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The Diversity, Distribution and Relative Abundance of Medium and Large-sized Mammals in Baroye Controlled Hunting Area, Illubabor Zone, Southwest Ethiopia

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Abstract The diversity, distribution and relative abundance of medium and large-sized mammals were studied in the newly established Baroye Controlled Hunting Area, Southwestern Ethiopia. The study covers two seasons extending between January and September, 2014. Three habitats types, grassland, woodland, and riverine forest were identified in the study area. A line transect survey method was implemented to record the mammalian diversity. Of the 38 arbitrarily established transects, 11 (5 from the grassland and 3 each from the woodland and riverine habitats) were randomly selected and permanently surveyed for two seasons. Each transect was surveyed twice a month for three months per season. A total of 23 species of mammals from 7 orders and 13 families were recorded from the area. Only five species including the rock hyrax (*Procavia capensis*) and Bush hare (*Lepus fagani*) were from medium sized mammals. Among the 18 large sized mammals, the African buffalo (*Syncerus caffer*) was the most abundant. The leopard (*Panthera pardus*), lion (*P. leo*), African civet (*Civettictis civetta*), honey badger (*Mellivora capensis*) and black backed jackal (*Canis mesamolas*) were represented by few individuals. Riverine forest harbored the highest mammalian species ($H'=2.37$) followed by the woodland ($H'=2.23$) during the dry season. During the wet season, diversity was highest in the woodland ($H'=2.25$). The similarity of mammalian species between the riverine forest and woodland were very high during both seasons ($SI=0.66$), and least between riverine forest and grassland ($SI=0.38$). Owing to the high faunal diversities, upgrading the current controlled hunting area into higher protected area category will have immense significance to better conserve the unique ecosystem and faunal resource of the area.

Keywords Baroye controlled hunting; Mammals; Diversity; Distribution; Relative abundance

Introduction

The extensive central massifs in Ethiopian covers over 80% land area making it the largest continuous highland area in Africa. As a result, the fauna and flora in the Ethiopian highlands are unique that makes it one of the planets' diversity hotspots (Freilich et al., 2014). Of the over 300 species of mammals recorded from the country 31 are endemic (Largen, 2001) and the high level of endemism is attributed to the large extent of highlands. Over sixty percent of the recorded mammals are medium and large sized (Bekele and Yalden, 2014).

Following the priority plan of Ethiopian government (poverty reduction) and the fast growing economy of

the country in recent decades, attracted more national and international investors in agricultural sector. More investments in agrarian economy demands more fertile lands in most remote wilderness areas. Such activities inevitably affect wildlife. 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 (e.g. 21 National or regional Parks, 11 Wildlife Reserves, 3 Sanctuaries, 22 Controlled Hunting Areas and 69 Important Bird Areas) (Young, 2010), yet many are left unrecognized. Despite unique floral and faunal resources, the present study area is grouped under the later categories, only recently, the Oromiya Forest and Wildlife Enterprise

(OFWE) proposed it under controlled hunting area category. However, except for the few preliminary surveys conducted by OFWE, no attempt was made to systematically record the mammalian faunal diversity that is crucial both for the management (for assigning appropriate mammals for controlled hunting) (Wihart, 2004), or to document the faunal resource to recommend appropriate conservation strategies (Varman and Sukumar, 1995).

As also the experience of most protected area categories of Ethiopia, the medium and large-sized mammals of the 'Baroye Controlled Hunting Area (BCHA)' are facing challenges for the highest hunting pressure, habitat destruction for agricultural expansion, competition for resource with domestic animals and illegal encroachments. Medium and large-sized mammals are most vulnerable and intolerant for the slightest habitat changes, hence used as indicators for habitat quality and stability. The continual deteriorating trends of the status of wildlife in the protected areas are frightening. Unless serious management interventions are taken, the condition becomes very crucial when it comes to the new candidates to protected area categories like BCHA. In any cases, fast recording of the biological resources of the areas precedes and managerial and conservation measures. Therefore, the present study was aimed to record the medium and large-sized mammalian species of BCHA and to determine their association to the diverse habitats as a base line to catalogue the faunal diversity of the area.

