Large Mammals Diversity Assessment in Chilalo-Galema National Park, Ethiopia

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Abstract: A study on the assessment of species diversity of large mammals was conducted in Chilalo Galema Mountain in east Arsi administrative zone from February 2019 to September 2019. The aim of this study was to assess large mammalian species diversity and human-wildlife conflict in Chilalo-Galema Mountain National Park. Line transects and observation methods were used to collect data. Twenty six transect lines were laid, varied in length from 1.41km to 4.34km. Transect width ranged from 200m to 400m. In this study both primary and secondary data were used. Direct observation, body parts, vocalization and indirect evidences such as footprints, burrowing and droppings were used to collect data on diversity of large mammals. Observation and direct count of animals were made during 6:00-10:00 a.m. in the morning and 3:00-6:00 p.m. in the late afternoon when most mammals were active. Species diversity of large mammals was calculated using the Shannon-Weaver index of diversity. The evenness of mammalian species was calculated as J=H’/H’max where H’max=ln(s). 28 species that belong to seven Orders (Primates, Artiodactyla, Carnivora, Hyracoidea, Tubulidentata, Rodentia and Lagomorpha) were identified and recorded during the study. Out of the 252 recorded mammals 26 (10.08%) were order primates, 50 (19.38%) were order carnivora, 1 (0.39%) were order hyracoida, 6 (2.33%) were order tubulidentata, 164 (63.57%) were artiodactyla, 8 (3.10%) were rodentia and 2 (0.78%) were lagomorpha. Mammalian fauna of the Chilalo Galema Mountain was dominated by two groups of orders, the most abundant orders; namely, order artiodactyla and order carnivora, which contain 164 (63.57%) and 50 (19.38%) mammals respectively. The least abundant was order hyracoidean with 1 (0.39%) recorded mammal. So, Chilalo-Galema is rich in mammalian species diversity and needs conservation measures.

Keywords: Abundance, Assessment, Chilalo-Galema, Large Mammals, Species Diversity

1. Introduction

About 1,150 species of mammals were described and listed from the continent of Africa [1]. East Africa is rich in mammalian fauna. Ethiopia is widely acknowledged as having high rates of endemism across all taxa including mammals. Ethiopia is rich in animal diversity for instance it harbours about 861 species of birds, 284 species of mammals, 201 species of reptiles, 63 species of amphibians and 150 species of fish [2]. Among these, 31 species of mammals, 16 species of birds, 24 species of amphibians, 9 species of reptiles and 40 species of fishes are endemic. Out of 31 species of endemic mammals, five species are larger mammals and the rest are smaller ones [3]. However, these vary from place to place and season to season due to climatic and environmental factors [4]

Ethiopia is often known as ‘the roof of Africa’ due to its rugged topography mountainous environment. It is endowed with extensive and unique environmental conditions, ranging from the lowest altitude in Dallol depression which is 100 masl to the highest altitude at Ras Dashen which is 4620 masl [5]. The wide variety of habitats in Ethiopia, ranging from arid desert, open grassland and semi-arid savannas to highland diversity of cultures and ecology is further reflecting by forests and Afro-alpine moorlands, supports an exceptionally diverse fauna and flora. Ethiopia’s uneven topography and the varied climatic conditions have endowed it with impressive wildlife species. Ethiopia is the home to various endemic, endangered,
vulnerable and rare species [6]. Ethiopia is one of the biodiversity hotspot areas of Africa. Ethiopia is among the world's best biodiversity area in terms of richness and endemism of mammalian species. Ethiopia and Tanzania are among the top 25 endemic rich countries of the world in terms of higher vertebrate species whereas Ethiopia, Kenya, Uganda and Tanzania are individually among the world leaders in terms of richness and endemic of mammals. Those areas face many challenges due to growing population, borders conflict and drought. Mammals are often the first taxa to be listed for a site. Ethiopia contains largest concentration of large mammals within the national parks. However, complete inventory does not exist and endemism not well illustrated the species diversity for better management of biodiversity [6].

