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**Human Interaction in the Ethiopian wolf Habitats in
Arsi Mountains and Sanetti Plateau: A Comparative
Study**

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS -----	i
Table of contents -----	iii
List of tables -----	v
List of figures -----	vii
List of appendices -----	ix
ABSTRACT -----	x
1. INTRODUCTION -----	1
1. 1. LITERATURE REVIEW -----	3
2. OBJECTIVE -----	15
2. 1. General objective -----	15
2. 2. Specific objective -----	15
3. THE STUDY AREAS -----	16
3. 1. Arsi Mountains -----	16
3. 2. Bale Mountains National Park -----	20
4. MATERIALS AND METHODS -----	25
4. 1. Materials -----	25
4. 2. Methods -----	25
4. 2. 1. Preliminary study -----	25
4. 2. 2. Data collection -----	26
4. 2. 2. 1. Questionnaire survey -----	26
4. 2. 2. 2. Direct observation -----	27
4. 2. 2. 3. Data analysis -----	28
5. RESULTS -----	29
5. 1. Questionnaire survey -----	29
5. 2. Data analysis of direct observation -----	35
6. DISCUSSION -----	63
7. CONCLUSION AND RECOMMENDATIONS -----	73
7. 1. Conclusion -----	73

7. 2. Recommendations	74
8. REFERENCES	76
9. APPENDICES	

LIST OF TABLES

Table 1. Resource utilization of respondents in the study areas-----	30
Table 2. Respondents who grazed livestock and cultivated in the study areas-----	30
Table 3. Respondents who grazed livestock during the months of the year-----	31
Table 4. Respondents who grazed livestock during the day times-----	32
Table 5. Views of respondents on the current status of the Ethiopian wolf population-----	32
Table 6. Attitude of respondents towards the Ethiopian wolf -----	33
Table 7. Response of respondents on the Ethiopian wolf preying on livestock and sheep killed -----	34
Table 8. Response of respondents on the Ethiopian wolf affected by people-----	34
Table 9. Number of livestock grazed in the Ethiopian wolf habitats-----	36
Table 10. Number of domestic dogs recorded in the Ethiopian wolf habitats-----	38
Table 11. Number of people seen in the Ethiopian wolf habitats-----	40
Table 12. Number of individuals collected grass from the study sites -----	42
Table 13. Number of individuals collected firewood from the study sites -----	44
Table 14. Number of individuals produced charcoal in the study sites-----	46
Table 15. Number of Individuals kept livestock in the study sites -----	48
Table 16. Number of individuals walked through each transects in the study sites -----	50
Table 17. Number of individuals observed in the study areas for farming and marketing -----	51
Table 18. Response of people to the Ethiopian wolf in the study sites -----	53
Table 19. Ethiopian wolf distribution in each transect of the study sites -----	55
Table 20. Daily mean of number vehicles that crossed the Ethiopian wolf territory -----	61

Table 21. Mean flight distance of the Ethiopian wolf from humans -----62

LIST OF FIGURES

Figure 1. An adult Ethiopian wolf -----	4
Figure 2. Ethiopian wolf foraging giant mole rat in the Sanetti Plateau-----	7
Figure 3. Ethiopian wolf defecation in the Sanetti Plateau -----	9
Figure 4. Map of the study area (Chilalo-Galma Range) -----	16
Figure 5. Mean monthly maximum and minimum temperature of Chilalo- Galama Range during 1991- 2009 -----	18
Figure 6. Mean monthly rainfall of Chilalo-Galama Range during 1991- 2009 -----	18
Figure 7. Ethiopian wolf habitat in the Chilalo-Galama Range -----	19
Figure 8. Map of the study area (Sanetti Plateau, BMNP) -----	20
Figure 9. Mean monthly rainfall of Sanetti Plateau during 1998- 2009 -----	22
Figure 10. Ethiopian wolf habitat in the Sanetti Plateau -----	24
Figure 11. Ethiopian wolf standing and walking in its habitat -----	56
Figure 12. Estimated mean length of time the Ethiopian wolf spent for different activities during the presence of human -----	57
Figure 13. Estimated mean length of time the Ethiopian wolf spent for different activities during the absence of human-----	58
Figure 14. Estimated mean length of time the Ethiopian wolf spent for different activities during the presence of livestock-----	59
Figure 15. Estimated mean length of time the Ethiopian wolf spent for different activities during the absence of livestock-----	60
Figure 16. Vehicle crossing the Ethiopian wolf habitat-----	61

APPENDICES

Appendix I. Data sheet for questionnaire survey -----	86
Appendix II. Data sheet for direct observation of the Ethiopian wolf disturbance and behavior-----	89

ABSTRACT

A comparative study was carried out the disturbances by humans on the Ethiopian wolf (*Canis simensis*) in Chilalo-Galama Range and Sanetti Plateau during July, 2009- March, 2010. Factors disturbing the Ethiopian wolf were investigated using a questionnaire survey and by direct observations. Descriptive statistics, Spearman correlation coefficient, one-way ANOVA, Tukey and Chi-square tests were used to analyze the mean amount of factors disturbed the Ethiopian wolf and compared the differences existing among the 15 transects and four wolf packs. The analysis indicated that 62.7% and 100% of the Chilalo-Galama and Sanetti Plateau respondents, respectively had positive attitude towards the wolf. In the Chilalo-Galama, 488(99%) and in the Sanetti Plateau, 5(1%) of people were observed disturbing the wolves while collecting fuel, grass and herding livestock. On the other hand, 229.8 ± 149.67 and 92.93 ± 49.3 mean of livestock per transect foraged in the study areas during the wet and dry seasons, respectively. There was a significance difference in the amount of livestock grazed in the wolf habitats per transect ($F_{3,11} = 13.56$, $P < 0.001$), wet season and ($F_{3,11} = 3.96$, $P < 0.039$), dry season. There was a serious wolf disturbance by humans ($\chi^2 = 34$, df. 1, $P < 0.05$) in making noise and ($\chi^2 = 4$, df. 1, $P < 0.05$) in chasing after the wolf in the Chilalo-Galama than in the Sanetti Plateau. Therefore, due attention should be given to alleviate the problem.

Key words/phrase: Chilalo-Galama, Ethiopian wolf, human interaction, Sanetti Plateau.

1. INTRODUCTION

Ethiopia has high level of biodiversity and endemism because of the diverse habitats, altitude and climate that vary from desert to tropical and afroalpine habitats (Yalden and Largen, 1992; Marino, 2003). According to Yalden and Largen (1992), the country is a major habitat block, comprising a high degree of endemism in both fauna and flora. Until 10,000 years ago, the Ethiopian highlands were widely covered with afroalpine heathland and grassland (Gottelli *et al.*, 2004). The country possesses the fifth largest floral composition in tropical Africa (Shimelis Aynalem and Afework Bekeke, 2008). The flora of the country is estimated to include in excess of 7,000 plants. The higher plants of the Ethiopian Mountains are well studied as a result of collections made predominantly from Bale, Arsi and the Simien Mountains (Malcolm and Sillero-Zubiri, 1997). The fauna of the country is also highly diversified with 284 species of mammals, 926 species of birds (Shimelis Aynalem and Afework Bekeke, 2008), 201 species of reptiles, 64 species of amphibians and 145 species of fresh water fishes (Malcolm and Sillero-Zubiri, 1997; Mohammed Kasso, 2008).

Many of the endemic animals of the country are specifically associated with high altitude moorland and grassland habitats (Yalden and Largen, 1992; Tallents, 2007). There are 31 (11%) endemic species of mammals in Ethiopia. Out of them, 19 are hosted in the highland areas, mainly in the Bale Mountains National Park (BMNP). Many of these endemic species are shrews and rodents (Addisu Aseffa, 2007). Malcolm and Sillero-Zubiri (1997) reported that the country comprises 26 endemic birds. Of these, 15 occur in the high mountains. Ethiopia also has 24 endemic amphibians, with 50 % residing in the highlands of the country.

According to Boddicker *et al.* (2002), many mammalian species, especially which are indigenous to tropical forests are cryptic, discrete and inhabit areas that are not easily accessible. During the last glacial age, afroalpine habitats were widespread across the highlands of the country. A wolf like canid ancestor is thought to have colonized this expanding habitat and given rise to a new species that was remarkably well adapted in the afroalpine environment. This endemic species is described as, the Ethiopian wolf (*Canis simensis* (Rüppell, 1835) (Gottilli *et al.*, 2004). The wolf used to occur at lower elevations before becoming subject to severe human persecution (Nowak, 1999). It is an afroalpine specialist with a restricted distribution in the high elevations (Zeleelem Tefera and Sillero-Zubiri, 2007). It is also considered as the world's rarest Canidae and qualified as a critically endangered species in the Red Data Book of IUCN (Sillero-Zubiri, 1996).

In Ethiopia, little attention is given to study the biodiversity of the country. Many of the high altitude adapted species of the country flourished in this vast mountain massif with high levels of endemism (Gottilli *et al.*, 2004). Fewer than 500 adult Ethiopian wolves survive in seven isolated mountain enclaves, where they feed exclusively on the abundant grass rats and mole rats (Malcolm, 1997; Marino, 2003). Although the Ethiopian wolves are solitary hunters, they live in family packs with a complicated social organization (Zeleelem Tefera and Sillero-Zubiri, 2007).

The main purpose of this study is to conduct a comparative investigation on the disturbances made by humans in the Sanetti Plateau of BMNP and currently unprotected Arsi Mountains (Chilalo-Galama Range), its effectiveness on the population and behavior of the Ethiopian wolf.

1. 1. LITERATURE REVIEW

The family Canidae is one of the most widely distributed families of the Order Carnivora. Members of this family occur in many places of all continents except Australia and Antarctica (Eisenberg, 1989). The richest diversity of this family reflects the success of the species (Hunt, 1996). The members of this family show a wide variety of behavioral and ecological adaptations. Their social systems vary from loose pairs to large packs occurring in almost each habitat, from desert to tropical rainforests, and high altitude to Arctic pack ice. They demonstrate a considerable intra-specific variation in social structure, habitat use and food preference. They also show differences in body size and reproductive parameters under different ecological conditions (Nowak, 1999). Canid species exhibit strong flexibility to environmental constraints. This makes them potentially strong competitors with many species (Johnson *et al.*, 1996).

The family Canidae is composed of 16 recent genera (Nowak, 1999) and 37 species (Moehlman, 1989). Of these, the Ethiopian wolf is one of the rarest and critically endangered species that occurs only in a few mountain ranges of the Ethiopian highlands (Sillero-Zubiri, 1996; Yalden *et al.*, 1996). The Ethiopian wolf is remarkably distinct from other canid species in the country. It has a medium body size, relatively longer legs and unique and beautiful reddish coat. It also possesses white markings around neck, tail, chest and between the two legs (Sillero-Zubiri and Gottelli, 1994; Sillero-Zubiri *et al.*, 1996) (Fig. 1).



Figure 1. An adult Ethiopian wolf (Photo: Alemayehu Edossa, 2009).

Even though the Ethiopian wolf is the most distinct canid species, it has certain common features with other species such as side-striped jackal, the South American zorros, grey wolf of North America and Europe and coyote of North America compared to African canids (Wayne and Gottelli, 1997; Zelealem Tefera and Sillero-Zubiri, 2007). The species closely resembles the grey wolf. There are two sub-species; *Canis simensis simensis* and *Canis simensis citernii*. *C. simensis simensis* occurs on the north western part of the Rift Valley. *C. simensis citernii* dwells in the southeast of the Rift Valley in Bale and Arsi Mountains (Yalden and Largen, 1992; Mace and Sillero-Zubiri, 1997).

The different names of the Ethiopian wolf include: Abyssinian wolf, Simen or Simenian fox, red fox, Simen or Simenian jackal, Ethiopian jackal and red jackal. Throughout the country, it is known by its Amharic name, Ky kebero and Walgie and its Afaan Oromo name, Jedalla farda and Jedella deemtu (Sillero-Zubiri and Macdonald, 1997). Like other *Canis*, the male Ethiopian wolves are significantly larger than the females (Dayan and Simberloff, 1996). In the BMNP, the male wolves are 20% larger than the females in body mass. Adult male has a mean weight of 16.2 kg and female has 12.8 kg (Sillero-Zubiri and Gottelli, 1994).

The species is unique among canids in which the population lives in separate and cohesive social packs (Swihart *et al.*, 1988; Marino, 2003). The maximum size in a pack is 3- 13 containing 3- 8 adult males, 1- 3 adult females, 1- 6 yearlings (juveniles) and 1- 6 pups (Sillero-Zubiri and Macdonald, 1997). The Ethiopian wolves are solitary hunters but they share and defend an exclusive territory (Randall *et al.*, 2007; Zelealem Tefera and Sillero-Zubiri, 2007). Sharing home ranges among wolves are primarily due to aggressive behavior of the animals (Swihart *et al.*, 1988). It is also believed that exclusive home ranges are expected when food resources are stable and evenly distributed (Jennings *et al.*, 2006). The Ethiopian wolves aggregate for social greetings and border patrols early in the morning, afternoon and evening hours (Sillero-Zubiri and Macdonald, 1997).

The pack disperses to forage individually during the morning and early afternoon. Energetic and noisy greeting occurs when members meet each other or before scent-marking around their home ranges. This behavior is an important component in keeping unity, socialization within the pack and to re-establish dominance hierarchies (Sillero-Zubiri and Macdonald, 1998). Like

many other animals, dominance hierarchies exist among adults of each sex. Among males changing rank is seldom but rare among females. Strong relations also develop between siblings during the first months of their life (Sillero-Zubiri and Gottelli, 1994). Violent play-fighting outside the den may determine the establishment of rank between the siblings during the first few weeks (Sillero-Zubiri and Gottelli, 1994; Newey and Sillero-Zubiri, 2002).

Canids of large to medium size are normally general predators (Eisenberg, 1989; Sillero-Zubiri *et al.*, 1998). According to Hefner and Geffen (1999), wolves in the Rift Valley are largely omnivores and feed mostly on surplus human production. Unlike other canids, the Ethiopian wolves developed an extreme feeding specialization on high altitude rodents, with a narrow ecological range and high habitat specificity (Gottelli *et al.*, 2004). The species typically forages and feeds on mole rats and grass rats (Fig. 2). Rodents account for 95% of the food of this species. These include: the endemic giant mole rats species (300-930 g), the common mole rat, *Arvicanthis blicki*, *A. abyssinicus*, *Lophuromys melanonyx* and *Otomys typus* (Sillero-Zubiri and Gottelli, 1995; Ray *et al.*, 2005). The giant mole rat is found only in BMNP (Sillero-Zubiri *et al.*, 1995). Even though the Ethiopian wolf is usually a solitary rodent hunter, occasionally small packs chase and prey on Starck's hare, rock hyrax and calves of mountain nyala. It also feeds on young and calves of grey duiker, reedbuck and bushbuck and attack isolated lambs and small goats (Hefner and Geffen, 1999; Zelealem Tefera *et al.*, 2005; Tallents, 2007). They also consume carrion or carcasses (Wilmers *et al.*, 2003).

