ISSN 1996-3343

# Asian Journal of Applied Sciences

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Asian Journal of Applied Sciences 5 (5): 279-289, 2012
ISSN 1996-3343 / DOI: 10.3923/ajaps.2012.279.289


# Large Mammals and Mountain Encroachments on Mount Kaka and Hunkolo Fragments, Southeast Ethiopia

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## ABSTRACT

A study on large wild mammals, livestock and pack animals, settlement and agriculture was carried out in two afromontane habitat fragments; Kaka and Hunkolo from August, 2008 to March, 2009. In Kaka, the study area was stratified into four habitat types (afroalpine, *Erica*, agricultural land and Riverine forest) and in Hunkolo, three habitat types (afroalpine, *Erica* and agricultural land). A total of 18 species of large wild mammals were recorded in Kaka and 7 species in Hunkolo. These were: *Tragelaphus buxtoni*, *Tragelaphus scriptus*, *Oreotragus oreotragus*, *Tragelaphus scriptus meneliki*, *Phacochoerus africanus*, *Sylvicapra grimmia*, *Canis aureus*, *Felis serval*, *Crocuta crocuta*, *Redunca fulvorufula*, *Canis simensis*, *Lepus starcki*, *Lepus habessinicus*, *Panthera pardus*, *Herpestes ichneumon*, *Civettictis civetta*, *Genetta genetta* and *Orycteropus afer* in Kaka and *Sylvicapra grimmia*, *Canis aureus*, *Felis serval*, *Lepus starcki*, *Herpestes ichneumon*, *Genetta genetta* and *Orycteropus afer* in Hunkolo. The highest large wild mammal diversity was observed in the afroalpine (Diversity = 0.799) habitat in Kaka, whereas, in Hunkolo, this was in the *Erica* scrub (Diversity = 0.711). The lowest diversity was observed in the *Erica* (Diversity = 0.677) in Kaka and afroalpine (Diversity = 0.588) habitat in Hunkolo. Livestock was the most frequently sighted animal in both Kaka and Hunkolo. Settlements and agriculture were common up to an altitude of 3500 m above sea level. The highest human population density was 616 $km^{-2}$ in the lower altitudes which declines with increase in altitude.

**Key words:** Encroachment, Hunkolo, Kaka, livestock, wild mammals

## INTRODUCTION

More than 1,150 species of mammals are currently listed from Africa (Kingdon, 1971). East Africa is also rich in mammalian fauna, of which about 28% of the total mammal fauna constitute rodents (Clausnitzer, 2003). Ethiopia is widely acknowledged as having high rates of endemism across all taxa including mammals (Wilson and Reeder, 1993; Cole *et al*., 1993). So far, 284 mammalian species have been recorded from Ethiopia (Bekele *et al*., 1993; Cole *et al*., 1993; Bekele and Corti, 1997; Abune, 2000). Among these, 31 (11%) are endemic to the country (Hillman, 1993).

However, the wildlife population has been declining throughout the world at an alarming rate. This is mainly due to habitat destruction and expansion of agriculture (Idris *et al*., 2001;

Maan and Chaudhry, 2001; Gabol *et al.*, 2005; Gundogdu, 2011). 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 mountains leading to habitat destruction and overgrazing by livestock. The Ethiopian highlands are at present among the most densely populated agricultural areas in Africa (Evangelista *et al.*, 2007). With the expansion of human habitation, many wildlife populations have become restricted to and are 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. Limited number of investigation on the biodiversity of the area has been carried out on habitat fragments that lie between the Arsi and Bale mountains, Kaka and Hunkolo. These mountain peaks are known to support two endemic species of Ethiopia, the mountain Nyala and the Ethiopian wolf (Brown, 1969; Sillero-Zuberi, 2004). However, due to population explosion, livestock raring and cultivation of crops these fragments are prone to anthropogenic disturbance practiced decades ago that are evident even on the mountain peaks. The aim of the present study is therefore to gather information on the distribution and abundance of large wild mammals, livestock, settlement and agriculture in Kaka and Hunkolo fragments.

## MATERIALS AND METHODS

**Study area:** The present study was conducted on Mount Kaka and Mount Hunkolo (Fig. 1), located in Oromia Regional State of Ethiopia, about 269 and 285 kms southeast of Addis Ababa, respectively (APEDO/ABRDP, 2004). Mount Kaka is located between 39°0'0" and 39°15' 0" E

