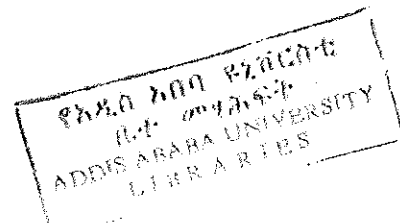


ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

SOME PATTERNS OF POPULATION DYNAMICS AND DISTRIBUTION OF SWAYNE'S
HARTEBEEST (*Alcelaphus buselaphus swaynei*) IN SENKELE SWAYNE'S HARTEBEEST
SANCTUARY

Berhanu Gebre

January, 2000



ACKNOWLEDGMENTS

I owe a deepest gratitude to my advisor Dr. Solomon Yirga whose extremely valuable guidance and advice without which this research project would not have achieved its goal. I would like also to express my special appreciation to Prof. Afework Bekele and Dr. Assefa Mebrate for their valuable advice and encouragement during my fieldwork.

I wish to thank the staff of the EWCO, in particular, Ato Tesfaye Hundesa (General Manager), for the permission to work in Senkele Swayne's Hartebeest Sanctuary (SSHS), and Ato Getenet Wondimu and W/rt Almaz Assefa for their encouragement and help. My thanks go to the staff of SSHS, in particular, Ato Gudesu Leffe for his kind help in the field and for allowing me to use the Sanctuary facilities including the car.

My special thanks are due to the Amhara National Regional State for allowing me to pursue the MSc. program. I wish to thank the School of Graduate Studies of A. A. U. for providing funds and the Department of Biology for facilitating my work.

I would like to express my sincere appreciation to the staff of Titta Boarding Special Secondary School, in particular to Abadi Seyuom, Hailu Fente and Bekele Fugi for their help.

I also thank all those people who assisted me in one way or the other during my study period, in particular, Ato Zelalem Assefa (National Museum) for providing GPS (Global Positioning System) and my friends Sisay Bekele, Leuel Teka, Ahmed Idris Abebe H/Mariam and Bekele Bahiru.

Finally, most of all I express my gratitude, respect and love to my wife, Mulu Nibret for her consistent support and encouragement throughout the study period.

DEDICATION

This work is dedicated to my daughter, Ayneye Berhanu and my wife, Mulu Nibret

TABLE OF CONTENTS	
ACKNOWLEDGMENTS	iii
LIST OF FIGURES	ix
LIST OF TABLES	x
LIST OF APPENDICES	xi
ABSTRACT	xii
1.0. INTRODUCTION AND LITERATURE REVIEW	1
1.1. Introduction	1
1.2. Literature review	8
1.3. Objective	14
2. DESCRIPTION OF THE STUDY AREA	15
2.1. Location and topography	15
2.2. Climate	17
2.3. Soil and geology	19
2.4. Vegetation	20
2.5. Wild animals	22
2.6. The land use system	22
3. MATERIALS AND METHODS	24

3.1. Duration of study.....	24
3.2. Dividing the study area.....	25
3.3. Population estimation.....	26
3.4. Sex and age structure.....	27
3.5. Group size.....	28
3.6. Distribution and vegetation type utilization.....	29
3.7. Movement and home range.....	29
3.8. Diurnal activity pattern.....	31
3.9. Assessment of the impact of the local people.....	32
4. RESULTS AND DISCUSSIONS.....	33
4.1. Population estimation.....	33
4.1.2. Population trends.....	37
4.2. <i>Age and sex structure</i>	39
4.2.1. Sex ratio.....	41
4.3. Group size.....	42
4.4. Distributions and vegetation type utilization.....	44
4.5. Movement and Home range.....	47
4.6. Diurnal activity pattern.....	51
4.7. Assessment of the impact of local people.....	53
4.7.1. Destruction of habitats.....	54

4.7.2. Disturbance	55
4.7.3. Livestock Abundance	58
4.7.4. Hunting.....	62
4.7.5. Predation	63
5. CONCLUSIONS AND RECOMMENDATIONS	65
5.1. CONCLUSIONS.....	65
5.2. RECOMMENDATIONS.....	66
6. References.....	69
7. APPENDICES.....	82

LIST OF FIGURES

	page
Figure 1: Distribution of Swayne's Hartebeest in Ethiopia.....	4
Figure 2: Distribution of the three subspecies of <i>Alcelaphus buselaphus</i> in Ethiopia.....	7
Figure 3: Physical characteristics of Swayne's Hartebeest.....	9
Figure 4: Map showing the study area	16
Figure 5: Map showing the previous and the present boundary of the study area.....	18
Figure 6: Map showing the vegetation communities of the Sanctuary.....	21
Figure 7: Map showing division of the study area into five counting blocks.....	25
Figure: 8. Monthly population estimation of Swayne's hartebeest in 1999	35
Figure: 9 Comparison of Swayne's hartebeest counted in both seasons.....	36
Figure 10: Comparison of Swayne's hartebeest in each counting blocks.....	37
Figure: 11. Population trend of Swayne's hartebeest in SSHS (1972-1999)	39
Figure 12: Number of Swayne's hartebeest in each age group during dry and wet seasons.	40
Figure 13: Percentage of total hartebeests observed on different vegetation communities .	47
Figure 14: Dry and wet seasons home range size	49
Figure 15: Movement of Swayne's hartebeest out of the Sanctuary	50
Figure 16: The variation in activities shown by Swayne's hartebeest during the hours of the day.....	53

LIST OF TABLES

Table 1: Results of soil analysis in the Senkele area.....	19
Table 2: Comparison of vegetation communities in previous years and the present study period.....	20
Table 3: Results of eight total counts of Swayne's hartebeest.....	34
Table 4: Average number of Swayne's hartebeest counted in five counting blocks during the dry and wet seasons.....	35
Table 5: Age and sex structure of Swayne's hartebeest in dry and wet season	39
Table 6: Adult and sub-adult sex ratios in Swayne's hartebeest.....	41
Table 7: Group size of Swayne's hartebeest in different months.....	43
Table 8: Percentage of total hartebeest observed on different vegetation communities.....	46
Table 9: Diurnal activity pattern of Swayne's hartebeest.....	52
Table 10: Number of human population around SSHS (1999).....	57
Table 11: Number of human population around SSHS (1994).....	58
Table 12: Number of livestock in peasant associations surrounding the Senkele sanctuary (1999).....	60
Table 13: Number of livestock in 8 peasant associations surrounding the Senkele sanctuary (1994).....	61

LIST OF APPENDICES

Appendix 1: Summary statistics of the wildlife of Ethiopia..... 82

Appendix 2: The distribution of *Alcelaphus buselaphus*..... 83

Appendix 3: Animal census form..... 84

**Appendix 4: Questionnaire/interview addressed to people living around Senkele Swayne's
hartebeest Sanctuary..... 85**

ABSTRACT

An ecological study of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*), an endangered subspecies of antelope, was made from February 1999 to December 1999 in Senkele Swayne's hartebeest Sanctuary (SSHS) located 300 km from Addis Ababa. Data regarding population size, structure, vegetation community utilization, home range and daily activities that included both dry and wet seasons were gathered. A direct count method was employed in estimating the population of the hartebeest in about 28 km² of its natural habitat.

The total estimate of Swayne's hartebeest was between 145 in the wet season and 179 in the dry season. Classification of 142 animals in dry season and 123 animals in wet season indicated different sex and/or age structures for the population. The majority of the population was largely comprised adult and sub-adult females (52.2%) adult and sub-adult males (31.6%). The proportion of the young constituted (16.1%).

Herd size altered monthly. A stable sub-group unit composed of 12 animals was observed. The maximum group size observed was 45. Hartebeest's number of groups were largest in wet season in the open plain and smallest in dry season in woody cover.

The results of the study showed that Swayne's hartebeest occupied the 3 vegetation communities in the Sanctuary. Their distribution and vegetation community utilization is found to be influenced by food availability and the presence of human and domestic animals within the Sanctuary. The animals were observed utilizing the 3 vegetation communities in both seasons, however, there was

more utilization of the Pennisetum Grassland (PG) community (77.2%) in the wet season and 62.5% in the dry season.

Locating all groups during counting provided the movement and home range data of both seasons. Minimum Convex Polygon (MCP) method was used to calculate the home range size. Seasonal home range size varied. Wet season home range size was twice larger than that of the dry season (16 vs 9 km²).

Swayne's hartebeest activity was recorded at 4 min-intervals for continuous period of 12 hr on two consecutive days every month of the eight months of the study period. About 48.9% of the total time was spent in feeding and about 38.6% in resting (standing and lying). There were two feeding peaks, one in the morning and another in the afternoon, and one resting peak in the middle of the day.

1.0. INTRODUCTION AND LITERATURE REVIEW

1.1. Introduction

East Africa is noted for its diversity and abundance of large mammalian herbivores (Kutilek, 1979). The extensive tropical and subtropical savanna biome which extends from Ethiopia and southern Sudan to the south on the eastern side of Africa provides the homeland for the largest number and variety of ungulates (Hirst, 1975). Compared to other regions, Africa has the largest number of endemic families and genera of the big games. This high degree of endemism is one of the reasons for African fauna to be so interesting and spectacular (Delany and Hoppold, 1979).