Wolves carefully assess the presence of prey, walking slowly and stop frequently to look for holes or localize rodents by hearing. Once a prey is observed, the wolf moves quietly towards it. It takes short steps and stops

slowly in order to minimize disturbances. Moving slowly and quietly towards the prey can last from seconds to up to one hour in the case of a giant mole rat. Wolves run usually zigzag across rat colonies picking up rodents (Sillero-Zubiri and Macdonald, 1997; Newey and Sillero-Zubiri, 2002).



Figure 2. Ethiopian wolf foraging giant mole rat in the Sanetti Plateau (photo: Alemayehu Edossa, 2009)

The Ethiopian wolves exhibit cooperative breeding (Brock-Clutton, 1988; Gompper and Wayne, 1996; Moehlman and Hofer, 1997). All members in the

natal pack help rearing the litter of the dominant female and chase potential predators. They regurgitate or carry rodent prey to feed the pups (Semeniuk, 2003; Drea and Carter, 2009). In the majority of communally breeding carnivores, subordinate males are reproductively suppressed (Crell, 1996). Subordinate males that have no chance of fathering mainly guard the pups against predators (Newey and Sillero-Zubiri, 2002). Subordinate females also nurse the pups of the dominant female. They can be daughter or younger sibling which can show pseudopregnancy (Asa, 1997). The allo-suckling activity also helps the true mother to reduce the mother's breast energetic cost (Marino, 2003; Tallents, 2007). According to Oftedal and Gittleman (1989), canids tend to invest more energy in their litters than do in the fields both during gestation and lactation period.

Newey and Sillero-Zubiri (2002) noted that in BMNP, females give birth once a year between October and December. After the gestation period of 60- 62 days, pups are born blind and without teeth. Their natal coat color is charcoal grey with attractive patches in the chest and inguinal regions. After three weeks, the pups come out from the den. At this time, the red color start to take the position of the dark natal coat color and the white areas become clearer.

The scent-marking activities of the Ethiopian wolves involve raised leg urination, defecation on conspicuous objects and scratching the ground (Sillero-Zubiri and Macdonald, 1998; Marino, 2003). They use defecation and squat urination for both elimination and scent-marking purposes (Newey and Sillero-Zubiri, 2002) (Fig. 3). They scratch and roll their body to release chemicals and odors for communication purposes at different distance with group members. They also use for advertising and maintaining their territory (Gorman and Trowbrdidge, 1989; Grant *et al.*, 1992). The territory of the wolf packs varies from 3 to 13 km² depending on prey densities (Evangelista *et al.*,

2009). Scent-marking rates are highest along or near the territory boundaries. Marking rates increase with the wolf number during patrols than other activities. They use the edges of their territories regularly for this activity (Sillero-Zubiri and Macdonald, 1998).



Figure 3. Ethiopian wolf defecation in the Sanetti Plateau (photo: Alemayehu Edossa, 2009)

The Ethiopian wolves make loud calls during different conditions (Newey and Sillero-Zubiri, 2002). They make alarm calls during scent-marking or at the sight of humans, dogs and unfamiliar wolves.

The spatial organization of carnivores is related to the availability of resources (Azevedo, 2006). The Ethiopian wolves are a rodent specialist hunter that evolved in Ethiopia during the Pleistocene glacial period (Gottelli *et al.*, 2004). They are limited to high montane ecosystem of afroalpine (3,700- 4,400 m asl) and the sub-afroalpine (3,000- 3,700 m asl) (Ray *et al.*, 2005).

Until the 19 century, the Ethiopian wolf lived in most parts of the country (Gottelli *et al.*, 2004). At the present time, the species has become extinct from various parts of Ethiopia. These include, Mount Choke of Gojjam (Marino, 2003; Gottelli *et al.*, 2004), Gosh-medea and Ankober of Shoa, Mount Guge of Gamogofa and Hererge (Malcolm and Sillero-Zubiri, 1997). According to Gottelli *et al.* (2004), the Ethiopian wolves are currently restricted to seven isolated populations in the high altitude ecosystem of the country. Their population has declined and fewer than 500 adult individuals are expected to exist (Wayne and Koepfli, 1996; Gottelli, 2004). The BMNP encompasses the largest population of them (300-350) (Randall, 2006). The BMNP also contains the largest suitable wolf habitat (1141 km²) (Gottelli *et al.*, 2004). The Simien Mountains National Park (SMNP) is the area where the species was first described in 1835 by Rüppell (Malcolm and Sillero-Zubiri, 1997). The suitable wolf habitat in the area is 273 km², which harbours about 54 individuals (Gottelli *et al.*, 2004).

Mount Guna is located in the northern part of the country, nearly 150 km south of the Simen Mountains (SM). Gottelli *et al.* (2004) reported that this afroalpine ecosystem is comprised of 10 wolf populations in 51 km² suitable wolf habitats. In the north of Rift Valley, South Wollo consists of 16-19 wolves in 243 km² available wolf habitat, whereas the North Wollo (Kewa) hosts 23 individuals in 140 km² of suitable wolf habitat (Marino, 2003). According to Gottelli *et al.* (2004), the Central Ethiopian North-East Shoa is also a potential

wolf habitat. It has 112 km² area of wolf habitat, where 23 individuals were reported. The Ethiopian wolves are largely distributed in the south of Rift Valley. The Arsi Mountains, south of the Rift Valley harbours the second largest population of 108 individuals in 870 km² suitable wolf habitat (Marino, 2003; Gottelli *et al.*, 2004)

Carnivores because of their position on the ecological pyramid are considerably rarer than their prey (Martin, 1989). The interaction between this group of mammals and humans also severely affect their number (Brock, 1996; Johnson *et al.*, 1996). In several parts of East Africa, local communities rely heavily on the natural resources of the area. This brings local hostility towards wildlife and protected areas. It also makes conservation of natural resources difficult (Holmern *et al.*, 2004). According to Zelealem Tefera and Sillero-Zubiri (2007), the Ethiopian wolves which have a narrow ecological niche, suffer in the afroalpine ecosystem because of human disturbance in the area. People in the highlands of Ethiopia use the home range of wolves for seasonal and permanent encroachment. Thus, the animals are forced to share their habitat with people and their livestock (Stephens *et al.*, 2001; Caro and Stoner, 2003; Madden, 2004). Sillero-Zubiri and Macdonald (1997) reported that people living in the south of Rift Valley have coexisted with the species peacefully. But, the situation has different in Arsi Mountains. In different parts of these mountains, it is usual to see villagers chasing wolves using cultural weapons such as spear and domestic dogs.

Dispersal of animals is likely to influence survival, foraging, access to mate, population and breeding opportunities. There is also evidence that emigrants face a risk of mortality and occupy unfamiliar territory (Waser, 1996). According to Zelealem Tefera *et al.* (2005), the animals are regularly dispersed

from their natural homes by humans. In area where humans and their livestock routinely visit wolf habitat, the animal frequently emigrate from one place to the other the whole day. The species flight distance, close to people, in a very peaceful area is, between 10 to 150 m, particularly in BMNP. In most disturbed areas, wolves close to people collecting grass and firewood at a distance greater than 200 m. They carry out their activity confidentially when human activity is totally absent in the area (Zealelem Tefera *et al.*, 2005).

Attitudes towards the Ethiopian wolf by local people are directly related to their farming and grazing needs (Ray *et al.*, 2005; Wang, 2008). Extensive overgrazing by livestock has a significant impact on rodent populations. Less number of rodent populations occurs in the area where livestock heavily graze (Sillero-Zubiri and Macdonald, 1997; Stephens *et al.*, 2001). In the area where small number of rodent population occurs, wolves cannot survive (Stephens *et al.*, 2001). Stephens *et al.* (2001) noted that regular disturbance by livestock is seen in all wolf habitat. The presence of livestock in afroalpine ecosystem has also a negative impact on tourists visiting the biodiversity of the country (Sillero-Zubiri and Macdonald, 1997; Zealelem Tefera and Sillero-Zubiri, 2007).

Habitat loss and fragmentation lead to environmental modification and can alter the spatial structure of vertebrate population (Caro, 2001; Gehring and Swihart, 2003; Schipper *et al.*, 2008). People frequently clear and burn the afroalpine vegetation to grow cereal crops and to graze their livestock. They also collect firewood and grass and produce charcoal for sale. These lead to increase conflict of with human and livestock (Stephens *et al.*, 2001; Deresse Dejene 2003; Mesele Yihune *et al.*, 2009). Habitat loss and fragmentation at their extreme cases result in population isolation, which increases the rate at which genetic variability is lost (Johnson *et al.*, 1996). It also aggravates the rates of

demographic and other stochasticity and increasing the rate of contact of wolf population with people and domestic animals including dogs. This finally leads to the local extinction of the species (Sillero-Zubiri and Macdonald, 1997; Maddox, 2003).

Domestic dogs, which serve as livestock guard, in the afroalpine habitat are also a direct cause of wolf and antelope disturbance (Laurenson *et al.*, 1998; Hemson, 2009). They can carry out prey competition and aggression with wolves. Dogs also spread their diseases such as rabies and canine distemper to the wolves (Johnson *et al.*, 1996; Laurenson *et al.*, 1997; Evangelista *et al.*, 2009). These diseases have high potential to spread among the wolf packs and cause a radical decline. They also pose serious threats to this rare species leading to extermination (Crooks *et al.*, 2001; Haydon *et al.*, 2006). Domestic dogs, which are regularly seen in the afroalpine wolf habitat also interbreed with the Ethiopian wolves (Laurenson *et al.*, 1997). The hybridization of the Ethiopian wolves with domestic dogs is not a natural phenomenon, but is due to the recent introduction of dogs to the wolf habitat by humans (Wayne and Gottelli, 1997; Hemson, 2009). According to Wayne and Gottelli (1997), following hybridization, wolf population may be affected by reduction in genetic fitness or out-breeding depression.

Many of the Ethiopian wolf packs cross roads daily in the afroalpine habitats. Wolves near vehicles and ignore them at short distance. In the BMNP, they make their den and rear pups within few meter away from the road (Sillero-Zubiri and Macdonald, 1997). Since 1984, death on the Ethiopian wolves was reported from the majority of wolf habitats because of traffic kills.

The Ethiopian wolf is an important indicator of ecosystem integrity. It influences the structure of ecosystem and reflects the vitality of trophic level upon which it depends (Kucera and Zielinski, 1995; Boddicker *et al.*, 2002). It is also an icon of a flagship species in the highland ecosystem of the country. As a result, it is used to raise environmental awareness (Sergio *et al.*, 2006; Zelealem Tefera and Sillero-Zubiri, 2007). At the same time, the afroalpine ecosystem regulates water flow from the vital catchment of the Ethiopian highlands. In the southern part of the country, the major rivers that provide water to the people have their headwaters in the BMNP (Malcolm and Sillero-Zubiri, 1997). The Arsi Mountains also offer water throughout the year for several nearby villages, towns and it is also the tributary of Lake Ziway, Langano, and Sodere.

2. OBJECTIVE

2. 1. General objective

The general objective of this study was to conduct a comparative investigation of disturbances by humans on the Ethiopian wolf in the Sanetti Plateau of BMNP and currently unprotected area of the Arsi Mountains (Chilalo-Galama Range).

2. 2. Specific objectives

- To identify the main causes of disturbances on the Ethiopian wolf both study areas.
- To investigate the activities of the Ethiopian wolves in the presence and absence of humans and livestock in the study areas and compare.
- To assess the flight distances of the Ethiopian wolves from humans in both study areas.
- To identify the attitude of local people towards the Ethiopian wolves.

3. THE STUDY AREAS

3. 1. Arsi Mountains

The present study was conducted in the Arsi Mountains and BMNP. The Arsi Mountains of Chilalo and Galama occur between 7°30' to 8°50' N latitude and 39°20' to 39°35' E longitude, in the central part of the Arsi Administrative Zone of Oromia Regional State. The Chilalo-Galama Mountain Range is one of the Arsi highland massifs occurring at about 60 km east of the Rift Valley lakes and about 230 km southeast of Addis Ababa (Fig. 4).

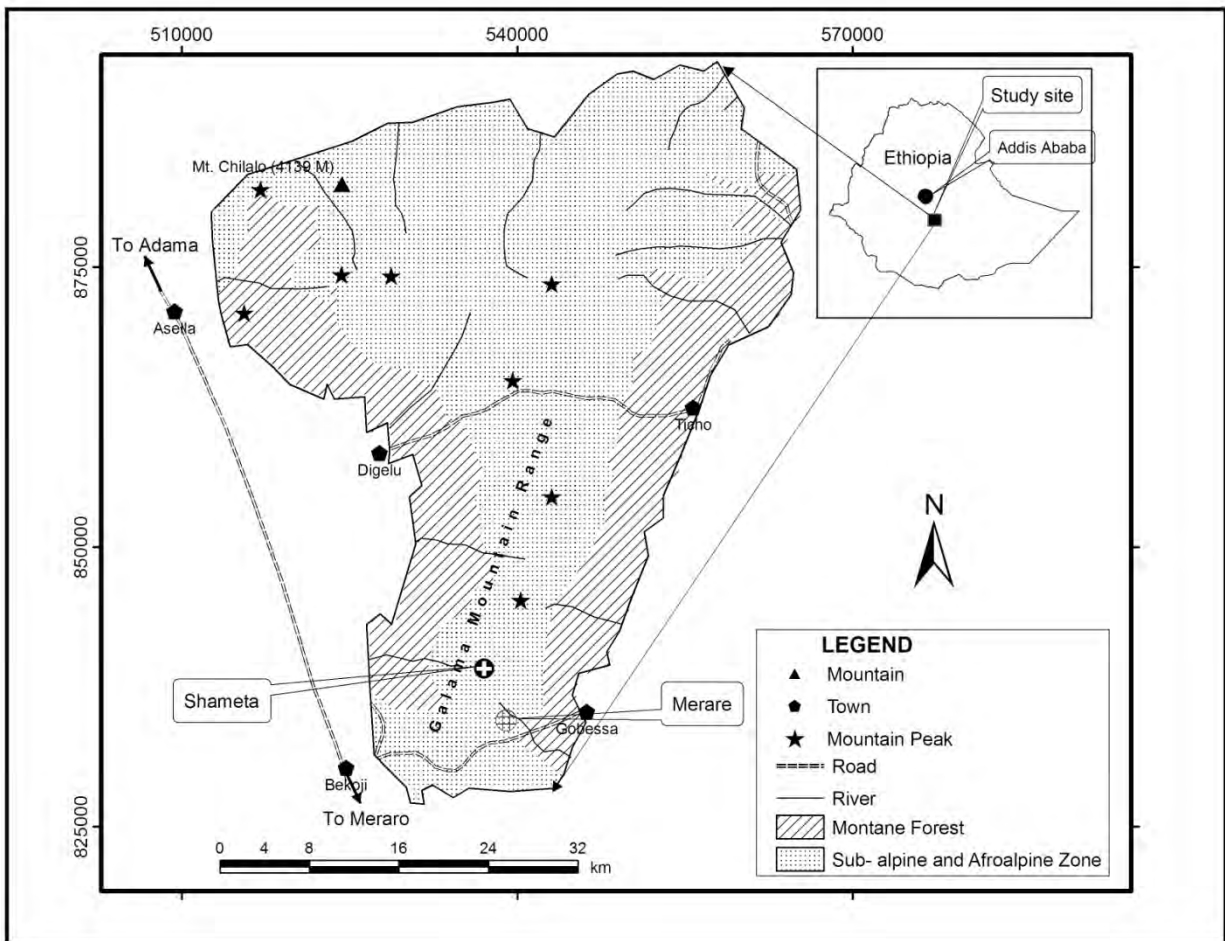


Figure 4. Map of the study area (Chilalo-Galama Range).