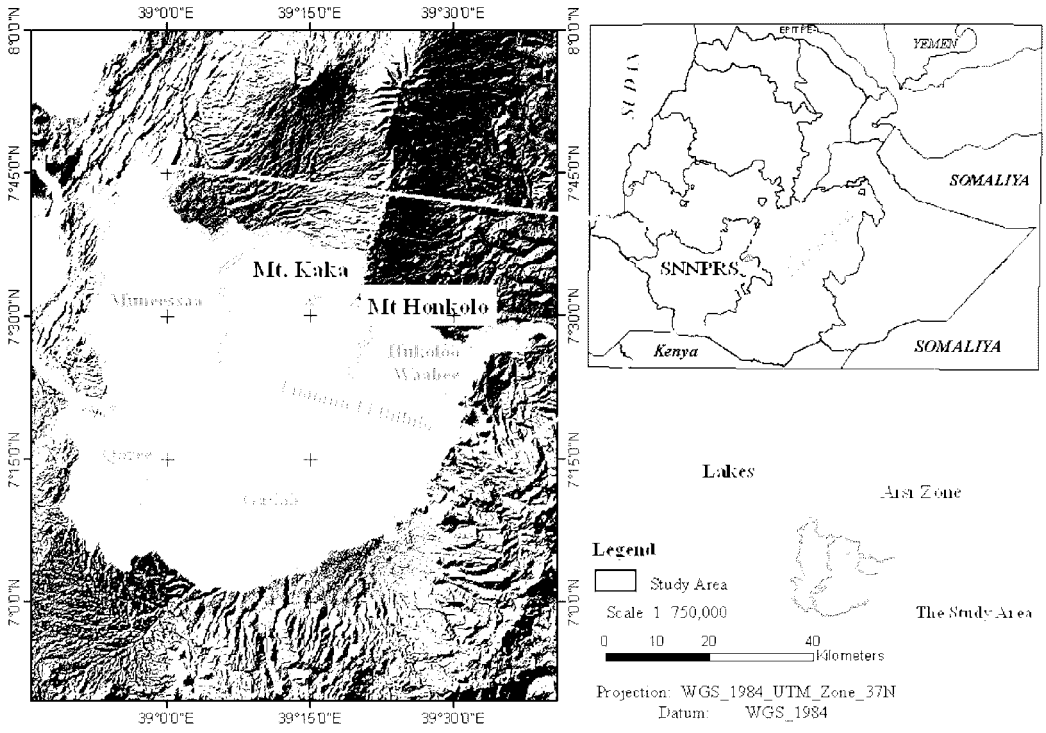


Fig. 1: Location map of Mount Kaka and Hunkolo, Ethiopia

longitudes and 7°15' 0" and 7°30' 0" N latitudes and covers 1442 ha. Mount Hunkolo is located between 39°15' 0" and 39°30' 0" E longitudes 7°15' 0" and 7°30' 0" N latitudes with coverage of 560 ha. Mount Kaka ranges in altitude from 3,146-4,217 m and Mount Hunkolo from 3,120-3806 m asl (EASE, 2002). Both the study areas are characterized by afroalpine vegetation at the higher altitudes, ericaceous vegetation at the middle and a few remnant afromontane forests at the lower altitudes. At Kaka, four habitat types with different altitudinal ranges were identified, viz., Afroalpine, *Erica*, agricultural land and Riverine forest while at Hunkolo, only three habitat types were identified (Afroalpine, *Erica* and agricultural land). Afroalpine habitats represent the areas greater than 3700 m asl in altitude. This habitat covers a considerably large part of Kaka while in Hunkolo, its extent is naturally diminished. It is characterized by sparse herb and shrub vegetation dominated by *Alchemilla* spp., *Helichrysum* spp. and the endemic *Lobelia rhynchopetalum* and some grass species which also form the vegetation type of afroalpine habitat of the adjacent Bale Mountains (Yaba *et al.*, 2011). The Ericaceous zone ranges from 3,200-3,700 m in elevation. This habitat type is dominated by *Erica trimera* shrub at higher elevations and *Erica arborea* at lower elevations. This is the most dominant habitat type in both Kaka and Hunkolo comprising about 70 % of the fragments. In the lower boundary of this zone, *Erica* is intermixed with other shrub and tree species such as *Hypericum revolutum* and *Rapanea simensis*. The upper limit of the ericaceous belt is interspersed with mosaic distribution of *Alchemilla* and *Helichrysum*. Historically, agricultural lands have been described as having dense cover of afromontane tree species such as *Hagenia abyssinica, Hypericum revolutum* and *Juniperus procera* (Brown, 1969; Hedberg, 1971; Miehe and Miehe, 1994). Presently the natural vegetation of these areas is reduced to remnant woody patches represented by rare and old trees of *Juniperus procera* in Kaka and *Hagenia abyssinica* in Hunkolo as most of these areas are dominated by agriculture and human settlement. An additional feature of Kaka area is the patches of remnant Riverine forests along Kechema, Ketar and Debulo rivers, with characteristic species of *Juniperus procera* and *Hagenia abyssinica* while Riverine forests are absent in Hunkolo.

