Grevy’s zebra (*Equus grevyi*, Oustalet, 1882)
Challenges of Survival in the Pastoralist Dominated
Arid Ecosystems of Chew Bahir and Sarite,
Southern Ethiopia

*A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfilment of the Requirements for the Degree of Master of Science in Biology*

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Dedication

This work is dedicated to my beloved mother W/o Wubete Tagel, and father Ato Tadesse Limen. Their tender love and care has made me what I am and in them I have learnt the essence of hard work. May the Almighty God grant healthy and longer life to my beloved parents. Amen!
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Abstract

This thesis documents the human-wildlife interaction (Grevy’s zebra, Equus grevyi, and the local pastoralists in Chew Bahir (Chalbi) and Sarite areas, southern Ethiopia. The study tried to investigate the challenges and the underlying causes that brought Grevy’s zebra population decline. Data were collected from September 2005 to October 2006 using interviews through questionnaire, transect survey and scan sampling methods. Chi-square tests and one way ANOVA were used to evaluate the opinions of pastoralists and the activity pattern and habitat association of Grevy’s zebra in the study areas. DISTANCE 4.1 was also used to estimate the Grevy’s zebra population density in the study areas. The results indicated that hunting for various purposes and directional change of Woito River and challenge to access the critical resource, (water), are the major factors that contribute to the dramatic decline of Grevy’s zebra population in Chew Bahir. There was significant difference on the reasons why Grevy’s zebra were declining in number (\( \chi^2 = 185.833, \) df = 4, \( P < 0.001 \)). Hunting was the most (50.8%) important factor. The hunting tradition of Hamar and Hor (Arbore) pastoralists contributed the most part. Grevy’s zebras were killed for food (46.3%) and medicinal value (45.4%). At Sarite, drought was a major factor for population decline. The result also indicated that the population density estimate for the study areas were 0.087/km² with 95% CI 0.044657 - 0.16982 and 0.115/km² with 95% CI 16.000 – 53.000 for Chew Bahir and Sarite, respectively. The availability of water to Grevy’s zebra was associated with distance of the water points to the nearest human settlement (\( F_{3,31}=3,805, \) \( P < 0.05 \)). At Chew Bahir, water was more available during non-drought seasons than that of Sarite. The activity pattern and habitat association of zebras in Chew Bahir also showed significant difference (\( \chi^2 = 32.991, \) df = 1, \( P < 0.001 \)). At Chalbi, mean frequency for each activity per hour was feeding 1.40 ± 0.157, vigilant 3.17 ± 0.155, walking 0.81 ± 0.086, resting 0.42 ± 0.094, grooming 0.14 ± 0.048, and running 0.12 ± 0.030. While in Sarite, the mean frequencies were feeding 2.93 ± 0.152, vigilant 0.542 ± 0.071, walking 0.618 ± 0.062, resting 0.99 ± 0.117, grooming 0.479 ± 0.085, and running 0.035 ± 0.018. Grevy’s zebras face the ultimate challenge of disappearing from the study areas due the human effect of hunting and water shortage. Therefore, urgent measures that can integrate the local pastoralist communities with the wildlife must be taken to save this endangered species.

**Key words:** Activity pattern, Grevy’s zebra, human-wildlife interactions, population density.
1. INTRODUCTION

1.1. Human-wildlife interactions in pastoralist ecosystems

Large parts of Africa are still dominated by pastoralist communities. Many of the regions with abundant and diverse wildlife communities are occupied by pastoralists (Prins, 1992). They rely heavily on the natural resources; water, rangeland, firewood, and bush meat.

The majority of pastoralist ecosystems are characterized by marked fluctuations in resource abundance during different seasons. Of these, in arid and semi-arid regions of tropical Africa extended periods of dryness are punctuated by erratic rainfall and a brief eruption of vegetation communities (Coppock, et al., 1986), where grazers and browsers use the opportunities of this sudden eruption of vegetation communities. Apart from the wild herbivores, traditional pastoralists are also using these opportunities for their livestock (Coppock, et al., 1986).

1.1.1. The conservation dilemma

There were different thoughts about conservation and the pastoralist communities. Since large concentration of wildlife occur in the arid and semi-arid areas of Africa where pastoralist communities occur, it is essential to treat these differing concepts. The classic approach to wildlife conservation is characterised by a top-down approach, which includes the establishment and expansion of protected areas, law enforcement and ownership of wildlife resources by the state (Zelealem Tefera, 2001). By virtue of it, natural resources management is an activity that, by definition, can be adequately managed only ‘from above’ (Turton, 1995). This top-down (preservationist) approach considers man as a prime factor for serious decline and to the eventual extinction of species from different habitats, hence a need to be expelled from conservation areas (Prins, 1992; Lindsay, 1987). The proponents of this thought question how harmonious is the relationship between the local communities and wildlife particularly the larger mammalian species. They argue that the pastoralist communities of Africa have a long history of hunting in such a way that life long prestige is awarded to any one who has killed larger wildlife like the Lion *Panthera leo*, Elephants *Loxodonta Africana*, Rhinoceros *Diceros bicornis*, and enemy tribesmen (Prins, 1992; Happold, 1995). In areas where wildlife occurs,
the herdsmen hunt carnivores and ungulates for protecting their cattle and meat respectively, and indiscriminately burn the vegetation to produce new swards of grass and herbs for their livestock. This is usually at the expense of wildlife (Osemeobo, 1988).

In a preservationist’s view, Africa’s mammal population numbers and the geographical distribution of many species have been reduced due to the activities of mankind. There are a number of ways in which the activities of mankind affect mammal species. Some of the most important activities are hunting, livestock rearing, and habitat modification for agriculture and disease control (Happold, 1995). For example, hunting has been an age old activity of humans. As a result of low human population, its effect on wildlife was less. However, as human population increased, a decline of larger species and constriction of their geographical ranges have resulted (Asibey, 1974). Reduction of habitat suitable for bush meat species, an increase in demand for bush meat, and changing economic conditions have undoubtedly caused a decline in the population numbers of many species (Happold, 1995).

According to Happold (1995), pastoralism is a form of interference competition in which wildlife feed on vegetation which could also be eaten by domestic stock, and *vice-versa*. As a result, the number of pastoralists (and their livestock) in an ecosystem must be controlled because too many of them will lead in time to environmental degradation (Brown, 1971). There is also an inverse relationship between population numbers of human/livestock and populations of wild mammals (Prins, 1992; Happold, 1995). For example, in many areas of Kenya and Tanzania where wildlife and livestock coexist, livestock are responsible to take most of the energy consumption (Prins, 1992). Hence, the assumption is that livestock with their herdsmen compete successfully with wildlife, resulting in competitive exclusion of wildlife (Prins, 1992; Happold, 1995). Prins (1992) pointed out that ‘at first livestock supplants wildlife; then, when the ratio between humans and livestock increases, and when wildlife is out-competed by livestock, people ultimately switch to agriculture, and there is less and less space for wild animals. Ultimately agriculture has to give space to urbanization and no space or food will be left for wildlife’.

Land-use conflicts in Africa are not confined to pastoral areas; but the land rights of pastoralists are peculiarly vulnerable. This is because they are overwhelmingly held in common and are liable to be classified as public (Turton, 1995). Communal lands, in the form
of pasture lands, are the basis of pastoral production. The land is used for the major productive activity, i.e., grazing of livestock. In the ‘tragedy of commons’ idea, it is suggested that individuals would have nothing to gain from limiting the number of their own stock grazing communally owned land- any environmental benefit from restraint would be exploited by others- and as a result, common land is systematically overgrazed (Hardin, 1968). Therefore, if large tracts of land are left to be used for pastoralists, the land will soon be changed into a bare ground.

However, the second thought accused that the early wildlife conservation activities in Africa have marginalised the pastoralist communities. They argue that prior to modern conservation activities by colonialists, pastoralist communities have been living with wildlife harmoniously and the pastoralist way of life was part of an integrated system of the ecosystem and if changes are apparent, it is as a result of climatic fluctuation rather than overgrazing and wood cutting. But, when colonialists demarcated large areas of land for wildlife conservation everything changed (Western, 1973; Lindsay, 1987; Homewood and Rodgers, 1984; Homewood and Rodgers, 1987).

They also argue that many conservation areas in the world were established as wilderness preserves for public recreation without permanent human habitation or extractive use (Holmern, et al., 2004). Conservation activities prioritized keeping local people out, following the view that human activities are incompatible with ecosystem conservation (Wells and McShane, 2004). Land was demarcated for national parks and game reserves to protect the large animal species and their habitats. This was done without considering traditional land-use systems, and without the consent of the local people whose lives would be affected by these activities. Indigenous people were seen as a threat to wildlife and their habitat (IIED, 1994). They were forced to abandon and live outside the area where they had lived for generations (Homewood and Rodgers, 1984; Homewood and Rodgers, 1987). In this respect, most conservation decisions were taken without the consultation of local communities and often these people were marginalized in resource utilization. Hence conflicts rather than cooperation are too common, and each side accuses the other of denying fundamental rights as each aspires to different uses of resources (Homewood and Rodgers, 1984; 1987; Martinet and McNeely, 1992; Holmern, et al., 2004).
Additionally, pastoralists were forbidden to use protected areas which are stores of resources for food for their livestock and themselves, firewood, ritual grounds, etc. When these resources became inaccessible to them, the relationship between local people, members staff of conservation and the resources turned to antagonism (Holmern, *et al*., 2004). Many of the local people were evicted from their settlements without adequate provision for alternative means of living (Zelealem Tefera, 2001). The alienation of grazing land for the exclusive use of wildlife and tourists had a direct impact upon pastoralist communities, giving rise to questions about ‘people versus wildlife’ in the formulation of African wildlife policy (Collett, 1987).

There are many instances where pastoralist communities take negative attitude towards wildlife conservation due to eviction and denying access to resources. According to Western (1982), the Maasai people developed negative attitude towards wildlife conservation in areas where they utilized the resources for their livestock for centuries. The Amboseli National Park was an important dry season watering point for both the Maasai pastoralists and the wildlife. But with the establishment of the Park, the Maasais were deprived of access to the area; *i.e.*, their dry season watering site was closed to them by the Park authorities. Additionally, the wildlife dispersed into their land and competed with their livestock. The Maasais also saw no benefit from the tourism development. As a result, they have developed a negative attitude towards wildlife. They were systematically slaughtering rhinoceros in the area as a protest against land alienation for wildlife preservation. A similar reaction has been recorded in Uganda, Kenya and Tanzania (Holmern, *et al*., 2004; Aveling, *et al*., 2005; Distefano, 2005).

Although human-wildlife interactions bring some positive impact on the wildlife, most are detrimental to wild animals. Human activities negatively influence the distribution of most of larger mammal species (Blom, *et al*., 2004). Populations of many species have declined because of competitive interaction with people for common resources. Human-wildlife conflicts are complex in their nature and are one of the major threats to conservation in Africa (Dublin, 1995; Naughton-Treves, 1997). While such conflicts have existed for decades, they occur in different settings today (Holmern, *et al*., 2004). As resource scarcity, economic imbalance, human population and continued use of inappropriate technology increase, challenges to conservation activities and the sustainable use of the environment as a whole become severe; and tomorrows conflict will be even worse than today’s.
The human factor in conservation activities had long been overlooked and misunderstood. Today, it is widely accepted that local communities must be taken onboard from the very beginning of the concept of conserving resources (IIED, 1994; Hackel, 1999; Zelealem Tefera, 2001). Most African rural communities had a wide understanding of conservation but their interest in modern approaches to wildlife conservation was tempered by the reality of poverty (Abrahamson, 1983). Therefore, it might be worth considering how poverty can be alleviated through integrated conservation projects in order to insure conservation of natural resources in the majority of the poor African countries (Wells and McShane, 2004). In the ‘preservationist’ (top-down) approach, the protection of wildlife can only be achieved through considerable management cost, particularly in terms of protecting the wildlife from local and other threats, which requires external subsidies (IIED, 1994). While the top-down approaches have ensured the survival of populations of certain species and ecosystems, and contributed to the generation of foreign exchange earnings, they have been against in integrating the local communities into resource management and decision making activities (IIED, 1994; Zelealem Tefera, 2001).

Conservation needs to involve local communities in the process of wildlife management. Conservation efforts will not succeed simply because they are the right thing to do. It should take the local people in confidence, enlist their support, win their sympathies, and arouse an interest to have the pride in their valuable heritage (Schaller, et al., 1987).

1.1.2. Community-based conservation (CBC)

Since the publication of the World Conservation Strategy (IUCN, 1980), approaches to wildlife conservation have undergone major changes. Conservation thinking has largely rejected ‘preservationist’ policies and at present encourages the utilization of wildlife resources. There has been a growing realization of the importance of understanding the need and aspirations of communities in conservation and resource utilization (IIED, 1994; Ghimire and Pimbert, 1997; Tache and Irwin, 2003).

The inclusion of local people in planning and managing of wildlife resources has also been considered to make conservation acceptable to the rural people (Dasman, 1975; Infield, 1988; Ghimire and Pimbert, 1997). This condition has led to the other approach of wildlife conservation, which aims to involve local communities through community-based conservation
The term Community-Based Conservation (CBC) refers to wildlife conservation efforts that involve local communities as an integral part of a wildlife policy. The coexistence of people and nature, as a distinct form of protectionism is the central point in community based conservation (IIED, 1994; Western and Wright, 1994; Ghimire and Pimbert, 1997; Zelealem Tefera, 2001). It is a strategy used throughout the world as a means to save wildlife (Hackel, 1999). The local people who were commonly hostile to wildlife conservation had to be won over as supporters of conservation efforts (IUCN, 1980). It was increasingly realised that, without the co-operation of rural peoples, wildlife conservation efforts would be a failure (Zelealem Tefera, 2001).

The overall aim is to make rural people an integral part of conservation activities. According to Hackel (1999), CBC perform this in three ways

1. allowing peoples living near protected lands to participate in land-use policy and management decisions,
2. giving people proprietorship or ownership over wildlife resources, and
3. giving local people economic benefit from wildlife conservation.

Community-based conservation is not an easy going activity as in papers. In order to be successful, it needs to be flexible enough to cope up with a countryside inhabited by a growing number of extremely poor people (Zelealem Tefera, 2001). Community-based conservation programs have more realistic approach in areas where big game animals are capable of generating large revenues from tourism and/or hunting. Clearly, the economic link between local communities and community-based conservation programs pose a serious practical problem (Hackel, 1999). The main concern was the right of the community to use the resources that they were once denied. This might make the programme incapable of dealing with the current socio-economic conditions for a number of reasons.

1. Those areas without big game animals will not have the potential to generate revenue required for conservation based activities.
2. Even in those areas where large amount of revenue is expected, there is a danger that the local communities will eventually reject it for various reasons;
3. In many areas, the amount of money received by the community may be low when compared to other forms of land-use activities.
Therefore, if a rural community accepted community based conservation program based on its economic benefits, they might also reject it if better economic alternatives were available (Hackel, 1999; Zelealem Tefera, 2001).

Generally, when conservationists are dealing with community-based conservation programmes, they need to be site specific because the social and economic reality in Africa will test their skills. In those areas where people and wildlife coexist, the coexistence will continue to be uneasy. Hence, it is a creative application of the inclusive philosophy of community-based conservation rather than the CBC programs themselves that will be of the greatest importance in Africa (Hackel, 1999).

