

**HABITAT USE AND DIET OF GOLDEN JACKAL (*Canis aureus*) AND
HUMAN - CARNIVORE CONFLICT IN GUASSA COMMUNITY
CONSERVATION AREA, MENZ**



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Abstract

*The study was aimed at revealing the day time habitat use and diet of golden jackal (*Canis aureus*) and human - carnivore conflict around Guassa-Menz Community Conservation Area. Data were collected from October, 2009 to April, 2010. Day time habitat use of golden jackal was recorded through focal group watch both in human dominated major agro-ecosystem and the conservation area. Scat analysis was carried out to determine prey items of jackals. Questionnaire survey was used to study attitudes of the local people to wildlife conservation in general and the Ethiopian wolf and golden jackal in particular. This method was also applied to reveal the degree of human - carnivore conflict in the study area. All data were analyzed using SPSS version 10 computer software program. Golden jackals during the day time use habitat cover to avoid human detection. They preferred habitat type with tall and thick vegetation cover. In human dominated major agro-ecosystem, they were observed sheltering in burrows and caves. Rodents were the principal prey items with 57.06% frequency of occurrence. The kill using traditional rodent trap 'Difit' along cultivated farmlands was important rodent source to golden jackals. Plant materials and insects were also important diet components. Among livestock, only sheep parts were identified in the scats of golden jackals. 75.6% of respondents showed positive attitude to wildlife, specially to the Ethiopian wolf. Human - carnivore conflict was a serious problem in Guassa. Livestock and pack animal predation was recorded by golden jackal (*Canis aureus*), Ethiopian wolf (*Canis simensis*), spotted hyaena (*Crocuta crocuta*) and serval cat (*Felis serval*). However, the conflict with golden jackals was serious. From the total predated livestock 74.59% was by golden jackals. Sheep predation by golden jackals was more intense. Sheep predation was positively correlated with grazing in the bushland ($r = 0.62$, $P < 0.05$). To protect sheep predation the local people persuade, and even poison golden jackals.*

Key words / phrases: *Diet, habitat use, human - carnivore conflict, golden jackal*

1. INTRODUCTION

Ethiopia is one of the most physically and biologically diverse countries of the world. This is rendered by extreme diverse ecological conditions determined by topography and climate. The country has impressive topography of highland massive surrounded by arid lowlands with diverse habitat rich in wildlife. Wildlife habitat types range from alpine moorlands to lowland savannas and arid lands and extensive wetlands (Yalden, 1983). In contrast to the lowlands, the highlands consist of many endemic species of plants and animals; however, they have few species diversity.

Ethiopia consists of 862 species of birds, 284 species of mammals, 201 species of reptiles, 64 species of amphibians and 150 species of fish, among these, 31 mammals, 17 birds, 30 amphibians, 9 reptiles and 40 fish are believed to be endemic (unpubl. data source in EWCA).

Intensification of agriculture, which is the sole economic activity for the large portion of the people, has been the main threat to the natural ecosystem. Most of the highlands and some of the lowlands have been converted into agricultural and pastoral lands. Major trees have been used for fuel wood, construction and other related purposes. As a result, wildlife resources of the country are largely restricted to a few protected areas. The total area established for conservation activity in Ethiopia is only 78,192 km². These comprise 15 National Parks, 3 Sanctuaries, 9 game reserves and 14 controlled hunting areas (unpubl. data source in EWCA). Of these conservation areas, only two National Parks are formally gazetted (Simen Mountain National Park and Awash National Park). However, there are still biodiversity rich habitats in Ethiopia that are not protected as conservation areas.

The Menz-Guassa highland is among the afroalpine ecosystems of Ethiopia. Like other similar ecosystems of Ethiopia, the Menz highland has been affected by human activity.

Destruction of the vegetation and inappropriate land use practices have resulted in degradation of the fertile soil.

To rescue the remaining unique habitats, and the endemic plant and animal species, the Menz-Guassa area at present is communally protected and managed by the local people. In this regard, appreciable community mobilization work is done which might be model to other related ecosystems that are not legally protected as an area for biodiversity conservation. This conservation area consists of different endemic animal species; among these, the endangered Ethiopian wolf and Gelada baboon can be mentioned.

The golden jackal (*Canis aureus* Linn., 1758), is one of the meso-carnivore canid of the Guassa area. It is found on the territory of the protected area following the farmlands of the local people. The jackal also inhabits the community plantations away from the protected area but closer to human settlements.

Golden jackal is a medium sized canid in the genus *Canis* (Clutton-Brock *et al.*, 1976). It is distinguished by its basic golden coat color that varies from pale creamy yellow to dark tawny hue on a seasonal basis, and a mixture of black brown and white hairs for the pelage on the back (Jahla and Mmoehlman, 2004). On average, the body weight of adult male and female golden jackals is estimated 6.6 kg and 5.8 kg, respectively with an approximate 12% difference between sexes (Moehlman and Hoffer, 1997). The belly underpart is light pale ginger to cream. Unique light markings on the throat and chest make it possible to differentiate individuals from the population (Moehlman, 1983). The tail is bushy with a tan to black tip. Legs are relatively long and the feet are slender with small pads. The skull of the golden jackal is more similar to that of the coyote (*C. latrans*) and grey wolf (*C. lupus*) than the sympatric jackal species (*C. adustus* and *C. mesomelas*) and the Ethiopian wolf (*C. simensis*) (Clutton-Brock *et al.*, 1976).

Despite threats like habitat destruction and persecution across its range, the jackal is grouped under “least concern” by IUCN classification. In this study, survival strategies of the species are revealed (habitat use and foraging) in the farmlands and fragmented

territorial zones of the community protected conservation area. The study also included human - carnivore conflict in the area, and comparison is made with respect to the existing global human - carnivore conflict problems and the consequences of economic loss and biodiversity crisis.

2. LITERATURE REVIEW

Golden jackals (*Canis aureus*) are habitat generalists. They are the most widely distributed of the three jackal species (*C. adustus*, *C. mesomelas* and *C. aureus*). Their ranges are extensive and include many areas of Africa, Asia, and Europe (Macdonald and Sillero-Zubiri, 2004). This confirms the species special adaptation to heterogeneous environmental conditions and the efficiency they have in adapting diverse habitats, similar to the Coyote (*Canis latrans*) in North America (Bekoff and Geese, 2003).

They have wide distribution in North and northeast Africa, occurring from Senegal on the west coast of Africa to Egypt in the east, in a range that includes Morocco, Algeria, and Libya in the north to Nigeria, Chad and Tanzania (Jhala and Moehlman, 2004).

They have wide distribution in the Ethiopian highlands (Yalden *et al.*, 1980). The Menz-Guassa highland is one of the Ethiopian highlands (Fig. 1). In these areas, the population density is high even though most of the land is used for subsistence farming. Their spatial ecology on the farmlands adjacent to the Bale Mountains is studied well and showed distribution in a mosaic of farmlands, grassland and woodland (Ermias Admassu *et al.*, 2004).

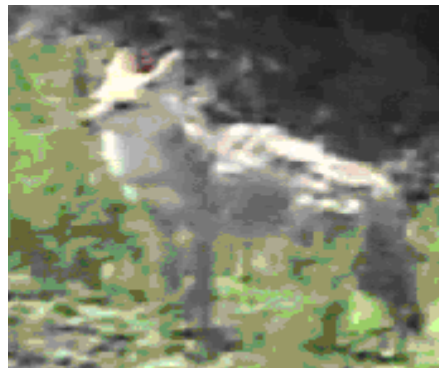


Figure 1. Golden jackal in Guassa highland
(December 12, 2009)

In Europe, golden jackal is considered as a resident species in the Caucasus, Turkey, Bulgaria, and Albania and on the eastern coast of the Adriatic Sea (Macdonald and Sillero-Zubiri, 2004). Recent observations show their distribution in Serbia, Slovakia, Romania and Ukraine. They are also observed occasionally in Slovenia, northeastern Italy and Austria (Mitchell-Jones *et al.*, 1999, in Jhala and Moehlman, 2004).

In Hungary and Greece, the jackal was recorded in the Red Data Book as extinct species. It had disappeared from Hungary by the beginning of the 20thC, which was an indigenous and common predatory species of the country until the end of the 19thC living in bushy and wetland areas of Hungary. Changes of natural habitat and persecution of mammal predators caused the decrease in population (Demeter and Spassov, 1993). However, through repatriation process, immigrants have been arriving in the southwest since the beginning of the 1990s (Helati *et al.*, 2000). After absence of a half century, they became again a common predator in the southern part of Hungary (Szabo *et al.*, 2009). Similarly, in Greece, the species which was considerable in the past have become the rarest canid as a result of habitat destruction (Giannatos *et al.*, 2005).

Black-backed jackals, golden jackals, side striped jackals, African wild dogs and bat eared foxes are sympatric in the Serengeti ecosystem and Rift valley of Tanzania and Kenya reflecting the high density and abundance of food in the region (Wayne *et al.*, 1989). Carnivores inhabit every habitat or vegetation zone, from short grassland (meerkats) sparse woodland (dwarf mongoose) desert (fenic fox), thick forest (banded palm civet) to oceanic water (sea otter) (Gittleman, 1989). Due to their tolerance in dry habitats and their omnivorous diet, they can live in a wide variety of habitats ranging from Sahel Desert to the evergreen forests of Burma and Thailand (Jhala and Moehlman, 2004). They occupy semi-desert, short to medium grasslands and savannas in Africa; and forested, mangrove, agricultural, rural and semi-urban habitats in India and Bangladesh (Poche *et al.*, 1987).

Golden jackals are able to exist in close proximity to humans, obtain suitable day time cover and food materials from agro-ecosystems. In Bangladesh, they occur in intensively

cultivated and human dominated areas (Poche *et al.*, 1987). Annual access to an area with suitable cover and a diet mainly of rodents are important factors influencing local abundance in the major agro-ecosystems (Jaeger *et al.*, 2007). Sugar cane plantations have been found as suitable habitat to jackals in some part of their distribution ranges. For example, they are dominant in sugar cane cultivated areas of Pakistan (Khan and Beg, 1986), the same is true in Bangladesh, where the jackal density is relatively high in such plantation areas (Jaeger *et al.*, 1996) which provide day time cover for avoiding humans and for feeding on roof rat (*Rattus rattus*) (Jaeger *et al.*, 2007). However, their distribution is affected by the extensive flooding that occurs during the annual monsoon rains which force jackals to leave submerged areas for up to 3 months. In Greece, they are restricted to patches of dense marsh along the coast (Giannatos *et al.*, 2005).