The wildlife population has been declining throughout the world at an alarming rate. This is mainly due to habitat destruction and expansion of agriculture [7-10]. This destruction is mainly pronounced in developing countries like Ethiopia. Ethiopia’s increasing human population has substantially fragmented the wildlife habitat as settlement and agriculture extends into the mountain leading to habitat destruction due to overgrazing by livestock. The Ethiopian high lands are among the most densely populated agricultural areas in Africa [11]. With expansion of human habitation, many wildlife populations have become restricted and isolated in National Parks. Small fragments of habitats exist outside protected areas; however, their significance in maintaining diverse groups of species in Ethiopia is poorly understood. Therefore, accurate population estimate of these diverse wildlife forms is an essential requirement for conservation efforts. An assessment of the conservation status of all known mammals was conducted by the International Union for Conservation of Nature and Natural Resources [12]. The IUCN Red List classifications of extinction risk have been used in numerous studies, including the identification of traits associated with high extinction risk [13-14] prediction of future species losses and prioritization of species for conservation action. However, an assessment of large mammalian species has never been carried out in Chilalo-Galema National Park until now to determine the conservation status. Therefore, the current study aimed at assessing the large mammalian species at Chilalo-Galema National Park.

2. Materials and Methods

2.1. Study Area

Arsi Mountains National Park was established recently in 2011. This Park is found in eastern and western Arsi zones. The Park is subdivided in to 4 Blocks. These are Dera-Dilfekar, Chilalo-Galema, Kaka and Honkolo blocks. Due to the presence of these blocks, the park has different agro-ecological zones. It has a total area of 931 km². Arsi Mountains National Park is about 114 km far away from the capital city Addis Ababa. Chilalo Galema Mountain block is found in the central part of the East Arsi Administrative Zone and lies between 7°28’ to 8°58’N latitude and 39°17’ to 39°28’E longitude (Figure 1). The block is located in the South Eastern part of Ethiopia. The total area of the block is about 792 km² this is the largest block from the rest of the 3 blocks. Before the establishment of the park it was used as priority forest conservation and controlled hunting area. Mount Chilalo-Galema is part of the Arsi Mountains comprising the second highest afro-alpine habitat in Ethiopia [15-16].
Mount Chilalo-Galema is about 3,300 masl. The average annual temperature is lessan 10°C while areas lessan 3, 300 masl show ranges from 10°C to 15°C. The maximum and minimum temperature is 25.9°C and 8.5°C respectively. The hottest and coldest months of the year are March and December respectively [17]. The annual rain falls range from 800 mm to 2000 mm [18]. The mountain is characterized by three vegetation zones and these are Erica forest, afro-montane and afro-montane forest which has been contributing for the survival of large mammals in the area.

2.2. Methods

Line transect method was used to collect data on the species of large mammals from the study area. Twenty six transect lines were laid, which varied in length from 1.41km to 4.34 km. Transect width ranged from 200 m to 400 m. Among 26 transect lines, ten transect lines were laid on Ericaceous forest habitat, six transect lines were laid on afro-alpine forest habitat and ten transect lines were laid on afro-montane (woodland) forest habitat. Each transect line was set at a distance of 500 m (0.5 km) from other transects to avoid double counting. Two rounds of observations of large mammals during the late dry season and early wet season were carried out from February 2018 to July 2019. A total of 67 km distance was covered during the study. Observation was carried out along the line transect against the direction of wind to minimize disturbances [19]. Direct observation method was used to identify and record large mammals in the study area.

2.3. Data Collection

The present assessment was conducted during dry and wet season which are suitable to get data on large mammals [20]. To assess large mammal species diversity, direct evidences include directly observing the animal, body parts and vocalization. Indirect evidences include observing footprints, burrowing and droppings [21]. During line transect survey, actual sightings of individual or group of animals or their signs such as droppings, footprints, vocalizations and dropped body structures such as spines for porcupine were recorded. Data collected from transect lines of similar habitats were pooled together for a particular habitat for analysis. Observation and direct counts of large mammals were made during 6:00 a.m to 10:00 a.m. in the morning and 4:00 p.m to 6:00 p.m. in the afternoon when most mammals were active in the study area. When mammals observed, instantly recorded with their local name and the scientific name was determined later with the help of the field guide book [22].

2.4. Data Analysis

Encounter rate was computed as the total number of encounters of a species (calls, spoors and droppings) per distance of transects walked (encounter rate) at the study area [23] and [24]. Thus,

\[ Ar = \frac{Tse}{Tlt} \]

where,

- Tse=total number of species encountered and
- Tlt=total length of transect walked

The Species diversity of large mammals in Chilalo-Galema Mountains was calculated using the Shannon-Weaver index.

\[ H = - \sum_{i=1}^{s} P_i \ln P_i = -NP_i \ln P_i \]

Where \( H \) is Shannon diversity index,

- \( P_i \) is the proportion (n/N) of the \( i \)th species in the habitat
- \( S \) is Number of species encountered
- \( \Sigma \) is sum for species 1 to species \( s \)
- \( ln \) is the natural logarithm
- \( N \) is Total number of individuals found and \( n \) is Number of one particular specie found

\( H \) is influenced both by number of species as well as by the evenness with which mammals are distributed with those species. Equal \( H \) values may thus be obtained if one habitat contains fewer and evenly distributed species of mammals [25].

