ADDIS ABABA UNIVERSITY

School of Graduate Studies

Population trend of human, livestock, dog and Ethiopian wolf in Bale Mountains National Park, Ethiopia

By

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DEPARTMENT OF BIOLOGY

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Abstract

Populations of human, livestock, dog and Ethiopian wolf were censused in the two study sites in the Afroalpine ecosystem of Bale Mountains National Park (BMNP), southern Ethiopia, during February-June 2003 using established road counts in Sanetti and horse back census in Kotera (lower Web Valley). Data collected since 1998 were examined to indicate trends in the populations. Census data were interpreted using encounter rates (as relative index of abundance) to analyze and understand spatial as well as temporal abundance of large mammals. They were more abundant in Kotera study site than in Sanetti Plateau. This was indicative of the presence of spatial variation in the Afroalpine ecosystem in this National Park. Over the past six years, the population of livestock in Sanetti was increased which indicates the growing density of domestic animals in the area. The trend was negative in Kotera. Seasonal variation of the Afroalpine use by domestic animals was commonly observed in the BMNP. Domestic animals were more abundant during the wet season. A greater number of sightings were recorded in the Alpine grass meadow than in the high altitudinal swamp in Kotera. These were the areas in which Ethiopian wolves were also sighted more often. In contrast, in Sanetti, most of the livestock were distributed in *Helichrysum* meadow and then in *Erica* moorland vegetation type. The Ethiopian wolves in this study site were tended to utilize Alpine grass meadow followed by *Helichrysum* meadow. The present study did not reveal any significant effect of livestock on the Ethiopian wolves.

Key words: Road count, Horseback count, Population, Census, Encounter rate, Temporal and spatial abundances, Bale Mountains National Park.

I. INTRODUCTION

Mammals occur in a wide variety of terrestrial and aquatic habitats throughout the world (Nowak, 1991), with more concentration of large mammals in Africa (Balakrishnan, 1994). In recent years, there has been growing recognition that the earth is facing a loss of biological diversity (Wilson, 1992). The ever increasing pressure of human population growth has led to worldwide habitat degradation that has driven many known plant and animal populations for extinction and put to other numerous risks (Wilson, 1988; Cole *et al.,* 1994).

The size criterion defining a large mammal is arbitrary. The threshold size for large mammal was set at a weight of 3.5 kg or a height of about 50 cm, and so include serval cat, dikdik, baboon, etc., where the chance of observing individuals of the smaller species is reasonable across a range of habitats ensuring that widely distributed species have a fair chance of being observed through out their range.

Population is a group of individuals of the same species occupying at a particular time with spatial and temporal boundaries, which is not always constant (Beeby and Brennan 1997). Information about animal populations is very important for various purposes such as to monitor the states of mammalian populations, to determine the fate of a species for conservation interest and for management programmes (Southwood and Henderson 2000; Macdonald and Carr, 1995).

Counting the number of sightings forms the basis for estimating density for many animals such as birds, large mammals like cattle, domestic dogs, wolves, bushbuck, buffalo, elephant, etc. Census is the counting of all the individuals belonging to the group of interest in a defined area. Counting often requires the observer to move over the census area and thus favors the use of strip transects of prefixed length and width along which the observer moves in a straight line. Strip surveys have been done on foot, car, boat, aircraft, vehicle, horse back or submarine (Southwood and Henderson, 2000).

Most species have a collection of population alive and separated spatially while some others may swap individuals regularly. Others may have little or no contact with each other. The degree of interchange within the met population is often crucial to the survival of the species, particularly of endangered species. To know the status of the current population is advantageous to save the species near to extinction as done in Napal for the greater one-horned rhino *(Rhinoceros unicornis)* in the Chitwan National Park of the lowland rivers of Himalaya, in Napal (Chapman and Reiss, 1999).

Information on the patterns of large mammalian population and abundance including their seasonal variation is needed to understand the significance of large mammals as an ecological driving force in the Bale Mountains National Park (BMNP). This information is vital in evaluating various management questions such as the conservation importance in the national park for persistence of large mammalian species since the park contained both endangered and endemic species like Ethiopian wolf (*Canis simenesis*), Mountain nyala (*Tragelaphus buxtoni)*, Menelik bushbuck and many other endemic species (Yalden, 1983). Assessing the presence or abundance of these animals require an understanding of the spatial and temporal patterns in which they occur.

Ethiopia is known for its endemic fauna and flora, including endangered species, with much of them found in the high altitude (Yalden, 1983), particularly in Bale Mountains National Park (BMNP). Hence, it is useful to know the changes in population size of species in this national park because large herbivores and carnivores are affected by modified ecosystems. Therefore information on population trends and ecosystem relationships are needed to help reach recovery goals of plans for endangered species and to mitigate human conflict in the study area where apparent habitat utilization between the wild and the domestic animals appeared. Current information on population trend is to be developed for ecologically sound management of large mammals in the park.

There are numerous factors that can be a cause for the decline of the populations of large mammals in their natural habitats, even leading to a threatened and become extinct species without being described and recorded in the scientific and conservation communities. Various parts of protected areas in the world are now subjected to encroachment by farming communities and livestock.

1.1 The trend of humans and livestock population and its impact

The world population is increasing from time to time and growing so rapidly that even popular magazines are referring to as 'demographic winter'. The world current annual population growth rate of 1.7 % added approximately 93 million people each year. Global population has tripled over the past seventy years with its fastest population growth in history, for that it was 2 billion only in 1930. This rapid and unplanned population growth, especially in the developing countries is overwhelming to satisfy their resource need. Human population growth and widespread poverty are putting enormous stress on the environment in different regions (Wilson, 1992; Coe *et al.*, 1994).

Natural habitats around the world are lost at faster rate in alarming condition with the activity of human population for more and more livestock production, agricultural and urban centers (Fisher, 1994; Samson and Knopf, 1996). Relatively persistence habitats are being lost at unprecedented rates. The increased human population brings a pressure for more and more livestock production in order to satisfy their need of life for different purposes such as their meat consumption, farming, transporting, clothing, etc.

Livestock production may utilize the vast majority of the landscape, including a majority of all public lands. In Ethiopia as seen in the national parks such as in Awash, Simien Mountains, Bale Mountains, etc., increased livestock production were believed to have numerous impacts on the variety of wildlife species surviving for longer period of time (Schloeder and Jacobes, 1993). Overgrazing and woodcutting caused deterioration in vegetation, increased soil erosion and habitat destruction in different parts of the world. In Pakistan, in Chital Gol Game Sanctuary the wild goat, Markhor is particularly under threat from domestic goats and sheep, which grazed plants preferred by the Markhor.

1.2 Competition for food and space between livestock and wild herbivores

Different animal species are at most partially competitive for food even when supply is abundant. In sub-Saharan Africa, Win rock international concluded that wildlife and domestic livestock were compatible in most rangelands across all agro-ecological zones. For example, in Zimbabwe and East Africa, eland were found to be well adapted to complement cattle in the low and middle veld (Skolvin *et.al.*, 1976). In West Africa, the introduction of livestock into areas occupied by wild ungulates had brought negative effects on the composition of wildlife communities. Sparks (1968) found evidence of direct competition for forage between cattle and black-tailed jackrabbits (*Lepus californicus*). In early spring, both species prefer green forage of wheat grass. The potential competition between cattle, lagomorphs and other small mammals for limited available forage are also analyzed in different regions of grazed lands such as in New Mexico and Colorado (Norris 1950; Crouch 1982).

Space can be a limiting factor for a number of animals. For example, organisms compete one another in an area where a small patch of cover or series of cliffs may only protect a given numbers of animals. Animals are also competing with one another to avoid being eaten by predators. In other words, they compete for enemy-free space. Predators aggregate in areas where prey is dense (Holling, 1959). So herbivorours preys are always alert to find a safer place to hide themselves from the attack of their predators. Animals compete for shade to avoid overheating during sunny days too.

1.3 Human - wildlife conflict

Human wildlife conflict arises from different point of view as such for the blame to diseases transmission, predation, destroying crops, breaking fences, damaging irrigation ditches, etc. Many diseases have the potential to affect both wildlife and livestock when they share the same environment. Hence, it becomes a problem of livestock and wildlife conflict. Rinderpest is a viral disease that destroys the population of both wildlife and domestic animals (Rossiter, 1986). Recently, a large number of deaths in wild animals, particularly on Kudu and Buffalo in Tsavo and other game parks in Kenya and Tanzania were recorded. Contagious bovine pleuropneumonia (CBPP) occurs in areas where wildlife and cattle co-exist (Schneider *et al.*, cited in Bourb, *et al.,* 1999). There is a disease known as malignant catarhral fever used wildebeests as the main reservoirs and routs for the transmission to cattle caused by herpes virus (Hedger, 1976; Hedger *et. al.*,1985; Dawe *et al.,* 1994; Thomson, 1995).

Human carnivore conflict through depredation of domestic livestock also became a problem for reasons that carnivores kill domestic animals using as prey. There will be an impact of predation as home range of domestic livestock and wildlife is overlapping. Livestock depredation problems were common in different parts of the world (Andelt, 1992; Blanco, 2001; Civcci and Boitani, 2000; Gilady, 2000). In Germany in the Brandenburg wolf management area, livestock predation by wolves is common. In Mercantour National Park, more than 25% of domestic sheep graze within wolf range. In Siena province of Italy, where wolves have recently colonized the highly agricultural land and live in close contact with sheep cause heavy losses on livestock. High livestock depredation in Romania within the wolf ecology range had also recorded. The wolf packs movements have high local predation on both domestic and wild ungulates in Spain in the Catabrian Mountains. Research on wolf ecology of Bialowieza forest in Poland had recorded carcasses of killed ungulates by large carnivores (wolf, lynx).

1.4 Domestic dog population and its effect

The domestic dogs are used by humans for different purposes such as to protect their homes, to serve as a pet and guard their livestock from predator attacks. They joined as a universal companion of man, all over the world for the last ten thousand years (Gittleman, 1996) and still expanding in different part of the continents (Rigg, 2001). The threat of domestic dog population on wildlife includes disease transmission, hybridization and effect of slaughtering in particular on the calves of wild herbivores.

1.4.1 Disease transmission

Diseases may be transmitted from domestic animals to wild animals. In BMNP the local people and their dogs live inside the park, and are sympatric with large number of animals such as with the critically endangered Ethiopian wolf, Mountain nyala, Minilik bush buck and several other wildlife. Canid diseases like rabies and canine distemper virus are carried by domestic dogs and serve as the main host and vector (Mebatsion *et al.,* 1992). In many parks such as in BMNP and the Serengeti National Park, the decline of lions by canine parvovirus (Roelke-Parker *et al.,* 1996), the death of Ethiopian wolves by rabies (Sillero-Zubiri *et al.,* 1996) and many other areas (Ginsberg and Macdonald, 1990) in Africa were blamed by dogs.

1.4.2 Hybridization

Hybridization occurs in a number of closely related animals. According to Dudash and Fenster (2000), hybridization has a great threat for the genetic variability in wildlife species particularly for rare and endangered species. Grey wolves and coyotes are the canid groups known to hybridize each other (Gottelli *et al.,* 1994). In Italy, the survival of wolves is at great risk with dog hybridization (Boitani, 1992). In Australia a breed of dogs with dingoes are recorded (Newsome and Corbett, 1982). In the Bale Mountains National Park, dogs freely roam in various habitats including the Ethiopian wolf home range (Gottelli and Silloro-Zubiri, 1992). The genetic analysis in the Web Valley indicated that hybridization between the two species has been taken place.

1.4.3 Slaughtering effect

Dogs in Bale Mountains National park are frequently seen without owners (homeless). They search their food outside homes of the people which are most likely feral and depend on offal and carrion (Gotteli and Sillero-Zubiri,1992). This condition creates more chance of contacting the domestic dogs with animals. Feral dogs are observed when chasing and hunting in packs on calves of the wild herbivores including the endangered and rare species like the mountain nyala (Befekadu Refera 2001; Woldegebriel Gebrekidane, 1996).

1.5 Human and livestock population in BMNP

People in Bale region are known by their livestock populations in the main massif of the mountains (Sillero-Zubiri, 1994). They usually allow grazing without attendance except for shoats (sheep and goats). The extensive agricultural development observed in the lowland from time to time has been changed the pastoralist people from temporary users to permanent dwellers inside the park (Hillman, 1986). This may have influence on the wildlife dwelling inside the national park for longer time as seen in different parts of the world such as in Townsend's in Capitol Reef National Park (San Juan College, 1994),

Bale Mountains National Park is an area that consists of large number of wildlife including endemic, endangered and rare as well as domestic animals and human settlements. Study to estimate the numbers on the status of the large mammals was made by Stephens (1997). In such area, recent and current information of p opulation trend to fulfill the gap is advantageous for application of sound management decisions.

1.6. Aim of the study

The aim of this study was to examine the use of Afroalpine ecosystem of the Bale mountains by domestic livestock. More specifically, the objectives were:-

a. to examine the temporal and spatial variation in the relative abundance of different species - in particular the domestic livestock and Ethiopian wolves in the Afro-alpine ecosystem.
b. to examine the apparent effect of domestic animals on Ethiopian wolves in the national park.

c. to determine the habitats in which domestic livestock and Ethiopian wolves are most often sighted.
d. to reveal the population trend of human, livestock, dog and Ethiopian wolf using the data gathered during 2003 and comparing with the data available since 1998.

