

## Research Article

# Abundance, Species Diversity, and Distribution of Diurnal Mammals in Humbo Community-Based Forest Area, Southern Ethiopia

Adanech Lemma and Wondimagegnehu Tekalign 

Department of Biology, College of Natural and Computational Sciences, Wolaita Sodo University, P.O. Box 138, Wolaita Sodo, Ethiopia

Correspondence should be addressed to Wondimagegnehu Tekalign; [wondimagegnehu.tekalign@wsu.edu.et](mailto:wondimagegnehu.tekalign@wsu.edu.et)

Received 23 December 2019; Revised 12 August 2020; Accepted 30 September 2020; Published 9 October 2020

Academic Editor: Hynek Burda

Copyright © 2020 Adanech Lemma and Wondimagegnehu Tekalign. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This study was undertaken with the intention of assessing abundance, species diversity, and distribution of medium and large diurnal mammals at the Humbo Community Based Forest Area, Ethiopia. The study area was stratified into three major habitats based on the vegetation cover of the area, such as riverine forest, bushland, and open grassland. The study in each vegetation type was surveyed using the transect method. It was conducted on foot along a randomly selected transect line. A total of eight large and medium mammalian species were recorded. The species recorded were *Papio anubis*, *Sylvicapra grimmia*, *Tragelaphus scriptus*, *Chlorocebus pygerythrus*, *Tragelaphus strepsiceros*, *Lepus fagani*, *Phacochorus ethiopicus*, and *Panthera leo*. During the survey, the leading order recorded was Artiodactyla followed by Primates. In terms of relative abundance, Anubis baboon (28.4% and 28.1%) and common duiker (19.4% and 11.4%) were the most abundant species, while warthog (12.1% and 8.9%) and lion (0.7% and 0.4%) were the least abundant during the wet and dry seasons, respectively. The highest number of mammalian species were distributed in bushland habitat during both wet ( $n = 7$ ) and dry ( $n = 7$ ) seasons. The highest Shannon-winner diversity index and evenness were obtained in the bushland habitat (1.70 and 2.21) during wet and dry seasons, respectively. Though the forest is the living place for various wild mammalian species, the conservation measures of the local community should also consider those species in line with the efforts that have been done on forest management practices.

## 1. Introduction

Mammals are one of the most important components of biodiversity in the world [1]. The great impact of mammals on their environment is largely the result of the endothermic process that requires more energy [2]. According to Miller [3], medium- and large-sized terrestrial mammals develop important functions in the ecosystem, maintained by affecting plant population dynamics through herbivore and also as seed dispersal. According to Kingdon [4], Africa hosts the highest number and diversity of mammalian species in the world.

Over 1,150 species of mammals belonging to 13 orders and 50 families were recorded from Africa. Tefera [2]

described that Ethiopia is among the world leaders in terms of richness and endemism of mammalian species. Although there are some researches that have been conducted on the large mammalian diversity in various parts of the world, there is a lack of ample information in various parts of Ethiopia. Very few studies have been carried out in the present study area; mainly, studies were done related to the diversity of woody plants and human-wildlife conflict by Kuma [5] and Oyda [6], respectively. However, studies on the diversity and distribution of mammalian species and the ecology of other wildlife of the area have not yet been carried out. Hence, this study was done on the medium and large mammalian species diversity and their distribution in Humbo community-based forest area, Southern Ethiopia.

## 2. Materials and Methods

**2.1. Study Area.** Humbo community-based forest is located in Humbo Woreda, Wolaita Zone administration, Southern Nation Nationalities People Regional State (SNNPRS), Ethiopia, at about 420 km, 180 km, 31 km, and 12 km away from the capital city of the country Addis Ababa, Hawassa, Wolaita Sodo, and Humbo Tebela towns, respectively. The area is located in the Great Rift Valley. The annual average temperature and the total annual precipitation of the area are 22.15°C and 1123 mm, respectively. 15,000 hectare of the study area was cleared prior to the late 1960s because the poor farmers have exploited the denuded, unmanaged forest in the Humbo area as a source of income through the grazing of livestock, the sale of charcoal, the deforestation to meet household needs for fuel wood, and the cultivation of steep slopes to accommodate expanding population [7]. The study area was classified into three major vegetation zones; such as riverine forest (RF: a type of forest ecology most dominant along waterways), bushland (BL: a land which supports remnant vegetation), and open grassland (OGL: a land covered with wild grass).

