ADAMA SCIENCE AND TECHNOLOGY UNIVERSITYOFFICE OF GRADUATE STUDIES

Human-Ethiopian Wolf *(Canis simensis)* Habitat Interaction in Sanetti Plateau and Web Valley

A Thesis

Submitted to the Department of Applied Biology School of Applied Natural Science

In Partial Fulfillment of the Requirement for the Degree of Master's in Biology

By: Alemayehu Hirpa Demissie

Adama, Ethiopia

September, 2017

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Advisor: Dr. Mesele Admassu

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Approval of Board of Examiners

We, the undersigned, members of the Board of Examiners of the final open defense by Alemayehu Hirpa Demissie have read and evaluated his/her thesis entitled "**Human-Ethiopian Wolf *(Canis simensis)* Habitat Interaction in Sanetti Plateau and Web Valley**" and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the Degree of Master of Science in Biology.

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Declaration

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

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This MSc Thesis has been submitted for examination with my approval as thesis advisor/ Supervisor.

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Date of submission 29/09/2017

Advisor's Approval Sheet

To: Applied Biology Department

Subject: Thesis Submission

This is to certify that the thesis entitled **"Human-Ethiopian Wolf Habitat *(Canis simensis*) Interaction in Sanetti Plateau and Web Valley"** submitted in partial fulfillment of the requirements for the degree of Masters of Science in Biology, the Graduate program of the department of Applied Biology, and has been carried out by Alemayehu Hirpa Demissie Id. No GSU/0396/ 06, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby he can submit the thesis to the department.

Name of major Advisor/supervisor: Dr. Mesele Admassu

Signature: _____

Date: _____

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Abstract

The study on Human-Ethiopian wolf habitat interaction in Sanetti plateau and Web Valley was carried out from October, 2016 to June, 2017. The Ethiopian wolf disturbances were investigated using a questionnaire survey and direct observation. Descriptive statistics, Spearman correlation coefficient, one-way ANOVA, Tukey and Chi-square tests were used to analyze the Ethiopian wolf disturbances and compared the disturbances existing among the 12 transects laid and four wolf packs. Human settlement and livestock in the Sanetti Plateau were low. In the Web-valley, 488 and in the Sanetti Plateau, five people were observed disturbing the wolves. The two study sites revealed a significant difference in the number of people disturbed the Ethiopian wolf habitats ($\chi 2$ = 96.04, df. 1, P < 0.05). During the wet season, there was 3003 and 444 livestock grazed in the Web Valley and Sanetti Plateau respectively. Similarly during the dry season, 759 and 446 livestock grazed in the Web Valley and Sanetti Plateau were observed respectively. There was a significance difference in the amount of livestock grazed in the Ethiopian wolf habitats per transect (X^2 = 35.56, df. 1, P < 0.05), wet season and (X^2 = 0.000, df. 1, P > 0.05), dry season. This is other than permanent users of the area; many people from the neighboring areas brought their livestock temporarily to graze in the Ethiopian wolf habitat during the wet season. Domestic dogs also frequently observed in the Web Valley but not observed in Sanetti plateau, the two study sites significantly differed in the number of domestic dog disturbing the Ethiopian wolf by direct competition and by acting as vectors of disease ($\chi 2$ = 100, df. 1, P < 0.05). People appeared in the Web Valley range of the Ethiopian wolf habitat for different activities and made noise on the animal at every sight from near and distance during the wet and dry seasons. 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 frequently chased after the Ethiopian wolves in the Web Valley range could be due to the large number of humans that frequently observed in the area. Some individuals chase Ethiopian wolf and all other wild animals as the pests of their livestock particularly in the Web Valley site. Therefore, due attention should be given to alleviate the problem, clear demarcation and buffer zone and conservation measure should be made to sustain this critically endangered species and the Park.

Key words: Afro alpine, Ethiopian wolf, Habitat, Human interaction, Sanetti plateau, Web-valley

1. INTRODUCTION

Ethiopia is one of the most physically and biologically diverse countries of the world. It comprises highland massive surrounded by arid lowlands. It contains various wildlife and wildlife habitats ranging from alpine moorlands to low land savannas and arid lands, and extensive wetlands (Yalden, 1996). Most highlands harbor many endemic plants and animals. The main reason for the presence of diverse wildlife and large number of endemic species is the rugged topography. This helped to create isolated and varied ecological situations (Yalden *et al*., 1996). Ethiopia has high level of biodiversity and endemism because of the diverse habitats, altitude and climate that vary from desert to tropical and afro alpine habitats (Yalden and Largen, 1992; Marino, 2003). 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 these, 19 are found in the highland areas, mainly in the Bale Mountains National Park (BMNP). Many of these endemic species are shrews and rodents (Addisu, 2007). According to Boddicker *et al*. (2002), many mammalian species, especially those indigenous to tropical forests are cryptic, discrete and inhabit areas that are not easily accessible. During the last glacial age, afro alpine habitats were widespread across the high lands 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 afro alpine 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 afro alpine specialist with a restricted distribution in the high elevations (Zelealem 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 International Union for Conservation of Nature (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 ranges of the Ethiopian highlands, the Semein Mountain National Park (SMNP),North

Gondar, Northeast Shoa in Menz traditionally known as Guassa, South Wollo highlands, North Wollo highlands, BMNP (Sanetti plateau, Web-valley, Gaysay and morabawa), Arsi mountain (mount Kaka, Galama ridge and Chilalo mountain) and Somkaro korduro mountains enclaves, where they feed exclusively on the abundant mole rats and other rats (Malcolm, 1997; Marino, 2003). Although the Ethiopian wolves are solitary hunters, they live in family packs with a complicated social organization (Zelealem and Sillero-Zubiri, 2007).

Unlike the northern highlands of Ethiopia, the Bale Mountains have never been heavily populated. Wolves in the Web Valley however have coexisted with Oromo pastoralists and their livestock (Malcolm and Sillero-Zubiri, 1997). Their traditional use of afro alpine pastures follows the pattern of rains, resulting in highest stock densities at the peak of the rainy season and lowest abundances in the dry season (Sillero-Zubiri, 1994).

Therefore, the current study focused on the disturbances made by humans in the Sanetti Plateau and Web-valley of BMNP and its influence on the population and behavior of the Ethiopian wolf.

1.1. Background of the study

The species was first described scientifically in 1835 by Rüppell (1835) who provided a skull for the British Museum (Powell-Cotton, 1902). European writers traveling in Ethiopia during the mid-19th century wrote that the animal's skin was never worn by natives, as it was popularly believed that the wearer would die if any Wolf hairs enter an open wound (Parkyns, 1853), while Charles Darwin hypothesized that the species gave rise to greyhounds (Darwin,1868). Since then, it was scarcely heard in Europe until the early 20th century, when several skins were shipped to England by Major Percy Horace Gordon Powell-Cotton during his travels in Abyssinia (Lydekker 1908, Powell-Cotton, 1902).

