Article

Diversity, abundance, and habitat preferences of mammals in Godebe National Park, Amhara Regional State, Ethiopia

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Abstract

In Ethiopia, the number of protected areas is increasing mainly to conserve the biodiversity resources facing anthropogenic threats and thereby mitigate the ever-changing climate change and its effects. The study was conducted in Godebe National Park to assess the variety, distribution, abundance, and habitat preferences of wild mammalian species. A stratified random systematic sampling technique was employed to collect data using line transect across four major habitat types. Direct sighting and indirect indicators were used to identify mammalian species. The information was analyzed employing a spreadsheet and R software version 4.2. Fifteen mammalian species were identified under five orders and ten families. Carnivora was the family's richest order, whereas Bovidae was the species' richest family. Combretum-Terminalia Woodland was the species richest with the best diversity (H′ = 1.98) and evenness (J=0.73). The best similarity in species occurrence was between Combretum-Terminalia Woodland and Riverine habitats (S=0.75). *Chlorocebus aethiops* was the foremost abundant (relative abundance = 46.22%) followed by *Hystrix cristata* (17.78%), whereas the smallest amount abundant was *Erythrocebus patas* (0.44%). Godebe National Park is endowed with moderate wild mammalian diversity distributed in all four major habitat types. The foremost preferable habitat type was the riverine forest with the foremost abundance of *Chlorocebus aethiops*.

Keywords biodiversity resources; combretum-terminalia woodland; distribution; habitat types; protected areas.

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1 Introduction

Due to its wide range of altitudinal variation, 110 meters below sea level at Dallol to 4543 meters above sea level at Simien Mountains National Park, Ethiopia is home to a diverse array of species. The nation's varied environments support a variety of lives because of the elevation difference (Demos et al., 2014; Bryja et al., 2018; Melese et al., 2018; Gebrehiwot et al., 2019). Despite the fact that the growing human population and its associated requirements are causes of biodiversity loss (Lwin et al., 2021), protected areas have been

established and are being preserved. Since the creation of the first park (Awash) in 1966 until the present, there have been 27 national parks and 73 protected areas under different management regimes (Mengist, 2020). The establishment of new protected areas has led to an increase in newly reported species (Morán-Ordóñez, 2020; Yalden et al., 1996; Tefera, 2011). Endemism and the number of mammalian species increased from 277 (Mengist, 2020) to 280 (Morán-Ordóñez, 2020) with 31 endemics and 311 (Lavrenchenko and Bekele, 2017) with 55 endemics, as well as the number of protected areas, which increased from 9 to 27. Protected areas primarily provide two important functions: enjoyment and consequently, economic growth from ecotourism, biodiversity conservation, and climate change mitigation (Melese et al., 2018 and Procko et al., 2022).

Mammals are ecosystem engineers who can alter ecosystem architecture and functions as well as boost habitat variety and biodiversity (Lacher et al., 2019). Mammals are numerous and diversified; they are considered indicators of the health of the ecosystem and the suitability of the habitat, and they offer a safety net for other species (Roberge and Angelstam, 2004; Jones and Safi, 2011; Qufa and Bekele, 2019). The majority of mammals and birds considered potential umbrella species are large mammals, but invertebrates are now receiving more attention. Due to their proximity to human populations, conspicuity, and need for a vast home range, large mammals deserve special consideration in conservation management since they are undergoing deterioration (double the hazard that small mammals face) (Macdonald et al., 2013; Macdonald. 2019)

Identification of natural resources and their conservation status would facilitate the implementation of conservation strategies in an effective manner (Pollock, 2002). When developing or enhancing management methods for protected areas, managers and specialists rely heavily on the abundance and distribution of mammalian species. The ability to adapt to the climate, the availability of food, and predation all affect the habitat preferences of mammalian species, which vary among species, in space and time (season). To fully comprehend the variety and distribution in various environments, long-term studies or monitoring procedures should be developed and put into practice (Qufa and Bekele, 2019).