Golden jackals also inhabit National Parks, non-protected cultural forests and the associated pastoral areas. In the Serengeti National Park, jackal density is as high as four adults per km² (Moehlman, 1989). In Thailand, they are found densely in non-protected traditional forests that showed the presence of adequate resource to the Asiatic jackal (Wongpakan *et al.*, 2007). Jackal populations achieve high densities in pastoral area of India such as Maharashtra, Rajasthan and Haryana (Jhala and Moehlman, 2004).

In Ethiopia, they have wide distribution, specially, in the highland ecosystems (Yalden *et al.*, 1980). They are found closer to farmlands and settlement areas. They have been recorded at elevation of 3,800 m in the Bale Mountains of Ethiopia (Sillero-Zubiri, 1996). In India, similarly they are inhabitants of hill stations at 2,000 m asl (Prater, 1980).

The type of ecosystem, resource distribution and extent of human pressure determines the size of their home range. Their home range is estimated from 11- 20 km² (Macdonald and Sillero-Zubiri, 2004). In *Acacia* woodland, in Kenya, the range of a pair of golden jackal is recorded to be 2.4 km² (Fuller *et al.*, 1989). In Serengeti, the defended territory ranges from 1-3 km² (Moehlman, 1986). The largest home range size is recorded on farmland adjacent to the Bale Mountains National Park, Ethiopia, that varied from 7.9-48.2 km² for adult jackals and from 24.2-64.8 km² for subadults (Ermias Admassu *et al.*, 2004).

Unlike strict carnivore species, golden jackals are omnivore and opportunistic foragers. They do not rely on persistent hunting. Depending on the availability, they use a wide range of food items (Macdonald, 1979). They feed on large and small mammals, birds, insects, fruits and garbage around human settlement areas. In southern Greece, the most common food items of golden jackals are mammals and birds. However, the percentage of birds as a food item for golden jackals depends on the availability of bird carcasses since the capture of live birds is very difficult with a high percentage of failure (Kauanda and Skinner, 2003). In East Africa, although they feed on invertebrates and fruits, large portion of their diet is composed of rodents, lizards, snakes, birds, hares and young Thomson's gazelle (Moehlman, 1989).

Habitat conditions and changes are well indicated by the diet composition and feeding habits of predators. For example, in habitats with low density of wild prey, the frequency of domestic livestock predation and the extent of carcasses and garbage material consumption increase. In wildlife poor ecosystem like the Mediterranean lowlands, high biomass of domestic livestock was scavenged indicating the opportunistic nature of the jackals (Giannatos *et al.*, 2009). Predation on domestic livestock in central Niger, especially by the golden jackal has been identified by herders (Mschane and Grettenberger, 1984).

Scat analysis of golden jackals discloses differences in the diet components and respective biomass between human dominated and protected ecosystems. In an intensively managed hunting reserve in Hungary, the occurrence of domestic animals in the diet of jackals is low (Lanszki and Helati, 2002). Similar result is recorded in protected area in India (Mukherjee *et al.*, 2004). However, in human managed ecosystem of India, the major food sources are domestic animals and human refuse such as leftovers of meals, pieces of fabrics and plastics (Poche *et al.*, 1987; Jhala and Mohelman, 2004). In areas near human habitations, they are known to subsist almost entirely on garbage and human waste (Macdonald, 1979). Scat analysis of golden jackals in Niger showed that

vegetable matters and invertebrates constituted the main identifiable items (Mschane and Grettenberger, 1984).

Rodents are basic food items among smaller mammals. Different studies have confirmed significant frequency in the occurrence of rodent species as a diet for golden jackals. It is reported as the primary prey to jackals (Lanszki and Helati, 2002), including bandicoot rats (Khan and Beg, 1986), wild ungulates, livestock and small mammals (Yom-Tov *et al.*, 1995). In agro-ecosystems of Bangladesh, rodents were the most common food items throughout the year, however, the incidence of refuse in scats were found increasing seasonally when availability of burrowing rats decreased (Jaeger *et al.*, 2007).

During their breeding season, golden jackals use diverse food items that are easily accessible closer to their den. In Greece, plant materials mainly grass and other vegetation components were obtained near their dens (eg. rhizomes) and fruits (eg. black berry, raspberry, melon and apple) in smaller quantity and domestic cattle carcasses were obtained in the scat analysis of golden jackals (Lanszki *et al.*, 2009). In Serengeti, they feed on larger prey and carcasses. A large variety but low quantity of invertebrates and small passerines, snakes, lizards, and fish are also found as food components for golden jackals and red fox at the time of cub rearing (Lanszki *et al.*, 2006). During the fruiting seasons, they feed on fruits showing their opportunistic feeding habit when available. In India, great quantity of vegetable material is obtained in the scat of golden jackals during the fruiting seasons (Jhala and Moehlman, 2004). In Asian habitats where the availability of smaller mammals is low, jackals subsidize consuming more fruits (Balasubra and Bole, 1993). Variety of fruits and vegetables, together with poultry and livestock are parts of their diet (Sarker and Ameen, 1990). Compared to the red fox, golden jackals showed quick response to food resource limitations. This is best exemplified when golden jackals shifted from small prey to other food items earlier when the availability of small mammals declined and also return to rodent hunting when available (Lanszki *et al.*, 2006).

Golden jackals are medium sized predators (mesocarnivores) and hunt in solitary. They also hunt in pairs or groups increasing the likelihood of success when they encounter larger prey (Ermias Admassu *et al.*, 2004). In Pannovian ecoregion, Hungary, they primarily consume small mammals which magnifies their typical searching and solitary hunting strategy at large (Lanszki *et al.*, 2006).

Group living is important to hunt large preys and defend carcasses. Golden jackals are successful at catching Thomson's gazelle fawns when hunting in pairs (Wyman, 1967). They have been observed to hunt on young, old, and weak ungulates that are heavier than their body weight (Kotwall *et al.*, 1991). They steal food from larger predators, usually waiting until they are done feeding before finishing off the carcass. They follow wolves on a hunt and scavenge wolf kills (Jhala, 1994).

Golden jackals live in small family groups consisting of a mother and a father together with some of their offspring, which serve as helpers when the mother has young puppies. Their social unit is basically built from a mated pair and its young (Ivory, 1999). Breeding pairs of jackals form annual residents that defend their cover (Jaeger *et al.*, 2007). They occasionally become gregarious when they feed on carcasses. Social group size of 10 and 20 individuals each in highly clumped and defensible food resources are seen in Israel (Macdonald, 1979). Group strategies in the care of offspring have been observed in all social carnivores, and could represent a second major factor, together with foraging strategies, in the evolution of social behaviour in the carnivore. The sociality of golden jackals is elaborated at large in cub rearing. In golden jackals and black backed jackals, the previous year young may remain with their parents and assist in various aspects of raising the next litter, regurgitating food for them, guarding from predators and assisting the parents in hunting for food (Moehlman, 1983).

Jackals are strictly monogamous. Their adult sex ratios are equal, and their male and female helping behaviour and dispersal are equivalent (Moehlman, 1989). Once the mate and territory has been selected, the pair spends a lot of time scent marking. Near estrus, semi-aggressive fighting will end and the pair attachment bond reaches peak. The male

frequently checks the readiness of the female. Mating has been observed at different months in different countries. Commences in February and March in India and Turkmenistan. In Tanzania, mating typically occurs from October to December with pups being born from December to March (Moehlman, 1989).

Availability of food supply is a limiting factor for reproduction. The time of birth in golden jackals, however, coincides with abundance of food supply. For example the beginning of the monsoon season in Northern and central India and calving of Thomson's gazelle in the Serengeti (Moehlman, 1983).

Human - wildlife conflicts have long history, since the beginning of the human era. Cave life of ancient man is believed to be a result of the conflict, to hide from the attack and shelter. Slowly, man began preparing and manipulating weapons such as axe during stone and iron ages to frighten wild attackers. Later on, they started hunting wild animals as food and protection (Eltringham, 1979).

Livestock predation by mammalian carnivore is one of the most frequent sources of conflict between humans and wildlife throughout the world (Mazzoli, 2002). Conflicts arise primarily because of competition between people and predators for shared and limited resources like wild herbivore and habitat. Many predators kill prey species that humans hunt, harvest or farm for and occasionally they may even kill people (Caro and Fitzgibbon, 1992). Domesticated breeds which have lost their anti-predator behaviours are easily killed by wild predators (Polisar, 2003).

Across the globe, the frequency and extent of economic cost of conflict between human and carnivores are increasing due to the expansion and growth of human population (Karanth *et al.*, 1999). Large home ranges of carnivores draw them into recurrent resource competition with humans. In addition, human exploitation of natural herbivores may reduce the availability of wild prey to predators and can increase the likelihood of attacks on livestock. The problem becomes serious when the resources have economic value and the predators involved are legally protected (Thirgood *et al.*, 2000). Under a

variety of demographic, economic and social pressure, human alteration of carnivore habitat has led to escalated conflicts (Naughton-Treves *et al.*, 2003). If the habitat in which they live consists of areas large enough to support them, with sufficient food resources and of the influence of human on their habitat decreases, these animals tend to avoid man and his domestic animals. Changing land use practices exemplified by the re-growth of forests in many regions of the United States are providing room for potential recolonization by previously extirpated carnivores (Mladenoff *et al.*, 1997).

Food provided by humans as illegal garbage dumps resulted in increase in population size of jackals that in turn accelerated the predation rate of cattle in Golan Heights, Israel, mainly by golden jackals, and the total damage in 1993 was estimated to be 42,000 USD (Yom -Tov *et al.*, 1995). Hence, farmers illegally poison jackals to reduce the predation. Loss of 2.6% of livestock holdings was equivalent to a loss of one quarter of the average annual per capita income of the villagers in Nepal (Olie *et al.*, 1994). In Israel, cattle grazed unattended all the year round and give birth in the field which favoured opportunistic jackals (Yom- Tov *et al.*, 1995). Predation on small stock mainly sheep was a serious problem in Bulgaria where 1053 attacks recorded from 1982 to 1987 in the southern part of the country (Genov and Vassiler, 1991).