The variation in the topography of Ethiopia, which ranges from 110 m below sea level (Afar depression) to 4,620 m above sea level (Ras Dejen) has resulted in the diversification of the wildlife (Houerou, 1986; WCMC, 1991 and Shibru Tedla, 1995). The majority of wildlife species are confined to the montane extremes of the Simien Mountains and Bale mountains, and the Arid Lowlands of the Rift Valley (EWCO, 1985).

Ethiopia is one of the few countries in the world which possesses a unique and characteristic fauna with a high level of endemism (WCMC, 1991). Two hundred and seventy-seven mammalian species are known in Ethiopia of which thirty-one mammal species are endemic (Appendix-1) (Hillman, 1993). However, due to man-made and natural degradation processes, these wildlife have largely been restricted within a few wildlife conservation areas of the country (Hillman, 1993). These include nine National Parks (of which only two are legally gazetted), three Sanctuaries,

eleven wildlife reserves, and eighteen controlled hunting areas.

Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) (Korkey in Amharic) is a subspecies of the widespread *Alcelaphus buselaphus*. It occurs in small numbers in only a few areas of southern Ethiopia. Until the early 1890's, *A. b. swaynei* was wide spread throughout Ethiopia and Somalia (Swayne, 1903). Herds of a thousand individuals were observed by Brigadier-General Swayne, who discovered the hartebeests in 1891-92, South of the Golis range of Somaliland, about 200 km from the coast (Blower, 1969; James, 1969 and Last, 1982). Within fifteen years, the tens of thousands that Brigadier Swayne had seen was dwindled to an extent that only about 800 were estimated to have remained (Last, 1982). The rapid decline was due to the rinderpest that swept Africa at the end of the last century. Up to 1940's, however, a large number of *A. b. swaynei* was present in the Awash area of Ethiopia. In the following decades, the mounting human population pressure, the development of mechanized agriculture, and the dramatic increase in hunting, resulted in the extermination of the hartebeest population in the vicinity. By the early sixties, the only sizable population of Swayne's hartebeest was located in the Senkele and Siraro Plains, west of Lake Awassa (Bolton, 1971). This area used to have minimal human settlement since it is an area of contention where two tribes, the Arsi and the Sidama, have traditionally fought for grazing rights.

At present, *A. b. swaynei* are found only in four localities in Ethiopia, namely, Awash National Park (ANP), Senkele Swayne's Hartebeest Sanctuary (SSHS), Nechsar National Park (NNP) and Maze Wildlife Area (MWA) (Hillman, 1993) (Fig. 1). The latest number of hartebeest recorded were sixty to seventy in NNP (Chemere, Pers. Comm., 1998), four to five in ANP and fifteen to twenty individuals in MWA (Getenet, Pers. Comm., 1999). Bolton (1973), reported the presence of Swayne's hartebeest in Yabello, but according to Hillman (1993), it is now extinct from the area.

The hartebeest is still one of the most widespread of African antelopes although it is no longer occurring in many parts of its former range (Bolton, 1973). Swayne's hartebeest is one of over fifty forms of *Alcelaphus* which has been named (Kingdon, 1982). The first specimen described by Sclater in 1892 and was classified as *Bubalis swaynei* later changed to *Alcelaphus buselaphus swaynei* by Ruxton and Schwartz (1929). Sclater and Thomas (1894) recognized eight distinct *Alcelaphus* species, Whereas Ruxton and Schwartz recognized the nine but ranked them as subspecies (Appendix 2). To date *A. b. buselaphus* and *A. b. bubastis* are already extinct (Kingdon, 1982, 1997). In Ethiopia, three distinct subspecies are recognized. These are: *Alcelaphus buselaphus swaynei*, *Alcelaphus buselaphus lelwel* and *Alcelaphus buselaphus tora*. *A. b. swaynei* is found in the central and south-west plains, *A. b. lelwel* in the south-east of the border, and *A. b. tora* in the west and north-west (Lealem Berhanu, 1974, Yalden *et al.*, 1984, Kingdon, 1997) (Fig. 2). *A. b. swaynei* and *A. b. tora* are classified as endangered by IUCN Red Data Book (IUCN, 1972). This is because they have suffered a drastic reduction in numbers.

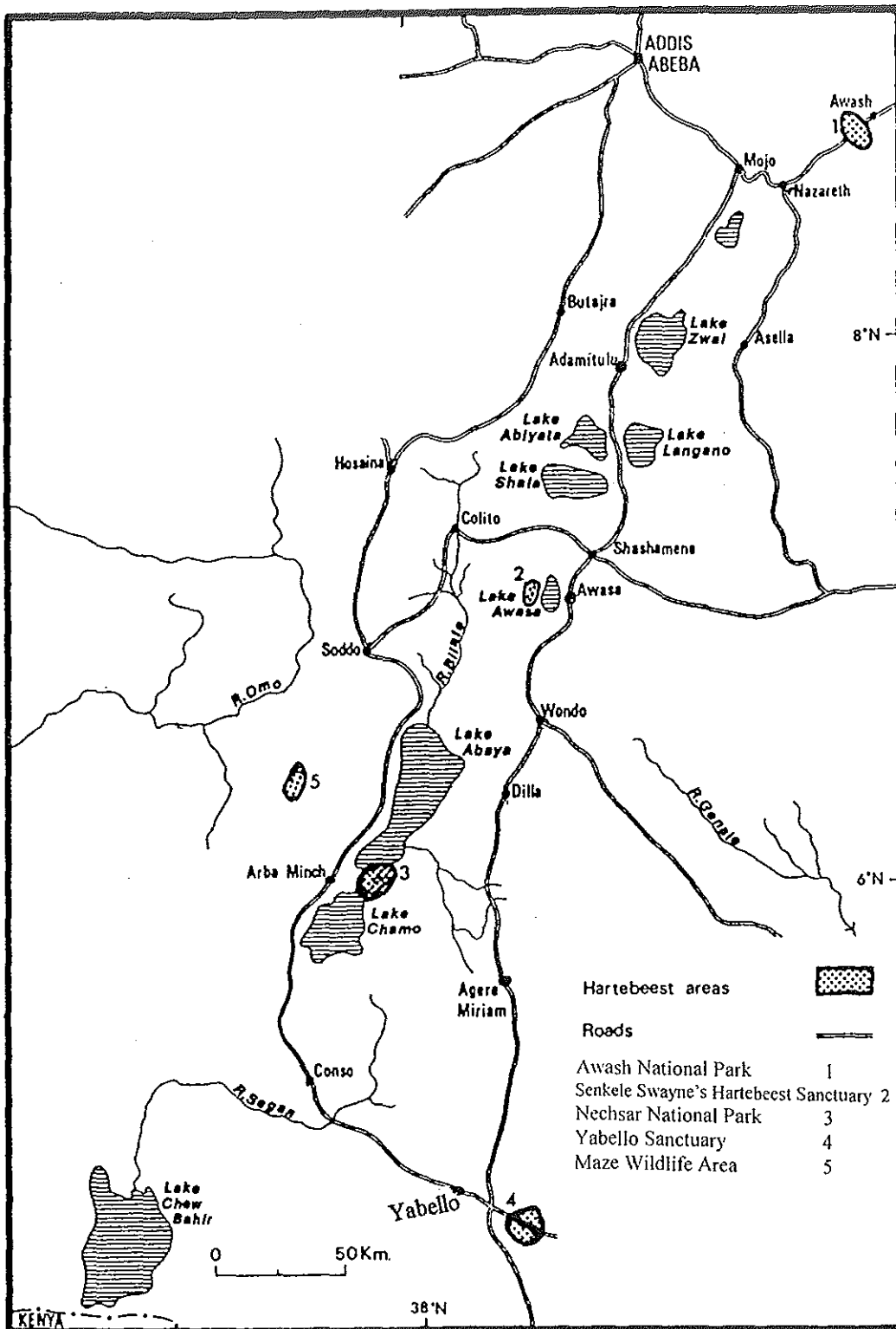


Figure 1: Distribution of Swayne's Hartebeest in Ethiopia (Modified from Hunting Technical Services, 1976)

According to Lealem Berhanu (1974), ninety hartebeests were translocated to Awash National Park and one hundred and ten to Nechsar National Park in May 1974. The reason for the translocation was the expansion of mechanized farms in Senkele area and the heavily settled pastoralists in the region.

Stephenson (1975) states that only few animals survived the operation. According to him, it is very likely that the population declined because of the increased encroachment by pastoralists on these National Parks. Tischler (1975) obtained information from a local headman that the translocated hartebeests had not yet joined the original population of the ANP. Generally, the translocation efforts of the animals by EWCO was not successful in both ANP and the NNP.

The hartebeest, once abundant, has been greatly reduced in numbers through direct killing and habitat modification by people. Kingdon (1982) noted that of all African ruminants the hartebeest probably suffered the greatest contraction in range. This may have been due to competition for forage with domestic cattle and also because it is easy to hunt. Since living in social groups of big numbers in a confined area is an integral part of its social system, the hartebeest is an easy target for hunters (Stanley-Price, 1978).