Both the study areas fall under humid montane climate having bimodal rainfall during the long rainy season (June to end of October) and the second shorter rainy season (March to April). The temperature of the study areas is relatively cool with a mean annual maximum temperature of 19.5°C and minimum temperature of 4.6°C recorded at an altitude of around 3000 m. Data collection for the present study was carried out in August and September, 2008 for the wet season and January, February and March, 2009 for the dry season.

**Methods:** To estimate the abundance and distribution of large wild mammals, livestock and pack animals and human population, randomly located line transects stratified by each habitat were used. The length and width of transects varied based on the habitat type and accessibility. As a result, in the Afroalpine habitat, transects of a length 800 m and a width of 300 m were used while in the *Erica* habitat the transects had a length of 1000 m and a width of 200 m. In the Riverine habitat which is unique to Kaka, a transect length of 1200 m and width of 200 m were used. Identification and recording of large wild mammals and livestock were made by direct observation aided with binoculars. The identification and recording of large wild mammals was based on a field guide of Kingdon (1974). While walking quietly along each transects, any observed large wild mammal, species number, sex, distance of observations and GPS position were recorded. Surveys of the large wild mammals were carried out in the morning (07:00-11:00 am) and late afternoon (03:00-05:00 pm). Three days and nights were spent per session in each habitat and transect to

census the mammals. Each transect was visited six times per season to effectively estimate the abundance and distribution of both wild mammals and livestock. As far as possible, the observer traveled along transects against the direction of wind to minimize disturbance following Yimer (2008).

Indirect evidence such as fecal droppings, feeding mark, digging or territorial marking, animal parts and other tangible evidences as well as occasional direct observations were used to confirm the presence of nocturnal mammals. However, the abundance for nocturnal wild mammals was not estimated. To estimate the abundance and distribution of human population and livestock number within the settlement areas, three transects each with a length of 1000 m and a width of 500 m were used. Direct counting of the number of people and livestock was carried out in each household.

To determine the distribution of agriculture and the availability of the remaining natural habitat on both of the study areas, altitude of agricultural land on all sampled areas of the fragments was taken using GPS. In addition, direct observation of new areas converted to agriculture within the study period and areas ready to be converted to agriculture were recorded and estimated in terms of hectares.

**Data analysis:** SPSS software version 15.0 and Chi-square test, Simpson's diversity index (D) and Shannon-Weaver diversity index (H') were used to analyze the data.

## RESULTS

A total of 18 species of large wild mammals in Kaka and seven species in Hunkolo was recorded and identified. The recorded species were: *Tragelaphus buxtoni, Tragelaphus scriptus, Oreotragus oreotragus, Tragelaphus scriptus meneliki, Phacochoerus africanus, Sylvicapra grimmia, Canis aureus, Felis serval, Crocuta crocuta, Redunca fulvorufula, Canis simensis, Lepus starcki, Lepus habessinicus, Panthera pardus, Herpestes ichneumon, Civettictis civetta, Genetta genetta* and *Orycteropus afer* in Kaka and *Sylvicapra grimmia, Canis aureus, Felis serval, Lepus starcki, Herpestes ichneumon, Genetta genetta* and *Orycteropus afer* in Hunkolo.

There was variation in species composition and abundance of large wild mammals among different habitats of Kaka and Hunkolo fragments. In Kaka, the highest species number was recorded in afroalpine habitat. There were eight species per 4.8 km walked during the wet season and seven species during the dry season. *Erica* had six species per 6 km walked while Riverine had six per 7.2 km during the dry season. During the wet season, *Erica* had six species per 6 km walked while Riverine had seven per 7.2 km (Table 1). In Hunkolo, *Erica* had four species per 6 km walked and afroalpine three per 4.8 km during both dry and wet seasons (Table 2). In Kaka, more individuals of large wild mammals were recorded in the *Erica* habitat during the dry season (74 per 6 km walked) and the lowest number was recorded in the afroalpine habitat during the wet season (26 per 4.8 km walked) (Table 1). Similarly, in Hunkolo the highest number of individuals was recorded in the *Erica* habitat during the dry season (11 per 6 km walked) and the lowest in the afroalpine habitat during the wet season (6 per 4.8 km walked) (Table 2). The seasonal variation in abundance of individuals among seasons of afroalpine habitats of both Kaka ($\chi^2$ =1.328, df = 1, p = .249) and Hunkolo ($\chi^2$ = 0.600, df = 1, p = 4.39) was statistically insignificant. The seasonal variation in the *Erica* habitat was statistically insignificant in Hunkolo ($\chi^2$ = 0.889, df = 1, p = 0.346), but significant in Kaka ($\chi^2$ = 9.470, df = 1, p = 0.002). The seasonal variation in the abundance of individuals was statistically significant in the Riverine forest of Kaka ($\chi^2$ = 4.6 df = 1, p = 0.032). During the study period, among a total of 291 individuals of large wild mammals