The Ethiopian wolf was recognized as requiring protection in 1938, and get attention since 1974. The first in-depth studies on the species occurrence were in the 1980s, with the onset of the American-sponsored Bale Mountains Research Project. Ethiopian wolf populations in the Bale Mountains National Park were negatively affected by the political unrest of the Ethiopian civil war, though the critical state of the species was revealed during the early 1990s, after a combination of shooting and a severe rabies epidemic decimated most packs in the

Web Valley and Sanetti Plateau. So, IUCN reclassified the species from endangered to critically endanger in 1994. The Species Survival Conservation (SSC) *Canid* Specialist Group advocated a three-front strategy of education, wolf population monitoring, and rabies control in domestic dogs. The establishment of the Ethiopian Wolf Conservation Programme in Bale soon followed in 1995 by Oxford University, in conjunction with the Ethiopian Wildlife Conservation Authority (IUCN, 2011).

Information on Ethiopian wolves remained scarce; although, first described in 1835 as living in the Semein Mountains, the paucity of information stemming from that area indicated that the species was likely declining there, while reports from the Gojjam plateau were a century out of date. Wolves were recorded in the Arsi Mountains since the early 20th century and in the Bale Mountains in the late 1950s. The status of the Ethiopian wolf was reassessed in the late 1990s, following improvements in travel conditions into northern Ethiopia. The surveys were taken revealed local extinctions in Mount Choke of Gojjam, and in every northern afro alpine region where agriculture was well developed and human pressure acute. This revelation stressed the importance of the Bale Mountains wolf populations for the species' long-term survival, as well as the need to protect other surviving populations. Because of extreme weather, the habitat encroachment was not much but by now people starts to gets into the area. A decade after the rabies outbreak, the Bale populations had fully recovered to pre-epizootic levels, prompting the species' down listing to endangered, in 2004, though, it still remains the world's rarest *canid*, and Africa's most endangered carnivore (IUCN, 2011).

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 afro alpine (3,700 m - 4,400 m asl) and the sub-afro alpine (3,000 m - 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). But 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), mount Aba farit of South Gondar, mount Abuye-meda of North Shoa, Mount Guge of Gamogofa and Hararge (Malcolm and Sillero-Zubiri, 1997).

1.2. Statement of the problem

Habitat loss and fragmentation due to a gradual warming of the African continent that pushed up wards the lower boundaries of the afro alpine grass land. The dangers posed by fragmentation of wolf habitat include increased contact with humans, dogs, and livestock. Furthermore, risk of isolation and inbreeding in wolf populations and human factors increase exposure of livestock to wild carnivores conceivably resulting in stock losses. Escalation of human and wild life conflict is due to increased contact of domestic dogs and wolves which result in potential hybridization and disease transmission. Domestic dogs are directly competing with the wolves and by acting as vectors of disease. Extensive overgrazing by cattle is a significantly unfavorable impact on rodent population. Since firewood and fuel the ericaceous heath lands have been an important source of firewood, human collect for the purpose of their daily life. Those are the main problems in the study sites.

1.3. Significance of the study

The following key points are taken as the significance of the study. To conserve the Ethiopian wolf in safe conditions to minimize the risk of rabies being passed from domestic dogs to the Ethiopian wolf in Sanetti plateau and Web Valley is a crucial issue. To understand the mechanisms of Ethiopian wolf ecosystem and to develop sustainable strategies for the managemant of threatened resources; to reconcile human needs and conservation of biological resources and, evaluate potential sites for essential biological parameters (prey abundance, habitat types, and competition with other carnivores) and socio-economic factors (human density, land use, livestock husbandry practices, domestic dogs, proximity to large settlements) in Sanetti plateau and Web valley. Provide factual information on Ethiopian wolf conservation requirements to government organizations and interested group. Investigate the feasibility, acceptability, effectiveness and sustainability of limiting the growth of the domestic dog population to prevent dog-wolf hybridization and disease transmission. Improve Ethiopian wolf conservation in Sanetti plateau and Web Valley.

1.4. Research Questions

- ✓ What is the current population status of the Ethiopian wolf in the Sanetti plateau and Web Valley?
- ✓ What are the attitudes of the local people to ward the Ethiopian wolf in the Sanetti plateau and Web Valley?
- ✓ What are the main causes of disturbances on the Ethiopian wolf in the Sanetti plateau and the Web Valley?
- ✓ What are the consequences of the human interaction on the Ethiopian wolf in the Sanetti plateau and Web Valley?

1.5. Objectives of the study

1.5.1. General objective

The general objective of this study was to conduct a comparative investigation of human interference on Ethiopian wolf habitat in the Sanetti Plateau and Web Valley of BMNP and to assess the intensity of conflict between human and the Ethiopian wolf.

1.5.2. Specific objectives

- ➢ to identify the main causes of disturbances on the Ethiopian wolf in Sanetti plateau and Web-Valley
- ➢ to identify the attitude of local people toward the Ethiopian wolves
- ➢ to assess the consequences of the human interaction on the habitats of the Ethiopian Wolf in Sanetti plateau and Web Valley
- ➢ to investigate the activities of the Ethiopian wolves in the presence and absence of humans and livestock in the study area
- ➢

2. LITERATURE REVIEW

2.1. The Ethiopian Wolf

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). Among 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, and chest and between the two legs (Sillero-Zubiri and Gottelli, 1994; Sillero-Zubiri *et al.*, 1996).

2.2. Nomenclature of the Ethiopian Wolf

Even though the Ethiopian wolf is the most distinct *canid* species, it has certain common features with other species such as side-stripped 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 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, Semein or Semeinian fox, red fox, Semein or Semeinian jackal, Ethiopian jackal and red jackal.

Throughout the country, it is known by its Amharic name, Key kebero and Walgie and its Afan Oromo name, Jeedala fardaa and Jeedala diimtuu (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).

2.3. Evolution

Although fossil records exist as wolf-like *canids* from Late Pleistocene Eurasia, no fossil records are known for the Ethiopian wolf. In 1994, a mitochondrial DNA analysis showed a closer relationship to the gray wolf and the coyote than to other African *canids*, and *Canis simensis* may be an evolutionary relic of a gray wolf-like ancestor's past invasion of northern Africa from Eurasia (Gottelli *et al*., 1994). Due to the high density of rodents in their new Afro alpine habitat, the ancestors of the Ethiopian wolf gradually developed into specialized rodent hunters. This specialization is reflected in the animal's skull morphology, with its very elongated head, long jaw, and widely spaced teeth. During this period, the species likely attained its highest abundance, and had a relatively continuous distribution. This changed about 15,000 years ago with the onset of the current interglacial, which caused the species' afro alpine habitat to fragment, thus isolating Ethiopian wolf populations from each other (Gottelli *et al*., 2004).

2.4. Taxonomy

The Ethiopian wolf is one of five *Canis* species present in Africa, and is readily distinguishable from jackals by its larger size, relatively longer legs, distinct reddish coat, and white markings. John Edward Gray and Glover Morrill Allen originally classified the species under a separate genus, *Simenia* (IUCN, 2011) and Oscar Neumann considered it to be "only an exaggerated fox" (Powell-Cotton,1902).Juliet Clutton-Brock refuted the separate genus in favor of placing the species in the genus *Canis*, upon noting cranial similarities with the side-striped jackal (Clutton-Brock *et al*., 1976).

