

1.Introduction

The most unique feature of the planet Earth is the existence of life, and the most extraordinary feature of life is its diversity. Approximately, 9 million types of animals, plants, protists and fungi inhabit the Earth (Living Planet Report, 2012). Biological diversity has emerged in the past decade as a key area of concern for sustainable development. It provides a source of significant economic, aesthetic, health and cultural benefits. It is assumed that the well-being and prosperity of earth's ecological balance as well as human society directly depend on the extent and status of biological diversity (CBD, 2009).

The wide variety of habitats in Ethiopia, ranging from arid desert, open grassland, and semi-arid savannas to highland diversity of cultures and ecology supports an exceptionally diverse fauna and flora (CBD, 2009). Currently, around 320 species of mammal including 39 endemics (both small and large mammals), 918 birds with 19 endemic species, 240 reptiles (16 endemics), 71 amphibians (30 endemics) and 172 freshwater fishes with 38 endemics and more than 1225 insects recorded in Ethiopia (Tefera, *et.,al*, 2012).

Protected areas are the main focus for the maintenance of biological diversity and contribute for economic development of a nation. In the past few decades, the numbers of protected areas in developing countries are expanding (Hofreiter, 2012). Ethiopia is one of few countries where the establishments of protected areas are increasing. For example, Ethiopia had only two protected areas (namely; Awash and Simien Mountains National Park) before 40 years and today has more than 55 protected areas (including 21 national parks) to protect and conserve the natural ecosystems and wildlife heritage of the country (Young, 2012). In Ethiopia, 40 protected areas cover roughly 16.4% of the country's geographic area (186000 km²). However, these areas are facing a range of problems, which threatens the survival, and continuity of its biodiversity resources owing to the rigorous human interference from agriculture, settlements, fuel wood and the construction of various infrastructures (Arega, 2005).

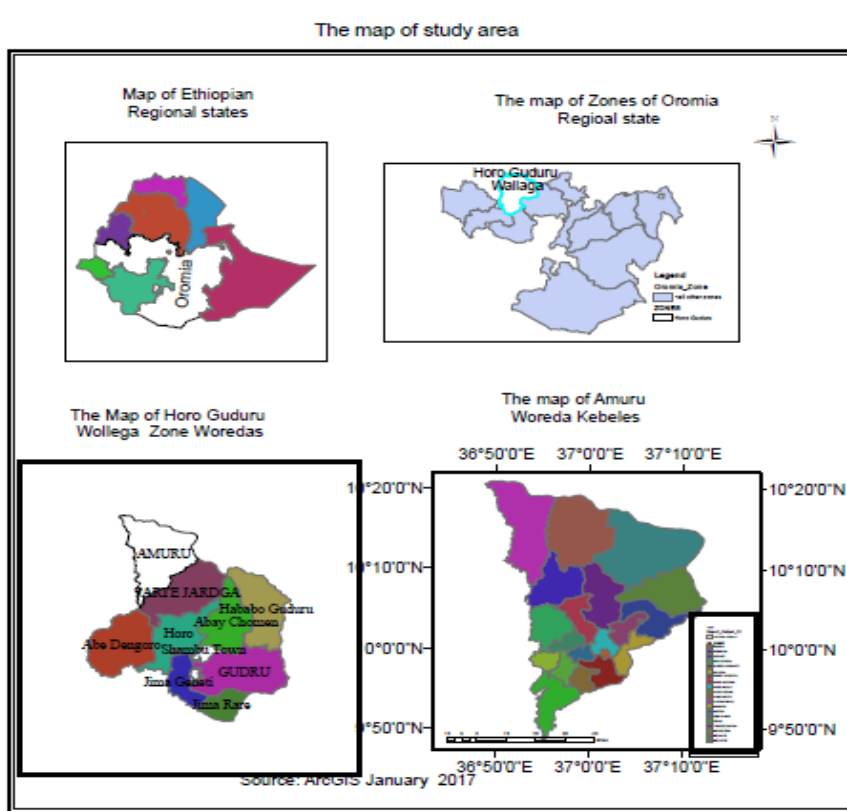
One of the common problems in biodiversity conservation is lack of information on the relative importance of habitats and ecosystems in terms of biological diversity (World Conservation Monitoring Center, 1994). Unlike the flora of Ethiopia, the fauna is not well investigated and documented (Alemneh Amare, 2015). Similarly, there was no comprehensive assessment and

documentation of mammal species diversity and abundance in the study area owing to lack of systematic study on the issue. Therefore, the study aimed at investigating the status of large mammal diversity and abundance and identify the major drivers of local extinction to these resources for better management and conservation of the protected area.