Table 1: Seasonal abundance and distribution of large wild mammals from Kaka per the distance walked in each habitat

| | Abundance/season | | | | | |
|---|---|---|---|---|---|---|
| | Afroalpine (per 4.8 km walked) | | *Erica* (per 6 km walked) | | Riverine (per 7.2 km walked) | |
| Species | Wet | Dry | Wet | Dry | Wet | Dry |
| *T. buxtoni* | 8 | 15 | 25 | 30 | - | - |
| *T. s. scriptus* | - | - | - | - | 27 | 21 |
| *O. oreotragus* | 5 | 3 | 6 | 24 | - | - |
| *T. s. meneliki* | - | - | - | - | 22 | 12 |
| *P. africanus* | - | 6 | 5 | 12 | - | - |
| *S. grimmia* | 2 | 3 | - | - | 8 | 7 |
| *C. aureus* | - | - | 3 | 1 | 6 | 2 |
| *F. serval* | 3 | 2 | - | - | 2 | 2 |
| *C. crocuta* | - | - | 1 | 6 | - | - |
| *R. fulvorufula* | 4 | 2 | - | - | - | - |
| *C. simensis* | 2 | 4 | - | - | - | - |
| *L. starcki* | - | - | - | - | 2 | 2 |
| *L. habessinicus* | - | - | - | - | 2 | - |
| *P. pardus* | 1 | - | - | 1 | - | - |
| *H. ichneumon* | 1 | - | 1 | - | - | - |
| Total | 26 | 35 | 41 | 74 | 69 | 46 |
| No. of species | 8 | 7 | 6 | 6 | 7 | 6 |

Table 2: Seasonal abundance and distribution of large wild mammals from Hunkolo fragment per the distance walked in each habitat

| | Abundance/season | | | | |
|---|---|---|---|---|---|
| | Afroalpine (per 4.8 km walked) | | *Erica* (per 6 km walked) | | |
| Species | Wet | Dry | Wet | Dry | Total |
| *S. grimmia* | 4 | 5 | 2 | 2 | 1 |
| *C. aureus* | - | 3 | 3 | 4 | 10 |
| *F. serval* | 1 | - | 1 | 4 | 6 |
| *L. starcki* | - | - | 1 | 1 | 2 |
| *H. ichneumon* | 1 | 1 | - | - | 2 |
| Total | 6 | 9 | 7 | 11 | 33 |
| No. of species | 3 | 3 | 4 | 4 | 5 |

recorded in Kaka, 155 per 18 km walked (53.3%) were observed during the dry season and 136 per 18 km walked (46.7%) during the wet season (Table 1). On the other hand, only 33 per 21.6 km walked, individuals of large wild mammals were observed in Hunkolo during the whole study period. There were 20 per 10.8 km walked (60.6%) observed during the dry season and 13 per 10.8 km walked (39.4%) during the wet season (Table 2). The seasonal variation in abundance of individuals of large wild mammals was not statistically significant both in Kaka ($\chi^2$ =1.241, df = 1, p = 0.265) and Hunkolo ($\chi^2$ = 0.209, df = 1, p = 0.647).

The highest large mammal diversity was obtained at Kaka in the afroalpine habitat (D = 0.79) and at Hunkolo in the *Erica* scrub (D = O.711). Erica had the lowest diversity in Kaka (D = 0.67) while Hunkolo, afroalpine (D = 0.588) (Table 3). The highest species evenness was obtained in the afroalpine habitat in Kaka (E = 0.847) and in Erica habitat in Hunkolo (E = 0.939). On the other

Table 3: Diversity indices of large wild mammals from different habitats of Kaka and Hunkolo

| Habitat | Species No. | Individual No. | H' | $H_{max}$ | Evenness (E) | D |
|---|---|---|---|---|---|---|
| Afroalpine | 9 (5) | 61 (15) | 1.860 (1.179) | 2.197 (1.609) | 0.847 (0.732) | 0.799 (0.588) |
| *Erica* | 7 (4) | 115 (16) | 1.359 (1.301) | 1.946 (1.386) | 0.698 (0.939) | 0.677 (0.711) |
| Riverine forest | 7 | 115 | 1.479 | 1.946 | 0.760 | 0.714 |