In 2015, a study of mitochondrial genome sequences and whole genome nuclear sequences of African and Eurasian *canids* indicated that extant wolf-like *canids* have colonized Africa from

Eurasia at least five times throughout the Pliocene and Pleistocene, which is consistent with fossil evidence suggesting that much of African *canid* fauna diversity resulted from the immigration of Eurasian ancestors, likely coincident with Plio-Pleistocene climatic oscillations between arid and humid conditions. According to a phylogeny derived from nuclear sequences, the Eurasian golden jackal (*Canis aureus*) diverged from the wolf/coyote lineage 1.9 million years ago, and with mitochondrial genome sequences indicating the Ethiopian wolf diverged from this slightly prior to that(Koepfli *et al*.,2015).

2.5. Physical description

The Ethiopian wolf is similar in size and build to North America's coyote; it is larger than the golden, black-backed, and side-striped jackals, and has relatively longer legs. Its skull is very flat, with a long facial region accounting for 58% of the skull's total length. The ears are broad, pointed, and directed forward. The teeth, particularly the premolars, are small and widely spaced. The canine teeth measure 14 mm–22 mm in length, while the carnassial are relatively small. The Ethiopian wolf has eight mammae, of which only six are functional. The front paws have five toes, including a dewclaw, while the hind paws have four. As is typical in the genus *Canis*, males are larger than females, having 20% greater body mass. Adults measure 841mm–1,012 mm in body length, and 530 mm–620 mm in height. Adult males weigh 14.2 kg–19.3 kg, while females weigh 11.2 kg–14.15 kg (Sillero-Zubiri *et al*., 1994).

The Ethiopian wolf has short guard hairs and thick under fur, which provides protection at temperatures as low as −15 °C. Its overall colour is ocher to rusty red, with dense whitish to pale ginger under fur. The fur of the throat, chest and under parts is white, with a distinct white band occurring around the sides of the neck. There is a sharp boundary between the red coat and white marks. The ears are thickly furred on the edges, though naked on the inside. The naked borders of the lips, the gums and palate are black. The lips, a small spot on the cheeks and an ascending crescent below the eyes are white. The thickly furred tail is white underneath, and has a black tip. It moults during the wet season (August–October), and there is no seasonal variation in coat colour, though the contrast between the red coat and white markings increases with age. Females tend to have paler coats than males. During the breeding season, the female's coat turns yellow, becomes woolier, and the tail turns brownish, losing much of its hair (Sillero-Zubiri *et al.*, 1994).

Animals resulting from Ethiopian wolf dog hybridization tend to be more heavily built than pure wolves, and have shorter muzzles and different coat patterns (IUCN, 2011).

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 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).

2.6. Behavior

2.6.1. Social and territorial behavior

The Ethiopian wolf is a social animal, which lives in family groups containing up to 20 individuals older than one year, though packs of six wolves are more common. Packs are formed by dispersing males and a few females, which with the exception of the breeding female, are reproductively suppressed. Each pack has a well-established hierarchy, with dominance and subordination displays being common. Upon dying, a breeding female can be replaced by a resident daughter, though this increases the risk of inbreeding. Such a risk is sometimes circumvented by multiple paternity and extra-pack mating. The dispersal of wolves from their packs is largely restricted by the scarcity of unoccupied habitat (IUCN, 2011).

These packs live in communal territories, which encompass 6 km^2 of land on average. In areas with little food, the species lives in pairs, sometimes accompanied by pups, and defends larger territories averaging 13.4 km^2. In the absence of disease, Ethiopian wolf territories are largely stable, but packs can expand whenever the opportunity arises, such as when another pack disappears. The size of each territory correlates with the abundance of rodents, the number of wolves in a pack, and the survival of pups. Ethiopian wolves rest together in the open at night, and congregate for greetings and border patrols at dawn, noon, and evening. They may shelter from rain under overhanging rocks and behind boulders. The species never sleeps in dens, and

only uses them for nursing pups. When patrolling their territories, Ethiopian wolves regularly scent-mark, (Sillero-Zubiri *et al*., 1998) and interact aggressively and vocally with other packs. Such confrontations typically end with the retreat of the smaller group (IUCN, 2011).

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). 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 km^2 to 13 km^2 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). 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.

2.6.2. Reproduction and development

The mating season usually takes place between August and November. Courtship involves the breeding male following the female closely. The breeding female only accepts the advances of the breeding male, or males from other packs. The gestation period is 60–62 days, with pups being born between October and December, pups are born toothless and with their eyes closed, and are covered in a charcoal-grey coat with a buff patch on the chest and abdomen (IUCN, 2011). Litters consist of two to six pups, which emerge from their den after three weeks, when the dark coat is gradually replaced with the adult colouration. By the age of five weeks, the pups feed on a combination of milk and solid food, and become completely weaned off milk at the age of 10 weeks to six months (Sillero-Zubiri *et al.*, 1994). All members of the pack contribute to protecting and feeding the pups, with subordinate females sometimes assisting the dominant female by suckling them. Full growth and sexual maturity are attained at the age of two years (IUCN, 2011).Most females disperse from their natal pack at about two years of age, and some become "floaters" that may successfully immigrate into existing packs. Breeding pairs are most

often unrelated to each other, suggesting that female-biased dispersal reduces inbreeding (Randall*et al*., 2007).

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 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. The allot-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.

2.6.3. Hunting behavior

Unlike most social carnivores, the Ethiopian wolf tends to forage and feed on small prey alone. It is most active during the day, the time when rodents are themselves most active, though they have been observed to hunt in groups when targeting mountain nyala calves (IUCN, 2011). Major Percy-Cotton described the hunting behaviour of Ethiopian wolves those they are most amusing to watch, when hunting. The rats, which are brown, with short tails, live in big colonies and dart from burrow to burrow, while the cube row stands motionless till one of them shows, when he makes a pounce for it. If he is unsuccessful, he seems to lose his temper, and starts digging violently; but this is only lost labour, as the ground is honeycombed with holes, and every rat is yards away before he has thrown up a pawful (Powell-Cotton, 1902). The technique described above is commonly used in hunting big-headed mole-rats, with the level of effort varying from scratching lightly at the hole to totally destroying a set of burrows, leaving meter-high earth mounds.

Wolves in Bale have been observed to forage among cattle herds, a tactic thought to aid in ambushing rodents out of their holes by using the cattle to hide their presence (Sillero-Zubiri *et al.,* 1994). Ethiopian wolves have also been observed forming temporary associations with troops of grazing geladas (Dartmouth, 2015). Solitary wolves hunt for rodents in the midst of the

monkeys, ignoring juvenile monkeys, though these are similar in size to some of their prey. The monkeys, in turn, tolerate and largely ignore the wolves, although they take run away if they observe feral dogs, which sometimes prey on them. Within the troops, the wolves enjoy much higher success in capturing rodents than usual, perhaps because the monkeys' activities flush out the rodents, or because the presence of numerous larger animals makes it harder for rodents to spot a threat (Venkataraman *et al*., 2015).