There are a number of countries from Africa which are of imaginative in attempting to involve local people, to varying degrees and with varying amounts of success, in the design and management of conservation projects. These countries include Kenya, Mali, Zimbabwe (Turton, 1995).

1.2. Grevy’s zebra

The Family *Equidae* comprises zebras, asses and horses. Only two genera: *Asinus* (Asses, Kulan and Kiangle) and *Equus* (Horses, Quagga and Zebras) are known. They were the most abundant during the Pliocene and Miocene in Asia, Africa and America. They have one of the best documented fossil histories of any mammalian group and often are used to illustrate the course of evolution (Duncan, 1992; Nowak, 1999).

The word ‘Zebra’ is derived from Portuguese term ‘Zebro’ means, wild donkey. Zebras are one component of the Family *Equidae*, Genus *Equus* Linnaues 1758 (Churcher, 1993; Duncan, 1992; Nowak, 1999). The three living species of zebras are placed under three subgenera, Subgenus *Dolichohippus* (Grevy’s zebra), Subgenus *Hipotigris* (Mountain zebra), and Subgenus *Quagga* (Burchell’s zebra) (Groves, 2002).

Zebras are grouped in the Order Perissodactyla, which make up the ‘odd-toed’ ungulates. Like that of the ‘even-toed’ Artiodactyls, Perissodactyls are unguligrades; that, they walk on the terminal bones of the toes and have enlarged toe nails forming hooves. But, contrary to the Artiodactyls either they walk on three toes (rhino, tapir) or on a single toe (modern horses).
Perissodactyls occur in Eastern Europe, central and southern Asia, parts of the East Indies, Africa, and in the region from southern Mexico to Argentina (Nowak, 1999). The main features that all Perissodactyls share is that the weight of the body is borne on the central digits, with the main axis of the foot passing through the third digit, which is the longest of all four digits. In equids, only the third digit is functional (Nowak, 1999).

The digestive system of equids is designed to extract energy and nutrients from coarse, low quality forage by permitting passage of large quantities of plant matter through a long hind gut (www.iucn.org/, 2006). Due to the inefficiency of their digestive system, they became tolerant to a wide range of grasses and are able to consume grasses at any stage of growth whenever they can get adequate quantities (Kingdon, 1979). Equids are primarily grazers. Most of these animals continue to exhibit considerable flexibility in diet, and browse forbs, shrubs, and small trees. The seasonal and geographic variation in forage quantity and quality, and water availability, which is typical of arid and semi-arid environments, make most wild equid populations to be migratory.

Apart from their stripes, zebras have so many things in common; they live in Africa and are exceptionally social within groups, range from two to several hundreds. They disperse or aggregate in response to the vagaries of pasture, water and climate. They are nomadic grazers of coarse grasses, active, noisy and alert. They never attempt to conceal themselves or to ‘freeze’ in response to predators and prefer to rest in groups, in exposed localities where they have the advantage of a good view at the cost of being conspicuous (Macdonald, 1984). The widespread theory that their stripes are camouflage is therefore contradicted by the zebra’s behaviour (Kingdon, 1979).

1.2.1. Ecology of Grevy’s zebra

A live Grevy’s zebra (*Equus grevyi* Oustalet 1882) was sent by Emperor Menllik of Abyssinia (now Ethiopia) as a gift to the President of France, President Grevy, thus acquired the name in honour of the recipient.

1.2.1.1. Description

Grevy’s zebra is the largest of all living wild equids. Adult males weigh up to 450 kg. It is long-legged and long-faced, with very narrow stripes and large and broad ears. The stripes at
their hindquarters are different from other zebras in that they curl down than being horizontal. Although, the black and white stripes are uniformly distributed all over the body, their width vary resulting in darker and lighter individuals (Haltenorth and Diller, 1977; Kingdon, 1997; Nowak, 1999). There is slight sexual dimorphism, males weighing 10% more than females (King, 1965). Different sexes can be easily distinguished by conspicuous black labia of females. In addition, males have large upper canines, which are lacking in females. Foals have lighter coloration than those of adults and become dark as they grow old (Williams, 2005).

1.2.1.2. Distribution

Grevy’s zebra is confined to the arid and semi-arid areas of the Horn of Africa (Ethiopia and Kenya). According to fossil records from South Africa, China and Uzbekistan, the ancestral forms of proto-Grevy’s zebra were once successful and widespread in Eurasia and Africa (Kingdon, 1997). Recent fossil remains also indicate that the range of Grevy’s zebra extended north to central Egypt during the Neolithic period from 3500 -5000 years ago (Churcher, 1993).

Historically, they were distributed from Danakil desert in Eritrea and Djibouti, through Awash Valley into the southern end of the Ethiopian Rift (north-east of Lake Turkana), and into the Ogaden in Ethiopia. Its range in Ethiopia, Eritrea and Djibouti has been much reduced (Fig. 1). In Kenya, they were also distributed to north of Mt. Kenya and south-east down the Tana River, east of Rift Valley, and east to western Somalia (Stewart and Stewart, 1963; Williams, 2002; Williams, 2003). At present they only occur in Ethiopia and Kenya. The present range of *E. grevyi* is much reduced and extremely discontinuous; they occur in different localities of Ethiopia (Chew Bahir, the Borana Plains and in Alledeghi Plains) and Kenya (from the eastern side of Rift Valley to Lorien Swamp and Tana River) (Fig. 1).

Currently in Ethiopia, this species is restricted to a few areas in Chew Bahir (Chalbi Wildlife Reserve), the Borana Plains and in Alledeghi Plains, within the Alledeghi Wildlife Reserve. Grevy’s zebras of Chew Bahir were reported to be abundant in the late 1970s (about 1500 individuals) (Klingel, 1980). However, Thoulesse’s (1995b) population estimate of 370 individuals shows a decline. In Borana Plains, zebras were more abundant during the surveys made by Rowen and Ginsberg (1992). But, only a single individual was recorded during the aerial survey made by Thoules (1995b).
Moreover, the Alledeghi population is the isolated population at the northernmost point of the species’ present distribution in the country. Its isolation from the rest of Grevy’s zebra population makes it very important in that they might add new discoveries in evolutionary relationship with the other population elsewhere in the world (Williams, 2002).

![Historic and current distribution of Grevy’s zebra](image)

**Figure 1.** The historic and current distribution of Grevy’s zebra.

In Kenya, 70% decline in the number of Grevy’s zebras has been recorded between 1977 and 1988. The largest and most stable population of Grevy’s zebra is found at the southern end of their historic range, in Buffalo Springs, Samburu, and Shaba National Reserves. They have expanded their range into the Lewa Wildlife Conservancy and the Laikipia Plateau (Williams, 2002).

Grevy’s zebras are considered to be locally extinct from Somalia, Djibouti and Eritrea and the last confirmed sighting in Somalia was in 1973. They probably have been extirpated from Somalia due to hunting for food, trophies, and for medicinal purposes (Williams, 2002). Although not verified, there have been recent sightings and reports of Grevy’s zebra in southern Sudan and southern Somalia (Williams, 2002).
1.2.1.3. Conservation status
Currently, Grevy’s zebra is placed under the IUCN Red List category and in Appendix 1 of the CITES listing (IUCN, 2003). During the 1970’s, due to its striking and more uniform colouration, they have been hunted intensively contributing to the destruction of several regional populations. It was assumed that about 70% of the 1970s population decline in Kenya was due to the need for skin for various reasons (Williams, 2002). In addition, the pastoralists pressure on their habitats for livestock utilization, reduction of water sources, habitat destruction and modification by agriculturalists and other factors have their inputs for its current conservation status (www.iucn.org/, 2006).

1.2.1.4. Habitat
Grevy’s Zebras live in arid and semi-arid (annual rainfall range 100–650 mm) grass/shrubland areas, where there is permanent water. They are mostly grazers and in drought conditions they become browsers (Rowen and Ginsberg, 1992). The lack of free-standing water is the determining factor for their incursion into more arid areas to the east and north, while competition with other grazers, including plains zebras, may limit their distribution into more humid areas. They fill a narrow niche between the more water dependent plains zebra and the more desert adapted wild ass (Kingdon, 1979; Bauer et al., 1994), while they associate themselves with giraffe, oryx, eland, plains zebra, impala and buffalo in their southern range (Kingdon, 1997). They are able to live in deserts if permanent water sources are available (Bauer et al., 1994; Nowak, 1999; Yalden et al., 1988).

1.2.1.5. Population status
Grevy’s zebra population have undergone a sharp decline in number and range (Kingdon, 1997; Williams, 1998; Williams, 2002). During the late 1970s, the total wild population of Grevy’s zebra was estimated at around 15,000 individuals. The 2002 estimates were between 3000 and 3500, which showed about 75% decline (Williams, 2002). At present, between 1,700 and 2,200 Grevy’s zebras are believed to remain in the wild (Williams, 2005). A detailed survey in northern Kenya indicated that the number of animals declined to between 2,500 and 3,000 from previous estimates (mid-1990s) of approximately 4,300 (Williams, 2002). But, this recent estimate was reduced between 1,600 and 2000 animals in Kenya (Williams and Low, 2004).
The Ethiopian population follows similar pattern as that of the world population. The total population in Ethiopia was about 1500 in 1980 (Klingel, 1980; Rowen and Ginsberg, 1992), but aerial survey carried out in 1995 estimated between 500 and 600 individuals (Thouless, 1995b; Williams, 1998). Recent counts indicate a 93% decline in numbers in Ethiopia, leaving less than 120 animals (Williams et al., 2003). This indicates that there has been a serious decline in the number of Grevy’s zebra since 1980.

Grevy’s zebras are distributed in three known localities of Ethiopia: The Alledeghi Plains, Borana Plains, and Lake Chew Bahr (the former Lake Stephanie). Grevy’s zebra population in the Alledeghi Plains showed a steady decline in numbers since the 1970s, from about 600 in 1970 to less than 300 in 1978 (Stephenson, 1978). The population estimate in 1992 was about 175 animals (Rowen and Ginsberg, 1992); and the 1995 total aerial count recorded about 177 individuals (Thouless, 1995a). Rowen and Ginsberg (1992) reported that the Grevy’s zebras in Borana Plains were abundant. However, aerial survey carried out in 1995 did not confirm this to be the reality and only a single animal was sighted (Thouless, 1995b). The population in Chew Bahr, which was believed to be abundant (about 1500) in the 1970s showed dramatic decline in 1995 to about 370 (Thoules, 1995b). Thouless’ 1995 aerial survey found that their densities were higher than elsewhere in Ethiopia but still indicates a remarkable decline in their numbers. The 2000 and 2003 ground and aerial survey confirmed that the country experienced further population decline and estimated at 130 individuals throughout the country (Williams, et al., 2003).

During the wet season, the zebras are widely dispersed. However, during the dry season, they are more concentrated near water points. In Ethiopia, they are abundant and easily observed in those areas where there are no records of livestock and herdsmen (Williams, 2002). They are also most abundant and most easily observed in the southern end of their range in Kenya, where they reach 2.4 animals per km² (Williams, 2005).

1.2.1.6. Foraging and food

Grevy’s Zebras are predominantly grazers on monocots (e.g., *Cynadon dactylon*, *Pennisetum mezianum*, *Aristida adscensionis*, *Chloris virgata*, *Chrysopogon plumulosus*) (Williams, 2005). However, during the times of drought, browsing can comprise as much as 30% of their diet (Rowen and Ginsberg, 1992). During the dry season or in overgrazed areas, the zebras feed in...
sward with the highest biomass (Williams, 1998) and benefit from the spread of tough grass species, which are often patches with high fibre grasses not tolerated by domestic livestock (Kingdon, 1997; Williams, 1998). When the level of fibre becomes intolerable to the zebras, they disperse in search of other pastures (Ginsberg, 1988; Williams, 1998).

Free-standing water is a requirement of the Grevy’s zebra. In much of their range, this is found in the form of springs. In areas where there are no pastoralists and livestock, zebras drink during the mid-day, probably to reduce the risk of predation at water sources. However, in areas used by pastoralists, they are excluded from the use of water during the day and so, drinking shifts to night time (Williams, 1998). Adults can tolerate between 2-5 days without water, whereas lactating females can tolerate only up to two days (Becker and Ginsberg, 1990; Williams, 1998).

1.2.1.7. Social behaviour

The social organisation of Grevy’s zebra has been described by Klingel (1974). Grevy’s Zebras are social animals. There is no permanent bond between any two or more adult animals. Females with young foals form relatively stable groups with other females with whom they are in reproductive synchrony (Ginsberg, 1989; Becker and Ginsberg, 1990; Rowen, 1992). Females without young foals (and females with foals in overgrazed areas) are less predictable. Their associations are fluid since their movements are determined by resource availability. Group composition, therefore, may change within hours or on daily basis (Klingel, 1974; Ginsberg, 1989). Group size is variable from one to over 150 individuals.

Territorial males are often solitary although they will associate with conspecifics and other animals (including those of other ungulate species such as Beisa Oryx, Giraffe and Plains Zebra). Recorded home range size of non-territorial individuals is up to 10,000 km² (Klingel, 1975; Ginsberg, 1988; Rowen and Ginsberg, 1992; Williams, 1998). They are extremely mobile and individuals have been recorded to move distances of greater than 80 km, sometimes returning to the original area within weeks (Williams, 1998). Their movements are determined by resource availability. During drought, as resources are depleted, they disperse into large distances in search of food and water (Ginsberg, 1989; Williams, 1998). Dispersal of zebras could be determined by the levels of reproductive status and resource depletion. Females without young foals take the first initiative followed by mares with young foals, and
finally in extreme conditions, the territorial male will follow (Klingel, 1974; Ginsberg, 1988; Williams 1998).

Breeding males will form territories with size ranging from 2-12 km² usually around water. Though it is not a guarantee for reproductive success, the formation of territories might be affected by the distribution of females (Klingel, 1974; Ginsberg, 1989). Territorial males are generally larger than other males and have a high degree of territorial loyalty, which may hold territories for up to seven years (Ginsberg, 1988). In addition, territorial males tolerate the presence of bachelor males but will chase them in a ritualized manner when an oestrous female is present (Klingel, 1974; Ginsberg, 1988).

In contrast to the males, resource requirement and distribution of females are determined by their reproductive status. Usually lactating females are found closer to water than other classes of females (Ginsberg, 1989; Rowen, 1992; Williams, 1998; Williams, 2002). The reproductive condition of a female will also have an impact on the territorial male behaviour. During courting, a territorial male will repeatedly mount the female in oestrus, with neither an erect penis nor intromission, while braying and squealing loudly. When intromission occurs, copulation is always silent (Klingel, 1974; Ginsberg, 1989; Ginsberg and Rubenstein, 1990).