Figures in brackets are from Hunkolo

Table 4: Seasonal abundance and distribution of domestic mammals from Kaka per distance walked in each habitat

| | Abnndance/season | | | | | | |
|---|---|---|---|---|---|---|---|
| | Afroalpine (per 4.8 km walked) | | *Erica* (per 6 km walked) | | Riverine (per 7.2 km walked) | | |
| Species | Wet | Dry | Wet | Dry | Wet | Dry | Total |
| Sheep | 155.0 | - | 199 | 32.0 | 120.0 | 59.0 | 607 |
| Cattle | 134.0 | - | 212 | 41.0 | 162.0 | 58.0 | 565 |
| Goats | 23.0 | - | 15 | - | 17.0 | 9.0 | 89 |
| Horse | 14.0 | - | 24 | - | 15.0 | 13.0 | 66 |
| Donkeys | 11.0 | - | 20 | - | 29.0 | 17.0 | 52 |
| Dogs | 3.0 | - | 0 | - | 0.0 | 0.0 | 3 |
| Total | 340.0 | 0 | 470 | 73.0 | 343.0 | 156.0 | 1382 |
| Percentage (%) | 24.6 | 0 | 34 | 5.3 | 24.8 | 11.3 | 100 |

Table 5: Seasonal abnndance and distribution of domestic mammals from Hunkolo per distance walked in each habitat

| | Abnndance/season | | | | |
|---|---|---|---|---|---|
| | Afroalpine (per 4.8 km walked) | | *Erica* (per 6 km walked) | | |
| Species | Wet | Dry | Wet | Dry | Total |
| Sheep | 227.0 | 37.0 | 197.0 | 114 | 575 |
| Cattle | 213.0 | - | 186.0 | 108 | 507 |
| Donkey | 23.0 | - | 18.0 | 6 | 47 |
| Horse | 16.0 | - | 9.0 | 5 | 30 |
| Dogs | 5.0 | - | - | - | 5 |
| Total | 484.0 | 37.0 | 410.0 | 233 | 1164 |
| Percentage (%) | 41.6 | 3.2 | 35.2 | 20 | 100 |

hand, the lowest species evenness was obtained in Kaka from the Erica Habitat (E = 0.698) and in Hunkolo, from the afroalpine habitat (E = 0.732).

During the study period, a total of 1379 individuals of livestock and pack animals per 36 km walked area were observed in Kaka and 1159 per 21.6 km walked in Hunkolo (Table 4, 5). Out of a total of 1379 observations in Kaka, 1150 (83.4%) were during the wet season and 229 (16.6%) during the dry season. While in Hunkolo, 889 (76.7%) were observed during the wet season and 270 (23.3%) during the dry season (Table 4, 5). The seasonal variation in abundance of livestock and pack animals was statistically significant both in Kaka ($\chi^2$ =615.113, df = 1, p = 0.000) and Hunkolo ($\chi^2$ = 318.579, df = 1, p = 0.000). In addition to the domestic animals dogs were rarely sighted in both Kaka and Hunkolo. There were only 3 dogs in Kaka during the wet season in the afroalpine habitat and 5 dogs in Hunkolo.

Settlement was widespread both in Kaka and Hunkolo. In Kaka, settlement extended up to an altitude of 3456 m asl in Koma kara (Table 6). Likewise, in Hunkolo, the peak elevation was

Table 6: Distribution and abundance of agriculture and settlement in Hunkolo

| | Altitude and No. of hectares | | | | | |
|---|---|---|---|---|---|---|
| Plot | Koma kara | Koma ketara | Koma hangera | Gesse biliblo | Koma walkite | Koje kaka |
| Peak of farmed land | 3468.0 | 3418 | 3263 | 3428.0 | 3210.0 | 3228.0 |
| Peak of settlement | 3456.0 | 3360 | 3223 | 3324.0 | 3183.0 | 3212.0 |
| Illegally cultivated land | 90.1 | 12 | 25 | 25.0 | 13.1 | 15.0 |
| Land converted to agriculture | 1.0 | 2 | 1 | 0.5 | 1.5 | 2.5 |

Table 7: Distribution and abundance of agriculture and settlement in Hunkolo

| | Altitude and No. of hectares | | |
|---|---|---|---|
| Plot | Lemu kara | Teje walkite | Sultana changicha |
| Peak of farm land | 3312 | 3340 | 3356 |
| Peak of settlement | 3286 | 3305 | 3320 |
| Illegally cultivated land | 44 | 112 | 66 |
| Land converted to agriculture recently | 0 | 8 | 0 |

recorded as 3320 m asl in Sultana Changicha (Table 7). The average human population, based on direct house to house count, living in an area of 0.5 $km^2$ was 308 in Kaka and 225 in Hunkolo. The average household size for Kaka was 5.8 and that of Hunkolo 5.1. The average livestock population per 0.5 $km^2$ area was: sheep 241.7, cattle 227.7 and goat 22 in Kaka. Similarly the average livestock population in Hunkolo per 0.5 $km^2$ area was: sheep 212.3 and cattle 136.7.

In Kaka, agriculture has extended up to an altitude of 3456 m asl in Koma Kara (Table 6). Likewise, in Hunkolo, the peak elevation was recorded at 3356 m asl in Sultana Changicha (Table 7). During the short study period, around 8.5 hectares of the Ericaceous belt in Kaka and 8 hectares in Hunkolo were converted to farmland (Table 6, 7).