2. Materials and Methods

Descriptions of Study area: Amuru Woreda is one of the woredas in Horo Guduru Wollega Western Ethiopia which is located at 382 km west of Addis Ababa. The district geographically lies between $9^{\circ}48'10''\text{N}$ - $10^{\circ}18'40''\text{N}$ latitude and $36^{\circ}50'20''\text{E}$ - $37^{\circ}12'40''\text{E}$ longitudes. According to (CSA, 2007), the *woreda* has an estimated total population of 70,501 of whom 29,774 (49%) were males and 30,984 (51%) were females. Furthermore, about 60,763 (86.2%) were rural population and the rest were urban inhabitants. A survey of the land in this *woreda* shows that 49.1% is arable or cultivable, 16% pasture, 10.5% forest and the remaining 24.4% is considered marshy, mountainous or otherwise unusable. The *woreda* has an altitude ranging from lowland of 760 to midland of 2,002 m above sea level (Amuru Woreda Agricultural Office, 2018). According to official sources, the *woreda* has moist and hot climate with average annual temperature of 11.1°C to 23.6°C and rainfall of 1167 mm to 1737.9 mm respectively (Shambu Metrological Office, 2017).

Fig. 1 Map of the Study Area



Source: Arc GIS, 2017

The Research Methods

The survey of large mammals was conducted by stratifying the study area in to natural forest, wooded grassland, bush land and plantation forest grounding on land cover feature(Mamo et al., 2012; Girma et al, 2012). Representative sample sites proportional to each habitat type were taken randomly and surveyed using random line transect method(Varman and Sukumar, 1995).

The adjacent transects were at least 500 m apart and all transects lines were roughly parallel to each other and their ends were less than 200 m far from the habitat edge. The average transect width was about 200 m in natural forest and about 400 m in wooded grassland habitat. The transect length was measured and located in the forest with the help of global positioning system (GPS). Generally, a total of 20 transect lines proportional to each habitat type was established to count the diversity and abundance of large mammals in the study area The total area surveyed accounts for about 20% of the total forest. Both direct (seeing) and indirectcount methods (foot prints, feeding marks and digging holes) were employed to assess the abundance and species

diversity of mammals. The size and distribution of mammals were assessed via ground survey in each habitat type during wet and dry seasons from (June, 2017-March,2018).Furthermore, the study was also supported by key informant interview conducted with purposively selected local community elders and critical personal observation of the sitefor investigation of the threats to large mammals in the study area.

Method of Data Analysis:In the process of analysis, the collected survey data of mammals was analyzed using various indexes.Accordingly,relative abundance of mammals was analyzed through percentage and frequency distributions, mammal species diversity and species similarity were analyzed using Simpson’s index of diversity and Sorenson’s similarity index respectively. Moreover, qualitative information obtained from key informant interview wassystematically summarized and used in the triangulation of evidences.

3. Results and Discussion

Relative Abundance and Species Diversity of Mammals: The present study identified and recorded the presence of ten species of mammals falling into four different orders in GuraLophoforest. During the study period, a total of 187 observations of mammals were surveyed and recorded within a total time of 72 hours in the study area..

Table 3.1 Relative Abundance of Mammals

Order	Common name	Scientific name	Number of mammals	Relative abundance (%)
Primates	Colobusmonkey	<i>Colobusguereza</i>	62	33.2
	Anubis Baboon	<i>Papioanubis</i>	37	19.8
	Vervet Monkey	<i>Chlorocebusaethiops</i>	28	15.0
Carnivora	Spotted hyena	<i>Crocutacrocuta</i>	10	5.3
	Serval Cat	<i>Felisserval</i>	5	2.7
	Wild Cats	<i>FelisSilvestris</i>	4	2.1
	White tailed	<i>Ichneumiaalbicauda</i>	8	4.3
	Mongoose			
Artiodactyla	Common Duiker	<i>Sylvicapragrimmia</i>	11	5.9
	Wild pig	<i>Potamochoeruslarvatus</i>	15	8
Rodentia	Crested Porcupine	<i>Hystrixcristata</i>	7	3.7
Total no of mammals			187	100