One of the most difficult problems facing those concerned with wildlife conservation in Africa is the tremendous toll taken by poachers (Philip, 1961). Local people have exploited Ethiopia's wildlife for subsistence. However, traditional method of hunting has never decimated wildlife and possibly it was a necessary factor for controlling the wildlife population (Andebrhan Kidane, 1982).

At present, the population size of the Swayne's hartebeest and its distribution in Ethiopia is not well

known due to the lack of research information. Consequently habitat loss, increase in human pressure and changes in land use threatens the future survival of Swayne's hartebeest. Poaching, habitat disturbance and poor management of the Sanctuary contributed to the rapid decline of the population of Swayne's hartebeest (Messana and Bereket Netsereab, 1994).

Larger herbivores are important natural resources. Their conservation and management require regular survey to provide a basis for measuring trends in population size and distribution (Elkan and Tchamba, 1995). This need of regular survey is even more obvious when the population we deal with is an animal, which is in real danger of extinction. Thus, the aim of the study was to determine the current population size, distribution in relation to vegetation types, home range and diurnal activity pattern of Swayne's hartebeest, and assess the attitude of the local people towards the animal.

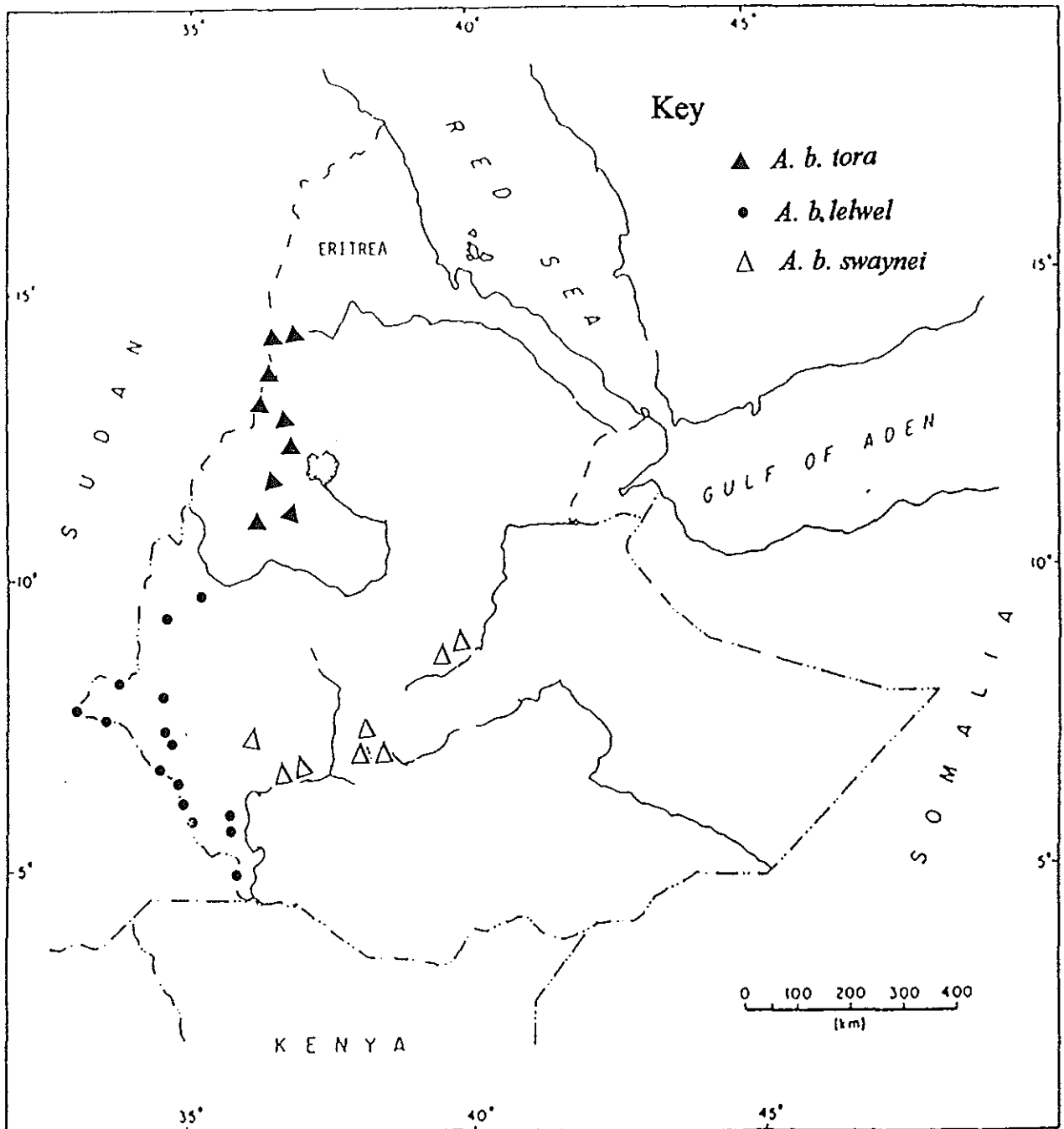


Figure 2: Distribution of the three subspecies of *Alcelaphus buselaphus* in Ethiopia (After Yalden et al., 1984)

1.2. Literature review

Early naturalists in the field (Swayne, 1903; Drake-Brockman, 1909) have given general description of Swayne's hartebeest. Bolton (1973) has given a more recent description of the animal. Sclater (1892) did the description of the type specimen.

The horns, carried by both sexes, spread into the wide graceful brackets. They are heavier in the males with more pronounced knobs (Bolton, 1973). The heart-shaped horns that gave the subspecies its name are usually hooked backward (Fig. 3). The general color is chestnut and the rump, hindlegs, and lower half of the forelegs, are brown. The tail-tuft is black and there is a black stripe extending from the shoulder to just above the 'knee' (Jackson, 1974).

Swayne's hartebeests in general resemble the vast majority of *Alcelaphus buselaphus* (Bolton, 1973). However, the subspecies of hartebeest differ conspicuously in morphology, coloration, and shape of horns (Grzimek, 1972). Swayne's hartebeest is the most attractive and colorful of the three subspecies of hartebeests (Tischler, 1975). Swayne's is the eastern race of *tora* to whom it is closely related. Both subspecies are smaller than the *lehvel*, but is distinguished from it by its considerable dark body color (Bolton, 1973). Hartebeests are large sized antelopes males weigh between 150 and 180 kg and females weigh on the average 5-10% less than males (Messana and Bereket Netsereab, 1994).

The main gaits of *Alcelaphus* antelopes are ambling walk and galloping, with horizontal neck and pointing muzzle down ward. When hartebeests are surprised or move away from danger, they toss their heads, give out a loud snort and stamp one fore-foot up on the ground before breaking into a fast gallop (Bere, 1962).

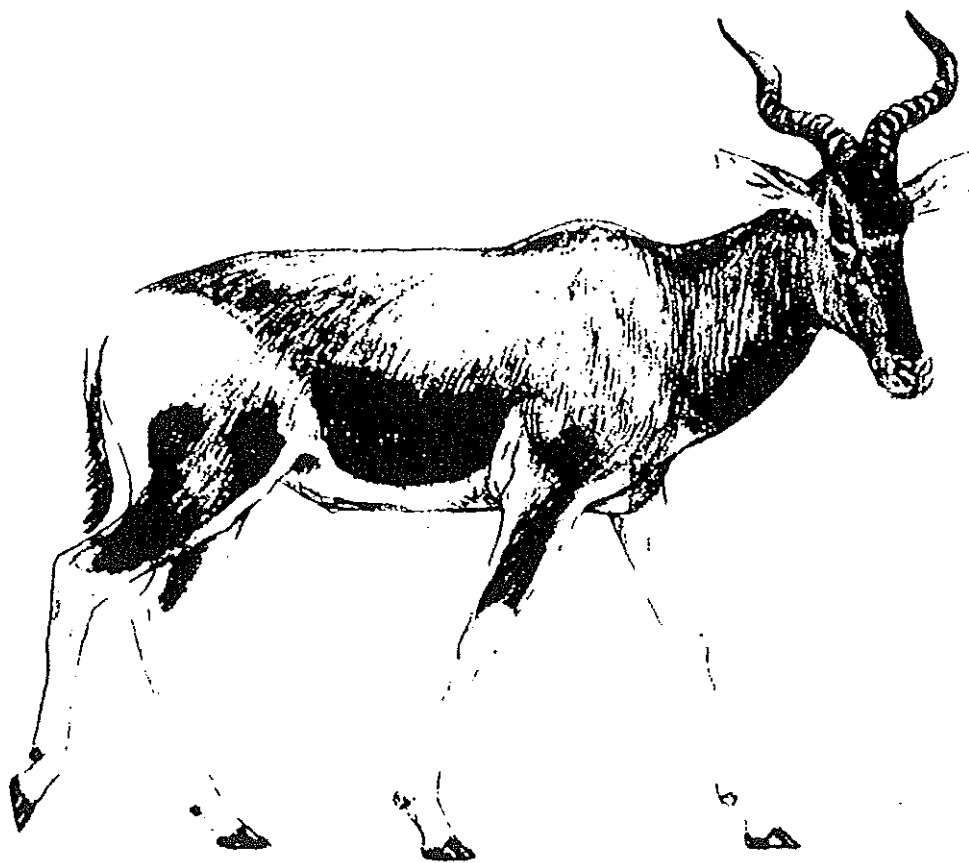


Figure 3: Physical characteristics of Swayne's Hartebeest (After Kingdon, 1997)

There are different opinions about the classification of the hartebeests. Some consider the group to be several geographic representatives of the same species, while others consider it to represent different species. The shape of horns and color of the fur seem to be the most important diagnostic characters. Hartebeests have long face and high withers and sloping hindquarters. Some authors still consider the shape of the horns as the most important character for species category (Last, 1982). However, the presence of hybrid forms has led many systematists to regard them as subspecies.