**2.2. Methods.** Census zone with transect was established in all the three vegetation types. Following the preliminary surveys, identification and recording of medium and large mammalian species were made through direct observation with naked eyes and/or aided with binocular (7×50 mm). The survey was conducted during both dry (November–January) and wet (February–April) seasons on foot along the established transects, observing the existing mammals on the left and right sides of each transect and recorded with the wildlife data collection sheet.

A total of 15 transect lines, three for open grassland, ten for bushland, and the rest two for riverine forest, were established. The transects varying in distance from 1.5 km to 4 km and 50 m to 400 m distance within each transect were established depending on the vegetation cover and topography of the area (Table 1). Each transect was visited three times per season. The species identification of the mammals was based on the Kingdon Field to African Mammals [8]. Observations were done early in the morning from 07:00 to 10:00 h and late in the afternoon from 15:00 to 18:00 h, when most of the wild animals are active.

Diversity measures take into account both the number of species and how evenly distributed individuals in those species are across the whole community [2]. Records of mammalian species from all observers in each season were analyzed together by major vegetation types and thus adjusted to describe the biological attributes of the mammalian community of the study area. Thus, such measures as the number of species, the relative abundance of individuals, and the diversity of species (a combination of the richness and evenness) were taken into account during data analyses. SPSS software version 20 (Chi-square test) and Shannon-Wiener diversity index ( $H$ ) were used to analyze the data. The species evenness and diversity of mammals in each habitat type were also computed using the Shannon-Wiener

diversity index based on the formula indicated below: Shannon-Wiener diversity index ( $H$ ) and evenness ( $E$ ). Shannon-Wiener diversity index assumes that all species are represented in a sample species and calculated by the following formula:

$$H = -\left(-\sum P_i \ln p_i\right), \quad (1)$$

where  $H$  = Shannon-Weiner diversity index,  $P_i$  = fraction of individuals belonging to  $i^{\text{th}}$  species, and  $\ln$  = natural logarithm.

Evenness is a measure of relative abundance of different species making up the richness of an area by the following formula:  $E = H/H_{\text{max}}$ , where  $H_{\text{max}} = \ln S$  in which  $S$  = number of species.

## 3. Results and Discussion

**3.1. Results.** In this study, eight mammalian species were identified during both the wet and dry seasons in the three habitat types. The number of mammals identified in the riverine forest was 330 and 147, bushland 1474 and 848, and open grassland 494 and 355 during the wet and the dry seasons, respectively (Table 2). The recorded total number of medium and large-sized mammals was 2298 and 1350 during the wet and dry seasons, respectively. There was a great difference between mammalian abundance during the wet and dry seasons ( $p < 0.05$ ). The bushland habitat has a greater number of species ( $n = 1474$ ), followed by open grassland and riverine forest during the wet and dry seasons, respectively (Table 3).