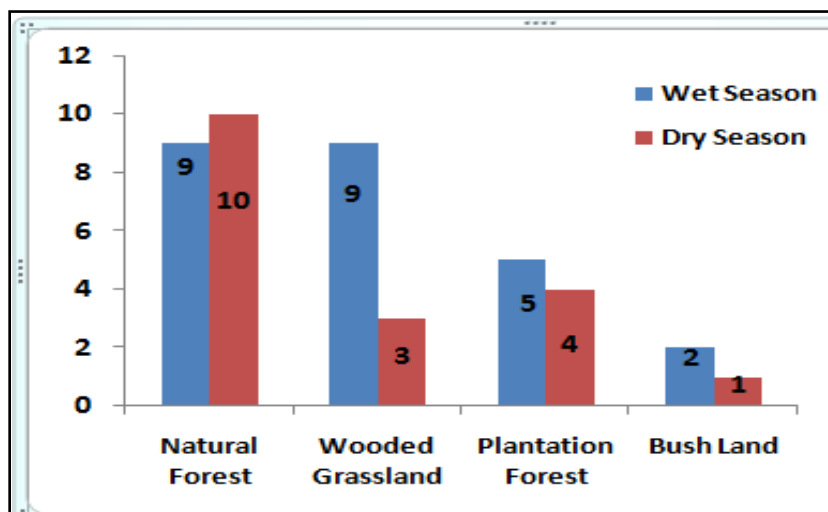
Source: Field Survey, 2018

Table 3.2 Seasonal Abundance of Mammals in Different Habitats

Mammal species (Scientific name)	Abundance during wet season				Abundance during dry season			
	Natural Forest	Wooded .grass L.	Plantatio n forest	Bush land	Natural Forest	Wood grass L.	Plantatio n Forest	Bush land
<i>Colobusguereza</i>	10	7	5	3	22	5	8	2
<i>Papioanubis</i>	5	8	-	-	15	5	4	-
<i>Chlorocebusaethiops</i>	2	5	1	3	9	3	5	-
<i>Crocucacrocuta</i>	3	2	-	-	4	-	-	-
<i>Felisserval</i>	1	1	-	-	3	-	-	-
<i>FelisSilvestris</i>	1	1	-	-	2	-	-	-
<i>Ichneumiaalbicauda</i>	5	-	-	-	3	-	-	-
<i>Sylvicapragrimmia</i>	2	2	2	-	5	-	1	-
<i>Potamochoeruslarvatus</i>	3	3	2	-	7	-	-	-
<i>Histrixcristata</i>	-	5	-	-	2	-	-	-
No of mammals	32	34	10	6	72	13	18	3
No of species	9	9	5	2	10	3	4	1

Source: Field Survey, 2018

Figure 3.1. Mammal Species Richness in Different Seasons



Source: Field Survey, 2018

Results

The survey of mammalian abundance (table 3.1) identified and recorded 187 mammals falling into ten species (four order) in the study area. Order primates were the most abundant mammal species accounting for about 66.8% of relative abundance followed by order carnivore (14.2%). Conversely, order rodentia was the least abundant (3.7%) represented by a single species in the study area. On species level, *Colobus guereza* (33.2%) and *Papio Anubis* (19.8%) were the first two most abundant mammals. whereas the least abundant was *Histrix cristata*. Spotted hyena was the most abundant species of order carnivora followed by white-tailed Mongoose (*Ichneumia albicauda*) in the present study area.

The survey of seasonal abundance of mammals in the different habitats (table 3.2), reveals that substantial number of mammals 109 (57.4%) were recorded during dry season whereas 81 (42.6%) were observed during wet season. On habitat level, natural forest hosts the largest mammal diversity (10 mammal species) and abundance (72 mammals) in dry season followed by wooded grass land (9 mammal species and 34 size of mammals) during wet season. Conversely, the least mammal species diversity and abundance was recorded in bush land in dry season followed by wet season in the same habitat type (fig.3.1).