The Arsi Mountains are the second largest afroalpine extension in the Ethiopia after the Bale Mountains (Marino, 2003). Suitable wolf habitat is distributed on the north-south running range of Galama, connected to the west with Mount Chilalo by broad saddle Cheleleka, situated at 3,300- 3,400 m altitude. South of Galama, Mount Kaka and Mount Hunkolo are additional patches of suitable wolf habitats (Malcolm and Sillero-Zubiri, 1997). The Chilalo-Galama Mountain range consists of a great diversity of landscape. These are high and rocky mountainous ridges, flat topped highland, a wide caldera and slightly raised slopes. It also comprises gently rising and falling steep hills and frequently intersected gorges along streams and rivers. It rises from the flat land surrounding from about 2,000 m to 4,000 m elevation. It forms triangular shaped highland massifs with peaks more than 4,000 m elevation in the northwest (Chilalo Mountains peak) and the northern part of Galama Ranges. Mount Kaka, the highest peak of Arsi Mountain (4,245 m asl) and Hunkolo, (3,850 m asl) occur nearly in separate patches south to Galama Ranges.

The mean annual temperature and rainfall of Chilalo-Galama vary depending on the altitude of the area. Areas above 3,300 m asl have annual mean temperature less than 10°C and areas below 3,300 m asl have annual mean temperature of 17-21.6°C. During the dry season, diurnal temperature is high and night temperature is low. The maximum temperature is in March (21.6°C) and the minimum is in July (16.8°C) (Fig. 5). The high altitudes especially around Chilalo area and northern part of Galama ranges get moderate rainfall. The annual rainfall ranges between 878-2,231 mm. The highest rainfall is in August (201.6 mm) and the lowest is in December (14.5 mm) (Fig. 6).

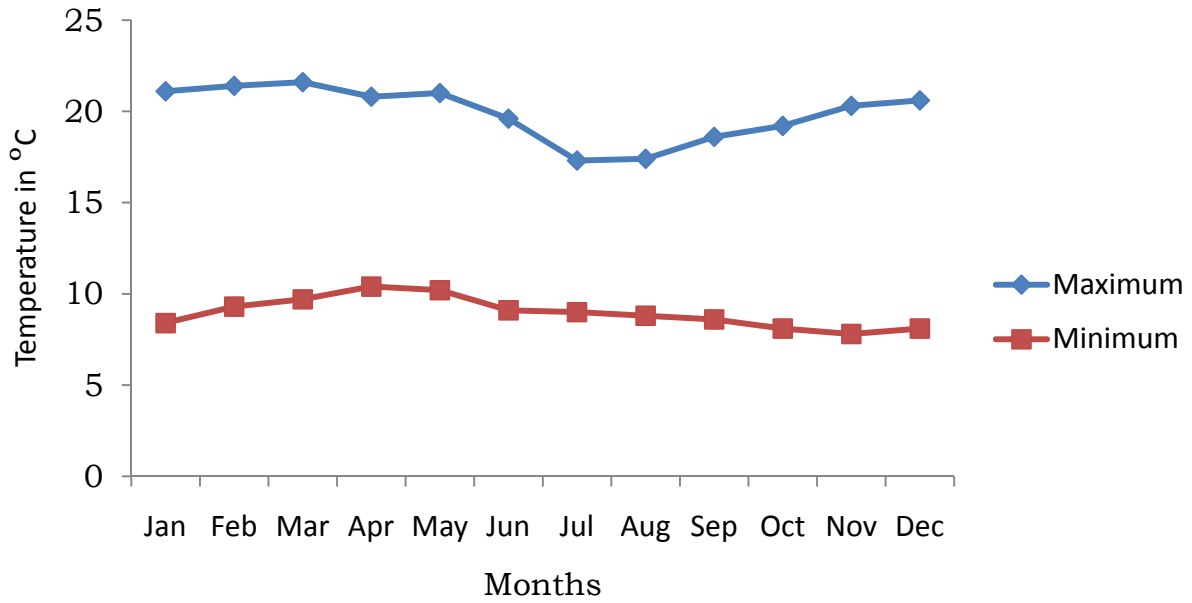


Figure 5. Mean monthly maximum and minimum temperature of Chilalo-Galama Range during 1991-2009 (Source: Ethiopian Metrological Agency).

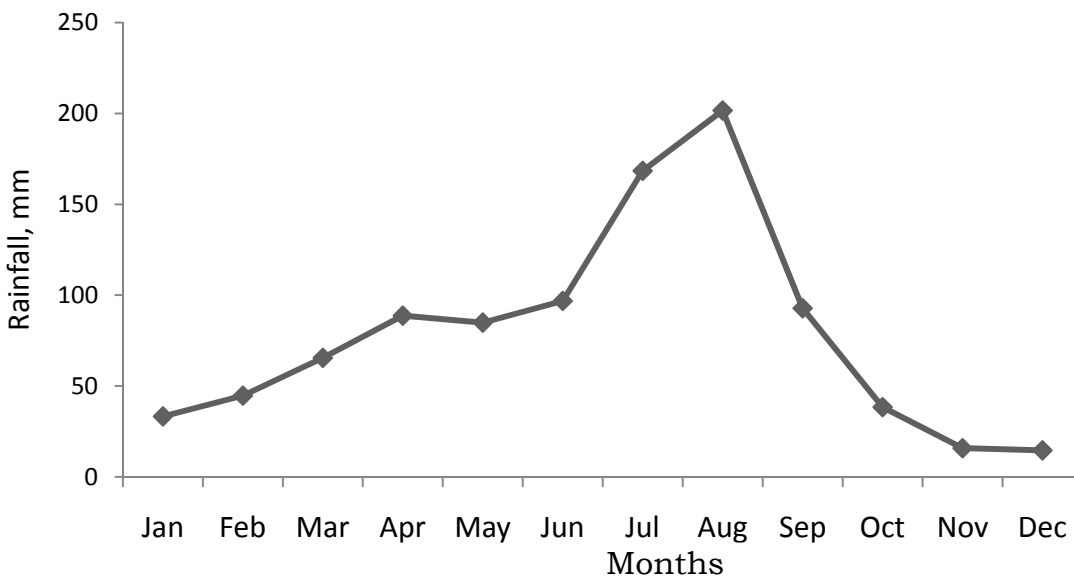


Figure 6. Mean monthly rainfall of Chilalo-Galama Range during 1991- 2009 (Source: Ethiopian Metrological Agency).

Three vegetation zones characterize the Arsi Mountains (Malcolm and Sillero-Zubiri, 1997; Marino, 2003). Mixed mountains forest (3,300 m) is dominated by *Juniperus procera*, *Podocarpus graciler* and *Hagenia abyssinica*. The ericaceous zones (3,300-3,900 m) are characterized by *Erica arborea* and *E. trimera*. Malcolm and Sillero-Zubiri (1997) reported that at least 90% of the area is covered by *Erica* vegetation (Fig. 7). The Afroalpine ecosystem (3,300-4,300 m) consists largely of *Alchemilla*, *Helichrysum* and the endemic *Lobelia rhynchopetalum*. Fauna of the area includes the Ethiopian wolf, mountain nyala, Menelik's bushbuck, reedbuck, warthog, leopard, hyena and grey duicker. It also includes Starck's hare, grass rat, swamp rats and common mole rat (Malcolm and Sillero-Zubiri, 1997).



Figure 7. Ethiopian wolf habitat in the Chilalo-Galama Range (Photo: Alemayehu Edossa, 2009).

3. 2. Bale Mountains National Park

The BMNP is located between 6°29' and 7°10'N latitude and 39°28' and 39°58' E longitude. It is situated in the southeast highlands of the country in the Oromia Regional State. The BMNP is about 450 km away from Addis Ababa (Fig. 8).

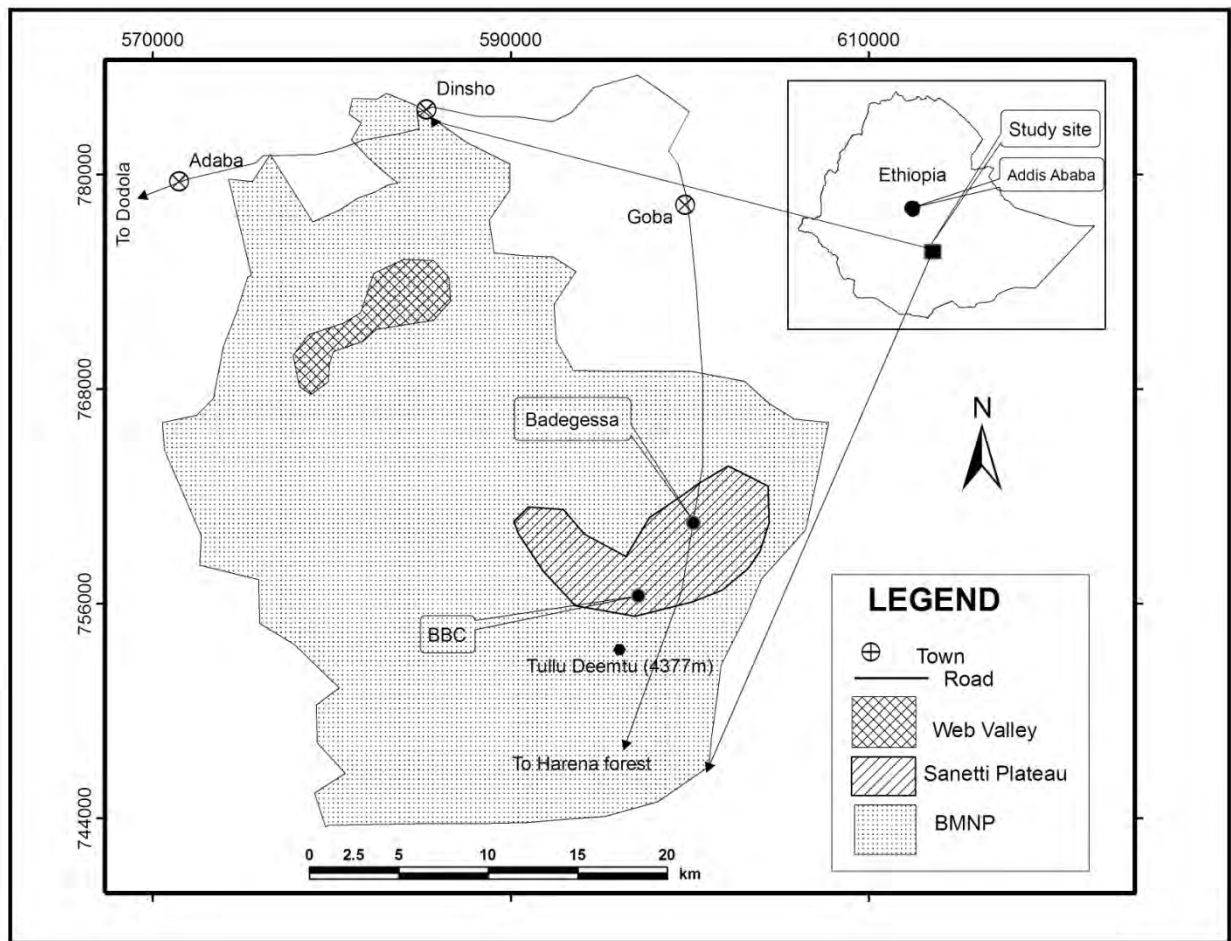


Figure 8. Map of the study area (Sanetti Plateau, BMNP).

BMNP is the largest area of continuous afroalpine habitat in Africa (Sillero-Zubiri *et al.*, 1998). It has a diversity of land features. These are very high mountainous ridges, plateaux, flat valley, afroalpine steppes and swampy land features. The Bale complex of Sanetti Plateau is the largest high altitude plateau in Africa (3,800 to above 4,000 m) (Evangelista *et al.*, 2009). It also consists of the flat valley bottom, Web Valley (3,450- 3,550 m), which is a typical afroalpine steppe or meadowland and the montane grasslands of Gaysay (3,000- 3,100 m). In the west of this main range, there is a smaller Somkeru-Korduro Mountain Range (Marino, 2003). In the western Sanetti Plateau, there are high mountain ridges such as Tullu Deemtu and Batu. The highest peak in Southern Ethiopia, Tullu Deemtu, 4,377 m, falls steeply on its southern side and slopes more gently on northern side towards the Wabe Shebelle River drainage (Marino, 2003).

The BMNP experiences two types of rainy seasons, heavy and short rains (EMA, 2009). Mist and rain sweep the area daily during the eight months of rainy seasons (Marino, 2003). The annual rainfall of the area varies from 800 to 1,500 mm. The heavy rain is from July to October, with the highest peak in August and the short rainy season from January to March and from November to December (Fig. 9). According to Marino (2003), the mean daily maximum temperature at 3,500 m is 19°C, ranging from 12.5°C to 25°C. The temperature of the area shows extremes during the dry season and more or less the same pattern during the wet season. The highest temperature is in February and the lowest is in January (1.4°C) (EMA, 2009).

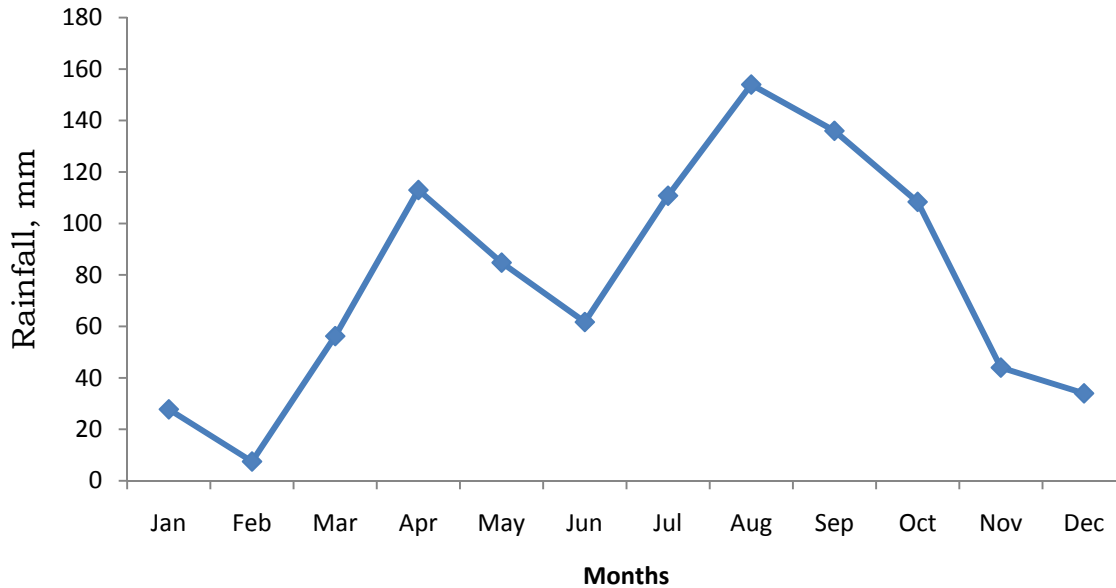


Figure 9. Mean monthly rainfall of Sanetti Plateau between 1998- 2009 (Source: Ethiopian Metrological Agency).