Hartebeests inhabit dry savannas and grasslands (Nowak, 1991). Trials have shown that hartebeests select a higher proportion of grass leaves in the rains, and sheathes are also selected at all times but particularly in defoliated swards (Kingdon, 1982). Wilson (1966), Kingdon (1982) examined a large number of stomachs of Lichtenstein's hartebeest and found 95% grass, the rest being leaves or shoots which were eaten off stumps or low shrubs of *Combretum* and other species. Lamprey (1963) recorded 3.75% of herbs and shrubs in the diet of *A. b. cokei*. Stewart and Stewart (1970) also noted very few greens or dicotyledons and there was a notable avoidance of *Cynodon* by hartebeest in their study. Gosling (1974) identified the two most consistent features of hartebeest habitat as medium or long, coarse, grassland, and an ecoton, usually between woods or scrub and open grassland. Estes (1991) pointed that like most grazers, *Alcelaphines* feed day and night, but generally are less active when it is dark and predation risk is greatest.

Non-migratory African herbivores like hartebeests satisfy their nutritional requirements within a limited home range by seasonally shifting between habitats and/or by selecting species and/or parts in different seasons. Selectivity in grazers generally result in an increase in the proportion of high amount of leaf in ingested food has been shown in buffalo (Sinclair and Gwynne, 1972) and

hartbeest (Stanley-Price, 1977).

Reproduction may be markedly seasonal. The young of *Alcelaphus buselaphus* are born from October to November in South Africa and from December to February in southern Ethiopia (Lewis and Wilson, 1979). The seasonal breeding of Swayne's hartbeest differs from the breeding regime of Coke's hartbeest. This has been shown by Stanley-Price (1974) and Lewis and Wilson (1979), that the latter conceive as soon as environmental conditions and body reserves allow. The gestation period is about eight months. The behavior of female hartbeests during the time of parturition is very different from that of wildebeest (Haltenorth *et al.*, 1977). Instead of calving in group in open plains, the hartbeest female isolates herself in scrub areas to give birth and leaves the calf "lying out" and hidden for a fortnight, only visiting briefly to suckle.

Hartebeests are gregarious, living in organized herds (Nowak, 1991). Habitat type often modifies the group size of ungulates increasing their population size with increase of habitat openness (Estes, 1974; Jarman, 1974; Hirth, 1977 and Van Vuren, 1983). One of the explanations for this is that, in an open area, individuals in a bigger group have a greater chance of detecting predators. At the same time they have a higher probability of escaping from predation (Estes, 1974; Hirth, 1977 and Cowan, 1987). In closed habitats, on the other hand, a smaller group has a lower probability being victimized by predators (Estes, 1974; Jarman, 1974; Hirth, 1977; Fritz and Garine, 1996). It has also been postulated that keeping visual contact (easier in open areas) is an important factor influencing the group formation. Thus, group size is determined by the degree of visibility within the habitat (Lagory, 1986). Group size may also be influenced by food conditions. For instance, Hanley (1982) explained that the increase of group size in elk (*Cervus elaphus nelsoni*) and blacktailed deer (*Odocoileus hemionus columbianus*) was caused by a change of food selection

pattern from a single plant to microhabitat patches that provided food of better quality than average.

If foraging efficiency plays an important part in determining group size, then group size should vary not only between habitats, but also between seasons. Thus, it is considered that both food conditions and avoiding victimization by predators contribute to determining group size of ungulates (Hanley, 1982).

Ungulates rarely range randomly (Duncan, 1983). A number of factors such as season, availability of food, breeding activity and population density affect home range estimates (Eberhardt *et al.*, 1984). Vegetation of an area is one of the most important factors of the environment that determines the distribution of wildlife (Balakrishnan and Easa, 1986). A number of wild species respond to environmental change by migration, while others exploit a finer grain of environmental heterogeneity with more localized movements (Stelfox *et al.*, 1986). Craighead *et al.* (1973), Koepl *et al.* (1975), Don and Rennolls (1983), Samuel and Garton (1985) and Samuel *et al.* (1985) defined home range as that area traversed by the individual in its normal activities of food gathering, mating and caring for young. Accurate estimation of size of home range is an important prerequisite to a better understanding of a species behavioral ecology and management (Sanderson, 1966; Cederlund and Okarma, 1988). The method used to collect movement data affects home range estimates (Jones and Sherman, 1983), with direct observation generally acknowledged as being superior to the conventional live trapping (Adams and Davis, 1967).

Biotic preservation is proving difficult in all parts of the world due to the world human population explosions, mechanized agriculture, and expanding mineral and timber extraction (Myers, 1983; Pryde, 1986; Wilson, 1989; Samson and Knopf, 1996). Natural habitats around the world are lost in faster rates as an expanding human population converts them to agriculture, forestry, and urban

centers (Samson and Knopf, 1996). As these habitats are altered, great number of species become extinct before they are recognized, and as such, the entire ecosystem is threatened (Wilson, 1989).

The status of Swayne's hartebeest is classified as 'Endangered' by the International Union for the Conservation of Nature and Natural Resource (IUCN, 1972, 1984). Swayne's hartebeests in SSHS are in greater danger of extinction now than any other time in the past. The range of subspecies is threatened by further loss of habitat to subsistence agriculture and livestock overgrazing, although poaching is still one of the main threats to the survival of the animals.

Of the four extant population of *Alcelaphus buselaphus swaynei*, the Senkele population is by far the largest, and probably constitutes more than 80% of the surviving world population (Lewis and Wilson, 1979). Due to the change of government in Ethiopia in 1991, the local people raided the Senkele Sanctuary (Messana and Bereket Netsereab, 1994).

1.3. Objective

- To assess the current population size and distribution of Swayne's hartebeest in SSHS.

The specific objectives

- To determine the current population size and trends of Swayne's hartebeest.
- To determine the population structure.
- To assess the distribution pattern in relation to vegetation communities, livestock and human interference
- To investigate their movement and home range size
- To describe the diurnal activity patterns

2. DESCRIPTION OF THE STUDY AREA

2.1. Location and topography

The study area, SSHA, is located about 300 km from Addis Ababa and about 12 km from the road running between Shashemene and Alaba Culito on the road to Arba Minch. The Sanctuary is currently in the Oromia Administrative Region, East Shoa Zone (Fig. 4). The area is situated on the Western side of the Ethiopian Rift Valley, found approximately on $7^{\circ} 12'N$, $38^{\circ} 17'E$ (Messana and Bereket Netsereab, 1994.) The Sanctuary was established in 1976 with the primary objective of saving the endangered subspecies, Swayne's hartebeest (EWCO, 1990 and Hillman, 1993). The 200 km² occupied by the hartebeest in 1972 was reduced to about 58 km² in October, 1973, and then to 36 km² (Messana and Bereket Netsereab, 1994). At present, about 28 km² of the Sanctuary remains for the hartebeest, as the rest of it was taken over by the peasants living nearby (Fig. 5).

To the east of the Sanctuary are the Tesisa, Borena and Lalima Hills. North and south of the Sanctuary lie extensive pasture and agricultural areas belonging to the Arsi and Sidama people respectively. The western part of the Sanctuary is demarcated by Senkele State Farm, which remained uncultivated since 1995 (Fig. 4). Most of the area is a gently undulating plain at an altitude of between 2000 and 2100 m A.S.L. (Messana and Bereket Netsereab, 1994).