The evenness of mammalian species was calculated as

\[ J = \frac{H}{H_{max}} \]

Where \( J \) is evenness of mammalian species,

- \( H \) is Shannon diversity index
- \( H_{max} = \ln(s) \)
- \( s \) is number of specie
- \( n \) is number of individual
- \( ln \) is the natural log

This measure varies between 1 (complete evenness) and 0 (complete unevenness). Chi-square (\( \chi^2 \)) was used to compare differences in abundance of mammal species between habitats and the overall significant difference in abundance of large-sized mammal species in the study area. SPSS computer program was used for Chi-square analysis to test the association of large mammal species and their habitats [26]. Simpson similarity index (SI) was also computed to assess the similarity among and between three habitats with reference to the composition of species.

\[ SI = \frac{3C}{I+II+III} \]

Where:

- SI=Simpson’s similarity index
- \( C \) is number of common species to all three habitat
- \( I \) is the number of species in habitat one
- \( II \) is the number of species in habitat two
- \( III \) is the number of species in habitat three
3. Results

A total of 28 species that belong to seven Orders were identified and recorded in Chilalo-Galema National Park, namely order Primates, Artiodactyla, Carnivora, Hyracoidea, Tubulidentata, Rodentia and Lagomorpha. The families under the above orders are listed in (Table 1).

| Order      | Family               | Common name      | Scientific name | Total observed | Relative abundance | Encounter rate |
|------------|----------------------|------------------|-----------------|-----------------|--------------------|----------------|
| Primates   | Cercopithecidae      | Anubis baboon    | Papio Anubis    | 13              | 0.19               | 0.19           |
|            | Grivet monkey        |                  | Cercopithecus aethiops | 7              | 0.1               | 0.1            |
| Colobidae  | Black-and-white colobus |                | Colobus guereza | 6               | 0.09               | 0.09           |
| Canidae    | Black-back jackal    |                  | Canis mesomelas | 4               | 0.06               | 0.06           |
| Mustelida  | Common jackal        |                  | Canis aureus    | *               | *                 | *              |
| Viverrida  | Zorilla               |                  | Ictonyx striatus | *               | *                 | *              |
|            | African civet         |                  | Civetictic civet | 2               | 0.03               | 0.03           |
| Carnivora  | Herpestidae          | Honey badger     | Mellivoracapensis | *               | *                 | *              |
|            | Mongoose/Egyptia      |                  | Herpestes inchneum | *             | *                 | *              |
|            | Spotted hyena         |                  | Crocuta crocuta  | 17              | 0.25               | 0.25           |
| Hyaenidae  | Aard wolf            |                  | Proctus cristiata | *             | *                 | *              |
|            | Caracal               |                  | Caracal caracal  | *               | *                 | *              |
| Felidae    | Leopard               |                  | Panthera pardin | 2               | 0.03               | 0.03           |
|            | Serval                |                  | Felis serval    | *               | *                 | *              |
| Hyracoidea | Procaviidae          | Ethiopian rock hyrax | Procavia habessinica | *          | *                 | *              |
| Tubulidentata | Orycteropodida   | Aardvark         | Orycteros afer  | 6               | 0.09               | 0.09           |
|            | Suidae                | Warthog          | Phacochoerus africanus | 48          | 0.72               | 0.72           |
|            | Bush duiker           |                  | Sylvicapra grimmia | 3              | 0.05               | 0.05           |
|            | Klipspringer          |                  | Oretagrus oreotagus | 12          | 0.18               | 0.18           |
| Artiodactyla | Bovidae             | Bohor reedback   | Redunca redunca | 70              | 1.04               | 1.04           |
|            | Bush buck             |                  | Tragelaphus scriptus | 2            | 0.03               | 0.03           |
|            | Menelik’s bush        |                  | Tragelaphus scriptus meneliki | 6        | 0.09               | 0.09           |
| Rodentia   | Hystricidae          | Porcupine        | Hystrix cristata | 8              | 0.12               | 0.12           |
| Lagomorpha | Leporidae             | Abyssinian hare  | Lepus capensis  | 2               | 0.03               | 0.03           |