The BMNP is one of the richest plant diversity centers of the highland ecosystem of the country. It encompasses about 150 highland endemic plants. Out of these, 27 of them including *Alchemilla haumannii* and *Euryops prostratus* are restricted to Bale Mountains (Tallents, 2007). Sillero-Zubiri and Macdonald (1997) reported five vegetation zones in BMNP. These are the northern grassland, ericaceous forest, the northern wetlands, the Afroalpine moorland and grassland and the southern Harena forest.

The BMNP hosts 23% of Ethiopia's mammalian species (66 of 284). These include the endemic Bale monkey, giant mole rat and Starck's hare. It also harbours the largest population of the two endemic species, the Ethiopian wolves and mountain nyala. The area has 17 (55%) of the 31 endemic mammals of Ethiopia. BMNP hosts 262 (28%) of 926 and 16(57%) of 26 of the endemic birds. A large and diverse raptor guild is one of the bird species, which

exploits the abundant rodent fauna in the Sanetti Plateau. The BMNP is also a hot spot of endemism for amphibians (Malcolm and Sillero-Zubiri, 1997; Stephens *et al.*, 2001; Tallents, 2007).

The Ethiopian wolves in BMNP occur in different areas at distinct densities. The Web Valley and Sanetti Plateau represent typically open and short afroalpine vegetation (Fig. 10). These habitats sustain the highest density of wolves (1.2 wolves/km²). The Tullu Deemtu area represents the *Helichrysum* heaths, along the southern western slopes of Sanetti, where wolves occur at much lower densities (0.25 wolf/km²) (Marino, 2003). According to Malcolm and Sillero-Zubiri (1997), the Gaysay Valley is characterized by montane grassland and scrubland dominated by sage brush (*Artemisia afra*) lower level is seen (less than 0.5 wolf/km²).



Figure. 10. Ethiopian wolf habitat in the Sanetti Plateau (Photo: Alemayehu Edossa, 200

4. MATERIALS AND METHODS

4. 1. Materials

Materials used during the study period include: binocular, camera, GPS data sheets, notebook, pen, pencils, ruler, topographic map, dry cell and battery.

4. 2. Methods

4. 2. 1. Preliminary study

A preliminary survey was conducted during July- August, 2009 in the study area. During this study period, all relevant information about Ethiopian wolf territories, active patrolling and foraging time were gathered. The major factors disrupting the animals in the study areas were identified. In addition, climatic condition, topography and vegetation types and coverage of the afroalpine part of BMNP and Arsi Mountains were observed. From the Chilalo-Galama Range, Merare and Shameta and from the Sanetti Plateau of BMNP, Badegessa and British Broadcast Corporation (BBC) Ethiopian wolf's focal packs were selected randomly to investigate the Ethiopian wolf disturbance by humans.

4. 2. 2. Data collection

Data collections were made during August, 2009- March, 2010 with longer term stay in both the study areas at different seasons.

4. 2. 2. 1. Questionnaire survey

A total of 59 people were interviewed from the two study areas. Even though in the buffer zone of the Chilalo-Galama Range, several people are living and a lot of them have settled in the range during the rainy season, many of the residents related the study with their economic interest. Because of these, only some were willing to be interviewed. Out of these, 51 respondents were selected randomly, 24 females and 27 males. In the Sanetti Plateau, comprehensive (available) sampling was used. There were only few inhabitants and as a result only four male respondents and four females were interviewed. The questionnaire was designed mainly to check whether people living in both study areas have positive attitude to the Ethiopian wolves or not. It was also designed to assess various parameters in relation to the issue. The questionnaire included both open ended and fixed response questions. Open ended questions were included to elicit information on the knowledge about the Ethiopian wolves of the study area (see Appendix I).

4. 2. 2. 2. Direct observation

To assess disturbances to the Ethiopian wolf by humans, distance sampling (Strip Transect Sampling) method was used (Buckland *et al.*, 1993; Ripple *et al.*, 2001; Azhar *et al.*, 2008). The investigator walked along the track lines of known length which were setup randomly in straight line and marked using global positioning system. All observed Ethiopian wolves, humans, domestic dogs and livestock were numerated and recorded from distance “w” on either side of the center line (Zerbini, 2006). Foraging, lying down and other behavioral activities of wolves were detected in the presence and absence of humans and livestock. In addition to these, the flight distance of Ethiopian wolves from humans in both study areas was recorded. The number and kind of observed animals occurred within a maximum distance “w” on left and right sides of the strip transect were distinguished using binocular. Large number of livestock grazed at maximum distance which was difficult to numerate sometimes estimated.

A total of 15 transect lines ranging from 1.58 to 1.62 km length were covered on foot. The length of transect lines was designed for comparative purposes of disturbance to wolf by humans in both study areas. Nine transects were designed from Merare and Shameta wolf packs of Arsi Mountains and six from BBC and Badegessa of the Sanetti Plateau. The transect studies were repeated every month during both the wet and dry seasons (Azhar *et al.*, 2008). The track lines were located separately at more than 200 m apart to avoid double counting of individuals. Daily data collections were carried out for more than 9 hours. This commenced from 07:30 to 12:30 and completed at 18:30 p.m. In Merare and Shameta, data collection was sometimes extended up to 7:30 p.m during moon night because of the partly nocturnal activity of wolves in the Chilalolo-Galama range (see Appendix II).

4. 2. 2. 3 Data analysis

All data collected were analyzed using SPSS version 17 computer software program. Data collected from each transect and the wolf packs were analyzed using descriptive statistic and one-way ANOVA. The Tukey test was used to identify the difference between the Ethiopian wolf pack of the study areas after a one-way ANOVA test. For the data collected using questionnaire and direct observation, chi-square test was used to determine and compare the significant differences between the study areas. Spearman correlation coefficient was also used to relate the significance impact of livestock and their grazing duration on the wolf habitat.

5. RESULTS

5. 1. Questionnaire survey

Firewood collection is a regular practice of people living around the forest habitat. People living in and around the afroalpine ecosystem collect *Erica* heather for sale and home use. The Chilalo-Galama Range respondents collected firewood from the Ethiopian wolf habitat. But, none of the Sanetti Plateau respondents gathered firewood from the study area. Therefore, the study areas statistically differed ($\chi^2 = 19.61$, $df = 1$, $P < 0.05$) in the amount of respondents who gathered firewood from the Ethiopian wolf habitat (Table 1). On the other hand, the Chilalo-Galama Range respondents collected grasses from the study area for sale. In contrast, the Sanetti Plateau respondents never gathered grass for sale. Hence, the study areas showed a marked difference ($\chi^2 = 23.52$, $df. = 1$, $P < 0.05$) in the amount of respondents who harvested grass from the Ethiopian wolf habitat (Table 1).

Even if people living in the rural areas usually do not produce charcoal for domestic use, they make charcoal for sale to support their economy. The study areas significantly differed ($\chi^2 = 17.64\%$, $df = 1$, $P < 0.05$) in the number of individuals who produced charcoal from the Ethiopian wolf territory. The Chilalo-Galama Range respondents made charcoal in the wolf habitat but the Sanetti Plateau residents did not have the experience of making charcoal from the area (Table 1).

Table 1. Resource utilization of respondents in the study areas

Study area	N	Firewood	Grass	Charcoal	Others
Chilalo-Galama	51	10(19.61%)	12(23.52%)	9(17.64%)	20(39.23%)
Sanetti Plateau	8		-	-	-

Livestock are the main factor responsible for disturbing the Ethiopian wolf habitat. All of the Sanetti Plateau and majority of the Chilalo-Galama respondents grazed their livestock in the study areas. Therefore, the study areas differed significantly ($\chi^2 = 9.44$, $df = 1$, $P < 0.05$) in the number of respondents grazed their livestock in the Ethiopian wolf habitat (Table 2). Farming activity in and around the wolf habitat made disturbed the animal. The Chilalo-Galama Range respondents' cultivated crops in the study area, but none of the respondents relied on the Sanetti Plateau for farming. Thus, the two study areas were significantly different ($\chi^2 = 5.9$, $df = 1$, $P < 0.05$) in cultivation of crops in the wolf habitat (Table 2).

Table 2. Respondents who grazed livestock and cultivated in the study areas

Study area	N	Grazing	Farming	Others
Chilalo-Galama	51	31(61%)	3(5.9%)	17(33.1%)
Sanetti Plateau	8	8(100%)	-	-

The average annual period livestock spent in the study areas was 7- 8.7 months ranging from 5 to 12. The two study areas differed significantly ($\chi^2 = 34.77$, $df = 3$, $P < 0.05$) in the period of grazing livestock in the wolf habitat. In

the Chilalo-Galama 48.4% and in the Sanetti Plateau 100% of the respondents grazed their livestock for 9-12 months in the study areas. Respondents grazed their livestock for long period of the year in the Sanetti Plateau than in the Chilalo-Galama Range. But, there was a negative correlation ($r = -0.29$) between monthly grazing duration and the amount of respondents who grazed their livestock in the study areas (Table 3).

Table 3. Respondents who grazed livestock during the months of the year

Study area	n	1-4 months	5-6 months	7-8 months	9-12 months
Chilalo-Galama	31	-	14(45.1%)	2(6.5%)	15(48.4%)
Sanetti Plateau	8	-	-	-	8(100%)

The average daily time spent by livestock for grazing in the study areas was 8-8.67 hours. All of the Sanetti Plateau and 25.8% of the Chilalo-Galama Range respondents grazed their livestock in the study areas for 10 hours per day. Therefore, the study areas showed a marked difference ($\chi^2 = 58.98$, $df = 2$, $P < 0.05$) in the daily duration of respondents that grazed livestock in the areas. Daily grazing duration is negatively correlated ($r = -0.30$) with the number of respondents who grazed their livestock in the study areas (Table 4).

Table 4. Respondents who grazed livestock during the day time

Study area	n	6-7 hours	8-9 hours	10 hours
Chilalo-Galama	31	8(25.8%)	15(48.4%)	8(25.8%)
Sanetti Plateau	8	-	-	8(100%)

In the Chilalo-Galama Range 68.6% and in the Sanetti Plateau 25% of the respondents confirmed that the number of the Ethiopian wolf population has declined severely. In contrast, 62.5% of the Sanetti Plateau and 5.8% of the Chilalo-Galama Range respondents revealed that the population of the wolf has increased. Therefore, the study areas statistically differed ($\chi^2 = 38.75$, $df = 3$, $P < 0.05$) in the current status of the Ethiopian wolf population (Table 5).

Table 5. Views of respondents on the current status of the Ethiopian wolf population

Study area	n	Increase	Decrease	No change	Do not know
Chilalo-Galama	51	3(5.8%)	35(68.6%)	8(15.6%)	5(9.8%)
Sanetti Plateau	8	5(62.5%)	2(25%)	1(12.5%)	-

Respondents whose livestock were not attacked by the Ethiopian wolf had positive attitude whereas whose livestock were attacked by the wolf had negative attitude towards them. Similarly, 67.7% and 100% of the respondents from Chilalo-Galama Range and Sanetti Plateau, respectively, had positive attitude towards the Ethiopian wolf. Hence, study areas differed statistically ($\chi^2 = 22.92$, $df = 1$, $P < 0.05$) in the attitude towards the Ethiopian wolf (Table 6).

Table 6. Attitudes of respondents towards the Ethiopian wolf

Study area	n	Positive	Negative
Chilalo-Galama	51	32(62.7%)	19(37.3%)
Sanetti Plateau	8	8(100%)	-

In many of its habitat, people usually did not blame the animal preying on their livestock. Accordingly, 74.5% and 100% of respondents from the Chilalo-Galama and Sanetti Plateau, respectively, did not accuse the animal preying on livestock. But, pastoralists who encroached into the Chilalo-Galama Range and disturbed the Ethiopian wolves assumed the animals preying on livestock. Therefore, the study areas differed significantly ($\chi^2 = 14.65$, $df = 2$, $P < 0.05$) in the number of people assuming wolf preying on livestock (Table 7).

In rodent abundant areas of the Sanetti Plateau of BMNP, wolves have 100% tolerance of livestock. In contrast, the Chilalo-Galama Range respondents reported two sheep were killed by wolves between 2008- 2009. The study areas were statistically different ($\chi^2 = 3.90$, $df = 1$, $P > 0.05$) in the wolf preyed on sheep in the past one year (Table 7).

Table 7. Response of respondents on the Ethiopian wolf preying on livestock and sheep killed.

Study area	n	Yes	No	Do not know	Sheep killed in 2008-9
Chilalo-Galama	51	8(15.7%)	38(74.5%)	5(9.8%)	2(3.9%)
Sanetti Plateau	8	-	8(100%)	-	

People living in and around the afroalpine ecosystem share the wolf habitats. As a result, the animal is frequently disturbed by people. None of the Sanetti Plateau and 49% of the Chilalo-Galama respondents confirmed that the animal has suffered by the activities of humans in the area. Thus, the study areas significantly differed ($\chi^2 = 43.68$, $df = 2$, $P < 0.05$) in the disturbance of the Ethiopian wolf by humans (Table 8).

Table 8. Response of respondents on the Ethiopian wolf affected by people

Study area	N	Yes	No	Do not know
Chilalo-Galama	51	25(49%)	20(39.2%)	6(11.8%)
Sanetti Plateau	8	-	8(100%)	-

5. 2. Data analyses of direct observation

During the wet season, 229.8 ± 149.67 mean of livestock per transect grazed in wolf habitats. Similarly, during the dry season 92.93 ± 49.3 mean of livestock per transect foraged in the study areas. During the wet season, there was a significance difference ($F_{3, 11} = 13.56$, $P < 0.001$) in the amount of livestock grazed per transect. Similarly, during the dry season, there was statistical difference ($F_{3, 11} = 3.96$, $P < 0.039$) in the amount of livestock grazed per transect. Similarly, the Tukey test during the wet season, revealed a significance difference between the packs of the Ethiopian wolf between Merare and BBC, Merare and Badegessa, Shameta and BBC, and Shameta and Badegessa ($P < 0.05$). But, there was no statistical difference between Merare and Shameta, and BBC and Badegessa. Merare pack carried more livestock while BBC the least (Table 9). On the other hand, the analysis of Tukey test during the dry season confirmed a significance difference between Merare and Shameta only ($P < 0.05$). During the dry season more livestock were sighted in Merare and the least in Shameta (Table 9)

In the Chilalo-Galama Range, 79.82% and 20.18% of livestock grazed in the area during the wet the dry seasons, respectively. Therefore, there was a seasonal variation ($\chi^2 = 35.56$, df. 1, $P < 0.05$) in the amount of livestock that grazed in the area. In the BMNP of Sanetti Plateau, 49.88% and 50.11% of livestock were sighted in the wolf habitat during the wet and dry seasons, correspondingly. As a result, in the Sanetti Plateau there was no seasonal variation ($\chi^2 = 0.0006$, df. 1, $P > 0.05$) in the number of livestock that grazed in the wolf habitat. On the other hand, the two study areas showed a marked difference ($\chi^2 = 38.09$, df. 1, $P < 0.05$) in the amount of livestock disturbing the wolf. In the Chilalo-Galama Range 3762(80.86%) and in the Sanetti Plateau 890(19.13%) livestock were sighted in the wolf habitats (Table 9).