One of the newest protected areas created to preserve the nation's natural riches and lessen the consequences of global climate change is Godebe National Park. There hasn't been any research on mammalian species done yet because this national park is newly established. The local government and the organizations in charge of managing the park had a pressing need for scientific knowledge about the classification, abundance, and ecological preferences of mammalian species. The findings of the study will, therefore, serve as at least a wake-up call for future research projects and will strengthen the conservation and oversight activities of the national park.

2 Study area and Methodology

2.1 Study site

The "Godebe" National Park is located in the Amhara Region's West Armachiho District, in the West Gondar Administrative Zone, Geographically, it is situated between the latitudes of $13^0$12'20.51" and $13^0$23'18.10" N and the longitudes of $36^0$13'56.73" and $36^0$28'04.63" E, with an altitude between 718 m and 1229 m above sea level. It has a wooded forest area that is 18,987 acres large. Under the 'Kolla' agro-ecological zone is the woodland forest known as 'Godebe. The region receives 600-1100mm of yearly rainfall from June through August and experiences year-round temperatures between 38 and 48°C. According to Friis et al. (2010), classification of Ethiopia's vegetation, the forest communities in Godebe National Park fall under the Combretum Terminalia woodland and wooded grassland forest categories. The geography of the Godebe woodland forest is 54.52% plain, 31.87% sloppy, and 13.61% gorg fields. According to data from the Amhara

area Culture, Tourism, and Parks Development office. Eutric nitisols, chromic vertisol, and Orthic luvisols are the three main soil types in the region.

According to the West Armachiho District Office of Culture and Tourism, the park was home to big mammals like elephants, lions, and Greater kudu in the past few decades. But, because of serious anthropogenic pressures, it is difficult to see such wildlife simply.

2.2 Data collection

Cross-sectional field data collection was conducted during the dry season (February to April 2021). Because animal habitats are heterogeneous, it was necessary to stratify the research region based on vegetation types during the initial survey. There are four different strata: the Combretum-Terminalia Woodland, Acacia Woodland, Riverine Forest, and the Savanna.

By laying sample transects over the four stratified habitat categories, the stratified random sampling approach was utilized to gather data. According to the area coverage of each habitat type (Combretum-Terminalia Woodland = 8, Acacia Woodland = 4, Riverine Forest = 5, Savanna = 2), transect lines were laid up in proportion to that area. Based on the geography and ecosystems, a total of 19 transect lines with lengths ranging from 1.5 km to 6 km were established. The study area's transect lines were measured and located using a handheld GPS (Garmin 60).

Mammal species were identified through direct observation and the use of markers like footprints, faces, and sounds along the transect lines. At locations where mammals were observed, GPS data were taken. In the field, mammals were recorded using their regional names and afterward identified using other sources (Bolton, 1973; Yalden et al., 1996; Tefera, 2011; Kent, 2011; Gippoliti, 2020).

2.3 Analysis of data

Data were gathered, encoded, and then entered into MS Excel. The data were compiled into tables and graphs. Shannon-Wiener indices were used to examine the variety and evenness of mammalian species. The formula for the Shannon-Wiener index:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

where p_i = the percentage of individuals or the abundance of the i^{th} species expressed as a fraction of overall abundance and ln = log base n. H' = Shannon diversity index, S = the number of species. The Shannon-Wiener index value typically ranges from 1.5 to 3.5, with a few unusual occurrences surpassing 4.5 (Abie et al., 2021). The evenness was determined using the formula J =H′/H′max, where J = evenness, H′max = ln(S), and S is the total number of species. The range of values for J is 0 to 1, with a greater value indicating a more evenly distributed species. With the help of the Sorensen similarity index, which was calculated using the formula (Kent, 2011), Ss = 2a/2a+b+c, where Ss is Sorensen's coefficient (index), a is the number of species commonly found between habitats, b is the number of species found in the first habitat, and c is the number of species found in the second habitat, the similarity of the mammalian species composition was evaluated. The formula for calculating relative abundance is: R. abundance = n/N*100, where n is the total number of individuals of a certain species and N is the number of individuals that have been documented. The analysis was conducted using the R program version 4.2.