People around protected areas develop a negative attitude towards wildlife as a result of livestock loss. The effect is very much pronounced especially in communities with subsistence economy (Olie *et al.*, 1994). Perceived economic losses due to livestock depredation often lead to retaliatory responses by agro-pastoralists. In many developing countries, lack of involvement by government and private agencies in human - wildlife conflicts, reflects, in part, priorities in other income sectors. Often the only perceived solution by the local people to predator problems is extermination (Sekhar, 1998). These include carnivore persecution and opposition to wildlife sanctuaries close to farms.

Human negligence plays an important role in many predation incidents, (Yom-Tov *et al.*, 1995), where losses could be prevented by greater vigilance during grazing, preventing animals from straying, and returning herds to enclosures in day light. Livestock guarding

dogs represent one of the most cost-effective methods of mitigating livestock predation. Dogs were found to be more effective at preventing coyote predation on sheep than any other technique in Montana (Ogara *et al.*, 1983).

Studies have shown that livestock losses are not necessarily correlated with predator density. Livestock losses to wolverines were a function of prey availability, rather than the abundance of predators (Landa *et al.*, 1999). As revealed by a study in Kenya, high densities of leopards (*Panthera pardus*) have less impact on livestock than might be expected. A study in California reported that kills of sheep by coyotes were not correlated with the number of coyotes (Conner *et al.*, 1998).

Golden jackal is threatened over its entire range except in protected areas like National Parks and Sanctuaries. Traditional land use practices like livestock rearing which were friendly to the survival of jackals and other wildlife are being steadily replaced by industrialization and intensive agriculture. Thus, wilderness areas and rural landscapes are being rapidly urbanized (Jhala and Moehlman, 2004). For example, destruction of habitats in Greece (Peloponnese) resulted in the reduction of the jackal population close to 10% of the population level 25 years ago (Giannatos *et al.*, 2005). As a consequence of changes in habitat and human use, a significant decline in the distribution of jackals is registered in Greece (Giannatos *et al.*, 2005). As a result, conservation action plan was prepared in 2004, which has an overall goal of maintaining and if possible restoring viable population of jackal as integral part of the ecosystems (Giannatos, 2004).

According to the IUCN (2004) list of threatened species, the status of golden jackal is “least concern”. There are no other known threats, except local policies of extirpation and poisoning and can be considered as a species requiring no immediate protection with caution and knowledge that populations throughout its range are likely to decline (Jhala and Moehlman, 2004).

3. OBJECTIVES

3.1. General objective

To investigate the habitat preference and foraging behaviour of golden jackal in human dominated agro-ecosystem and determine the status of the species, and threats associated with human conflict.

3.2. Specific objectives

- ❖ to know the day time habitat use of golden jackal in human dominated agro-ecosystem
- ❖ to examine food source used and the foraging behaviour of the animal
- ❖ to evaluate the attitude of the people towards wildlife conservation
- ❖ to suggest possible solutions to the problems observed

4. THE STUDY AREA

4.1. Location

Guassa area of Menz is located in the Amhara Regional State, within the North Shoa Zonal Administration Gera-Keya Woreda (Fig. 2). The area occurs 265 km northeast of Adis Ababa by road and 135 km north of Debre Birhan, the capital of north Shoa Zone. The capital of Gera-Keya Woreda is Mehal Meda and it is 17 km from the Guassa area.

Guassa area lies at latitude $10^{\circ} 15' - 10^{\circ} 27' N$ and longitude $39^{\circ} 45' - 39^{\circ} 49' E$. The total area of Guassa is 98.45 km^2 . It forms part of the western edge of the Great Rift Valley. Its altitude ranges from 3200 to 3700 m asl.

4.2. Geology and Soil

The formation of Guasa area during the Oligo-Miocene was a result of the tectonic and volcanic activity (Zanettin and Justen-Visentin, 1974; in Zelalem Tefera, 2000). Lava covered all the previous rock formations that had been formed prior to the formation of the Rift Valley. Guassa area contains 15-26 million year old Miocene rhyolites and basalts, sometimes referred as an Alaji-Molale formation and 20-26 million year old Oligo-Miocene basalts and Phonolites (Zanettin and Justen-Visentin, 1974; in Zelalem Tefera, 2000). On the plateau of Guassa area, the following formation of Trao series lava have been identified; Ashangi basalts, Aiba stratoid basalts, Alaji rhyolites and Termaber basalts linked to central volcanism (Zanettin and Justen-Visentin, 1974; in Zelalem Tefera, 2000).

The central highland soil is characterized by two principal types, originating from the disintegration of volcanic substrates intermingled with sand and limestone. These comprise: black clay soil (vertisols) and reddish brown heavy loam (redsoil). The former type appears on flat plateau along the bottom of valleys. The latter appears on valley slopes and well-drained areas. Generally, the soil of Guassa area is deep. However, on higher ground, the soil is shallow and highly mineralized.

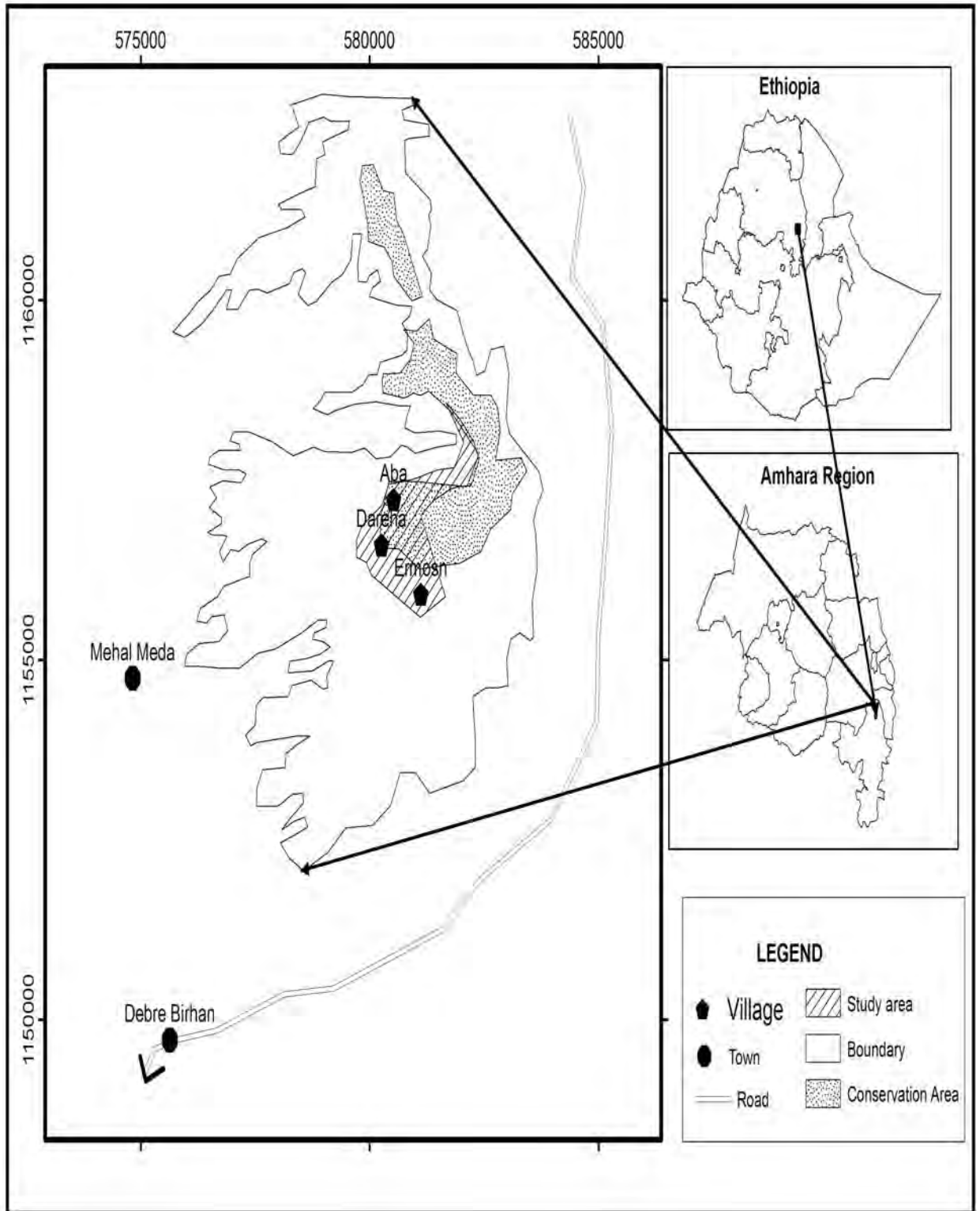


Figure 2. Map of the study area (Prepared by Bamelaku Y.)

4.3. Climate

The central highlands of Ethiopia are characterized as temperate rain climate type, with distinct dry and wet months. However, considerable variation occurs as a result of differences in altitude and size of the mountain blocks.

The climate of Guassa area is affected by northerly winds, which blow throughout the year. There is high rainfall, frequent hill storms and occasional snow at higher altitudes during the wet season and frequent frosts during the dry season. Therefore, the climate of the study area is unfavourable for most crops. However, the surrounding farming communities grow barley and some pulses (Zelalem Tefera, 2000).

In the driest months (December, January and February), the day time temperature can be as high as 21⁰C while at night it can fall to -7⁰C, a diurnal fluctuation of 28⁰C. The diurnal temperature variation is low during the wet season with a day time temperature of 12⁰C and temperature of 3⁰C at night. This fluctuation is expected to cause high temperature stress on the flora and fauna of the area. In the early dry season, frost is very common and fog can be seen any time of the year

Guassa lies in an area influenced by the Equatorial Westerlies and the Indian Ocean air streams. The area receives rain from two different sources at different times of the year. In the Ethiopian highlands, rainfall increases with altitude until 3800 m, above which it begins to fall again. Rainfall of the study area is characterized by one main rain season (Kiremt or Mehir) during June, July, August and September and small rain season (Belg) during February, March and April. However, showers of light rain can occur in any month of the year.