Table 9. Number of livestock grazed in the Ethiopian wolf habitats

Pack	Season	Number of livestock recorded					Total
		on each transect					
		1	2	3	4	5	
Merare	W	473	266	341	211	454	1745
	D	126	98	115	69	201	609
Shameta	W	254	386	347	271		1258
	D	18	95	13	24		150
BBC	W	48	56	80			184
	D	62	49	70			181
Badegessa	W	109	106	45			260
	D	98	111	56			265
Ch-Ga	W	3003 (79. 82%)					
	D	759 (20. 18%)					
Sa. Pl	W	444 (49. 88%)					
	D	446 (50. 11%)					
Ch-GaT		3762(80. 86%)					
Sa. PIT		890 (19. 13%)					

Ch-Ga =Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The mean number of domestic dogs that shared the Ethiopian wolf habitat per transect during the wet and dry seasons was 0.73 ± 0.40 and 0.56 ± 0.20 , respectively. During the wet season, there was no marked difference ($F_{3,11} = 1.138$, $P > 0.376$) in the number of domestic dog per transect. Similarly, during the dry season, there was no significance difference ($F_{3,11} = 1.375$, $P < 0.302$) (Table 10). On the other hand, the Tukey test showed no significance difference between the multiple pairs of all the Ethiopian wolf packs both during the wet and dry seasons.

In the Chilalo-Galama Range, 66.67% and 33.33% of domestic dogs shared the Ethiopian wolf habitat during the wet and dry seasons, respectively. Thus, the Chilalo-Galama Range significantly differed ($\chi^2 = 11.12$, df. 1, $P < 0.05$) in the number of domestic dog occurred in the wolf habitat during the wet and dry seasons. In contrast, in the Sanetti Plateau no domestic dog was observed in the Ethiopian wolf habitat. Therefore, the two study areas drastically differed ($\chi^2 = 100$, df. 1, $P < 0.05$) in the number of domestic dog disturbing the Ethiopian wolf (Table 10).

Table 10. Number of domestic dog recorded in the Ethiopian wolf habitats

Site	Season	Number of domestic dogs recorded on each transect					Total
		1	2	3	4	5	
Merare	W	2	1	1	-	-	4
	D	2	-	1	-	-	3
Shameta	W	-	2	-	-	-	2
	D	-	-	-	-	-	-
BBC	W	-	-	-	-	-	-
	D	-	-	-	-	-	-
Badegessa	W	-	-	-	-	-	-
	D	-	-	-	-	-	-
Ch-Ga	W	6(66.67%)					
	D	3(33.33%)					
Sa.Pl	W	-					
	D	-					
Ch-GaT		9(100%)					
Sa.PIT		-					

Ch-Ga =Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The mean number of human presence in the wolf habitat per transect during the wet and dry seasons was 16.60 ± 15.12 and 15.85 ± 15.00 , respectively. The number of people appeared in the wolf habitat per transect during the wet season showed marked differences ($F_{3,11} = 28.71$, $P < 0.001$). On the other hand, during the dry season, there was significance difference ($F_{3,11} = 7.56$, $P < 0.005$) in the number of people that observed in the Ethiopian wolf habitat. However, during the wet and dry seasons the Tukey test showed a statistical

difference ($P < 0.05$) between all multiple pairs of the wolf packs except between Merare and Shameta, and BBC and Badegessa (Table 11).

The number of people appeared in the Ethiopian wolf habitat in the Chilalo-Galama Range was not statistically deferent ($\chi^2 = 1.38$, df. 1, $P > 0.05$) during the wet and dry seasons. Likewise, in the Sanetti Plateau, it also showed no significance difference ($\chi^2 = 0.2$, df. 1, $P > 0.05$) during both seasons. However, the two study areas revealed a marked difference ($\chi^2 = 96.04$, df. 1, $P < 0.05$) in the number of people disturbed the Ethiopian wolf habitats. In the Chilalolo-Galama Range 488(99%) people were observed in the Ethiopian wolf habitat during the wet and dry seasons. In contrast, only five people were seen in the Sanetti Plateau (Table 11).

Table 11. Number of people seen in the Ethiopian wolf habitats

Site	Season	Number of people					Total
		recorded on each transect					
		1	2	3	4	5	
Merare	w	36	43	23	25	33	160
	d	32	39	10	10	29	120
Shameta	w	27	25	15	29		96
	d	36	32	34	10		112
BBC	w	1	-	-			1
	d	-	-	-			-
Badegessa	w	-	2	-			2
	d	2	-	-			2
Ch-Ga	w	256(52.46%)					
	d	232(47.54%)					
Sa.PI	w	3(60%)					
	d	2(40%)					
Ch-GaT		488(99%)					
Sa.PIT		5(1%)					

Ch-Ga = Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. PI = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The mean number of individuals who collected grass from the study areas per transect during the wet and dry seasons was 4.12 ± 2.67 and 3.68 ± 2.00 , respectively. Grass collection from each transect during the wet season differed significantly ($F_{3,11} = 32.59$, $P < 0.001$). Likewise, during the dry season, there was a significance variation in the number of individuals that collected grass per transect ($F_{3,11} = 6.28$, $P < 0.001$). However, the Tukey test confirmed a significance difference only between Merare and all other remaining the wolf packs ($P < 0.05$) both during the wet and dry seasons. People were collected grass only from the Merare wolf pack (Table 12).

In the Chilalo-Galama Range, 57.14% and 42.86% of individuals collected grass from the area during the wet and dry seasons, respectively. As a result, the study area showed no statistical disparity ($\chi^2 = 2.04$, df. = 1, $P > 0.05$) in the collection of grass from the wolf habitat during the wet and dry seasons. In contrast to this, no individuals collected grass from the Sanetti Plateau. Therefore, the study areas significantly differed ($\chi^2 = 100$, df. = 1, $P < 0.05$) in the number of individuals that collected grass from the Ethiopian wolf habitat. (Table 12).

Table 12. Number of individuals collected grass from the study sites

Site	Season	Number of individuals recorded on each transect					Total
		1	2	3	4	5	
Merare	W	10	8	8	10	4	40
	D	12	8	1	4	5	30
Shameta	W	-	-	-	-	-	-
	D	-	-	-	-	-	-
BBC	W	-	-	-	-	-	-
	D	-	-	-	-	-	-
Badegessa	W	-	-	-	-	-	-
	D	-	-	-	-	-	-
Ch-Ga	W	40(57.14%)					
	D	30(42.86%)					
Sa. Pl	W	-					
	D	-					
Ch-GaT		70(100%)					
Sa. PIT		-					

Ch-Ga =Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The mean number of individuals collected firewood per transect during the wet and dry seasons was 3.81 ± 3.33 and 8.61 ± 5.67 , respectively. There was a statistical difference ($F_{3,11} = 5.02$, $p < 0.013$) in the number of individuals collected firewood per transect during the wet season. Similarly, during the dry season there was a significant disparity ($F_{3,11} = 5.68$, $p < 0.020$). However, the Tukey test indicated a statistical difference between Shameta and BBC, and Shameta and Badegessa ($P < 0.05$) but did not show a statistical difference

between the remaining multiple comparisons of the Ethiopian wolf pack both during the dry and wet season (Table 13).

In the Chilalo-Galama Range, 37.04% and 67.96% of individuals gathered firewood during the wet and dry seasons, respectively. Therefore, the number of firewood collection per season significantly differed in the area ($\chi^2 = 6.72$, $df = 1$, $P < 0.05$). On the other hand, in the Sanetti Plateau, there was no collection of firewood. Thus, the two study areas revealed a marked difference ($\chi^2 = 100$, $df = 1$, $p < 0.05$) in the number of individuals gathered firewood from Ethiopian wolf habitats (Table 13).

Table 13. Number of individuals collected firewood from the study sites

Site	Season	Number of individuals recorded on					Total
		each transect					
		1	2	3	4	5	
Merare	W	2	3	3	4	12	24
	D	8	7	-	-	6	21
Shameta	W	6	10	6	4		26
	D	20	21	23	-		64
BBC	W	-	-	-			-
	D	-	-	-			-
Badegessa	W	-	-	-			-
	D	-	-	-			-
Ch-Ga	W	50(37.04%)					
	D	85(67.96%)					
Sa. Pl	W	-					
	D	-					
Ch-GaT		135(100%)					
Sa. PIT		-					

Ch-Ga =Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The mean number of individuals produced charcoal per transect during the wet and dry seasons was 3.56 ± 1.6 and 4.21 ± 2.20 , respectively. On the other hand, there was a significance disparity during the wet season ($F_{3,11} = 5.38$, $P < 0.05$) in the number of individuals produced charcoal per transect. Similarly, during the dry season, there was a statistical difference ($F_{3,11} = 15.02$, $P < 0.001$). In the same way, the Tukey test showed significance difference between Shameta and Merare, Shameta and BBC, and Shameta and

Badegessa but did not indicate a statistical difference between the remaining multiple comparisons of the Ethiopian wolf packs both during the wet and dry seasons (Table 14).

In the Chilao-Galama Range, 42.12% and 57.89% of individuals produced charcoal during the wet and dry seasons, correspondingly. As a result, the study area showed no significance disparity ($\chi^2 = 2.48$, $df = 1$, $P > 0.05$) in the number individuals that produced charcoal per season. On the other hand, no individual produced charcoal in the Sanetti Plateau. Therefore, the study areas showed a marked difference ($\chi^2 = 100$, $df = 1$, $P < 0.05$) in the number of individuals that produced charcoal in the Ethiopian wolf habitat (Table 14).

Table 14. Number of individuals produced charcoal in the study sites

Site	Season	Number of individuals recorded					Total
		on each transect					
		1	2	3	4	5	
Merare	W	-	-	-	-	-	-
	D	-	-	-	-	-	-
Shameta	W	12	2	2	8		24
	D	14	8	6	5		33
BBC	W	-	-	-			-
	D	-	-	-			-
Badegessa	W	-	-	-			-
	D	-	-	-			-
Ch-Ga	W	24(42. 12%)					
	D	33(57. 89%)					
Sa. Pl	W	-					
	D	-					
Ch-GaT		57(100%)					
Sa. PIT		-					

Ch-Ga =Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The mean number of individuals kept livestock per transect during the wet and dry seasons was 6.93 ± 5.95 and 2.93 ± 2.92 , respectively. During the wet season showed a significance difference ($F_{3,11} = 48.99$, $P < 0.000$) in the number of shepherd kept livestock per transect. Likewise, during the dry season there was a statistical difference ($F_{3,11} = 28.52$, $P < 0.000$). However, the Tukey test during the wet season, confirmed statistical difference between all compared Ethiopian wolf packs ($P < 0.05$) except between Merare and Shameta, and BBC and Badegessa. In contrast, during the dry season, all multiple

comparisons the Ethiopian wolf pack showed a significance difference ($P < 0.05$) except BBC and Badegessa packs (Table 15).

There was a marked statistical difference ($\chi^2 = 15.78$, $df = 1$, $P < 0.05$) in the number of shepherds kept livestock per season in the Chilalo-Galama Range. In this study area, 69.86% and 30.14% of shepherds kept their livestock during the wet and dry seasons, respectively. Similarly, in the Sanetti Plateau, there was a significance disparity ($\chi^2 = 100$, $df = 1$, $P < 0.05$) in the number of people that kept their livestock per season. In the Sanetti Plateau, 100% of the herders kept their livestock during the wet season. On the other hand, 98.65% and 1.35% of individuals kept their livestock in the Chilalo-Galama Range and Sanetti Plateau, respectively. Therefore, the two study areas showed a marked difference ($\chi^2 = 47.34$, $df = 1$, $P < 0.05$) in the proportion of livestock guard in the Ethiopian wolf habitats (Table 15)

Table 15. Number of individuals kept livestock in the study sites.

Site	Season	Number of individuals					Total
		recorded on each transect					
		1	2	3	4	5	
Merare	W	16	13	12	10	13	64
	D	6	4	8	6	7	31
Shameta	W	9	10	7	12		38
	D	2	3	3	5		13
BBC	W	-	-	-			-
	D	-	-	-			-
Badegessa	W	-	2	-			2
	D	-	-	-			-
Ch-Ga	W	102(69.86%)					
	D	44(30.14%)					
Sa. Pl	W	2(100%)					
	D	-					
Ch-GaT		146(98.65%)					
Sa. PIT		2(1.35%)					

Ch-Ga = Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The mean number of people walked through the wolf pack per transect during the wet and dry seasons was 5.03 ± 4.93 and 3.10 ± 1.50 , respectively. On the other hand, during the wet season, there was no statistical difference ($F_{3,11} = 0.99$, $P > 0.05$) in the number of people crossed the wolf territory per transect. In the same way, during the dry season, there was no significance disparity ($F_{3,11} = 1.29$, $P > 0.05$). Likewise, the Tukey test revealed no significance difference

between all multiple comparisons of the Ethiopian wolf pack both during the wet and dry seasons (Table 16).

In the Chilao-Galama Range there was no statistical difference ($\chi^2 = 0.03$, $df = 1$, $P > 0.05$) in the number of people that walked through the wolf habitat per season. In this range, 51.22% and 48.78% the people crossed through the Ethiopian wolf territory during the wet and dry seasons, respectively. In contrast, in the Sanetti Plateau, there was a significance difference ($\chi^2 = 11.16$, $df = 1$, $P > 0.05$) in the number of people passed through the study area per season. In this study area, 33.33% and 66.67% of the people walked through the study area during the wet and dry seasons, respectively. The Chilalo-Galama Range and Sanetti Plateau revealed a marked difference ($\chi^2 = 74.58$ $df = 1$, $P < 0.05$) in the number of people walked through the wolf territory. In the Chilalo-Galama 93.18% and in the Sanetti Plateau 6.82% of the people walked through the study areas (Table 16).

Table 16. Number of individuals walked through each transects in the study sites.

Site	Season	Number of individuals recorded on each transect					Total
		1	2	3	4	5	
Merare	W	8	-	-	1	4	13
	D	6	-	1	-	11	18
Shameta	W	-	3	-	5		8
	D	-	-	2	-		2
BBC	W	1	-	-			1
	D	-	-	-			-
Badegessa	W	-	-	-			-
	D	2	-	-			2
Ch-Ga	W	21(51. 22%)					
	D	20(48. 78%)					
Sa. Pl	W	1(33. 33%)					
	D	2(66. 67%)					
Ch-GaT		41(93. 18%)					
Sa. PIT		5(6. 82%)					

Ch-Ga =Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w= wet, d = dry.