2. THE STUDY AREA AND METHODS

2.1 The study area

The study was carried out in south-central Ethiopia in Bale region. It is one of the highland regions in the country separated from Sidamo highlands by the Genale River to the south western and from Arsi highlands by the head and main stream of Wabishebelle river (Beyene *et.al.* 1991). The highlands are comprised by a basaltic plateau in the northern central part and huge mountain massif of the Bale region (Hillman, 1993) to the south including the Afroalpine summit of Sanetti plateau that is topped by the highest mountain peaks known as Tulu Deemtu (4377m asl) and Mt. Batu (4307m asl).

Bale region consists of BMNP, which is located at the southeastern edge of the Rift Valley containing the largest protected area of the Afroalpine habitat in Africa. Currently, the park covers 2,200km^2 including the total area of 1000km^2 of the Afroalpine ecosystem. The park lies between 6^0 30'- 7^0 10' N and 39^0 30'-39^0 57' E (Hillman, 1993) in Fig. 2.1. The park was established in 1969 for the purpose of protecting mountain nyala (*Tragelaphus buxtoni)* and Ethiopian wolf (*Canis simenesis*). It is still one of the non-gazetted national parks in the country (Sillero-zubiri1994). It is believed that its unusual geographic nature sustained diverse fauna and flora with its volcanic origin, modified by glacial action before 20,000-12000 years ago (Messerli *et al.,* 1977).

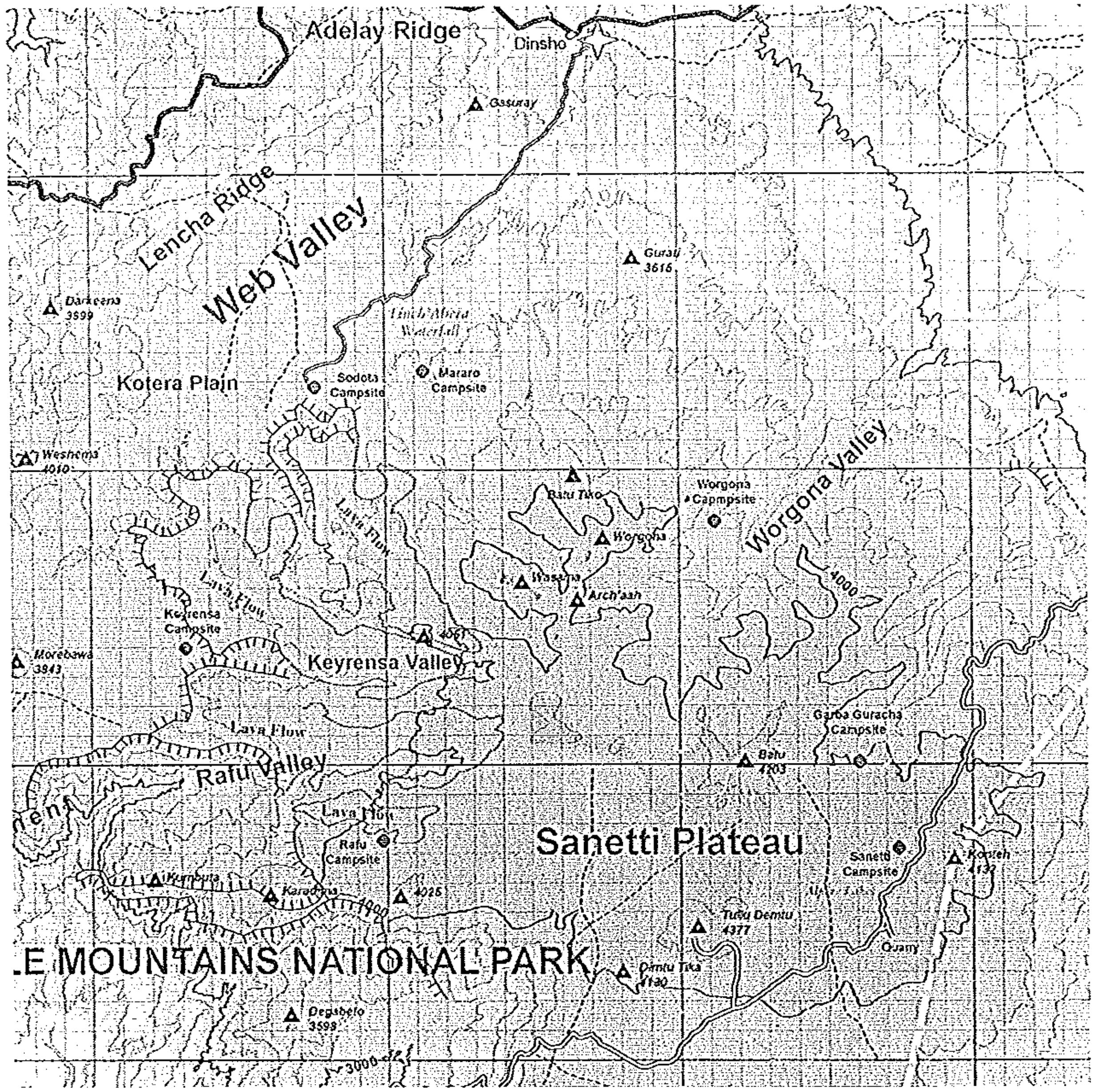


Fig 2.1 Map of BMNP and the study areas

Soure: Topography of Ethiopia
BMNP trekking map
Scale: 1:200000

Different habitats have been recognized in the Afroalpine ecosystem - as mixtures of vegetation type, vegetation height, slope, and substrate.

The pattern of rainfall in the area is shown in Fig. 2.2 or 2.3. In Bale Mountains the rainy season is from March to October and dry season is from November to February (Daniel Gamachu, 1977). The rainfall is bimodal with rain from the southwest and southeast at different times of the wet seasons. The wet season from March to June is caused by humid masses from Indian Ocean whereas the rain from July to October is by the incoming (influx) of Atlantic moist monsoon wind from the southwest (Miehe and Miehe, 1994). In the wet season, rainfall peaks in July and August as indicated by Dinsho rain fall station for the Web Valley, whereas it was during August and September in Goba station for Sanetti plateau.

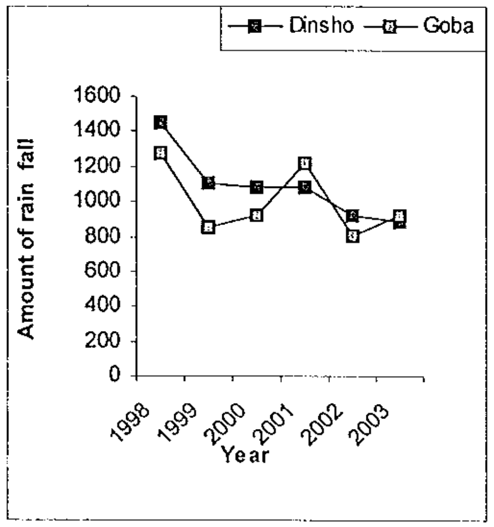


Fig.2.2 Annual rainfall

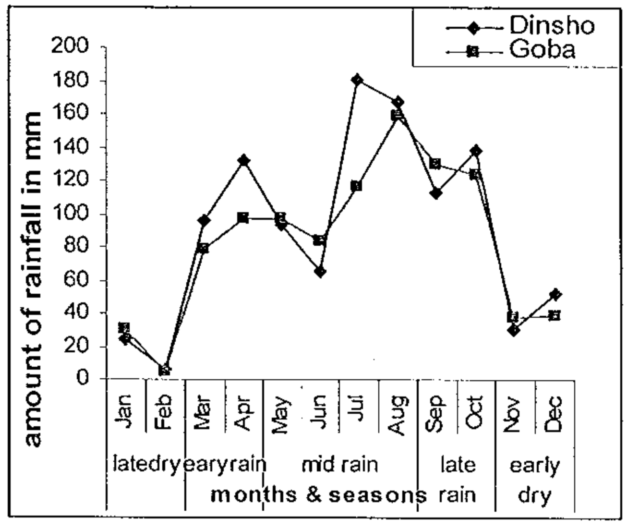


Fig.2.3 Monthly mean rainfall and its seasonal category

Through examination of the rainfall data collected from the Ethiopian Meteorological Authority has revealed that the wet seasons in the Bale Mountains could be divided as early rain, mid rain and end rain seasons, and the dry season can be categorized as early dry and late dry seasons (see Fig. 2.3; Table 2.1).

Table 2.1 Major seasons in the study areas with months.

Seasons	Code number	Months
Early rain	1	March 15- end of April
mid rain	2	May 1^{st} - end of August
Late rain	3	September 1^{st} –end of Oct
Early dry	4	November 1^{st} – end of Dec
Late dry	5	January 1^{st} – mid of March

In the park, two study sites were identified for census through sightings for the estimation of populations of human, large wildlife and domestic animals.

Two study areas were examined to determine spatial and temporal variation in the relative abundance of livestock and wildlife in the Bale Mountains. These were the Sanetti Plateua and the Kotera plain of the lower Web valley (Fig.2.1). They differed in their altitude (>4,000m and 3,600m, respectively), vegetation and rainfall (Hillman, 1986). The methods used to census the animals were different in these two areas. On the Sanetti plateau in the eastern central part of BMNP, a road count was used as the census method. The route was 32 km long and started at

Chorchora and ended at the escarpment of the plateau more or less in a straight line transect along Goba to Dollo Mena main road. It consists of a variety of habitats including Ericaceous heath land used by mountain nyala, bushbuck, grey duiker and klipspringer (Hillman, 1986), which is a marginal habitat of Ethiopian wolves (Gottelli and Sillero-Zubiri, 1992) and Afroalpine meadows which consists of herbaceous forbs, grassy meadows and areas of *Helichrisum* scrub.

The Kotera plain – the area in the Lower Web Valley – is found to the south eastern part of BMNP and to the south of the head quarter of the park (Dinsho). The area was censused from horseback as there are no vehicle tracks in the area. It consists of Afroalpine meadows with mima mounds, flat, open marshy areas, and steep relief. Peaks of ridges and cliffs surrounded the area as shown on Fig. 2.1. The census route was 20.5 km long and started in Sodota camp site. It ran initially in a northern direction towards Finch-Habera waterfall and Darkina and then goes to the west direction of Argona. It extends again to the south towards the central peaks and rounds to the east and ends near the camp site in a circuit design manner (Gotteli and Silloro-Zubiri, 1990). Historical data has shown that this area harbors the highest density of Ethiopian wolves, rodents and livestock in the Bale Mountains (Silloro-Zubiri 1994).

2.2 Data collection methods

For the current study of the population trend of large mammals, I was collected the data from January 2003 to June 2003. Data were collected for all sightings of large wild mammals (grey duiker, Starck's hare, Ethiopian wolves, klipspringer, mountain nyala, serval cat and warthog), domestic animals (cattle, shoats, transport animals and domestic dogs) and humans. Data were collected once in a month in the two study sites along the predetermined route of line transects. The fieldwork in Sanetti involved a minimum of three individuals, in vehicle including the driver, watching on either side of the road carefully and was standardized to occur during daylight hours when the animal activity was greatest.

Survey in Kotera involved one or more observers on horseback over a length of 20.5 km of transect (Kreps, 1999). When a group of animals was sighted, the following data were recorded: date, time, species, group size, group number, area, location, sighting distance, direction, slope, terrain, habitat and weather condition. Location was recorded using a global positioning system (GPS). Binoculars were used to verify animal species and number when necessary. The distance to the group of animals was estimated following the training of the observers and the bearing to the group was taken using a standard compass. The habitat was recorded by vegetation type, slope, terrain and vegetation height (see Table 5 in the Appendix for the codes used for each parameter). Records of all the above variables have taken when animals were sighted (James *et al.,* 1998) remaining at one point for a fixed time.

In addition, the data already collected by the Ethiopian Wolf Conservation Programme (EWCP) since 1998 have been analyzed to show the trend of populations.

2.3 Data analysis

The data were analyzed using the encounter rate as the unit of analysis. This was calculated as the number of animals observed per kilometer for any given time period. As such, it is a relative index of abundance and indicates changes in abundance in time (seasons and years) and is used to compare the abundance of animals in the two study areas. Using regression analysis has tested the presence of significance difference in the encounter rates of animals and the effect of domestic livestock on Ethiopian wolves. Chi-square test was also used to show the presence of spatial variation of animals in the study sites to compare the abundance of each species in a given area.