4.4. Habitat and Vegetation

According to Zelalem Tefera (2000), the vegetation and habitat type of the Guassa area are listed below:

***Festuca* grassland**

Occurs where the drainage is good and the soil is deep. It grows on steep to moderately steep slopes up to altitude of 3500 m asl. The plant species that are common in *Festuca* Grassland are: *Festuca abyssinica*, *F. simensis*, *F. richardii*, *F. macrophyll*, *Andropogon abyssinicus*, *Poa shimperina*, *Trifolium burchellianum*, *T. multinerve*, *Alchemilla abyssinicus*, *Semecio vulgaris*, *Thymus schimperi*, *Helichrysum formosissiu*, and *Artemesia sp.*

***Euryops-Alchemilla* shrubland**

Occurs on flat and gentle slopes and well drained areas, and is restricted to areas above 3200 m asl. It is the most extensive habitat type that covers 21.7% of the total area. Common plant species include: *Euryops pinifolius*, *Alchemilla abyssinica*, *Kniphofia foliosa*, *Thymus schimperi*, *Urtica simensis*, *Anthemis tigreensis*, *Echinops steudneri*, *Ferula communis*, *Hebenstretia dentate*, *Agrostis graclifolia*, *Geranium arabicum*, *Kalanchoe deficiens*, *Senecio gigas*, *S. vulgaris* and *S. Schultz*.

***Euryops-Festuca* Grassland (Mima mound)**

Euryops-Festuca grassland or Mima mound is usually interspersed with scattered mounds that can reach a height of 1.5 m and a diameter of 5-10 m. These mounds consist of high organic and deep soil that is made by the activity of the rodent community, the most important of which is the common Mole rat (*Trachyoryctes splendens*). The common species of plants which characterize the habitat are: *Euryops pinifolius*, *Festuca abyssinica*, *F. richardii*, *F. macrophylla*, *F. simensis*, *Agrostis gracilifoli*, *Andropogon amethystinus*, *Alchemilla abyssinica*, *Anthemis tigreensis*, *Thymus schimperi*, *Rumex abyssinicus* and *Crisium vulgare*.

The mounds are predominantly covered by *Euryops* and *Alchemilla* while the area in between the mounds is covered mainly by *F. abyssinica*. This habitat accounts for 15.5% of the total area of Guassa. It is commonly used as a den by wolves and it is important for human use as long as the *Festuca* grass is dominant.

***Helichrysum-Festuca* grassland**

This vegetation occurs on high ground and hill tops, where the soil is poor. The plants that are dominant in this particular habitat are: *Helichrysum splendidum*, *H. gofense*, *H. formosissimum*, *Pinnisetum* sp., *Alchemilla abyssinica* and *Echinnops* sp. This habitat accounts 4.4% of the total area of Guassa. It is little used by humans since the *Helichrysum* shrub produces lots of smoke when burnt.

***Erica* Moorland**

Erica moorland is common in high ground areas with shallow and well drained soil. The total area coverage of the habitat is 10.4% of Guassa. The *Erica* shrubland is collected for fire wood mainly during the wet season. The common plant species in the *Erica* moorland habitat are: *Erica arboria*, *Thymus schimperi*, *Trifolium burchellianum*, *Alchemilla abyssinica*, *Helichrysum splendidum*, *Kniphofia foliosa*, *Swerti abyssinica*, *Rubus abyssinicus*, *R. stedneri* and *Urtica simensis*.

Swamp Grassland

This habitat is permanently or temporarily inundated during the wet season. It accounts 3.7% of the total Guassa area. It provides a year round green grass to cut and carry home. The dominant plant species of this habitat are: *Carex monistachia*, *Carex fischeri*, *Hydrocotyle mannie* and *Alchemilla* sp.

4.5. Fauna

Among the small mammals, two shrew and six rodent species are recorded. *Crocidura thalia* and *C. baileyi* are the most widespread of the endemic shrews in Ethiopia (Yalden and Largen, 1992; in Zelalem Tefera, 2000). The rodent species found in Guassa include, porcupine (*Hystrix cristata*), common mole rat (*Tachyoryctes splendens*), the unstriped grass rat (*Arvicanthis abyssinicus*), the Harsh-furred rat (*Lophuromys flavopunctatus*), the Abyssinian meadow rat (*Stenocephalemus grisecauda*) and the Groove-toothed rat (*Otomys typus*). Two of the rodent species, *A. abyssinicus* and *S. grisecauda* are endemic to Ethiopia. The Ethiopian wolf (*Canis simensis*), Gelada baboon (*Theropithecus gelada*) and Abyssinian hare (*Lepus starcki*) are the endemic large mammal fauna of Guassa. The other large mammal species inhabiting the guassa area are: Grey duiker (*Sylvicapra grimmia*), Klipspringer (*Oreotragus oreotragus*), Common jackal (*Canis aureus*), Spotted hyaena (*Crocuta crocuta*), Civet (*Civeta civettictis*), Rattle (*Melivora capensis*), Egyptian mongoose (*Herpestes ichneumon*) and Serval cat (*Felis serval*).

The dominant economic activity of the people is farming. Land holding throughout the entire Woreda varies from 0.75 to 3.5 ha per household with average holding of 1.4 ha. There are two farming seasons corresponding to the short and long rain seasons. The importance of 'Belg' (short rain season) is strongly emphasized in Menz. The dominant crops of the area are barley, beans and lentils. Barley is the single most important subsistence crop. Land is ploughed in January and February for the short rain crop (Belg) and in June or July for the main rain season crop (Meher). The main draught animals are oxen, although horses and donkeys are used sometimes (Zelalem Tefera, 2000).

Livestock is a key element of the economy in the mixed farming systems of northern Ethiopia. In Menz, the role of livestock in subsistence livelihood has increased because of unreliability of cultivation (Zelalm Tefera, 2000). Livestock holding in Menz is low compared to other parts of the country, and only a few households can keep different forms of livestock. The average household owns one cow, a pair of oxen and one donkey while some households own horses and mules. Sheep are the most common form of livestock in every household (Fig. 3).



Figure 3. Sheep herders in Guassa
(February 3, 2010)

5. MATERIALS AND METHODS

5.1. Materials

Different materials were used while gathering data in the field and during laboratory analysis process. These materials are listed below:

Field equipments

Binocular

GPS (Garmin)

Compass

Metre

Specimen tube

Camera (Photograph and Video)

Laboratory apparatus and chemicals

Heater

Water

Sieve(1mm)

Ethanol (100%)

Beaker

Acetone

Mortar

Filter paper

5.2. Preliminary survey

Preliminary survey was conducted in August, 2009. During this survey, information about the physical and biological features of the study area was collected. Habitat type and vegetation distribution were studied. In particular, habitats of golden jackals were visited and the vegetation composition of the habitat was identified. In addition, discussion with some of the local people was carried out, and information about the major wild fauna of the area and their abundance was gathered. Besides this, their attitude towards the wild fauna was assessed. Furthermore, it was in this period information about the year round climate condition of the area was collected.

5.3. Data collection methods

All data for habitat use, diet preference and human – carnivore conflict were collected between October, 2009 and April, 2010, hence major seasons are considered in to account.

Focal group watch

The method used to collect data of day time habitat use by golden jackals was focal population watch. This method is devised considering the territorial behaviour of the species. Data were collected through daily visit. Focal watch was made on two groups of jackals. One group that was inhabiting the boundary of the conservation area adjacent to the farmlands and the second group far from the conservation area mainly in human dominated agro-ecosystem closer to settlement areas (Figs. 4-6).

All available habitats were identified and classified based on the vegetation height following (Ermias Admassu *et al.*, 2004). In every successful visit days, habitat type that the jackal sighted was registered including the activity, time spent and GPS location.



Figure 4. Community plantation
(February 1, 2010)



Figure 5. Golden jackal
around the protected area
(November 20, 2009)



Figure 6. Habitat of golden jackals around the protected area
(February 1, 2010)

Scat analysis

Scats of golden jackals were collected in all habitats of the species including the specific den sites (Fig. 7) to identify food items used by the jackal. The scat of golden jackal was identified from other carnivores through the characteristic size, shape and contents following Breuer (2005). Because scats were collected near their dens and by chance on the spot, the potential confusion by scats of other species is reduced. More importantly, dogs of the local people are uncommon; they are restricted to clusters of houses.



Figure 7. Golden jackal excreting
(December 23, 2010)

Data on date of collection, time of collection, location are recorded and those scats closer to each other were not considered to avoid collection of the same individual. The scat samples were sun dried, grounded in mortar and washed in 1mm sieve using hot water to separate prey components and other indigestible remains. The separated components are washed with acetone, dehydrated in 100% ethanol and dried on filter paper. Finally, each component was identified assisted by magnifying instruments and reference specimens. Direct observation was also made to determine foraging strategy of jackals.

5.3. Questionnaire survey

A total of 250 people sampled from three villages (Ermosh, Darcha and Aba) were interviewed using questionnaire. From the total respondents, 180 were males and 70 were females. The questionnaire included both open-ended and fixed response questions and it was designed to check the presence of human - carnivore conflict, the intensity and the fundamental causes. The questionnaire also consisted of questions which evaluated the attitude of the people towards wildlife and their knowledge of biodiversity conservation.

5.4. Data analysis methods

All data collected were analyzed using SPSS version 10 computer software programme. Descriptive statistics, chi-square test and one-way ANNOVA were used in the analysis process. Logistic regression was used to determine the factors which might be important in determining the attitude of respondents towards wildlife.

6. Results

6.1. Day time habitat use

Habitat use of jackal population in the human dominated major agro-ecosystem habitats was recorded in 73 day time locations (Table 1). Their most frequent location was woodland (60.27%). The use of farmlands was recorded seasonally (26.03%). The frequency of finding jackals in the bushland and grassland habitats was low 9.59% and 4.11%, respectively. Jackals used cover throughout the hours of daylight. They preferred habitats with tall vegetation to take rest and avoid human detection.

Table1. Frequency of jackal occurrence in different habitat types

Habitat type	N	%	Height of habitat (in cm)			
			0-20	20-50	50-100	> 100
Farm	19	26.03	5	14	0	0
Grass	3	4.11	3	0	0	0
Bush	7	9.59	2	5	0	0
Wood	44	60.27	0	0	0	44
Total	73	100.00	10	19	0	44

From 73 successful visit opportunities between 7:00 a.m. and 7:00 p.m., 82.19% of locations were during the day time resting cover (Fig. 8). Woodland was the preferred type of cover where the jackals were most frequently sighted at rest during the day time (68.33%). The use of farmlands as day time resting location was 28.33%. Only at two incidences that jackals were located resting in the bush 3.33 %. Grassland habitats were not preferred by jackals. Resting locations were characterized by tall vegetation with thick cover. In addition burrows and caves were important diurnal hiding sites for jackals.