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 reestablish 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 (Silliro-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). 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. Rodents account for 95% of the food of this species. These include: the endemic giant mole rats species (300 g - 930 g), the common mole rat, *Arvicanthis blicki, A. abyssinicus, Lophuromysmelanonyx* and *Otomys typus* (Sillero-Zubiri and Gottelli, 1995; Ray *et al*., 2005). The giant male 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 *et a*l., 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 (SilleroZubiri and Macdonald, 1997; Newey and Sillero- Zubiri, 2002).

2.7. Ecology of the Ethiopian wolf

2.7.1. Habitat

The Ethiopian Wolf is restricted to isolated pockets of afro alpine grasslands and heathlands inhibited by afro alpine rodents. The Ethiopian wolf uses all afro alpine habitats, but has a preference for open areas containing short herbaceous and grassland communities inhabited by rodents, which are most abundant along flat or gently sloping areas with poor drainage and deep soils. Prime wolf habitat in the Bale Mountains consists of short *Alchemilla* herbs and grasses, with low vegetation cover. Other favorable habitats consist of tussock grasslands, high-altitude scrubs rich in *Helichrysum*, and short grasslands growing in shallow soils. In its northern range, the wolf's habitat is composed of plant communities characterized by a matrix of *Festuca* tussocks, *Euryops* bushes, and giant lobelias, all of which are favored by the wolf's rodent prey. Although marginal in importance, the ericaceous moorlands at 3,200 m -3,600 m in Semein may provide a refuge for wolves in highly disturbed areas (IUCN, 2011).

2.7.2. Diet

In the Bale Mountains, the Ethiopian wolf's primary prey are big-headed mole-rats, though it also feeds on grass rats, black-clawed brush-furred rats, and highland hares. Other secondary prey species include vile rats, yellow-spotted brush-furred rats, and occasionally goslings and eggs. Ethiopian wolves have twice been observed to feed on rock hyraxes and mountain nyala calves. In areas where the big-headed mole-rat is absent, the smaller East African mole-rat is targeted. In the Semein Mountains, the Ethiopian wolf preys on Abyssinian grass rats. Undigested sedge leaves have occasionally been found in Ethiopian wolf stomachs. The sedge possibly is ingested for roughage or for parasite control. The species may scavenge on carcasses, but is usually displaced by dogs and African golden wolves. It typically poses no threat

to livestock, with farmers often leaving herds in wolf-inhabited areas unattended (Sillero-Zubiri *et al.,* 1994).

2.7.3. Distribution

According to Gottelli *et al*. (2004), the Ethiopian wolves are currently restricted to seven isolated populations in the high altitude ecosystem of the country. North of the Rift Valley, the species occurs in the Semein Mountains in Gondar, in the northern and southern Wollo highlands, and in Guassa Menz in northeast Shoa. It has recently become extinct in Gosh Meda in north Shoa and mount Abafarit in South Gondar, and has not been reported in Mount Choke for several decades. Southeast of the Rift Valley, it occurs in the Arsi and Bale Mountains (IUCN, 2011).

2.8. Threats

The Ethiopian wolf has been considered rare since it was first recorded scientifically. The species likely has always been confined to afro alpine habitats, so is never widespread. In historical times, all of the Ethiopian wolves' threats are both directly and indirectly human-induced, as the wolves' highland habitat. Its proximate threats include habitat loss and fragmentation due to overgrazing, road construction, livestock farming, diseases (primarily rabies and canine distemper), conflict with humans (poisoning, persecution, and road kills), and hybridization with dogs (IUCN, 2011).

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 and Sillero-Zubiri (2007), the Ethiopian wolves which have a narrow ecological niche, suffer in the afro alpine 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.

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 *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. They carry out their activity confidentially when human activity is totally absent in the area (Zelealem *et al.,* 2005).

2.9. Habitat loss

Habitat loss in the Ethiopian highlands is directly linked to agricultural expansion into afro alpine areas. 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 afro alpine vegetation 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, 2003; Mesele *et al*., 2009). 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 *etal*., 2001). Stephens *et al*. (2001), noted that regular disturbance by livestock is seen in all wolf habitat the presence of livestock in afro alpine ecosystem has also a negative impact on tourists visiting the biodiversity of the country (Sillero-Zubiri and Macdonald, 1997; Zelealem and Sillero-Zubiri, 2007).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

Bale Mountain National Park

The Bale Mountain National Park (BMNP) is located between $6^0$29′N and $7^0$10′N latitude and $39^0$28′E and $39^0$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 (Fig1).

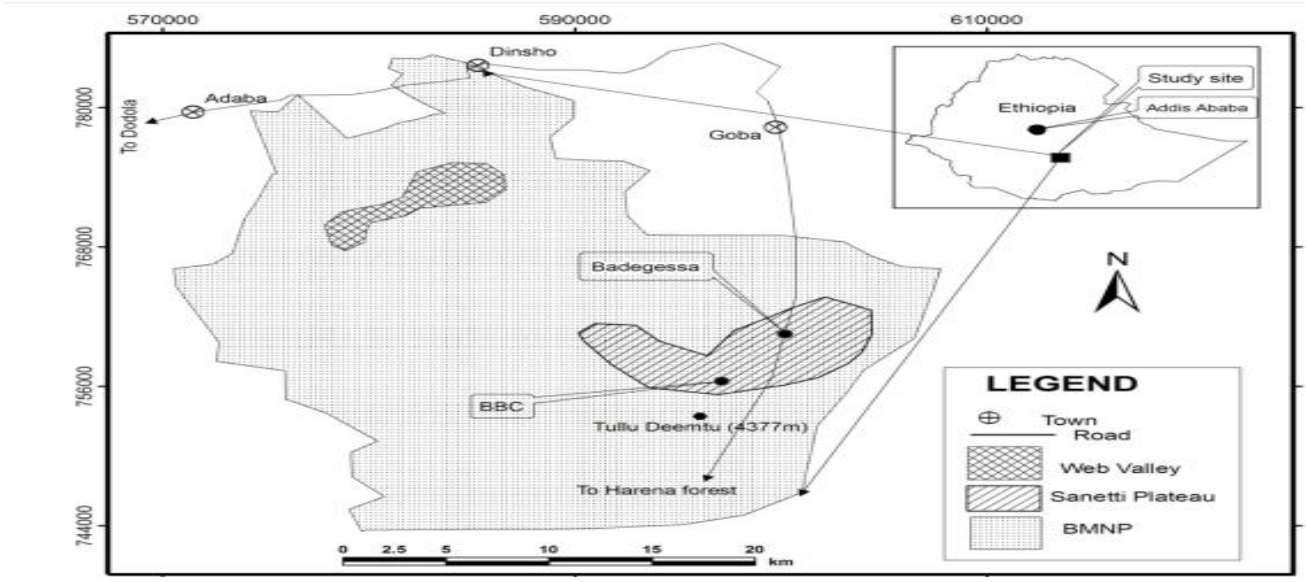

Figure 1. Bale Mountains showing distribution of Ethiopian wolf habitats and map of the study sites.