1 Results

1.1 Species composition

During the present study, a total of 1 720 (965 and 755 during the dry and wet seasons, respectively) individual mammals distributed in 23 species, 13 families and 7 orders were recorded from Baroye Controlled Hunting Area (Table 1). Among these, only five species: Crested porcupine (*Hystrix cristata*), Vervet monkey (*Chlorocebus aethiopsis*), Bush hare (*Lepus fagani*), Rock hyrax (*Procavia capensis*) and White tailed mongoose (*Icheumia albicauda*) were considered medium-sized and the remaining were large-sized mammals. The African civet (*Civettictis civetta*) was indirectly recorded, using its scat. From all the recorded

families, Bovidae contributed the highest (five species), followed by Cercopithecini (four species) and Felidae (three species). While Suidae was represented by two species, the remaining families including Hystricidae, Leporidae, Procaviidae, Oryctestidae, Hyaenidae, Canidae, Hyrpestidae, Mustelidae and Viverridae were represented by one species each (Table 1).

Seasonal variations were observed in the mammalian species composition and number of individuals among habitats and between seasons. Accordingly, the highest number of species (17) was recorded in the riverine forest during the dry season and the least was from Grassland (10 species) during the dry season (Table 2). Likewise, the highest number of individual mammals (475) was recorded from the riverine forest during the dry season and the least (135 individuals) from the grassland habitat during the same season. Within habitat, the seasonal abundance of mammals was significantly vary for all habitats (grassland: $\chi^2=26.7$, 1 df, $P<0.05$; Woodland: $\chi^2=46.3$, 1 df, $P<0.05$ and Riverine forest: $\chi^2=48.0$, 1 df, $P<0.05$).

1.2 Mammalian species richness and evenness

Among the three habitat types, riverine forest supported the greatest diversity of mammals ($H' = 2.37$) during the dry season followed by woodland during wet season ($H' = 2.25$). The highest species evenness was obtained from woodland during wet seasons ($J = 0.85$) and riverine forest during dry season ($J = 0.84$) (Table 3).

1.3 Relative abundance of mammals

Among the 23 species of mammals recorded, African buffalo (*S. caffer*) was the most abundant species (contributing 24.24% and 22.07% individuals during the wet and dry seasons, respectively). With 21.72% (during the wet) and 20.73% (dry season), Olive baboon (*P. anubis*) was the second most abundant mammal, while Leopard (*P. pardus*) (with 0.13% and 0.52%) and Lion (*P. leo*) (0.26% and 0.41%) during the wet and dry seasons, respectively, were the least abundant species (Table 4).

Table 1 Medium and large-sized mammalian species recorded from Baroye controlled hunting area, Illubabor Zone, southwest Ethiopia