The majority of the mammalian species in the area were Anubis baboon (*Papio Anubis*) ( $n = 653$  and  $n = 379$ ) followed by common duiker (*Sylvicapra grimmia*) ( $n = 446$  and  $n = 154$ ), bushbuck (*Tragelaphus scriptus*) ( $n = 344$  and  $n = 351$ ), vervet monkey (*Chlorocebus pygerythrus*) ( $n = 380$  and  $n = 197$ ), greater kudu (*Tragelaphus strepsiceros*) ( $n = 281$  and  $n = 134$ ), Ethiopian hare (*Lepus fagani*) ( $n = 108$  and  $n = 115$ ), Warthog (*Phacochoerus ethiopicus*) ( $n = 70$  and  $n = 28$ ), and lion (*Panthera leo*) ( $n = 16$  and  $n = 5$ ) during the wet and dry seasons, respectively (Table 4). The relative abundance of mammals in the riverine forest varied from 0–51.5 in the wet seasons and 0–63.3 in the dry season. While in the bushland, it was ranging from 0–33.4 and 0–38.3 in the wet and dry seasons, respectively. In the case of open grassland, it varied between 0–41.7 and 0–38.9 during the wet and dry seasons, respectively.

As indicated in Table 5, the diurnal mammals were identified and recorded by four orders, five families, and eight species. Of these, the order Artiodactyla ( $n = 4$ ) recorded the highest number followed by the Primates ( $n = 2$ ), Lagomorpha ( $n = 1$ ), and Carnivora ( $n = 1$ ) in the study area. The family Bovidae contained the highest number of species ( $n = 3$ ), followed by Cercopithecidae ( $n = 2$ ), while the remaining each of the families such as Suidae, Leporidae, and Felidae contained only a single species.

The species diversity index and evenness of the mammalian species between seasons on different habitat types of

TABLE 1: Length and width for randomly selected transects.

Habitats	Number of potential transects		Number of sample transects		Length and width of the transect (km)
Riverine forest	8		2		2 km × 0.4 km
Bushland	40		10		1.5 km × 0.1 km
Open grassland	12		3		3.5 km × 0.05 km
Total	60		15		

TABLE 2: Mammalian species in the three habitats during dry and wet seasons.

Common name	Habitat types							
	Riverine forest		Bushland		Open grassland		Total	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Vervet monkey	170	93	210	104	—	—	380	197
Common duiker	—	—	240	16	206	138	446	154
Ethiopian hare	—	—	—	—	108	102	108	102
Lion	—	—	16	5	—	—	16	5
Warthog	—	—	70	28	—	—	70	28
Bushbuck	—	—	164	236	180	115	344	351
Greater kudu	—	—	281	134	—	—	281	134
Anubis baboon	160	54	493	325	—	—	653	379
Total	330	147	1474	848	494	355	2298	1350
Mean	238.5		1161		424.5		1824	

TABLE 3: Relative abundance of mammalian species in the three habitat types.

Common name	Habitat type					
	Riverine forest		Bushland		Open grassland	
	Wet	Dry	Wet	Dry	Wet	Dry
Vervet monkey	51.5	63.3	14.2	12.3	—	—
Greater kudu	—	—	19.1	15.8	—	—
Common duiker	—	—	16.3	1.9	41.7	38.9
Ethiopian hare	—	—	—	—	21.9	28.7
Lion	—	—	1.2	0.6	—	—
Warthog	—	—	4.7	3.3	—	—
Bushbuck	—	—	11.1	27.8	36.4	32.4
Anubis baboon	48.5	36.7	33.4	38.3	—	—

the study area are indicated as follows: the open grassland (0.647 and 0.97), riverine forest (0.501 and 1.00), and bushland (0.790 and 0.82) habitats during the wet season, respectively. While during the dry season, the species diversity index and evenness among the habitat types were as follows: in the open grassland habitat 0.663 and 0.99, riverine forest 0.468, and bushland habitat 0.96, 0.805, and 1.06, respectively (Table 6).