Source: From World Wildlife Fund (WWF) Non-Governmental Organization Office Dinsho District

BMNP is the largest area of continuous afro alpine habitat in Africa (Sillero-Zubiri *et al*., 1998). It has a diversity of land features. These are very high mountainous ridges, plateau, flat valley, afro alpine steppes and swampy land features. The Bale complex of Sanetti Plateau is the largest high altitude plateau in Africa (3,800 m to above 4,000 m) (Evangelista *et al*., 2009). It also consists of the flat valley bottom, Web Valley (3,450 m - 3,550 m), which is a typical afro alpine steppe or meadowland and the montane grasslands of Gaysay (3,000 m - 3,100 m). In the west of this main range, there is a smaller Somkaru-Korduro Mountain Range (Marino, 2003). In the western Sanetti Plateau, there are high mountain ridges such as Tulu Dimtu and Batu.

The highest peak in Southern Ethiopia, Tulu Dimtu, 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 (Bale Goba Metrological Agency, 2016). 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 mm to 1,500 mm. The heavy rain is from July to October, with the highest peak in August and the short rainy season from March to June and from November to December (Fig 2).

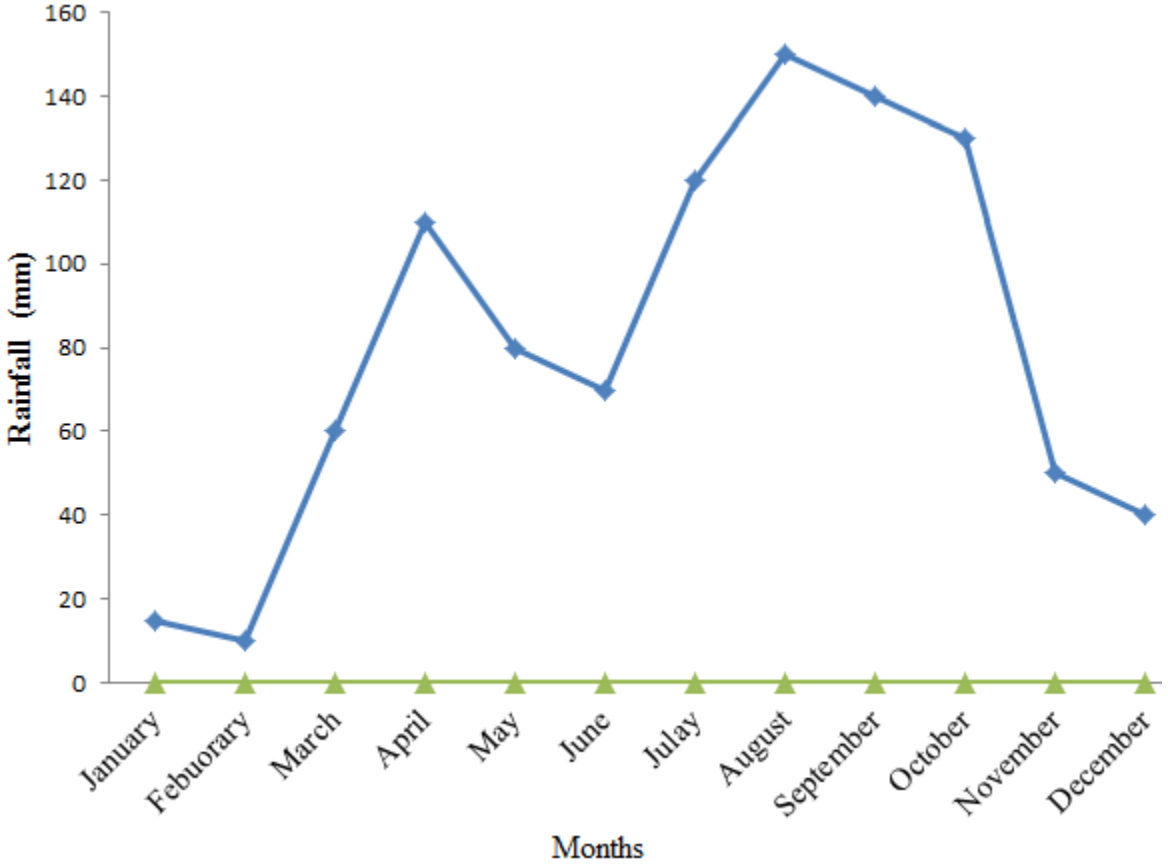

Figure 2. Mean monthly rainfall of BMNP Range during 2012–2016

Source: Bale Goba Metrological Agency

According to Marino (2003), the mean daily maximum temperature at 3,500 m is 19^0C, ranging from 12.5^0C to 25^0C. The temperature of the area shows extremes during the dry season and more or less the same pattern during the wet season (fig 3). The highest temperature is in February ($25.5\ ^0$C) and the lowest is in January (1.4^0C) (Bale Goba Metrological Agency, 2016).

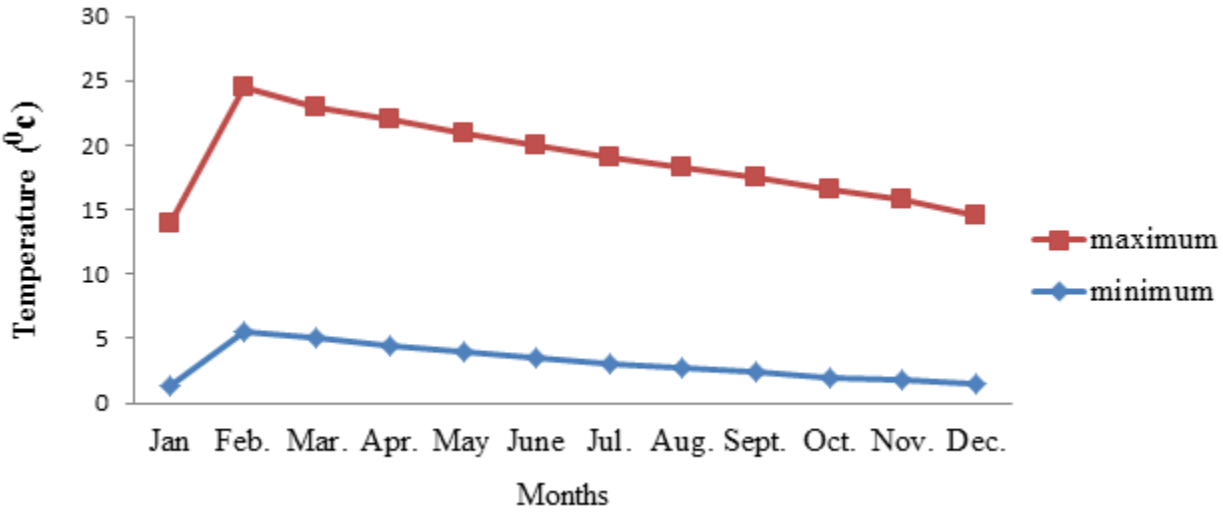

Figure 3. Mean monthly maximum and minimum temperature of BMNP Range during 2012 - 2016

Source: Bale Goba Metrological Agency.

Vegetation (Flora) of the study area

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 *Euryopsprostratus* 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 afro alpine moorland and grassland, the northern wetlands and the southern Harena forest.

Animal (Fauna) of the study area

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 BMNP is also a hot spot of endemicity 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 afro alpine vegetation. These habitats sustain the highest density of wolves. The Tullu Deemtu area represents the *Helichrysum* heaths, along the southern western slopes of Sanetti, where wolves occur at much lower densities

(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.

