	42	46.66	78	60.42	60	57.14	142	55.9	76	5.26	38	51.35
Ethiopian hare (*L. fagani)*					3	2.86	1	0.39				
Rock hyrax (*P. capensis)*					2	1.91	1	0.39				
Menelik's bushbuck(*T.scriptus*)	4	4.49	9	7.03	2	1.91	10	3.94	5	3.76	2	2.7
Grey Duiker(*S. grimmia*)	1	1.11	3	2.34	4	3.81	12	4.72	3	2.26	1	1.35
Bush pig(*P. larvatus*)					5	4.76	12	4.72				
Warthog(*P.africanus*)					4	3.81	7	2.76				
Spotted hyena(*C.carcuta*)	5	5.55	7	5.47	10	9.52	13	5.12	6	4.51	8	10.81
Leopard(*P.pardus)*	2	2.22	1	0.78	1	0.95	2					
Common jackal(*C.aures*)					6	5.71	6	2.36	1	0.75		
Total	90	100	128	100	105	100	254	100	133	100	74	100

4.6. Species similarity based on habitat type

During the dry season, mammal species were more similar between Montane Forest and Grassland and Riverine forest habitat (SI=1), that followed by both woodland& riverine forest habitats (SI=0.706) and Montane Forest with Grassland and riverine forest habitats (SI=0.706) which have similar number of species (Table 9)

However, during wet season, highest similarity index was observed between Montane Forest with Grassland and Riverine forest (SI=0.91), the second similarity index was observed b/n Montane Forest with Grassland and Woodland (SI=0.667) (Table 9).Mammalian species were least similar between Woodland and Riverine forest (SI=0.588).

Table 9. Similarity of medium and large sized mammal species between habitats during wet and dry seasons

Habitat types				
	Montane forest with Grassland		Riverine Forest	
	Wet	Dry	Wet	Dry
Woodland	0.667	0.706	0.588	0.706
Riverine Forest	0.91	1		

Among the three habitat types for combined seasons, more similarity of mammalian species was obtained from Montane forest with Grassland and Riverine forest (SI=1).The next similarity observed between Montane grassland &woodland (SI=0.666) and woodland and Riverine (SI=0.6666) that have equal number of species.(Table 10).

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

Habitat types		
	Montane forest &Grassland	Riverine forest
Woodland	0.667	0.667
Riverine forest	1	

5. Discussion

In a short time completely record all mammalian species in such a complex and steepy habitat like Chukala mountain Forest is difficult. In this study, a total of Twelve (12) species of medium and large sized mammals were recorded. However the number of mammalian species that recorded from Chukala mountain Forest are not the same with similar studies in different parts of Ethiopia by scholars like Chane and Yirga, 2014; Gonfa *et al.*, 2015 that recorded 28 mammalian species in Bati wolel National park and Dereje et al., (2015) that recorded a total of 23 species of mammalian species from Baroye Controlled Hunting Area, Illubabor Zone, Southwest Ethiopia. This may be due geographical location and untouchable natural resource for the area studied by these scholars. However due to its location in central Ethiopia and unprotected area not more expected like other area even if such species number of mammals recorded. This indicates that long-term studies by extending the study period and the sampling area may identify additional mammalian species.

Among the three habitats of the study area during dry season, the highest diversity index (H‟=1.700) and evenness (J=0.709) of medium and large sized mammals were recorded in the woodland habitat. Similarly, Meseret Chane(2010) reported that woodland supported the highest number of mammalian species that followed by riverine forest in Borena Sayinti National park. The possible reason for this distribution and diversity of medium and large-sized mammal species might be due to the presence of food, water and stability of the area from disturbances.

