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THE DIVERSITY, DISTRIBUTION AND RELATIVE ABUNDANCE OF MEDIUM AND LARGE-SIZED MAMMALS IN DERA DILFEKAR BLOCK OF ARSI MOUNTAINS NATIONAL PARK, ARSI ZONE, SOUTHEAST ETHIOPIA

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Table of Contents

List of tables

List of Plates

Appendices

List of Acronyms

UNDP	United Nation Development Programme
IBC	Institute of Biodiversity Conservation
OFWE	Oromia Forest and Wildlife Enterprise
IUCN	International Union for Conservation of Nature and Natural Resources
APEDO	Arsi Zone Planning and Economic Development Office
ABRDP	Arsi-Bale Rural Development Project

Abstract

The diversity of mammals varies based on variation of altitude, climate and vegetation type. The study was conducted to investigate the diversity, distribution and relative abundance of medium and large-sized mammals in Dera dilfekar block of arsi mountains national park, Arsi zone, southeast Ethiopia. The study covered two seasons extending between February and September, 2018.Three habitat types; woodland, grassland and Erica forest were identified in the Dera dilfekar block. A line transect survey method was implemented to record the diversity of mammalian species. Of the seven arbitrarily established transects, (three from the woodland and two each from the grassland and Erica forest habitats) were randomly established and permanently surveyed for two seasons. Each transect was surveyed once per season. A total of 18 species of mammals from six orders and eleven families were recorded from the area. Only four mammalian species including the honey badger (Mellivora capensis) and white tailed mongoose (Ichneumiaalbicauda) were the medium sized mammals. Among the 16 large mammals, the greater kudu (Tragelaphus strepsiceros), lesser kudu (Tragelaphus imberbis) and warthog (Phacochoerus africanus) were the most abundant. Serval cat (Leptailurus serval), klipspringer (Oreotragus oreotragus), Spotted hyena (Crocutacrocuta), Side-striped jackal (Canis adustus), Common jackal (Canis aureus) and Abyssinian hare(Lepus habessinicus) were represented by few individuals. The Bovidae family contained the highest number of species. The highest mammalian species diversity was recorded from woodland (H'=2.011) followed by the grassland (H'=1.838) and the least was from Ericaforest (H'=1.633) during the dry season. The highest mammalian species was recorded from the grassland (H'=2.136) followed by woodland (H'=1.968) and the least was from Erica forest (H'=1.598) during the wet season. The similarity of mammalian species between the grassland and woodland was high during wet season (C=0.875), and least between Erica forest and woodland (C=0.454) in the same season. Most local communities had positive attitude toward Dera dilfekar block. In contrast, some local communities had the negative attitudes towards conservation of Dera dilfekar block due to lack of loss of job opportunity like employment in guarding the block. Awareness should be created in thelocal community about conservation of the study area.

Keywords:*Dera dilfekar block, Arsi Mountains Park; Mammalian species; Relative abundance; Diversity*

1. INTRODUCTION

1.1. Background of the study

Mammals are the most important components of biodiversity all over the world. Particularly 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).

Body weight is one parameter to categorize mammals in to medium and large-sized. According to Emmons and Feer (1997), mammals weighing between 2 and 7 kg are considered as medium-sized and above 7 kg are categorized under large-sized. Functional structures of medium and large-sized mammals are determined by the composition of functional traits. Such structures often vary along environmental gradients such as disturbance and resource availability (Hashim and Mahgoub, 2007).

Of the 5,487 mammalian species assessed, nearly one-quarter of species (22.2 %) are globally 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). A total of 320 mammalian species currently recorded in Ethiopia, of which, 39 species are endemic and medium, and large sized mammals also comprises over 60% (Afwerk, 2014).The variations in 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 (Laykum, 2000).

Ethiopia is topographically and biologically diverse country as the result of extensive altitudinal variation (Laykum, 2000). The Afromontane forest of Arsi Mountainsis endowed with varieties of large and medium sized mammals. However, these areas possess dense concentration of human population as the result of suitable weather and climatic condition of the surrounding area (APEDO and ABRDP, 2004). The increase in human population in the area can cause habitat fragmentation and degradation.

The fauna and flora in the Ethiopian highlands are unique that makes it one of the planets' diversity hotspots (Freilich *et al.,* 2014).However many areas of the Afro Montane Forests and critical areas in Africa, including Ethiopia are subjected to ecological degradation and fragmentation and may cause wildlife habitat destruction .The loss of mammalian diversity could change ecosystems in ways that we do not recognize and understand (Chapman and Onderdonk, 1998). Subsistence agriculture and investment in the forest disturbs the quantity and quality of food, water and cover of forest habitat for wild animals. This may lead to a great impact on mammalian diversity and its role on the forest ecosystem as well as conservation measures of biodiversity.

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 21 national parks, 11 wildlife reserves, 3 sanctuaries, 22 controlled hunting areas and 69 important bird areas (Young, 2012; IBC, 2012).However, many areas of these protected areas are exposed to severe deforestation due to human activities. There is no scientific information about medium and large sized mammalian species in the Dera dilfekar block. Therefore, this study is designed to document the diversity, distribution and relative abundance of medium and large sized mammals in the study area.

1.2. Statement of the problem

Due to the expansion of human settlement and agriculture many wildlife species have become increasingly smaller. 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.

Rapid population increase in Dera dilfekar district may lead to deforestation and fragmentation of the study area as a result of using the forest for fuel wood and increasing subsistence agriculture. Habitat fragmentation can affect the potential mammals to abandon their suitable range in Dera dilfekar block of Arsi Mountains National Park. Current resource exploitation is opportunistic and unregulated. Knowledge on diversity, distribution and relative abundance of mammals is very essential for the development of effective land management plan. Unless serious management interventions are taken, the condition can become very serious when it comes to the new candidates of protected area categories like Deradilfekar block. However, there is no current information on diversity, distribution and relative abundance of medium and large mammals in the study area. Therefore, the present study was proposed to fill this gap by collecting current information on the diversity, distribution and relative abundance of medium and large mammals in Dera dilfekar block of Arsi Mountains National Park, Arsi zone, Southeast Ethiopia.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of this study was to assess species diversity, distribution and relative abundance of medium and large-sized mammals in Dera dilfekar block of Arsi Mountains National Park.

1.3.2. Specific Objectives

- Identify the species composition of medium and large sized mammals in Dera dilfekar block of arsi mountain national park.
- Estimate the relative abundance of medium and large sized mammalian species at different seasons.
- Determine the distribution of medium and large sized mammalian species in the study area.