Order	Family	Common name	Scientific name	Identification methods	
Primate	Cercopithecii	Colobus monkey	<i>Colobus abyssinicus</i>	Visual	
		De brazza's monkey	<i>Cercopithecus neglectus</i>	Visual	
		Vervet monkey	<i>Chlorocebus aethiopsis</i>	Visual	
		Olive baboon	<i>papio anubis</i>	Visual	
Rodentia	Hystricidae	Crested porcupine	<i>Hystrix cristata</i>	Visual/spine	
Lagomorpha	Leporidae	Bush hare	<i>Lepus fagani</i>	Visual	
Hyracoidea	Procaviidae	Rock hyrax	<i>Procavia capensis</i>	Visual	
Tubulidentata	Orycterostidae	Aardvark	<i>Orycteropus afer</i>	Visual/hole	
Artidactyla	Bovidae	Common bushbuck	<i>Tragelaphus scriptus</i>	Visual	
		Common reedbuck	<i>Redunca arundinum</i>	Visual	
		Grey Duiker	<i>Sylvicapra grimmia</i>	Visual	
	Suidae	African buffalo	<i>Syncerus caffer</i>	Visual/faeces	
		Tora harte beast	<i>Alcelaphus buselaphus</i>	Visual	
		Bush pig	<i>Potamochoerus larvatus</i>	Visual/faeces	
		Warthog	<i>Phacochoerus africanus</i>	Visual	
		Hyaenidae	Striped hyena	<i>Hynae hynae</i>	Visual/faeces
			Viverridae	African civet	<i>Civetticivis civetta</i>
	Black backed jackal			<i>Canis mesamolas</i>	Visual
	Hyrpestidae		White tailed mongoose	<i>Icheumia albicauda</i>	Visual
	Mustelidae	Honey badger	<i>Mellivora capensis</i>	Visual	
		African wild cat	<i>Felis servestris</i>	Visual	
Felidae		Leopard	<i>Panthera pardus</i>	Visual/scat	
		Lion	<i>Panthera leo</i>	Visual /sound	

Table 2. Seasonal abundance (number of individuals counted) and distribution of mammals among different habitats in Baroye controlled hunting area, Illubabor Zone, southwest Ethiopia

Species	Grassland		Woodland		Riverine forest	
	Dry	Wet	Dry	Wet	Dry	Wet
<i>C. abyssinicus</i> (colobus monkey)	0	0	45	20	50	50
<i>C. neglectus</i> (De brazza's monkey)	0	0	3	5	15	11
<i>C. aethiopsis</i> (vervet monkey)	0	15	46	38	102	54
<i>p. anubis</i> (olive baboon)	34	68	84	44	82	52
<i>H. cristata</i> (crested porcupine)	0	8	4	0	12	7
<i>L. fagani</i> (Bush hare)	0	7	8	7	8	0
<i>P. capensis</i> (rock hyrax)	0	0	14	9	14	7
<i>O. afer</i> (aardvark)	6	10	5	6	0	5
<i>T. scriptus</i> (common bushbuck)	11	9	16	4	0	0
<i>R. arundinum</i> (Common reed buck)	9	11	6	0	0	0
<i>S. grimmia</i> (Grey Duiker)	6	6	9	5	0	0
<i>P. larvatus</i> (bush pig)	0	9	12	12	12	7
<i>P. africanus</i> (warthog)	0	0	0	0	18	13
<i>S. caffer</i> (African buffalo)	47	95	80	50	86	38
<i>A. buselaphus</i> (Tora harte beast)	11	14	7	0	0	0
<i>H. hynae</i> (striped hyena)	0	0	0	0	13	7
<i>F. servestris</i> (African wild cat)	5	3	9	0	10	8
<i>C. mesamolas</i> (blackback jackal)	0	0	7	4	14	5
<i>I. albicauda</i> (white tailed mongoose)	0	0	0	7	10	6
<i>M. capensis</i> (honey badger)	0	0	0	0	14	8
<i>C. civetta</i> (African civet)	0	0	0	8	12	0
<i>P. pardus</i> (leopard)	2	1	0	0	3	0
<i>P. leo</i> (lion)	4	2	0	0	0	0
Total No. of individuals per habitat	135	258	355	219	475	278
Total No. of species per habitat	10	14	16	14	17	15

Table 3 Diversity indices of medium and large sized mammals in different habitat types during dry and wet seasons

Habitat type	No. of Species		No. of individuals		SWI (H')		H 'max		H/ H 'max	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Grassland	10	14	135	258	1.87	1.92	2.30	2.63	0.81	0.73
Woodland	16	14	355	219	2.23	2.25	2.78	2.63	0.81	0.85
Riverine forest	17	15	475	278	2.37	2.16	2.83	2.70	0.84	0.8

Table 4 Relative abundance of medium and large sized mammalian species recorded in the study area during dry and wet seasons