3 Results and Discussion

3.1 Mammalian species composition

Under five orders and ten families, fifteen mammalian species were identified (Table 1). The richest family belonged to the Order Carnivora, while the Bovidae and Cercopithecidae families had the highest species, with

four and three species, respectively. The two orders (Carnivora and Artiodactyla) contain the maximum number of species, which is in line with those of (Lemma and Tekalign, 2020; Abie et al., 2021, Gebo et al., 2021). According to Gonfa et al. (2015), the family Bovidae contained the greatest number of mammalian species and the order Carnivora was represented by the greatest number of families. Possible explanations for this resemblance include habitat or environmental parallels.

Table 1 Mammalian species composition and conservation status.

Order	Family	Scientific name	Common name	Conservation status
Artiodactyla	Bovidae	*Sylvicapra grimmia*	Common- duiker	LC
		Tragelaphus strepsiceros	Greater kudu	LC
		Ourebia ourebi	Oribi	LC
		Traglaphus scriptus	Common-bushbuck	LC
	Suidae	*Phacochoerus africanus*	Warthog	LC
Carnivora	Canidae	*Canis aureus*	Common jacal	LC
	Viverridae	*Civettictis civetta*	African civet	LC
	Felidae	*Panthera pardus*	Leopard	NT
	Hyaenidae	*Crocuta crocuta*	Spotted Hyena	LC
Primate	Cercopithecidae	*Chlorocebus aethiops*	Grivet/ Vervet monkey	LC
		Erythrocebus patas	Patas monkey	LC
		Papio anubis	Anubis baboon	LC
Rodentia	Histricidae	*Hystrix cristata*	Porcupine	LC
	Sciuridae	*Funisciurus spp.*	Squirrel	-
Tubulidentata	Orycteropodidae	*Orycteropus afer*	Aardvark	LC

LC=least concerned, NT= near threatened.

A single mammalian species covered the majority of the family. According to the baseline assessment report of the Amhara National Regional State Office of Culture, Tourism, and Parks Development, there were 21 mammals before the national park was established (Taju, 2022). The assessment report and this research findings varied by six types of mammals. There are two possible causes for this. First, due to safety and road accessibility issues, data collection for this study was done during a dry season. Mammals may leave the national park if the rainy season is missed and go to nearby ecosystems outside of it, such as Sinnar Abdereg forest, which is being protected using the participatory forest management (PFM) method with the aid of non-governmental groups. Second, not all locations where the baseline survey was carried out might not be incorporated into the National Park when it is constituted.

3.2 Diversity and distribution of mammalian species

The CombretumTerminalia Woodland had the highest diversity (H′ = 1.98) and evenness (J=0.73) among the four habitat types, as shown in Table 2 below, making it the species richest habitat type. The least variety and

evenness were found in the Riverine (H′ = 1.15 and J=0.42), whereas Savanna had the lowest species richness. The national park has medium diversity of mammals. Less variance in the elevation range is presumably the reason for this (data were recorded from 767 to 850 meters above sea level).

Table 2 Mammalian diversity and evenness in different habitats of the national park.

Habitat types	Number of species	Diversity (*H*′)	Evenness (*J*)
Combretum-Terminalia Woodland	14	1.98	0.73
Acacia Woodland	7	1.79	0.66
Riverine	10	1.15	0.42
Savana	4	1.55	0.57

The national park has 225 individual mammal species altogether, of which Combretum-Terminalia Woodland, Acacia Woodland, Riverine forest, and Savanna include 59, 22, 137, and 7 mammal species, respectively. Ten of the fifteen mammalian species were found in riverine environments, while 14 were found in Combretum Terminalia Woodland. This was due to the fact that the Combretum-Terminalia Woodland habitat type predominates in the national park as opposed to the riverine, which was likely because the data was taken during the dry season when water shortage was more severe. According to Agebo and Tekalign (2022), the distribution of mammalian species varied depending on the season, with the riverine habitat having the maximum number of species and woodland and grassland in the dry season. The total number of mammalian species in Lemma and Tekalign (2020) during the wet and dry seasons was 2298 and 1350, respectively.