1.4. Significance of the Study

Identifying the diversity, distribution and the relative abundance of mammalian species is very important to conserve and manage properly for sustainable use of mammals. Therefore, the investigation of the present study focused on the scientific documentation of the diversity, distribution andrelative abundance of medium and large mammals and assessment of the awareness of community about cultural, ecological and economic significance of wildlife in the Dera dilfekar block which will serve as a base for the development of important conservation strategy.

2. LITERATURE REVIEW

2.1. Classification of Mammals

Earth has a large variety of animals living on it. Scientists classify animals into groups based on common characteristics. Mammals are vertebrates that have fur and feed their young with milk. They are warm-blooded and they have four-chambered hearts. Wilson and Reader (2005) provide useful recent compendiums. Many earlier ideas have been completely abandoned by modern taxonomists; among these is the idea that bats are related to birds or humans represent a group outside of other living things. Competing ideas about the relationships of mammalian orders do persist and are currently in development.

Molecular studies by molecular systematic, based on DNA analysis, in the early 21stcentury have revealed new relationships among mammalian families. Classification systems based on molecular studies reveal three major groups or lineages of placental mammals, Afrotheria, Xenarthra and Boreotheriawhich diverged from early common ancestors in the Cretaceous(Nicholas *et al.*,2015).The relationships between these three lineages are contentious, and all three have been proposed as basal in different hypotheses. The first divergence was that of the Afrotheria 110–100 million years ago(Okada*et al.,* 2009). The Afrotheria proceeded to evolve and diversify in the isolation of the African-Arabian continent. The Xenarthra, isolated in South America, diverged from the Boreotheria approximately100–95million years ago. The Boreotheria split into the Laurasiatheria and Euarchontoglires between 95 and 85 million years ago; both of these groups evolved on the northern continent of Laurasia (Nicholas *et al.*, 2015).

2.2.Distribution of Mammals in Ethiopia

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).

2.3.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 trophic 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 effect because they contribute in many ways to the functioning of the natural ecosystem.

2.4. Threats to Mammals

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 interspecific interactions that influence population persistence and community structure and dynamics(Wilson, 1996).

2.5. 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).

2.5.1.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 animal's habitat on the protected areas as a result various mammals are disturbed.

2.5.2. DemographicFactor

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.

2.5.3. 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).

2.5.4.Land Tenure and Development Policies

The land tenure system, land use policies and market conditions may have detrimental impacts on biodiversity. The privately owned land outside the core protected areas has allowed the land owners to respond to market opportunities for mechanized agriculture at the expense of wildlife habitats (Homewood, 2001). In contrast to private land tenure, State control of land has the advantage that the State can restrict the policies and land uses likely to cause detrimental impact on wildlife.

2.5.5. Inadequate Economic Incentive

Like in many terrestrial ecosystems, wildlife conservation in Oromia is pursued along with several other land uses. These uses may be ecologically destructive but economically rewarding. For local people to forgo these uses in favor of conservation, the wildlife- related benefits should be equitably distributed and be able to contribute sufficiently to the local human economy (Debushe and Itana, 2010). The local communities receive too small amounts, which can hardly offset the wildlife- induced costs and outweigh the returns from alternative land uses.

3. THE STUDY AREA AND METHODS

3.1. The Study Area

The present study was conducted in Dera dilfekar block of Arsi Mountains National Park, Dodota district; southeast Ethiopia the central part of the Arsi Administrative Zone of Oromia Regional State. This Block is one of the four Blocks (1)Dera dilfekar (2) Chilalo-Galama, (3)Honkolo (4) Kaka of arsi mountains national park. It is bounded by Dera town in the West, Dirre Qiltu Kebele in the East, Dilfekar Kebele in the South, and Awash Bisholla in the North. The study area is characterizedby humidmontane climate with bimodal rainfall pattern.The total area of the block covers 1341 hectare (13.41km^2). The Block is situated 125 km from capital city of the country, 25 kilometers far from Adama city and 50km from Asalla town. It is located at $8^0$20'30.88"N latitude and $39^0$19’44.85’’E longitude and has an altitude ranging between 1652–2400 m above the sea level (Figure 1). The vegetation cover of the Dera dilfekar block includes scattered acacia wooded grassland. Some of the trees and shrubs found in the block are *Opuntia ficus-indica, Acacia abyssinica, Balanites aegyptica, Acacia senegal, Strychnos spinosa, Ficus sycomorus, Terminalia brownie, Euphorbia Abyssiniaca, Solanum habrochaites, Acacia seyal*. The type of grass which is dominantly found in this area is genus *Hyparrhenia*(Getachew et al,2018).