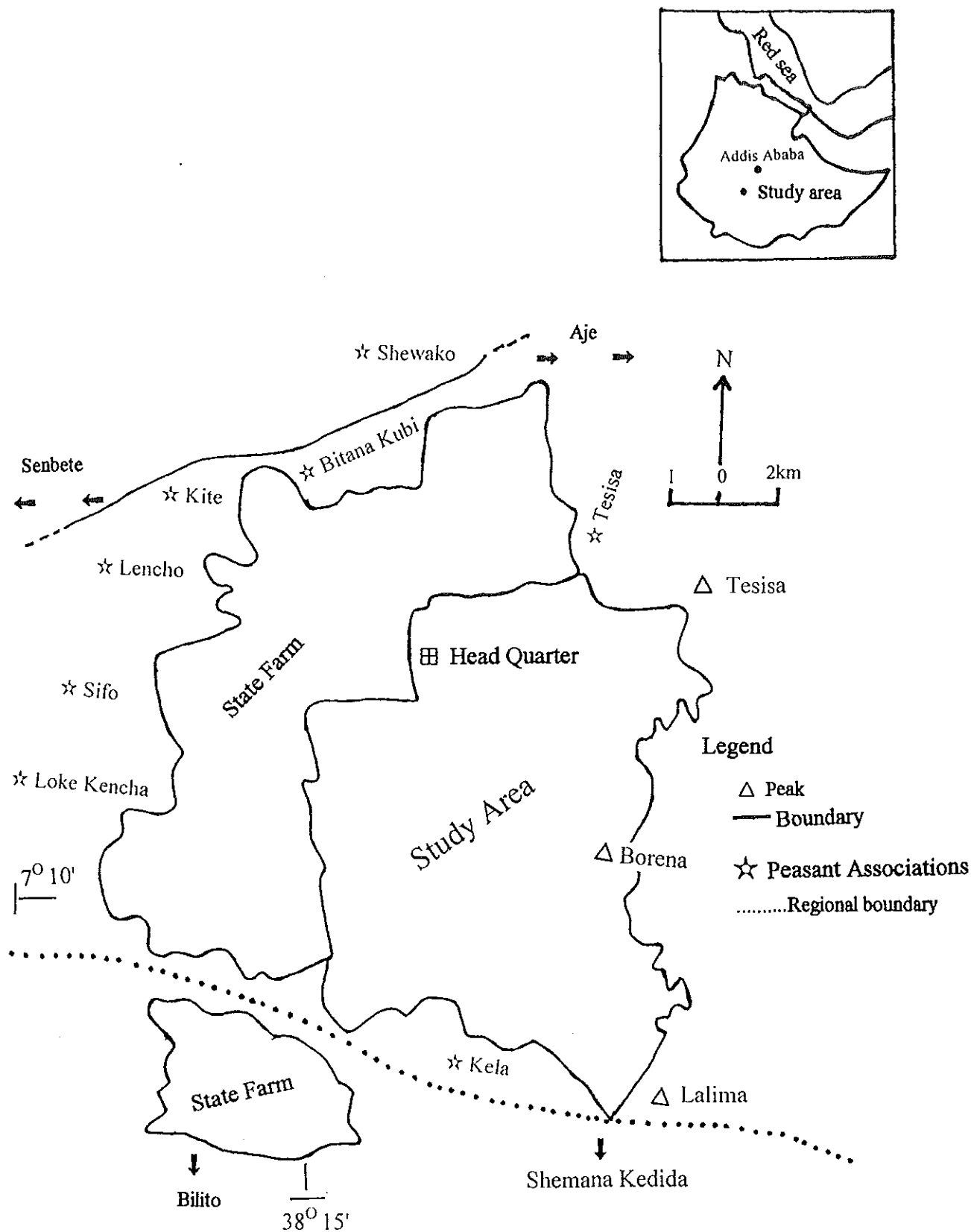


Figure 4: Map showing the study area (After Messana and Bereket Netsereab, 1994)

2.2. Climate

Rainfall at Senkele has a moderately bimodal pattern, typical of the 'Woina Dega' Agro-Ecological Zone of Ethiopia (1,700-2,700 m altitude; 600-1200 mm annual rainfall). The three months dry season, from November to January, is followed by the 'Belg rains' (small rainy season), from April to May, and the 'Kiremt rains' from June to August. During the present study period, however, there was no 'belg rains', and as a result February and March were taken as part of the dry season. Mean monthly temperatures are relatively constant throughout the year, but diurnal variations can be considerable. Monthly maximum temperature ranges between 26 °C in the dry and 21°C in the late wet season. Monthly minimum temperatures are lowest during the dry season, falling to 8-9 °C on some occasions, and rising to their maximum values of 14-15 °C between March and May. Predictably, relative humidity values increases from 30-40% in the dry season to 50-60% in the wet season. During the dry season, cloud cover is at a minimum and wind speeds are at their maximum, contributing to high levels of evapo-transpiration associated with tropical climatic pattern (Messana and Bereket Netsereab, 1994).

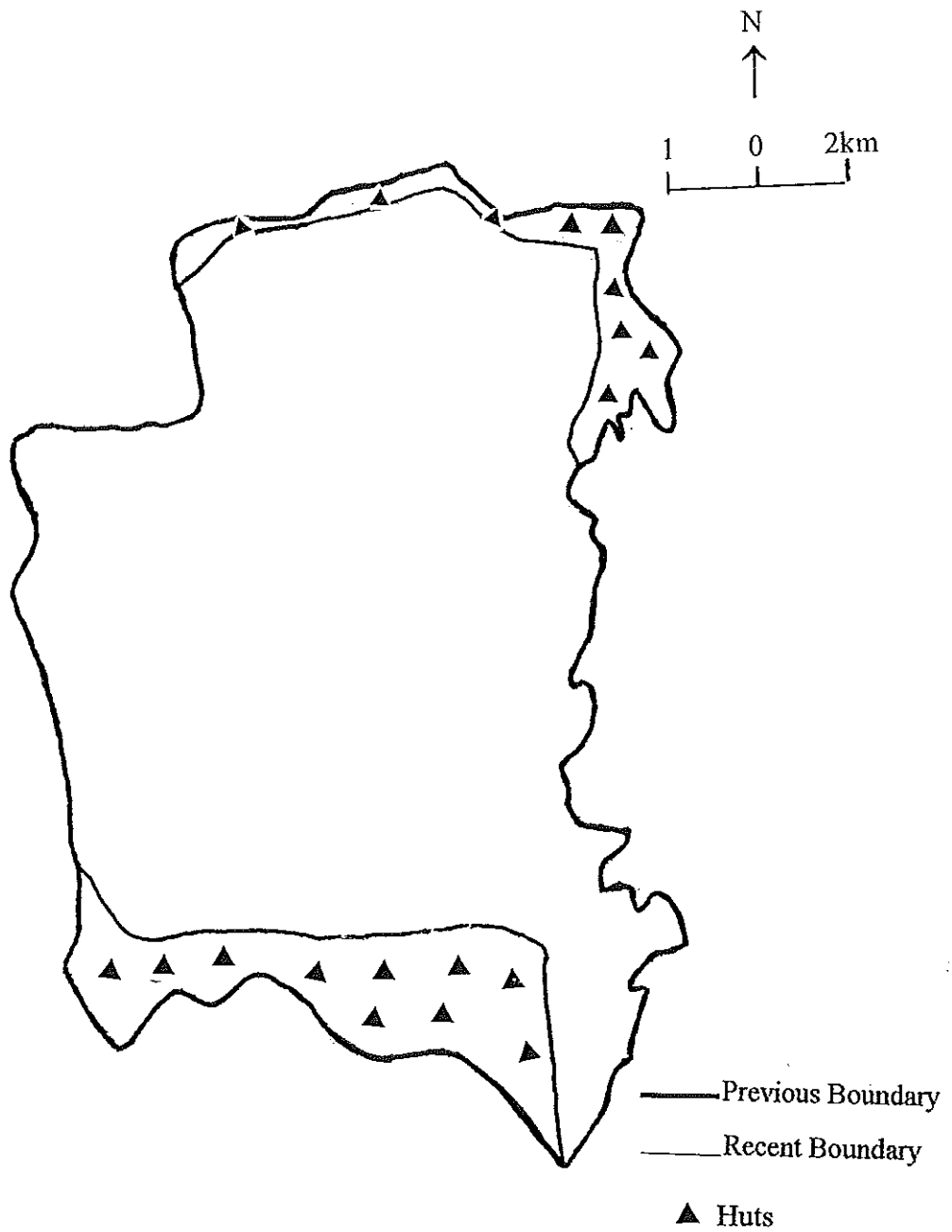


Figure 5: Map showing the previous and the present boundary of the study area.

2.3. Soil and geology

The result of soil analysis in Senkele area is given in Table 1. The main geological formation in the Senkele area is ignimbrite, which on weathering has given rise to heavy textured, dark sandy loam to clay top-soils, moderately deep to deep on the open plains, but shallower on slopes. Sub-soils vary from gritty, brownish sandy loams to clay (Hunting Technical Services, 1976; Messana and Bereket Netsereab, 1994). The erodability of the soil is very high, particularly along tracks and plough lines, where, gullies are rapidly formed once the vegetation cover is removed, (Hunting Technical Services, 1976).

Table 1: Results of soil analysis in the Senkele area.

Source: Messana and Bereket Netsereab (1994); Senkele State farm (1999).

Parameter	View
pH	6-6.63
Sodium (ppm)	0.499-0.76
Potassium (ppm)	0.397-1.05
Calcium (ppm)	8.2-17.3
Magnesium (ppm)	1.7-10.8
Fe (ppm)	46-101.4
Mn (ppm)	1.2-5.14
Zn (ppm)	5.6-21.2
Cu (ppm)	0.22-1.94
Org. matt.(%)	2.57-16.84
Tot. N (%)	0.19-0.57
Sand (%)	55-68
Silt (%)	15-33
Clay (%)	9-17

2.4. Vegetation

Messana and Bereket Netsereab (1994) analyzed the vegetation within the Sanctuary based on differences in the species composition and cover of grasses resulted in the identification of three distinct communities (Fig. 6). These are:

1. Pennisetum Grassland (PG).
2. Pennisetum Grassland Type 2 (P2).
3. Mixed Grassland (MG).

Due to the farming activities and the construction of huts within the Sanctuary, these vegetation communities available to Swayne's hartebeest were much reduced compared to the previous years (Table 2).