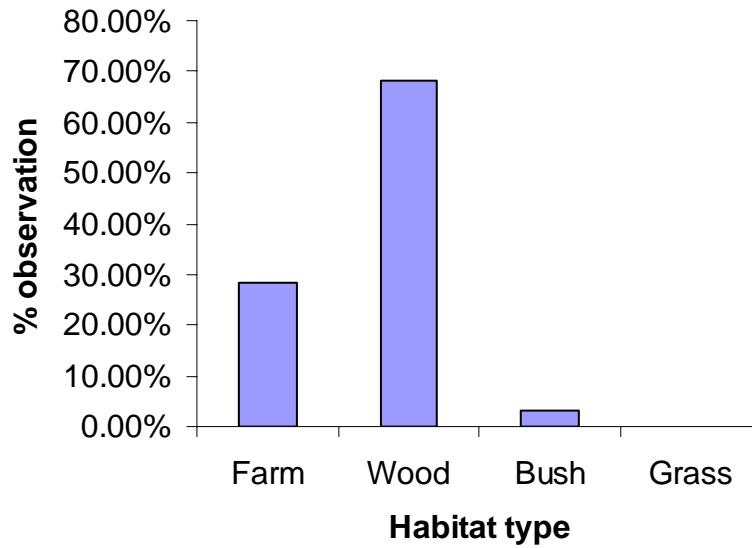


Figure 8 . Resting locations of jackals

There was a significant difference in day time habitat use both during wet and dry seasons (Fig. 9). In both cases, woodland was the preferred habitat. During dry season, 66.67 % of the day time location was in the woodland ($\chi^2 = 20.742$, $df = 3$, $P < 0.001$) followed by bushland (16.67%) and farmland (13.33%). The use of grassland was very low (3.33%). During the dry season, 27.27 % of the resting locations were burrows and caves along farmlands and bushlands. Similarly during the wet season habitat use differed ($\chi^2 = 35.524$, $df = 3$, $P < 0.001$), 55.81% of locations were in the woodland. Unlike the dry season, the use of farmlands during the wet season was high (34.88%). Barley crop fields were important day time resting locations. The occurrence of jackals in the bushland (4.65%) and grassland (4.65%) was low during the wet season.

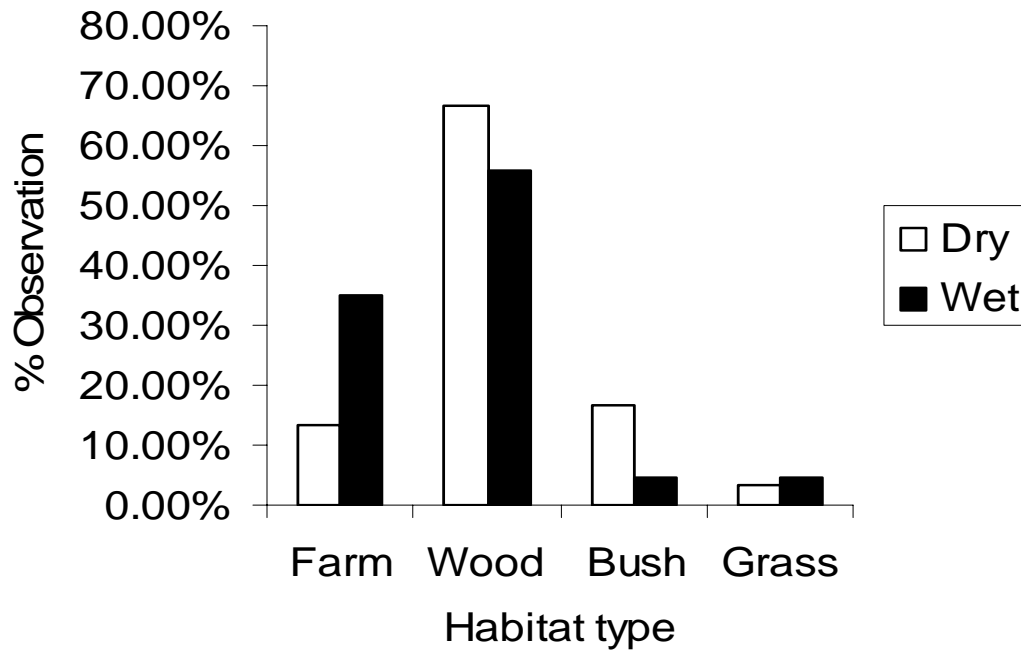


Figure 9. Habitat use during wet and dry seasons

Jackals inhabited along the boundary of the community conservation area as recorded in 101 day time locations (Table 2). Jackals were sighted more frequently in the bushland and farmland. The use of grassland was less frequent (17.82%).

Table 2. Frequency of jackal occurrence in different habitats around the protected area

Habitat type	N	%	Height of habitat (in cm)			
			0-20	20-50	50-100	> 100
Farm	31	30.69	17	14	0	0
Grass	18	17.82	12	6	0	0
Bush	52	51.49	0	6	18	28
Total	101	100.00	29	26	18	28

From the total 101 successful visit opportunities 68% (n = 69) were in day time resting cover (Fig. 10). Bushland (60.86%) and farmlands (28.99%) were the preferred resting locations. Grasslands were less preferred to others (10.14%).

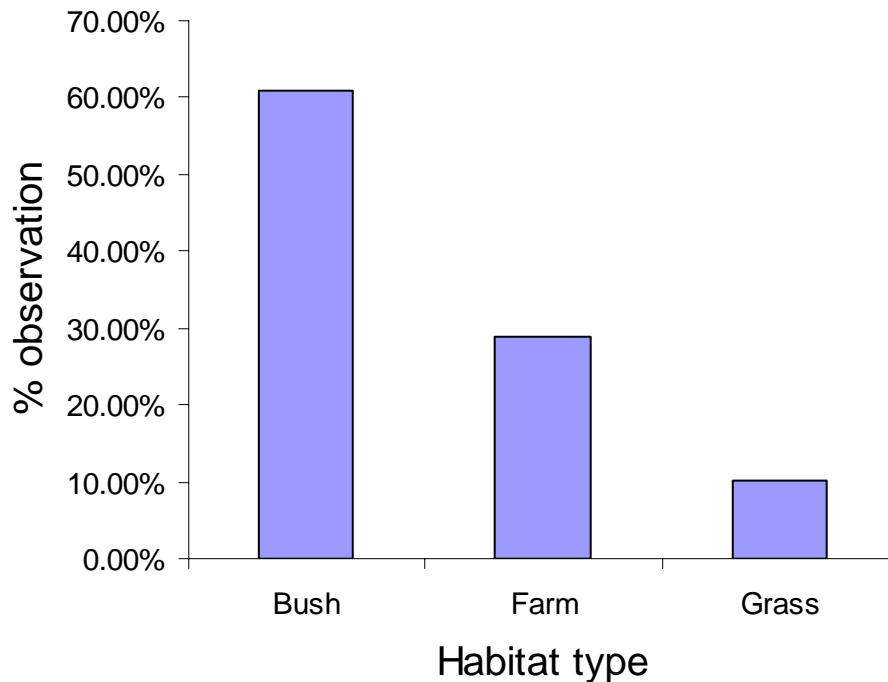


Figure 10 . Resting locations of jackals around the protected area

There was a significant difference in the use of habitats both during wet and dry seasons (Fig. 11). In all cases, bushland was the preferred habitat, with 52.5% and 50.0% locations recorded in wet and dry seasons, respectively. During the wet season, farmlands were used by jackals frequently next to bushland ($\chi^2 = 18.034$, $df = 2$, $P < 0.001$). Frequency of occurrence in grassland was low (8.5%). During wet season, 55% of the observation in barley crop fields was at rest while 45% was hunting rodent prey. Jackals around the protected area preferred habitats with sufficient cover and at the same time high rodent prey.

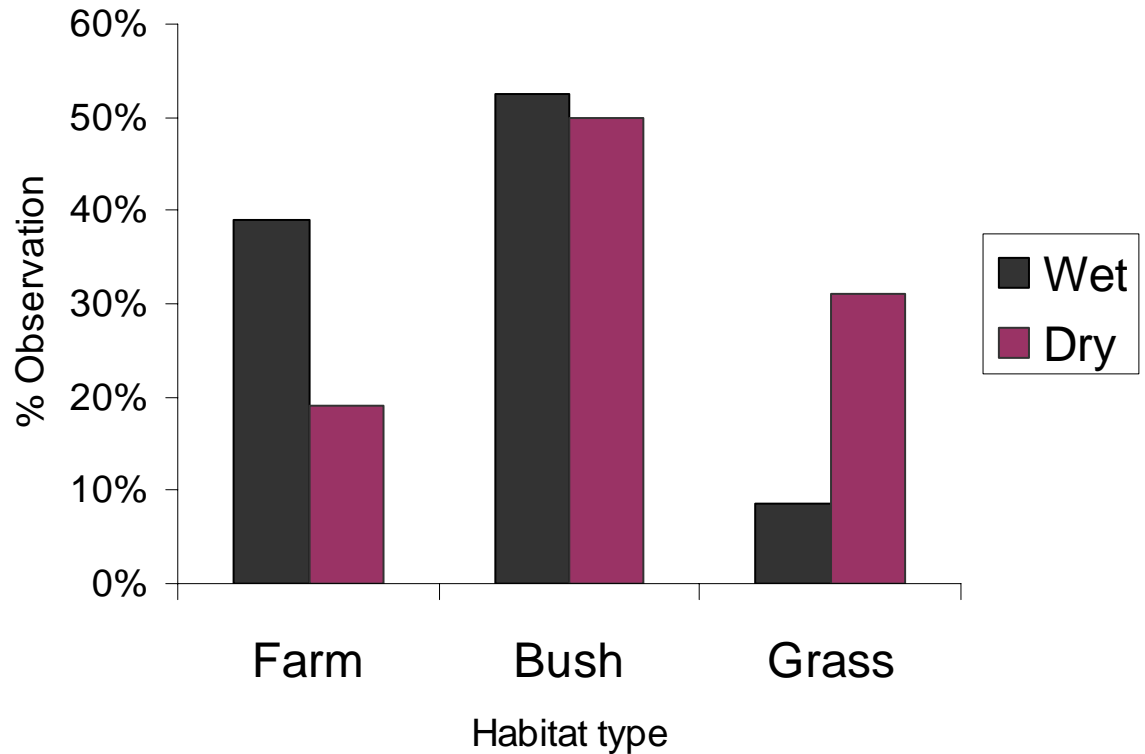


Figure 11. Habitat use during wet and dry seasons around the protected area

The majority of day time locations during October and November were in barley crop fields. A significant shift in habitat use from farmland to bushland and grassland occurred starting from December as a result of harvesting of the barley crop and respective reduction of the rodent density and absence of cover. During the dry season, jackals were sighted significantly less frequent (19.0%) in farmlands as compared to bushland (50.0%) and grassland (31.0%) ($\chi^2 = 6.143$, $df = 2$, $P < 0.001$).