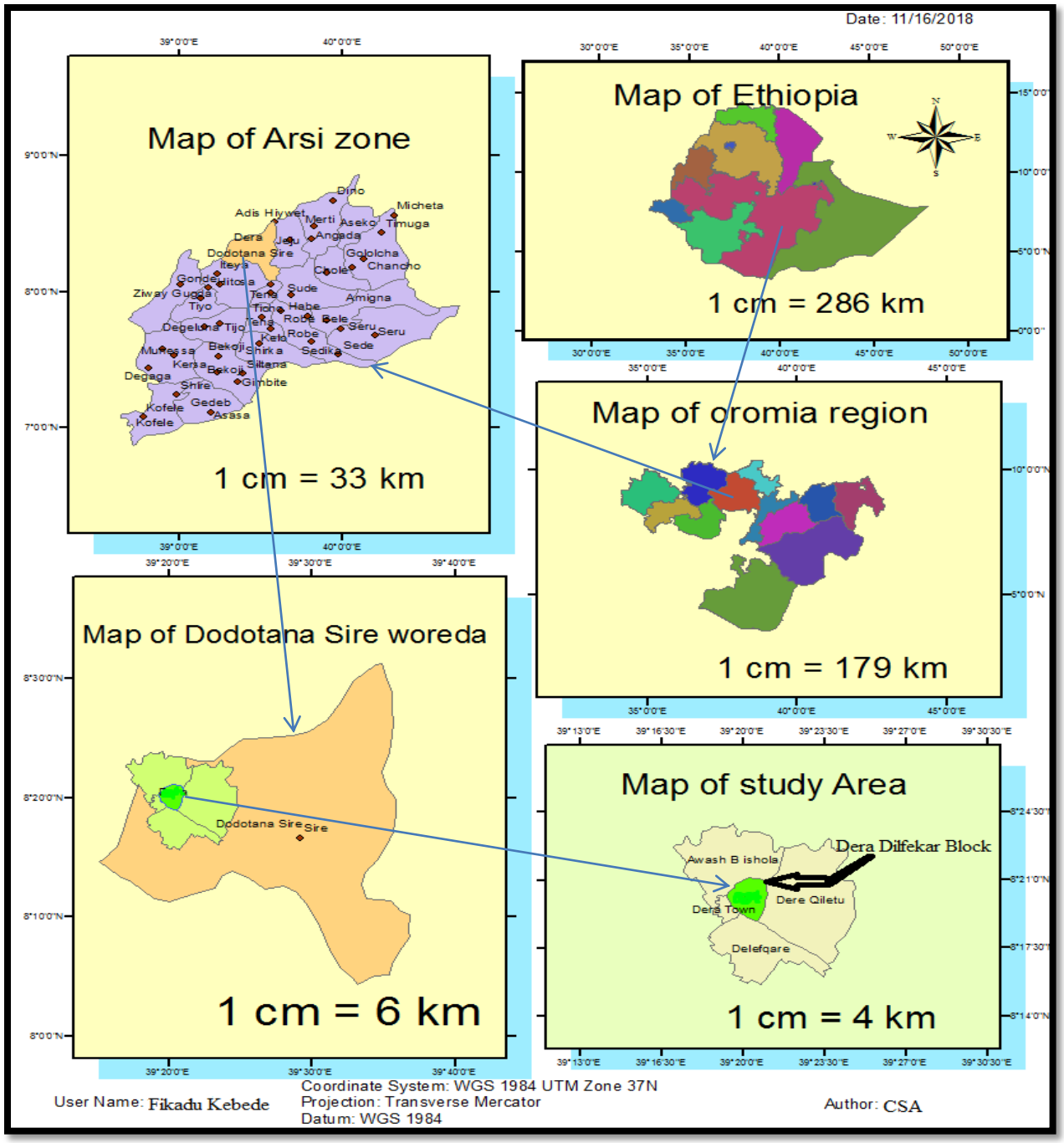

Figure-1 Map of the study area

3.2. Methods

3.2.1. Preliminary survey

Before beginning the main research work the preliminary survey was conducted in November, 2017. Observation and interviews with the concerned bodies (Manager, tourism manager, Sociologist, Scout and Guard)were carried out for gathering relevant information about Dera dilfekar block of Arsi Mountains National Park such as the size of the study area, topography, habitat types, and climatic conditions of the study site. The study area was divided into woodland, grassland and Erica forest based on the nature of vegetation. The sampled areas were made to cover at least 20% to 25% of the study area (Bibby, 1992). During the preliminary survey permanent transect lines were established and the locations were marked using global positioning system. The number of transect line and the distance between each transect line was determined by the size of habitat and vegetation.

3.2.2. Interviewwith Local Community

Interviews were used for the collection of information related to the attitude of local community toward wildlife and protected area. Information was obtained through the use of semi-structured interviews (Huntington, 2000). Respondents were divided by gender among three age groups, based on the classification criteria of the Asalla hospital: adolescents (13 to 20 years old), adults (21 to 60 years old), and elderly (over 61 years old) ten people for each age group. The selected fifteen houses of communities (two people per household) and five focal groupswere visited for interview.

3.2.3. Survey ofMedium andLarge-Sized Mammalian Species inthe Study Area

Sampling area was determined proportionally to make results representatives of the whole study area (Sutherland, 1996; Bibby et al., 1998).The transect lines were used to estimate the abundance and distribution of medium and large mammal species. A total of seven transect lines were established representing each habitat kind in the Dera dilfekar block. Three transect lines in woodland, two transect lines in Erica forest and two transect lines in grassland were established. The length of transect lines in the woodland grassland and Erica forest were(2.5 km,2km,1km) respectively. The number of transect lines vary based on the size of selected habitat.

Data for dry and wet seasons were gathered along randomly selected line transect on foot by the two field assistants and the researcher walked along the transect lines along opposite directions. Mammals that can be visually detected were recorded. The size of mammals was identified based partly on literature for species (Derejeet *al.*, 2015).When an unknown species was spotted to species level in field theindigenous guides were consulted for the local name and the scientific name was determined later with the help of the field guidebook, Field Guide to African Wildlife, (Alden ,1995).

Indirect methods including faecal droppings and quills (Wemmer et al., 1996) were also employed to record the mammalian species. Transect survey were conducted early in the morning between 7:00-11:00 and afternoon at 15:00-18:00 when the species were active. Each transect was surveyed once a month for two months per season.Movement was stopped when mammals were observed. The number of individual per species, habitat type, species kind and geographic location were recorded along each line transect (Kingdon, 1997).

During the study the recorded mammals were categorized into different age classes. The morphological characteristics such as horn length and shape,body size,fur and tusk development were used to distinguish different age groups. The assignment of age categorieswas according toYalden and Largen (1992).Accordingly,theywereassigned as infant,young,sub-adult and adult.

3.2.4. Data analysis

The chi-square statistical test methodwas used to carry out the analysis of seasonal abundance of mammals among differenthabitat.The species diversity of medium and large mammalian species was computed using the Shannon-Wiener index (H') of diversity (Shannon and Wiener, 1949).

$$H' = -\sum\left[\left(\frac{n_i}{N}\right)\times \ln\left(\frac{n_i}{N}\right)\right]$$

Where H'=Shannon-Wiener index of diversity, ni=number of individuals per species and N= the total number of individuals for the selected area 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; $J = \frac{H'}{H_{max}}$ where J= Pielou Evenness index,H_{max}=the maximum diversity index, $H_{max=}\ln(S)$,'S' is the number of species.

Sorenson's coefficient was also calculated to investigate the similarity between the different habitats based on the species composition. Sorenson's Coefficient $= \frac{2C}{S_1 + S_2}$ where; C= the number of species the two communities have in common, S_1 = the total number of species found in habitat one and S_2 = the total number of species found in habitat two.

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

A total of 544 and 576sightings of medium and large mammals were recorded during dry and wet seasonsrespectively,which belong to 18 species, eleven familiesand six orders (Table 1). Among these sixspecies:Serval cat (*Leptailurusserval*), Abyssinian hare (*Lepus habessinicus*), Crested porcupine (*Hystrix cristata*), White tailed mongoose (*Ichneumiaalbicauda*), Vervet monkey (*Chlorocebus aethiopis*) and Rock hyrax (*Procavia capensis*) were considered as medium-sized and the remaining were large-sized mammals. The Spotted hyena (*Crocutacrocuta*) andCrested porcupine(*Hystrix cristata*)were indirectly recorded, using their fecal dropping and quills respectively. From all the recorded families, Bovidae contributed the highest number of species (five species), followed by Canidae (three species) and Cercopitheci(two species).The remaining families including Suidae,Hyrpestidae, Procavidae,Felidae,Hyrstricidae,Leporidae,Hyaenidae and Mustelidae had only one species each(Table 1).