*Indicate secondary data from Chilalo-Galema National Park

3.1. Large Mammalian Species Identified and Recorded in Chilalo-Galema National Park

Twenty-eight mammalian species were encountered during this assessment. The species identified, habitat types and methods of detection were given in (Table 2). Out of 28 mammalian species the presence of 19 (67.86%) species were confirmed through direct and indirect evidence while 9 (32.14%) species were recorded from secondary data sources of Chilalo-Galema National Park (Table 2).

| S.No | Common name     | Local name     | Scientific name     | Methods of identification | Habitat types |
|------|-----------------|----------------|---------------------|---------------------------|---------------|
| 1    | Mountain nyala  | Gadamsa baddaa | Tragelaphus buxtoni  | Observation               | Erc           |
| 2    | Bohor reedback  | Godaa          | Redunca reunca      | Observation               | Af-al         |
| 3    | Red duiker      | Kuruphee       | Cephalophus natalensis | Observation          | Af-mo         |
| 4    | Ethiopian wolf  | Jeeldala Dmintu | Canis simens         | Observation               |               |
| 5    | Porcupine       | Xaddee         | Hystrix cristata    | Spine, Burrow & footprint |               |
| 6    | Anubis baboon   | Jaldeessa      | Papio anubis        | Observation                |               |
| 7    | Warthog         | Gollajaa       | Phacochoerus africamus | Observation           |               |
| 8    | Leopard         | Qeeransa       | Panthera pardin     | Observation                |               |
| 9    | Menelik’s bush  | Borofa gurracha | Tragelaphus scriptus meneliki | Observation         |               |
| 10   | Black-back jackal | Sardiida dugda gurracha | Canis mesomelas   | Observation                |               |
| 11   | Monkey          | Qumalee        | Cercopithecus aethiops | Observation              |               |
| 12   | Abyssinian Hare | Illeetti       | Lepus capensis      | Observation                |               |
| 13   | Aardvark        | Awwaaligessa   | Orycteros afer      | Burrow & R                 |               |
| 14   | Bushbuck        | Bosoomu        | Tragelaphus scriptus | Observation                |               |
Bohor reedbuck was the most dominant species in the area and it is about 27.8% and followed by warthog about 19.1%. Totally 252 large mammals belongings to 28 species were recorded from three vegetation habitat types. About 28.97% mammals were recorded from ericaceous forest, 10.32% from afro-alpine forest and 60.32% from afro-montane (Woodland) forest were recorded (Table 3).

### Table 3. Observation site and large mammals recorded via direct and indirect methods in Chilalo-Galema National Park.

| S.No | Common name | Local name | Scientific name | Methods of identification | Habitat types | Erc | Af-al | Af-mo |
|------|-------------|------------|----------------|--------------------------|---------------|-----|-------|-------|
| 15   | Guerza      | Weenmi     | *Colobus guereza percula* | Observation             |               | 0   | 0     | 1     |
| 16   | Spotted hyena | Warabessa     | *Crocuta crocuta* | Observation             |               | 1   | 1     | 1     |
| 17   | Klipspringer | Gecii      | *Oreotragus oreotragus* | Observation             |               | 1   | 1     | 0     |
| 18   | Humorous Rock | Olool        | *Procavia habessinica* | Secondary data source    |               | 0   | 1     | 0     |
| 19   | Mongoose    | Amaa       | *Herpestes sanguine* | Observation             |               | 1   | 0     | 1     |
| 20   | Serval et   | Deeroo     | *Felis serval* | Secondary data source    |               | 0   | 0     | 1     |
| 21   | Zorilla     |            | *Ictonyx striatus* | Secondary data source    |               | 1   | 0     | 0     |
| 22   | Civet cat   | Moor’ee    | *Civettictis civetta* | Scent mark              |               | 1   | 0     | 1     |
| 23   | Caracal     | Warbaa     | *Caracal caracal* | Secondary data source    |               | 1   | 0     | 0     |
| 24   | Common jackal | Jeedala bakka maraa | *Canis aureus* | Secondary data source    |               | 1   | 0     | 1     |
| 25   | Honey badger | Amaa gaaguraa   | *Mellivoracapensis* | Secondary data source    |               | 0   | 0     | 1     |
| 26   | Mongoose/Egyptian | Amaa   | *Herpestes inconnun* | Secondary data source    |               | 0   | 0     | 1     |
| 27   | Aard wolf   |            | *Proteus cristatus* | Secondary data source    |               | 0   | 0     | 1     |
| 28   | Stark’s hare | Illletiti  | *Lepus starki* | Secondary data source    |               | 0   | 1     | 0     |
|      | Total       |            |                |                          |               | 13  | 9     | 20    |