1.2.1.8. Reproduction

Breeding is highly dependent on conditions that facilitate oestrus which is directly related to stochastic patterns of climatic variation (Ginsberg, 1988; Williams, 1998). Females in poor body condition will not enter in oestrus during times of low resource availability (Ginsberg, 1989). A peak in oestrus among females follows the onset of high resource availability during the wet season (Williams, 1998). Recorded gestation period is 58 (range=55-61) weeks (King, 1965; Churcher, 1993). Mares give birth to a single foal and come into oestrus from 6 to 15 days post-parturition. If they are not impregnated, they will continue to cycle every 27 days (Ginsberg, 1989). As breeding is dependent on climatic conditions, inter-birth intervals are highly variable. Mean inter-birth interval for Grevy’s Zebra has been recorded to be 16.2 months (Williams, 1998).
Williams (1998) has shown that foal survival has been directly related to the movement pattern of their mothers. There is low foal survival when mares make large or frequent small-scale movements (Rowen, 1992; Williams, 1998).

1.2.1.9. Predators

The major predator of Grevy’s zebra is lion. However, the impact of predation can be considered as low due to the severe reduction of their densities as a result of poisoning lion by local people to protect livestock predation (Williams, 1998). In areas where densities of lions (*Panthera leo*) are high, their impact on Grevy’s Zebra populations is profound. Nonetheless, cheetah (*Acinonyx jubatus*) and hyenas (*Crocuta crocuta*) are known to predate on foals, and crocodiles (*Crocodylus niloticus*) predate upon adults (Rowen and Ginsberg, 1992; Williams, 1998). In addition, in areas where the local communities control water points, zebras are forced to drink at night. This exposes unprotected foals in kindergartens to nocturnal predators (Williams, 1998).

1.2.1.10. Grevy’s zebra in human perspectives

The historical importance of Grevy’s zebra in human culture has not been studied well. The present day range of this species overlaps with pastoralist communities of Ethiopia and Kenya (Afar, Somali, Borana, Hamar, Arbore, Dassentetch, Turkana, Samburu, Aarial, Rendille, and Gabbra in Ethiopia and Kenya). Of these people, Somali, Hamar, Arbore, Dassenetch, Borana and Turkana are known to exploit Grevy’s zebra for food (Williams, 2002).

Until the early 1980s, Grevy’s zebra skins were sought by hunters as trophies and for export in the markets of Europe and North America. This condition contributed to a major decline of Grevy’s zebra population in Kenya. Hunting for skins in the late 1970s may have contributed to this dramatic decline. But since CITES listing, the killing of Grevy’s zebra for their skins ceased. At present, there is no legal trade of their skins (Williams, 2002). However, the decline of their population in Kenya is continuing although at a slower rate as recruitment is very low due to low juvenile survival. This is a result of competition for resources – both food and access to water – with pastoral people and domestic livestock (Williams, 1998).
1.3. Statement of the problem

The human impact in the area on Grevy’s zebra and other wildlife includes grazing of cattle by the local pastoral people together with killing of the zebras. As the human population continues to increase, demands on natural resource grow larger. Few places on Earth are unaffected by human activities. Even many protected areas or nature reserves are not well protected from human interference. The need for socio-economic development for local residents is often in serious conflict with the objective to protect wildlife (Liu, et al., 1999).

The same may be true on the effect of pastoralists on Grevy’s zebra continued existence. The areas are used by the Hamar, Arbore, Borana and Gabra people. They are traditional pastoral people who use the areas for livestock husbandry. To minimize the conflict between resource utilization of Grevy’s zebra and local communities, we need to understand how human activities affect the Grevy’s zebra habitat; how different stakeholders, the local pastoral communities and Grevy’s zebra use critical resources water and food.

1.4. Objective of the study

The objectives of the present study are to assess the Grevy’s zebra interaction with their neighbouring local pastoralist communities and to investigate the major factors behind the dramatic and sudden decline of their populations in the arid ecosystem of Chew Bahir and Sarite. It is also aimed to suggest possible conservation measures to be taken for the conservation of this species.

1. 4. 1. Specific objectives

- To identify the population status and distribution of the Grevy’s zebra in Chew Bahir and Sarite.
- To determine Grevy’s zebras activities and habitat preference at different time of the day and season.
- Assess resource availability (water and food) for *E.grevyi* and other wildlife in the area.
- To examine the interaction and level of threats exerted on grevy’s zebra by pastoral communities (hunting, livestock grazing and competition for limited water resource).
2. MATERIALS AND METHODS

2.1. Study area

2.1.1. Location

The study was carried out in Chew Bahir (Chalbi) and Sarite in Ethiopia. Both are located in southern most part of the country in Southern Nations and Nationalities People’s Region and Oromiya Region, between Hamar uplands and the Borana Plains $36^045’-37^045’$ E and $4^030’-4^055’$ N (Fig. 2).

Figure 2. Map of the study areas; A, Chew Bahir and B, Sarite (Digitized from scanned map of 1:250000).

Chew Bahir area is found over the desert plains within the Hor (Arbore) Kebele. It is bordered with the Kenyan frontier to the south, the foot hills of Hamar uplands to the west and the foot hills of Borana uplands to the east (Tadesse Wolde, 2002). It is the area where Lake Chew Bahir (the former Lake Stephanie) occurs. The majority of Chew Bahir area (more than 80%) is occupied by the salt pan. It is part of the north south subsidiary Rift Valley some 100 km
long bounded on the east and west by steep walls 100-1500 m high. This valley floor is underlain by alluvial deposits with a narrow band of colluvium below the valley walls. Soils are black cracking clays (vertisols) and grey saline-alkaline clays (solonchacks) (Sutcliffe, 1992).

Chew Bahir is a soda lake. Most of the lake basin currently consists of open salt pans surrounded by a narrow band of grassland with only a small area of open water (Stephenson, 1978). This narrow band of grassland is the only grazing ground for the wildlife. To the north of the lake, there is a marsh. Away from the marsh, there is a valley extending about 70 km north, with dense woodland along the Woito Segan River, and a mixture of thick bushland and bushed grassland. Between the lake and the Kenyan border is an area of open bushland. The altitude of Chew Bahir ranges from 525 m asl in the north to the (Hor) Arbore village ‘Gonderoba’ to 400 m asl in the south to the Ethiopian Kenyan border.

Sarite Plain is found in the heart of the Borana Plains in Teltele Woreda, to the south-east is bordered with Yabello. The main soil textures of the region comprise 53% sand, 30% clay and 17% silt (Coppock, 1994). The area is dominated by slightly undulating plains where the altitudinal difference ranges from 960 m asl in the plain to 1500 m asl up in the mountain where the water point ‘El Sarite’ is found. The area has diverse vegetation. The arid area is with dry wooded or bushed grassland and the very arid one with dwarf shrub grassland, dry bushed grassland, or barren land. The area is dominated by savannah vegetation containing a mixture of perennial herbaceous and woody vegetation. The savannah vegetation varies from open grassland to bush encroached areas. The major grass species are Pennisetum, Themeda, Cynodon, and Chrysopogon species. Woody vegetation mainly composed of Acacia sp. like Acaia seyal, A. nilotica, A. senegal and A. tortilis are common in the area (Coppock, 1994).

Chew Bahir and Sarite Plain are about 800 km and 720 km by road, respectively, from Addis Ababa. The total area of Chew Bahir is about 2000 km² out of which the core area is about 400 km² and Sarite is about 250 km².

2.1.2. People

Three major ethnic groups, namely the Hor (Arbore), Hamar, and Borana reside in the area. They are agro-pastoralists, whose lives depend on livestock raring and subsistence agriculture.
The Hor (Arbore) people obtain their subsistence from both sorghum cultivation and animal husbandry and live on the delta of the River Woito (Limo), which is the most fertile area of the whole basin. They use flood-retreat cultivation along the banks of this river. This type of cultivation is more reliable than rain fed cultivation, but the cultivation area varies from year to year depending upon the height of the flood. The population of the Hor people was about 3,438 in 1995 (Tadesse Wolde, 2002). This has increased to 4500 (per.com).

The Borana and Hamar are numerically dominant ethnic groups inhabiting the Borana lowlands of southern Oromiya and Hamar uplands of South Omo Zone of SNNP, respectively. They are agro-pastoralists whose subsistence lives mainly depend on livestock husbandry with very minimal rain fed agriculture. The Hamar and Borana are relatively highlanders, when compared to the Hor people. Their habitats are settled at 1000 m altitude, which is relatively cool. These people in the whole region have perceptions of livestock grazing suitability and potential grazing capacity of individual landscapes (Oba and Kotile, 2001). They have indigenous ecological knowledge about land-use and resource degradation. They have developed elaborated methods for assessing rangeland conditions and trends. To cope with variable range production, they combined mobility and sedentary livestock management (Oba and Kotile, 2001).

Some of the larger mammal species found in the area include Grants gazelle, Oryx, Lelwel Hartebeest, Warthog, Common Jackal, and Hyena. Larger predators like lions do not occur in the area due to hunting by the local communities to protect against their livestock and for social prestige.

### 2.1.3. Rainfall

There are two rainfall seasons in the region, one in October /November, and the other in March/April. The March/April rainfall season is the main rainy season for the region as a whole. Chew Bahir area has a comparable rainfall with that of the adjacent northern Kenya which has a mean of around 160-200 mm/year (Nelson and Williams, 2003).

The rise and fall of the Woito River is affected more by the heavy rainfalls in the highlands of Ethiopia between March and September than by the erratic rainfalls over the region. Average annual rainfall in Chew Bahir is about 511 mm, while average monthly rainfall varies from
11.76 mm in September to 117 mm in April. Rainfall is bimodal in the region where the highest rainfall is recorded in April and the lowest is between June to September (Fig. 3).

Sarite has a comparable rainfall to that of the adjacent Yabello and Teltele, areas which averages from 500 to 700 mm/year while average monthly rainfall varies from 5.56 mm in August to 125 mm in April. However, there is a great variability on year-to-year basis. Rainfall in the region is highly unreliable in quantity, timing and location. According to Coppock (1994), 59% of the precipitation falls during March-May whereas 27% falls during September-November seasons.

![Average monthly rainfall around Chew Bahir and Sarite](image)

**Figure 3.** Average monthly Rainfall around A, Chew Bahir and B, Sarite from 1997-2005 (Data: Ethiopian Meteorological Agency).

### 2.2. Methods

#### 2.2.1. Data collection

The actual data collection was conducted between September 2005 and October 2006 with fragmented short term gaps.
2.2.2. Grevy’s zebra and pastoralist communities

Interviews were conducted on household heads living adjacent to the study areas of Chew Bahir (Chalbi) and Sarite (Plate 1). The questionnaire survey was planned mainly to understand the level of interactions of pastoralists with Grevy’s zebra and other wildlife in the study areas and to search for any threats that might undermined Grevy’s zebra survival in the study areas. It was also designed to disclose whether the underlying causes of the dramatic decline of Grevy’s zebra population were connected to various activities of the local pastorals particularly with hunting and resource use conflict. Structured and semi structured interviews were conducted during the questionnaire survey.

Plate 1. Photo to show how the questionnaire survey was conducted.

The interviews were structured in different parts. The first part was an introductory question that tried to unravel details of the interviewee, age, ethnic group, occupation, place of residence and educational level. The second part was related to the household economy, particularly livestock population and protein sources for the family. The third part discussed about resource uses in the study areas. Data were obtained on whether there was critical resources (grazing ground to livestock and water) use competition that resulted in conflict among different ethnic groups living adjacent to the study areas. The fourth part was directed towards the wildlife resource of Chew Bahir and Sarite areas in general and the Grevy’s zebra in particular. Data were collected on the wildlife population trend in general and Grevy’s zebra in particular in the eyes of the pastoralists. This part tried to get detailed information on the extent of local
community's interaction with Grevy’s zebra and other wildlife. It also tried to get data whether local communities hunt Grevy’s zebra, its extent and impact on the long term survival of the species (Appendix 1).

Participants from three ethnic groups (in three Kebeles) who are living adjacent to Chew Bahir and one ethnic group in Sarite who make use of the areas were identified and questioned. The three ethnic groups participated in the study were: Hor (Arbore); Hamar (Asle); Borana (Mermero) in Chew Bahir Area and Borana (Sarite). The distances of the Kebles adjacent to Chew Bahir were more than 20 km; whereas in Sarite, the study area is within the Kebele boundary.

Interviews were administered to household heads randomly on first come basis. However, due to lack of permit from household heads, the questionnaire survey with female respondents was not undertaken. A total of 320 pastoralists were interviewed. Information was also gathered through informal meetings and discussions. The area was surveyed by visiting all villages in the area. Data on the number and distribution of people and the number of livestock in the area were collected.

2.2.3. Grevy’s zebra population

A preliminary survey was conducted in mid-August 2005 in the area to determine sites for sampling and to find information on the accessibility, climate, topography and approximate size of the core area of Grevy’s zebra in Chew Bahir and Sarite.

The population status, distribution and habitat association of Grevy’s zebra in the areas were studied on selected transects (Appendix 2). The surveys were carried out every day early in the morning and late in the afternoon on foot and using a vehicle. In addition, other larger mammalian species observed were recorded in relation to their position in space and time. Binoculars, field guides, GPS and digital camera were used during the census.

In Chew Bahir, line transects were marked in the area along the narrow band of grassland, east-west guided by GPS, and using natural boundaries of the salt pan and the grassland. Transects in Sarite were laid north-south randomly on the plain grassland and woodland habitats. The
total transect length covered in the study area were 56 km and 29 km in Chew Bahir (Chalbi) and Sarite, respectively.

Distance sampling was used following the method of Buckland et al (1993) and Sutherlands (1996). The perpendicular distance of the animal from transect was estimated to determine the density of the animals in the study area. In addition, attempt was also made to identify population structure such as age and sex categories of Grevy’s zebra. Data were also recorded whether zebras avoid human and livestock presence. Data on livestock population in the study areas were taken to get information on interference competition by humans and their livestock.

2.2.4. Activity pattern and time budget

Data on the activity pattern of Grevy’s zebra and their time budget were collected to investigate their behavioural response to human presence in the area. Using point scan sampling (Altmann, 1974), Grevy’s zebra activities were recorded every 10 minutes, six observation units per hour. The observations were carried out from dawn 06:00 hr to dusk 18:00 hr for 4 consecutive days in Chalbi and Sarite. The activities followed were feeding, resting, running, vigilant, and grooming and others (Appendix 4). Of these, feeding, vigilant and resting activities were considered and followed seriously. Data on Grevy’s zebra habitat preference in the study areas were also taken.

2.2.5. Browse abundance

Data on the percentage ground cover, plant type (herb or grass), grass height and visibility were recorded to determine the availability of forage for the species. Samples were taken on step-point basis starting from a random point at north-south direction (Appendix 3; Ginsberg, 1988). A total of 96 samples at a sampling gap of 10 paces were taken. Ground cover and height of the grass hit by the front big toe were recorded. Where there was no plant touched, the grass or herb nearest to the toe towards the pacing direction was recorded. Dry and wet seasons were used as a time frame for collecting the data.
2.2.6. Human presence at water points of Chew Bahir

Using point scan sampling, the water points were continuously monitored and data on presence or absence of humans were recorded. Data were collected from 06:00-18:00 hours for four days during severe drought season in January 2006.

![Plate 2](image)

Plate 2. Water points occupied by armed pastoralists during the drought season.

Interviews were also conducted with those pastoralists, who were found occupying the water points. Points like how long they occupy the water points and for how long they make free water points from human presence were raised. A total of 30 individuals were interviewed at water points of ‘Tabal’, ‘Eto’ and ‘Gom’.