Species	Total number of individuals recorded		Relative abundance (%)	
	Dry	Wet	Dry	Wet
<i>C. abyssinicus</i> (colobus monkey)	95	70	9.84	9.27
<i>C. neglectus</i> (De brazza's monkey)	18	16	1.87	2.12
<i>C. aethiopsis</i> (vervet monkey)	148	107	15.34	14.17
<i>p. anubis</i> (olive baboon)	200	164	20.73	21.72
<i>H. cristata</i> (crested porcupine)	16	15	1.66	1.99
<i>L. fagani</i> (Bush hare)	16	14	1.66	1.85
<i>P. capensis</i> (rock hyrax)	28	16	2.90	2.12
<i>O. afer</i> (aardvark)	11	21	1.14	2.78
<i>T. scriptus</i> (common bushbuck)	27	13	2.80	1.72
<i>R. arundinum</i> (Common reed buck)	15	11	1.55	1.46
<i>S. grimmia</i> (Grey Duiker)	15	11	1.55	1.46
<i>P. larvatus</i> (bush pig)	24	28	2.49	3.71
<i>P. africanus</i> (warthog)	18	13	1.87	1.72
<i>S. caffer</i> (African buffalo)	213	183	22.07	24.24
<i>A. buselaphus</i> (Tora harte beast)	18	14	1.87	1.85
<i>H. hynae</i> (striped hyena)	13	7	1.35	0.93
<i>F. servestris</i> (African wild cat)	24	11	2.49	1.46
<i>C. mesamolas</i> (blackback jackal)	21	9	2.18	1.19
<i>I. albicauda</i> (white tailed mongoose)	10	13	1.04	1.72
<i>M. capensis</i> (honey badger)	14	8	1.45	1.06
<i>C. civetta</i> (African civet)	12	8	1.24	1.06
<i>P. pardus</i> (leopard)	5	1	0.52	0.13
<i>P. leo</i> (lion)	4	2	0.41	0.26
Total	965	755	100%	100%

1.4 Occurrence of mammals

Of the 23 species of mammals recorded for the Baroye Controlled Hunting area, during this study, 9 species (39.13%) were common, 9 species (39.13%) were uncommon and 5 (21.74%) species were rare (Table 5).

1.5 Species similarity

Among the three habitat types, the highest mammalian species similarity was observed between woodland

and riverine forest both during the dry (SI =0.67) and wet seasons (SI =0.66) and followed by the species between grassland and woodland habitats (with SI values of 0.64 and 0.65 during the wet and dry seasons, respectively). However, with the SI value of 0.48 (during the wet) and 0.31 (during the dry season), mammalian species were least similar between grassland and riverine habitats.

Table 5 Occurrence of mammals in Baroye controlled hunting area, Ilubabor Zone, southwest Ethiopia

Common Name	Scientific Name	Occurrence
Colobus monkey	<i>Colobus abyssinicus</i>	Common
De brazza's monkey	<i>Cercopithecus neglectus</i>	Uncommon
Vervet monkey	<i>Chlorocebus aethiopsis</i>	Common
Olive baboon	<i>papio anubis</i>	Common
Crested porcupine	<i>Hystrix cristata</i>	Uncommon
Bush hare	<i>Lepus fagani</i>	Uncommon
Rock hyrax	<i>Procavia capensis</i>	Common
Aardvark	<i>Orycteropus afer</i>	Uncommon
Common bushbuck	<i>Tragelaphus scriptus</i>	Common
Common reedbuck	<i>Redunca arundinum</i>	Uncommon
Grey Duiker	<i>Sylvicapra grimmia</i>	Common
Bush pig	<i>Potamochoerus larvatus</i>	Common
Warthog	<i>Phacochoerus africanus</i>	Uncommon
African buffalo	<i>Syncerus caffer</i>	Common
Tora harte beest	<i>Alcelaphus buselaphus</i>	Uncommon
Striped hyena	<i>Hynae hynae</i>	Common
African wild cat	<i>Felis servestris</i>	Uncommon
Black backed jackal	<i>Canis mesamolas</i>	Rare
White tailed mongoose	<i>Icheumia albicauda</i>	Uncommon
Honey badger	<i>Mellivora capensis</i>	Rare
African civet	<i>Civetticitis civetta</i>	Rare
Leopard	<i>Panthera pardus</i>	Rare
Lion	<i>Panthera leo</i>	Rare