3. RESULTS

3.1 Results from January to June, 2003

Current population data of all species interims of encounter rate are presented in Table 3.3. The results of the present transect counts; six in Kotera plain and five in Sanetti plateau from January to June, 2003 is summarized in Table 3.1 Due to vehicle problem the count in Sanetti in Aril 2003 could not be carried out. A comparison between Kotera (55 animals/km) and Sanetti (16.1 animals/km) in the overall encounter rate of animals showed significant population difference ($\chi^2 = 21.28$, d.f. = 1, $p < 0.01$). In addition to spatial variation, the encounter rate also indicated the presence of temporal variation in each transect. In Sanetti the maximum number recorded was in January (22.4 animals/km) and the minimum was in March (10.5 animals/km), whereas in Kotera the maximum was in June (147.9 animals/km) and the minimum was in April (17.5 animals/km) as shown in Table 3.1.

Table3.1 Number of animals counted in each transect and their encounter rate/km from January-June 2003.

Area	Month wise data							
		Jan	Feb	Mar	Apr	May	Jun	Total/Average
Sanetti	Total observed	718	344	337	-	605	566	2570
	Encounter rate/km	22.44	10.75	10.5	-	18.91	17.96	16.1
Kotera	Total observed	1116	589	781	358	895	3032	6771
	Encounter rate/km	54.4	28.7	38.1	17.5	43.66	147.9	55

A comparison of the data of the current study with that of the data from 1998-2002 is given in Table 3.2. In Sanetti the trend of population showed an increase from 15.3 to 16.1 animals/km but had no significant difference ($\chi^2 = 0.02$, d.f. = 1, $p > 0.05$). In contrast in Kotera, the overall populations were declined from the earlier (122 animals/km) to the present study (55 animals/km) showing significant difference ($\chi^2 = 25.3$, d.f. = 1, $p < 0.01$).

Table 3.2 Number of animals counted and average encounter rate/km during 1998-2002 and the current study

Area	Period	Transact	Total	Encounter rate/km
Sanetti	1998 - 2002	50	24434	15.3
	2003	5	2570	16.1
Kotera	1998 - 2002	62	155046	122
	2003	6	6771	55

The total number of each species counted from January up to June is summarized on Table 3.3. A comparison of all species in the current study showed that the livestoocks were the most abundant species of all animals in the two study areas. Of all the livestocks, cattle were the most commonly observed animals followed by shoats (goats and sheep) and transport animals (horses, mules and donkeys) ($\chi^2 = 30.35$, d.f. = 2, $p < 0.01$ in Kotera and $\chi^2 = 13.6$, d.f. = 2, $p < 0.01$ in Sanetti). The domestic dog was the least recorded of all animals in the study area. The humans were also recorded only 0.18/km in Sanetti and 0.9/km in Kotera. The Ethiopian wolves were seen and recorded more than other large wild mammals as indicated in Table 3.3.

Table 3.3 Total numbers of each species counted and their encounter rate/km from January-June 2003 (current population data).

Area	Species	Jan	Feb	Mar	Apr	May	Jun	Total	Encounter rate/km
Sanetti	CT	549	237	146	-	476	511	1919	12
	ST	124	74	173	-	85	22	478	3
	TR	31	28	8	-	27	15	109	0.7
	DD	1	0	0	-	2	0	3	0.02
	HU	11	0	2	-	2	14	29	0.18
	EW	2	3	8	-	12	4	29	0.18
	OWM	0	1	0	-	1	0	2	0.1
Kotera	CT	736	342	550	115	598	2158	4499	37
	ST	190	85	115	115	173	652	1330	11
	TR	151	131	95	94	92	196	759	6.2
	DD	1	2	7	0	2	1	13	0.1
	HU	16	15	12	26	25	15	109	0.9
	EW	14	4	2	8	5	10	43	0.35
	OWM	8	10	0	0	0	0	18	0.115

- CT- cattle, ST- shoats, TR- transport animals, DD- domestic dog, HU- human, EW- Ethiopian wolf, OWM- other wild mammals

A comparison of the present date of livestock with the data collected during 1998-2002 and of Hillman (1986) in the average encounter rate for cattle and transport animals showed an increasing trend in Sanetti, whereas in Kotera the trend of populations of all livestock was negative (Table 3.4).

Table 3.4 Comparison of livestock's encounter rate/km of Hillman (1986) and 1998-2002 with the current study (2003)

Area	Year	Cattle	Shoats	Transport animals	Human	Ethiopian wolves
Sanetti	1986	29.4	8.9	1.01	-	-
	1998 – 2002	88.3	14.3	9.5	0.26	0.13
	2003	37	11	6.2	0.18	0.18
Kotera	1986	2.94	0.64	0.066	-	-
	1998 – 2002	9.4	5.2	0.53	1.3	0.41
	2003	12	3	0.7	0.9	0.35

The encounter rate of human was declined slightly in the current study as compared to the data collected of 1998-2002 in the two study sites (Table 3.4). In the case of Ethiopian wolf, an increasing trend was observed in Sanetti and the opposite was revealed in Kotera (Table 3.4).

3.2 Results from 1998-2003

A total of 123 repeated transects were analyzed from 1998-2003 in both Sanetti and Kotera including the present study (11transects) with 55 in Sanetti and 68 in Kotera. The overall encounter rate for all species indicated that the abundance of animals in Kotera plain (116/km) was more than seven times in Sanetti plateau (15.3 animal/km) showing significant difference (Table 3.5:χ^2=77.4, d.f. =1, $p < 0.01$).

Table 3.5 Overall encounter rate of animals (all species) from 1998- 2003

Area	No. of transects	Total number of animals encountered	Encounter rate/km
Sanetti	55(5)	27004	15.3
Kotera	68(6)	161817	116
Total	123(11)	188821	

❖ Numbers in parentheses are the number of transects from January- June 2003

The overall encounter rate of domestic and wild animals is summarized in Table 3.6 from 1998-2003 showing spatial variations. The result of livestock among the three species (cattle, shoats and transport animals) showed significant difference in both study sites (χ^2 =7.88, d.f. = 2, $p < 0.05$ for Sanetti and χ^2 = 84.13, d.f. = 2, $p < 0.05$ for Kotera). Over these specified periods, the abundance of domestic dogs in Kotera (0.1/km) was ten times higher than that in Sanetti (0.01/km) (Table 3.6)

The abundance of wild mammals in Kotera was higher than in sanetti. The populations were not significantly different in the two study sites (χ^2 =0.2, d.f. = 1, p > 0.05 for Sanetti and χ^2 =0.27, d.f. = 1, p > 0.05 for Kotera). The wild mammals observed during the period of census in Sanetti were Ethiopian wolves, grey duiker, hare, mountain nyala and klipspringer. The species sighted in Kotera study site were grey duiker, hare, mountain nyala, klipspringer, serval cat and warthog.

Table 3.6 Overall encounter rates for each species from 1998-2003.

	Encounter rate of each species/km						
Area	CT	ST	TR	DD	HU	EW	OWM
Sanetti	9.4	5	0.54	0.01	0.25	0.22	0.01
Kotera	83.7	21.3	9.2	0.1	1.3	0.41	0.12

*CT (cattle), ST (shoats), TR (transport animals), DD (domestic dog), HU (human), EW (Ethiopian wolf), OWM (large wild mammals excluding Ethiopian wolf)

3.2.1 Cattle

The overall encounter rate result of large mammalian sighting data showed that cattle were the most frequently sighted animals in the study area than any other animals. This was a finding similar to the present study in Table 3.3. The encounter rate of cattle presented on Table 3.7 exhibited a significant difference in the abundance of these animals between Sanetti and Kotera

($\chi^2 = 59.6$, d.f. = 1, $p < 0.01$). In Kotera the abundance recorded (83.7/km) was nine times larger than that in Sanetti (9.4 cattle/km).

Table 3.7 Overall encounter rate of cattle from 1998-2003 in the two study areas

Area	No. of transect	Total number of animals counted	Encounter rate/km
Sanetti	55	16573	9.4
Kotera	68	116717	83.7
Total	123	133290	

3.2.1.1 Monthly variation of cattle in each transect

The total number of animals counted in each transect from 1998-2003 was significantly different in the two study sites ($F_{1, 54} = 9.5$, $p = 0.003$, $r^2 = 0.15$, and -1.62 regression coefficient in Sanetti and $F_{1, 67} = 4.34$, $p = 0.04$, $r^2 = 0.06$, and 0.02 regression coefficient in Kotera). The highest concentrations of cattle appeared during the rainy season from June to September in most surveying years as shown in Fig. 3.1 for Sanetti and 3.2 for Kotera. The maximum group size recorded for cattle in a single transect in Sanetti was 889 cattle and the minimum record was 73 cattle (Fig. 3.1), whereas in Kotera the maximum was 4,550 cattle, observed in 2002 and the minimum was 73 cattle (Fig. 3.2).

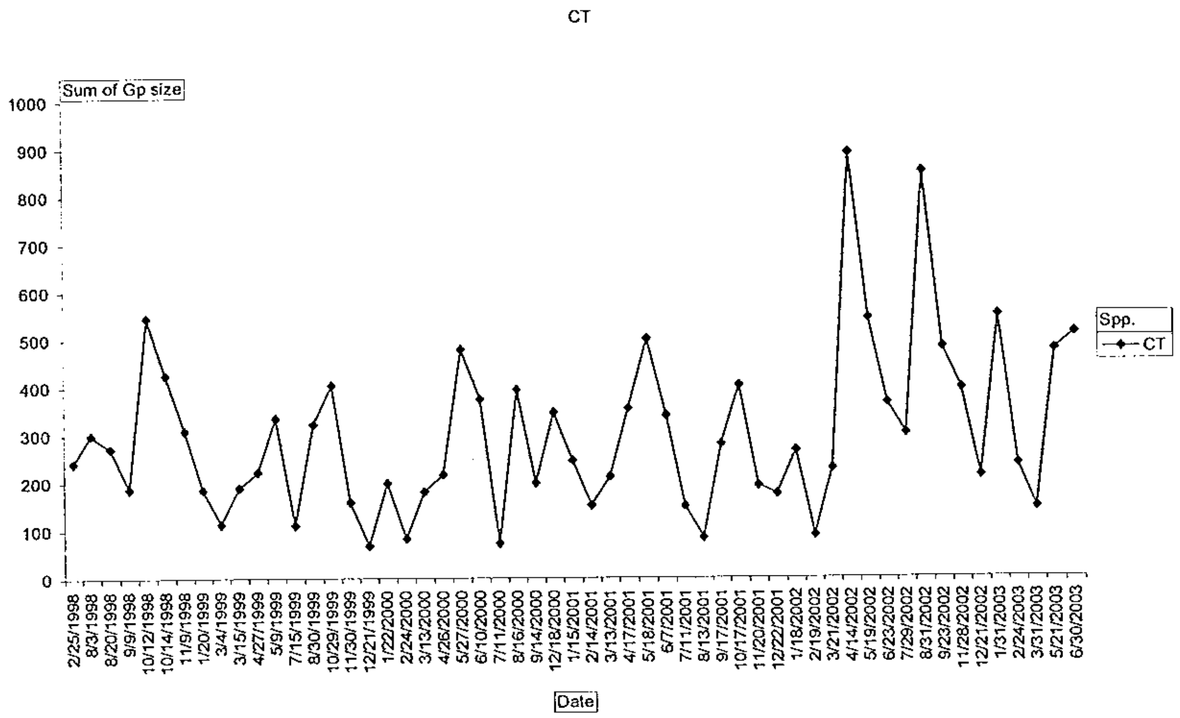


Fig 3.1 Number of cattle counted in each transect by month in Sanetti from 1998-2003

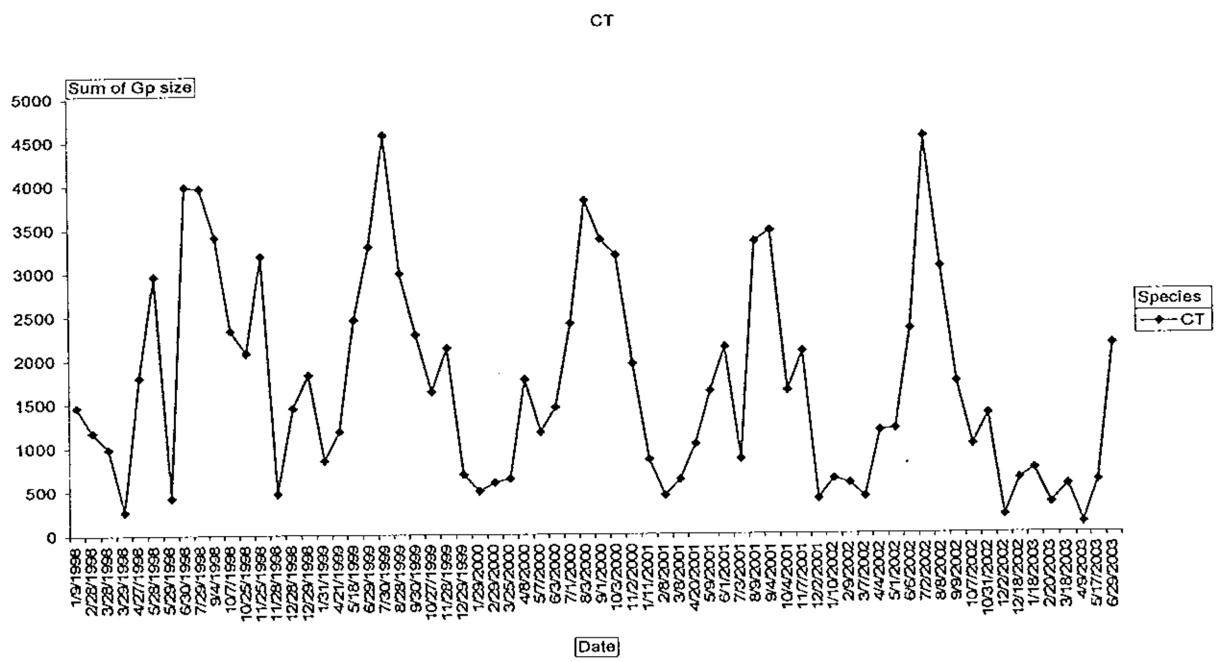
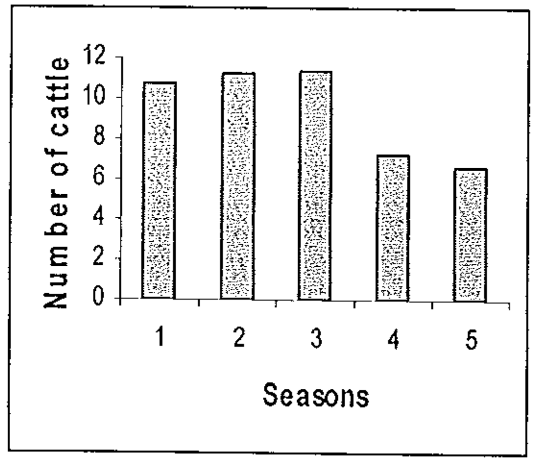