2. 3. Data Analyses

The data collected were analyzed using SPSS version 11 computer software programme. The explanatory variables for the questionnaire survey were kebele (ethnic group), age and the number of livestock an individual owned. Using these explanatory variables, data were analyzed using descriptive statistics and responses compared using non-parametric Chi-square test. One-way ANOVA and Tukey test were used to get the difference in responses.
Relative abundance, distribution and resource use of Grevy’s zebra in the area were analysed using DISTANCE 4.1. Moreover, distribution, habitat association and critical resources have also been mapped using geo-referenced data in Arc GIS 9.1.

Habitat association and activity patterns were also analysed using SPSS. The explanatory variables were time of the day and habitat. Browse abundance was also expressed in terms of percentage grass cover and analysed using time of the day and season as explanatory variables. Water availability to Grevy’s zebra were also analysed using SPSS. Level of protection (thorn fences), distance to the nearest settlement, and thickness of vegetation (visibility) were used as explanatory variables to test whether the water is available to zebras and other wildlife.
3. RESULTS

3.1. Grevy’s zebra and pastoralists

3.1.1. Chew Bahir

A total of 240 individuals, 80 from each Kebele were included in the interview. The age of respondents ranged from 17 to 95 (Fig. 4).

![Bar chart](image)

**Figure 4.** Age distribution of respondents among the three Kebeles, Chew Bahir.

3.1.1.1. Protein source

Most pastoralists (52.5%) responded that their major protein source for their family is wildlife (bush meat), whereas, 47.5% pastoralists use livestock as their protein source (Table 1). There was no significant difference in protein source ($\chi^2 = 0.600$, df = 1, $P>0.05$). In addition, there was no difference between categories of age ($\chi^2 = 6.416$, df = 8, $P>0.05$) or livestock ownership ($\chi^2 = 6.216$, df = 6, $P>0.05$) in the protein sources of their family. However, there was significant difference ($\chi^2 = 30.977$, df = 2, $P<0.001$) among the three Kebeles in the source of protein for their family. Most (68.7%) people from Asle (Hamar) and (61.2%) from Arbore fulfil their protein requirement from wildlife, while most (72.5%) pastoralists from Mermero (Borana) utilise livestock as their protein source.
### Table 1. Protein sources for family in Arbore, Asle and Mermero.

<table>
<thead>
<tr>
<th>Kebele</th>
<th>Livestock (%)</th>
<th>Wildlife (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbore</td>
<td>38.8</td>
<td>61.2</td>
<td>80</td>
</tr>
<tr>
<td>Asle</td>
<td>31.3</td>
<td>68.7</td>
<td>80</td>
</tr>
<tr>
<td>Mermero</td>
<td>72.5</td>
<td>27.5</td>
<td>80</td>
</tr>
<tr>
<td>Mean</td>
<td>47.5</td>
<td>52.5</td>
<td></td>
</tr>
</tbody>
</table>

Most (56.7%) of the respondents stated that there is an overall decrease in livestock population; whereas, 43.3% of the respondents claim there is an increase in livestock population in the region (Table 2). There is a significant difference in the response for the overall livestock trend for the last twenty years ($\chi^2 = 4.267$, df = 1, $P < 0.05$). An association was also observed ($\chi^2 = 26.606$, df = 2, $P < 0.001$) between the respondents of the three Kebeles where most (65%) Hamar pastoralists have an increasing livestock population, while Borana (75%) and Arbore (60%) pastorals have a decreasing livestock population in the area. However, no association was found among different age groups ($\chi^2 = 11.128$, df= 8, $P > 0.05$) or number of livestock owned ($\chi^2 = 8.601$, df = 6, $P > 0.05$). Tukey test showed significant difference in livestock population trend among Asle and the other two Kebeles, Arbore ($P<0.05$) and Mermero ($P<0.001$), but no significant difference between Arbore and Mermero ($P>0.05$) was observed.

### Table 2. Responses on livestock population trend in Chew Bahir Areas.

<table>
<thead>
<tr>
<th>Kebele</th>
<th>n</th>
<th>Decreasing (%)</th>
<th>Increasing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbore</td>
<td>80</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Asle</td>
<td>80</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>Mermero</td>
<td>80</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Total/mean</td>
<td>240</td>
<td>56.7</td>
<td>43.3</td>
</tr>
</tbody>
</table>

#### 3.1.1.2. Chew Bahir (Chalbi) visit by pastoralists

Most of the local pastoralists (60.4%) travel to Chalbi for hunting wildlife, whereas 29.4% travel to Chalbi to protect their livestock from severe drought and 10% responded that they travel to drink mineral water in Chalbi. There is a significant difference ($\chi^2 = 93.025$, df = 2, $P$
< 0.001) in the purposes for which the local people visit to Chalbi. In respect to the Kebele respondents, they held different views ($\chi^2 = 206.6758$, df = 4, P < 0.001) on the reasons of visit to Chew Bahir. Pastoralists with different livestock number gave different responses ($\chi^2 = 23.211$, df = 12, P < 0.05) on why they travel to Chalbi. Most (88.6%) of the Borana pastoralists utilize Chew Bahir as their dry season watering and grazing ground, while most (90%) pastoralists from Asle and 80% from Arbore visit Chalbi for hunting (Table 3). However, no association was found on age group ($\chi^2 = 23.599$, df = 16, P > 0.05).

Table 3. Reasons why local people travel to Chew Bahir.

<table>
<thead>
<tr>
<th>Kebele</th>
<th>n</th>
<th>Drink the mineral water (%)</th>
<th>Livestock watering and grazing (%)</th>
<th>Hunting (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbore</td>
<td>80</td>
<td>20</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>Asle</td>
<td>80</td>
<td>10</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Mermero</td>
<td>80</td>
<td>0</td>
<td>88.6</td>
<td>11.4</td>
</tr>
<tr>
<td>Total/mean</td>
<td>240</td>
<td>10.0</td>
<td>29.6</td>
<td>60.4</td>
</tr>
</tbody>
</table>

Among the respondents, 85.8% had the view that wildlife population was decreasing and 14.2% viewed as increasing (Table 4) with significant difference ($\chi^2 = 123.267$, df = 1, P < 0.001). There was no significant difference on this between the Kebeles ($\chi^2 = 0.069$, df = 2, P > 0.05). The age of respondents was not important ($\chi^2 = 8.583$, df = 8, P > 0.05) in perceiving the wildlife population trend in the area.

Table 4. Views on wildlife population trend in Chew Bahir.

<table>
<thead>
<tr>
<th>Kebele</th>
<th>n</th>
<th>Increasing (%)</th>
<th>Decreasing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbore</td>
<td>80</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td>Asle</td>
<td>80</td>
<td>13.7</td>
<td>86.3</td>
</tr>
<tr>
<td>Mermero</td>
<td>80</td>
<td>13.7</td>
<td>86.3</td>
</tr>
<tr>
<td>Total/mean</td>
<td>240</td>
<td>14.2</td>
<td>85.8</td>
</tr>
</tbody>
</table>

The reasons given by the pastoralists for wildlife population trend was hunting (52.9%), followed by change of the Woito river course (22.1%). Both drought and those who do not
know the reason have equal ratio (7%), whereas automatic rifle distribution and wildlife migration was acknowledged by 5% and 4% of respondents, respectively (Fig. 5). There was a significant difference in the views of respondents of the three Kebeles ($\chi^2 = 73.323, \text{df} = 10, P < 0.001$) on the driving factor behind the wildlife population trend in the region. Views on the reasons for wildlife population trend in Chew Bahir also differed between age groups ($\chi^2 = 65.943, \text{df} = 40, P < 0.05$). Livestock number of the respondents have no impact ($\chi^2 = 35.185, \text{df} = 30, P > 0.05$) on their views of the wildlife population trend in the area.

![Figure 5](image.png)

**Figure 5.** Factors for wildlife population decline in Chew Bahir.

The local pastoralists hunt wildlife (Plate 3) for various reasons. 67.9% of the respondents admitted that they hunt wildlife whereas 32.1% denied wildlife hunting. There was significant difference among the Kebeles ($\chi^2 = 133.242, \text{df} = 2, P < 0.001$) on hunting wildlife. Most Asle (93.8%) and Arbore (91.3%) people hunt wildlife while Mermero Boranas (81.3%) do not hunt wildlife in the area (Table 5). Livestock number of the respondents have an impact ($\chi^2 = 18.834, \text{df} = 6, P < 0.05$) on their views. However, no association was found with age group ($\chi^2 = 14.631, \text{df} = 8, P > 0.05$) and the views of hunting wildlife in the area.
Table 5. Proportion of wildlife hunting by Kebeles around Chew Bahir.

<table>
<thead>
<tr>
<th>Name of Kebele</th>
<th>n</th>
<th>Wildlife Hunting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes (%)</td>
<td>No (%)</td>
</tr>
<tr>
<td>Arbore</td>
<td>80</td>
<td>91.3</td>
<td>8.7</td>
</tr>
<tr>
<td>Asle</td>
<td>80</td>
<td>93.8</td>
<td>6.2</td>
</tr>
<tr>
<td>Mermero</td>
<td>80</td>
<td>18.8</td>
<td>81.2</td>
</tr>
<tr>
<td>Total/mean</td>
<td>240</td>
<td>67.9</td>
<td>32.1</td>
</tr>
</tbody>
</table>

3.1.1.3. Resource use conflicts

Most Arbore (61.3%) graze their livestock nearby River Woito, while all (100%) respondents of Asle graze their livestock in ‘Gola’. However, neither Arbore nor Asle take their livestock to the southern part of Chew Bahir where most wildlife grazing ground and water occur, but most Borana pastoralists (93.8%) take their livestock during drought seasons (Table 6). There was a significant difference in grazing grounds ($\chi^2 = 79.084$, df = 4, P<0.001), and between Kebeles ($\chi^2 = 471.429$, df = 8, P < 0.001)

Table 6. Dry season livestock grazing ground in Chew Bahir Area.

<table>
<thead>
<tr>
<th>Respondents</th>
<th>n</th>
<th>Wuro %</th>
<th>Golla %</th>
<th>Chalbi %</th>
<th>Woito %</th>
<th>Mountain %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbore</td>
<td>80</td>
<td>36.3</td>
<td>-</td>
<td>-</td>
<td>61.3</td>
<td>2.5</td>
</tr>
<tr>
<td>Asle</td>
<td>80</td>
<td>-</td>
<td>100.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mermero</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>93.8</td>
<td>-</td>
<td>6.3</td>
</tr>
<tr>
<td>Total/mean</td>
<td>240</td>
<td>12.1</td>
<td>33.3</td>
<td>31.3</td>
<td>20.4</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Among the interviewee, 70.4% responded that there was no conflict during resource utilization particularly for water and grazing. However, 89.4% of the respondents agreed that there is antagonistic attitude between Hamar-Borana and Hamar-Gabra pastoralist communities (Table 7). Among the interviewee that admitted the presence of antagonistic attitude, 94.6% responded that there is conflict between Hamar and Borana and while 5.4% responded the conflict between Gabra and Hamar which shows significant difference between these groups ($\chi^2 = 190.817, df= 1, P<0.001$).

**Table 7. Pastoralists attitude towards the other ethnic group (N= Normal, C= Conflict).**

<table>
<thead>
<tr>
<th></th>
<th>Hamar</th>
<th>Borana</th>
<th>Arbore</th>
<th>Gabbra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamar</td>
<td>N</td>
<td>C</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td>Borana</td>
<td>C</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Arbore</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Gabbra</td>
<td>C</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

### 3.1.1.4. Grevy’s zebra in pastoralists’ perspective, Chew Bahir

Most respondents (87.9%) know Grevy’s zebra whereas 12.1% never seen this animal at all. However, 28.3% respondents saw Grevy’s between the last five years, while 16.3% of the respondents found Grevy’s zebra within the last two years and 13.3% of the respondents found zebras recently within a year. However, 17.1% and 14.6% of the respondents have not seen since the last 5-10 and >10 years, respectively (Fig. 6). There was a significant statistical difference ($\chi^2 = 28.975, df = 10, P < 0.05$) among the Kebeles in the number of years Grevy’s zebras seen. Age group was also associated ($\chi^2 = 120.992, df = 40, P<0.001$) on the time Grevy’s zebras observed by the local communities. Among the youngsters who are less than 20 years of age, (42%) never seen Grevy’s zebra, while 77.8% of elders who are more than 80 years of age, did not see for more than 10 years. Among the Arbore pastoralists 23.8% have observed Grevy’s zebra in the recent times compared to 2.5% and 8.8% pastoralists of Asle and Mermero, respectively.
3.1.1.5. Grevy’s zebra population trend and associated factors in Chew Bahir

The Grevy’s zebra population trend in the area shows a decline. 98.3% of the respondents confirm that Grevy’s zebras are disappearing from time to time. There is a significant difference ($\chi^2 = 224.267$, df = 1, $P < 0.001$) on the Grevy’s zebra population trend among the respondents. However, no association ($\chi^2 = 2.034$, df = 2, $P > 0.05$) was found among the three Kebeles. Age group ($\chi^2 = 8.868$, df = 8, $P > 0.05$) and number of livestock owned ($\chi^2 = 3.503$, df = 6, $P > 0.05$) were not important in perceiving Grevy’s zebra population trend in the area.

Among the respondents, 50.8% responded that hunting is the major factor for the population decline of Grevy’s zebra, whereas 26.7% of respondents attributed Woito River course change as a factor. 15% and 3.3% of respondents targeted disease and drought as factors, respectively, while 4.2% did not know the reasons behind. There is a significant difference between Kebeles ($\chi^2 = 51.344$, df = 2, $P < 0.001$) in case of population decline. There is also a significant difference in the factors that affect the population trend of Grevy’s zebra ($\chi^2 = 185.833$, df = 4, $P < 0.001$); hunting being the most important factor than drought. However, there was no significant difference ($\chi^2 = 27.85$, df = 32, $P > 0.05$) between different categories of age or livestock number ownership ($\chi^2 = 20.744$, df = 24, $P > 0.05$) to reason out the factors for Grevy’s zebra population decline (Fig. 7).
Figure 7. The views of pastoralists on Grevy’s zebra population decline at Chalbi.

3.1.1.6. Grevy’s zebra Hunting in Chew Bahir

Views on Grevy’s zebra hunting were evenly divided amongst the pastoralists around Chew Bahir areas. Among the respondents 47.9% hunt Grevy’s zebra while 52.1% responded that they did not hunt at all (Fig. 8 and Plate 4). However, there was a significant difference ($\chi^2 = 88.186$, df = 2, $P < 0.001$) in the views on hunting zebras amongst the Kebeles. There was also an association ($\chi^2 = 27.957$, df=8, $P< 0.001$) with age groups in hunting Grevy’s zebra. Middle aged respondents (21-50 years of age) hunt more Grevy’s zebra than young respondents (<20 years of age). The number of livestock owned by the respondents have no impact ($\chi^2 = 5.589$, df = 6, $P > 0.05$) on views of hunting Grevy’s zebra.