Table 1.Medium and large-sized mammals recorded from Dera dilfekar block of arsi mountain national park, Arsi Zone, Southeast Ethiopia.

Order	Family	Common	Scientific Name
Artiodactyla	Bovidae	Greater kudu	*Tragelaphus strepsiceros*
Artiodactyla	Bovidae	Lesser kudu	*Tragelaphusimberbis*
Artiodactyla	Suidae	Warthog	*Phacochoerus africanus*
Carnivora	Hyrpestidae	White tailed mongoose	*Ichneumiaalbicauda*
Artiodactyla	Bovidae	Menelik's bush buck	*Tragelaphusseriptus*
Artiodactyla	Bovidae	Grey duiker	*Sylvicapra grimmia*
Primate	Cercopithecidae	Anubis baboon	*Papio anubis*
Carnivora	Hyaenidae	Spotted hyena	*Crocutacrocuta*
Carnivora	Canidae	Common jackal	*Canis aureus*
Primate	Cercopitheci	Vervet monkey	*Chlorocebus aethiopis*
Carnivora	Mustelidae	Honey badger	*Mellivora capensis*
Hyracoidean	Procavidae	Rock hyrax	*Procavia capensis*
Rodentia	Hyrstricidae	Crested porcupine	*Hystrix cristata*
Carnivora	Canidae	Black-backed jackal	*Canis mesomelas*
Carnivora	Canidae	Side-striped jackal	*Canis adustus*
Lagomorpha	Liporidae	Abyssinian hare	*Lepus habessinicus*
Carnivore	Felidae	Serval cat	*Leptailurusserval*
Artiodactyla	Bovidae	Klipspringer	*Oreotragusoreotragus*

Seasonal variations were observed in mammalian species composition,distribution and number of sightings among habitats and between seasons. Seventeen mammalian species were recorded in the grassland which was the highest in species composition than the other two habitat types during the wet season and the least was from Erica forest in whichonly five mammalian species were recorded during the wet season (Table 2).However, the highest number of sighting of mammals was recorded from the woodland during the wet season. The least number of individual mammals recorded from the Erica forest during both seasons. Similarly this habitat had the least number of species during both seasons.

The seasonal abundance of mammals significantly valid for all habitats (grassland: χ^2 =27.36, 1 df, p<0.05; woodland: χ^2=35.25, 1 df, p<0.05 and Erica forest: χ^2 =44.01, 1 df, P<0.05) in Dera dilfekar block.

Table 2.Seasonal abundance and distribution of mammals among different habitats in Dera dilfekar block of arsi mountains national park, Arsi zone, Southeast Ethiopia

Species sightings	Habitat types						Species identification methods
	Grassland		Woodland		Erica forest		
	Dry	Wet	Dry	Wet	Dry	Wet	
Greater kudu (*T. Strepsiceros*)	44	46	76	81	23	26	Visual
Lesser kudu(*T. imberbis*)	33	35	59	66	21	24	Visual
Warthog(*P.africanus*)	31	32	46	49	20	22	Visual
White tailed mongoose *(I. albicauda)*	1	1	2	-	-	-	Visual
Menelik's bushbuck*(T. seriptus)*	3	2	4	6	-	-	Visual
Grey duiker*(S. grimmia)*	1	1	2	1	-	-	Visual
Anubis baboon (*P.anubis*)	24	25	48	50	16	16	Visual
Spotted hyena *(C. crocuta)*	-	1	2	2	-	-	dropping
Common jackal*(C. aureus)*	-	1	3	-	-	-	Visual
Vervet monkey (C. *aethiopis*)	16	16	30	31	26	26	Visual
Honey badger (*M. capensis)*	1	1	-	-	-	-	Visual
Rock hyrax (*P. capensis*)	1	1	-	1	-	-	Visual
Crested porcupine (*H. cristata)*	1	1	-	2	1	-	quills
Black-backed jackal (*C. mesomelas*)	-	1	2	-	-	-	Visual
Side striped jackal (C. *adustus*)	-	1	2	1	-	-	Visual
Abyssinian hare (*L. habessinicus)*	-	1	1	1	-	-	Visual
Serval cat (*L. serval)*	1	-	1	1	-	-	Visual
Klipspringer*(O. oreotragus)*	1	1	1	2	-	-	Visual
Total number of species	13	17	15	14	6	5	
Total no of sightings per species	158	168	279	294	107	114	

4.2. Diversity and evenness index

The highest diversity of mammals was recorded in the woodland (H' =2.011) during the dry season. The second diversified habitat was grassland (H'=1.838) and the least diversified habitat was Erica forest (H'=1.633)in the same season. The calculated species evenness was J=0.696,J=0.762 and J=0.911 for the grassland, woodland and Erica forest respectively during this season (Table-3).

During wet season the highest diversity was seen in grassland (H'=2.136). The second diversified habitat was woodland (H'=1.968) and the least diversified habitat was Erica forest (H'=1.598) in the same season. The calculated species evenness was J=0.789, J=0.695 and J=0.993 for grassland, woodland and Erica forest respectively during this season(Table 3).

Table 3.Diversity and evenness of species in different habitat types during dryand wet seasons

Habitat types	Number of species		Number of individuals		Diversity(H')		H maximum		Evenness(J)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Grassland	13	17	158	168	1.838	2.136	2.639	2.708	0.696	0.789
Woodland	15	14	279	294	2.011	1.968	2.639	2.833	0.762	0.695
Erica forest	6	5	107	114	1.633	1.598	1.792	1.609	0.911	0.993

4.3. Relative abundance of mammalian species in the study area

Among 544 sightings of medium and large sized mammalian species recorded during the dry season, the most abundant species was Greater kudu (*T. strepsiceros*) with 143(26.24%) (Table 4)sightings, the second abundant species was Lesser kudu(*T. imberbis*) 113(20.78%) (Table 4) sightings, the third abundant species was Warthog (*P. atricanus*) with 97 individuals (17.84%),the fourth abundant species was Anubis baboon with 88 individuals (16.19%) (Table 4) and the fifth abundant species was Vervet monkey(*C. aethiopis*) with 72 individuals (13.25%)(Table 4) in the study area. Honey badger (*M. capensis*), Abyssinian hare (*L. habessinicus)*androck hyrax(*P. capensis*) with 1 individual each (0.18%) (Table 4) were the least abundant species in the study area during dry season.