6.2. Scat analysis

The occurrence of food items in the scats significantly differed ($\chi^2 = 215.154$, $df = 5$, $P < 0.001$). Rodents were the principal food type. The incidence of occurrence was high (Table 3).

Table 3. Frequency occurrence of food items in scats

Food item	Frequency in scats
Rodents (<i>Arvicanthis</i> and <i>Lophuromys spp.</i>)	89
Sheep	2
Bird	2
Insect	22
Plant material	35
Plastic	6
Total	156

Bones and teeth of small mammals were found 57.06% of the total prey item occurrence. The second most common food item was plant material (22.43%), mainly leaves (barley and grass), vegetables (carrot) and unidentified stem component. Insect body parts such as exoskeleton of different types had 14.10% frequency of occurrence. The occurrence of birds and sheep was low, each of them, accounted 1.28% occurrences. Plastic material, commonly used for packing of goods was found in 6 of the 101 scats, with frequency of occurrences 5.99%.

Only 12 scats out of the total 101 were without rodent. More than one rodent was found in several scats. Single rodent was found in 46 scats (51.67%), two rodents in 26 scats (29.21%) and 17 scats (18.11%) were with three rodents each. The occurrence of more than one rodent in a scat was frequent during the wet season, especially in October and

November. They easily collect killed rodent in traditional rodent trap 'Difit' located along farmlands (Fig. 12).



Figure 12. Traditional rodent trap 'Difit' in barley crop field

(February 19, 2010)

Plant materials were common both during the wet and dry seasons. Scats collected in settlement and conservation areas showed differences in frequency of food items (Fig. 13). Percentage frequency of rodents was high both in the conservation 69.44% and settlement areas 46.43%. Plant materials were common in both sites with percentage frequency of 23.81% in settlement and 20.83% in the conservation area. High percentage frequency of occurrence (21.42%) of insect components was recorded in scats collected around settlement than conservation area (5.55%). Similarly, plastic substances were more common in settlement (5.95%) than conservation area (1.39%). Predated sheep components were only found in scats collected around conservation area with percentage frequency of 2.78%. Feathers of birds were found only in scats around settlement with percentage frequency of 2.38%.

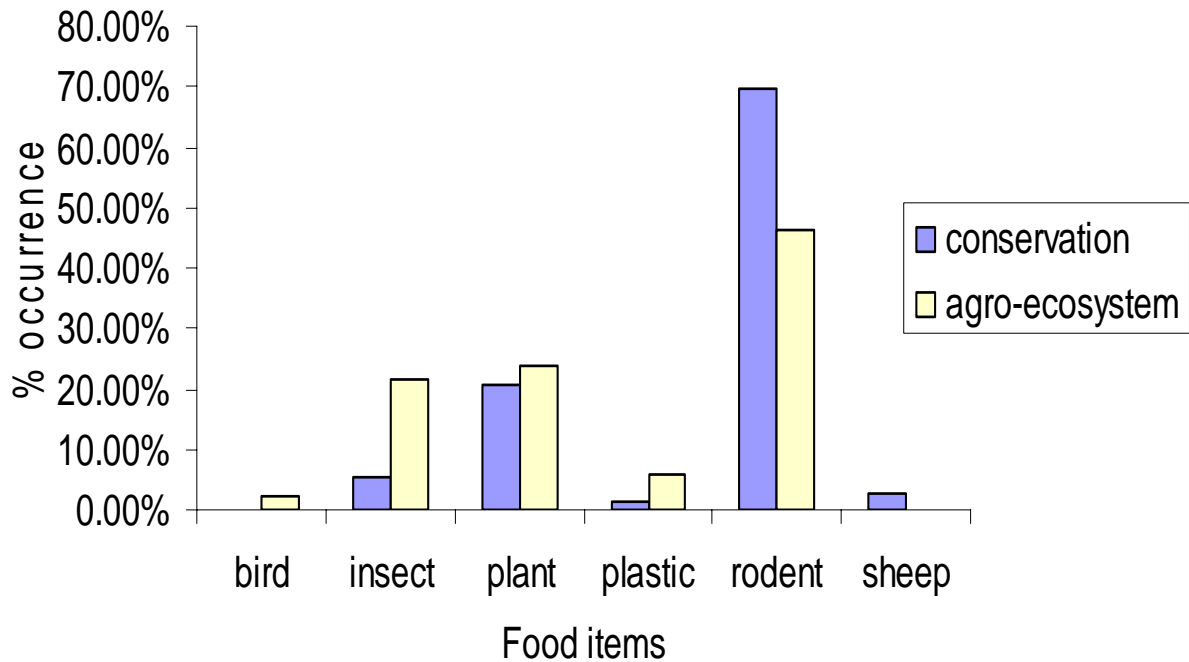


Figure 13. Occurrence of food items in scats collected around the conservation area and agro-ecosystem

6.3. Evaluation of attitude

Respondents were represented from villages Ermosh (34%), Darcha (35.2%) and Aba (30.8%). Female respondents in Ermosh accounted 29.41% (n = 25). The percentage of females in Darcha and Aba was 29.54% (n = 26) and 24.67% (n = 19), respectively. The age of respondents ranged from 18 to 77 years. There was no age difference between male and female respondents. Significant difference ($\chi^2 = 6.211$, $df = 1$, $P < 0.05$) between male and female respondents occurred in their educational status. Male respondents have better educational background than females (Table 4).

Table 4. Educational status of the respondents

	Illiterate	Reading and writing	Primary (1-4)	Junior (5-8)	High school (9-12)	Total
M	72	13	54	33	8	180
F	46	0	14	9	1	70
Total	118	13	68	42	9	250

The number of Livestock and pack animals was recorded in 250 households. The figure obtained revealed that sheep was the most common livestock with the highest figure in each successive years (Table 5). Sheep holdings ranged from 0 to 51. Next to sheep the second large number of livestock was recorded to cattle. Among pack animals, donkey was fairly common while mules and horses were less common.

Table 5. Number of livestock recorded (2008-2010)

	Year			Total
	2008	2009	2010	
Sheep	3,331	2,830	2,593	8,754
Goat	426	376	340	1,142
Cattle	856	806	797	2,459
Donkey	398	367	406	1,171
Mule	98	107	102	307
Horse	138	109	104	351
Total	5,247	4,595	4,342	14,184

Among livestock, mean sheep holding per household was the highest (Table 6). The lowest mean livestock holding was recorded to mule. On average 11.67 sheep were owned by each respondents. The trend showed a decrease in sheep mean holdings.

Table 6. Mean livestock holding per household

	Year		
	2008	2009	2010
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Sheep	13.32 \pm 5.18	11.32 \pm 3.14	10.37 \pm 2.76
Cattle	3.42 \pm 0.52	3.22 \pm 0.99	3.19 \pm 1.20
Goat	1.70 \pm 0.63	1.50 \pm 0.88	1.36 \pm 0.55
Donkey	1.59 \pm 0.99	1.47 \pm 1.11	1.62 \pm 0.95
Horse	0.55 \pm 0.49	0.44 \pm 0.49	0.42 \pm 0.49
Mule	0.39 \pm 0.48	0.43 \pm 0.49	0.41 \pm 0.49

Among villages, average sheep holding per household was relatively larger in Aba (Table7).

Table 7. Mean livestock holding in each village

Livestock	Village		
	Ermosh	Darcha	Aba
Sheep	11.56 \pm 0.49	11.38 \pm 0.47	12.13 \pm 0
Cattle	3.22 \pm 0.77	3.24 \pm 1.08	3.38 \pm 1.15
Goat	1.41 \pm 0.77	1.82 \pm 0.57	1.30 \pm 0.81
Donkey	1.58 \pm 0.66	1.64 \pm 0.59	1.49 \pm 0.71
Horse	0.45 \pm 0.56	0.48 \pm 0.43	0.32 \pm 0.77
Mule	0.31 \pm 0.88	0.47 \pm 0.32	0.32 \pm 0.85

Farming and livestock rearing were basic economic activities of the people. Livestock rearing specially sheep rearing was their major income source. However, 78% of the respondents have no private grazing land; only 22% of the respondent's possessed private grazing land. Villages differed in private grazing land holding, 26% of the respondents in Aba and 22.4% in Ermosh have grazing land. In contrast to Aba and Ermosh, few respondents in Darcha had private grazing land (18.2%). Local people used their livestock in communal grazing fields including bushlands close to the conservation area throughout the year. The use of bushlands around the conservation area differed among villages ($F_{2, 241} = 87.64$, $P < 0.05$). Using Tukey test, the mean use of bushlands as grazing land in Darcha was compared to Ermosh ($P < 0.05$) and Aba ($P < 0.05$). Respondents in Darcha used bushlands mainly close to the conservation area. These areas were the principal habitats to jackals. During the night time, they keep livestock specially sheep, goat, horse, donkey and mule in houses while cattle are kept outside in wooden bomas. The majority of the respondents have domestic dogs to guard livestock from nocturnal predators.

Most of the respondents (75.4%) had positive attitude towards wildlife conservation (Table 8). Respondents in different villages do not show significant difference in conservation attitude towards wildlife. However, male and female respondents differ in their attitude towards wildlife conservation, 86.77% of male respondents have positive attitude towards wildlife, while only 52.85% of the female counterparts gave value to wildlife ($\chi^2 = 85.422$, $df = 1$, $P < 0.001$)

Table 8. Response to wildlife protection

Response	No.	Male	Female	%
Agree	194	157	37	75.4
Disagree	56	23	33	24.6
Neutral	0	0	0	0.0
Total	250	180	70	100.0

Spears man Correlation Coefficient showed that there was no correlation between livestock predation by wildlife and conservation attitude of respondents towards wildlife ($r = -0.28, P > 0.05$). The attitude of respondents towards wildlife did not depend on problem caused by wildlife.

Most of the respondents (85.2%) had positive attitude towards the Ethiopian wolf. Respondent's attitude towards the Ethiopian wolf was not related to livestock predation. There was no difference in attitude towards Ethiopian wolf between villages. In contrast, only 19.2% of the respondents have positive attitude towards golden jackal. Large number of respondents (80.8%) showed negative response to golden jackal (Table 9). Therefore, only few respondents showed positive response to the species. Attitude of the people to jackals was dependent on livestock predation. Spears man Correlation Coefficient showed that there was negative correlation between livestock predation by golden jackal and the attitude of the people towards the animal ($r = -1.00, P < 0.05$).