Fig 3.2 Number of cattle counted in each transect by month in Kotera from 1998-2003

Sum of Gp. Size – total number of cattle counted in each transect, Spp- species, CT- cattle

3.2.1. 3 Seasonal variation of cattle

There was difference in the encounter rate of cattle from season to season. They were more abundant during the wet season. In Sanetti the overall encounter rate of cattle reached up to 6.6 to 11.4 per kilometer. The highest relative abundance was observed during the end rain, which was 11.4 individuals/km, almost twice as large as from the lowest encounter rate (6.6) appeared during the late dry season (Fig. 3.5). In Kotera, the encounter rates of cattle were between 35 and 123. The lowest relative population size appeared during late dry season (35 cattle per kilometer) and the highest was 123/km during mid rain season, which was more than three times that of the lowest encounter rate (Fig.3.6).



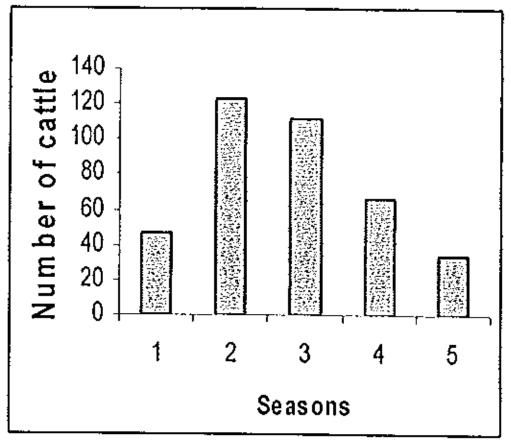


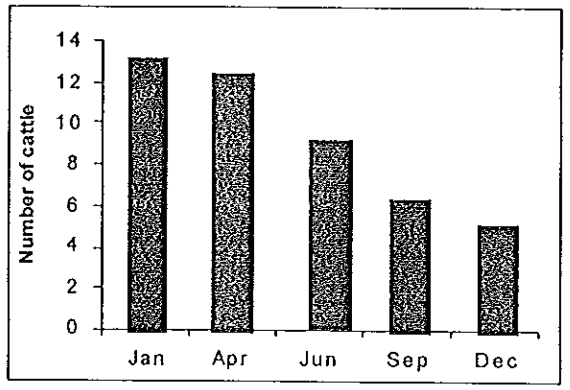
Fig. 3.5 Seasonal encounter rate of cattle in Sanetti Fig. 3.6 Seasonal encounter rate of cattle in Kotera

CT- cattle, see the code number 1, 2...5 for seasons in Table 2.1

The number of cattle changed during each of the seasons over all years in Sanetti indicated significant difference in the population density ($F_{1, 54}$, $p = 0.003$, $r^2 = 0.15$ and -1.62 regression coefficient) whereas in Kotera, it was insignificant with $F_{1,\ 67}$, p =0.15, r^2=0.03 and -7.7 regression coefficient.

3.2.1. 4 Variation of cattle in selected months

The encounter rate of cattle during selected months showed variations. Comparison of overall encounter rate during each of the selected months showed insignificant difference. In Sanetti, the highest abundance of animals was recorded in January with no significanct difference ($F_{1,\ 4}$ =5.29, p= 0.11, r^2 = 0.64 and 3.63 regression coefficient), followed by April ($F_{1,\ 3}$ =6.1, p= 0.13, r^2 = 0.75 and 6.7 regression coefficient) and June ($F_{1,\ 3}$ =2.26, p= 0.27, r^2 = 0.53 and 1.37 regression coefficient). In the remaining two months the lowest abundance of populations were observed ($F_{1,\ 3}$ =4.7, p= 0.16, r^2 = 0.7 and 2.1 regression coefficient for September, $F_{1,\ 3}$ =0.21, p= 0.09, r^2 = 0.09 and 0.85 regression coefficient for December). In Kotera, the peaks of abundance were in June and April (Fig. 3.8) but statistically insignificant except in December in a pattern of declined trends ($F_{1,\ 5}$ = 0.38, p= 0.57, r^2 = 0.09 and -13.0 regression coefficient for June, $F_{1,\ 5}$ =3.8, p= 0.12, r^2 = 0.49 and -14.2 regression coefficient for April). In the remaining months also the difference was insignificant ($F_{1,\ 4}$ = 0.3, p= 0.18, r^2 = 0.5 and -21.54 regression coefficient for January; $F_{1,\ 4}$ =0.68, p= 0.47, r^2 = 0.18 and –10.54 regression coefficient for September; $F_{1,\ 5}$ =11.6, p= 0.03, r^2 = 0.74 and -14.1 regression coefficient for December).



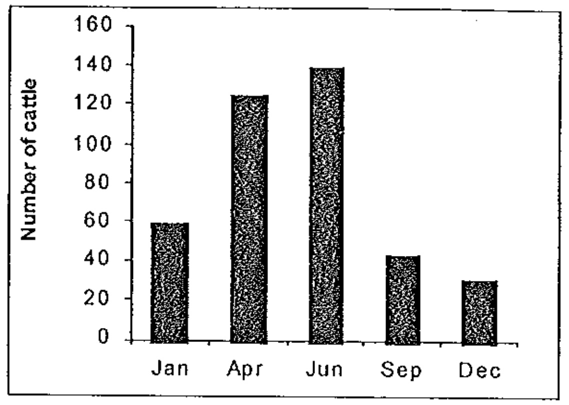


Fig. 3.7 Encounter rate of cattle in selected months in Sanetti

Fig. 3.8 Encounter rate of cattle in selected months in Kotera

3.2.2 Shoats

The result of the overall encounter rate of shoats is summarized in Table 3.8 for both Sanetti and Kotera. There was significant difference between population abundance of the two study sites ($\chi^2 = 10.1$, d.f =1, $p < 0.05$). The encounter rate of these animals showed temporal variations in the number of animals by months in each transect, seasons and years.

Table 3.8 Annual encounter rate of shoats from 1998-2003

Area	No. of transect	Total number of animals counted	Encounter rate/km
Sanetti	55	8707	5.0
Kotera	68	29629	21.3
Total	123	38336	

3.2.2.1 Monthly variation of shoats

The total number of animals recorded for shoats in each transects are presented on Fig. 3.9 for Sanetti and 3.10 for Kotera. The abundance of them fluctuated through transects significantly in both the study sites ($F_{1, 54} = 6.8$, $p = 0.01$, $r^2 = 0.11$ and -1.4 regression coefficient in Sanetti and $F_{1, 67} = 10.1$, $p = 0.002$, $r^2 = 0.13$ and -0.01 regression coefficient in Kotera). In Sanetti, the maximum number of animals counted in a single transect was 645 shoats in 2001 and the minimum was as low as four, whereas in Kotera the maximum number was 1454 observed in 1998 and the minimum was as low as 23 shoats in 2002 (Fig.3.9 and Fig.3.10).

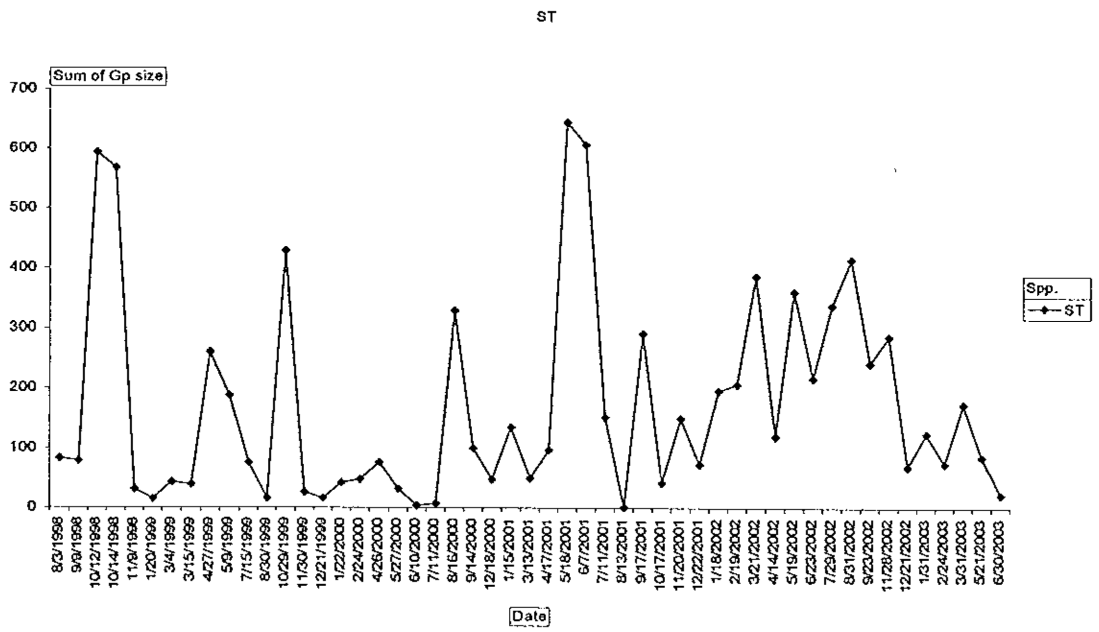


Fig 3.9 Monthly count of shoats counted in each transect in Sanetti from 1998 - 2003

Sum of Gp. Size – total number of shoats counted in each transect, Spp- species, ST- shoats

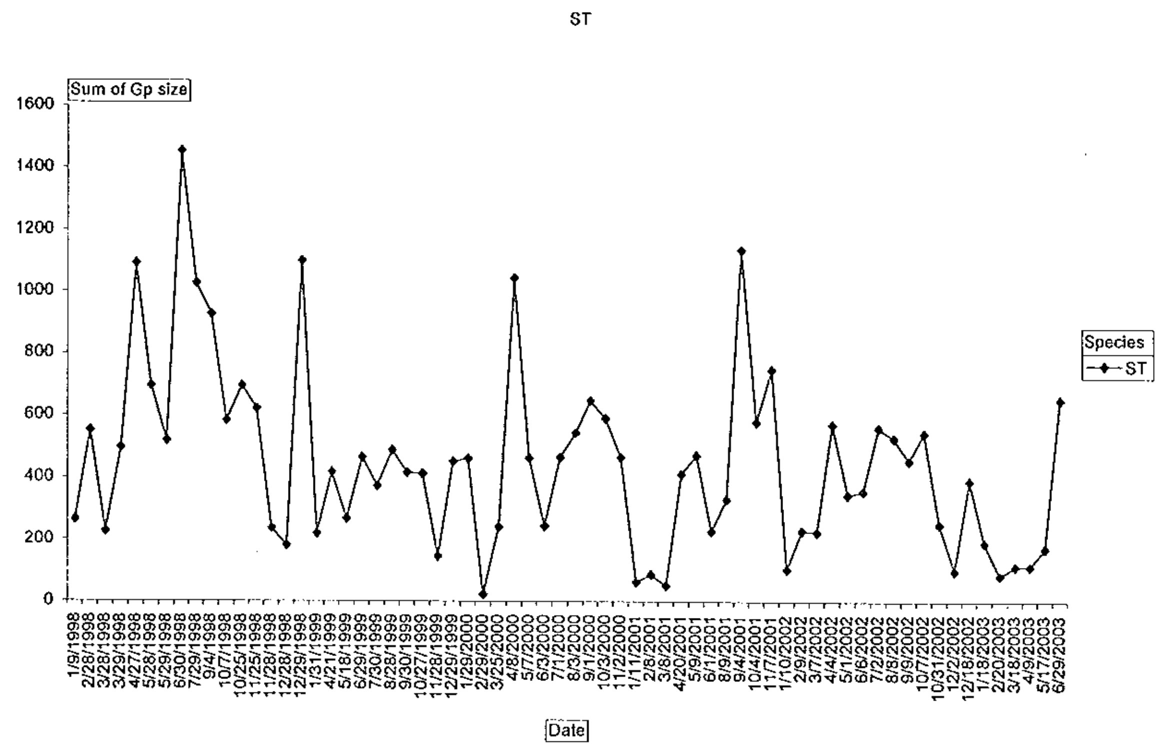


Fig 3.10 Monthly count of shoats in each transect in Kotera from 1998-2003

Sum of Gp. Size – total number of shoats counted in each transect, Spp- species, ST- shoats

3.2.2.2 Annual Variation of shoats

The annual encounter rate of shoats varied as observed from the census data of 1998-2003. In Sanetti, the overall encounter rate was in a range between 2.2-8.1 animals/km showing a downward trend from 1998-2000 followed by an increasing population trend until 2002 and declined in 2003. The maximum abundance of these animals was recorded in 2002, which indicates that the highest population abundance was in the recent year, nearly as big as four times compared to the lowest annual encounter rate (Fig. 3.11). In Kotera, the variation in overall encounter rate was wider than in Sanetti, ranged from 10.8 to 32.6 animals per kilometer (see Fig. 3.12). The encounter rate of each transects over years showed significant difference of population increase in Sanetti ($F_{1, 54} = 0.66$, $p = 0.041$, $r^2 = 0.01$ and 0.36 regression coefficient) and a decline in Kotera ($F_{1, 67} = 12.7$, $p = 0.007$, $r^2 = 0.16$ and -3.5 regression coefficient).