The Chilalo-Galama Range of the Ethiopian wolf habitat was used as a mini-market place and for growing crops. As a result, the two study areas showed a statistical difference ($\chi^2 = 39$, df. = 1, $P < 0. 05$) in the number of individuals utilized the wolf habitat as a mini-market place. The Chilalo-Galama Range and the Sanetti Plateau did not show a marked difference ($\chi^2 = 2$, df. = 1, $P > 0. 05$) in the number of individuals cultivated crops in the wolf habitat. All people cultivated crops and used the study area for mini-market place were observed in the Chilalo-Galama Range (Table 17).

Table 17. Number of individuals observed in the study areas for farming and marketing

Study area	Season	number of individuals carried out	
		Farming	Mini-market
Chilao-Galama	w	2(100%)	19(48.72%)
	d	-	20(51.28%)
Sanetti Plateau	w	-	-
	d	-	-

The mean number of noise that made in the Ethiopian wolf habitat per transect during the wet and dry seasons was 1.36 ± 1.25 and 1.73 ± 1.58 , respectively. During the wet season, there was a statistical difference ($F_{3,8} = 37.83$, $P < 0.000$) in the number of noise made on the wolves per transect. Similarly, during the dry season, it revealed a marked difference ($F_{3,8} = 63.17$, $P < 0.000$). On the other hand, the Tukey test showed a significance disparity between Merare and Badegessa, Merare and BBC, Shameta and BBC, and Shameta and Badegessa of the Ethiopian wolf packs ($P < 0.05$) but did not show a statistical difference between the remaining pairs both during the wet and dry seasons (Table 18).

The mean number of chased after the Ethiopian wolf per transect during the wet season was 0.49 ± 0.33 . During the wet season, there was no statistical difference ($F_{3,8} = 2.67$, $P > 0.0119$) in the amount of chased after the animal per transect. Similarly, the Tukey test showed no significance difference between all multiple comparisons pair of the Ethiopian wolf pack. On the other hand, the mean amount of Ethiopian wolf ignored by people per transect was 0.753 ± 0.750 and 0.790 ± 0.580 during the wet and dry seasons, respectively.

During the wet season, there was no statistical difference ($F_{3,8} = 1.1, P > 0.951$) in the number of Ethiopian wolf ignored by the people. During the dry season, it also revealed no significance disparity ($F_{3,8} = 1.9, P > 0.201$). Similarly, the Tukey test showed no significance difference between all multiple comparisons of the Ethiopian wolf pack both during the wet and dry seasons (Table 18).

In the Chilalo-Galama Range, the amount of noise that made in the Ethiopian wolf habitat per season showed no statistical difference ($\chi^2 = 0.47, df = 1, P < 0.05$). However, the Chilalo-Galama Range and Sanetti Plateau significantly differed ($\chi^2 = 34, df = 1, P < 0.05$) in the number of noise that made in the Ethiopian wolf habitat. In the same way, the study areas showed a statistical disparity ($\chi^2 = 4, df = 1, P < 0.05$) in the number of chased after the animal. The entire chasing after the Ethiopian wolf was recorded from Chilalo-Galama Range. On the other hand, the Sanetti Plateau and Chilalo-Galama Range revealed no significant difference ($\chi^2 = 1, df = 1, P > 0.05$) in the amount Ethiopian wolf ignored by people (Table 18).

Table 18. Response of people to the Ethiopian wolf in the study sites

Site	Season	Response	Response recorded in each transect				
			1	2	3	4	5
Merare	w	ni	2	no	2	3	no
		ch	1	no	1	ab	no
		ig	1	no	1	1	no
	d	ni	3	3	no	2	no
		ch	ab	ab	no	ab	no
		ig	1	1	no	2	no
Shameta	w	ni	3	2	no	3	
		ch	ab	1	no	1	
		ig	1	1	no	ab	
	d	ni	4	3	no	4	
		ch	ab	ab	no	ab	
		ig	ab	1	no	ab	
BBC	w	ni	+	+	+		
		ch	+	+	+		
		ig	2	+	+		
	d	ni	+	+	+		
		ch	+	+	+		
		ig	+	+	+		
Badegessa	w	ni	+	+	+		
		ch	+	+	+		
		ig	+	2	+		
	d	ni	+	+	+		
		ch	+	+	+		
		ig	2	+	+		

ni = noise, ch = chase, ig = ignore, no = no wolf, + = wolf present but human absent, ab = absent noise or chase or ignore

The mean number of the Ethiopian wolf population per transect was 1.6 ± 1.35 and 1.5 ± 1.23 during the wet and dry seasons, respectively. During the wet season revealed there was a significance difference ($F_{3,11} = 7.33$, $P < 0.006$) in the number of the Ethiopian wolf population per transect. Similarly, during the dry season, there was a marked difference ($F_{3,11} = 20.60$, $P < 0.001$). On the other hand, during the wet season, the Tukey test confirmed a significance difference only between BBC and Merare, and BBC and Shameta wolf packs ($P < 0.05$). Likewise, the Tukey test during the dry season realized a statistical difference between Merare and BBC, and Merare and Badegessa but did not indicate the significance difference between the remaining multiple comparisons of the Ethiopian wolf packs (Table 19).

In the Chilalo-Galama Range, 53.85% and 46.15% of the Ethiopian wolf population occurred during the wet and dry seasons, respectively. As a result, the study area showed no statistical difference ($\chi^2 = 0.59$, $df = 1$, $P > 0.05$) in the number of the Ethiopian wolf population per season. Similarly, in the Sanetti Plateau, 50% of the Ethiopian wolf population occurred both during the wet and dry seasons. On the other hand, 70.83% and 29.17% of the Ethiopian wolves were hosted in the Sanetti Plateau and Chilalo-Galama Range, respectively. Therefore, study areas statistically differed ($\chi^2 = 17.36$, $df = 1$, $P < 0.05$) in the number of the Ethiopian wolf population inhabiting in its habitat (Table 19).

Table 19. Ethiopian wolf distribution in each transect of the study sites

Site	Season	Transect					total
		1	2	3	4	5	
Merare	w	1	-	1	1	-	3
	d	1	1	-	1	-	3
Shameta	w	2	1	-	1		4
	d	1	1	-	1		3
BBC	w	5	3	2			10
	d	4	3	3			10
Badegessa	w	3	2	2			7
	d	2	3	2			7
Ch-Ga	w	7(53. 85%)					
	d	6(46. 15%)					
Sa. Pl	w	17(50%)					
	d	17(50%)					
Ch-GaT		7(29. 17%)					
Sa. PIT		17(70. 83%)					

Ch-Ga = Chilalo-Galama Range, Ch-GaT = Chilalo-Galama Total, Sa. Pl = Sanetti Plateau, Sa. PIT = Sanetti Plateau Total, w = wet, d = dry.

The Chilalo-Galama Range and Sanetti Plateau significantly differed in the mean time spent for foraging ($\chi^2 = 6.21$, df. 1, $P < 0.05$), lying ($\chi^2 = 5$, df. 1, $P < 0.05$), walking ($\chi^2 = 5.3$, df. 1, $P < 0.05$), standing ($\chi^2 = 4.5$, df. 1, $P < 0.05$) and running ($\chi^2 = 5.4$, df. 1, $P < 0.05$) by the Ethiopian wolf during the presence of humans. The Ethiopian wolves spent more time to forage, lie down and walk through the pack for food in the Sanetti Plateau than in the Chilalo-Galama Range during the presence of humans. In contrast, the animal spent more time to stand and run in the Chilalo-Galama Range than in the Sanetti Plateau in the presence of humans (Figs. 11 and 12).



Figure 11. Ethiopian wolf standing and walking in its habitat (photo: Alemayehu Edossa, 2009).

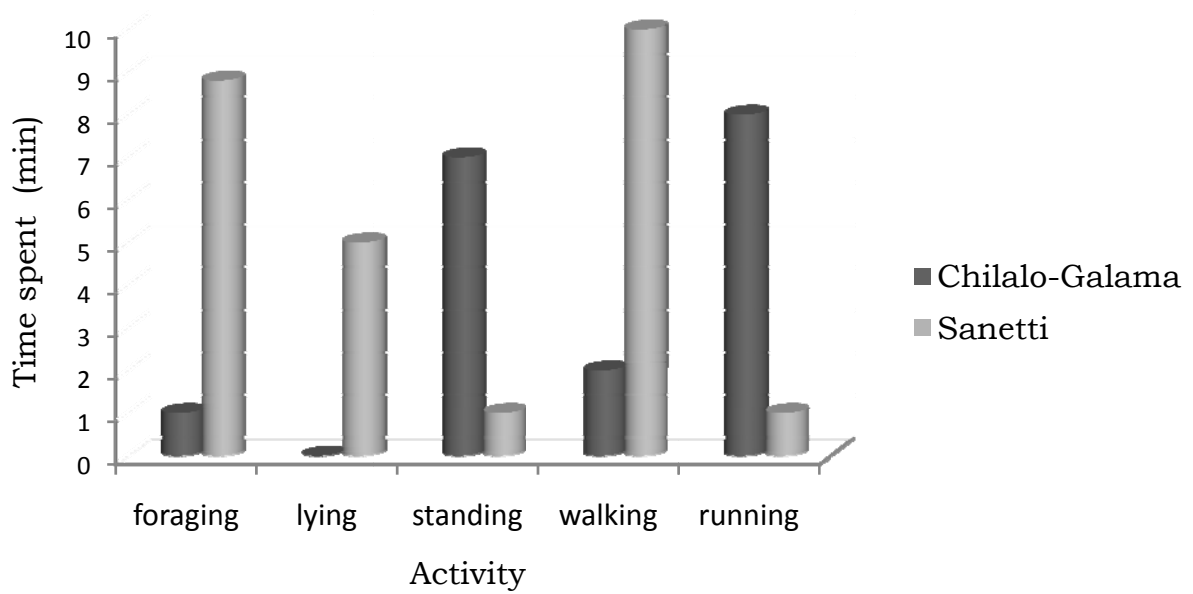


Figure 12. Estimated mean length of time the Ethiopian wolf spent for different activity during the presence of human.

The Chilalo-Galama Range and the Sanetti Plateau of the Ethiopian wolf habitats showed no statistical difference in the mean time spent for foraging, ($\chi^2 = 3.14$, df. 1, $P > 0.05$) and running ($\chi^2 = 1.53$, df. 1, $P > 0.05$) by the Ethiopian wolf in the absence of humans. However, the study areas revealed a significance difference in the mean time duration for lying ($\chi^2 = 4.02$, df. 1, $P < 0.05$), walking ($\chi^2 = 4.5$, df. 1, $P < 0.05$) and standing ($\chi^2 = 4$, df. 1, $P < 0.05$) by the Ethiopian wolf during the absence of humans. Similarly, the Ethiopian wolf spent more time to lie down and walk through the pack in the Sanetti Plateau and to stand in the Chilalo-Galama Range during the absence of humans (Fig. 13).

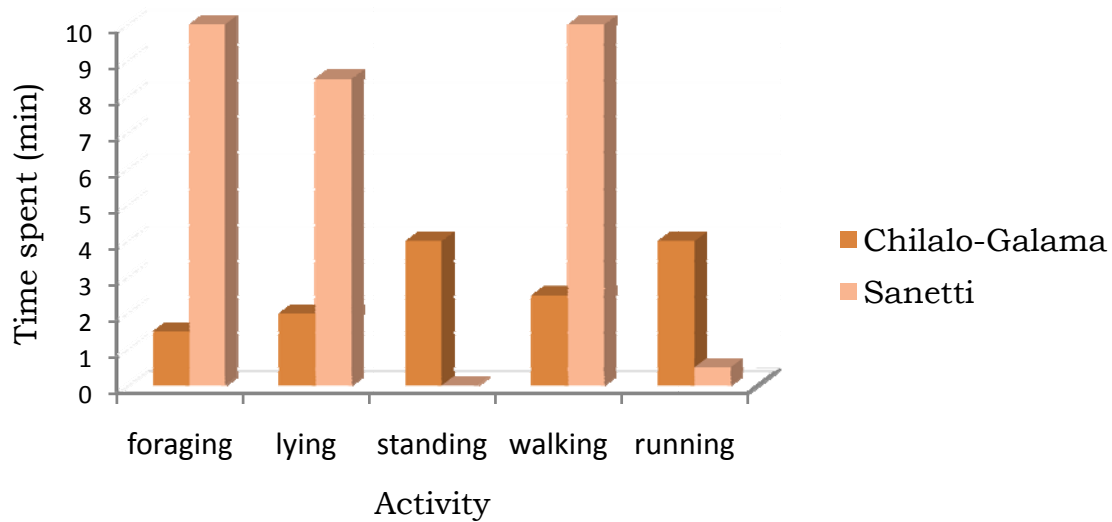


Figure 13. Estimated mean length of time the Ethiopian wolf spent for different activity during the absence of human.

The Sanetti Plateau and the Chilalo-Galama Range showed a marked statistical difference in the mean time spent for foraging ($\chi^2 = 5.3$, df. 1, $P < 0.05$), lying ($\chi^2 = 4.9$, df = 1, $P < 0.05$), standing ($\chi^2 = 4$, df = 1, $P < 0.05$) and walking ($\chi^2 = 6$, df = 1, $P < 0.05$) by the Ethiopian wolf during the presence of livestock. The animal spent more time to forage, lie down and walk through the habitat in the Sanetti Plateau than in the Chilalo-Galama Range during the presence of livestock. However, the wolves used more time to stand in the Chilalo-Galama Range than in the Sanetti Plateau during the presence of livestock. On the other hand, the two study areas revealed no significance difference in the mean time spent for running ($\chi^2 = 1.53$, df = 1, $P > 0.05$) by the Ethiopian wolf during the presence of livestock (Fig. 14).

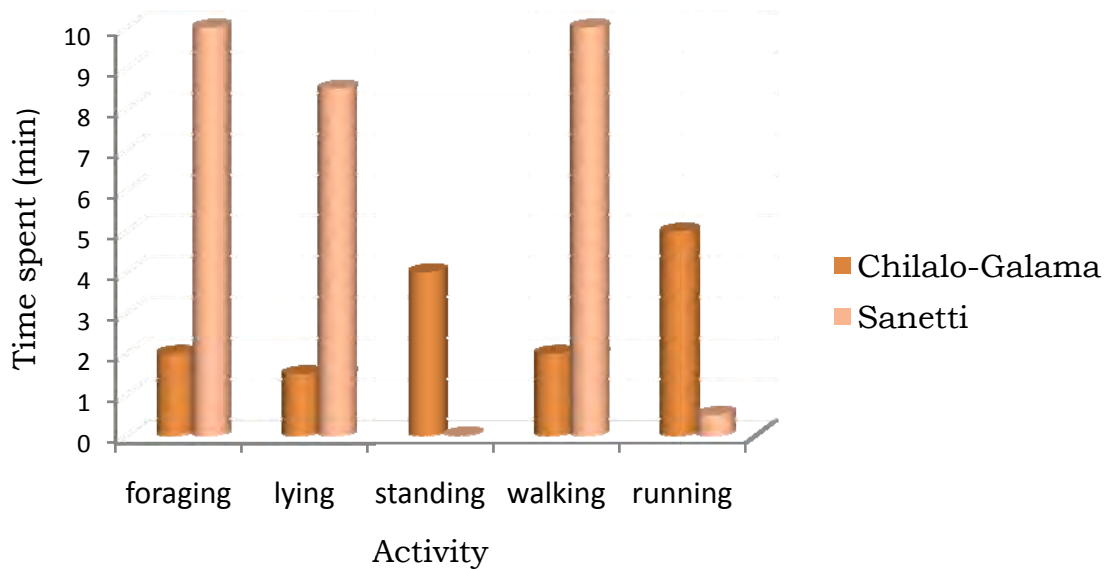


Figure 14. Estimated mean length of time the Ethiopian wolf spent for different activity during the presence of livestock.