Among 576 sightings of medium and large sized mammalian species recorded during the wet season, the most abundant species was Greater kudu (*T. strepsiceros*) with 153 individuals (26.56%) (Table 4)the second abundant was Lesser kudu(*T. imberbis*)with 125 individuals (21.7%) (Table 4), the third abundant was Warthog (P. *atricanus*) with 103 individuals (17.89%) (Table 4), the fourth abundant was Anubis baboon (*P. anubis*) with 91individuals (15.79%) (Table 4)and the fifth abundant species was Vervet monkey (*C. aethiopis*) with 73 individuals (12.68%) (Table 4) in the study area. Serval cat (*L. serval*) 1(0.17%) (Table 4), Honey badger (*M. capensis*) 1(0.17%) (Table 4), Blacked-backed jackal(*C. mesomelas),* Side-striped jackal (*C. adustus*) and rock hyrax (*P. capensis*) with 1individual each (0.17%) (Table 4) were the least abundant species in the study area during wet season.

Table 4. Relative abundance of medium and large sized mammalian species recorded.

Mammalian species	Total recorded		Relative abundance (%)	
	Dry	Wet	Dry	Wet
Greater kudu (*T. Strepsiceros*)	143	153	26.24	26.56
Lesser kudu(*T. imberbis*)	113	125	20.78	21.70
Warthog(*P. africanus*)	97	103	17.84	17.89
White tailed mongoose *(I. albicauda)*	3	1	0.55	0.35
Minelik's bush back *(T. seriptus)*	7	8	1.29	1.39
Grey duiker*(S. grimmia)*	3	2	0.55	0.35
Anubis baboon (*P. anubis*)	88	91	16.19	15.79
Spotted hyena *(C. crocuta)*	2	3	0.37	0.52
Common jackal*(C. aureus)*	3	1	0.55	0.35
Vervet monkey(C. *aethiopis*)	72	73	13.25	12.68
Honey badger (*M. capensis)*	1	1	0.18	0.17
Rock hyrax(*P. capensis*)	1	2	0.18	0.35
Crested porcupine (*H. cristata)*	2	3	0.37	0.52
Black-backed jackal(*C. mesomelas*)	2	1	0.37	0.17
Side-striped jackal(C. *adustus*)	2	1	0.37	0.17
Abyssinian hare(*L. habessinicus)*	1	2	0.18	0.35
Serval cat (*L. serval)*	2	1	0.37	0.17
Klipspringer*(O. oreotragus)*	2	3	0.37	0.52
Total	544	576	100%	100%

4.4. Frequency of mammals in the study area

Among the recorded mammalian species, six were common, six were uncommon and six were rare (Table 5).

Table-5: Occurrences of mammalian species in the study area during dry and wet season.

Mammalian species	Common	Uncommon	Rare
Greater kudu (*T. strepsiceros*)	✓		
Lesser kudu (*T. imberbis*)	✓		
Warthog (*P.africanus*)	✓		
White tailed mongoose *(I. albicauda)*		✓	
Menelik's bush back *(T. seriptus)*	✓		
Grey duiker*(S. grimmia)*		✓	
Anubis baboon (*P. anubis*)	✓		
Spotted hyena (*C. carcuta)*		✓	
Common jackal*(C. aureus)*		✓	
Vervet monkey (C. *aethiopis*)	✓		
Honey badger (*M. capensis)*			✓
Rock hyrax (*P. capensis*)			✓
Crested porcupine (*H. cristata)*		✓	
Black-backed jackal (*C. mesomelas*)			✓
Side-striped jackal (C. *adustus*)			✓
Abyssinian hare (*L. habessinicus)*			✓
Serval cat (*L. serval)*			✓
Klipspringer*(O. oreotragus)*		✓	
Total	6	6	6

4.5. Age Structure ofGreater Kudu (*T. Strepsiceros*), Lesser Kudu (*T. Imberbis*) and Warthogs (*P.africanus*)

In the present study an attempt was made to identify the age structure of three most abundant species; namely greater kudu (*T. Strepsiceres*),Lesser kudu(*T. imberbis*) and warthogs (*P.africanus*).These species were selected because their age was categorized in simple way than the others. A total of 143 and 153 individuals of greater kudu (*T. Strepsiceres*) were counted during dry and wet seasons respectively(Table 6).The population of greater kudu (*T. Strepsiceros*) were identified into age groups as; infant, young, sub adult male, sub adult female, adult male and adult female.

Table 6.Demography of sex and age categories of greater kudus (*T. strepsiceros*)

Age group	Grassland				Woodland				Erica forest			
	dry	wet	Total	Mean	Dry	wet	Total	Mean	Dry	Wet	total	Mean
Infant	-	1	1	1	-	2	2	2	-	-	0	0
Young	19	15	34	17	19	21	40	20	4	3	7	3.5
Sub adult male	4	5	9	4.5	6	5	11	5.5	4	6	10	5
Su adult female	15	16	31	15.5	28	27	55	27.5	6	4	10	5
Adult male	2	3	5	2.5	4	3	7	3.5	6	5	11	5.5
Adult female	4	6	10	5	19	23	41	20.5	3	8	11	5.5
Total	44	46	90	45	76	81	157	78.5	23	26	49	24.5

In present study, a total of 113 and 125 individuals of lesser kudu(*T. imberbis*) were recorded during the dry and wet seasons respectively(Table 7).The population of lesser kudu(*T. imberbis*) were identified in terms of age groups as infants, young, sub adult males, sub adult females, adult males and adult females.

Table 7.Demography of sex and age categories of lesser kudus (*T. imberbis*)

Age group	Grassland				Woodland				Erica forest			
	dry	Wet	Total	Mean	dry	wet	Total	Mean	Dry	wet	total	mean
Infant	-	-	0	0	1	-	1	0.5	-	-	0	0
Young	9	7	16	8	10	12	22	11	3	2	5	2.5
Sub adult male	3	2	5	2.5	8	7	15	7.5	3	5	8	4
Sub adult female	11	12	23	11.5	23	25	48	24	9	11	18	9
Adult male	4	5	9	4.5	3	4	7	3.5	2	2	4	2
Adult female	6	9	15	7.5	14	18	32	16	5	4	9	4.5
Total	33	35	68	34	59	66	125	62.5	21	24	45	22.5

In present study, a total of 97 and 103 warthogs(*P. africanus*) were counted in dry and wet season respectively(Table 8).The population of warthogs identified in terms of agegroups as; infant, young, sub adult male, sub adult female, adult male and adult female.