3.2. Methods

3.2.1. Sampling techniques

A pilot study was carried out before starting actual data collection to gather relevant information from local community of the area. This helped to identify the number of grids. During this survey, all the available and relevant information about the area (seasons and topography) were collected. The ground line transects and direct observation methods were used. From the Web Valley range, Alandu and Tarura and from the Sanetti Plateau, Garba-guracha and Batu Ethiopian wolf's focal packs were selected randomly to investigate the Ethiopian wolf disturbance by humans.

3.2.2. Sampling size

A study was conducted in different microhabitats during the different months of the year. The number, length and width of ground line transect used can be varied depending on the size and type of each micro habitat. A total of 12 transect lines ranging from 1 km to 1.5 km length were selected. Six transects were designed from Alandu and Tarura of Web Valley wolf packs and six from Batu and Garba-guracha of the Sanetti Plateau. A total of 33 people were selected randomly for interview from the two study sites. Out of these, 21 respondents were selected from Web Valley and 12 were selected from Sanetti plateau.

3.2.3. Data collection

The actual data collection was conducted from December, 2016 to May, 2017 by means of face-to-face interview and by direct observation.

3.2.3.1. Direct observation

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 once a month from distance 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 running distance of Ethiopian wolves from humans in both study sites was recorded. The number and kind of observed animals occurred within a maximum distance on left and right sides of the strip transect were distinguished.

The transect studies were repeated every month for six months during both the wet and dry seasons (Azhar *et al*., 2008). The track lines were located separately at more than 100 m apart to avoid double counting of individuals. (Appendix II).

3.2.3.2. Interview question

The interview question was designed mainly to check whether people living in both study sites to collect information about the attitude of the community towards the Ethiopian wolf. It was also designed to assess various parameters in relation to the issue. The interview question included both open ended and close ended response questions. Open ended questions were included to elicit information on the knowledge about the Ethiopian wolves of the study site. The interview questions were discussed with the interviewee in local language Amharic or Afan Oromo to reduce communication barriers and to get more information (Appendix I).

3.3 Data analysis

Collected data were analyzed using SPSS version 22 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 sites after a one-way ANOVA test. For the data collected using interview question and direct observation, chi-square test was used to determine and compare the significant differences between the study sites. Spearman correlation coefficient was also used to relate the significance impact of livestock and their grazing duration on the wolf habitat.

4. RESULTS

4. 1. Direct observation

During the wet season, there was 79.82% and 49.88% of livestock grazed per transect in the Web Valley and in the Sanetti plateau respectively. Similarly, during the dry season, there was 20.18% and 50.11% of livestock grazed per transect in the Web Valley and in the Sanetti plateau respectively (Table 1). During the wet season, there was a significant difference between Web Valley and Sanetti plateau in the amount of livestock grazed per transect (X^2= 35.56, df. 1, P < 0.05). Similarly, during the dry season, there was a significant difference between Web Valley and Sanetti plateau in the amount of livestock grazed per transect (X^2 = 0.000, df. 1, P > 0.05).

Table 1. Mean number of livestock recorded grazing in Web Valley and Sanetti plateau of BMNP

Area	Season	
	Wet	Dry
Web Valley	3003	359
Sanetti plateau	444	446

In the Web Valley, 66.67% and 33.33% of domestic dogs shared the Ethiopian wolf habitat during the wet and dry seasons, respectively. While, there was no domestic dogs recorded in the Sanetti Plateau (Table 2). Therefore, the two study sites significantly differed in the number of domestic dog disturbing the Ethiopian wolf ($\chi 2$ =100, df. 1, P < 0.05).

Table 2. Mean number of domestic dogs recorded in Web Valley and Sanetti Plateau of BMNP

Area	Season	
	Wet	Dry
Web Valley	6	3
Sanetti plateau	0	0

During the wet season, there was 52.46% and 60 % of people appeared in the wolf habitat per transect in the Web Valley and in the Sanetti plateau respectively. During the dry season, there was 47.54% and 40% of people appeared in the wolf habitat per transect in the Web Valley and in the Sanetti plateau respectively (Table 3). In the Web Valley 488 people were observed in the Ethiopian wolf habitat during the wet and dry seasons. While, only five people were observed in the Sanetti Plateau. However, the two study sites revealed a significant difference in the number of people disturbed the Ethiopian wolf habitats ($\chi 2$ = 96.04, df. 1, P < 0.05).

Table 3. Mean number of people seen in Web Valley and Sanetti plateau of BMNP

Area	Season	
	Wet	Dry
Web Valley	256	232
Sanetti plateau	3	2

In the Web Valley, 69.86% and 30.14% of shepherds kept their livestock during the wet and dry seasons, respectively. In the Sanetti Plateau, 100% of the herders kept their livestock during the wet season (Table 4). Therefore, the two study sites showed a marked significant difference in the proportion of livestock guard in the Ethiopian wolf habitats ($\chi 2$ = 47.34, df = 1, P < 0.05).

Table 4. Mean number of People looking after livestock in Web Valley and Sanetti plateau of BMNP

Area	Season	
	Wet	Dry
Web Valley	102	44
Sanetti plateau	2	

In the Web Valley during the wet season, there was no significant difference between Alandu and Tarura in the number of chased, ignore and noise made on the wolves, but during the dry season there was a significant difference between Alandu and Tarura in the number of Ethiopian wolf ignored and noise made by the people in the study sites of wolf habitat (Table 5). However, the Web Valley range and Sanetti Plateau significantly differed in the number of noise that made in the Ethiopian wolf habitat ($\chi 2$ = 34, df = 1, P < 0.05. In the same way, there was a significant disparity in the number of chased after the animal in the study sites ($\chi 2$ = 4, df = 1, P < 0.05). The entire chasing after the Ethiopian wolf was only recorded from Web-valley range. On the other hand, the Sanetti Plateau and Web-valley range revealed no significant difference in the amount of Ethiopian wolf ignored by the people ($\chi 2$ = 1, df = 1, P > 0.05).

Table 5. Reaction of the people to the Ethiopian wolf in Web Valley and Sanetti Plateau of BMNP

Area	Season	observed activities		
		noise	chase	ignore
Web Valley	Wet	15	4	5
	Dry	19	0	5
Sanetti plateau	Wet	0	0	4
	Dry	0	0	2

In the Web Valley, 53.85% and 46.15% of the Ethiopian wolf population occurred during the wet and dry seasons, respectively. Similarly, in the Sanetti Plateau, 50% of the Ethiopian wolf population occurred both during the wet and dry seasons (Table 6). On the other hand, 72.34% and 27.66% of the Ethiopian wolves were hosted in the Sanetti Plateau and Web Valley range, respectively. Therefore, the study sites significantly differed in the number of the Ethiopian wolf population inhabiting in its habitat ($\chi 2$ = 17.36, df = 1, P < 0.05).