*Habitat types code: Erc=Ericaceous habitat, Af-al=Afro-alpine habitat, Af-MO=Afro-Montane habitat, present=1, absent=0

### Table 3. Continued.

| Site of observation | Klipspringer | Monkey | Hare | Aardvark | Bushbuck common | Colobus black and white | Civet cat | Mongoose | Hyena | Total (N) |
|---------------------|--------------|-------|------|----------|-----------------|------------------------|-----------|----------|-------|----------|
| Tulu Negeso         | 0            | 0     | 2    | 0        | 0               | 1                      | 0         | 2        | 29    | 12       |
| Bora laku           | 2            | 0     | 1    | 0        | 0               | 0                      | 0         | 1        | 13    | 12       |
| Chilalo             | 0            | 7     | 0    | 2        | 1               | 6                      | 0         | 4        | 42    | 12       |
| Ukamsa              | 0            | 0     | 0    | 2        | 1               | 6                      | 0         | 4        | 82    | 12       |
| Chefé Gedemsa       | 0            | 0     | 1    | 0        | 0               | 0                      | 0         | 3        | 13    | 12       |
| Tulu saleni         | 0            | 0     | 0    | 0        | 0               | 0                      | 0         | 1        | 16    | 12       |
| Merar               | 3            | 0     | 0    | 0        | 0               | 0                      | 0         | 2        | 10    | 12       |
| Merar Chefe         | 0            | 0     | 0    | 0        | 0               | 0                      | 0         | 1        | 47    | 12       |
| Total               | 12           | 7     | 2    | 6        | 2               | 6                      | 2         | 6        | 252   | 12       |

3.2. Species Distribution and Abundance of Large Mammalian Species Recorded Through Direct and Indirect Observation Indifferent Study Sites in Chilalo-Galema National Park

The three habitat types (eight study sites) with their species type, number of individual species (n), Total number of all species observed (N), Pi, Pi^2 LnPi & PiLnPi are shown in (Table 4).
3.3. Diversity Indices of Large Mammalian Species in Chilalo-Galema National Park Block

A total of 28 large mammalian species were identified and recorded. Three habitat types Ericaceous forest, Afro-montane (Woodland) forest and Afro-alpine forest were represented by 8, 16, and 8 species respectively. Diversity indices ($H'$) and evenness ($J$) of large mammal species along the three habitat types were shown in (Table 6). Afro-montane (Woodland) forest had the highest diversity index (1.904) and evenness (0.686), thus afro-montane forest had the highest similarity occurrence between the three habitat types where 28.1% of the species were common for all 3 habitats. This indicated that 28.1% of the species were common for all three habitats. The highest similarity occurrence between

Table 4. Species type, number of each species (n), and total number of all species (N) recorded through direct and indirect observation method in three habitat types.