Table 2: Comparison of vegetation communities in previous years and the present study period.

Vegetation type	Previous cover		Present cover		Area reduced	
	(km ²)	(%)	(km ²)	(%)	(km ²)	(%)
Pennisetum Grassland (PG)	18.1	49.7	17.1	61.1	1.0	11.9
Pennisetum Grassland (P2)	14.5	39.7	10.2	36.4	4.3	51.1
Mixed Grassland (MG)	3.8	10.5	0.7	2.5	3.1	36.9
Total	36.4	-	28.0	-	8.4	-

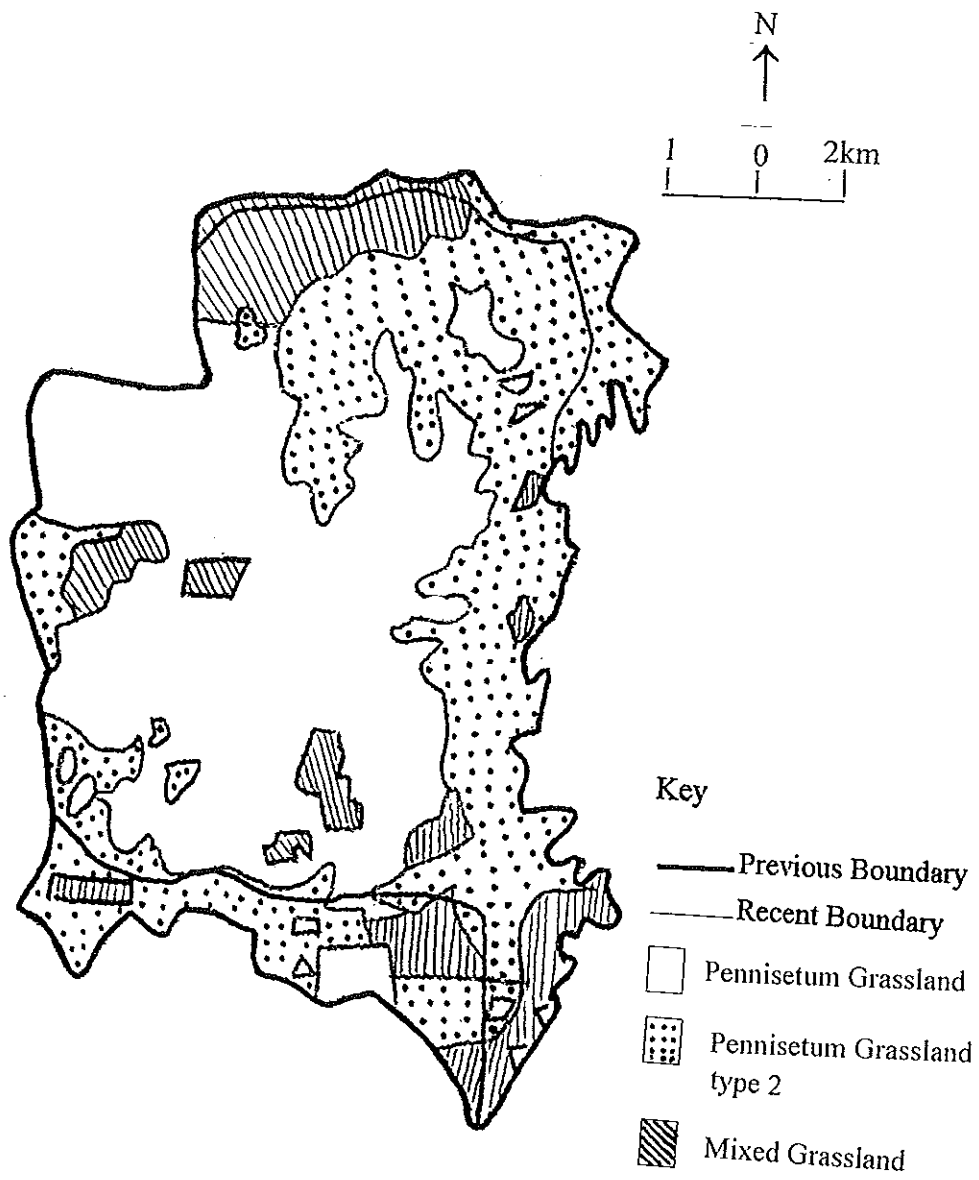


Figure 6: Map showing the vegetation communities of the Sanctuary.

2.5. Wild animals

In addition to the hartebeests, several other species occur at Senkele. Oribi (*Ourebia ourebi*) was probably very common in the past since Senkele means Oribi in the local dialect (Hunting Technical Services, 1976).

The common Jackal (*Canis aureus*) is frequently seen, and perhaps it is the most important predator of newborn hartebeests. Common smaller mammalian carnivores include African civet (*Viverra civetta*), ratel (*Mellivora capensis*), Serval (*Felis serval*), White-tailed mongoose (*Ichneumia albicauda*). The large carnivores have traditionally been hunted for sport or as pests by the local pastoralists. Lion (*Panthera leo*) has now disappeared, whilst Leopard (*Panthera pardus*) seems still existing in the more wooded areas around Lalima (Messana and Bereket Netsereab, 1994; Gemed, Pers. Comm., 1999). Spotted hyaena (*Crocuta crocuta*) can be heard in the night and about 12 were killed by EWCO (Gudesa, Pers. Comm., 1999).

2.6. The land use system

In the Senkele plains, the dominant form of land use up to 1940s was pastoralism. Subsequently, the influx of a powerful new elite following the Italian war (1936-1941), led to the development of mechanized farming in the area (Helland, 1976). In the late sixties, areas of pasture in the area were increasingly brought under cultivation and pressure on remaining pasture was intensified (Messana and Bereket Netsereab, 1994).

The traditional use of the land by man has included transhumant grazing by the domestic animals of the Arsi and Sidamo pastoralists. Due to the lack of permanent water and the small size of the grazing area, the nomadic pastoralists used to move to other areas during the dry season (Gemed, Pers. Comm.).

There was a serious conflict between the Sanctuary and the State Farm that lies to the west of the Sanctuary, as the hartebeest were raiding the plantations of the bordering State Farms. In order to prevent the damage caused by the hartebeest through crop raiding and trampling, the State Farm employed full-time guards. In addition, corns were planted on the edge of the farm by the State Farm exclusively for the hartebeests (Pers. Comm., Solomon Yirga) in an attempt to limit its losses. At present, however, the land of the State Farm near the Sanctuary was left uncultivated for more than four years.

Livestock production is secondary to crop production. The principal crop of the area is maize (*Zea mays*) but some small areas under haricot beans (*Phaseolus vulgaris*) are also observed.

3. MATERIALS AND METHODS

3.1. Duration of study

The study was undertaken between February 1999, and December 1999. Quantitative data were obtained on the population size, structure, distribution, home range size, activity pattern and assessment of the impact of local communities living around the Sanctuary, on the dry and wet seasons. A reconnaissance survey of the Senkele Swayne's Hartebeest Sanctuary was conducted covering most of the area. The study commenced on February 23rd, 1999. It aimed at the preliminary observation of the study area which included assessing the distribution of the Swayne's hartebeest and observing the vegetation type classification previously carried out by other workers.

Separation of the study period into the dry and wet seasons was important in order to observe the influence of the different seasons and the vegetation communities on the animal. Seasonal differences in the population size, distribution, home range and diurnal activity pattern of the hartebeest in the study area were compared. Separation of dry and wet seasons was based on the change of rainfall pattern, color of the grass and its amount. After identifying the seasons, the study continued from February 1999 to December 1999.

3.2. Dividing the study area

The entire study area was divided into five blocks with artificial and natural boundaries (Fig. 7). The term 'block' in this context refers to a small area with natural and/or artificial boundaries that can be easily identified on maps as well as in the field. The distance between consecutive transects varies depending on the vegetation cover. A distance of 1 km between block-1 and 2, and 0.8 km between areas of the rest (blocks 3, 4 and 5) was taken. Block-1 and 2 had less acacia cover and the other blocks were relatively denser with acacia and other vegetations on the eastern side.