2 Discussion

The two season survey may not enough to completely record all mammalian resource in such a complex habitat like the Baroye Controlled Hunting Area. The 23 species of medium and large sized mammals during the present study, however, gives good picture for how rich the area was. In some instances, the mammalian species recorded for the BCHA was comparable to the mammalian diversity recorded from some well-established national parks in the country with similar ecosystem (e.g. Ayele, 2008 (unpublished); Girma et al., 2012; Woldegeorgis and Tilaye, 2012; Chane and Yirga, 2014; Gonfa et al., 2015). This indicates long-term studies by extending the study period and the sampling area may identify additional mammalian species.

The high diversity of mammalian species in the riverine forests and woodland during the dry season,

during this study, was expected because these are areas with fresh grass and other leafy plants closer to the perennial river mouths and wetlands associated with the major rivers. Unless the mid-dry season bush fire cleared the debris of dry grasses, finding sufficient fresh grass is difficult for mammals. Most species of mammals recorded for the present study area require water in daily basis (e.g. Yirga, 2008; Redfern et al., 2003), however, accessing surface water in grassland and part of woodland habitats was difficult during the dry season. Such tendency of mammals to favor one habitat over the others following the change in the abundance and quality of resources was also repeatedly reported (Smith, 1992; Mekonen et al., 2011; Yimer and Yirga, 2013). The over flooding of the major rivers and thick undergrowth, observed in the study area, during the wet season probably made the riverine and the majority of woodland habitats less

hospitable for mammals.

In abundance, the three primate species, the Olive baboon (*Papio anubis*), Vervet monkey (*Chlorocebus aethiopsis*) and Colobus monkey (*Colobus abyssinicus*) stood from the second to fourth level, respectively, in both seasons. They particularly favored the riverine and woodland habitats and Colobus totally absent from grassland. From their high reproductive success, the diversified foraging behavior (Johnson et al., 2012) and for the abundance of alternative prey species for carnivores, the abundance of these species was highly predicted. Studies from different localities, in Ethiopia, reported the abundance of these primate species in riverine and woodland habitats (Girma and Bekele, 2008; Fetene et al., 2011; Woldegiorgis and Tilaye, 2012).

During this study, some mammals including Leopard (*P. pardus*), Lion (*P. leo*), African civet (*C. civetta*), honey badger (*M. capensis*) and black backed jackal (*C. mesamolas*) were least abundant. Information from local informants, however, the former two big cats were abundant and occasionally predate livestock, lions blamed most. As the consequence, there was high human-lion conflict in the area and many lions were persecuted each year. The reason for the present record may be attributed to their cryptic nature and the demand for high home range. During this study the African civet was blamed for crop raiding, black backed jackals for predated sheep and goats, and honey badger for bee hive breaking. In Ethiopia, the least abundance records were common for these species in different localities (e.g. Chane and Yirga, 2014; Gonfa et al., 2015).

Mammals in the present study area show no uniform distribution among the three habitats. Hence, their abundance significantly varies among habitats between seasons. More mammals shift from grassland to the riverine and woodland habitats during the dry season. Such seasonal movement in search of resources conditions is common in mammals (Yaba et al., 2011; Girma et al., 2012).