## DISCUSSION

During the study period, a total of 18 species of large wild mammals were identified from Kaka and 7 species from Hunkolo. Similar surveys of 53 stands in 75.500 $km^2$ of wintering habitat of Houbara (*Chlamydotis undulata macqueenii*) in Balochistan (Pakistan) identified the presence of 20 mammal and 41 bird species (Mian, 2003). Nor *et al.* (2001) also recorded 27 non-volant small mammals from mountains of Malaysia. Furthermore, the result is comparable with the studies in different parts of Ethiopia; particularly, in areas of the similar altitudinal and ecological zonation. For example, in the Simien Mountains National Park, Dunbar (1978) recorded 12 species of large mammals and Bekele (1988) recorded 25 species of large mammals in the Harenna forest using similar line transect techniques. Even though, these two localities are highly fragmented, they still harbor high number of large mammals. Moreover, these areas were found to be homes for three endemic species and one subspecies of Ethiopia namely; *Tragelaphus buxtoni, Canis simensis, Lepus starcki* (Mekonnen *et al.*, 2011) and *Tragelaphus scriptus meneliki* that are all inhabitants of afroalpine habitats of Ethiopia. These localities are neither national parks nor protected areas and as a result, habitat degradation is immense. If these threats persist, it is likely that these species will disappear soon. At the same time, the transitional migration route/corridor for large mammals from Arsi to Bale is also likely to be affected. The lower number of species in Hunkolo is due to the severe degree of fragmentation and livestock encroachment. Studies have revealed that

fragmentation and livestock encroachment have adverse effects on the species composition and abundance of mammals in some areas (Haule, 1997; Nor *et al*., 2001; Busby, 2005; Bonnington *et al*., 2007).

The number of large wild mammals recorded during the dry season surpassed the number recorded during the wet season in both Kaka and Hunkolo. It is possible that the invasion of livestock, dogs and people during the wet season temporarily displaced wild mammals or perhaps caused them to become more cautious to be exposed. In addition, human activity such as collection of firewood and harvesting of grass was high during the wet season. Livestock encroachment was the cause for affecting the foraging opportunities of wild mammals, thereby reducing the sighting of wild mammals. Several studies in different localities have revealed the adverse effect of livestock encroachment and human settlement on the abundance and distribution of wild mammals (Stephens *et al*., 2001; Busby, 2005; Bonnington *et al*., 2007; Yimer, 2008).

The highest number of species in Kaka was recorded from the afroalpine habitat during the dry season. This may be due to the movement of large wild mammals from the *Erica* forest into the afroalpine belt. During the dry season, the *Erica* was drier than the elevated afroalpine because of less rain. At the same time, there was also least disturbance by people and livestock during the dry season in this habitat. Studies in different parts of Ethiopia have revealed similar patterns. Species diversity was high in areas where there was sufficient food and water source (Ayele, 2008; Yimer, 2008). In Hunkolo, the highest species record was among the *Erica* habitat. Since Hunkolo is a more disturbed and degraded area, large wild mammals were rare and the number of livestock was very high, even on the peaks. There is less afroalpine habitat on Hunkolo than on Kaka, hence less species diversity.

Livestock and pack animals were the most frequently sighted animals in both Kaka and Hunkolo. There was a statistically high significant seasonal variation in the abundance of livestock and pack animals in both Kaka and Hunkolo. The possible explanation is due to the extensive cultivation at lower altitudes during the wet season leading to the displacement of livestock and pack animals into the high altitudes. This helped to minimize the impact of livestock and pack animals on farmed areas and allowed the remaining lowland pastures to recover. As a result, livestock and pack animals were evident in every part of both Kaka and Hunkolo during the wet season. However, during the dry season, after crops were harvested, livestock and pack animals move to lower altitude. Seasonality in the abundance of livestock grazing had been observed by Stephens *et al*. (2001).

In addition to the livestock and pack animals, less number of dogs was also recorded from the fragments. The reduced number of dogs is mainly attributed to the degraded forest and open habitat. As revealed from wild mammal surveys, the number of carnivores was less compared to other similar localities like the Bale mountains. Locals use dogs to safeguard domestic animals from carnivores. Since the number of carnivores is less and at the same time the habitat is open, there was no need to accompany dogs as a safe guard from carnivores, hence only few dogs. However, in the Bale Mountains National Park, each settler is accompanied by a dog or dogs to keep their livestock especially from the frequent hyena predation.