The two study areas did not show a marked difference in the mean time spent for foraging ($\chi^2 = 3.78$, $df = 1$, $P > 0.05$), walking ($\chi^2 = 3.13$, $df = 1$, $P > 0.05$) and running ($\chi^2 = 1.78$, $df = 1$, $P > 0.05$) by the Ethiopian wolf during the absence of livestock. In contrary, the study areas revealed significance difference in the mean time spent for lying ($\chi^2 = 4.45$, $df = 1$, $P < 0.05$) and standing ($\chi^2 = 3.9$, $df = 1$, $P < 0.05$) by the Ethiopian wolf in the absence of livestock. The animal took more time to stand in Chilalo-Galama Range and lie down in the Sanetti Plateau during the absence of livestock (Fig. 15).

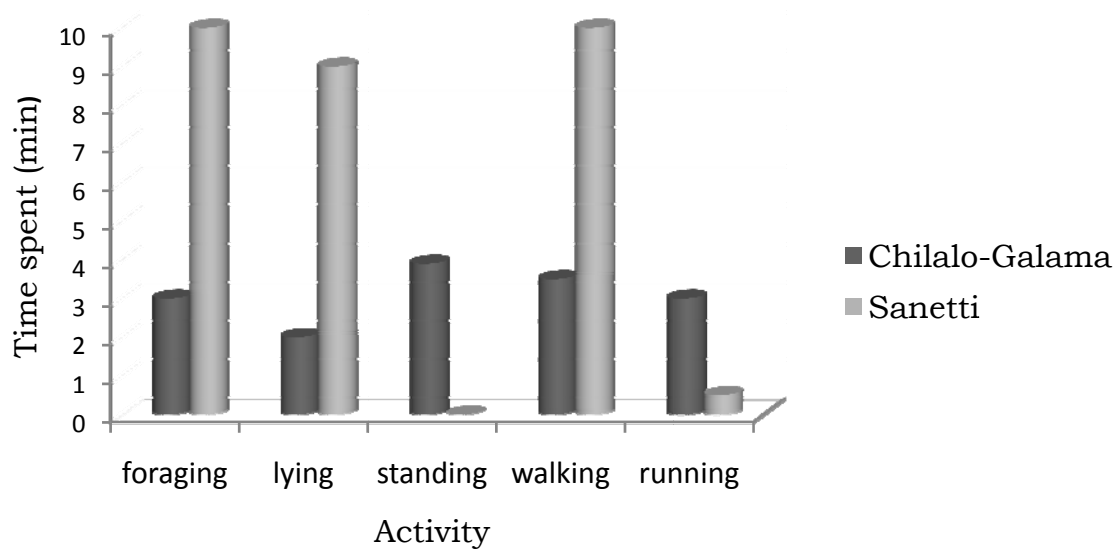


Figure 15. Estimated mean length of time the Ethiopian wolf spent for different activity during the absence of livestock.

Traffic through the roads in the Ethiopian wolf habitat released high pitched music that disturbed the animal (Fig 16). Moreover, the animals were highly exposed to traffic kill. The mean number of vehicles that crossed through the Ethiopian wolf habitat per transect daily was 22.02 ± 19.53 . The study areas revealed no significant difference ($F_{3,11} = 2.29$, $P > 0.135$) in the number of vehicles that crossed through the Ethiopian wolf territory per transect. Similarly, the Tukey test did not indicate significance difference between the multiple comparisons of Ethiopian wolf packs (Table 20). There was also no statistical difference ($\chi^2 = 2.14$, $df = 1$, $P > 0.05$) in the mean number of vehicles that crossed through the Ethiopian wolf habitat per day.



Figure 16. Vehicle crossing the Ethiopian wolf habitat (photo: Alemayehu Edossa, 2009).

Table 20. Daily mean number of vehicles that crossed the Ethiopian wolf territory.

Site	Number of vehicles recorded on each transect				
	1	2	3	4	5
Merare	-	35	-	35	35
Shameta	-	-	-	-	-
BBC	47	47	-	-	-
Badegessa	-	47	47	-	-

The flight distance of the Ethiopian wolf showed a marked statistical difference ($\chi^2 = 159.26$, $df = 1$, $P < 0.05$) between the two study areas. Wolves moved away long distance from humans in the Chilalo-Galama Range than in the Sanetti Plateau (Table 21).

Table 21. Mean flight distance of the Ethiopian wolf from humans.

Site	Number of sighting	Distance	
		minimum	maximum
Merare and Shameta	27	150 m	275 m
BBC and Badegessa	75	10 m	150 m

6. DISCUSSION

In the present study, large number of livestock was observed dominating the Ethiopian wolf habitats. Other studies also revealed that livestock were the most commonly sighted animals in the Ethiopian wolf habitat (Malcolm and Sillero-Zubiri, 1997; Stephens *et al.*, 2001). During direct observations, large number of livestock disturbing the Ethiopian wolf was sighted from Chilalo-Galama Range of Merare pack. On the contrary, small number of livestock shared the Ethiopian wolf habitat in the Sanetti Plateau of BBC pack. This might be due to the large number of livestock and people encroaching around the Chilalo-Galama Range relied on the area for grazing. Malcolm and Sillero-Zubiri (1997) also observed that the whole area of the Chilalo-Galama Range was grazed by livestock. On the other hand, Stephens *et al.* (2001) reported that human settlement and livestock in the Sanetti Plateau were low. Moreover, in the Chilalo-Galama Range, the mean number of livestock grazed per transect during the wet season was greater than the dry season. This could be because of other than permanent users of the area; many people from the neighboring areas brought their livestock to graze in the Ethiopian wolf habitat during the wet season. Similarly, Sillero-Zubiri and Macdonald (1997) reported that more number of pastoralists grazed their livestock in the Arsi Mountains.

During the present study, it was confirmed that the Sanetti Plateau respondents grazed their livestock for long period of the year and day time than the Chilalo-Galama Range. But, there was a negative correlation between the grazing duration and the amount people grazed their livestock in the study areas. Therefore, more number of livestock was disturbing the Ethiopian wolf in the Chilalo-Galama Range than in the Sanetti Plateau during yearly and daily grazing periods. This might be due to the larger number of livestock and

people encroachment in the Chilalo-Galama Range than the Sanetti Plateau. Other studies also reported that livestock were regularly grazed in the Chilalo-Galama Range (Malcolm and Sillero-Zubiri, 1997) and in the Sanetti Plateau (Stephens *et al.*, 2001). Yearly and daily grazing duration of livestock in the study areas have a significance impact on foraging and reproductive behavior of the Ethiopian wolf (Tallents, 2007).

During the direct observation of the present study, large number of shepherds was observed in Merare and Shameta wolf packs of the Chilalo-Galama Range. The mean shepherd herded livestock per transect during the wet season was greater than the dry season. As a result, in the Chilalo-Galama Range there was a marked seasonal variation in the number of people kept livestock. At the same time, larger number of herders was observed disturbing the Ethiopian wolf in the Chilalo-Galama Range than in the Sanetti Plateau. This could be associated with the effort to protect their livestock from hyena which occurred in the dense afroalpine vegetation of the Chilalo-Galama Range. Several studies also showed that people living in the afroalpine ecosystem herded their livestock in the wolf habitat every day (Malcolm and Sillero-Zubiri, 1997; Stephens *et al.*, 2001; Hemson, 2009).

Habitat loss and fragmentation are the common practices currently observed in most developing countries. Likewise, the loss of afroalpine ecosystem is increasingly fragmenting the remaining Ethiopian wolf habitat (Sillero-Zubiri, *et al.*, 1999). In the present study, people living in and around the afroalpine ecosystem altered the vegetation and wildlife structure of the area. During the direct observation, individuals collected firewood was recorded only from Shameta and Merare packs of the Chilalo-Galama Range. In the Chilalo-Galama Range, there was a marked seasonal variation of people collecting firewood. More number of people collected firewood from the study area during

the dry season. The Chilalo-Galama Range residents confirmed that they gathered firewood from the study area. Firewood collection was disturbing the Ethiopian wolves in the Chilalo-Galama Range, but not in the Sanetti Plateau. This might be due to the large number of people encroached into the Chilalo-Galama Range and the need to collect firewood for domestic use and as an income source. Similarly, Sillero-Zubiri and Macdonald (1997) also observed people collecting firewood from the Chilalo-Galama Range every day.

Habitat availability is one of the main factors which determine the Ethiopian wolf population (Gottelli *et al.*, 2004). On the contrary, people living in and around the afroalpine ecosystem frequently devastate the Ethiopian wolf habitat. The Chilalo-Galama Range residents produced charcoal from the root of burnt heather. These people spent long day of time disturbing the wolf by smoke and making noise while producing charcoal in the area. Large number of individuals was observed making charcoal in the Shameta pack of the Chilalo-Galama Range. On the other hand, in the Chilalo-Galama Range there was no seasonal variation in the number of individuals produced charcoal. Therefore, charcoal production activity disturbed the Ethiopian wolves in the Chilalo-Galama Range but did not disrupt wolves in the Sanetti Plateau. This could be due to encroachment of individuals around the Chilolo-Galama Range who had no farm land as the cost of charcoal in the town is very high. Similar result was reported by Malcolm and Sillero-Zubiri (1997) that burnt heather was the main fuel source of people living around the Chilalo-Galama Range.

Collecting grass is also one of the most important factors that led to habitat loss and fragmentation. The loss of habitat in the afroalpine ecosystem immediately affects the Ethiopian wolf prey abundance. 95% of the Ethiopian wolf prey is rodents that inhabit in the grassland habitat (Sillero-Zubiri *et al.*, 1995). The Chilalo-Galama Range residents frequently cut grass from the area.

During the direct observation, individuals collecting grass were recorded from the Merare pack of the Chilalo-Galama Range. In the Chilalo-Galama Range, there was no seasonal variation in the number of individuals' collecting grass. Thus, grass collecting activity disturbed the Ethiopian wolves in the Chilalo-Galama Range but did not disrupt wolves in the Sanetti Plateau. This might be due to the settlement of people in the buffer zone of Chilalo-Galama Range who used the vegetation of the area as alternative income generating source.

During the direct observation, individuals were observed ploughing land in Merare Ethiopian wolf pack. In contrary, no people observed cultivating crops in the Sanetti Plateau. The Chilalo-Galama Range respondents' cultivated crops in the study area. Thus, the two study areas were significantly different in the number of people that cultivated crops in the wolf habitat. Agriculture activity disturbed the Ethiopian wolf in the Chilalo-Galama Range but did not disturb wolves in the Sanetti Plateau. This might be due to increase in population leading to more demand to sustain their family. Similar observation was reported by Malcolm and Sillero-Zubiri (1997) human settlement and cultivation were practiced above the zone of agriculture in the Chilalo-Galama Range. Sillero-Zubiri and Macdonald (1997) also noticed the barley cultivation in the wolf habitat extending up to 3600 m asl.

The Ethiopian wolf habitat is also exposed to traffic kill. During the direct observation, vehicles were observed crossing the Ethiopian wolf habitat. Other studies also noted that the Ethiopian wolves and other afroalpine wildlife are increasingly exposed to vehicle disturbance (Sillero-Zubiri and Macdonald, 1997; Zelealem Tefera and Sillero-Zubiri, 2007). The study areas were significantly disturbed by vehicles crossing the wolf habitat daily. On the other hand, in the Chilalo-Galama Range, individuals were frequently observed using the wolf habitat as market place during the wet and dry seasons. The Merare

Ethiopian wolf pack was serving as a mini-market place for people purchase of potato, carrot, cabbage and other vegetables to be taken Addis Ababa. As a result, the two study areas showed a marked difference in the number of individuals disturbed the Ethiopian wolf using the area for marketing. This could be due to the availability of track crossing the Ethiopian wolf habitat and agricultural activity that is heavily practiced in the buffer zone of the Chilalo-Galama Range.

Moreover, the Ethiopian wolf habitat also served as a means of path for the local people living in and around the afroalpine ecosystem. During the direct observation, people were observed crossing regularly the wolf habitat. More number of people crossing the Ethiopian wolf habitat was observed in the Chilalo-Galama Range than in the Sanetti Plateau.

People's attitude towards the Ethiopian wolf is directly associated with resource utilization of the afroalpine ecosystem (Ray *et al.*, 2005). In the present study, 62.7 % of Chilalo-Galama Range and 100% of the Sanetti Plateau respondents had positive attitude towards the wolf. Marino (2003) reported that out of the total 15 individuals interviewed, 28% of the Chilalo-Galama respondents had positive attitude towards the Ethiopian wolf. The variation of the results might be due to the increased encroachment of people and livestock during the current study. The result of the present study showed that the Sanetti Plateau residents had better positive attitude towards the Ethiopian wolf than the Chilalo-Galama Range. This could be due to the local acceptance of the animal in BMNP.

The current situation of the Ethiopian wolf population is worsened in the Chilalo-Galama Range than in the past. During the preliminary visit to the Chilalo-Galama Range, it was observed that only 23 wolves in 19 days stayed in the area. Similarly, more number of the Chilalo-Galama Range respondents revealed that the number of the wolf has declined in the area. On the contrary, most of the Sanetti Plateau respondents revealed that the wolf population has increased in the recent past. Sillero-Zubiri *et al.* (1999) reported that the local people in the Chilalo-Galama Range perceived increase on the number of the Ethiopian wolf population. During the direct observation, the largest Ethiopian wolf pack size observed in the Chilalo-Galama Range was four. Marino (2003) observed the largest Ethiopian wolf pack size of nine in the Chilalo-Galama Range. In this study, the Sanetti Plateau packs relatively hosted larger number of the Ethiopian wolves than the Chilalo-Galama Range. The large pack size count of the Ethiopian wolves in the Sanetti Plateau could be due to a relatively low disturbance and more prey abundance (Sillero-Zubiri *et al.*, 1995). It is also due to few permanent settlers who considered the Ethiopian wolf as a part of their livestock in the Sanetti Plateau.

In the present study, nearly half of the Chilalo-Galama Range respondents revealed that the conflict exists between the Ethiopian wolf and local people. On the other hand, during direct observation, people appeared in the Chilalo-Galama Range of the Ethiopian wolf habitat for different activities made noise on the animal at every sight from near and distance during the wet and dry seasons. Likewise, some individuals observed chasing the Ethiopian wolf in the area at every encounter with the animal. In the highly disturbed unprotected areas, wolves are afraid of humans and unable to carry out their normal behavior (Zealelem Tefera *et al.*, 2005). Marino (2003) reported lack of conflict between the Ethiopian wolf and people in Chilalo-Galama Range. The Sanetti Plateau of the Ethiopian wolf packs was almost free from human noise and the wolves were never chased. The high loud noise made on the animals and

frequent chased after the Ethiopian wolves in the Chilalo-Galama Range could be due to the large number of humans that frequently observed in the area. Other could be because of some individuals were considering all wild animals as the pests of their livestock.