The Combretum-Terminalia Woodland and Riverine habitats had the most similarity in species occurrences (S=0.75), and the Combretum-Terminalia Woodland and Savana had the lowest similarity (S=0.52) (Table 3). The difference in the number of species between the two environments may be the cause of this variation.

Table 3 Species occurrence similarity index between habitats.

	Sorensen similarity			
	Combretum-Terminalia Woodland	Acacia Woodland	Riverine	Savana
Habitats				
Combretum-Terminalia Woodland		0.66	0.75	0.52
Acacia Woodland			0.59	0.67
Riverine				0.53
Savana				

3.3 The abundance of mammalian species

The Grivet monkey (*Chlorocebus aethiops*) was the most prevalent species type of mammal followed by the Porcupine (*Hystrix cristata*), in the national park (46.22%). However, the Patas monkey, *Erythrocebus patas*, was the least frequent mammal in the national park (0.44%), followed by carnivore species including leopard, spotted hyena, and common jackal (Table 4). This is most likely a result of the nomadic lifestyle present there, which compels armed shepherds to kill carnivores in order to protect their domesticated livestock (Ayalew and Melese, 2024). This result was in line with (Lemma and Tekalign, 2020; Gebo et al., 2021) who found that the order Primate was the most numerous.

Table 4 Mammalian species abundance in each habitat type (CTW= Combretum-Terminalia Woodland, AW= Acacia Woodland, R= Riverine and S= Savana), R= relative.

Species	Habitat types				Total	R. abundance (%)
	CTW	AW	R	S		
Sylvicapra grimmia	1	1	2	1	5	2.22
Traglaphus scriptus	3	0	0	0	3	1.33
Tragelaphus strepsoceros	1	2	0	0	3	1.33
Ourebia ourebi	4	4	2	0	10	4.44
Phacochoerus africanus	6	4	3	2	15	6.67
Canis aureus	1	1	0	0	2	0.89
Civettictis civetta	1	0	3	0	4	1.78
Panthera pardus	1	0	1	0	2	0.89
Crocuta crocuta	1	0	0	1	2	0.89
Chlorocebus aethiops	8	0	96	0	104	46.22
Erythrocebus patas	1	0	0	0	1	0.44
Papio Anubis	2	0	17	0	19	8.44
Hystrix cristata	25	5	8	2	40	17.78
Funisciurus spp.	0	0	3	0	3	1.33
Orycteropu afer	4	5	2	1	12	5.33
Total	59	22	135	7	225	

Grivet monkeys and porcupines were the two mammals that were most prevalent in the national park. This is consistent with the findings of (Legese et al., 2019), who discovered that Grivet monkeys were the most numerous, followed by Colobus monkeys.

3.4 Mammalian species' habitat preference

The second most common mammalian species (*Hystrix cristata*) was primarily restricted to Combretum-Terminalia Woodland, despite the fact that Combretum-Terminalia Woodland was preferred practically by all mammalian species. The most numerous mammal order, *Chlorocebus aethiops*, a species kind of primate, loved the riverine habitat (Fig. 1). This might be because most wild mammal species require bathing and the area along rivers is suitable for primates as well as because there is a lack of water and most of them need it. Savana was the least preferred habitat type. This could be a result of increased exposure, difficulties with wild forest fires that make mammals vulnerable to attack, and a lack of food for browsers. Similar investigations carried out in Borena-Saynt National Park and Dati Wolel National Park revealed that the riverine environment is the second most abundant habitat after the forest and Erica woodland, respectively (Chane and Yirga, 2014;

Gonfa et al., 2015). It is likely that the riverine forests in the aforementioned cases are not situated in lowlands where there is a severe lack of water, as was the situation with our research location.