| Habitat type     | Study site                              | Species type         | n   | N   | n/N | $P_i$ | $P_i^2$ | ln($P_i$) | Piln$P_i$ | $H'(Index of diversity)$ |
|------------------|-----------------------------------------|----------------------|-----|-----|-----|-------|---------|------------|-----------|------------------------|
| Afro-montane     | Chilao Ukansa & Tulu Negeso             | Bohor reeduck        | 38  | 152 | 38/152 | 0.25  | 0.063  | -1.386    | -0.347   |                        |
|                  |                                         | Red duiker           | 2   | 152 | 2/152  | 0.013 | 0       | -4.343    | -0.056    |                        |
|                  |                                         | Porcupine            | 8   | 152 | 8/152  | 0.053 | 0.003  | -2.937    | -0.156    |                        |
|                  |                                         | Warthog              | 35  | 152 | 35/152 | 0.23  | 0.053  | -1.469    | -0.338    |                        |
|                  |                                         | Leopard              | 2   | 152 | 2/152  | 0.013 | 0       | -4.343    | -0.056    |                        |
|                  |                                         | Menelik's bush back  | 6   | 152 | 6/152  | 0.039 | 0.001  | -3.244    | -0.127    |                        |
|                  |                                         | Jackal               | 2   | 152 | 2/152  | 0.013 | 0       | -4.343    | -0.056    |                        |
|                  |                                         | Aardvark             | 6   | 152 | 6/152  | 0.039 | 0.001  | -3.244    | -0.127    |                        |
|                  |                                         | Civet cat            | 2   | 152 | 2/152  | 0.013 | 0       | -4.343    | -0.056    |                        |
|                  |                                         | Mountain nyala       | 9   | 152 | 9/152  | 0.059 | 0.004  | -2.83     | -0.167    |                        |
|                  |                                         | Mongoose             | 4   | 152 | 4/152  | 0.026 | 0.001  | -1.347    | -0.035    |                        |
|                  |                                         | Bush buck            | 2   | 152 | 2/152  | 0.013 | 0       | -4.343    | -0.056    |                        |
|                  |                                         | Hyaena               | 10  | 152 | 10/152 | 0.066 | 0.004  | -2.718    | -0.179    |                        |
|                  |                                         | Baboon               | 13  | 152 | 13/152 | 0.086 | 0.007  | -2.453    | -0.211    |                        |
|                  |                                         | Monkey               | 7   | 152 | 7/152  | 0.046 | 0.002  | -3.219    | -0.148    |                        |
|                  |                                         | Guereza              | 6   | 152 | 6/152  | 0.039 | 0.001  | -3.244    | -0.127    |                        |
|                  |                                         | Red duiker           | 1   | 73  | 1/73   | 0.014 | 0       | -4.269    | -0.059    |                        |
|                  |                                         | Ethiopian wolf       | 7   | 73  | 7/73   | 0.068 | 0.005  | -2.688    | -0.182    |                        |
|                  |                                         | Klipspringer         | 10  | 73  | 10/73  | 0.137 | 0.019  | -1.988    | -0.272    |                        |
|                  |                                         | Warthog              | 6   | 73  | 6/73   | 0.082 | 0.007  | -2.501    | -0.205    |                        |
|                  |                                         | Mountain nyala       | 12  | 73  | 12/73  | 0.164 | 0.027  | -1.808    | -0.296    |                        |
|                  |                                         | Bohor reed buck      | 32  | 73  | 32/73  | 0.438 | 0.192  | -0.826    | -0.361    |                        |
|                  |                                         | Mongoose             | 2   | 73  | 2/73   | 0.027 | 0.001  | -3.612    | -0.098    |                        |
|                  |                                         | Mountain nyala       | 2   | 73  | 2/73   | 0.074 | 0.005  | -2.603    | -0.192    |                        |
|                  |                                         | Warthog              | 7   | 73  | 7/73   | 0.259 | 0.067  | -1.35     | -0.349    |                        |
|                  |                                         | Jackal               | 1   | 27  | 1/27   | 0.037 | 0.001  | -3.296    | -0.121    |                        |
|                  |                                         | Abyssinia hare       | 2   | 27  | 2/27   | 0.074 | 0.005  | -2.603    | -0.192    |                        |
|                  |                                         | Ethiopian wolf       | 8   | 27  | 8/27   | 0.296 | 0.087  | -1.217    | -0.36     |                        |
|                  |                                         | Hyaena               | 5   | 27  | 4/27   | 0.185 | 0.034  | -1.687    | -0.312    |                        |
|                  |                                         | Klipspringer         | 2   | 27  | 2/27   | 0.074 | 0.005  | -2.603    | -0.192    |                        |

There were 16 species in Afro-montane habitat, eight species in ericaceous and 8 species in afro-alpine habitat. Between three habitats they have 3 species in common. Simpson’s similarity index ($SI$) of large mammalian species among three habitats (eight study site area) was 0.281. This indicated that 28.1% of the species were common for all three habitats. The highest similarity occurrence between

Table 5. Diversity indices ($H'$) and evenness ($J$) of mammals in Chilalo-Galema National Park.

| Habitat type     | Study site                              | Number of species (s) | Total number of species in habitat (N) | $-\Sigma P_i ln(P_i)$ | $H'(Index of diversity)$ | $J$ (evenness) |
|------------------|-----------------------------------------|-----------------------|----------------------------------------|----------------------|--------------------------|----------------|
| Afro-montane     | Tulu Negeso, Ukamsa and chilalo          | 16                    | 152                                    | -1.904               | 2.772                    | 1.904          | 0.686          |
|                  | Tulu saleni Merarie chef and Meraro     | 8                     | 73                                     | -1.57                | 2.079                    | 1.57           | 0.755          |
|                  | Boraluku and Cheffe gedemsa              | 8                     | 27                                     | -1.809               | 2.079                    | 1.809          | 0.87           |