#### 4. Discussion

The field evidence is indispensable for developing the conservation actions of the terrestrial mammal surveys [9]. The current survey identified eight mammalian species in the study area. Among those of the mammalian species, three were medium-sized (common duiker, Ethiopian hare,

and warthog), while the remaining were large-sized mammalian species (bushbuck, greater kudu, vervet monkey, Anubis baboon, and lion). The identification was undertaken on randomly selected sampling transects of the three different vegetation types of the area. The number of species recorded during this study is lower than expected. Likewise, different researches conducted similar studies in different parts of Ethiopia and came across relatively more precise estimation and overestimated findings by using similar study methods. For instance, Qufa and Bekele [10] recorded a total of 15 medium- and large-sized mammals from Lebu Natural Protected Forest, Southwest Showa; Kerorsa et al. [11] recorded 12 large- and medium-sized mammals in Wabe forest fragments, Gurage zone, and Getachew and Yihune [12] recorded 12 medium- and large-sized mammalian species at Mengaza communal forest, East Gojjam, Ethiopia. In contrary, the mammalian species diversity of the present study is too small compared with the findings of Gonfa et al. [8] that counted 28 mammalian species in Dati Wole National Park; Chanea and Yirga [13] counted 23 species in Borena-Sayint National Park, and Girma et al. [14] counted 19 at Wondo Genet Forest, Ethiopia. The dissimilarity of terrestrial mammals in different parts of the same country might be due to the difference in the mammalian and vegetation structure and anthropological impacts. The study conducted in diverse countries indicated that the recorded number of medium- and large-sized mammalian species was higher than the finding of the present study [15–17]. The reason for this alteration might be for the variation in the climate, seasonal consideration, sampling technique, and vegetation composition of the study areas.

In the present study, four orders of the medium- and large-sized terrestrial mammals, such as Artiodactyla, Primates, Carnivora, and Lagomorpha were recorded. This is consistent with the investigation of Qufa and Bekele [10] that recorded the same number and kind of orders in Lebu Natural Protected Forest. However, during this study, the leading order recorded was Artiodactyla followed by Primates, while the results of the survey in the Lebu Natural Protected Forest are vice versa. On the contrary, our finding is inconsistent with the study conducted by Woldegeorgis and Wube [18] in Yayu forest, southern Ethiopia, in which they recorded seven orders, that is different from the result of the present study.

During this study, the highest numbers of mammals were found in the bushland area, followed by open grassland, while riverine forest supported the least number of the animals. The possible reason for this distribution of mammalian species might be due to the availability of foraging resources and the stability of the area from human disturbance. Mekonen et al. [9] and Yimer and Yirga [19] reported

TABLE 4: The relative abundance of mammals during wet and dry seasons.

Mammals	Season			
	Wet		Dry	
	Number	Relative abundance	Number	Relative abundance
Vervet monkey	380	16.6	197	14.6
Greater kudu	281	12.2	134	9.9
Common duiker	446	19.4	154	11.4
Ethiopian hare	108	4.7	102	7.6
Lion	16	0.7	5	0.4
Warthog	70	3.0	28	2.1
Bushbuck	344	15.0	351	26
Anubis baboon	653	28.4	379	28.1
Total	2298	100	1350	100

TABLE 5: Abundance of mammalian species based on their taxonomic category.

Order	Family	Species name	Common name	Season	
				Wet	Dry
Artiodactyla	Bovidae	<i>Sylvicapra grimmia</i>	Common duiker	446	154
		<i>Tragelaphus scriptus</i>	Bushbuck	344	351
		<i>Tragelaphus strepsiceros</i>	Greater kudu	281	134
	Suidae	<i>Phacochoerus ethiopicus</i>	Warthog	70	28
Primates	Cercopithecidae	<i>Chlorocebus pygerythrus</i>	Vervet monkey	380	197
		<i>Papio Anubis</i>	Anubis baboon	653	379
Lagomorpha	Leporidae	<i>Lepus fagani</i>	Ethiopian hare	108	102
Carnivora	Felidae	<i>Panthera leo</i>	Lion	16	5

TABLE 6: Diversity indices of mammals in the three habitats during both seasons.