Figure 8. Views on Grevy’s zebra hunting in Chew Bahir.
There is a significant difference in the number of zebra hunted in Chalbi (\( F_{2, 237} = 81.261, P < 0.001 \)). Tukey test also showed a significant difference (\( P < 0.001 \)) within these three Kebeles (Table 8). There was also a significant difference with age group (\( F_{8, 237} = 4.036, P < 0.001 \)) on the number of Grevy’s zebra killed in the area.

Table 8. Proportion of zebras hunted by local pastoralists in Chew Bahir.

<table>
<thead>
<tr>
<th>Name of Kebele</th>
<th>n</th>
<th>None %</th>
<th>1-5 %</th>
<th>5-10 %</th>
<th>10-15 %</th>
<th>&gt;15 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbore</td>
<td>80</td>
<td>47.5</td>
<td>15.0</td>
<td>27.5</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Asle</td>
<td>80</td>
<td>17.5</td>
<td>61.3</td>
<td>20</td>
<td>-</td>
<td>1.3</td>
</tr>
<tr>
<td>Mermero</td>
<td>80</td>
<td>91.3</td>
<td>1.3</td>
<td>7.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total/mean</td>
<td>240</td>
<td>52.1</td>
<td>25.83</td>
<td>18.33</td>
<td>3.33</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Among the respondents, 46.3% responded that Grevy’s zebras are being killed by the pastoralist communities for food, while 45.4% responded for its medicinal value. Only 8.3% of the respondents responded Grevy’s zebras have been hunted to get some social prestige in the society (Table 9). No association was found (\( \chi^2 = 9.400, df = 4, P > 0.05 \)) among the Kebeles in this respect. However, there was a significant difference (\( \chi^2 = 67.525, df = 2, P < 0.001 \)) in the responses of the local communities on killing Grevy’s zebra. No association (\( \chi^2 = 11.727, \))
$df = 16, P > 0.05$) was found between age groups or with livestock possession ($\chi^2 = 11.440, df = 12, P > 0.05$) on hunting Grevy’s zebra (Fig. 9).

### Table 9. Views on Grevy’s zebras hunting in Chew Bahir Area.

<table>
<thead>
<tr>
<th>Place</th>
<th>n</th>
<th>Social value</th>
<th>Medicine</th>
<th>Food</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Arbore</td>
<td>80</td>
<td>10.0</td>
<td>50.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Asle</td>
<td>80</td>
<td>10.0</td>
<td>51.3</td>
<td>38.8</td>
</tr>
<tr>
<td>Mermero</td>
<td>80</td>
<td>5.0</td>
<td>35.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Total/mean</td>
<td>240</td>
<td>8.3</td>
<td>45.4</td>
<td>46.3</td>
</tr>
</tbody>
</table>

**Figure 9.** Hunting of Grevy’s zebra by age group in Chew Bahir.

### 3.1.2. Sarite

The age of respondents in Sarite differed from 16 to 95 years (Fig. 10) while their livestock population ranged from 4 to 150 heads.
3.1.2.1. Protein source

Most pastoralists (88.75%) responded that their major protein source was livestock, whereas, 11.25% of the pastoralists responded they use wildlife (bush meat) as their protein source for their family. There was a significant difference in the protein source for the family ($\chi^2 = 48.050$, df = 1, $P < 0.001$). However, no difference was found between categories of age ($\chi^2 = 10.836$, df = 7, $P > 0.05$) or livestock number ownership ($\chi^2 = 4.847$, df = 6, $P > 0.05$) in the protein sources for their family.

Among the interviewee, 72.5% responded there was an overall decrease in livestock population; whereas, 27.5% of the respondents said there was an increase in livestock population in the region during the last 20 years. There was a significant difference for the overall livestock population trend ($\chi^2 = 16.2$, df = 1, $P < 0.001$). Livestock population ownership has impact ($\chi^2 = 13.966$, df = 6, $P < 0.05$) on the views of the respondents on livestock population trend in the region. However, no association was found among different age groups ($\chi^2 = 4.633$, df = 7, $P > 0.05$). Those having few numbers of livestock responded in favour of decreasing livestock population than those who owned large livestock population (Fig. 11).

![Age distribution of respondents in Sarite.](image)

**Figure 10.** Age distribution of respondents in Sarite.
3.1.2.2. Wildlife population trend and associated factors

Wildlife population trend was viewed by the local pastoralists as decreasing (80%) and increasing (20%). There was a significant difference ($\chi^2 = 28.8$, df = 1, $P < 0.001$). However, there was no significant difference between livestock ownership and the attitude of respondents on the wildlife population trend ($\chi^2 = 6.362$, df = 6, $P > 0.05$). The age of respondents also was not important in perceiving the wildlife population trend in the area ($\chi^2 = 4.002$, df = 7, $P > 0.05$).

Drought and water shortage comprised 32.5% of the respondent’s views each. However, some of the respondents (35%) do not know the reason for the wildlife population trend in the area. There was no significant difference in the views among the respondents ($\chi^2 = 0.100$, df = 2, $P > 0.05$) on the driving factor behind the wildlife population trend in the region. There was no statistical difference between different categories of age ($\chi^2 = 11.624$, df = 14, $P > 0.05$) or livestock ownership ($\chi^2 = 7.097$, df = 12, $P > 0.05$) in determining their views on the reasons for wildlife population trend in Sarite.

3.1.2.3. Wildlife hunting

12.5% of the respondents admitted that they hunt wildlife whereas 87.5% stated that they do not hunt wildlife. There was a significant difference ($\chi^2 = 45.00$, df = 1, $P < 0.001$) on the responses of wildlife hunting (Table 10). However, no association was found on age group ($\chi^2$
= 8.635, df = 7, P > 0.05) or livestock ownership ($\chi^2 = 3.624$, df = 6, P>0.05) on the views of hunting wildlife in the area.

**Table 10.** Responses on wildlife hunting at Sarite.

<table>
<thead>
<tr>
<th>Respondent</th>
<th>n</th>
<th>Wildlife Hunting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarite</td>
<td>80</td>
<td>Yes 12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No 87.5</td>
</tr>
<tr>
<td>Total/mean</td>
<td>80</td>
<td>Yes 12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No 87.5</td>
</tr>
</tbody>
</table>

### 3.1.2.4. Grevy’s zebra in pastoralists perspective, Sarite

Finding Grevy’s zebra in Sarite is relatively easy and all (100%) the respondents of Sarite have seen Grevy’s zebra in the past one year (Plate 5).

![Plate 5. Accessibility of Grevy’s zebra in Sarite.](image)

### 3.1.2.5. Population trend and associated factors

63.75% of the respondents stated that the population of Grevy’s zebra is increasing in the area from time to time, whereas, 36.25% responded that zebra population is declining. There was a significant difference ($\chi^2 = 6.050$, df = 1, P > 0.05) on the Grevy’s zebra population trend among the respondents. However, age group ($\chi^2 = 8.868$, df = 8, P> 0.05) or livestock ownership ($\chi^2 = 10.156$, df = 6, P > 0.05) were not important to perceive Grevy’s zebra population trend in the area.
According to 36.25% of the respondents, drought is the major factor for the decline of Grevy’s zebra population. Among those who responded there is an increase in the population of zebras in the area (n=51) 62.7%, and 37.3% had the view that food availability and absence of hunting, respectively. However, no association was found ($\chi^2 = 3.475$, df = 2, $P > 0.05$) in reasoning the factors affecting the population. Age group ($\chi^2 = 15.383$, df =14, $P > 0.05$) or livestock ownership ($\chi^2 = 14.616$, df = 12, $P > 0.05$) had no relationship to reason the factors for the decline of Grevy’s zebra population.

3.2. Grevy’s zebra resource use, habitat preference and activity pattern

3.2.1. Population estimate

The population density of Grevy’s zebra in Chew Bahir is estimated to be 0.087 /km², whereas in Sarite their population density is 0.115/km² (Table 11). The total population of Grevy’s zebra in Chew Bahir and Sarite was estimated to be 35 and 29, respectively. Other larger mammal species found in the area include Grants gazelle, Oryx, Lelwel Hartebeest, Warthog, Common Jackal, and Hyena. Larger predators were not recorded in the areas.

### Table 11. Grevy’s zebra population density in Chew Bahir and Sarite

<table>
<thead>
<tr>
<th>Area</th>
<th>Density estimate/km²</th>
<th>%CV</th>
<th>df</th>
<th>95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chew Bahir</td>
<td>0.09</td>
<td>32.71</td>
<td>18.78</td>
<td>0.044657 - 0.16982</td>
</tr>
<tr>
<td>Sarite</td>
<td>0.11</td>
<td>30.14</td>
<td>20.16</td>
<td>16.000 – 53.000</td>
</tr>
</tbody>
</table>

3.2.2. Water availability to Grevy’s zebra

There were five water points in each of the study areas. All the water points in Chew Bahir were natural including one hot spring (Table 12). In Sarite, there were three man made ponds, one natural spring and a borehole.
Table 12. Description of water points in Chew Bahir and Sarite (Y = Yes, N = No)

<table>
<thead>
<tr>
<th>Water point name</th>
<th>Type of water point</th>
<th>Longevity</th>
<th>Distance to the nearest settlement (km)</th>
<th>Protection Type</th>
<th>Level</th>
<th>Accessibility</th>
<th>Distance to the nearest Vegetation (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tabal</td>
<td>Spring</td>
<td>permanent</td>
<td>&gt;25</td>
<td>No</td>
<td></td>
<td>Y</td>
<td>4</td>
</tr>
<tr>
<td>Eto</td>
<td>Spring</td>
<td>permanent</td>
<td>&gt;25</td>
<td>Thorny twigs</td>
<td>Moderate</td>
<td>Y</td>
<td>1</td>
</tr>
<tr>
<td>Gom</td>
<td>Spring</td>
<td>permanent</td>
<td>&gt;25</td>
<td>Thorny twigs</td>
<td>Moderate</td>
<td>Y</td>
<td>4</td>
</tr>
<tr>
<td>Koffa</td>
<td>Spring</td>
<td>permanent</td>
<td>&gt;25</td>
<td>Thorny twigs</td>
<td>Moderate</td>
<td>Y</td>
<td>.1</td>
</tr>
<tr>
<td>Shenshela Neko</td>
<td>Spring</td>
<td>permanent</td>
<td>&gt;25</td>
<td>No</td>
<td></td>
<td>Y</td>
<td>8</td>
</tr>
<tr>
<td>El Sarite</td>
<td>Spring</td>
<td>permanent</td>
<td>4</td>
<td>Stone</td>
<td>Moderate</td>
<td>N</td>
<td>.1</td>
</tr>
<tr>
<td>Chebi</td>
<td>Pond</td>
<td>seasonal</td>
<td>8</td>
<td>No protection</td>
<td></td>
<td>Y</td>
<td>2</td>
</tr>
<tr>
<td>Haro Dhalch</td>
<td>Pond</td>
<td>seasonal</td>
<td>0.5</td>
<td>Thorny twigs</td>
<td>High</td>
<td>N</td>
<td>.5</td>
</tr>
<tr>
<td>Horo 2</td>
<td>Pond</td>
<td>seasonal</td>
<td>0.5</td>
<td>Thorny Twig</td>
<td>High</td>
<td>N</td>
<td>2</td>
</tr>
<tr>
<td>Motor</td>
<td>Bore hole</td>
<td>permanent</td>
<td>1</td>
<td>Thorny Twig</td>
<td></td>
<td>N</td>
<td>2</td>
</tr>
</tbody>
</table>

Form the total of 35 observations in four rounds, the foot prints of Grevy’s zebras were found at 65% of the observation near water points. However, no foot print was found in the two (El Sarite and Motor) of water points in Sarite. All of the water points found in Chalbi occur at more than 10 km from the nearest human settlement than those at Sarite where 60% occur within 1 km distance (Table 13). There was a significant difference ($\chi^2 = 22.029$, df = 3, $P > 0.05$) on the distance of water points to the nearest human settlement. No significant difference was obtained ($\chi^2 = 5.8$, df = 1, $P > 0.05$) in the distance of water points from the nearest vegetation, while it ranges from 0-8 km.

Table 13. Water points and their distance from the nearest settlement

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number of water points</th>
<th>Distance to the nearest human settlement (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-1 (%)</td>
<td>2-5 (%)</td>
</tr>
<tr>
<td>Chalbi</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Sarite</td>
<td>5</td>
<td>60.0</td>
</tr>
</tbody>
</table>
Grevy’s zebra footprint was associated with distance of the water points to the nearest human settlement ($F_{3, 31} = 3.805, P < 0.05$). There was also a positive correlation ($r = 0.4, P = 0.41$) between Grevy’s zebra footprint and distance to the nearest settlement. However, no impact on human presence at the water points ($\chi^2 = 7.516, df = 3, P > 0.05$) was found. No association was found between thickness of the vegetation around water points and zebra footprint ($\chi^2 = 0.49, df = 1, P > 0.05$), or human presence ($\chi^2 = 1.762, df = 1, P > 0.05$). Level of water points protection against drinking by wildlife (Table 12) has an impact on Grevy’s zebra footprint around the water point ($\chi^2 = 10.026, df = 3, P < 0.05$). Distance of the water point from the nearest vegetation has no impact on zebra footprint ($\chi^2 = 1.159, df = 3, P > 0.05$), or human presence ($\chi^2 = 3.411, df = 3, P > 0.05$). No association was found between season ($P > 0.05$), rotation ($P > 0.05$) or locality ($P > 0.05$) on zebra footprint or human presence.

3.2.2.1. Human presence at water points of Chew Bahir

Out of the 293 observations at each water point, humans were present at ‘Tabal’ (87%), ‘Eto’ (86.3%), and ‘Gom’ (67.2%) (Fig. 12). There was a significant difference in the human presence of water points at ‘Tabal’ ($\chi^2 = 160.713, df = 1, P < 0.001$), ‘Eto’ ($\chi^2 = 154.843, df = 1, P < 0.001$), ‘Gom’ ($\chi^2 = 34.816, df = 1$). Time of the day was associated with human presence ‘Tabal’ ($\chi^2 = 22.418, df = 2, P < 0.001$), ‘Eto’ ($\chi^2 = 22.958, df = 2, P < 0.001$), ‘Gom’ ($\chi^2 = 25.329, df = 2, P < 0.001$).

Humans, armed by Kalashnikov rifles, were present in all of the observation in ‘Tabal’ and ‘Eto’ during the mid-day hours compared to 86.5% in ‘Gom’ (Table 14 and Plate 6). Time of the day was associated with human presence ‘Tabal’ ($\chi^2 = 22.418, df = 2, P < 0.001$), ‘Eto’ ($\chi^2 = 22.958, df = 2, P < 0.001$), ‘Gom’ ($\chi^2 = 25.329, df = 2, P < 0.001$).

Figure 12. Human presence and absence at water points of Chew Bahir.
Table 14. Observation on human presence at water points of Chalbi.