Regarding species similarity among the three habitat types of the study area, the highest species similarity

was obtained from woodland and riverine forest both during the dry and wet seasons followed by grassland and woodland. The reason for the observed similarity may be because the resource and cover conditions of these two habitats are relatively similar to each other than either to the grassland habitat. The species similarity was relatively less between the riverine and grassland than the transitional woodland habitat. This record contradicts with the findings by Mengesha and Bekele (2008) and Gonfa et al. (2015) that report high mammalian species similarity between woodland and grassland habitat.

As short term conservation measures, delineating the mosaic borders, specifying appropriate species and setting law enforced quota for hunting may increase the importance of the area as a key wildlife area in the region. As long term conservation measures, however, the national wildlife conservation authority, based on the current and potential biological resources of the area, should design appropriate management plan to upgrade the current status to higher protected area categories with all the logistics and personnel are recommended to safeguard the ecosystem and the resources there in.

3 Materials and Methods

3.1 The Study Area

This study was conducted in Baroye Controlled Hunting Area, Oromia National Regional State, Metu District, southwest Ethiopia. BCHA is located between 36 P740000 and 770000 East and between 36 P928000 and 942000 North and covers an area of 335 km² (Figure 1). The altitude within the study area ranges between 1350 and 1811 m asl. The area is within the southwestern tropical forest best receiving about 1705 mm average annual rainfall (ranging between 1527 and 2015 mm). The average annual temperature of the area is 19.9 °C and shows little variation through the year (EMA, 2014). The area is characterized by rugged landscape dissected by perennial rivers including Sor, Geba, Offa and Chebel. Three habitat types Grassland (60%), Woodland (25%) and Riverine forest, are recognized in the study area, the latter being the smallest (15%).