Habitat	Season	Number of species	Number of individuals	$H$	$H_{max}$	Evenness	1-D
RF	Wet	2	330	0.69	0.693	1.00	0.501
	Dry	2	147	0.66	0.693	0.96	0.468
BL	Wet	8	1474	1.7	2.08	0.82	0.790
	Dry	8	848	2.21	2.08	1.06	0.805
OGL	Wet	3	494	1.065	1.099	0.97	0.647
	Dry	3	355	1.087	1.099	0.99	0.663

that the resource abundance and their quality are the major factors of mammals to prefer one habitat over the others. Balakrishnan and Easa [20] asserted that the distribution and habitat association of large mammals determined in terms of their water and food requirements. According to this finding, the distribution of mammalian species during the wet seasons exceeded that of the dry seasons. The underlying reason behind this fact might be the nature and diversity of vegetation in the study area.

Regarding the relative abundance of mammals, the study revealed that Vervet monkey was the most abundant in the dry seasons, while greater kudu, common duiker, Ethiopian hare, lion, warthog, and bushbuck were totally absent in the riverine forest both during the dry and wet seasons. The common duiker comes next followed by bushbuck, Anubis baboon, greater kudu, Ethiopian hare, and warthog; while the least abundant mammal in the area was lion. Getachew and Yihune [12] described Olive baboon as the most abundant species during the dry and wet seasons, which is

different from the present result. The warthog is also the second least abundant mammals recorded in the present study from bushland habitat during both wet and dry seasons. In this study, area mammals were not distributed uniformly among the different habitat types, and their abundance significantly varies between seasons. Girma et al. [14] described that seasonal movement in search of the requirement of the resources is common in many terrestrial mammals. Although the forest is the living place for various wild mammalian species, there is a need for integrated conservation measures by various stakeholders including the adjacent communities with special consideration for the mammalian fauna of the forest area in line with the efforts put on the forest management practices.

## 5. Conclusion

The effective management of animal species is greatly improved by the accurate knowledge of population distribution



and abundance. Hence, abundance, species diversity, and distribution of diurnal mammals are the essential ecological information required for the population ecology. The study confirmed that there are higher numbers of mammals distributed in the bushland area, followed by open grassland, while riverine forest supported the least number of the animals. The finding also revealed that order Artiodactyla was the largest order while Bovidae was the largest family in the study area. Based on the species, the most abundant mammals were Anubis baboon, Bushbuck, and Common Duiker, while the rest such as vervet monkey, greater kudu, Ethiopian hare, warthog, and lion were the least abundant. For the conservation and the welfare of those terrestrial mammals of the area, there is a need for integrated conservation practice of the concerned governmental bodies with the local community. Thus, this research will be relevant as a baseline for the other scholars who are interested to investigate further other ecological and behavioral aspects of the species for their sustainable conservation.

### Data Availability

No data were used to support the study.

### Disclosure

The authors declare that this research did not receive specific funding from any fundraising organizations; however, it was performed as part of Master's thesis.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

### Acknowledgments

The authors would like to acknowledge the Department of Biology, Wolaita Sodo University, the staff of the Humbo Community Based Forest Area, the local communities, and local government officials for their help during data collection and provided information.