During the direct observation, it was observed an encouraged response of people towards the animal. Few individuals of the Chilalo-Galama Range and all of the Sanetti Plateau ignored the animal to carry out its normal activities. This might be due to the awareness of individuals on the significance of the Ethiopian wolf.

The most important immediate threat to the Ethiopian wolf population comes from domestic dogs (Haydon *et al.*, 2006; Evangelista *et al.*, 2009). In the present study, the mean number of domestic dog per transect revealed was 0.73 ± 0.40 and 0.56 ± 0.20 during the wet and dry seasons, respectively. Marino (2003) observed no interaction of wolf and domestic dog in the Chilalo-Galama Range. During the present study, all domestic dogs were recorded from Merare and Shameta Ethiopian wolf packs. Therefore, the study areas showed a significant difference in the number of domestic dog as a threat to Ethiopian wolf. This might be the result of domestic dog and shepherds in the Chilalo-Galama Range becoming responsible to protect livestock from hyena.

It was observed that the Ethiopian wolf spent more time to forage in the Sanetti Plateau than in the Chilalo-Galama Range during the presence of humans in the areas. In the Sanetti Plateau, wolves preyed on rodents little hesitation in the presence of humans around. In contrast, in Chilalo-Galama Range wolves foraged at very instant time encountered by chance with their prey. The

interaction between humans and wildlife can have a harmful effect on the survival of a species (Zealelem Tefera *et al.*, 2005). Adequate feeding resource and time determine the reproductive success and litter size of the Ethiopian wolves (Tallents, 2007). During breeding season the Ethiopian wolves gave birth in BBC and Badegessa packs. Thus, the two study areas revealed a significant disparity in the average foraging time length of the Ethiopian wolf. This might be due to a relatively stable environment and prey abundance in the Sanetti Plateau as compared to the Chilalo-Galama Range.

In the Chilalo-Galama Range, wolves took no time to lie down in their habitat in the presence of humans. In contrast, in the Sanetti Plateau the Ethiopian wolves lied down in their habitats even in the presence humans. In this area, it is usual to see the species lying down in the morning, mid-day and afternoon times. Therefore, the study areas showed significant difference in the length of time of the Ethiopian wolf resting in its habitat. In a suitable afroalpine ecosystem, the wolves frequently defend their territory (Randall *et al.*, 2007; Zealelem Tefera and Sillero-Zubiri, 2007) and sent-mark their habitat (Sillero-Zubiri and Macdonald, 1998; Marino, 2003). Similarly, during the present study, in the Sanetti Plateau, wolves were observed walking through their territory in the presence of humans to defend and sent-mark their territories. In the Sanetti Plateau, the maximum measure that wolves showed on the presence of humans was alarm call (Zealelem Tefera *et al.*, 2005). Unlike in the Sanetti Plateau, wolves in the Chilalo-Galama Range walked through their territory for very short period of time. In the Chilalo-Galama Range, wolves were not observed sent-marking patrolling and defending their exclusive territory. Hence, the study areas showed a marked difference in patrolling and sent-marking behavior of the animal. This might be due to the serious disturbances frequently observed in the Chilalo-Galama Range.

Ethiopian Wolves often stand and make alarm calls at the sight of humans and unfamiliar things (Newey and Sillero-Zubiri, 2002). During the present study

they were observed standing repeatedly for definite period of time in the Chilalo-Galama Range. At high disturbance, it was also observed running throughout their habitat in the Chilalo-Galama Range. On the other hand, in the Sanetti Plateau, wolves were not observed most of the time standing in their habitat and running away in the presence of humans. This might be due to the serious disturbance exist in the Chilalo-Galama Range than in the Sanetti Plateau.

Ethiopian wolves spent more time in their habitat in the absence of human than in the presence of humans (Zeleelem Tefera *et al.*, 2005). In human absence, the study areas showed no marked difference in the length of time of foraging and running. In contrast, the study areas revealed a significance disparity in the duration of time of lying, walking and standing. Wolves spent more time to lie down and walk in the Sanetti Plateau and stand in the Chilalo-Galama Range in the absence of humans. This could be because; wolves in the Chilalo-Galama Range carry out their activity after checking the absence of humans and livestock in the area.

Ethiopian wolves were relatively stable in their habitat in the presence of livestock than in the presence of humans. They do not respond to livestock as they do to people (Zeleelem Tefera *et al.*, 2005). Even if, the pressure exerted by livestock was not equally pronounced as humans, the study areas showed a marked difference in the length of time performed different activities in the presence of livestock. In the presence of livestock, wolves spent more time to forage, lie down and walk through their habitat in the Sanetti Plateau than in Chilalo-Galama Range. In the presence of livestock, the animal took more time to stand in the Chilalo-Galama Range than in the Sanetti Plateau. This could be because in the Chilalo-Galama Range most of the time people accompany their livestock especially during the wet season. On the other hand, the study

areas did not show significant difference in the average time spent by the Ethiopian wolves for running in their habitat in the presence of livestock.

In the absence of livestock, the study areas showed no marked difference in average time spent for foraging, walking and running of the animals in their territory. In contrast, the study areas differed significantly in the average time spent for lying down and standing in the absence of livestock. Wolves took more time to lie down in the Sanetti Plateau whereas to stand in the Chilalo-Galama Range in the absence of livestock.

Ethiopian wolves have shorter flight distance in less disturbed areas. In this area, wolves moved away slowly from humans and made alarm calls. (Zealelem Tefera *et al.*, 2005). Similarly, during the direct observation, wolves were seen close to people at very short distance and made their den near to road in the Sanetti Plateau. Usually, the animal performed its normal behavior quietly even in the presence humans. In contrast, in the Chilalo-Galama Range, wolves frequently ran away in the presence humans. Ethiopian wolves in the Chilalo-Galama Range spent most of their time dispersing from one place to another. As a result, the animal has longer flight distance in Chilalo-Galama Range than in the Sanetti Plateau. The flight distances affect the foraging and breeding behavior of the animal and its survival rate. Therefore, the study areas showed a marked difference in the flight distance Ethiopian wolves made from the human. This could be due to the serious disturbance frequently observed in the Chilalo-Galama Range.

7. CONCLUSION AND RECOMMENDATIONS

7. 1. Conclusion

The data collected during the present study provided valuable comparative information on the Ethiopian wolf disturbance rate by humans in the Chilalo-Galama Range and Sanetti Plateau of BMNP. The information obtained in this study will help for further detailed studies to secure the world's rarest carnivore, the Ethiopian wolf.

The Ethiopian wolf is a homeless species in the Chilalo-Galama Range. In the Chilalo-Galama Range of the Ethiopian wolf territory people observed increasingly damage the wolf habitat. Wolves were disturbed while individuals cutting grass, collecting firewood, producing charcoal and farming in the area. The animals were also troubled as human made noise in their territory. Sometimes wolves were affected by individuals who deliberately chased after the animal to harm and for fun. During the presence of humans, wolves hindered to carry out their normal behavior. Regular patrolling, scent-marking and defending exclusive territories were not carried out by the animals as compared to the Sanetti Plateau's wolves. In this range, breeding behavior of the animal seems ceased. Wolves in the Chilalo-Galama Range spent most of the day time by running away from humans here and there throughout its habitat. Diurnal activity of the wolf was changed to partly nocturnal because of the serious disturbance exists in the area. Even if, disturbance closed down in late early morning and night time the animal disabled to find its prey during these period because the diurnal activity of its prey.

On the other hand, wolves in the Chilalo-Galama Range shared their territory with domestic dogs. Domestic dogs observed in the area made prey competition with the Ethiopian wolves. Moreover, the wolves in this range were highly vulnerable to rabies and hybridization than which live in the Sanetti Plateau.

Livestock that shared the wolf habitat resulting in habitat loss and fragmentation directly affected the rodent abundance through reduction in plant biomass. Even if, livestock were sighted in both the study areas, livestock grazed in the Chilalo-Galama were highly disturbed as a result of their numbers.

7. 2. Recommendations

The Ethiopian wolf is an indicator species in the afroalpine ecosystem of the country. To alleviate the Ethiopian wolf disturbance by humans, the following recommendations are forwarded:

- ❖ The government should compensate grazing and farming land for the people who regularly visit the Ethiopian wolf habitat to herd their livestock and grow crops in the area.
- ❖ BMNP and the Arsi Mountains are the largest areas of continuous afroalpine habitats in Africa that host various endemic flora and fauna. Ethiopian wolves are easily accessible in the Sanetti Plateau and reachable for tourists. These ecosystems are also vital catchment areas used by millions of people. Therefore, a comprehensive national and regional conservation program should be initiated in the areas.

- ❖ The conservation effort of the Chilalo-Galama Range recently proclaimed by regional government should be implemented as soon as possible. Clear demarcation and frequent patrol of boundaries should be made.
- ❖ Past and present strategies of managing the Ethiopian wolf by the Ethiopian Wolf Conservation Program in the Arsi Mountains may need to be evaluated by concerned bodies.
- ❖ Preventing and mitigating Ethiopian wolf disturbance should be based on an improved understanding of the Ethiopian wolf behavioral ecology. These should also be public acceptance of wildlife management and based upon accumulated empirical knowledge and local exercise.
- ❖ Encroachment of people around the wolf habitat in the Chilalo-Galama Range should be minimized.
- ❖ The present acceptance of the Ethiopian wolves and other wildlife by the Bale people should be encouraged and the same measure should be taken by the Arsi people.
- ❖ Billboard which informs the presence of Ethiopian wolf and other wildlife in the areas should be installed to inform the drivers not to disturb them by releasing high pitched music.
- ❖ People living around the Ethiopian wolf habitat should control their domestic dogs.
- ❖ People living around the afroalpine ecosystem should be informed on the negative consequence of destruction of the biodiversity of the area. Similarly, they should be aware of the advantage of wildlife.

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APPENDIX I

Addis Ababa University School of Graduate Studies, Department of Biology
Interview sheet for people that live in and around the study areas.

1. Introductory questions

- 1.1. Age _____
1. 2. Sex _____
1. 3. Kebele _____
1. 4. Estimated distance from the study area _____
1. 5. Family size _____
1. 6. Education level _____

2. Resource use in the study area

2. 1. Does your livestock graze in the study area?
A. Yes _____ B. No _____
2. 2. 1. If "yes" how many sheep? _____
2. 2. 2. Goats? _____
2. 2. 3. Cattle? _____
2. 2. 4. Horses? _____
2. 2. 5. Donkeys? _____
2. 2. 6. How long do you use for grazing? _____
2. 2. How long do your livestock stay in the study area daily? _____
2. 3. At what time do you bring your livestock daily? _____
2. 4. At what time do you take your livestock daily? _____
2. 5. Do you use the study area for farming?
A. Yes ----- B. No -----
2. 5. 1. If "yes" what is the size of your farming land? _____
2. 6. Do you collect grass from the study area? A. Yes. ----- B. No-----
2. 7. Do you collect firewood from the study area? A. Yes. ----- B. No-----
2. 8. Do you produce charcoal in the study area? A. Yes. ----- B. No-----
2. 9. How long do you stay in the study area for different activities?

3. About Ethiopian wolf

3. 1. Do you know Ethiopian wolves/Jedalla farda?
A. Yes. ----- B. No -----
3. 2. Is the number of Ethiopian wolf in this study area
A. increasing ----- B. decreasing ----- C. No change -----
D. I don't know -----
3. 4. What is the largest group of Ethiopian wolf you have seen so far
in the area? _____. What about recently? _____
3. 5. What is your attitude towards the Ethiopian wolf?
A. Positive ----- B. negative -----
3. 6. Did the Ethiopian wolf prey on your livestock?
A. Yes ----- B. No ----- C. I don't know -----
3. 7. If "yes" what type of livestock and how many in the past
one year? _____
3. 8. Do people create proplem to the Ethiopian wolf ?
A. Yes ----- B. No ----- C. I don't know _____
3. 8. 1. If "yes" what type? _____

3. 9. What is the value of the wolf in the study area? _____

3. 10. What type of measure should be taken to conserve the wolf in
the area? _____

APPENDIX II

Data sheet for direct observation of the Ethiopian wolf disturbance and behavior (activity)

- 1. Study area A. Sanetti Plateau _____ B. Chilalo_Galama _____
- 2. Season _____ round _____ date _____ starting time _____ ending time _____
- 3. Pack name _____ transect number _____ length _____
- 4. Number of wolves observed in the strip transect _____
- 5. Number of livestock disturbing Ethiopian wolf during observation
 - A. Sheep _____ B. Goat _____ C. Cattle _____ D. Horse _____
 - F. Donkey _____
- 6. Number of people seen performing different activities in the area
 - A. collecting grass _____ B. collecting firewood _____
 - C. farming _____ D. producing charcoal _____
 - E. herding livestock _____ F. walking through the pack _____
 - G. any other _____
- 7. Number of domestic dog sharing the habitat with the Ethiopian wolf _____
- 8. Distance of wolf/wolves: A. from people _____ B. from researcher _____
- 9. Estimated mean length of time for each behavior during human presence and absence.

Present

Absent

- | | |
|----------------------|-------|
| A. Foraging ----- | ----- |
| B. Laying down ----- | ----- |
| C. Standing ----- | ----- |
| D. Walking ----- | ----- |
| E. Running ----- | ----- |
- 10. Response of humans to Ethiopian wolf during observation
 - A. Chasing _____ B. Noise making _____
 - C. Ignoring _____

11. Estimated mean length of time for each behavior during livestock presence and absence.

Present

Absent

- | | |
|----------------------|-------|
| A. Foraging ----- | ----- |
| B. Laying down ----- | ----- |
| C. Standing ----- | ----- |
| D. Walking ----- | ----- |
| E. Running ----- | ----- |

12. Food items consumed by Ethiopian wolves during observation.

- | | |
|--------------------------------------|--|
| A. Giant mole rat _____ | B. <i>Lophuromys melanonyx</i> . _____ |
| C. <i>Arvicanthis blicki</i> . _____ | D. <i>A. abyssinicus</i> _____ |
| E. <i>Otomys typus</i> _____ | F. any other _____ |

13. Habitat (vegetation type) that supported wolves during observation.

- | | |
|--|--------------------------------|
| A. <i>Alchemilla</i> ----- | B. <i>Helichrysum</i> ----- |
| C. <i>Lobelia rhynchopetalum</i> ----- | D. <i>Erica</i> heathland----- |
| E. Swamp grassland ----- | F. Any other ----- |

14. Number of vehicles crossing the pack daily -----

15. Causes of Ethiopian wolf disturbance in the study area

- | | |
|-----------------------|------------------------------|
| A. Livestock _____ | D. Farming _____ |
| B. Encroachment _____ | E. Habitat destruction _____ |
| C. Road killing _____ | F. Any other _____ |

DECLARATION

I, the under signed, declare that the information provided in this work is an original work, and that it has not been presented in other universities or colleges, seeking for similar degree or other purposes and all sources of materials used for the thesis have been acknowledged.

Name Alemayehu Edossa

Date _____

Signature _____

Advisor Professor Afework Bekele

Date _____

Signature _____