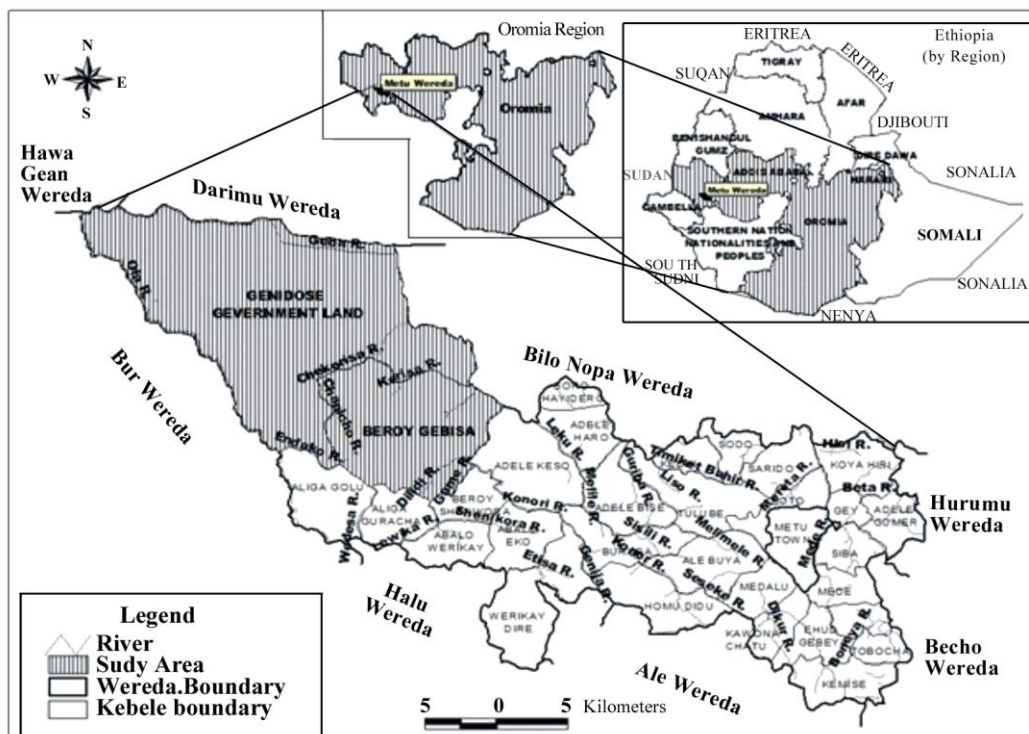


Figure 1 Map of the study area

3.2 Methods

Data to study the diversity, relative abundance, and habitat association of medium and large-sized mammals in Baroye controlled hunting area were collected from the three habitats through line transect survey (Varman and Sukumar, 1995; Sutherland, 2007). In rough proportion to the extent of the area, a total 38 line transect were arbitrarily established (18 on the grassland and 10 each on the woodland and riverine forests). The maximum length of transect in grassland was 3.2 km, 2.5 km for the woodland and 3.5 km for the riverine. Each transect was spaced at least by 2 km and the width of each was between 200 m (both for grassland and woodland) and 50 m (for the riverine). From the established transects, 11 (5 from the grassland, 3 each from the woodland and riverine habitats) were randomly sampled and permanently surveyed. Each transect was surveyed twice a month for three months in each season (from January to March, 2014, for the dry and between July and September, 2014, for the wet season). All line transects in a habitat were surveyed at the same time, two individuals per transect and twice in a day,

between 06:00 and 10:00 am in the morning, and between 16:00 and 18:00 pm in the afternoon.

All mammals observed along transect lines were identified, counted, sexed and age categorized. Observation was conducted with naked eyes or aided by binoculars (7x50 mm). Body size, pelage color, presence or absences of horn were used to determine sex and age (Kingdon, 1997; Yirga, 2008; Bekele and Yalden, 2014). Field guide to the African Mammals (Kingdon, 1997), Mammals of Ethiopia and Mammals of Eritrea and Ethiopia (Bekele and Yalden, 2014) were used for mammalian identification. Indirect records such as fecal droppings, calls, track survey for marks and prints, quills, holes, feeding signs were employed to record the presence or absence of mammals (Wilson et al., 1996; Silveira et al., 2003; Swihart, 2004). Indigenous people were also consulted for vernacular name, call and sign identifications.

During this study, using body weight as a basic feature, Emmons and Feer (1997) mammals in the study area were categorized in to medium-sized (those between 2

and 7 kg) and large sized (those over 7 kg body mass) mammals. According to this classification, mammals such as small carnivores and primates, large rodents, hyraxes, and pangolins are grouped under medium and most diurnal primates, carnivores larger than a fox or house cat, all perissodactyla and artiodactyls categorized under large sized mammals.

Shannon-Wiener diversity Index (H') ($H' = -\sum P_i \ln P_i$, where H' is Shannon index of diversity, P_i is the proportional of individuals of species in a sample) was used to compute diversity of mammals in the study area (Krebs, 1999). The evenness index (J) ($J = H' / H'_{max}$, where H' is observed index of diversity and $H'_{max} = \ln(S)$, where S is the number of species in a sample) was computed to determine the number of individuals of the mammalian species between habitats and seasons (Krebs, 1999). Species similarity between seasons and among the different habitats was determined using Simpson's similarity index (SI) ($SI = 2C / (A+B)$,) where C is common species in the habitats A and B . A is the number of species observed in habitat A and B is the number of species observed in habitat B (Simpson, 1949). Abundance of mammals was calculated as, Abundance = total number of individual species/ sample blocks (Brown, 1984). Chi-square (χ^2) was calculated for each test to determine whether the differences were significant. A mammalian species was labeled as common if the probability of seeing it was 100% every time during each survey or indirect evidences recorded once a day, uncommon if probability of seeing is more than 50% and/or evidence recorded once a week and rare if the probability of seeing it was less than 50% or only single recorded for the indirect evidences during the whole survey periods (Hillman, 1993).

Author's contributions

Author 1 and 2 identified the problem and prepared the proposal. The same authors also carried out the field data collection though more weight is given to author 1. All the three authors participated in the preparation of the first draft of the manuscript. The final version of the manuscript is done by author 2 and 3. All the authors have read the final version.

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