The second diversified habitat was Montane forest with grassland (H‟=1.156) and evenness (J=0.646); and the least diversified habitat was Riverine forest (H‟=1.070) and evenness (J=0.597) in the same season. The grassland and woodland harbored different plant species which might be used as the source of food for different mammalian species, compared to Riverine forest habitat. Bailey (1984) reported that Cover is also important as mammals interdependent for food sources as well as protection,

Mammals in the present study area show no uniform distribution among the three habitats. Hence, their abundance significantly varies among habitats between seasons. More mammals shift from one habitat to another habitat seasonally during the dry and wet season. During the dry

season there is no enough fresh grass and other food resource due to lack of large river flow inside and water reservoir rather than small springs that start and end in the forest. According to (Girma *et al*., (2012), such seasonal movement in search of resources conditions is common in mammals. The mammalian species like Olive baboon (Papia anubis), Menelik's bushbuck (Traglaphus scriptus) Grey duiker (Sylvicapra grimmia) and spotted Hyena were observed and recorded in all habitats while Vervet monkeys (*Chlorocebus aethiopis*) and Common jackal(*Canis aures*) were observed in woodland and Riverine forest in the present study area. The distribution of these mammals in all habitats is attributed to their adaptation to variety of habitat types. This is in line with the idea of Smith (1992) who suggested that differences in the diversity and evenness of mammals are governed partly by differences in their feeding habits. Bailey (1984) also suggested that, the distribution of mammals in the different habitat types of the area might indicate habitat selection of the different species of mammals based on their ecological preferences as well as evolutionary adaptation.

Regarding their abundance, the three primate species, the Olive baboon (*Papio anubis*)(55%), Vervet monkey (*Chlorocebus aethiopis*)(15%) and Colobus monkey (*Colobus guereza*)(10%) were most abundant mammalian species in both seasons as general. These mentioned by Johnson *et al*.,(2012) by saying that from their high reproductive success, the diversified foraging behavior and for the abundance of alternative prey species for carnivores, the abundance of these species was highly predicted. Studies from different localities in Ethiopia reported the abundance of these primate species in Riverine and woodland habitats (Woldegiorgis and Tilaye, 2012). During this study, some mammal's species like Spotted Hyena (C. carcuta) was less abundance mammalian species. The low number of spotted hyena in the study area could be due to its nocturnal behavior. Mammals need densely forested habitats and cover that could make the sighting of them difficult. (Girma, 2006).

Similarly mammalian species like Menelik's bushbuck (*T.scriptus*), Grey Duiker(*S. grimmia)* Rock hyrax , warthog and Bush pig are low in number in this study. The low abundance of some of mammals in the study area was due to factors that are known to decrease mammal number in an area. That suggested by Aagesen(2000),Similar to other anthropogenic pressures, live- stock grazing can have strong impacts on native wildlife, their habitat and overall ecosystem function and structure. Water and food requirement of medium and large sized mammals might determine

their distribution and habitat association in the natural habitats. Water and pasture conditions or the combinations of both are the major factors determining the distribution of wildlife populations in their natural habitats (Balakrishinan and Easa,1986).In this study mammalian species like Leopard (*P. pardus*) was least abundant mammalian species. In Ethiopia, the least abundance records were common for these species in different localities (Chane and Yirga, 2014; Gonfa *et al.*, 2015).

Regarding species similarity among the three habitat types of the study area, the highest species similarity was obtained from Montane forest with grassland and Riverine forest both during the dry and wet seasons(SI=1) that each of them contained six(6) species. The reason for the observed similarity may be because the resource and cover conditions of these two habitats are relatively approach to each other. The species similarity was relatively less between the Montane forest with grassland and woodland (SI=0.6666) which have equal to woodland and Riverine forest (SI=0.666) in Chukala mountain Forest. This record line with the findings by Mengesha and Bekele (2008) and Gonfa *et al.* (2015) that report high mammalian species in both woodland and grassland habitat from Alatish National Park.

6. Conclusion and Recommendation

6.1. Conclusion

This study identified and recorded medium and large sized mammalian species in Chukala Mountain forest and provided current information about their existence. Twelve (12) species of medium and large size mammals were identified. Those observed mammalian species belong to five families and eight orders. The differences in diversity, distribution and abundance might be due to difference in vegetation cover and other biotic and a biotic factor. Little variation in species diversity was observed among the three major habitat types. However, the differences in the abundance of medium and large sized mammals showed among the habitat were high. This might be due to difference in vegetation cover in the habitats of the study area

Seasonal variations were observed in mammalian species composition, distribution and number of sightings individual mammals among habitats. Thus high number of individual mammals and species were recorded in wet season than dry season this might be due to different reasons.