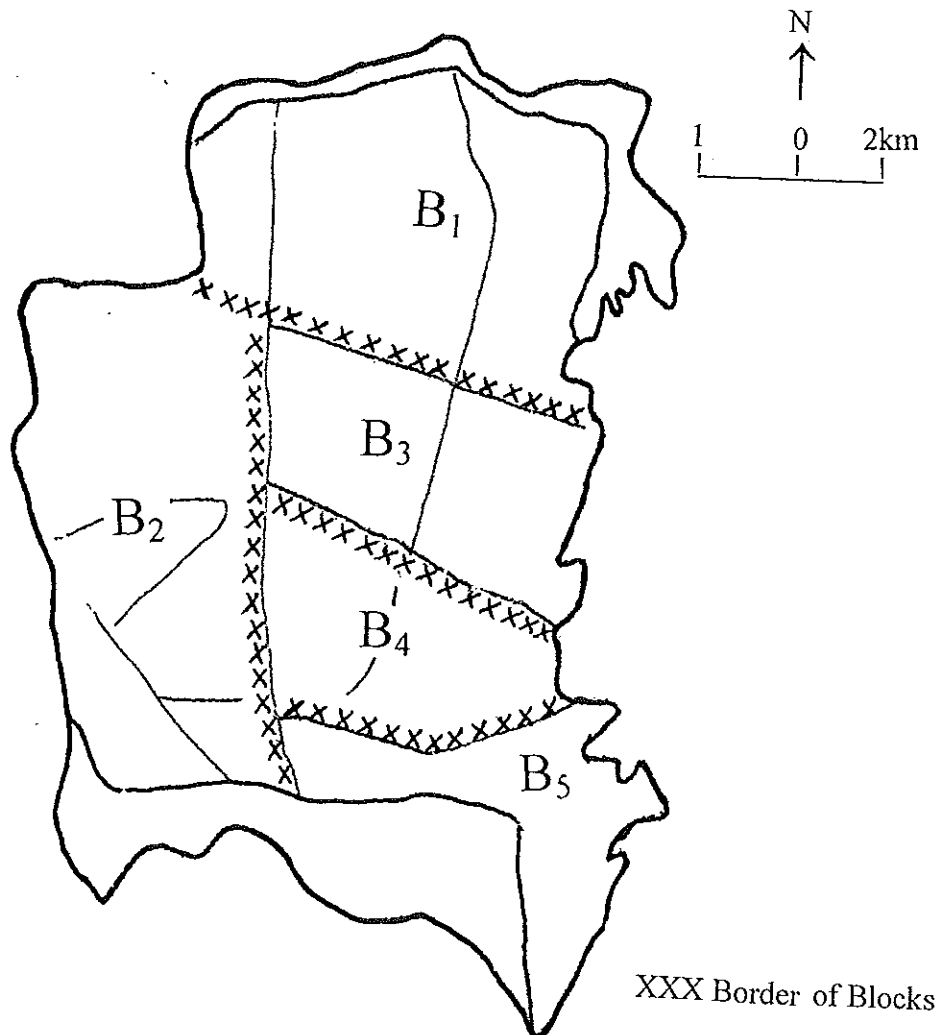


Figure 7: Map showing division of the study area into five counting blocks.

3.3. Population estimation

Total estimation of hartebeest population size involved intensive coverage of the whole study area, in both the dry and wet seasons. Total counts were made using direct count method based on silent detection to estimate the population size as was adopted by Harper *et al.* (1967); Martinka (1969); Leuthold and Sale (1973); Mukinya (1973); Norton-Griffiths (1978); Melton, (1983); Sale and Berkmuller (1988); Caughley and Sinclair (1994); Wilson *et al.* (1996). Such direct observational technique was most appropriate for censuses of medium sized to very larger terrestrial mammals that live in a relatively open habitats on fairly flat terrain (Norton-Griffiths, 1978; Wilson *et al.*, 1996) since it is relatively easy to locate and count every single animal in a census area. Direct counts of large mammals can be made by dividing the study area into blocks and counting the number of individuals in each block (Sale and Berkmuler, 1988; Sutherland, 1996). In the beginning of the project it was planned to follow road transect census method conducted by some people as obtained from the literature. However, the situation of the Sanctuary has completely changed compared to these days. Some of these are, human population increase around the Sanctuary, construction of plenty of huts inside and on the border of the Sanctuary and livestock abundance. From this point of view, road transect census has a lot of uncertainty since the ranging pattern of Swayne's hartebeest is limited by the above factors. Hence the most direct way to estimate the abundance of a biological population, total count method, was chosen as described by Burnham *et al.* (1980). Observational techniques provide total counts of individuals inhabiting a survey area if the entire area is searched, if all animals could be located during searches, and if located animals are counted accurately (Norton-Griffiths, 1978).

The counting was carried out using unaided eyes and/or binoculars, while on foot and/or on

horseback, four times during the dry season (February, March, November and December, 1999), and four times during the wet season (May, June, July and August, 1999). The censuses were conducted when the Swayne's hartebeests were most active (9:00-11:00 AM) in the morning and (3:00-5:00 PM) in the afternoon following the method of Lewis and Wilson (1979).

Each count was completed in one day with the help of 2-3 experienced Scouts of the Sanctuary. Data were collected as per the animal census form (Appendix 3). During these counts records were also taken on the numbers and distribution of domestic stocks as well as other wild animal species (herbivores and carnivores).

Good visibility and the small size of the study area help to make accurate counting (Plessis, 1972 and Eltringham, 1977). This fact made it possible to make a total count of the Swayne's hartebeest with a reasonable degree of accuracy.

3.4. Sex and age structure

During the counting, detailed observations of the entire herd were made, which enabled to categorize them into their respective age groups. The categories used are Calf, Juvenile, Sub-adult and Adult and the sex of each sub-adult and adult individual was identified. Knight (1970); Bergerud (1971); Peterson and Casebeer (1972); Kitchen (1974); Lewis and Wilson (1979); Woolf and Harder (1979); Bowyer (1984); Schaller *et al.* (1987); Balakrishnan and Ndhlovu (1991) have used such a method for categorizing herds of different animals.

Clues to age and sex were provided by body size, horn sizes, pelage and above all the primary sexual characteristics such as the presence of penis sheath, scrotum or udder as described by Caughley, (1977) and Wilson *et al.* (1996) for different animals. Using such criteria as the genitalia and variations in the size and shape of horns, it was possible to place individuals of different animals into approximate age and sex categories (Allsopp, 1979).

The female Swayne's hartebeests are distinguished from the male by their smaller size. Horns are present in both sexes and the horns are shorter in the females than in the males. In calves the horns grow first as a straight spike developing their first twist by age of twelve months (Kingdon, 1982). By the end of the second year, horns reach their adult shape, diverging widely from the pedicle and sharp hooks facing backward (Hunting Technical Services, 1976; Kingdon, 1982). Sex ratios for the herds were obtained from the direct counts of animals at feeder conducted during the research period using the method of Woolf and Harder (1979) and Melton (1983).

3.5. Group size

During each total count, the location of every group of Swayne's hartebeests was plotted on the map of the area. Such method was applied by several workers on other animals (Hunting Technical Services, 1976; Dinerstein, 1979; Lewis and Wilson, 1979; Hudson and Karstad, 1984; Hillman, 1987). Individuals were considered as members of the same group if the distance between them was less than 50 m as used in Borkowski and Furubayashi (1998). Hartebeest group member was defined as any hartebeest that was apparently in the same area, that responded in a related manner to external stimuli and was moving in the same direction or behaving similarly with the rest of the

group members.

3.6. Distribution and vegetation type utilization

Following the method of Martinka (1969); Hunting Technical Services (1976) and Compton *et al.* (1988) to assess the distribution pattern and the diurnal utilization of each vegetation type, data from the breakdown of the total counts were used. The location of each herd and the vegetation type at each location was recorded. This could give dry and wet seasons distribution and vegetation type utilization of each herd as in Larson *et al.* (1978) and Norton-Griffiths (1978). Taking group sightings as scores with respect to habitat types and comparing their frequencies to the relative availability of vegetation types, it was possible to detect habitat utilization (Harvey, 1974).

'Utilized' vegetation type is here defined as areas where most hartebeests were observed grazing at a definite time whether in a single group or association with different group of herbivores on the basis of the criterion developed by Andere (1981).

3.7. Movement and home range

Data on movement and home range size were obtained from the ground observation of all the groups of Swayne's hartebeest. All the groups were located two times in 24 hours for eight months following the method of Leuthold and Sale (1973); Mukinya (1973) and Wilson *et al.* (1996). A number of naturally marked individuals (broken legs, broken horns, etc.), group size and

composition of animals permitted identification of a group of Swayne's hartebeest as was done by Leuthold (1972) for buffalo.

As used in Pennyquick (1975), the technique used in mapping home ranges was by checking the movement and location of the animals. The location of the animals on the ground was approximated on the map and then transferred to a working map of the same scale (1:50,000) with 1 km² grids as was adopted in Martinka (1969); Wyatt and Eltringham, 1974; Lindzey and Meslow (1977); Larson *et al.* (1978) and Murray (1982). Points on the ground, which were readily identifiable on a 1:50,000 map showing features such as roads and hills were used to mark the location accurately.

The size of home range for the animal was calculated by the Minimum Convex Polygon (MCP) following the method used by Hayne (1949); Sanderson (1966); Van Winkle (1975); Southwood (1978); Dedulding (1981); Kangwana (1996); Wilson *et al.* (1996) and Massei *et al.* (1997) for studying different animals. The boundary of the home range was obtained by connecting the most peripheral locations where the members of a group have been seen, following the method of Goddard (1967); Nelson and Mech (1981); Singer *et al.* (1981); Anderson (1982); Mills (1982); Schoen and Kirchhoff (1985); Catt and Staines (1987); Jaremovic and Croff (1987) and Massei *et al.* (1997).