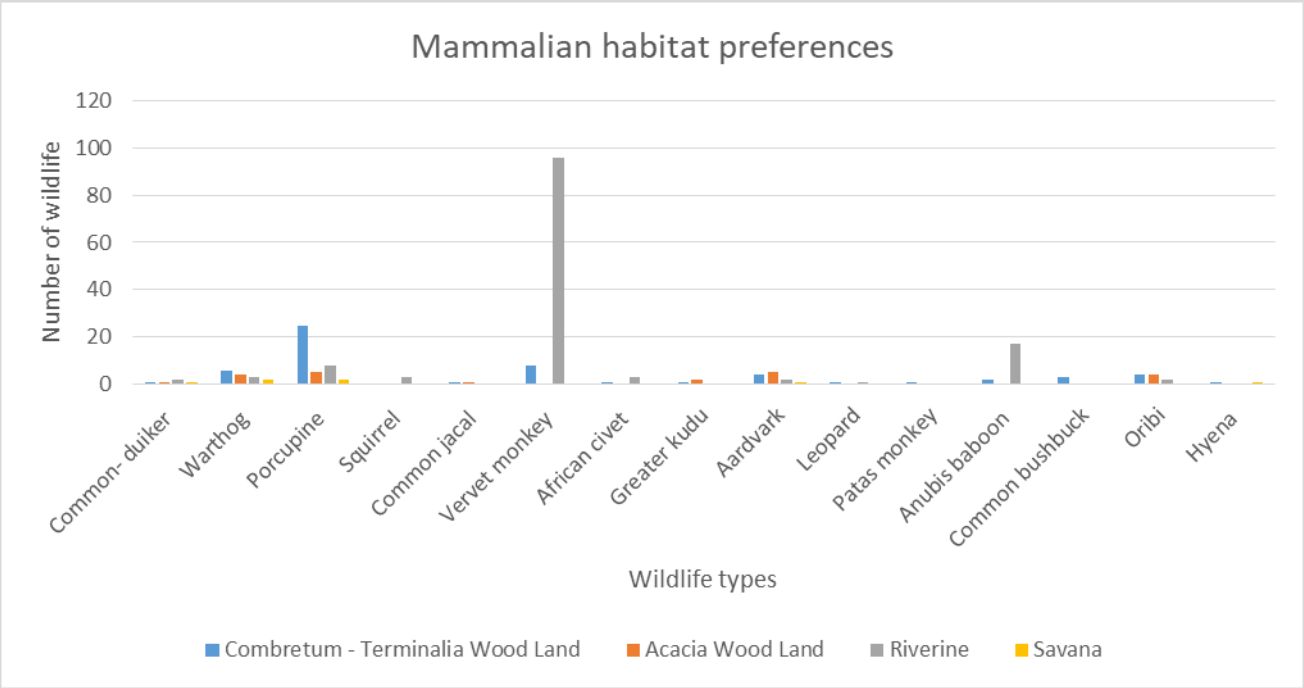

Fig. 1 Habitat preferences of mammals in the Godebe National Park.

4 Conclusions

The study implied that the national park is a potential site for biodiversity conservation and management to make the site for tourism and country development. Fifteen different mammalian species, ten families, and five different orders, totaling 225 individual mammal species, were identified. These species were dispersed over 4 different habitat strata, with riverine habitats having the highest species abundance. Rats were not recorded since they require special methods. The park has a moderate diversity of mammalian species spread over four main habitat types, with the Combretum Terminalia and riverine habitats having the highest habitat preferences. Since the national park is new, it is open to many types of research. The management of the national park is advised to apply this document to monitor and conserve the biodiversity resources. Researchers could use this research output for further research work in the area for small mammals and others as the national park is new. The work was limited to the dry season as the environment was totally challenging to carry out wet season data.

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