Table 6. Mean number of Ethiopian wolves population recorded in Web Valley and Sanetti plateau of BMNP

Area	Season	
	Wet	Dry
Web Valley	7	6
Sanetti plateau	17	17

The Ethiopian wolves spent more time to forage, lie down and walk through the pack for food in the Sanetti Plateau than in the Web Valley range during the presence of humans. While, the animal spent more time to stand and run in the Web Valley range than in the Sanetti Plateau in the presence of humans. The Web Valley range and the Sanetti plateau of the Ethiopian wolf habitats showed no significant difference in the mean time spent for foraging, by the Ethiopian wolf in the absence of humans. However, the Ethiopian wolf spent more time to lie down and walk through the pack in the Sanetti plateau and to stand in the Web Valley Range during the absence of humans (Table 7).

Table 7. Mean length of time (hours) the Ethiopian Wolf spent during the presence and absence of humans

Activities	Mean length of time the Ethiopian Wolf spent during			
	In the presence of humans		In the absence of humans	
	In Web Valley	In Sanetti plateau	In Web Valley	In Sanetti plateau
Foraging	1.5	2	2.5	3.5
Resting	0.5	1.5	1.5	2
Standing	2.5	0.5	3	0.5
Walking	1	2.5	2	3
Running	2	3	1.75	1

The animal spent more time to forage, rest and walk through the habitat in the sanetti plateau than in the Web Valley range during the presence of livestock. However, the wolves used more time to stand in the Web Valley range than in the Sanetti plateau during the presence of livestock. The two sample sites did not show a marked difference in the mean time spent for foraging, walking and running by the Ethiopian wolf during the absence of livestock (Table 8).

Table 8. Mean length of time (hours) the Ethiopian Wolf spent during the presence and absence of livestock

Activities	Mean length of time the Ethiopian Wolf spent during			
	In the presence of livestock		In the absence of livestock	
	In Web Valley	In Sanetti plateau	In Web Valley	In Sanetti plateau
Foraging	2.5	3	2.5	3.5
Resting	1.5	2.5	1.5	2.5
Standing	3	1.5	3	0.5
Walking	2.75	3.5	2	2.75
Running	1.75	1	1.75	0.75

The escape distance of the Ethiopian wolf showed a marked significance difference between the two study sites (Table 9). Wolves moved away long distance from humans in the Web Valley range than in the Sanetti Plateau ($\chi 2$ = 159.26, df = 1, P < 0.05).

Table 9. Mean escape distance (meters) of the Ethiopian wolf from humans

Site	Number of wolf population observed	Distance	
		Minimum	maximum
Web Valley	9	150	200
Sanetti plateau	17	50	100

4. 2. Interview Questions

Firewood collection was a regular practice of people living around the forest habitat. People living in and around the afro alpine ecosystem collects *Erica* for sale and home use, the Web Valley range respondents collected firewood from and around the Ethiopian wolf habitat. But, none of the Sanetti Plateau respondents gathered firewood, grass and produce charcoal from the study sites (Table 10).

Table 10. Resource utilization of respondents in the study sites

Study site	Number of respondents	Firewood	Grass	Charcoal	Others
Web Valley	21	3(14.28%)	12(57.14%)	1(4.76%)	5(23.82%)
Sanetti Plateau	12	0	0	0	0

Livestock are the main factor responsible for disturbing the Ethiopian wolf habitat. All of the Sanetti Plateau and majority of the Web Valley respondents grazed their livestock in the study sites (Table 11).

Table 11. Number of respondents who grazed livestock and cultivated in the study sites

Study site	Number of respondents	Grazing	Farming	Others
Web Valley	21	17(80.95%)	1(4.76%)	3(14.29%)
Sanetti Plateau	12	12(100%)	0	0

The average annual period livestock spent in the study sites was 7- 9 months ranging from 5 to 12. In the Web Valley 52.4% and in the Sanetti Plateau 100% of the respondents grazed their livestock for 9-12 months in the study sites (Table 12). Respondents grazed their livestock for long period of the year in the Sanetti Plateau than in the Web Valley 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 sites.

Table 12. Respondents who grazed livestock during the months of the year

Study area	Number of respondents	1-4 months	5-6 months	7-8 months	9-12 months
Web Valley	21	0	9(42.8%)	1(4.8%)	11(52.4%)
Sanetti plateau	12	0	0	0	12(100%)

The average daily time spent by livestock for grazing in the study sites was 8-9 hours. All of the Sanetti Plateau and 52.38% of the Web Valley respondents grazed their livestock in the study sites for about 10 hours per day (Table 13). Daily grazing duration is negatively correlated (r = -0.30) with the number of respondents who grazed their livestock in the study sites.

Table 13. Respondents who grazed livestock during the day time

Study site	Number of respondents	6-7 hours	8-9 hours	10 hours
Web Valley	21	2(9.52%)	8(38.1%)	11(52.38%)
Sanetti Plateau	12	0	0	12(100%)

In the Web-valley range 57.14% and in the Sanetti Plateau 25% of the respondents confirmed that the number of the Ethiopian wolf population has declined severely. While, 66.7% of the Sanetti Plateau and 9.52% of the Web Valley range respondents revealed that the population of the wolf has increased (Table 14).

Table 14. Views of respondents on the current status of the Ethiopian wolf population

Study site	Number of respondents	Increase	Decrease	No change	Do not know
Web Valley	21	2(9.52%)	12(57.14%)	3(14.29%)	4(19.05%)
Sanetti Plateau	12	8(66.7%)	3(25%)	1(8.3%)	0

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, 85.71% and 100% of the respondents from Web Valley and Sanetti Plateau, respectively, had positive attitude towards the Ethiopian wolf (Table 15).

Table 15. Attitudes of respondents towards the Ethiopian wolf

Study site	Number of respondents	Positive attitude	Negative attitude
Web Valley	21	18(85.71%)	3(14.29%)
Sanetti Plateau	12	12(100%)	0

In many of its habitat, people usually did not blame the animal preying on their livestock. Accordingly, 71.5% and 100% of respondents from the Web Valley and Sanetti Plateau, respectively, did not blame the animal preying on livestock (Table 16).

Table 16. Response of respondents on the Ethiopian wolf preying on livestock

Study site	Number of respondents	Yes	No	Do not know	Sheep killed in 2016/17
Web Valley	21	3(14.3%)	15(71.4%)	2(9.5%)	1(4.8%)
Sanetti Plateau	12	0	12(100%)	0	0

People living in and around the afro alpine ecosystem share the wolf habitats. As a result, the animal is frequently disturbed by the people. None of the Sanetti Plateau and 47.6% of the Web Valley respondents confirmed that the animal has suffered by the activities of humans in the site (Table 17).

Table 17 Response of respondents on the Ethiopian wolf affected by people

Study site	Number of respondents	Yes	No	Do not know
Web Valley	21	10(47.6%)	8(38.1%)	3(14.3%)
Sanetti Plateau	12	0	12(100%)	0

5. DISCUSSION

In the current finding, 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 Web Valley range of Alandu pack. On the contrary, small number of livestock shared the Ethiopian wolf habitat in the Sanetti Plateau of Batu pack. This might be due to the large number of livestock and people encroaching around the Web Valley range relied on the area for grazing. Therefore, more number of livestock was disturbing the Ethiopian wolf in the Web Valley 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 Web Valley range than in the Sanetti Plateau.