<table>
<thead>
<tr>
<th>Time</th>
<th>n</th>
<th>TABAL Absent (%)</th>
<th>TABAL Present (%)</th>
<th>ETO Absent (%)</th>
<th>ETO Present (%)</th>
<th>GOM Absent (%)</th>
<th>GOM Present (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>303</td>
<td>21.8</td>
<td>78.2</td>
<td>21.8</td>
<td>78.2</td>
<td>46.5</td>
<td>53.5</td>
</tr>
<tr>
<td>Mid-day</td>
<td>288</td>
<td>-</td>
<td>100.0</td>
<td>-</td>
<td>100.0</td>
<td>13.5</td>
<td>86.5</td>
</tr>
<tr>
<td>Afternoon</td>
<td>288</td>
<td>16.7</td>
<td>83.3</td>
<td>18.8</td>
<td>81.3</td>
<td>37.5</td>
<td>62.5</td>
</tr>
<tr>
<td>Total/mean</td>
<td>879</td>
<td>13.0</td>
<td>87.0</td>
<td>13.7</td>
<td>86.3</td>
<td>32.8</td>
<td>67.2</td>
</tr>
</tbody>
</table>

Plate 6. Armed Borana pastoralists at water points, Chew Bahir.

3.2.3. Habitat Association

3.2.3.1. Chew Bahir

Out of the total 876 observations, Grevy’s zebra were found in the pan (59.7%) and grassland (40.3%), respectively. They were distributed at the southeast corner of the study area (Fig 13). These results showed a significant difference ($\chi^2 = 32.991$, df = 1, P < 0.001) in the habitat preference of zebras in Chalbi. Time of the day also had an association with habitat preference ($\chi^2 = 248.525$, df = 2, P < 0.001). They spent most (70.7%) of the morning hours in the grassland while most (93.1%) of the mid-day observation showed their presence in the pan. During the afternoon, zebras spent 40.3% and 59.7% of their time in the grassland and pan, respectively (Table 15).
Figure 13. Grevy’s zebra distribution in Chew Bahir.

Table 15. Diurnal habitat preference of Grevy’s zebra, Chew Bahir.

<table>
<thead>
<tr>
<th>Time</th>
<th>N. of observations</th>
<th>Grassland (%)</th>
<th>Pan (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>300</td>
<td>70.7</td>
<td>29.3</td>
</tr>
<tr>
<td>Mid-day</td>
<td>288</td>
<td>6.9</td>
<td>93.1</td>
</tr>
<tr>
<td>Afternoon</td>
<td>288</td>
<td>42.0</td>
<td>58.0</td>
</tr>
<tr>
<td>Total/mean</td>
<td>876</td>
<td>40.3</td>
<td>59.7</td>
</tr>
</tbody>
</table>

3.2.3.1.1. Activity pattern

In Chew Bahir vigilance has more mean frequency per hour than the other activity patterns (Fig. 14). During the study period, Grevy’s zebras were observed vigilant in 52.1% of the observation time than feeding (23.4%), walking (12.3%), resting (8.0%), grooming (2.3%) and running (1.9%). The overall activity patterns of zebras in the region showed significant difference ($\chi^2 = 954.233$, df = 5, $P < 0.001$). Habitat was also an important factor ($\chi^2 =$ - 43 -)
109.967, df = 5, P < 0.001) in determining the activity patterns of Grevy’s zebra in the region.

Time of the day was associated ($\chi^2 = 151.728$, df = 10, P < 0.001) with activity patterns of zebras in the area.

![Graph](image)

**Figure 14.** Mean ± SE hourly activity patterns of Grevy’s zebra in Chew Bahir.

They were more vigilant during the mid-day 10:10 to 14:00 hrs and late afternoon 14:10 to 18:00 hr than during morning 06:00 to 10:00 hr. They were vigilant for 66.3% and 50.7% during the mid-day and late afternoon, respectively. Feeding was observed only for 1.8% and 26.3% of the observation time during mid day and late afternoon, respectively. However, feeding was more pronounced in the morning, (42.7% of the observation period), than other behavioural activities like vigilant (40.0%), walking (11.7%), resting (2.3%), grooming (1.3%), and running (2%) (Table 16).
Table 16. Diurnal activity pattern of the Grevy’s zebra, Chew Bahir.

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of observations</th>
<th>Feeding %</th>
<th>Vigilant %</th>
<th>Walking %</th>
<th>Resting %</th>
<th>Grooming %</th>
<th>Running %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>300</td>
<td>42.7</td>
<td>40.0</td>
<td>11.7</td>
<td>2.3</td>
<td>1.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Mid-day</td>
<td>288</td>
<td>1.7</td>
<td>66.0</td>
<td>13.2</td>
<td>13.2</td>
<td>3.8</td>
<td>2.1</td>
</tr>
<tr>
<td>Afternoon</td>
<td>288</td>
<td>25.0</td>
<td>50.7</td>
<td>12.2</td>
<td>8.7</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Total/mean</td>
<td>876</td>
<td>23.4</td>
<td>52.1</td>
<td>12.3</td>
<td>8.0</td>
<td>2.3</td>
<td>1.9</td>
</tr>
</tbody>
</table>

A. Grassland

In the grassland areas, zebras spent more time feeding (57.8%) than vigilant (28.6%) (Fig. 15). Other behavioural activities like walking (10%), resting (2%) and running (1.4%) were also observed. There was a significant difference ($\chi^2 = 400.357$, df=4, $P < 0.001$) in the behavioural activities of Grevy’s zebra occurring in and around the Grassland Habitat of Chew Bahir.

Figure 15. Grevy’s zebra behavioural observation in the grassland habitat.

Time of the day also has an impact ($\chi^2 = 32.123$, df = 8, $P < 0.001$) on the behavioural display of zebras. Zebras spent most of morning (60.8%) and late afternoon (57.9%) time feeding. During the mid-day, they spent 45% and 30% of their time walking and in vigilance, respectively (Table 17).
### Table 17. Diurnal activity pattern in the Grassland, Chew Bahir.

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of observation</th>
<th>Feeding (%)</th>
<th>Vigilant (%)</th>
<th>Walking (%)</th>
<th>Resting (%)</th>
<th>Running (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>212</td>
<td>60.8</td>
<td>26.9</td>
<td>8.0</td>
<td>2.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Mid-day</td>
<td>20</td>
<td>25.0</td>
<td>30.0</td>
<td>45.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Afternoon</td>
<td>121</td>
<td>57.9</td>
<td>31.4</td>
<td>8.3</td>
<td>0.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Total/mean</td>
<td>353</td>
<td>57.8</td>
<td>28.6</td>
<td>10.2</td>
<td>2.0</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**B. The Salt Pan**

In the pan, they were more vigilant (68.3%) than other behavioural activities like walking (13.8%), resting (12%), grooming (3.8%) and running (2.1%) (Fig. 16). There is a significant difference ($\chi^2 = 782.497$, df = 4, $P < 0.001$) in the activity patterns of zebras when they were in the Salt Pan.

![Behavioural observations of Grevy’s zebras in the Pan, Chew Bahir.](image)

**Figure 16.** Behavioural observations of Grevy’s zebras in the Pan, Chew Bahir.

Time of the day was an important factor ($\chi^2 = 19.672$, df = 8, $P < 0.05$) in determining the zebras activity in the pan. The zebras were more vigilant (70.3%) in the morning than (64.7%) in the afternoon in the pan (Table 18).
Table 18. Diurnal activity pattern of zebras in the Salt Pan.

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of observation</th>
<th>Vigilant (%)</th>
<th>Walking (%)</th>
<th>Resting (%)</th>
<th>Grooming (%)</th>
<th>Running (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>89</td>
<td>73.0</td>
<td>21.3</td>
<td>1.1</td>
<td>4.5</td>
<td>-</td>
</tr>
<tr>
<td>Mid-day</td>
<td>267</td>
<td>68.5</td>
<td>10.9</td>
<td>14.2</td>
<td>4.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Afternoon</td>
<td>167</td>
<td>64.7</td>
<td>15.0</td>
<td>14.4</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Total/mean</td>
<td>523</td>
<td>68.1</td>
<td>14.0</td>
<td>12.0</td>
<td>3.8</td>
<td>2.1</td>
</tr>
</tbody>
</table>

3.2.3.1.2. Browse abundance

There was a significant difference on grass height, percentage grass cover, and visibility at one meter (P < 0.001). However, no association was found in visibility at two metres and nearness to a water point (P > 0.05) (Table 19).

Table 19. Grass height, % grass cover, visibility and nearness to a water point in Chew Bahir

<table>
<thead>
<tr>
<th>Grass height</th>
<th>Grass cover (%)</th>
<th>Visibility one meter</th>
<th>Visibility two meter</th>
<th>Nearness water point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>222.617</td>
<td>59.691</td>
<td>116.511</td>
<td>.340</td>
</tr>
<tr>
<td>df</td>
<td>41</td>
<td>12</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.560</td>
</tr>
</tbody>
</table>

Seasons have had an impact on grass height ($\chi^2 = 87.807, df = 41, P < 0.001$) and percentage grass cover ($\chi^2 = 39.042, df = 12, P < 0.001$). There was an increase in % grass cover by 37.5% during the wet season from mean ± SE grass cover of 19.00±1.093604 to 26.21053±1.521985

3.2.3.2. Sarite

Out of the total 876 observations, Grevy’s zebras were observed in the woodland (47.5%) and grassland (52.5%), respectively. There was no significant change ($\chi^2 = 2.21, df = 1, P > 0.05$) in the pattern of habitat association of Grevy’s zebra at Sarite. However, their habit preference differed significantly in the morning, mid-day and afternoon ($\chi^2 = 13.198, df = 2, P < 0.05$). They spent most (58.7%) of the morning hour in the grassland while most (55.9%) of the noon
time was spent in the *Acacia* woodland. During the afternoon, zebras spent 45.5% and 54.5% of their time in the woodland and grassland, respectively (Table 20).

### Table 20. Diurnal habitat preference of Grevy’s zebra at Sarite.

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of observations</th>
<th>Grassland (%)</th>
<th>Woodland (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>300</td>
<td>58.7</td>
<td>41.3</td>
</tr>
<tr>
<td>Mid-day</td>
<td>288</td>
<td>44.1</td>
<td>55.9</td>
</tr>
<tr>
<td>Afternoon</td>
<td>288</td>
<td>54.5</td>
<td>45.4</td>
</tr>
<tr>
<td>Total/mean</td>
<td>876</td>
<td>52.5</td>
<td>47.5</td>
</tr>
</tbody>
</table>

#### 3.2.3.2.1. Activity pattern

Grevy’s zebras were observed feeding in 47.3% of the observation time compared to running (0.6%), vigilant (8.6%), walking (10.6%) resting (19.2%) and grooming (13.7%). The mean frequency for each activity per hour was feeding $2.93 \pm 0.152$, vigilant $0.542 \pm 0.071$, walking $0.618 \pm 0.062$, resting $0.99 \pm 0.117$, grooming $0.479 \pm 0.085$, and running $0.035 \pm 0.018$ (Fig. 17). There was significant difference ($\chi^2 = 688.863, df = 5, P < 0.001$) among the activity patterns. Habitat was also an important factor ($\chi^2 = 44.923, df = 5, P < 0.001$) in determining the activity patterns of Grevy’s zebra in the region, showing more feeding in grassland than the woodland. Time of the day was associated ($\chi^2 = 209.915, df = 10, P < 0.001$) with activity patterns of zebras in the area.

![Figure 17](image)

**Figure 17.** Mean ± SE hourly activity patterns of Grevy’s zebra at Sarite.
Zebras spent more time in feeding during the morning 0600-1000 hrs and late afternoon 1410-1800 hrs than mid-day 10:10 to 14:00 hr. During the morning and late afternoon, zebras spent more time to feeding (71% and 45.5%), respectively than the other of activities (Fig. 18).

![Figure 18. Diurnal activity patterns of zebras in Sarite](image)

**A Grassland**

In the grassland habitats, zebras spent more time to feeding (56.5%) than in vigilance (7.8%). Other behavioural activities like walking (10.7%), resting (12.2%) and grooming (12.2%) were also observed during the study period. There was a significant difference ($\chi^2 = 551.887$, df =5, $P < 0.001$) among the behavioural activities of Grevy’s zebra in the grassland habitats of Sarite.

Time of the day also has an impact ($\chi^2 = 79.434$, df = 10, $P < 0.001$) on the behavioural display of zebras in the grassland habitats. During the morning and afternoon hours, zebras spent 72.8% and 52.2% of their time, respectively in feeding. While in the mid-day, they spent 39.4% of the time in feeding and 22% of the time each in resting and grooming (Table 21, Fig. 19).
Table 21. Proportion of diurnal activity patterns of zebras in grassland habitat at Sarite.

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of observations</th>
<th>Resting (%)</th>
<th>Feeding (%)</th>
<th>Vigilant (%)</th>
<th>Walking (%)</th>
<th>Grooming (%)</th>
<th>Running (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>176</td>
<td>.6</td>
<td>72.7</td>
<td>11.4</td>
<td>12.5</td>
<td>2.3</td>
<td>.6</td>
</tr>
<tr>
<td>Mid-day</td>
<td>127</td>
<td>22.0</td>
<td>39.4</td>
<td>5.5</td>
<td>10.2</td>
<td>22.0</td>
<td>.8</td>
</tr>
<tr>
<td>Afternoon</td>
<td>157</td>
<td>17.2</td>
<td>52.2</td>
<td>5.7</td>
<td>8.9</td>
<td>15.3</td>
<td>.6</td>
</tr>
<tr>
<td>Total/mean</td>
<td>460</td>
<td>12.2</td>
<td>56.5</td>
<td>7.8</td>
<td>10.7</td>
<td>12.2</td>
<td>.7</td>
</tr>
</tbody>
</table>

Figure 19. Behavioural activities of zebras at woodland and grassland habitats, Sarite.

B. Acacia woodland

In the woodland, zebras exhibited more time for feeding (37%). Other behavioural activities like vigilant (9.6%), resting 26.9%, grooming15.4%, walking 10.6%, and running (0.5%) were also observed during the study period. There was a significant difference ($\chi^2 = 217.115$, df = 5, $P < 0.001$) among the behavioural activities of Grevy’s zebra found in and around the woodland habitat of Sarite.

Time of the day also had an impact ($\chi^2 = 135.632$, df = 10, $P < 0.001$) on the behavioural display of zebras in the woodland habitat. Zebras spent most of morning 68.5% and afternoon 37.4% of the time, respectively feeding. During the mid-day, they spent 46.6% of the time in resting followed by grooming (23.6%) (Table 22).
Table 22. Proportion of diurnal activity patterns of zebras in woodland habitat at Sarite

<table>
<thead>
<tr>
<th>Time</th>
<th>Number of observation</th>
<th>Resting %</th>
<th>Feeding %</th>
<th>Vigilant %</th>
<th>Walking %</th>
<th>Grooming %</th>
<th>Running %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>124</td>
<td>4.0</td>
<td>68.5</td>
<td>14.5</td>
<td>8.1</td>
<td>4.8</td>
<td>-</td>
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<td>11.5</td>
<td>15.3</td>
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<tr>
<td>Total/mean</td>
<td>416</td>
<td>26.9</td>
<td>37.0</td>
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3.2.3.2.2. Browse abundance

There was no significant difference ($\chi^2 = 19.617$, df = 11, P > 0.05) in % grass cover in Sarite, and season has no association ($\chi^2 = 19.617$, df = 11, P > 0.05) with percent grass cover. However, there was an increase by 33.82% in grass cover from mean ±SE of 28.61702± 2.044273 to 38.29787± 2.130548 during the wet season.
4. DISCUSSION

In the past few decades, many studies about species conservation were mainly based on the biology and ecology. However, the human element, particularly the knowledge and experience of local communities, were overlooked in many aspects of conservation. Most of the findings and implementation of results of ecological studies have relied on opinions given by ecologists; while ignoring the indigenous knowledge of the local communities. Nowadays however, many studies are gearing towards incorporating the local communities indigenous knowledge and experience into various strategies of natural resources conservation (Pierotti and Wildcat, 2000; Oba and Kotile, 2001). The present study is an attempt to find out the real causes of Grevy’s zebra population decline borrowing the knowledge and experience of the pastoral communities in and around the study areas of Chew Bahir (Chalbi) and Sarite.