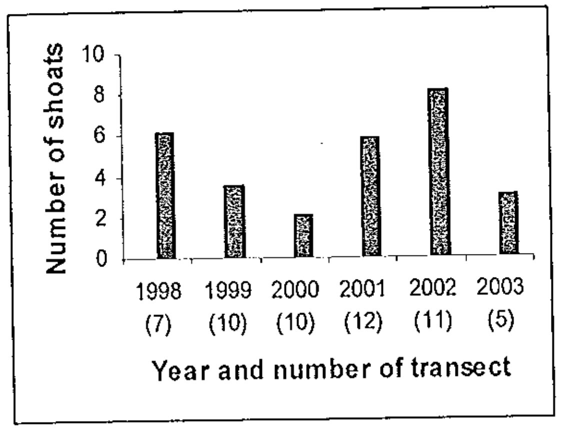


Fig. 3.11 Annual encounter rate of shoats in Sanetti

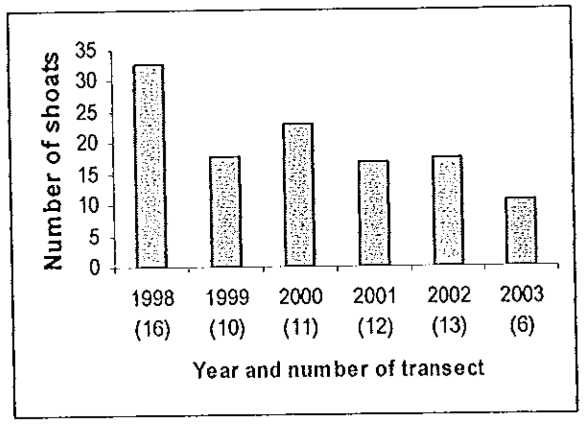
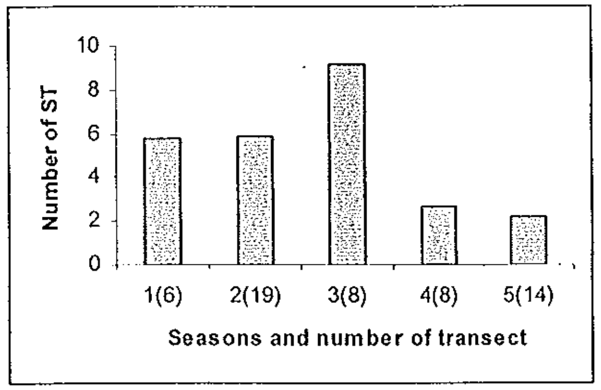


Fig. 3.12 Annual encounter rate of shoats in Kotera

❖ Numbers in parenthesis are number of transects

3.2.2.3 Seasonal variation of shoats

Seasonal variation of shoats was also observed with high concentration of animals during wet seasons than in the dry seasons. In Sanetti, the encounter rate ranged between 2.2 - 9.2 shoats/km. In this area the highest abundance was during the end rain (9.2), which was more than four time than the lowest (2.2) encounter rate observed during late dry season (Fig. 3.13). In Kotera, the encounter rate reached from 9.6 to 29.4 animals/km with the highest abundance during the end rain, which was more than three times the late dry season population size (Fig. 3.14). The number of shoats during each of the seasons over the years in Sanetti revealed no significant difference in the population abundance ($F_{1, 54}$ =0.54, p = 0.47, r^2 = 0.01 and –0.16 regression coefficient) whereas in Kotera, there was significant difference($F_{1, 67}$ = 6.5 p = 0.01, r^2=0.09 and –3.4 regression coefficient).



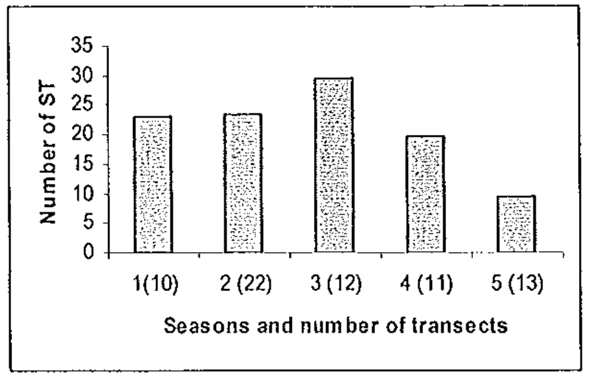


Fig. 3.13 Seasonal encounter rate of shoats in Sanetti.

Fig. 3.14 Seasonal encounter rate of shoats in Kotera

❖ Numbers in parenthesis are number of transects

ST- shoats, see the code number 1, 2...5 for seasons in Table 2.1

3.2.2.4 Variation of shoats in selected months

The variation of shoats by specified months is summarized in Fig. 3.15. In Sanetti, relatively high peak was seen in April and June, whereas in Kotera in June and January. The lowest abundance was recorded during December and September in both study sites. When the overall encounter rates of each selected months were compared, over all annual mean showed insignificant difference in the number of shoats in both study sites ($F_{1, 4}$ = 0.12, p = 0.75, r^2 =0.04 and 0.3 regression coefficient for January; $F_{1, 3}$ = 1.22, p = 0.39, r^2 =0.38 and –1.23 regression coefficient for April; $F_{1, 3}$ = 0.05, p = 0.85, r^2 =0.23 and –1.02 regression coefficient for June; $F_{1, 3}$

$= 4.1$, $p = 0.18$, $r^2 = 0.67$ and 1.56 regression coefficient for September; $F_{1,3} = 10.65$, $p = 0.08$, $r^2 = 0.84$ and 0.59 regression coefficient for December in Sanetti and $F_{1,5} = 0.87$, $p = 0.4$, $r^2 = 0.18$ and -1.55 regression coefficient for January; $F_{1,5} = 3.83$, $p = 0.12$, $r^2 = 0.49$ and -7.04 regression coefficient for April; $F_{1,4} = 3.8$, $p = 0.15$, $r^2 = 0.56$ and -11.62 regression coefficient for June; $F_{1,5} = 0.04$, $p = 0.85$, $r^2 = 0.013$ and -1.1 regression coefficient for September; $F_{1,5} = 1.65$, $p = 0.27$, $r^2 = 0.29$ and 0.55 regression coefficient for December in Kotera).

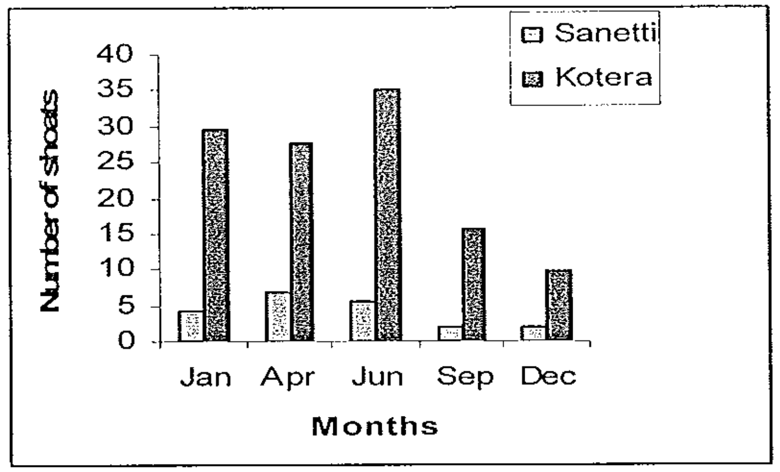


Fig. 3.15 Encounter rate of shoats in selected months

3.2.3 Transport animals

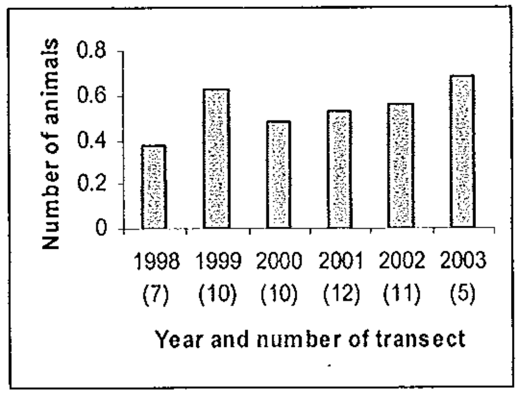
Transport animals had the lowest population size recorded of all livestock in the study areas (Table 3.9). In Sanetti, this species were recorded only 0.54 animals/km and in Kotera 9.2/km with no significant difference between the two study sites ($\chi^2 = 6.4$, d.f $=1$, $p => 0.05$).

Table 3.9 Overall encounter rate of transport animals from 1998-2003

Area	No. of transect	Total number of animals counted	Encounter rate/km
Sanetti	55	950	0.54
Kotera	68	12800	9.2
Total	123	13750	

3.2.3.1 Annual Variation of transport animals

The annual encounter rate of transport animals varied slightly as compared to the other livestocks with a range of 0.38-0.69 animals/km in Sanetti and 6.2-10.5 animals/km in Kotera (Fig. 3.16, 3.17). In Sanetti, the population pattern showed slightly upward and downward trends from the beginning to the end of the study indicating a relatively higher abundance in 2003. The encounter rate of each of the transects over years showed insignificant difference in both study sites ($F_{1, 54)}$ $= 0.75$, $p = 0.4$, $r^2 = 0.01$ and 0.03 regression coefficient in Sanetti and $F_{1, 67} = 1.82$, $p = 0.18$, $r^2 =$ 0.03 and –0.57 regression coefficient in Kotera).



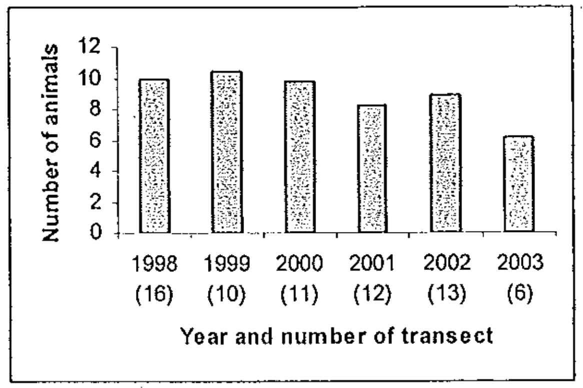


Fig. 3.16 Annual encounter rate of transport animals in Sanetti

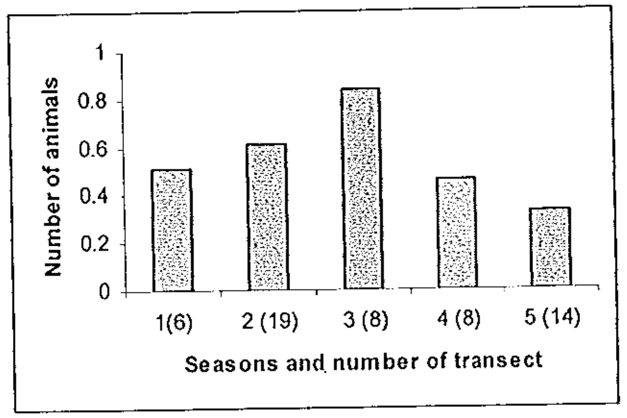
Fig.3. 17 Annual encounter rate of transport animals Kotera

❖ Numbers in parenthesis are number of transects

3.2.3.2 Seasonal variation of transport animals

The seasonal encounter rate of transport animals varied slightly on seasonal bases. In Sanetti, the number of animals observed per kilometer in different seasons was between 0.33-0.84/km only with the maximum during the end rain and the minimum during the late dry season (Fig. 3.18). In Kotera, the range of the encounter rate was between 0.5.2-12.9 animals/km (Fig.3.19).