Table 8. Demography of sex and age categories ofwarthogs (*P. africanus*)

Age group	Grassland				Woodland				Erica forest			
	dry	wet	Total	Mean	Dry	wet	Total	Mean	Dry	wet	total	mean
Infant	-	1	1	1	2	3	5	2.5	-	-	0	0
Young	14	12	26	13	23	22	45	22.5	5	4	9	4.5
Sub adult male	3	6	9	4.5	4	5	9	4.5	2	1	3	1.5
Sub adult female	10	9	19	9.5	11	12	23	11.5	9	12	21	10.5
Adult male	1	2	3	1.5	2	2	4	2	1	2	3	1.5
Adult female	3	2	5	2.5	4	5	9	4.5	3	3	6	3
Total	31	32	63	31.5	46	49	95	46.5	20	22	42	21

4.6. Species Similarity

During the dry season, there was more similarity between grassland and woodland habitats (C= 0.714), followed by between Erica forest and grassland habitats(C= 0.6). However, with the C value of 0.5, woodland and Erica forest habitats were the least similar (Table-9).

During the wet season, species were more similar between grassland and woodland habitat(C= 0.875), followed by the species between grassland and Erica forest habitats (C= 0.5). However, with the C value of 0.454 mammalian species were least similar between woodland and Erica forest habitat (Table-9).

Table-9: Species similarity between habitats during dry and wet seasons.

	Woodland		Erica forest	
	Dry	Wet	Dry	Wet
Grassland	0.714	0.875	0.6	0.5
Woodland			0.5	0.454

4.7. Local Community Attitude toward the Wildlife in the Area

The attitude of the local community towards the wildlife and block was positive except for the lack of benefit from the block. The various benefits needed by people in and around the block were settlement, farmland, timber, firewood and fodder. The contribution of the local people in and around the protected area to conservation of theforest and wildlife were services like guarding and reporting the illegal activity such as overgrazing, releasing cattle into an area and car accident over wild animals.

The local communities reported that all people have an obligation to protect wild animals whether they have value or not. They believe whenever there is an opportunity to generate revenue the wild animals could serve as benefit to local people. The local people have confirmed as the wildlife have the potential to significantly contribute to both local and national economies. Some local people reported the wild life have a major aesthetic value to tourism who want to see

and appreciate wild game species and they had an attitude that wildlife could provide a variety of products such as meat, skin, hide, hornand traditional medicine.They also confirmed that the natural ecosystem involved in wastes disposal and recycling nutrients For example the spotted hyena (*C. crocuta*) scavenges on dead animal carcass.

The study indicated the presence of human wildlife conflict. Among the total respondents, 23(65.7%) (Table10)of them reported that the cause of human-wildlife conflict was crop damage, 8(22.9%)(Table10) of them said the conflict was due to predation, 2(5.7%) (Table10)of respondents responded that the conflict was the result of disease transfer as well 2(5.7%)(Table10) reported that the cause of conflict was due to attacking human being.

Table 10: Respondents' response about the cause of human-wildlife conflict in the area

Human wildlife conflict causes	Frequency	Percentage
Disease transmission	2	5.7
Raiding crops	23	65.7
Predation	8	22.9
Attacking human	2	5.7
Total	35	100

The community uses different protection techniques of crop damage right from seed sawing up to harvesting of the crop. For example 57.1%(Table-11) of respondents reported permanently guarding, 17.1%(Table-11)scow clawclaw models11.4% (Table-11)using traps, 8.5% (Table-11)fencing and 5.7%(Table-11) using dogs to frighten and chase away crop raiders and placing the models of man in the crop field.

Table 11.Respondents response on the common methods of controlling human-wild conflict.

Common methods used by community	Frequency	Percentage
Using traps	4	11.4
Hunting wild animals	0	0
Permanently guarding	20	57.1
Using Dogs to chase away the wild animals	2	5.7
Scow claw	6	17.1
Fencing	3	8.5

The level of awareness of community towards the wildlife resources and use was high, 62.85% of respondents reported the block had importance for local community(Table 12).This might be as they are allowed for firewood collection, grass collection and others support for indirect income from the block. Before establishment of this block, about 58 households of the local communities were using this block as animal graze site, residential site and farm land.

Table 12:Respondents'response on the type of resources used from the study area

Resources used by local community from the block	Frequency	Percentage
Obtaining income from the sale of their body part	0	0
Getting pleasure by looking them	2	5.7
Getting income via tourism	0	0
Food value	0	0
Fire wood	10	28.57
pasture	21	60
Fence construction	2	5.7

However, 37.13%ofrespondents reported as the block do not use the local community in terms of farmland and settlement (Table 13).

Table 13: Level of awareness regarding the use of wildlife and the study area

Attitudes of respondents on the importance of the block and wildlife	Frequency	Percentage
Community can share benefits so the block should be managed	22	62.85
Community cannot share benefits for so does not concern community	9	25.71
There is no benefit at all from the block rather it harm the community	4	11.42

5. DISCUSSION

In the current study, a total of eighteen species of medium and large sized mammals were recorded. ; several studies on the diversity and ecology of wild animals in elsewhere, have recorded a number of species. For example; Hinde *et al*., (2001) recorded 20 speciesin woodland in Tanzania and Olupot and Sheil (2011) also recorded 7 speciesin India.Dereje et al., (2015) recorded a total of 23 species of mammalian species from Baroye Controlled Hunting Area, Illubabor Zone, Southwest Ethiopia.

Among the three habitats of the study area during dry season, the highest diversity index(H'=2.011) of medium and large sized mammals were recorded in the woodland habitat followed by grassland habitat that contained diversity index of(H'=1.833).The woodland and grassland harbored different vegetation species which might have used as the source of food for various mammalian species, compared to Erica forest habitat.

Among the three habitats of the study area during wet season, the highest diversity index (H'=2.136) of medium and large sized mammals were recorded in the grassland habitat followed by woodland habitat that contained diversity index of(H'=1.968).The grassland and woodland harbored different vegetation species which might have used as the source of food for various mammalian species, compared to Erica forest habitat. This might be the presence of sufficient supply of food and water in the site. Food resources and water are the major factors influencing the distribution of mammals in their natural environment.