Recently, settlement has increased as far as the peaks of both Kaka and Hunkolo. This was due to the need to have more land for cultivation. The increase in human population at the lower elevations has led to less space and limited employment opportunities. As a result, individuals look for higher elevations in search of new plots of land for cultivation. The human density was very high at the lower elevation (606 $km^{-2}$), leading to the expansion of settlement and agriculture at

the upper elevations. The threat is likely to continue leading to further fragmentation. Globally, livestock grazing, agriculture and human settlement are known to negatively impact the vegetation limiting the distribution of mammals (Al-Wadie, 2002; Subramanian *et al*., 2005; Dinakaran and Anbalagan, 2007; Hassani *et al*., 2008). Particularly in Ethiopia, the increased number of livestock in the lower elevation was also a major threat followed by their movement in the upper elevations, affecting the vegetation of the fragile mountain ecosystem (Nigatu and Tadesse, 1989; Wesche *et al*., 2000). According to Sillero-Zuberi (2004), barley farming was dominant up to an altitude of 3,600 m asl in Simien and 3,300 m asl in Bale and Arsi. More recently, Busby (2005), noticed crop cultivation at altitude of 3, 800 m asl in Simien, an increase of about 200 m altitude within a short time. Furthermore, it is estimated that over 60% of the Arsi plateau is under cultivation (APEDO/ABRDP, 2004). The present findings are consistent with these earlier studies.

## CONCLUSION

The study has revealed that the two habitat fragments are homes for diverse mammalian species including the endemics like the endangered Mountain Nyala and critically endangered the Ethiopian wolf. At the same time, since the areas are located between Arsi and Bale, they act as a main transitional migration route/corridor for large mammals. Despite the importance of the two localities as homes for the endangered and endemic mammals, they are not considered under legally protected areas. At the same time, livestock grazing, agriculture and human habitation are very evident in the areas, putting an enormous strain on the flora and fauna. There is a need for urgent conservation measures to save the area.

## ACKNOWLEDGMENTS

Our special gratitude goes to the Ethiopian Wolf Conservation Project for funding this study. We are also grateful to the Department of Biology, Addis Ababa University for providing facilities.

## REFERENCES

APEDO/ABRDP, 2004. Atlas of Arsi Zone. Arsi Zone Planning and Economic Development Office and Arsi-Bale Rural Development Project, Asella, pp: 1-35.

Abune, L., 2000. The challenges of conserving Ethiopian wildlife: Overview. Walia, 21: 56-62.

Al-Wadie, H., 2002. Floristic composition and vegetation of Wadi Talha, Aseer Mountains, South West Saudi Arabia. J. Biological Sci., 2: 285-288.

Ayele, S., 2008. Species diversity, distribution, habitat association and similarity of bird and large mammal fauna in Kore community area, Southern Ethiopia. M.Sc. Thesis, Addis Ababa University.

Bekele, A. and M. Corti, 1997. Forest blocks and altitude as indicators of *Myomys albipes* (Ruppel, 1842) Mammalia: Rodentia distribution in Ethiopia. Trop. Zool., 10: 287-293.

Bekele, A., 1988. A census of large mammals in the Harenna forest Ethiopia. SINET: Ethiop. J. Sci., 11: 27-39.

Bekele, A., E. Capanna, M. Corti, L.F. Marcus and D.A. Schlitter, 1993. Systematic and geographic variation of the Ethiopian *Arvicanthis* (Rodentia, Muridae). J. Zool., 230: 117-134.

Bonnington, C., D. Weaver and E. Fanning, 2007. Livestock and large wild mammals in the Kilombero valley, in Southern Tanzania. Afr. J. Ecol., 45: 658-663.

Brown, L.H., 1969. Observations on the status, habitat and behavior of the mountain Nyala *Tragelaphus buxtoni* in Ethiopia. Mammalia, 33: 545-597.

Busby, G., 2005. An expedition to the Simen Mountains, Ethiopia. The Lone Wolf Project. Retrived from http://www. Lonewolfproject.org.uk on April, 20, 2009.

Clausnitzer, V., 2003. Rodents of Mt. Elgon, Uganda: Ecology, biogeography and the significance of fire. Ecotrop. Monogr., 3: 1-7.

Cole, F.R., D.M. Reeder and D.E. Wilson, 1993. A synopsis of distribution patterns and the conservation of mammal species. J. Mammal., 75: 266-276.

Dinakaran, S. and S. Anbalagan, 2007. Effects of riparian vegetation on the functional organization of stream communities in southern Western Ghats. J. Aquatic Biol., 22: 25-31.

Dunbar, R.I., 1978. Competition and niche separation in a high altitude herbivore community in Ethiopia. Afr. J. Ecol., 16: 183-199.

EASE, 2002. Ethiopian agricultural sample enumeration: Results for Oromiya regional state. Statistical Report on Livestock and Farm Implements. Part IV. Ethiopian Agricultural Sample Enumeration, Addis Ababa, pp: 35.