### References

- [1] M. R. Muchai, "Ishaqib in conservation: large mammal distribution. Abundance and habitat use," Report No. 2, National Museum of Kenya, Nairobi, Kenya, 2008.
- [2] M. Tefera, "Wildlife in Ethiopia: endemic large mammals," *World Journal of Zoology*, vol. 6, no. 2, pp. 108–116, 2011.
- [3] C. Micaela, T. Jeffrey, A. Laura, C. Sara, D. M. Silvia, and A. Mariana, "Using local ecological knowledge to improve large terrestrial mammal surveys, build local capacity and increase conservation opportunities," *Biological Conservation*, vol. 244, p. 108450, 2020.
- [4] J. Kingdon, *The Kingdon Field Guide to Africa Mammals*, p. 475, Academic Press, London, UK, 2003.
- [5] M. Kuma, "Diversity of woody plant species of gamuwa and oda forests of Humbo carbon project, Wolaita, Ethiopia: for conservation and management of forests," *International Journal of Biodiversity*, vol. 2016, Article ID 7930857, 8 pages, 2016.
- [6] S. Oyda, "Human-wildlife conflict in Humbo community managed forest area, Humbo district, Ethiopia," Ph.D. thesis, p. 86, Wolaita Sodo University, Wolaita Sodo, Ethiopia/Wolaita Sodo University, 2017.
- [7] World Vision Ethiopia, "Humbo reforestation carbon project. Project information document concept stage," 2006, <http://documents1.worldbank.org/curated/en/258081468031581179/pdf/34683.pdf>.
- [8] R. Gonfa, T. Gadisa, and T. Habtamu, "The diversity, abundance, and habitat associations of medium and large-sized mammals in Dati Wolele national park, western Ethiopia," *International Journal of Biodiversity and Conservation*, vol. 7, no. 2, pp. 112–118, 2015.
- [9] T. Mekonen, M. Yaba, A. Bekele, and J. Malcolm, "Food selection and habitat association of starck's hare (*Lepus starcki petter*, 1963) in the Bale mountains national park Ethiopia," *Asian Journal of Applied Sciences*, vol. 4, pp. 728–734, 2011.
- [10] C. A. Qufa and A. Bekele, "A preliminary survey of medium and large-sized mammals from Lebu natural protected forest, southwest Showa, Ethiopia," *Ecology and Evolution*, vol. 9, no. 21, pp. 12322–12331, 2019.
- [11] K. L. Kerorsa, A. Bekele, and S. K. Youm, "A Survey of large and medium-sized mammals in Wabe forest fragments, Gurage zone, Ethiopia," *International Journal of Avian and Wildlife Biology*, vol. 4, no. 2, pp. 32–38, 2019.
- [12] A. Getachew and M. Yihune, "Species composition and relative abundance of medium and large mammals in Mengaza communal forest, East Gojjam, Ethiopia," *Journal of Ecology and the Natural Environment*, vol. 10, no. 2, pp. 34–40, 2018.
- [13] M. Chanea and S. Yirga, "Diversity of medium and large-sized mammals in borena-sayint national park, south Wollo, Ethiopia," *International Journal of Sciences: Basic and Applied Research*, vol. 15, no. 1, pp. 95–106, 2014.
- [14] Z. Girma, Y. Mamo, and M. Ersado, "Species composition, distribution and relative abundance of large mammals in and around Wondo Genet forest patch, southern Ethiopia," *Asian Journal of Applied Sciences*, vol. 5, no. 8, pp. 538–551, 2012.
- [15] G. Bastos, O. Marçal-Júnior, and V. L. d. C. Brites, "Medium and large-sized mammals of a fragment of Cerrado in the Triângulo Mineiro region, Southeastern Brazil," *Bioscience Journal of Uberlandia*, vol. 30, no. 3, pp. 863–873, 2014.
- [16] M. J. Crawley, "The population Biology invaders," *Philosophical Transaction of the Royal Society of London, Series B*, vol. 314, no. 1167, pp. 711–731, 1986.
- [17] R. A. Ojeda, P. G. Blendinger, and R. Brandl, "Mammals in south American drylands: faunal similarity and trophic structure," *Global Ecology and Biogeography*, vol. 9, no. 2, pp. 115–123, 2000.
- [18] G. Woldegeorgis and T. Wube, "A survey on mammals of the Yayu forest in Southwest Ethiopia," *Ethiopian Journal of Science*, vol. 35, no. 2, pp. 135–138, 2012.
- [19] D. Yimer and S. Yirga, "Mammals of the maze national park, southern nations, nationalities and peoples regional state, Ethiopia," *SINET: Ethiopian Journal of Science*, vol. 36, no. 1, pp. 55–61, 2013.
- [20] M. Balakrishiman and P. S. Easa, "Habitat preference of large mammals in the Parambikulam wildlife sanctuary Karala, India," *Biological Conservation*, vol. 37, no. 3, pp. 191–200, 1986.