The encounter rate of each transects between years showed insignificant difference ($F_{1, 54)} = 2.9$, $p = 0.1$, $r^2 = 0.05$ and 0.07 regression coefficient in Sanetti and $F_{1, 67} = 2.3$, $p = 0.14$, $r^2 = 0.03$ and −0.82 regression coefficient in Kotera).



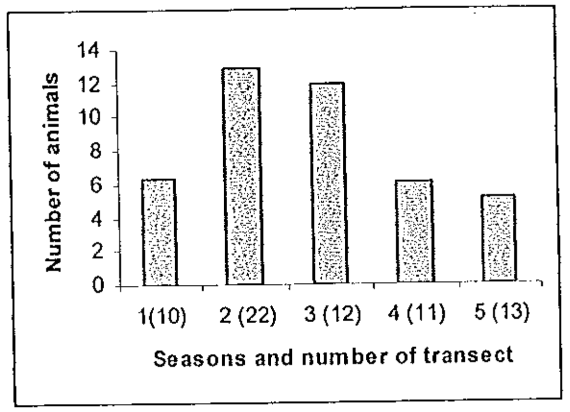


Fig.3.18 Seasonal encounter rate of transport anmals in Sanetti

Fig. 3.19 Seasonal encounter rate of transport animals in Kotera

❖ Numbers in parenthesis are number of transects

See the code number 1, 2...5 for seasons in Table 2.1

3.2.3.3 Variation of transport animals in selected months

The variation of transport animals in selected months was too small as summarized in Fig. 3.20. In Sanetti relatively higher records of animals were seen in June (0.8 per km.) and January (0.6), whereas in Kotera high record were in April (14.2) and June (14.0). When the overall encounter rate of each selected months were compared, over all annual mean showed insignificant difference in the number of transport animals in both study sites ($F_{1,4}$ = 1.65, p = 0.29, r^2 =0.36 and 0.09 regression coefficient for January; $F_{1,3}$ = 3.72, p = 0.19, r^2 =0.65 and 0.23 regression coefficient for April; $F_{1,3}$ = 0.71, p = 0.49, r^2 =0.26 and 0.05 regression coefficient for June; $F_{1,3}$ = 0.14, p = 0.75, r^2 =0.07 and 0.01 regression coefficient for September; $F_{1,3}$ = 0.04, p = 0.87, r^2 =0.02 and 0.01 regression coefficient for December in Sanetti and $F_{1,5}$ = 0.34, p = 0.59, r^2 =0.08 and 0.27 regression coefficient for January; $F_{1,4}$ =6.9, p = 0.06, r^2 =0.64 and –1.03 regression coefficient for April; $F_{1,4}$ =0.32 , p = 0.61, r^2 =0.51and –1.42 regression coefficient for June; $F_{1,4}$

= 0.11, p = 0.77, r^2 =0.03 and 0.54 regression coefficient for September; $F_{1,3}$ = 4.48, p = 0.1, r^2 =0.53 and -0.8 regression coefficient for December in Kotera).

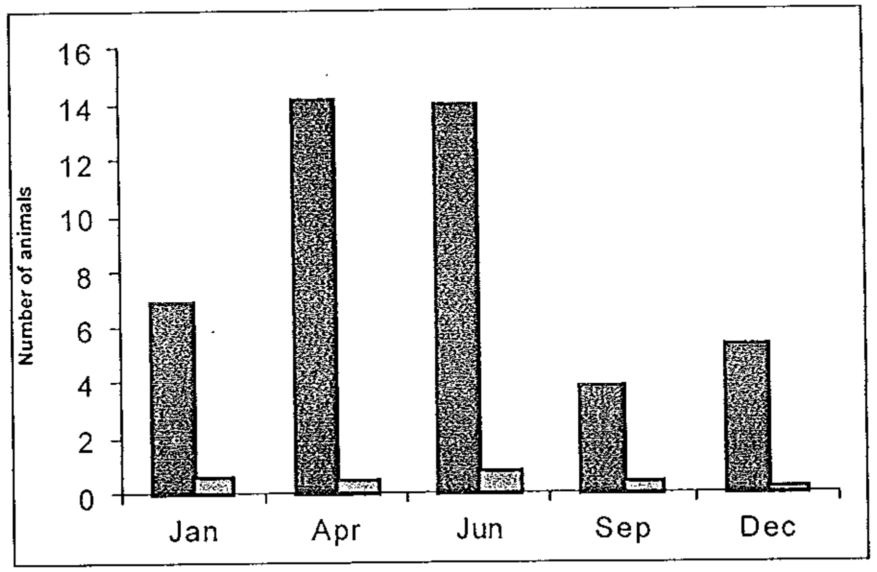


Fig. 3.20 Encounter rate of transport animals in selected months

2. 3.4 Human population

Humans were infrequently sighted in both the study sites. The summary of the encounter rate of humans indicated that the abundance was as low as 0.25/km in Sanetti and 1.3/km in Kotera (Table 3.10).

Table 3.10 Overall encounter rate of human from 1998 - 2003

Area	No. of transects	Total number of human counted	Encounter rate/km
Sanetti	55	447	0.25
Kotera	68	1804	1.3

3.2.4.1 Monthly variation of humans

The monthly record of human sightings in each transect from 1998-2003 showed variations in the number of humans counted but it has no significant difference in the two study sites (Fig 3.21 and 3.22) ($F_{1, 54}$ = 0.105, p = 0.75, r^2 =0.002 and -2 E.05 regression coefficient in Sanetti and $F_{1, 67}$ =2.01, p = 0.161, r^2= 0.297 and -.0002 regression coefficient in Kotera).

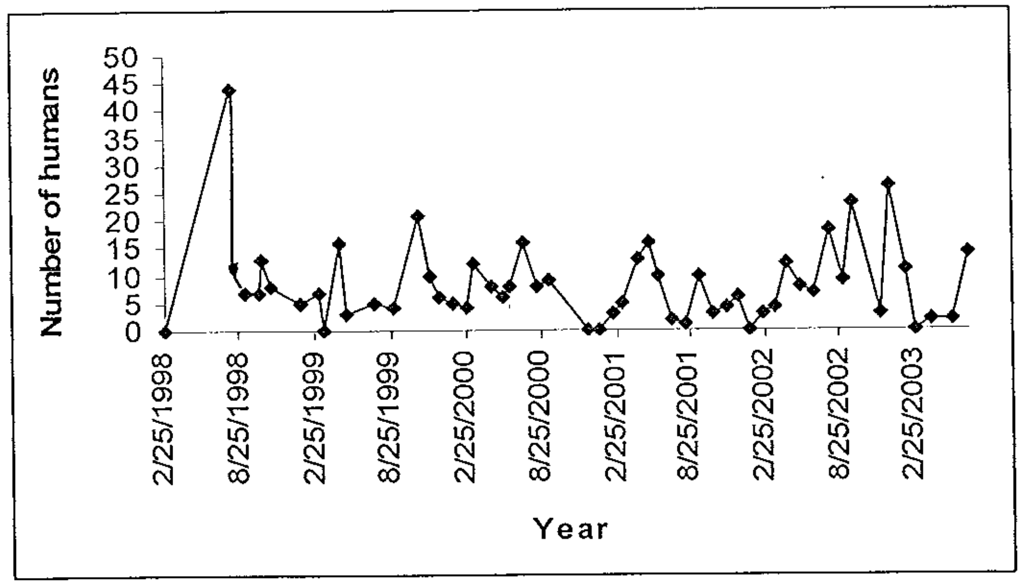


Fig 3. 21 Number of humans counted in each transect by month in Sanetti from 1998-2003

3.2.5 Ethiopian wolves

The records of the Ethiopian wolves from 1998-2003 in the two study sites is summarized in terms of encounter rate in Table 3.14. Ethiopian wolves were more frequently sighted than any other wild mammals in the study areas. The abundance of the wolves was relatively higher in Kotera (0.41 wolves/km) than in Sanetti Plateau 0.22 wolves/km (Table 3.14) but there was no statically significant difference ($\chi^2 = 0.057$, d.f. =1, $p > 0.05$).

Table 3.14 Overall encounter rate of Ethiopian wolves from 1998-2003

Area	No. of transect	Total number of animals counted	Encounter Rate/km
Sanetti	55	384	0.22
Kotera	68	565	0.41
Total	123	949	

3.2.5.1 Annual variation of Ethiopian wolves

The variation in the encounter rate of wolves from 1998-2003 in Kotera ranged between 0.2-0.54/km. The rate of the encounter increased from 1998 to 2001 and then decreased until 2003 (Fig. 3.23). In Sanetti, the encounter rate ranged between 0.08-0.18 only, showing a pattern of increasing trend from 1998 up to 2000 and then a downward trend for the two consecutive years (2001 and 2002) followed by a time of recovery in 2003 (Fig. 3.23). In Sanetti, the changes in the number of wolves showed insignificant difference between all surveying years ($p > 0.05$).

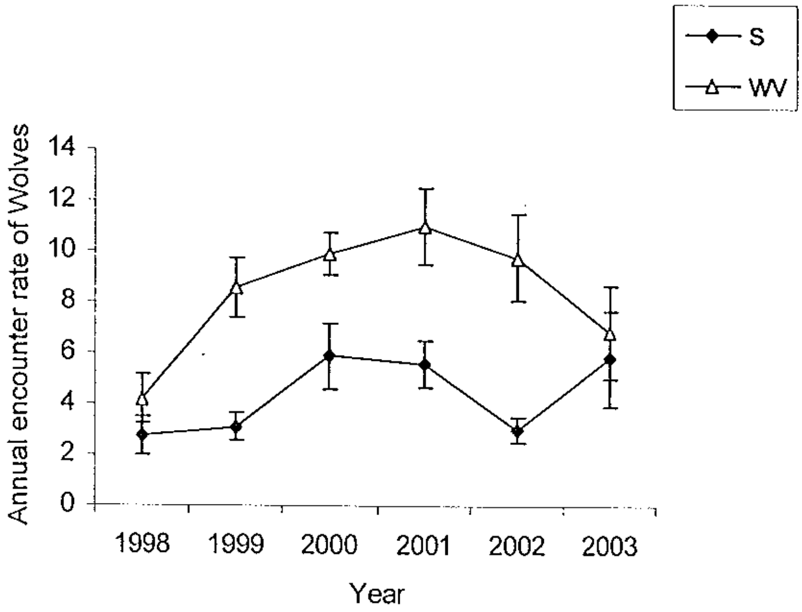


Fig. 3.23 Annual encounter rate of Ethiopian wolf in the study sites (Sanetti and Kotera)

3.2.5.2 Seasonal variation of Ethiopian wolves

The seasonal variation of Ethiopian wolves was within a range of narrow limit indicating that the variation was too low. In Sanetti, the encounter rate was between 0.07-0.17 wolves/km and in Kotera, it was between 0.2-0.5 animals/km in different seasons (Fig. 3.24) showing insignificant difference in both study sites ($F_{1,\ 54)}$ = 2.9, p = 0.1, r^2 =0.05 and 0.07 regression coefficient in Sanetti and $F_{1,67}$ = 2.3, p = 0.14, r^2= 0.03 and -0.82 regression coefficient in Kotera).

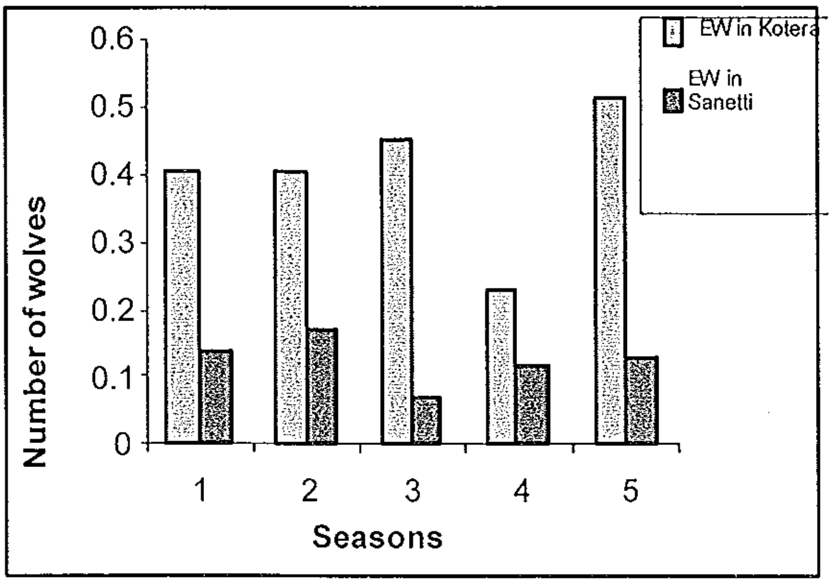


Fig. 3.24 Seasonal encounter rate of Ethiopian wolf in the study sites

EW- Ethiopian wolves

3.2.5.3 Variation of wolves by specified months

The variation of wolves in specified months is shown in Fig. 3.25.This data indicated that the number of animals in Kotera was relatively high in June (0.56 per kilometer) and January (0.55), whereas in Sanetti it was during April (0.19) followed by September (0.16). When the overall encounter rate of each selected months compared, annual mean showed insignificant difference in the changes of the number of this animal in both study sites except in January in Kotera ($F_{1,4}$ = 0.03, p = 0.87, r^2 =0.01 and 0.007 regression coefficient for January; $F_{1,3}$ = 0.08, p = 0.8, r^2 =0.04 and –0.02 regression coefficient for April; $F_{1,3}$ = 0.57, p = 0.08, r^2 =0.85 and –0.09 regression coefficient for June; $F_{1,3}$ = 5.1, p = 0.16, r^2 =0.71 and -0.008 regression coefficient for September; $F_{1,3}$ = 0.14, p = 0.74, r^2 =0.07 and -0.02 regression coefficient for December in Sanetti and $F_{1,5}$ = 16.7, p = 0.02, r^2 =0.81and 0.12 regression coefficient for January; $F_{1,5}$ = 0.91, p = 0.39, r^2 =0.19 and 0.06 regression coefficient for April; $F_{1,4}$ = 3.0, p = 0.18, r^2 =0.5 and -0.04 regression coefficient for June; $F_{1,4}$ = 0.61, p = 0.49, r^2 =0.17 and 0.054 regression coefficient for September; $F_{1,5}$ = 0.56, p = 0.50, r^2 =0.12 and 0.04 regression coefficient for December in Kotera).