Generally, the study area supports variety of medium and large sized mammalian species.

6.2. Recommendation

- ✓ The scientific documentation of mammalian diversity and distribution help to protect mammalian species and Ecosystem so, all stake holders start educating the rural communities and create awareness about the environmental benefits and economical gain they would get by conserving the natural forest, mammalian diversity and other biodiversity on the Chukala mountain Forest.
- ✓ To preserve recorded mammalian diversity and others the Woreda administration has made the right decision in banning deforestation for agriculture and animal grazing on the top and all parties of the mountain
- ✓ To protect and conserve mammalian species on historic Chukala mountain government must stop new human settlement on the top of mountain by working with monastery, apply special policy and strategy and Resettle previously settled people on other areas to preserving mammalian species
- ✓ To safe identified Mammalian species and other secure their habitat additionally reforestation of deforested area on the top of mountain and around mountain by planting trees.
- ✓ As this study show mammalian species like Colobus Monkey, Menilik bush buck and Leopard are rare and need special attention so, all concerned body, Government administration, Gada Father, Religious leaders and local community should have to work to safe Chukala mountain ecosystem: the home of biodiversity like mammals, migratory birds, plants species from extinction, unless the animal that we seen today next generation hear only their name.
- ✓ The study identified mammalian species so, other researchers are recommended to find out plants species, birds species, mammalian species and biodiversity presents, impacts on and rehabilitation of Chukala Mountain Forest.

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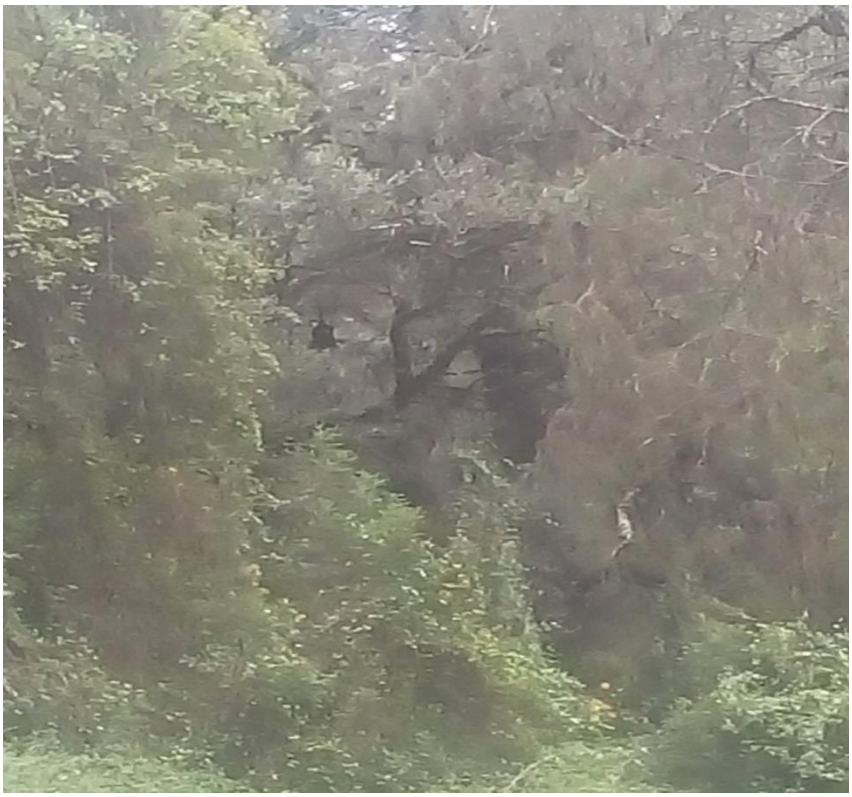
Appendix

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

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

No	Species	Number of individuals	Habitat type	Method of identification

Appendix 2.ColobusMonkey*(Colobus abyssinicus*) in study area



Appendix 3 Spotted Hyena(C.carcuta)and his drop

Appendix 4Olive Baboon(*Papio Anubis*) in woodland (a)