Table 9. Attitude of respondents towards golden jackal

Response	Village		
	Ermosh (%)	Darcha (%)	Aba (%)
Positive	20	17.32	21.78
Negative	80	82.68	79.22
Neutral	0	0	0
Total	100	100.00	100.00

A total of 492 domestic livestock loss due to carnivore predators was recorded since 2008 (Table 10). The weight of predation differed among predators ($\chi^2 = 692.878, df = 3, P < 0.001$). Jackals were number one predators, sheep and goats were predated by jackals which accounted 74.59% of the total loss. Sheep and goat predation was also recorded by Ethiopian wolf (20.53%). Predation by hyaena and serval cat was 4.67% and 0.02%, respectively.

Among livestock, predation was intense on sheep (90.45%). Goat predation was 7.11%, donkey 1.62%, horse 0.61%, and cattle 0.20%. No mule predation was recorded. Both small and large sized livestock were killed by hyaena. However, sheep and goats were predated by jackals and Ethiopian wolf. There was no difference in livestock and pack animal predation among villages ($\chi^2 = 1.304$, $df = 2$, $P > 0.05$). 74.03 % of the respondents in Ermosh, 77% in Darcha and 72.06 % in Aba have lost their livestock to carnivore predators.

Table 10. Number of livestock predated (2008-2010)

Livestock	Predator				Total
	Golden jackal	Ethiopian wolf	Serval cat	Hyaena	
Sheep	351	83	0	11	445
Goat	16	18	1	0	35
Cattle	0	0	0	1	1
Donkey	0	0	0	8	8
Mule	0	0	0	0	0
Horse	0	0	0	3	3
Total	367	101	1	23	492

Sheep loss by jackals was significant ($t = 18.618$, $df = 249$, $P < 0.001$). Mean sheep loss per household was 1.40 ± 1.1 . Villages differed in sheep loss ($\chi^2 = 10.786$, $df = 2$, $P < 0.01$). In each of the three successive years, large number of sheep predation was

observed in Darcha (Table 11). There was no significant difference in the number of sheep loss between village Ermosh and Aba. Total sheep loss in these two villages was 103 and 102, respectively. The difference is also low when the total sheep loss is compared in relation to the number of sheep recorded in each village, 76.45% of the respondents in Darcha have lost their sheep to jackals, while in Ermosh and Aba respondents who claimed sheep loss were 72.88% and 69.04%, respectively.

Table 11. Sheep predation among villages

Village	Year						Total
	2008	(%)	2009	(%)	2010	(%)	
Ermosh	55	30.73	29	24.37	19	35.85	103
Darcha	68	37.99	58	48.74	20	37.74	146
Aba	56	31.28	32	26.89	14	26.41	102
Total	179		119		53		351

Sheep loss was not related with sheep holding (Table 12). Mean sheep loss was high in Darcha despite the lowest mean sheep holding. Sheep predation was positively correlated ($r = 0.62$, $P < 0.05$) with mean utilization of bushlands around the conservation area as grazing field. Respondents in Darcha used bushlands closer to the conservation area as grazing field throughout the year.

Table 12. Mean sheep loss among villages

Village	Mean sheep holding	Mean sheep loss
Ermosh	11.56 ± 0.49	1.21 ± 0.33
Darcha	11.38 ± 0.47	1.65 ± 0.44
Aba	12.13 ± 0.33	1.32 ± 0.25

Different age groups of sheep were preyed by jackals (Table 13). Minimum age among the predated sheep was 4 months and the maximum age was 30 months. However, 87.75% of the predated sheep were age group between 6-24 months. Approximate average weight of sheep below 12 month was 11 kg; from 12-24 months was 20 kg.

Table 13. Age category of predated sheep

Age group (in month)	N	%
1-6	34	9.69
6-12	115	32.76
12-18	73	20.80
18-24	120	34.19
> 24	9	2.56
Total	351	100.00

Sheep predation was common in all months of the year (Table 14). However, the rate of predation differed ($\chi^2= 346.949$, $df = 11$, $P < 0.001$). Predation was more intense in the four consecutive months, January-April. The intensity decreased from May-August and became low from September-December. It was in November, where the lowest figure of sheep loss recorded. Highest frequency of predation was registered in March, followed by April and February. From January to April, the number of sheep loss registered was 253 which accounted 72.08% of the total loss. On average, loss of more than 21 sheep was recorded in each month from January to April every year since 2008. Every month, from September, 2008 to April, 2010, there was on average 10.97 sheep predation by jackals. On the other hand, within the above mentioned period of time the average daily loss was 0.36. Mean sheep loss per day was high during the dry season (1.03 ± 0.157) than the wet season (0.95 ± 0.210).

Table 14. Sheep predation in the different months of the year

Month	Number of sheep predated	% predation
September	9	2.56
October	6	1.71
November	3	0.85
December	9	2.56
February	60	17.10
March	98	27.92
January	32	9.12
April	63	17.94
May	22	6.27
June	10	2.84
July	18	5.13
August	21	5.98
Total	351	100.00

All sheep loss occurred in the hours of the day light (Table 15). Sheep predation was not recorded in the night time. Predation was considerably large in the hours between 11:00 a.m. and 1:00 p.m. and between 1:00 p.m. and 3:00 p.m. The time 11:00 a.m. – 3:00 p.m. was the peak time where the major sheep predation events occurred (79.77%).

Table 15. Frequency of sheep predation at different hours of the day

Time of the day	Frequency of predation	%
7:00-9:00	9	2.56
9:00-11:00	23	6.55
11:00-1:00	153	43.59
1:00-3:00	127	36.18
3:00-5:00	31	8.83
5:00-7:00	8	2.29
Total	351	100.00

Total economic loss due to sheep predation was high (Table 16). The economic damage at individual level was also significant in the fact that sheep rearing is the major income source to the people in Guassa area.

Table 16. Economic loss due to sheep depredation by golden jackal

Year	No. of sheep predated	Total loss in birr	Average loss per household	Total loss in USD
2008	179	37,240	148.96	3,546.00
2009	115	19,400	77.60	1,763.64
2010	57	10,955	43.82	912.92
Total	351	67,595	270.38	6,222.56

Various measures have been taken by the people to reduce the problem of sheep predation by golden jackals (Table 17). They severely attacked jackals through smoke poisoning during their breeding time. Some of the respondents used guarding as the only solution to protect sheep predation. Few respondents have reduced the number of sheep they had and others have changed sheep grazing areas away from the jackal habitat. Most of the strategies used (guarding, reducing number of sheep and changing grazing areas) were positive to the jackal population.

Table 17. Measures undertaken by the people to minimize predation

Solution	Number of respondents	%
Guarding	89	35.6
Changing sheep grazing system (Away from jackal habitat)	12	4.8
Reduction in sheep number	39	15.6
Attacking jackals to minimize their number	110	44.0
Total	250	100.0

7. Discussion

Golden jackals in human dominated major agro-ecosystems preferred cover during the day time. They preferred habitat types with tall and thick vegetation cover primarily to take rest and get potential shelter and minimize threats. The most preferred day time resting locations were woodland community plantations. Even though community plantations have little coverage being islands in the ocean of farmland, they were preferred day time resting locations by jackals. Similar study in farmlands of Bale highlands, Ethiopia showed woodland as the preferred day time resting locations of jackals despite large size coverage of farmlands (Ermias Admassu *et al.*, 2004). Woodland community plantations are available throughout the year and hence favoured jackals as potential day time shelter to avoid human disturbance. Farmlands were less preferred by jackals for day time resting locations. They are only observed for a short period of time. This is because farmlands that are closer to settlements are highly managed and are not free from human disturbance. In any instant when jackals are sighted, they will be attacked and persuaded by the local people. Widely cultivated barley crop was available seasonally and could function as cover to jackals for a brief period usually in the months of October and November. In December, barley crops are harvested and in the absence of crop cover jackals were observed using burrows along farmlands as day time resting site. Bushland was not preferred by jackals as day time resting location. Besides to the patchiness, bushlands closer to settlements were the most managed and exploited habitat used by the local people as livestock grazing field. It is common to see group of herders and their livestock from dawn to dusk around bushlands. Jackals were rarely sighted in grassland habitat. In Serengeti, golden jackals were most common on grassland habitats (Moehlman, 1986). Open grassland were not preferred by jackals as day time resting locations in the present study. In such human dominated ecosystem, their importance to rescue jackals from human detection was low.

Around the protected area, jackals were more frequently sighted in bushland habitat. Bushland was the most preferred habitat type for day time resting. In Bale highlands, the majority of diurnal resting sites were recorded in the bush (Ermias Admassu *et al.*, 2004).

Woodland habitat was not available around the protected area. Cultivated farmlands adjacent to the protected area were the second habitat type where jackals sighted during the day time. Rodent density along farmlands increases considerably during the wet season following cultivation of barley crop. As a result, during wet season, the frequency of locating jackals in farmlands was high. Specially barley crop fields were more preferred day time resting locations during the months of October and November. Farmlands therefore, provide cover from human disturbance and also they were prey sources. The frequency of occurrence in farmlands decreased during the dry season beginning from December following the decrease in prey density and absence of cover because of crop harvest. The occurrence of jackals in the grassland increased during the dry season as a result of crop harvest and lack of alternative day time cover. In general, jackals around the protected area preferred farmlands during the wet season and grasslands during the dry season.

Jackals in the major agro-ecosystem habitat used burrows and caves as alternative day time hiding places different from those groups around the protected area. This was an indication for shortage of promising day time cover and the extent of disturbance around settlements. Cultivated farmlands were used as cover and to collect rodent. The influence of prevailing human disturbance is clearly observed during the day time habitat use of jackals.