The species richness and diversity index (table 3.3) shows that natural forest habitat constituted 10 mammal species with the highest Simpson Index of Diversity (0.84) whereas wooded grassland habitat hosts 9 mammal species which was the second most diversified with Simpson Index of Diversity (1-D) of 0.82. Conversely, bush land and plantation habitat were the least diversified with Simpson Index of Diversity of .0.53 and 0.73 respectively. In addition, the natural forest habitat is the most abundant hosting about 104 abundance of mammals compared to only 8 mammals in bush land habitat. The similarity index of habitats in the composition of large mammals, (table 3.4) shows strong Sorensen's similarity index (I S)) between natural forest and wooded grassland habitats (0.74), followed by between natural forest and plantation (0.62) and also between plantation forest and bush land habitat (0.57). Conversely, mammalian composition between wooded grassland and bush land habitats was found to have no similarity (0.36).

Table 3.3 Simpson's Index of Diversity and Species Richness of Mammals

Habitat type	No of species/ Richness	Abundance	Simpson's Index of Diversity (1-D)
Natural Forest habitat	10	104	0.84
Wooded grassland	9	47	0.82
Plantation forest	6	28	0.73
Bush land	2	8	0.53

Source: Field Survey, 2019

Table 3.4. Similarity Index of Large Mammals

S.N	Habitats	Sorensen's Similarity Index (I S)
1	Natural Forest Vs Wooded Grass Land	0.74
2	Natural Forest Vs Plantation Forest.	0.62
3	Plantation Forest Vs Bush Land	0.57
4	Wooded Grass.Land Vs Bush Land	0.36

Source: Field Survey, 2019

Discussions

A total of 187 large mammals falling into 10 species were observed and recorded in the study area. The result was similar with the findings of other studies conducted in Ethiopia. For instance, Admasu et al (2012) recorded 9 species of large mammals in Tululujia Wildlife Reserve, Dunbar (1978) recorded 12 mammal species in Simien Mountains National Park (SMNP) and also Mosissa (2016), recorded 15 species of mammals in Wacha Protected Forest, Western Ethiopia. Conversely, compared with other similar studies conducted in Ethiopia that have used similar transect techniques, the number of mammal species recorded in the study area was small. For instance, Zerhinet *al.*, (2012) recorded 19 species in Wendo Genet, Afework (1988), recorded 25 species in Harena forest. The lower size of species richness in the present study area could be attributed to severe habitat loss and fragmentation by various anthropogenic activities in the area and limited survey period. As stated by Nelson, (2009) the greatest threat to wildlife is the loss of habitat as humans develop land for agriculture, grazing livestock and draining wetlands.

Order primates were the most abundant mammal species observed and recorded in the present study area. In terms of individual species, *Colobus guerezaw* was the most abundant mammal

species recorded in the natural and plantation forests mainly along rivers and streams where relatively dense and taller trees were found. The reason for abundant number of this mammal was, therefore, since the natural forest habitat is relatively dense and less disturbed, it serves as refuge for the shy behavior of the animal. *Colobus guereza* selected riverine and large trees as their preferred habitat (Feteneet *al.*, 2011). Anubis baboon (*Papio Anubis*) was the second most abundant mammal in the forest. This finding was contrary to the study conducted by Girma (2012), who observed Anubis baboon as the most abundant mammal around Wondo Genet forest and Mosissa (2016) also found high relative abundance of Anubis baboon in Wacha Protected Forest, Western Ethiopia. It was also stated that Anubis baboon is widely known in varieties of habitats in Africa which is attributed to the adaptation of the species to feed on variety of food items (Aramde Feteneet *al.*, 2011). However, in the present study, it was found to be less abundant than *Colobus guereza* due to several threats like human-anubis baboon conflicts. The conflict between human-anubis baboon is one of the most interesting topical problems in countries that depend on agriculture (Datiko and Bekele, 2013). This conflict create negative attitude toward the conservation of Anubis baboon and farmers kill them as revenge which eventually reduces their abundance from time to time. Interview with local community elders disclosed that Anubis baboon is hunted for its attack both on most of agricultural crops and domestic animals like sheep, goat and dogs.