The results of this study have clearly shown that the wildlife population of the region, once plenty before the 1980s is dwindling at an alarming rate. Though, other ecological factors are not included in this study, the major challenge for survival of Grevy’s zebra and other wildlife survival is found to be human impacts. Pastoralist communities exert various pressures to *Equus grevyi* and other wildlife species in the area due to internal and external factors exerted on them. The major pressures were hunting and denying access to critical resources particularly water.

A good proportion of the respondents of Chalbi fulfil their meat requirement from wildlife. Particularly more than 64% of Asle (Hamar) and Hor (Arbore) pastorals prefer bushmeat over livestock for their protein requirement. Many local people in Africa prefer bushmeat that of livestock. For example, Asibey (1977) estimated 70% of Ghanaians consume bushmeat. In Cameroon, bushmeat is an important part of the diet providing 70-80% of the animal protein. Pastoral communities consider livestock as an expression of wealth, social respect and honour; hence they usually refrain from the utilization of livestock resources to the betterment of their day to day requirements.

The local pastoralist communities perceive the general wildlife trend in the region and gave the underlying causes for this trend. Given that pastoral communities have their indigenous ecological knowledge and experience about their environment, and given that they have the
capacity to monitor and measure environmental changes (Oba and Kotile, 2001). Most (85.8%) of Chalbi and of Sarite (80%) respondents were aware of the general wildlife population decline from time to time. Williams (2003) there were severe wildlife population decline in the region.

The pastoralist communities of the region in general and those living adjacent to Chalbi have had long tradition of hunting wildlife for various reasons (Plate 7). From the respondents’ observation, most of the pastoralist communities travel to Chew Bahir mainly for hunting to support the major protein source. Most respondents of Hamar and Hor (Arbore) travel to Chalbi mainly for hunting Grevy’s zebra and other wildlife. However, most respondents of the Mermero Borana travel to Chalbi only when there is severe drought. As the only permanent water points for the adjacent Borana pastoralists in the region that can render for livestock during drought season are the waters of Chew Bahir, the Borana and Gabra of Kenya travel to the area as a refugee for their livestock. Most of the respondents who have admitted hunting as a reason for wildlife decline, attributed to the large number of automatic rifles especially Kalashnikov from different sources. This fact was also revealed by Williams (2003).

Plate 7. Caracas of wounded zebras that run long distances to escape from the hunters

Availability of these rifles made easier for the locals to hunt wildlife. Following is how a 65 years old leader of Hor (Arbore) community described the history of rifle and hunting in the region:
“Long ago before the occupation of the Italians there were no rifles in the whole region and we were living peacefully with other ethnic groups. Hunting was made possible with traditional equipment like spear and traps. But, during the Italian occupation, they armed some of the ethnic groups and conflict started to arise in the region. Even after the eviction of the Italians, we had very few rifles and getting the bullets were the most challenging business. If a woman gives birth, it is in our tradition that she needs to eat meat and drink blood of wild animals. Hence, first we need to get the permission from the ‘Qawot’ (a ritual leader), then we need to borrow the rifle, paid for a bullet and finally find a person who is sharp shooter for the execution of the animal. But after the fall of the Emperor, rifles became available for those who can afford. The most serious problem for wildlife and also for our people came during the downfall of the Mengistu’s Regime. By then, the availability of Kalashnikov rifles reached at its maximum that now even a child under the age of ten can have it. Nowadays, you do not have to beg for the rifle and search for days to get the bullet, and also you do not have to ask to get the shooter. Kalashnikov solved our problem of hunting and thanks to it that we lost most of the wildlife, and also our peace.”

These ideas were also shared by most elders of the pastoral communities in the whole region. This is an indication that these people through their traditional knowledge and resource management systems, have been living in harmony with the wildlife for centuries. For example, the ‘Qawots’ of Hor (Arbore) have influence over the wildlife resources as well as over the order of the region. They usually made a decree against hunting wildlife in Chalbi. Therefore if a Hore individual wants to hunt getting the permission and blessing is the first priority. In this respect, the external pressure played the major role in depleting the wildlife resources of the region; like colonization and its associated impacts, automatic weapon smuggling and social and political changes in the country (1974 revolution) which weakened traditional institutions. Thus, hunting with automatic rifle was further strengthened by another elder of 60 years of age from Hamar: “With these rifles, no need to aim at the particular animal because out of the many bullets that will be fired definitely, one will hit the target.”

Next to hunting, the change of the River ‘Woito’ (‘Limo’) was also an important factor. The river used to flow near the foot of the Borana mountains to Chew Bahir some two decades ago. However, a German scholar living in the region for more than 35 years, made some successful
arrangement to divert the direction of the river to end near the foot of Hamar Mountains called ‘Golla’ far above the historic ending to make the Hamar to engage in flood retreat agriculture. This change of direction of the river affected not only the wildlife in the region but also forced many of the local communities of Arbore and Watta to abandon their fertile land (‘Bulkicha’) for flood retreat agriculture. Following the water, many of the wildlife species came near to the Hamar who were the most known hunters of the region, hence many perished there. At present the remaining wildlife in the area occur only near the Borana Mountains and near the Kenyan border. It is not easy to find larger mammals near the Hamar side of the study area. Similar result was recorded in Northern Kenya by Williams (1998) where upland drainage of water for agriculture affected the lowland biodiversity.

Many respondents expressed that during drought seasons, the nearby Borana and Gabra of Kenya bring their livestock to make use of the waters of Chalbi. Since the Borana and Gabra have antagonistic relation with Hamar, they have to patrol the water points day and night, otherwise, they might be attacked and lose their livestock and the water points. This denied the wildlife access to drink resulting in death (Plates 8 and 9) or might be forced to migrate towards safe places like neighbouring Kenya. The water points of Chalbi are not only occupied by the Borana and Gabra. Any group with the upper hand can occupy and utilize the resources. However, during the present study it was the Borana and Gabra who occupied the water points. Most respondents admitted that they have been hunting wildlife mostly in Chalbi.

Plate 8. Challenges of zebras and other wildlife at water points of Chalbi.
One 49 years old elder from Arbore described how he used to hunt in Chew Bahir (Chalbi):

“You know what, when you want to hunt zebras and other wildlife, first you have to get permission and blessing from the community leader ‘Qawot’. Once you get the permission and blessing it takes about two days to reach there spending the first night in the satellite camps ‘Fora’. There you will drink milk with cattle blood that will give you the strength in the area. The next day, you approach one of the water points and scan the area. If there are wild animals near the water point, then it is free and you can make the water under control. However, if there is no wildlife nearby, you have to be careful that someone might be there, it is dangerous. If it is certain that someone is there, either you have to wait from a distance until he leaves the area or go to the other water point. Once you take the water point, it is easier to kill any thing because the water points are strategic that no one can take over from you. You hide near the water point whenever zebra or other wildlife come to drink and simply pull the trigger and you will have what you sought for.”

According to the respondents of Sarite, unlike that of Chalbi, permanent water for wildlife was not adequate. There is no permanent river or stream found in the region. During drought seasons, all the water will be kept and guarded by the local community that the wildlife will not have easy access. Therefore, most of the wildlife will be severely affected by water
shortage and drought. Similar situation were recorded in Northern Kenya by Williams (1998) where water was not available to wildlife due to the occupation of water points by the local people.

Most (87.9%) respondents of Chalbi and all respondents of Sarite knew Grevy’s zebra very well. However in Chalbi, it has been long (more than 5 years) since most of the respondents saw Grevy’s zebras. This clearly indicates it is getting very difficult from time to time to see zebras. Most of the youngsters tried but never seen zebras and nearly all of the elders spent more than ten years since they encountered live Grevy’s zebra. However, Arbores took the advantage of having relatively peaceful relationship with both Borana and Hamar to travel to Chalbi more frequently than others. This might indicate that sometimes, antagonistic attitude to one another might give the wildlife a temporary relief from human impacts. This was clearly indicated in the survey that the hunters of Hamar pastoralists were unable to move to Chalbi for hunting as frequently as before. In Sarite, it is different from that of Chalbi. It is relatively easy to search and get Grevy’s zebra and all of the respondents saw zebras within the past one year. Unlike others, zebras in Sarite have less hunting pressure. During the present study, the local people and herdsmen were not observed carrying the famous Kalashnikov as those of Chalbi dwellers.

However, according to the respondents of Sarite, Grevy’s zebra population is increasing in number; which is in contradiction with the respondents of Chalbi and also from the transect assessment. This contradiction might be due to the easy availability of zebras in the ‘Arbala’ plains, which is the main grazing area for livestock and wildlife. Otherwise, the species is declining in number. Similar results were recorded by Thouless (1995b) and Williams et al, (2003). However, the Borana tradition towards hunting Grevy’s zebra might have a positive impact towards the species survival. This might be the result of their strong indigenous resource management systems and strong social systems (the ‘Gada’ system). If it were not for the Boranas, Grevy’s zebra might have gone long ago from Sarite (considering the absence of enough permanent water for wildlife). This can indicate that pastoralist people can coexist peacefully with the wildlife living adjacent to them.

The number of zebras killed in Chalbi differed from Kebele to Kebele. This was associated with the pastoralists cultural attitude towards hunting Grevy’s zebra. Most of Grevy’s zebras were killed by Hamars compared to Borana. This might be due to the fact that Hamars have
special affection to donkeys, as zebras look-like donkeys. In the tradition of Hamar, if highly valued guest comes to a certain household, it is a donkey that is going to be slaughtered for him. Therefore, donkeys have respect among Hamar. This idea of the similarity of the two animals and Hamar attachment to donkeys needs further research.

Grevy’s zebras valued differently among the societies. The results indicated three major reasons why it is being killed by pastoralists in the whole region. Most (77.5%) of the pastoralist communities bordering Chew Bahir hunt zebras for food, medicinal value and few responded for social honour (Table 9). All of the communities of Arbore and Hamar eat meat and drink blood of zebras for food, which is similar with other north Kenyan tribes (Williams, 1998; Mohelman, 2002). In addition, the result showed that the meat and blood of Grevy’s zebra have a curative effect for certain diseases mostly the sexually transmitted Gonorrhoea (widely distributed among the community). Similar results were also recorded for the medicinal value of Grevy’s zebra in Afar (Mohelman, 2002) and in northern Kenya (Williams, 1998).

As for social prestige, any one who killed lion, elephant, giraffe, or other larger animals are respected among the community. Hence, most youngsters try their best to get this respect. However, for the zebras, the results showed little support and getting the honour by killing zebras is not as such important compared to the other two (food and medicine). Most of the hunters of Grevy’s zebra are Hamar and Hor (Arbore), while Borans do not usually hunt them. However, sometimes they mistakenly kill zebras, when they are mixed with Oryx or other wildlife. Some people hunt zebras to see the striking coloration particularly the stripes.

Conflicts in pastoralist communities have grown rapidly due to their vested interest to gain access to resources and/or political power, which often overlaps with poverty. However, during this particular study, every ethnic group has its own specific grazing and watering areas hence; no overlap has been observed in resource utilization that can lead conflict. This helped them to minimize ethnic clashes and conflicts that might be aroused during resource utilization. The major grazing and watering areas for pastoralists were Wuro (Hor), Golla (Hamar) and Chalbi (Borana only during drought seasons). Cattle raiding was a common source of conflict between these ethnic groups a decade ago. But since then, due to various efforts made by different government officials from local to regional level and NGOs, the level of ethnic clash has been reduced (Gebre Ayalew, 1995; Tadesse Wolde, 2001). During the study period, no ethnic clash
was observed among the groups. However, antagonistic attitude toward one another between Hamar and Borana, and Hamar and Gabra is still at large.

During the present study, most water points in Chalbi were occupied by the Borana pastoralists and Gabra from Kenya (Plate 8). The results showed, pastoralists were present during most (80.2%) of the day time at the water points. ‘Tabal’ and ‘Eto’ were occupied continuously (100%) during midday hours than Gom and they were also guarded by pastoralists during night. However, ‘Gom’ was not guarded during night and no zebras were sighted near the water points indicating zebra’s avoidance of human presence. Similar result was recorded in areas used by pastoral people (Williams, 1998), where very few zebras were recorded. The only water points that could be available to wildlife were Shenshela Neko at all times and ‘Gom’ during night and for a brief mid-day hours. According to the pastoralists, ‘Shenshela Neko’ has an oily test and less volume to sustain livestock; hence they avoid this water point.

The underlying reason for the occupation of water points day and night, according to pastoralists, was the problem of security and cattle raiding. This provides an evidence that water point occupation by the pastoralists might have denied zebras access to the most important critical resource, water, in that arid ecosystem, adversely affecting zebras and other wildlife (Plate 4). Therefore, the occupation of water points by pastoralist communities might add up the challenges that zebras are facing from their neighbouring human communities.

Sarite possesses two permanent and a dozen of temporary water points near to the study area. Among the permanent water points, El Sarite is the only natural spring water at the middle of the mountain that might be available to wildlife when there is no severe water shortage in the area. All of the temporary water points were ponds constructed by the local people fenced by thorny bushes that can hamper wildlife from using it. Moreover, most of these ponds have difficulty in accumulating water for a longer period. Only three water points were in a better condition to hold water that can sustain for a relatively longer time during the normal years. Probably the only and major challenge for Grevy’s zebra survival in Sarite might be water availability.

Though fenced by the local Borana pastoralists (Plate 6) during dry season, Grevy’s zebra have relatively easy access to all of the water points found in Chalbi, hence plenty of foot prints in most water points. However, during severe drought, all the water points are occupied and
guarded day and night denying zebras and other wildlife access to water. According to Williams (1998), water availability to wildlife is affected by the distance from the nearest settlement. Those water points near to settlement areas were not accessible to zebras and other wildlife. Similar result was found in the present study where those water points distant from settlement have more foot prints of zebras than those nearer to settlements. However, in contradiction with other studies of Northern Kenya (Williams, 1998), visibility (distance of water point from the nearest vegetation) was not associated with Grevy’s zebra foot print. This might be due to the absence of large predators like lions in Sarite where water points are surrounded by vegetation.