During the direct observation of the current finding, large number of shepherds was observed in Alandu and Tarura wolf packs of the Web Valley range. The mean shepherd herded livestock per transect during the wet season was greater than the dry season. As a result, in the Web Valley 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 Web Valley range than in the Sanetti Plateau. This could be associated with the effort to protect their livestock from hyena.

The most important immediate threat to the Ethiopian wolf population comes from domestic dogs (Haydon *et al*., 2006; Evangelista *et al*., 2009). In the current finding, the mean of domestic dog per transect revealed was 0.73 ± 0.40 and 0.56 ± 0.20 during the wet and dry seasons, respectively. During the current finding, all domestic dogs were recorded from Alandu and Tarura Ethiopian wolf packs. Therefore, the study sites 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 Web Valley range becoming responsible to protect livestock from hyena.

Moreover, the Ethiopian wolf habitat also served as a means of path for the local people living in and around the afro alpine 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 Web-valley range than in the Sanetti Plateau.

People's attitude towards the Ethiopian wolf is directly associated with resource utilization of the afro alpine ecosystem (Ray *et al*., 2005). In the current finding, 85.71% of Web Valley range and 100% of the Sanetti Plateau respondents had positive attitude towards the 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 current finding showed that the Sanetti Plateau residents had better positive attitude towards the Ethiopian wolf than the Web Valley range. This could be due to the local acceptance of the animal.

The current situation of the Ethiopian wolf population is worsened in the Web Valley range than in the past. Similarly, more number of the Web Valley range respondents revealed that the number of the wolf has declined in the area. While, most of the Sanetti Plateau respondents revealed that the wolf population has increased in the recent past. During the direct observation, the largest Ethiopian wolf pack size observed in the Web Valley range was four. In the current finding, the Sanetti Plateau packs relatively hosted larger number of the Ethiopian wolves than the Web-valley 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 current finding, nearly half of the Web-valley 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 Web Valley 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 an afraid of humans and unable to carry out their normal behavior (Zelealem Tefera *et al*., 2005). 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 frequently chased after the Ethiopian wolves in the Web Valley 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 Web Valley 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.

It was observed that the Ethiopian wolf spent more time to forage in the Sanetti Plateau than in the Web Valley 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. While, in Web Valley 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 (Zelealem Tefera *et al*., 2005). Adequate feeding resource and time determine the reproductive success and litter size of the Ethiopian wolves (Tallents, 2007). Thus, the two study sites 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 Web Valley range.

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

Ethiopian wolves spent more time in their habitat in the absence of human than in the presence of humans (Zelealem Tefera *et al*., 2005). In the absence of human, the study sites showed no marked difference in the length of time of foraging and running. While the study sites 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 Web Valley range in the absence of humans. This could be because; wolves in the Web Valley 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 (Zelealem Tefera *et al*., 2005). Even if, the pressure exerted by livestock was not equally pronounced as humans, the study sites 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 Web Valley range. In the presence of livestock, the animal took more time to stand in the Web Valley range than in the Sanetti Plateau. This could be because in the Web Valley range most of the time people accompany their livestock especially during the wet season.

Ethiopian wolves have shorter escape distance in less disturbed areas. In this area, wolves moved away slowly from humans and made alarm calls. (Zelealem 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 of humans. While in the Web Valley range, wolves frequently ran away in the presence of humans. Ethiopian wolves in the Web Valley range spent most of their time dispersing from one place to anthers. As a result, the animal has longer escape distance in Web Valley range than in the Sanetti Plateau. The escape distances affect the foraging and breeding behavior of the animal and its survival rate. Therefore, the study sites showed a marked difference in the escape distance Ethiopian wolves made from the human. This could be due to the serious disturbance frequently observed in the Web Valley range.

6. CONCLUSION AND RECOMMENDATIONS

6. 1. Conclusion

The current finding study provided valuable comparative information on the Ethiopian wolf disturbance rate by humans in the Web Valley range and Sanetti Plateau. 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 Web Valley range. In the Web Valley range of the Ethiopian wolf territory people were observed increasingly damaging the wolf habitat. The animals were 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 is highly reduced. Wolves in the Web Valley range spent most of the day time by running away from humans here and there throughout its habitat.

On the other hand, wolves in the Web Valley 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 sites, livestock grazed in the Web Valley were highly disturbed as a result of their numbers.

6. 2. Recommendations

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

- The government should compensate grazing land for the people who regularly visit the Ethiopian wolf habitat to herd their livestock (buffer zone should be established).
- Clear demarcation and frequent patrol of boundaries should be made between the people living in the area and the park.
- Past and present strategies of managing the Ethiopian wolf by the Ethiopian Wolf Conservation Program in the BMNP may need to be evaluated by concerned bodies.
- The present acceptance of the Ethiopian wolves and other wildlife by the Sanetti people should be encouraged and the same measure should be taken by the Web Valley people.
- Work with local communities and local government to foster coexistence between BMNP staff and park resident, invite residents to participate in development of conservation programmes.
- Involves BMNP residents in the protection of afro alpine wildlife through a community education and extension programme.
- Extend management and staff assignment to the afro alpine ecosystem of the BMNP.
- Awareness creation should be made in the community on how to control the spread of zoonotic diseases and rabies in the park.

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APPENDIX I

Adama Science and Technology University School of Graduate Studies, Department of Biology, interview sheet for people that live in and around the study sites

Introductory Questions

1. Age _____
2. Sex _____
3. Kebele _____
4. Education level _____

Resource use in the study area

1. Does your livestock graze in the study area?

A. Yes _____ B. No _____

2. How long do you use for grazing? _____
3. How long do your livestock stay in the study area daily? _____
4. At what time do you bring your livestock daily? _____
5. At what time do you take your livestock daily? _____
6. Do you collect grass from the study area? A. Yes. ------- B. No------
7. Do you collect firewood from the study area? A. Yes. ----- B. No--------

About Ethiopian wolf

1. Do you know Ethiopian wolves/Jedala fardaa?

A. Yes. --------- B. No ----------

2. Is the number of Ethiopian wolf in this study area?

A. Increasing ---------- B. Decreasing ---------- C. No change ------D. I don't know -------

3. What is the largest group of Ethiopian wolf you have seen so far in the area? .

What about recently? _____

4. What is your attitude towards the Ethiopian wolf?

A. Positive --------- B. negative ----------

_____

5. Do people create problem to the Ethiopian wolf?

A. Yes ---------- B. No ---------- C. I don't know _____

APPENDIX II

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

1. Study site A. Sanetti Plateau _____ B. Web-valley_____

2. Season _____round _____date _____starting time _____ending time _____

3. Pack name _____ transect number _____ length _____

4. Number of wolves observed in the strip transects _____

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: from people _____

9. Estimated mean length of time for each behavior during the presence and absence of humans.

Present	**Absent**
A. Foraging ----------	----------
B. Laying down ----------	----------
C. Standing ----------	----------
D. Walking ----------	----------
E. Running ----------	----------

10. Reaction of humans to Ethiopian wolf during observation

A. Chasing _____ B. Noise making _____C. Ignoring _____

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

Present	**Absent**
A. Foraging ----------	----------
B. Laying down ----------	----------
C. Standing ----------	----------
D. Walking ----------	----------
E. Running ----------	----------