The frequency of rodent prey was high in scats of golden jackals. This was an indication that rodents were the preferred and available food items of jackals in the agro-ecosystem of Guassa. Similar study in the agro-ecosystem of Bangladesh revealed that rodents were the most common prey in the scats of golden jackals (Jaeger *et al.*, 2007). Lanszki *et al.* (2006), found that the major food items in southern Greece were small mammals. Rodents are widely available small mammals in the bushland and grassland habitats of Guassa area. Moreover, they are important crop pests in cultivated farmlands. As a result, during the crop season, the incidence of more than one rodent in a scat was high because of the increase in rodent density along farmlands. Jaeger *et al.* (2007), reported the increase in incidence of rodents in scats during the cropping season. Opportunistic jackals

were seen collecting rodents killed by traditional trap along cultivated farmlands even during the day time using barley crop as cover. Scats of jackals collected around the protected area and human dominated settlement locations differed in the frequency of rodent prey occurrence. Even though rodents were found to be the major food items in both locations, the frequency occurrence was low in scats of jackals inhabiting settlement area. This is because unlike jackals of the conservation area, jackals in human dominated settlement places are rarely seen foraging during the day time.

Plant materials like leaves of grass species, barley and vegetables mainly carrot was also identified in scats of jackals. Plant materials were a secondary important food item in the diet of golden jackals. This finding is consistent with a study in Hungary, where the frequency occurrence of plant materials was found next to small mammals (Lanski *et al.*, 2006). The percentage occurrence of plant materials was high in scats collected around settlements. This indicated that jackals used easily accessible materials around their den site to subsidize shortage of rodent prey. Among the invertebrates, only insects were found to be important prey items in the diet of jackals. A study in southern Greece, revealed the occurrence of insects in the scats of golden jackals (Giannatos *et al.*, 2009). Plastic packing materials were found in the scats of jackals. It might have been taken together with some food item remnants thrown away by the people. Plastic materials were also reported in southern Greece (Giannatos *et al.*, 2009). This material which might have been collected from garbage dumps could be an indication for occasional intrusion of jackals into settlements during the night time. However, no other domestic human refuses were found in scats of jackals. Garbage dumping places were not common in Guassa area. The incidence of birds in the scat was low. However, in agro-ecosystem habitat of Bangladesh the incidence of birds was reported to be high (Jaeger *et al.*, 2007). The decrease in occurrence of birds in the study area could be associated with the accessibility of rodent prey. Similarly, the occurrence of domestic livestock in scats was low. Among the livestock population in Guassa, sheep was identified in few scats being preys to jackals.

Most respondents have a good knowledge about wildlife resources of the area. They also knew the importance of protecting wildlife resources with positive attitude. Similar result was reported in this area by Zelalem Tefera (2001). Deresse Dejene (2003) reported that the local people around conservation area have positive attitude to wildlife.

There was no correlation between problems caused by wildlife and conservation attitude to wildlife ($r = -0.28$, $P > 0.05$). Despite high livestock predation, local people were positive to wildlife conservation. This feeling might have developed as a result of the conservation area protected by the community. For sustainable management and utilization of wildlife, wildlife management policies should be directed to enhance incorporation of expertise and views of the local people (Balakrishnan and Ndhlovu, 1992).

In this study, attitude of respondents to Ethiopian wolf was not correlated with predation. Even though Ethiopian wolf was second to golden jackal in terms of livestock predation, local people showed positive response to its protection. This sense of concern to Ethiopian wolf arose from the credit they give to legally protected species. Most respondents knew that Ethiopian wolf is endemic. According to Zelalem Tefera (2001), large number of residents in Guassa area knew that Ethiopian wolf is an endemic species. As a result majority of the respondents have a good understanding about the prospect of Ethiopian wolf as heritage to the nation and income source from visitors specially to the residents. According to Mesele Yihunie, *et al.* (2008), local people around Simien Mountains National Park considered Ethiopian wolf as important source of income. People in Minnesota, USA showed strong positive attitude towards timber wolf as a symbol of nature's wonder and beauty (Kellert, 1985).

In contrast to the Ethiopian wolf, 80.8 % of respondents in this study showed strong negative attitude towards the conservation of golden jackal. Attitude towards golden jackal was negatively correlated with sheep predation ($r = -0.93$, $P < 0.01$). Sheep predation by jackals was a serious problem in Guassa area. They are number one livestock predators. A study in Simien Mountains National Park showed that a large

number of the local people around the Park have negative attitude to jackals as compared to the Ethiopian wolf (Mesele Yihunie, 2006). The conflict in Guassa was high and the animals considered as pest by the people.

Respondents mentioned hyaena, Ethiopian wolf, golden jackal and serval cat were the most important predators of livestock. Mazzoli (2002) reported that livestock predation by mammalian carnivore is the most frequent sources of conflict between humans and wildlife. In the present study area, golden jackals were the primary carnivore predators which killed large number of livestock. The majority of sheep and goat predation was caused by golden jackal and Ethiopian wolf. However, predation and the associated economic loss caused by jackals were more intense than Ethiopian wolves. Hence, human conflict with jackals was very serious compared to other carnivore predators. Livestock loss was also recorded by hyaena and serval cat. Hyaena was the most known night time predator. All kills by hyaena were recorded during the night time.

Among others, sheep predation by jackals was very significant ($P < 0.001$). This is because sheep was the most important livestock kept by the local people. Predation on small stock mainly sheep by jackals was a serious problem in Bulgaria (Genove and Vassiler, 1991). Despite this, the local people had no sufficient private grazing land. The local people therefore keep their sheep during the day time away from settlement area in communal grazing fields mainly bushland. The majority of respondents in Darcha have serious problem of grazing land and they were number one in using bushlands specially close to the protected area for long period annually. Sheep predation was correlated with mean use of bushlands as grazing field ($P < 0.05$) but not on mean sheep holding. A study in Italy revealed that majority of sheep attack by wolves was when they were grazing in proximity with shrub or woodland cover (Cozz *et al.*, 1996). Among villages, sheep predation was significant in Darcha, the village with the lowest private grazing field holding and number one users of bushlands. Therefore, intense sheep predation by jackals in the study area was primarily caused by shortage of sufficient grazing field but not sheep density.

As shown in (Table 14) sheep predation occurred in all months of the year. The increased predation intensity during different periods was associated with the breeding time of golden jackals. Golden jackals in Guassa begin mating from January to February and give birth from March to April. During this period, availability of rodent prey along farmlands was low. A study in Greece disclosed that jackals feed their cubs with a diverse diet with highest biomass of domestic cattle carcasses (Lanszki *et al.*, 2009). Similarly a study in Serengeti showed that during their breeding time, golden jackals feed on larger prey and carcasses (Lamprecht, 1978). Therefore, golden jackals used incidence of 'Belg' rain and available vegetation as cover to prey sheep and satisfy their energy demand during their breeding time. A study in Waza National Park, Cameroon, revealed that jackals attack small domestic livestock camouflaged by the noise of rain when walking in the tall grass (Bauer, 1999).

Sheep of different age groups were attacked by golden jackals. Golden jackals in the study area were able to kill prey with body weight estimated up to three fold heavier than their mean body weight. According to Kotwall *et al.* (1991), jackals hunt young, old and weak ungulates that are heavier than their body weight.

Local people have been taking various protective measures to alleviate the problem of sheep predation by jackals. They persuade jackals, abandon day time hiding burrows and poison using smoke during their breeding time while they shelter in burrows. Similarly farmers in Israel illegally poison jackals to reduce predation (Yom-Tov *et al.*, 1995). According to Sekhar (1998), the only perceived solution by the local people in developing countries to predator problems is extermination. These illegal acts were the result of conflict that arose from economic loss due to jackals. The local people were unable to consider the importance of jackals in preying rodents that are crop pests.

8. Conclusion and Recommendations

Golden jackals in Menz-Guassa area were predominantly located in cover to avoid human detection during day time. They preferred habitats mainly with tall and dense vegetation. They were also observed being sheltered in burrows and caves. These places were preferred by jackals to escape attack from humans in human populated major agro-ecosystems. The study found out that jackals in highly managed agro-ecosystem of Guassa face habitat loss caused by human activities. In contrast, jackals around the protected area were less disturbed and able to use available habitats. This study also revealed that rodents are the principal diet of golden jackals. When they face shortage of rodent prey, they subsidize eating plant materials and insects. Among livestock sheep was the preferred prey identified.

Large numbers of respondents have positive attitude to wildlife conservation in general and the Ethiopian wolf among carnivores in particular. They have strong negative attitude towards golden jackals. This study indicated that the majority of the local people are against golden jackals and the conflict is serious to the extent of considering jackals as pest. In any incident when jackals are sighted, they will be chased by the people. People also severely kill jackals poisoning the cubs inside their den site during their breeding time.

To minimize the conflict, the following recommendations are suggested:

- ❖ Farmers should work in rehabilitating degraded landscapes using indigenous trees.
- ❖ Land use authorities ought to work with the local people in guiding the people to use land resource sustainably in harmony with wildlife.
- ❖ Farmers need to adopt the practice of cultivating plant species selected as fodder to their livestock around their farmlands.
- ❖ Farmers have to intensify private grazing fields so that they could be able to live peacefully with jackals and other carnivore predators.
- ❖ Farmers have to carefully guard their livestock during the day time.

- ❖ The authority need to work with the local people to create awareness about the protection of those species that are not legally protected.
- ❖ The concerned people are advised to work on the human - golden jackal conflict to devise solutions that are ecologically friendly.
- ❖ The community should be able to strengthen the protection of the conservation area from livestock and human disturbance.

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APPENDIX I

Questionnaire

A. Introductory questions

1. respondent's number ----- 2. village -----
3. age----- 4. sex ----- 5. educational status -----

B. Household livestock number

6. Do you keep livestock? Yes, No, if yes,

	2008	2009	2010
a. number of cattle	-----	-----	-----
b. number of sheep	-----	-----	-----
c. number of goat	-----	-----	-----
d. number of donkey	-----	-----	-----
e. number of horse	-----	-----	-----
f. umber of mule	-----	-----	-----

C. Livestock grazing and guarding

7. Where do you keep your livestock in the day time?

	For how long annually?
a. communal grazing field	-----
b. farmlands	-----
c. other-----	-----

8. Do you have private grazing field? yes, no

a. if yes, size of grazing land in ha. -----

b. for how many months do you keep your livestock in private grazing area? ----

9. Where do you keep livestock during the night time?

10. Do you have dogs?

D. Conflict and damage

11. The type of wildlife you know in the area

.....
.....
.....

12. Do you think that protecting wildlife is important?
13. Do you agree that protecting Ethiopian wolf is important?
14. Do you agree that protecting golden jackal is important?
15. Have you ever faced livestock predation problems due to wildlife?

Livestock predation

Year	Type of livestock predated	Predator type	Age of the predated livestock	Month	Time	Cost of the predated livestock
2008						
2009						
2010						