The activity budget of an animal varies in response to both internal and external factors that influence its survival strategy (Knoop and Owen-Smith, 2006). E. grevyi spent more of the day time in the Salt Pan than in the Grassland habitat. Though, the data were collected only for a few days, the results can give a clue to their timely activity and their response to different factors. Time of the day has also a significant effect on the habitat selection of zebras found in Chalbi, where they spent most of their morning time in the grassland, while most of the noon and late afternoon time was spent in the Salt Pan (Table 15). Moreover, Grevy’s zebras devoted more time for vigilance than any other activities in Chew Bahir than in Sarite. This contradicts with the findings of Kivai (2006), where zebras spent most of their time feeding than other activities in Northern Kenya. This might suggest that the presence of Borana pastoralists and hunting of zebras by the local pastoral communities might affect their habitat preference, time budget and activity pattern of zebras (Plate 10). They spent more (59%) of their day time vigilant in the Pan where they can spot pastoralists from considerably large distances than feeding contrary to other the findings where abundance of forage was an important determining factor for use of space by Grevy’s zebra (Williams 1998); feeding as a dominant activity pattern than vigilance (Kivai, 2006); and digestive inefficiency will drive towards more feeding than other activities (Owen-Smith, 1992). This finding also contradicts with the findings of Moehlman (1998) where the adult Feral Asses spent 30.7% to 57.6% of their time feeding.
This in turn might suggest that as the narrow band of grassland is bordered by mountainous *Acacia* woodland that can conceal any danger to them, they might have altered their time budget and activity pattern spending more time in the Pan. However, this needs further study. Hence it might be possible to conclude that in areas where there is high level of hunting pressure, animals might respond in accordance with the level of hunting pressure exerted on them. This low level of activity allocated to foraging might reflect high intensity of hunting. Thus, hunting might have resulted in serious repercussions to the survival of zebras in the region or might force zebras to spend most of the night time feeding in the grassland to compensate what they have lost during day time. However, in the grassland, zebras spent more time feeding than vigilant, which is similar to the findings of Kivai’s (2006). Vigilance takes considerable amount of time (28.6%) than the recent findings of Kivai (2006) where vigilant was observed in 5-6% of their time budget.

On the other hand, those zebras found in Sarite do not show significant difference in habitat preference and also their activity pattern was dominated by feeding which coincides with the results of Kivai (2006) and Rubeinstein *et al.* (2004). Their habitat association were evenly distributed to the habitats available. Nonetheless, time of the day has a significant impact on the habitat selection of zebras in the study area; where they spent most (56.7%) of their morning and afternoon time in the grassland than woodland. This evenly distributed habitat
preference of zebras in Sarite might suggest that in areas where there are very few large predators (none was reported by the local community) and with little human impact, the time budget and activity pattern of zebras might not be determined by visibility of a habitat and also browse abundance. Similar result was found in Buffalo Springs by Williams (1998) where irrespective of the difference in forage availability, zebras did not show habitat selection on the basis of abundance of forage. However, the exact distribution of zebras in Sarite in relation to water availability, forage abundance and their interaction with their conspecific Plains zebra need further study.

The Grevy’s zebra population estimate at Chalbi and Sarite were 35 and 29, respectively. The result overestimated the number of zebras in the study areas that contradicted with the previous studies of Williams et al. (2003), where the estimated population of zebras in Chew Bahir and Sarite were 22 and 24 animals, respectively. A number of reasons can be given to this increase in number. The previous survey included both ground and aerial surveys and only five individuals were seen, while the present study was carried out from the ground and 14 and 9 animals in Chalbi and Sarite, respectively were observed in one transect. Transects were also laid near the Pan-Grassland interface and near the water points, hence might have a problem of edge effect. In addition, there might be variation between the present study and the previous surveys in the seasons when the censuses were undertaken.

Though the results indicate a slight population increase from the previous survey, by taking into consideration all the above factors in this discussion, the pastoralists response, their hunting tradition, Kalashnikov rifle availability and the reasons for hunting, continuous water point occupation during the drought seasons, zebras time budget, habitat association and activity patterns, all these possibly show that the population of Grevy’s zebra in Chalbi and Sarite are still declining. Despite this population decline, the local communities have been an important element in conserving this species from time immemorial. They have lived and still living with the wildlife peacefully through their indigenous institutions and traditional systems. If it were not for the ban from the ‘Qawot’ of Hor, ‘Gada’ system and hunting tradition of Borana, the Grevy’s zebra and other wildlife could have been extirpated from the region long ago.

If appropriate conservation measures are not taken soon, Grevy’s zebra populations at Chew Bahir and Sarite will be liable to extinction.
Plate 11 Territorial male at the middle of the Arbala Plains, Sarite
5. CONCLUSION

Grevy’s zebra are threatened in both the study areas. The threats are mainly attributed to the human elements that happened to live for centuries with this species harmoniously. However, due to the dynamic nature of the human society and the influx of firearms and machine guns, since the last sixty years, the peaceful coexistence has been challenged.

The major ethnic groups found in the region are the Hor (Arbore), Hamar and Borana. These people have long tradition of interaction with wildlife and Grevy’s zebra in particular. Hunting wildlife for various purposes particularly for ceremonial purposes is common among these ethnic groups. However, the pastoralist community, particularly Hor (Arbore) and Hamar, hunt Grevy’s zebra for food, medicinal purposes and prestige.

The other major threat to *E. grevyi* is access to critical resources mainly for water. Water accessibility is the problem of both Chalbi and Sarite, though the degree of accessibility varies. In Chew Bahir, water accessibility will be difficult when the local Borana pastoralists control the water points; however, in Sarite the absence of accessible permanent water point in the nearby grazing area makes the problem even worse.

Diurnal time budget, for this species showed significant difference in Chew Bahir. This might be associated with the hunting pressure. This in turn might have brought adaptive behavioural change to zebras that occur at Chalbi in such a way that they became more vigilant than feeding. However, feeding and resting are the major activities in Sarite population.

The human element had played a positive role for the survival of this species in the region for centuries. The traditional institutions ‘Qawot’ of Hor (Arbore), ‘Gada’ of the Borana and ritual leaders of Hamar played important roles by banning hunting wildlife and resource utilization. However the weakening of these institutions brought serious consequences not only on Grevy’s zebra but also on the peaceful coexistence of these people. Therefore, conservation of Grevy’s zebra will be achieved effectively if and only if these institutions and their people are the leading players of the game.
6. RECOMMENDATIONS

Grevy’s zebra that occur Chalbi and Sarite are on the verge of extinction from anthropogenic as well as climatic uncertainty. In order to curb the challenges, conservation of Grevy’s zebras and their fragile arid ecosystem are inseparable and is at most priority. Though, Chew Bahir and Sarite areas covered by the present study were Wildlife Reserve and Controlled Hunting Areas, respectively they no longer provide any kind of protection to Grevy’s zebra and other wildlife against all the threats posed on them. Therefore, if this species need to be conserved, the ‘top-down approach’ will not work. Conservation of this species will be successful if we can use community led conservation approach that can integrate the traditional institutions.

The following measures need to be taken to reduce the level of threats.

- Detailed and long-term studies on the Grevy’s zebra populations need to be undertaken to obtain information on their behavioural patterns, distribution, population status, and breeding in relation to all available habitats.
- Local institutions ‘Gada’, of Borana, ‘Qawot’ and other age organizations like ‘Jald’aba’ of Hor and traditional institutions of Hamar need to be strengthened. Empowering these institutions over the wildlife resources is critical to make use of these institutions for the continued survival of wildlife.
- Possible dry season watering points of zebras in Sarite need to be studied further. Measures and negotiations with the Borana pastoralists must be taken to make water accessible to zebras.
- Intensive and continuous reconciliation effort must be undertaken between Borana and Hamar pastoralists to make water accessible to wildlife during the evening in Chew Bahir.
- Government officials need to recognise the importance of traditional institutions and empower these institutions and make use of their knowledge towards the betterment of living in the region.
- There is a need for conservation education campaign on intensive awareness programs using indigenous ecological knowledge of these people focusing on changing their attitudes on hunting, conservation, and understanding on the value of wildlife and wildlife habitats.
- There is an urgent need to have up to date wildlife policy and relevant legislation on wildlife conservation and Grevy’s zebra in particular. This should incorporate community involvement and law enforcement to take appropriate action.
- Improve the living standards of the local pastoralist people living adjacent to the study areas through education, better health services and economic development to reduce dependency on hunting.

Therefore, in order to take the above recommended actions, the establishment of a conservation programme for Grevy’s zebra and its arid ecosystem is critical. The conservation programme needs to integrate the local institutions to:

- address all the threats imposed on this species in its arid ecosystems and take counteracting measures.
- take local communities as a leading and integral part of the programme that can consider how poverty can be alleviated within the pastoralist community to insure the long-term survival of this species with its arid ecosystem.
- negotiate with the nearby pastoral communities to make critical resources on which zebras depend remain accessible and sufficient to meet their nutritional requirements.
- introduce education campaign that can raise the awareness and the attitude of the local pastoralists toward Grevy’s zebra and other wildlife; empower the local community over the wildlife resources and ensure the economic benefit from wildlife conservation.
- assist the pastoral communities in developing and involving in wildlife tourism activities and become the beneficiaries of this sector.
- assess the opportunities for collecting the widely distributed Kalashnikov rifle in the whole region. This weapon not only brought an acute threat to zebra but to the coexistence of the pastoral communities as well. This might need trans-border agreements and cooperation, local and international NGOs and also a series of negotiations with the pastoral communities of the whole region. Reconciling differences should be the first attempt.
7. REFERENCES


Boku Tache and Irwin, B. (2003). Traditional institutions, multiple stakeholders and modern perspectives in common property: Accompanying change within Borana pastoral systems. *Securing the Commons* No. 4, 51 pp


8. LIST OF APPENDIXES

Appendix 1. Questionnaire data sheet

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<td>Interviewer</td>
<td>Number</td>
<td>Location</td>
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1. Name____________________ Sex______________ Age_____________
   Ethnic Group_________ Occupation _______________
   Martial status________
How long have you lived in this area? _________________________________

Level of education
   None □ Primary school □ Secondary School □
   College □ University □ Other________________________

Religion
   Muslim □ Christian □ Traditional □ Others_______

2. What is your income (earning) what do you work for living
   Agriculture □ Livestock □ Bee keeping □ Trade □

3. If it is agriculture, size of the farmland________

3.1 Type of agriculture
   Rain fed □ Irrigation □ Both □ Other________

3.2 What type of crops do you grow? _________________________________

3.3 Is there a problem during your farming activities? Yes □ No□

3.4 If yes what are they? __________________________________________

3.5 Which members of your family participate in farming activities? _________

3.6 How much did you harvest from these crops last year? ________________

3.7 What do you sell in the market? _________________________________

4. Do you have livestock? Yes □ No□

4.1 If yes what type and number?
   Cattle ____ sheep ____ Goat_____ Donkey ____ Other_______

4.2 Did you sell livestock with in the last 12 months? Yes□ No□

4.3 If yes, how much did you earn last year? _______________________

4.4 Where do you get meat for your family? Livestock □ Wildlife □
4.5 What is the of livestock population trend for the past 20 years?
   Increasing □       Decreasing □
4.6 The reason for the increase/decrease of livestock population?
   ____________________________
4.7 Where do your livestock graze? ____________________________
4.8 How much time dose it take to reach for their grazing area? ________
4.9 Do you have your own (private) grazing land?       Yes□       No□
4.10 If no, who manages the grazing lands? _______________________
4.11 Have you ever experienced shortage of feed for your livestock?  Yes □    No □
4.12 If yes, on which season ____________________________
4.13 Does increase in number of livestock have any benefit? Yes □    No □

   Why? ___________________________________________________________________
5. Did you have any livestock died within the last 12 months?  Yes □    No □
5.1 If yes type and number? Cattle____ Goats ___Sheep_____ Other ____
   What is the reason for the death ________________________________________
5.2 What are the benefits you get from your livestock? _____________________
6. Where do your livestock drink water? ____________________________
6.1 How much time it take to travel to drink water? ______________________
6.2 Where did they drink during drought seasons? ________________________
   6.3 Is there any one who manages these water points? Yes □        No □
6.4 If yes, who? ____________________________
6.5 Did you experience water shortage?   Yes □         No □
6.6 Where did your livestock drink during severe water shortage? __________
6.7 How much time it take to get this water? ____________________________
7. Are there any other ethnic groups who use these grazing land and water points?
   Yes □        No □
7.1 If yes, which groups enter in to conflict? _________________________
7.2 Is there any conflict between ethnic groups due to the use of grazing and
   water resources?  Yes □        No □
8. What type of wild animals occurs in the area? _________________________
8.1 What is the trend of their numbers? Increasing □       Decreasing □
   What is the reason for this wildlife population trend ______________________
8.2 Do wild animals have any use?       Yes□       No □
   If yes, what are the benefits? ____________________________
8.3 If they have benefits, do you think that protecting them to increase their numbers is
8.4 Do you eat bush meat? Yes □ No □
8.5 If yes what type of wild animals do you eat? ______________________________
8.6 How did you get bush meat? ______________________________
8.7 Did you ever hunt wild animals? Yes □ No □
8.8 If yes where? ______________________________
8.9 What do you use to hunt? Rifle □ spear □ other ________
8.10 Is it possible to hunt wild animals easily now than five years ago?
     Yes □ No □
8.11 If no, why? ______________________________
8.12 Why the local pastoralists go to Chalbi ______________________________
9. Did you ever see Grevy’s zebra? Yes □ No □
9.1 If yes, when did you see zebras for the last time? _________________
     Where? ______________________________
9.2 What is their population status? Increasing □ Decreasing □
     What is the reason for Grevy’s zebra population trend? _________________
9.3 Did the local people hunt Zebras? Yes □ No □
9.4 If yes, why? ______________________________
9.5 Did you hunt Zebras? Yes □ No □
9.6 How many? ______________________________
9.7 Which ethnic group hunt zebras ______________________________
9.8 Why do they hunt? ______________________________
     Where did zebras graze and drink? ______________________________
9.9 Did cattle use the Grazing and watering points of zebras?
     Yes □ No □
9.9 Can livestock and zebras use grazing & water resources together? Yes □ No □
9.10 In your opinion what needs to be done to increase the population of the zebras living
     in the area ______________________________

Thank you very much for your cooperation.
## Appendix 2. Census sheet

<table>
<thead>
<tr>
<th>Locality</th>
<th>Observer</th>
<th>Transect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>length</td>
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<tr>
<td>season</td>
<td>Date</td>
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</table>

<table>
<thead>
<tr>
<th>Start time</th>
<th>Finish time</th>
<th>Group composition</th>
<th>Notes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>time</th>
<th>Location</th>
<th>Distance from transect.</th>
<th>Direction animal degree</th>
<th>Group number</th>
<th>Group size</th>
<th>Total adults</th>
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</thead>
<tbody>
<tr>
<td>WPT</td>
<td>loc x</td>
<td>loc y</td>
<td>transect</td>
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</table>

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Appendix 3. Browse abundance

Date __________________

<table>
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<tr>
<th>Visibility</th>
<th>Location</th>
<th>Habitat</th>
<th>vegetation composition</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1m</td>
<td>2m</td>
<td>loc x</td>
<td>loc y altitude</td>
<td>grass cover Grass height.</td>
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</tbody>
</table>

Appendix 4. Scan Sampling data sheet

Date __________________ Location __________________

<table>
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<th>Time</th>
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<th>Activity</th>
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</thead>
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</table>
DECLARATION

I, the undersigned, declare that this Thesis is my original work, has not been presented for a Degree in any other University and that all sources of material used for the Thesis have been dully acknowledged.

Name: Degu Tadie Limenh

Signature ___________________