In other word, among the three habitats of the study area during dry and wet seasons, the lowest diversity index (H'=1.633) and (H'=1.598) of medium and large sized mammalian species were recorded in the Erica forest habitat respectively. However, evenness (J=0.991and J=0.933) was the highest in the Erica forest during dry and wet seasonsrespectively. The low diversity and abundance of some mammalian species in the study area was as a result of the factors(human activities such as deforestation, and grazing land) that were known to minimize the mammalian number in an area. Human population led to the appropriation of extensive space of land for agriculture, settlement and extraction of infrastructure for their existence, which in turn are responsible for wildlife habitat loss and fragmentation (Foley, 2005).

Greater kudu was the most abundant species of mammals (26.56%) (Table 4). Large number of this species was recorded in the woodland and grassland site. This might be due to the existence of suitable food resources for these mammals. The second most abundant mammalian species was lesser kudu (21.70 %) (Table 4). The high abundance of this mammal might be due to suitable environment. These mammals are associated with shorter grassland, acacia wooded grass and flood plains (Veraman and Sukumer, 1995). The third most abundant species was Warthog (17.89 %) (Table 4) in the study area. This might be depending on the feeding habit of the mammal. The warthog is adapted to feed on different food items.The least species recorded were Honey badger, black backed jackal, Side-striped jackal and Serval cat. Their territoriality behavior might determine their abundance. According to Nievergelt(1998) mongoose species typically occur in low diversity might be due to territoriality and as more sensitive to ecological disturbance. Social behavior and reproduction of mammals are determined by their age structure (Kleiman,2004).

According to Smith (1992) the difference in the diversity and evenness of mammalian species are determined by differences in their feeding behavior. The distribution of mammals in the various habitat types of the area might show habitat selection of the different mammalian species rely on their ecological selection and evolutionary adaptation. The distribution of mammals in the Dera dilfekar block indicates that the species were not uniform across the three study sites. Their distribution might be based on the absence or presence of suitable environment. In the present study, Greater kudu (*T. strepsiceros*) and lesser kudu (*T. imberbis*) were largely associated to grassland and woodland. The relatively high number of these mammals might be linked to the relatively thick ground cover of the forest and grazing land that is assumed to be ideal for the species to secure cover and food.

The presence of various floral species in woodland and grassland in the study areaof Arsi Mountains National Parks might account for high species diversity index. Heterogeneous condition yield higher diversity while homogenous conditions yield low diversity (Mekonnin, 2001). The cover is also important as mammals are interdependent for protection and food (Baily, 1984).A pressure forced by ecological factors such as the temperature difference has resulted in declining mammalian diversity.

The highest similarity of mammalian species in different seasons was obtained from the wood land and grassland during dry and wet seasons (0.714 and 0.875) respectively. This might be due to the fewer disturbances of these habitats by humans. The least species similarity was obtained from woodland and Erica forest during dry and wet seasons (0.5 and 0.454) respectively. This might be due to dissimilarity of these two habitats in the presence of suitable food and other resources important for their survival. In the study area, the mean number of livestock grazed per transect during the wet season was greater than the dry season. This could be because of other than permanent users of the area; many people from the neighboring areas brought their livestock to graze in the area during the wet season. Similarly, Sillero-Zubiri (1997) reported that more number of pastoralists grazed their livestock in the Arsi Mountains. Similarly, different scholars reported the positive influence of local communities from the protected (Yosef, 2014). The local community said that the study area have to managed by different punishment methods (Getachew*et al,* 2018). Yearly and daily grazing duration of livestock in the study areas have a significance impact on foraging and reproductive behavior of the mammalian species. Some communities have less awareness towards protection of the area by comparing the previous benefits before the Dera dilfekar block of Arsi Mountains of National Park establishment.

Habitat loss and fragmentation are the common practices currently observed in most developing countries. Likewise, the loss of ecosystem is increasingly fragmenting the remaining Ethiopian wildlife habitat (Sillero-Zubiri, 1999). Principal sources of feed for livestock were from communal land, which includes the block area; hence the Dera dilfekar block of Arsi Mountains National Park Authority was faced with a challenging task to implement the required measures to conserve wildlife of the block such as prevailing high grazing pressure. The study reveals that some local communities did not consider the blockas a source of substantial benefit. However, they acknowledged the ecotourism potential of the block because the legal benefits they were getting from the block such as employment as tour guide are tourism related. In contrast, local people have a strong belief and hope that the future development of tourism sector of the block could bring them sustained benefits. Kruger (2005) highlighted the importance of ecotourism as a means of generating much needed foreign currency, both locally and nationally, while at the same time providing a strong incentive to manage nature's strongholds in a way that would conserve them. Irrespective of the consent of the block's authority, the study revealed that, the local people were able to extract what they call 'their customary right' such as fuel wood and construction materials from the study area in their day-to-day activities. The views on perceived

benefits and conflicts, forest cover change and ecological variables and local knowledge about the mammals in Dera dilfekar block to some extent were diverse across the livelihood source. The overall attitude of the local people towards the block and the wildlife conservation seemed positive. However, having positive attitude does not guarantee positive behavior because some of the local people carry out unchecked exploitation of the block's natural resources.In summary, the present study confirms that the Dera dilfekar block of Arsi Mountains National Park contains rich diversity of mammalian species and hence its conservation and biodiversity documentation efforts should be sustained.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

A total of18 species sightings of medium and large mammals which belong toeleven families and six orderswere recorded from Dera dilfekar block. Among these six specieswere considered as medium-sized and the remaining were large-sized mammals. From all the recorded families, Bovidae contributed the highest number of species followed by Canidae and Cercopithecidae. The remaining had only one species each.

Seasonal variations were observed in mammalian species composition,distribution and number of sightings among habitats.Grassland was the highest in species diversity than woodland and Erica forest during the wet season and the least was from Erica forest during the same season.However, the highest number of sighting of mammals was recorded from the woodland during the wet season. The least number of individual mammals recorded from the Erica forest during both seasons. However, Ericaforests had the highest evenness during dry and wet seasons than the two habitats. Similarly this habitat had the least number of species during both seasons. The seasonal abundance of mammals significantly valid for all habitats.

6.2. Recommendation

To ensure the long term conservation of mammalian species in this area, the next recommendations are suggested. The current study focused on wild animals' assessment that aimed to understand diversity, distribution and relative abundance of mammalian speciesin Dera dilfekar block of Arsi Mountain National Park. Knowing species diversity,distribution and relative abundance at this scale can help focus conservation efforts and decide where mammalian species focus may be more effective in preventing species extinctions.Since this study cannot provide the complete number of individuals and mammalian species in the study area, the further study that include wide period of study and wide study area should also be conducted.