Simpson similarity index (SI) of large mammalian species among three habitats (eight study site area) was 0.281. This indicated that 28.1% of the species were common for all three habitats. The highest similarity occurrence between
ericaceous against afro-alpine (0.625) and followed by ericaceous against afro-montane (woodland) (0.5). Whereas the lowest similarity occurrence (0.333) was between afro-
alpine against afro-montane (woodland). The Simpson’s similarity index of large mammals for three habitat types is given in (Table 6).

| Table 6. Simpson similarity index (SI) of large mammalian species among three habitat types. |
|---------------------------------------------------------------|
| Habitat (vegetation type) | Species number | Common species | Simpson’s similarity |
|--------------------------|----------------|----------------|---------------------|
| Ericaceous against afro-montane | 8 & 16 | 6 | 0.5 |
| Ericaceous against afro-alpine | 8 & 8 | 5 | 0.625 |
| Afro-montane against afro-alpine | 16 & 8 | 4 | 0.333 |

4. Discussion

In the current study about 16 species of large mammals were identified and recorded. The habitat types contributed a lot for the distribution of large mammals in the area. Predominantly there are three habitat types in the area namely, afro-alpine, afro-montane and ericaceous. Accordingly, 16 species were distributed in afro-alpine habitat, 8 species in afro-montane and 8 species in ericaceous.

The possible reason for this distribution of large mammalian species in the area may be due to the availability of sufficient resources such as food and water. The result of this study agrees with studies conducted in different areas both in Ethiopia and in other African countries where large mammals were abundantly distributed in different habitat types. For instance the current study agrees with the findings of [27] where he recorded 23 species in Arawale National Reserve, Kenya; [28] recorded 23 species in Sime Darby, Liberia; [29] recorded 19 species in Wendo Genet, Ethiopia, [30], recorded 25 species in Harena forest, Ethiopia, and [24] recorded 23 species in the moist semi-deciduous forest of Ghana.

The species of mammals detected through direct observation were mountain nyala (Tragelaphus buxtoni), bohor reedbuck (Redunca redunca), red duiker (Cephalophus natelesnis), Ethiopian wolf (Canis simensis), anubis baboon (Papio anubis), warthog (Phacochoerus africanus), Menelik’s bushback (Tragelaphus scriptus meneliki), black-back jackal (Canis mesomelas), Monkey (Cercopithecus aethiops), Abyssinian hare (Lepus capensis), bushback common (Tragelaphus scriptus), guereza (Colobus guereza percivali), spotted hyena (Crocuta crocuta), Leopard (Panthera pardus), mongoose (Herpestes sanguine) and klipspringer (Oreotragus oreotragus).

Nocturnal species such as civet cat (Civettictis civetta), aardvark (Orycteropus afer) and porcupine (Hystric crist) were detected through indirect evidences such as foot print, burrow, spine and scent marks. Secondary data source from Arsi Mountains National Park indicated the that there are also different species such as serval cat (Felis serval), zorilla (Ictonyx striatus), caracal (Caracal caracal), scrub hare (Lepus fagoiani), common jackal (Canis aureus), honey badger (Mellivora capensis), mongoose/Egyptian (Herpestes inchneunmon) and aard wolf (Proteles cristatus) were also observed and recorded in Chilalo-Galema National Park. Regarding the habitat type they are found in Ericaceous and woodland forest. Ethiopian wolf which is endemic and usually depend on prey rodents was found in Afro-alpine forest of the Chilalo Galema Mountains. This study agreed with [16] Chilalo-Galama Mountain they found the second largest population of the Ethiopian wolf next to the Bale Mountains with 572 km² of suitable habitat.