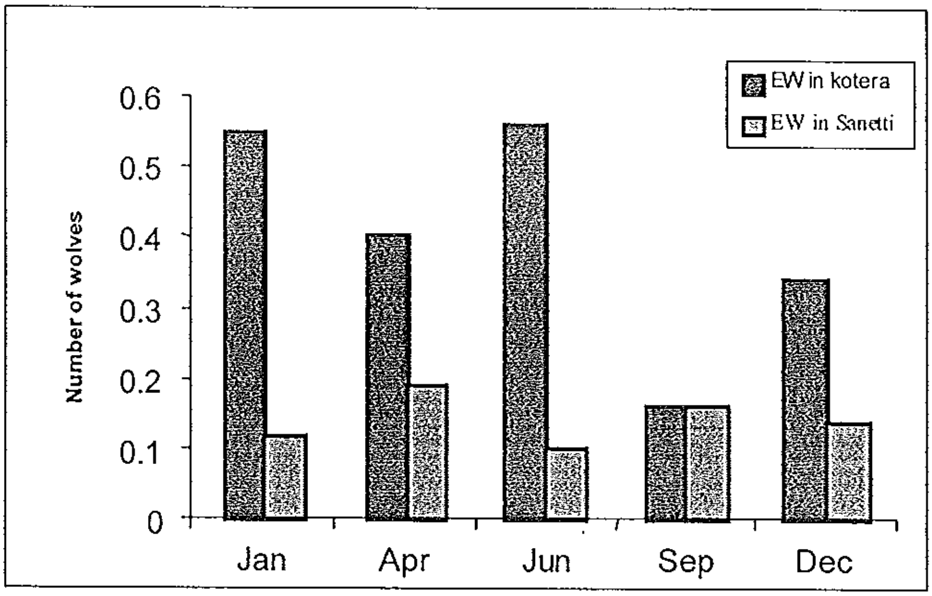


Fig. 3.25 Encounter rate of Ethiopian wolf (EW) in selected months.

EW- Ethiopianwolves

A. The effect of livestock on Ethiopian wolves

The effect of domestic livestock on the Ethiopian wolves was summarized using the encounter rate by regression analysis (Table 3.15). Domestic livestock didn't show any significant effect on the number of Ethiopian wolves (p >0.05).

Table 3.15 Effect of livestock on Ethiopian wolves using regression analysis. The degrees of freedom for all analyses were 1, with 67 residual degrees of freedom for the analyses in the Kotera plain and 54 in Sanetti plateau.

Area	Effect of Species	F-value	r^2	p-value
Sanetti	Cattle	0.03	0.001 NE	0.87 NS
	Shoat	0.01	7.96e05NE	0.94 NS
	Transport animal	2.28	0.033 NE	0.14 NS
Kotera	Cattle	1.66	0.03 NE	0.20 NS
	Shoat	1.46	0.027 NE	0.23 NS
	Transport animal	0.62	0.011 NE	0.43 NS

NE: - No effect where r^2 is < 40 % or > 70 %

NS: - Non significance

B. Effect of habitat use of domestic livestock on Ethiopian wolves

The distribution of livestock and Ethiopian wolves from 2001-2003 is summarized in Table 3.16. These animals were sighted unevenly among the different habitats of vegetation types in the study areas. In Sanetti the highest percentage of the livestock (77%) was observed in the *Helichrysum* meadow vegetation type. The next habitat in which denser population sizes were observed was the *Erica* moor land (9.4%), followed by Alpine grass meadow (8.9%). The remaining percentage of the livestock was also distributed unevenly in the high altitudinal swamp

(2.8%), *Alchemilla haumanii* (0.7%), *Artemesia* grassland (0.4%), and open grassland (0.2%). The livestock were not recorded in *Guassa* grassland, *Charranfe heaths*, *Charranfe guassa* and *Guassa lobelia* during the period of census (see Table 3.16).

The human population in the different habitats of vegetations recorded was low as indicated in Table 3.8. Humans in this study site were relatively sighted more in open grassland (62.9%) followed by *Artemesia* grassland (15.5) and then in alpine grass meadow (5.2%). In *Alchemilla haumanii* and in *Erica* moorland human records were rare.

The wolves were observed at highest population size in the Alpine grass meadow (50 %), followed by *Helichrysum* meadow (24.3 %) and in *Alchinella* meadow (11.8 %). They were also recorded in high altitudinal swamp (5.8 %), open grassland (4.4 %) and in *Alchimella haumanii* (3.7 %) habitat (Table 3.16).

In Kotera as indicated in Table 3.16, the highest population size of the livestock (59.9%) was sighted in the alpine grass meadow. The high altitudinal swamp (12.4%) was the next habitat in which the livestock were observed more abundantly, followed by *Kniphofia* grassland (10.2 %) and *Artemesia* grassland habitats (7.4%). The remaining percentage of the livestock was sighted unevenly in *Alchemilla* meadow (4.7%), *Helichrysum* meadow (3.2%), open grassland (1.8%), *Erica* moorland (0.3%), *Alchemilla humanii* (0.1%) and in *Lobelia* stand (0.04%). The livestock were not recorded in *Guassa* grassland, *Charranfe heaths*, *Charranfe guassa* and *Guassa lobelia* during the period of census in this area.

Table 3.16 Habitat distribution of livestock and Ethiopian wolf in Sanetti and Kotera from [illegible] 2003

Area	Species	Vegetation type								
		1	2	3	4	5	6	7	8	9
Kotera	Cattle	26772	5061	3297	2164	2480	1202	673	70	72
	Shoats	4582	720	1954	1829	67	440	265	138	0
	Transport animals	2744	1303	565	204	164	82	98	3	0
	Human	441	63	71	38	27	24	15	4	0
	Ethiopian wolf	190	39	4	11	34	12	3	0	0
Sanetti	Cattle	1089	431	0	3	25	6561	33	1356	92
	Shoats	262	0	0	53	0	5172	0	100	0
	Transport animals	42	7	0	4	2	328	6	109	16
	Human	13	3	0	0	3	73	0	18	6
	Ethiopian wolf	68	8	0	0	16	33	6	0	5

❖ 1. alpine grass meadow, 2. high altitudinal swamp, 3. *Kniphofia* grassland, 4. *Artimesia* grassland, 5. *Alc*[illegible] meadow, 6. *Helichrysum* meadow, 7. open grassland, 8. *Erica* moorland, 9. *Alchemella haumanii*

In this study site, humans were recorded in alpine grass meadow (64.6%), *Kniphofia* grassland (10.5%), high altitudinal swamp (9.2%), *Artemesia* grass land(5.6%), *Alchemella* meadow(4.0 %), *Helichrysum* meadow (3.5%), open grassland(2.1%) and in *Erica* moorland(0.5%).

In Kotera the wolves were most often sighted in the Alpine grass meadow (64.8%) followed by high altitudinal swamp (13.3%) and *Alchemella* meadow (11.6 %). They were also found in *Helichrysum* meadow (4.1%) and *Artemesia* grass land (3.4 %). Their record was low in the open grassland (1.0 %) and in *Kniphofia* grass land (1.4 %). There were habitats like *Erica* moorland, *Alchemilla haumanii* and *Guassa* grassland where wolves were not observed (see the Table 3.16).

4. DISCUSSION

Domestic livestock

The abundance of livestock in the study area was higher than any other animal species. The fluctuation in their relative abundance correlated with the rainfall pattern in the areas. The highest population size was appeared during the wet season, when the high rainfall was also high in the area (see Fig. 2.1). This indicated that domestic animals sighted and recorded were not all from settlers within the boundary of the park. There are a large number of herds coming from outside the park boundaries. The areas outside the park are occupied by cultivation during the wet season, and hence pastoralists are forced to bring their livestock for grazing in the park, where they in order to get free rangelands. Similar observation was also made earlier (Smeds, 1959). According to Smeds (1959, pastoralists were inhabited in the low lands and their cattle were taken to the BMNP during the wet season. So it is during the dry seasons that the areas outside the park are available for grazing by domestic animals. The report of BMNP warden and written documents (Fekadu Garedew and Dereje Tadesse, 2001) in different times also support these facts.

The encounter rate of livestock in Sanetti increased over the duration of the studied period. This may be due to a consequence of the appearance of increased settlement in the plateau or the low density of livestock in the area as compared to Kotera.

In contrast, in Kotera even though the livestock especially cattle showed a declining trend, a large number of animals recorded was high as compared to Sanetti plateau. Even though, when looking at the data gathered during 1998-2003, the encounter rate of the selected months, particularly June, September and December in Kotera showed significantly increased cattle density. The downward trend in the livestock was not as a result of lower number of permanent settlements as well as reduced number of pastoral people (those that come during the rainy season only). This may be as a result of factors such as the low amount of rainfall from time to time (Fig. 2.2) or it may be associated with the carrying capacity (biomass production) of the area in which it supports (Almaz Tadesse and Masresha Fetene, 1999). In general the number of livestock in BMNP has increased as compared to the earlier times. According to Hillman (1986), the total population in all the national park was estimated to be 10,500 only and again later on according to Stephens (1997) 6,000 livestock were estimated only in Gojera/Simbirro study site by the use of distance sampling method. In addition, he has indicated the increasing pressure of livestock from time to time in Sanetti and Upper Web Valley (Stephens *et al.*, 2001). The present study, particularly in Sanetti also supports this condition. The livestock increase, exhibited from time to time may be due to the problems of strict law regulations that protect the park. This population pressure can have impacts to a certain degree with wildlife mammals in competing for food or space inside the park. Grazing can have effect to reduce habitat diversity by altering or reducing vegetation (Lisanework Adimasu and mesfin Tadesse, 1988). Intensified grazing might cause extensive deforestation during wet season. The livestock pressure in the area may have eliminated many of the dominant vegetation types preferred by wild ungulates resulting in lower carrying capacity, ultimately leading to the lower population size observed (Tables 1 and 2 in the appendix). As human impacts may result in depletion of vegetations over such areas, climate may also get affected. This might be the reason for the reduced annual rainfall observed in the present study areas. Rainfall decreases as a result of less water vapor circulation in the atmosphere that in turn changes the heating and cooling patterns of the land surface.

Human

The data recorded for humans during the present was too low. Evidences in different time showed increased human population inside the park since its establishment (Hillman, 1986; Bale Zone Statistical Office, 1994; Shibiru Tedela, 1995). Even though, the data recorded for human population was not sufficient to predict the relationship with the wild mammals in the area, it was clearly seen that humans were recorded in different habitats of the study area and a relatively increased numbers of humans during wet season than in the dry season. This also corresponds to the increased populations of livestock observed during wet season. According to the study of Anagaw Atikem (2002), human settlement and population has increased in the lower Web Valley. The appearance of humans inside the park indicated their extraction of many of the resources required by wild mammals including their shelter, food, water, and other essential requirements of life. Cultivation up to an altitude of 3450 m. a. s. l. is observed; even extremely steep slopes are commonly used in many parts of the mountains. Hence the presence of humans in the area of any part of the Afroalpine ecosystem can be a cause for deterioration in vegetation by wood cutting, farming, etc for the increased habitat destruction that brought numerous species to the brink of extinction.

Domestic Dog

The abundance of the domestic dogs recorded was too small as shown in Table 1 and 2 in the Appendix but these animals were recorded in almost all the habitats used by the Ethiopian wolf. According to the study of Anagaw Atikem (2002) in the lower Web Valley, the number of domestic dogs in the area is growing and apparently a small proportion of the domestic dogs have close contact with the wolves; those that roamed into wolf range. This indicated that the population of the domestic dogs is not as such small in the area .In addition to this, the observed population is enough for the transmission of diseases, particularly the rabies disease that regularly occurring in the area.