The number of individual mammals varies across different seasons and habitats where the size of mammals observed in dry season outnumbers the size observed in wet season. Consistent with this finding, Belete (2016) found that the distribution of mammals during dry season is higher than wet season. On habitat level, natural forest hosts the largest mammal species diversity and abundance. This could be attributed due to the movement of large mammals from the peripheral part of the forest (bush land and wooded grass land) towards the inner and relatively protected part (the natural forest habitat) in search of food and safe shelter. During dry season, marginal habitats like bush land and wooded grass land were relatively dry that tends to reduce the availability of water and grasses forcing mammals to move towards the inner part of the habitat where relatively water and foods found. Literature shows that species diversity is often high in areas where there are sufficient food and water resources (Ayele, 2008, UNESCO, 2008). In addition, the drying up of under growth in forest habitats during dry season also increases the sighting of mammals. Moreover, since human interferences like agricultural activities and

collection of fire woods are often high during wet season, this reduces the sighting of mammals. Live stock and human encroachments often reduce the foraging opportunities of wild animals which in turn reduce the mammal opportunities of being sighted (Dinkaran and Anbalagan, 2007). Richness and abundance of mammals were reduced in more disturbed marginal habitats mainly in bush land and wooded grass land. Among the carnivores, the *Felis serval* and *Ichneumia albicauda* were observed only in the natural forest which might have attributed due to their nocturnal behavior and their need for densely forested habitat for safe life from poachers. The presence of spotted hyena was confirmed by droppings in the natural forest, plantation forest and bush land, and by footprints only in the riverine forest.

Drivers of Local Extinction in the Study Area

Habitat Destruction and Fragmentation: Habitat destruction in the study area mostly results from agricultural land expansion around marginal areas of the forest, removal of trees for charcoal and timber production. Laurance (1998), stated that habitat fragmentation is often associated with population decline and increased risk of extinction. It is considered as one of the greatest threats to biodiversity. During the transect walk, evidences of grazing by livestock, clearing forest from adjacent crop lands, illegal cutting of trees for fuel wood, construction materials and charcoal production from both plantation and natural forests were observed.

Poaching: Poaching of wild animals in the areas are conducted for the purpose of meat and cultural medicine mostly taking place in dry times when farmers are free from agricultural activities. For instance, wild pig (*Potamochoerus larvatus*) and Porcupine (*Hystrix cristata*) were listed as locally endangered mammals as they are highly demanded for cultural medicine by the local community. And also Common duiker (*Sylvicapra grimmia*) was listed as critically endangered mainly as it's highly demanded for meat. Surprisingly, Warthog (*Phacochoerus africanus*) was listed as locally extinct mammal from the forest some before ten years due to severe poaching as it is highly required for cultural medicine by the local community. Moreover, evidence of dead bodies, skins and skeletons of wild animals were observed during transect walks through the forest.

Human-wild animal conflict: key informants from local community elders disclosed that proximate forest edge and farm land is the reason behind the occurrence of humans and wild animal conflicts which often results in hunting and shooting of wild animals as a temporary remedy. Most victims of this episode as mentioned by the local communities were Anubis baboon

(*Papio Anubis*), Wild pig (*Potamochoerus larvatus*) and Vervet monkey (*Chlorocebus aethiops*) mainly for raiding on crops. For instance, interview results disclosed that *Papio Anubis* is frequently hunted for its attack both on most of agricultural crops like maize, sorghum, coffee wheat and domestic animals like sheep, goat and dogs.

Weak Legal Protection: Absence of law enforcement is also cited as one of the major threats for biodiversity decline in the study area. Key informants disclosed that there is no adequate law enforcement to punish poachers, illegal clearing of forests, timber and charcoal production and grazing of the forest area. They further uncovered that the forest is protected only by name as the local communities interfere the forest and its wildlife without fear of any law enforcement. Fischer (2008), stated that law enforcement is a recommended remedy to prevent further biodiversity erosion and is necessary to achieve proper management of protected areas as a common good.

Conclusion

The present study identified and recorded a total of 187 large mammals falling into 10 species in the study area. Order primates were the most abundant mammal species observed which were dominated by *Colobus guereza* and *Papio Anubis*. In terms of individual number of mammals, the study found uneven distribution of mammals in different season across different habitats. Richness and abundance of mammals were reduced in more disturbed marginal habitats mainly in bush land and wooded grass land. However, despite the existence of a wide variety of large mammals, anthropogenic activities particularly poaching, habitat destruction, livestock grazing, human-animal conflict and weak legal enforcement were identified as the major drivers of local extinction to large mammals in the protected area. Hence, the research concludes that the existing mammalian local decline both in species variety and abundance needs urgent conservation measures to ensure the sustainability of both fauna and flora in the protected area.

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