Order artiodactyl have two families (Suidae and Bovidae) and seven species warthog (Phacochoerus africanus), red duiker (Sylvicapra grimmia), klipspringer (Oreotragus oreotragus), bohor reedbuck (Redunca redunca), bush buck (Tragelaphus scriptus), Menelik’s bush (Tragelaphus scriptus meneliki) and mountain nyala (Tragelaphus buxtoni). Out of
the 252 recorded mammals in this study 26 (10.08%) were order primates, 50 (19.38%) belongs to order carnivora, 1 (0.39%) belongs to order hyracoidea, 6 (2.33%) belongs to order tubulidentata, 164 (63.57%) belongs to artiodactyla, 8 (3.102 and (0.78%) were rodentia and lagomorpha respectively. The current study indicated that the mammalian fauna of the Chilalo Galema Mountain (ChGM) was dominated by two groups of mammalian orders (the most abundant orders); namely, order artiodactyla and order carnivora, composed of 164 (63.57%) and 50 (19.38%) respectively. The least abundant was order hyracoidea 1 (0.39%) mammals. Endemic species like Mountain nyala (Tragelaphus buxtoni) and Menelik’s bushbuck (Tragelaphus scriptus meneliki)) belongs to order artiodactyla and Ethiopian wolves (Canis simensis) were also found in Chilalo Galema Mountains which is endemic to Ethiopia. From recorded 164 mammals of Order artiodactyla family Bovidae has 6 species that is 70 (42.68%) were bohor reedbucks (Redunca redunca), 23 (14.02%) was Mountain nyala (Tragelaphus buxtoni), 12 (7.32%) was Klipspringer (Oreotragus oreotragus), 6 (3.66%) was Menelik’s bush (Tragelaphus scriptus meneliki), 3 (1.83%) was Red duiker (Sylvicapra grimmia) and 2 (1.22%) was common bush buck (Tragelaphus scriptus meneliki), family Suidae has one species which is 48 (29.27%) was warthogs (Phacochoerus aethiopicus). This showed that the most dominant and abundant species in Chilalo Galema Mountains range was bohor reedbucks (Redunca redunca) and followed by warthogs (Phacochoerus africanus). This species appeared to be more concentrated in ericaceous forest and afro-montane (plantation) forest habitat. The species were more frequently observed during the mid-day and late afternoon. This might prevent the species from nocturnal predators.

Order tubulidentata has one family (Orycteropodidae) and one species (Orycteropus afer). Among mammalian species recorded in Chilalo Galema Mountains, aardvark (Orycteropus afer) was the only representatives of the Order Tubulidentata detected in the study area. Aardvark was a nocturnal animal and shelters during the day in deep burrows. The current study agrees with [34] that aardvark has been overlooked in Ethiopia due to its habits and shelters during the day in deep burrows. Order rodentia has one family (Hystricida) and one species (Hystrix cristata). Porcupine (Hystrix cristata) is a nocturnal mammal that belongs to order rodentia. Order hyracoidea has one family (Procaviidae) and one species, Ethiopian rock hyrax (Procavia habessinica). Order lagomorpha has one family (leporidae) and two species of abyssinian hare (Lepus capensis) and scrub hare (Lepus fagani).

During this study it was observed that the forest which serves wildlife as home, sources of food and other resources has been deforested, as a result the wildlife in the area would be at risk of local extinction, and wildlife conflict was also observed because animals raid crops. Thus, conservation measures will be taken by the local community as well as by the government to safeguard the mammalian species in the study area.

5. Conclusion and Recommendations

5.1. Conclusion

This study revealed that Chilalo Galema Mountains National Park is home for endangered and endemic mammals like critically endangered endemic Ethiopian wolf, endangered and endemic Mountain nyala and Menelik’s bushbuck. The present study also identified and documented mammalian species of Chilalo Galema Mountains National Park and gave base line information about their presence. The distribution and abundance of mammalian species in Park varied based on vegetation types and altitudinal variation. For example, guereza, anubis baboon, monkey, bushbuck, Menelik’s bush buck and leopard were frequently observed in woodland habitat. The numbers of large mammalian species recorded during the entire study period from Chilalo Galema Mountains forest were compared with several other studies conducted in Ethiopia and other African countries. The area harbors many large mammalian species, birds and other wildlife species. Therefore, it can be considered as important center for conservation of the wildlife species and used as tourist destination area.

5.2. Recommendations

Based on the findings of the current study the following recommendations were suggested:
1. The present study confirms that the Chilalo Galema Mountain forest contains rich diversity of mammals and hence its conservation and biodiversity documentation efforts should be considered critically
2. To conserve the wildlife in the park, threats such as encroachment, livestock grazing, grass cutting, environmental degradation, poaching and deforestation should be minimized.
3. To reduce human-wildlife conflict, using physical barriers such as fences and also buffer zones should be demarcated.
4. Promote community-based solutions to prevent and manage human-wildlife conflicts.

Conflict of Interest

Authors have no conflict of interest

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