The other problem associated with the presence of the domestic dog in the Afro alpine ecosystem was the threat of hybridization. From the total group size of 565 sightings in the lower Web Valley, 22 (3.9 %) were hybrids. If these hybrids mingle closely with the natural populations, the vigor may be lost which may ultimately affect the wild strain of the Ethiopian wolf and its status.

Ethiopian Wolf

The critically endangered species, the Ethiopian wolf, is relatively widely distributed in BMNP. They are more in the Lowe Web Valley than in Sanetti. The encounter rate of wolves as a relative measure for abundance showed that the wolves suffered from population decline in the study areas. The downward population trend of the Ethiopian wolf may be associated with the outbreak disease of rabies in the area where wolves and dogs utilized the same habitats. Macdonald (1993) stated that disease can be transmitted through close contact between the dogs and wolves. The study of Silloro-zubiri *et al.* (1996) showed that Ethiopian wolves are kwon to be susceptible to disease and major epidemics and stated that about two-third of the population was lost by rabies and canine distemper outbreak in the early 1990. According to the report of EWCP (2003), 70% of the Ethiopian wolves in Web Valley have also been died with rabies.

The other large wild mammals as compared to Ethiopian wolves were sighted infrequently. The result of the encounter rate from February –June 2003 in Table 3.5 indicated that the reduced abundance as compared to the census result seen before1998 may be as a result of a number of factors. The wild mammals and livestock might be compatible in most rangelands across the different ecological zones of vegetations in the afroalpine ecosystem. The appearance of livestock into areas occupied by wild ungulates had brought negative effects on the composition of wild communities. Cattle graze much portion of the land including the higher part of the forest lands which most probably used by wild mammals. The grazing effect of the livestock in the area may be responsible for the declining population trend and infrequent sightings of the wild mammals in the area. In Colorado Plateau National Park, the negative ecological impact of grazing has contributed to about 41 % for the decline of the endangered species (Flather *et al.,* 1994).

According to the report of the BMNP warden in different times, humans are using the park area for crop cultivation with permanent settlement and as nomadics. They are also using this park area as a source of wood for construction and fuel by destroying forests, which is a disturbance for a large number of wildlife species. Nomadic pastoralists and settled agriculturalists are the major causes for destruction of forests. According to Hillman (1986), fire was set deliberately by the people around the forest to expand the arable land, to get fuel wood and shorten the giant *Erica heath* to a grazable size for their cattle. Wild mammals may not prefer such disturbed natural habitats (areas) for that they are shy and may be exposed to predators easily. According to the study of Befekadu Refera (2001), the mountain nyala was not attracted by frequently burned heath lands.

The slaughtering of wild ungulates particularly, the calves by domestic dogs could also be a reasons for infrequent sightings of ungulates in the area and may contribut for the small population size of these wild mammals in the afroalpine ecosystem. Woldegebriel Gebrekidane (1996) and Befekadu Refera (2001) have reported that young ones of the mountain nyala were killed by domestic dogs.

The different methods used in the two study sites may also have contributed for the wider range of spatial and temporal variation in the number of animals recorded in the study area. The reasons are most probably associated with: -

The census methods in the two sites were different in that each method has its own setbacks. In Sanetti, it was road counts by vehicle through which animals have been censused for a maximum of two hours only covering a transect length of 32 km. But in Kotera, it was horseback count of the duration of more than three hours for 20.5 km transect length. This may have made temporal biases in the observation of animals during the period of surveying.

The number of transects that were used in the two study sites may also have contributed to the differences in the rate of animals observed. The relatively large number of transacts used in Kotera allowed an intensified survey on horseback, which gave better chances for animal sightings in Kotera than in Sanetti. The difference in the vegetation types in the two study sites may also have the effects with differences in the population data revealed during the present investigation.

5. Recommendations

The livestock have utilized vast majority of the vegetation types at a higher abundance relative to the other species in the afroalpine ecosystem. In the long-term, this may result in the displacement, fragmentation and reduction of the wildlife populations through destruction of habitats and competition for grazing and other essential requirements of life. Hence, a sound management for the protection of BMNP including components of settlement of the dwellings in and around the park, implementation of strict regulation, etc is required for the persistence of wild animals.

The present investigation could not reveal any negative impacts of the livestock on the population trend of Ethiopian wolves as indicated by the regression analysis in the results. But the Alpine grass meadow, *Helichrysum* meadow and high altitudinal swamp supports high population density of livestock, which is the most preferable habitat of the critically endangered Ethiopian wolf (Sillero-Zubiri, 1994). These livestock may have competition with the rodents, which are herbivores and the prey base of the wolves. Hence, it may have indirect effect on these animals so that proper management of the area to maintain population of large herbivores is required (Ridder *et al.*, 1982). Because it is very important to know the total biomass production of an area as it provides information on the carrying capacity of the area, controlling the density of grazing animals in relation to grass biomass production is important. Therefore its carrying capacity has to be studied.

The common habitat utilization of domestic dogs, Ethiopian wolf and ungulates is a cause of great threat for wildlife and may become the cause for the reduction of populations in the area in that it affects through disease transmission, hybridization and slaughtering effect. Therefore, the dogs are to be managed by the owners. Educating settlers found around and inside the park, such as tying dogs at their home, following their health through regular vaccination, strengthening the habit of castration.

The appearance of humans almost in all habitats the study area is an indication for the penetration of any habitat inside the park by man and this would result in human induced disturbance in the Afroalpine ecosystem, which will ultimately affect wild animals negatively.

Data collection through sightings once a month is not pertinent to indicate the population trends of humans, domestic dogs and large wild mammals and their relationships. Hence, the method has to be improved by shorting the time interval for data collection. Surveys should be carried out at least twice in a month, by adding the number of transects and the sites of census.

6. Conclusion

Although the abundance of livestock in Kotera declined over the period of the study, BMNP contains high populations of livestock, especially during the wet season. Over the long-term, these high densities of livestock and the resulting sustained grazing pressures may have a negative effect on the productivity of the area as well as on the dependent wildlife.

Information on large mammal distribution and abundance is necessary for management planning and actions. Hence, this study contributes some information on the baseline of current trends of livestock and of Ethiopian wolves in BMNP and to reveal the impacts in the national park.

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Table 1. Summary of Sanetti road count from 1998-2003

Sum of Gp size	Spp.										
Date	CT	DD	EW	GD	HA	HU	KS	MN	ST	TR	WC
2/25/1998	242		5	1							
8/3/1998	300		2				44		83	20	
8/20/1998	272		5							4	
9/9/1998	187		4				7		79	20	
10/12/1998	546	1					7		594	6	
10/14/1998	425		1				13		568	10	
11/9/1998	309		2	1			8		31	26	
1/20/1999	185		3				5		15	20	
3/4/1999	113		6				7		43		
3/15/1999	189		5						39		
4/27/1999	222		2				16		260	11	
5/9/1999	335		3				3		188	16	
7/15/1999	111		4				5		75	18	
8/30/1999	322		3	2			4		16	22	
10/29/1999	404			1			21		429	86	
11/30/1999	159		2				10	1	26	21	
12/21/1999	68		3	1			6		16	8	
1/22/2000	199		1				5		42	15	
2/24/2000	83		5				4		48	4	
3/13/2000	181						12			5	
4/26/2000	217	2	5				8		76	7	
5/27/2000	479	3	4				6		32	14	
6/10/2000	375		9				8		4	9	
7/11/2000	73		13				16		7	33	
8/16/2000	395		8				8		329	25	
9/14/2000	199		4				9	2	100	26	
12/18/2000	347		10						48	14	
1/15/2001	246		8					2	135	9	
2/14/2001	152		6				3				
3/13/2001	212		11				5		50	7	
4/17/2001	355		8				13	2	97	3	

										0
5/18/2001	501		6			16			645	37
6/7/2001	340		6	1		10			607	19
7/11/2001	150		9		1	2			152	23
8/13/2001	84					1			1	7
9/17/2001	280		3			10	2		291	21
10/17/2001	403		4			3			42	9
11/20/2001	193	2	2		2	4			150	25
12/22/2001	176	1	4			6			73	16
1/18/2002	267		1						196	24
2/19/2002	89		4			3			207	5
3/21/2002	229		3			4			387	18
4/14/2002	889					12			120	24
5/19/2002	543		3			8			361	29
6/23/2002	366		5			7			217	15
7/29/2002	302		5			18			338	25
8/31/2002	849		3			9			415	13
9/23/2002	482		2			23	1		242	36
11/28/2002	396		4			3			286	
12/21/2002	213	3	3			26			69	9
1/31/2003	549	1	2			11			124	31
2/24/2003	237		3				2		74	28
3/31/2003	146		8			2			173	8
5/21/2003	476	2	12	1		2			85	27
6/30/2003	511		4			14			22	15
Grand Total	16573	15	238	8	3	447	10	2	8707	950

Table 2. Summary of Kotera horseback counts

Sum of group size	Species											
Date	CT	DD	Ehy	EW	GD	HA	HU	KS	MN	OB	SC	ST	TR
09/01/98	1464	2		5			16					265	112
28/02/98	1176	2		6			30					552	160
28/03/98	986	4					18					227	141
29/03/98	271	1		2			25					497	91
27/04/98	1800	5		4	2		48		8	15		1092	195
28/05/98	2961			3			42					696	189
29/05/98	426						11					519	88
30/06/98	3987	5		8			51					1454	497
29/07/98	3968	6		9			33					1028	337
04/09/98	3407	2		13			57					928	292
07/10/98	2335	4		4	1		26					584	252
25/10/98	2079	2		7			38				1	696	339
25/11/98	3188	3		5			60					622	255
28/11/98	470	1					27					237	58
28/12/98	1447	2		1			13		7			181	163
29/12/98	1826	4										1100	87
31/01/99	850			5			21					219	97
21/04/99	1181	4	1	11			18		6			417	137
18/05/99	2457			5			15					268	155
29/06/99	3297			9			33					465	374
30/07/99	4573			9			32				1	373	378
28/08/99	2989			17	1		26					488	335
30/09/99	2289			6			29					416	226
27/10/99	1635	1		5			31				1	412	162
28/11/99	2135			11			44					146	178
29/12/99	689	2		8			17					452	115
29/01/00	497			10			15					461	42
29/02/00	597			4			25					23	85
25/03/00	643	3		10			55					241	128
08/04/00	1771	5		12			19					1045	190
07/05/00	1172			10			21					463	98
03/06/00	1454	2		9			20					244	156
01/07/00	2411	1		10			33					465	400
03/08/00	3823	2		10			48					544	382
01/09/00	3377	4		7			37					648	241
03/10/00	3194	1		14			29					591	276
02/11/00	1949	4		13			32					465	223
11/01/01	855	1	2	9					3			63	111
08/02/01	444		1	14		1	9					88	78
08/03/01	628			20			17					52	129
20/04/01	1030		7	6			31		7			411	152
09/05/01	1636	1		10			10					472	204
01/06/01	2137		2	6			38					228	190
03/07/01	859	1		4			15						26
09/08/01	3351	2	1	10			20			1		330	306
04/09/01	3474	5		18			37					1137	440

04/10/01	1641		1	11		29		2		580	207
07/11/01	2090			4		34				750	176
02/12/01	400		1	5	1						7
10/01/02	631	3	2	16		10				105	73
09/02/02	580		2	4		27				230	92
07/03/02	421	1		16		10				226	117
04/04/02	1180	5		20		30			5	572	78
01/05/02	1200	3		11		30				346	135
06/06/02	2339	1		5		26				357	337
02/07/02	4550	8		6		66			8	561	633
08/08/02	3054	1		14		54				528	292
09/09/02	1735			15		26			23	455	236
07/10/02	1017			5		33	2			544	136
31/10/02	1366			6		42				250	145
02/12/02	202	2		1	5					100	49
18/12/02	624	1		4		6				390	58
18/01/03	736	1		14		16			7	190	151
20/02/03	342	2		4		15		10		85	131
18/03/03	550	7		2		12				115	95
09/04/03	115		2	6		26				115	94
17/05/03	598	2		5		25				173	92
29/06/03	2158	1		10		15				652	196

Table 3. Codes used for the name of species

Code	Common name
CT	Cattle
DD	Domestic dog
EW	Ethiopian wolf
Ehy	Dog hybrid
GD	Grey duiker
HA	Hare
HU	Human
KS	Klipspringers
MN	Mountain nyala
OB	Olive baboon
SC	Serval cat
ST	Shoats
TR	Transport animals
WH	Warthog
WC	Water crane
OWM	Other wild mammals

Table 4. vegetation types of the study areas

Code No.	Vegetation type
1	Alpine grass meadow
2	High altitrudinal swamp
3	Kniphofia grassland
4	Artimesia grassland
5	Alchemella meadow
6	*Helichrysum* meadow
7	Open grassland
8	*Erica* moorland
9	Alchemella haumanii
10	Oblia stand
11	Guassa grassland
12	Charranfe heath
13	Charranfe guassa
14	Guassa lobelia

Table 5. Abbreviations for daily weather records of the study areas

C	Cloudy
CB	Cloudy bright
CD	Cloudy dull
DZ	Drizzle
MI	Mist
SU	Sunny
W	Windy
RN	rainy