Evangelista, P., P. Swartzinski and R. Waltermire, 2007. A profile of the mountain Nyala (*Tragelaphus buxtoni*). Retrieved from www.Africanindaba @ co za on December, 20, 2008, pp: 46.

Gabol, K., S. Mehmood, N. Yasmin, R.M. Tariq and R. Tabassum, 2005. Distribution, status of migratory and resident waterfowls of Drigh lake (Sindh) wildlife sanctuary. Int. J. Zool. Res., 1: 37-40.

Gundogdu, E., 2011. Population size, structure and behaviours of wild goat in cehennemdere wildlife improvement area. Asian J. Anim. Vet. Adv., 6: 555-563.

Hassani, N., H.R Asghari, A.S. Frid and M. Nurberdief, 2008. Impacts of overgrazing in a long term traditional grazing ecosystem on vegetation around watering points in a semi-arid rangeland of North-Eastern Iran. Pak. J. Biol. Sci., 11: 1733-1737.

Haule, K.S., 1997. Wildlife prospects in the Kilombero game controlled area, Tanzania. Traditional versus State Management Centre for International Environment and Development Studies, Noragric Agricultural University of Norway, Norway, pp: 109-123.

Hedberg, O., 1971. The high mountain flora of the Galama Mountains in Arussi Province. Ethiop. Webbia, 26: 101-127.

Hillman, J.C., 1993. Ethiopia: Compendium of Wildlife Conservation Information (CWCI). Vol. 1, Ethiopia Wildlife Conservation Organization, Addis Ababa, pp: 27.

Idris, A.B., A.D. Gonzaga, N.N. Zaneedarwaty, B.T. Hasnah and B.Y. Natasha, 2001. Does habitat disturbance has adverse effect on the diversity of parasitoid community? J. Biol. Sci., 1: 1040-1042.

Kingdon, J., 1971. East African Mammals: An Atlas of Evolution in Africa. Vol. I, Acadamic Press, London, Pages: 242.

Kingdon, J., 1974. East African Mammals: An Atlas of Evolution in Africa. Vol. II, Academic Press, London, pages: 252.

Maan, M.A. and A.A. Chaudhry, 2001. Wildlife Diversity in the Punjab (Pakistan). J. Biological Sci., 1: 417-420.

Mian, A., 2003. On biology of Houbara bustard (*Chlamydotis undulata macqueenii*) in Balochistan, Pakistan: Animal populations sharing habitat. J. Biological Sci., 3: 782-796.

Miehe, S. and G. Miehe, 1994. Ericaceous Forests and Heathlands in the Bale Mountains of South Ethiopia, Ecology and Man`s Impact. Koeltz Scientific Books, Germany.

Mekonnen, T., M. Yaba, A. Bekele and J. Malcolm, 2011. Food selection and habitat association of Starck`s hare (*Lepus starcki* Petter, 1963) in the Bale Mountains National Park, Ethiopia. Asian J. Applied Sci., 4: 728-734.

Nigatu, L. and M. Tadesse, 1989. An ecological survey of the vegetation of the Harenna forest, Bale, Ethiopia. SINET: Ethiop. J. Sci., 12: 63-93.

Nor, S.M., Z. Batin and Z. Akbar, 2001. Elevational diversity pattern of non-volant small mammals on mount Nuang, Hulu Langat, Selangor. J. Biol. Sci., 1: 1081-1084.

Sillero-Zuberi, C., 2004. Behavioral ecology of Ethiopian wolf (*Canis simensis*). Ph.D. Thesis, Oxford University.

Stephens, P.A., C.A. d'Sa, C. Sillero-Zubiri and N. Leader-Williams, 2001. Impact of livestock and settlement on the large mammalian wildlife of the Bale Mountains National Park, Southern Ethiopia. Biol. Conserv., 100: 307-322.

Subramanian, K.A., K.G. Sivaramakrishnan and M. Gadgil, 2005. Impact of riparian land use on stream insects of Kudremukh National Park, Karnataka state, India. J. Insect Sci., 5: 49-49.

Wesche, K., G. Miehe and M. Kaeppeli, 2000. The significance of fire for *Afroalpine ericaceous* vegetation. Mount. Res. Dev., 20: 340-347.

Wilson, D.E. and D.A. Reeder, 1993. Mammal Species of the World: A Taxonomic and Geographic Reference. 2nd Edn., Smithsonian Institution Press, Washington, D.C., pages: 2142.

Yaba, M., T. Mekonnen, A. Bekele and J. Malcolm, 2011. Food selection and feeding behavior of giant mole rat (*Tachyoryctes macrocephalus*, Ruppell, 1842) from the Sanetti Plateau of Bale Mountains National Park, Ethiopia. Asian J. Applied Sci., 4: 735-740.

Yimer, D., 2008. Mammahan diversity in mazie national park, Ethiopia. M.Sc. Thesis, Addis Ababa University, Addis Ababa.