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Appendix-1: Interview agreement form:

Dear Interviewee:

I have selected you as an interviewee for the study of Dera dilfekar block of arsi mountains national park. The aim of the study is to assess the diversity distribution and relative abundance of medium and large mammals in this Block. Thus, as you have agreed to provide information for the study through the interview, I will make a record of our discussions on pieces of paper.

However, I would like to assure you that the information you will provide for the study will be kept confidential and nobody will have access to it. Besides, I would like to inform you that you have the right to ask questions for clarification, to withdraw from the interview any time you want and to provide information that you know about this study area.

Interviewee: -	Interviewer: -
Name: - _____	Name: - _____
Signature: - _____	Signature: - _____
Date: - _____	Date: - _____

Thank you very much!

Appendix-2: Interview questions:

I. Household background interview for local respondents around Dera dilfekar block.

a. Age _____

b. Sex_____

c. Residence:_____

d. Educational status:

e. Uneducated

f. Primary school

g. Secondary school

h. Beyond secondary school

II. How long have you lived in this area?

A. Below six years

B. Seven to eleven years

C. Twelve to sixteen

D. Seventeen to twenty years

E. Above twenty

III. Respondent's knowledge and practice about human wild life conflict.

1. Which of the following is the cause of conflict between the human and the wild animals in this area?
   A. Disease transmition
   B. Damaging crops
   C. Predation
   D. Attacking human
   E. If any cause please would you mention?
2. Rank the wild mammals those damage the crops.
3. List the wild mammals which attack domesticated animals in rank.
4. Do you think conserving wildlife is important?

A. Yes B) No

5. If yes, why?
   A. Obtaining income from the sale of their body part (horn, teeth, skin fur etc.)
   B. Getting pleasure by looking them
   C. Getting income vie tourism
   D. Food value
   E. If any more could you tell me
6. Which of the following methods of crop damage or domesticated animals control are common in your area?
   A. Using traps
   B. Hunting wild animals
   C. Permanently guarding
   D. Using dogs to chase away the wild animals
   E. Placing a model of man around crop field
   F. Destructing their habitat
   G. Fencing
   H. If any more could you tell me
7. What measures do you think should be taken by the following bodies in order to prevent the crop damage or wild animals attack? By:

   I .Farmers (II) Non-governmental organization (III) Government organization
8. What is the importance of conserving wildlife?
9. What should be done to increase the local community benefit from this area? By:
   a. Conservationist (b)local community
10. Do you think local community affect wildlife?
    a. Yes b) No
11. If your answer is yes, how they affect?
12. How could local community and wildlife in Dera dilfekar block couldcoexist in peace?
13. Do you think the establishment of Dera Dilfekar Block benefits the local people?
14. What benefits have been seen until now?
15. Do the diversity and distribution of medium and large mammals vary seasonally?
    a. Yes b) No
16. If your answer is yes, what do you think the causes are?

17. What comment do you give in order to bring sustainable development?

Thank you very much!

Appendix-3: Field data sheet used for surveying mammalian species

Order	Family	Common	Scientific Name

Appendix 4: Row data of species recorded during dry and wet season from different habitat.

Species recorded	Habitat types						Species identification methods
	Grassland		Woodland		Erica forest		
	Dry	Wet	Dry	Wet	Dry	Wet	
Greater kudu							
Lesser kudu							
Warthog							
White tailed mongoose							
Minelik's bushback							
Grey duiker							
Anubis baboon							
Spotted hyena							
Common jackal							
Vervet monkey							
Honey badger							
Rock hyrax							
Crested porcupine							
Black-backed jackal							
Side striped jackal							
Abyssinian hare							
Serval cat							
Klipspringer							
Total number of species							
Total no of individual per species							

Appendix 5: Row data sheet for species composition of Greater kudus, lesser kudu and Warthogrespectively.

Age group	Habitat types											
	Grassland				Woodland				Erica forest			
	dry	wet	total	mean	dry	wet	total	mean	dry	wet	total	mean
Infant												
Young												
Sub adult male												
Sub adult female												
Adult male												
Adult female												
Total												

Age group	Habitat types											
	Grassland				Woodland				Erica forest			
	dry	wet	total	mean	dry	wet	total	mean	dry	wet	total	mean
Infant												
Young												
Sub adult male												
Sub adult female												
Adult male												
Adult female												
Total												

Age group	Habitat types											
	Grassland				Woodland				Erica forest			
	dry	wet	total	mean	dry	wet	total	mean	dry	wet	total	mean
Infant												
Young												
Sub adult male												
Sub adult female												

Adult male

Adult female

Total

Appendix 6:

Checklist for respondents' knowledge and practice about human wild life conflict.

Human wildlife conflict causes	Frequency	Percentage
Disease transmission		
Raiding crops		
Predation		
Attacking human		
Total		

Checklist for respondents' response on the type of resources used from Dera dilfekar block of arsi mountains national parks by the local community.

Resources used by local community from the block	Frequency	Percentage
Obtaining income from the sale of their body part		
Getting pleasure by looking them		
Getting income via tourism		
Food value		
Fire wood		
Grass for their cattle		
Fence construction		

Checklist for Common methods of controlling crop damaging or domesticated animals attacking wild animals.

Common methods used by community	Frequency	Percentage
Using traps		
Hunting wild animals		
Permanently guarding		
Using Dogs to chase away the wild animals		
Placing models of man around crop field		
Fencing		

Checklist for level of awareness regarding benefits of wildlife and Dera dilfekar block of arsi mountains national park to the local community.

Attitudes of respondents on benefits of the block and wildlife	frequency	Percentage
Community can share benefits		
Community cannot share benefits		
There is no benefit at all from the block rather it harm the community		

(A)

(B)

Plate 2(A,B): Indirect observation of medium and large mammals in Dera dilfekar block.

(photo by: Fikadu kebede,2018)

plate 3: Lesser kudu(*T. imberbis*)

(photo by: Fikadu kebede,2018)

(A)

(B)

plate 4 (A,B):Female and MaleGreater kudu(*T. Strepsiceres*)

(photo by: Fikadu Kebede,2018)

Plate 5: Worthog (*P. africanus*)

(photo by:Fikadu kebede,2018)

Plate 6: Human-wildlife conflict in Dera dilfekar block.

(Photo by: Fikadu Kebede, 2018)

plate 7: Interviews with local community and experts conducted.

(Photoby:FikaduKebede,2018)