3.8. Diurnal activity pattern

The method used to record the activity pattern of Swayne's hartebeest followed the one described by Rollinson *et al.* (1956) for the study of Zebu cattle and Mitchell (1977) for the study of Lesser Kudu. The technique involves classifying the behavior into a number of specific activities and noting which one is being carried out in a given time.

To obtain information on diurnal activity pattern particular hartebeests were observed for extended period of time 6:00 to 18:00 hours two days per month at 4-min interval for eight months, as described by Carighead (1973); Seidensticker (1976); Lewis and Wilson (1979) and Eberhardt *et al.* (1984) for the study of different animals. Direct observations were made from the ground as used by Dinerstein (1979) and Ono *et al.* (1988) for studying different animals.

The diurnal activities were recorded under the headings: 'feeding', 'standing', 'lying', 'walking' and 'other activities.' 'Walking' was recorded only if the hartebeest was walking at a steady pace, usually with the rest of the herd, and not if it were merely moving from one feeding position to the next based on the criterion developed by Wyatt and Eltringham (1974) for studying elephants. Other activities include social interactions, suckling, grooming, fighting, running.

3.9. Assessment of the impact of the local people

In order to have a better understanding of the activities of the local people in relation to the hartebeest and their impacts on the Sanctuary, field survey of the people living in the Sanctuary and its surroundings was undertaken. The method used for assessing impacts of the local people included meeting elderly people who are respected by their community, any member of the community, local officials, and warden and scouts of the Sanctuary. The discussions made were guided by the Questionnaire prepared for this purpose as it was used elsewhere by O'Shea *et al.* (1988) (Appendix 4).

4. RESULTS AND DISCUSSIONS

The results and discussions of population estimation, structure, group size, distribution and vegetation type utilization, home range, diurnal activity pattern and impact of local people are given as follows.

4.1. Population estimation

Eight total counts were undertaken during the study period (February to December 1999). The results of each total count of Swayne's hartebeest in the study area is given in Table 3. The highest total number of hartebeest counted was 179 in December 1999; the lowest number was 145 in July 1999 (Fig. 8). Averages of 150 and 173 hartebeests were counted during the wet and dry season's censuses respectively (Table 4). There was no marked differences in the total number of hartebeests counted in the dry and wet season. However, there is slight increase in the dry season compared to the wet season (Fig. 9). This may be due to the fact that the animals give birth mainly in the dry season, December to February (Lewis and Wilson, 1979; Messana and Bereket Netsereab, 1994). In addition it may be accounted for by the random distribution of the population all over the area due to the abundance of food resources during the wet season that may have made counting more difficult.

Table 3: Results of eight total counts of Swayne's hartebeest.

Month	Counting blocks					Total
	B-1	B-2	B-3	B-4	B-5	
February, 1999	10	-	62	61	39	172
March, 1999	15	4	58	60	32	169
May, 1999	7	96	3	39	11	156
June, 1999	21	11	46	40	31	149
July, 1999	10	99	22	2	12	145
August, 1999	17	106	13	5	9	150
November, 1999	8	-	81	70	12	171
December, 1999	20	-	76	68	15	179
Total	108	316	361	345	161	1291
Average	13.5	39.5	45.1	43.1	20.4	161.4

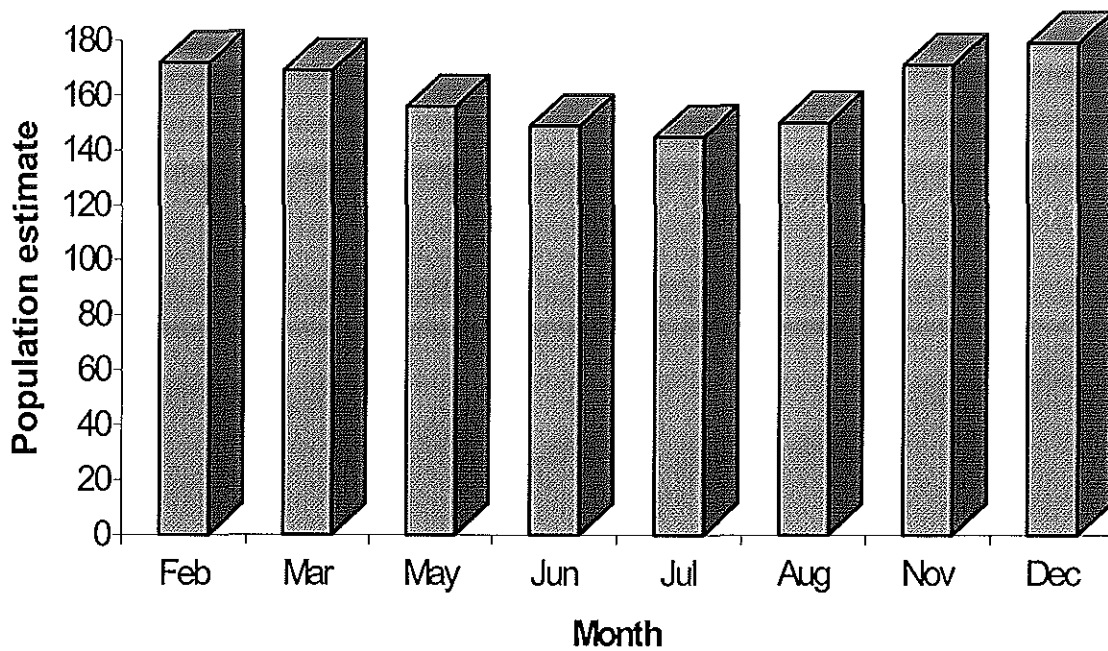


Figure: 8. Monthly population estimation of Swayne's hartebeest in 1999

Table 4: Average number of Swayne's hartebeest counted in five counting blocks during the dry and wet seasons.

Counting block	Dry season	Wet season	Average
B-1	13.2	13.8	13.5
B-2	1	78	39.5
B-3	69.3	21	45.1
B-4	64.8	21.5	43.2
B-5	24.5	15.7	20.1
Total	172.8	150	161.4

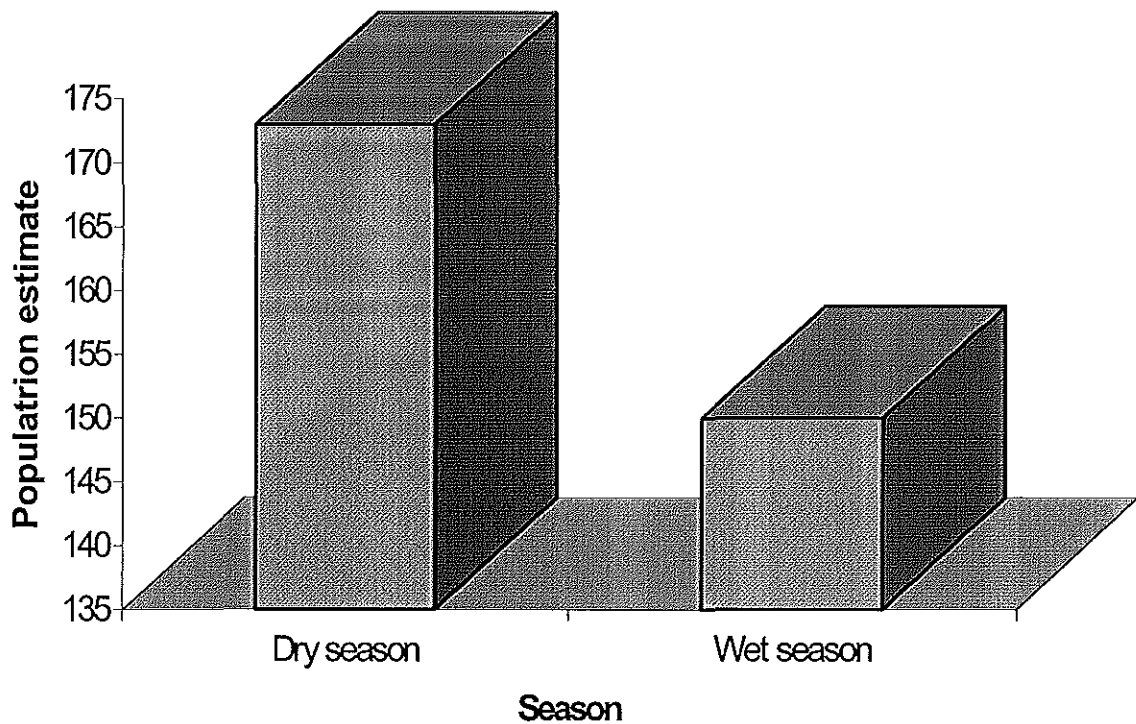


Figure: 9 Comparison of Swayne’s hartebeest counted in both seasons

Some counting blocks had higher numbers of hartebeests than others depending on the habitat quality, influence of human activities and livestock distribution (Table 4). The highest average number of hartebeest counted was 45 in block-3 and the lowest number was 13 in block-1 (Fig. 10). However, when we consider each block in a given season, during the wet season, in B-2, the highest number of 78 individuals was counted. The same block had the smallest number of individuals counted during the dry season (Table 4).

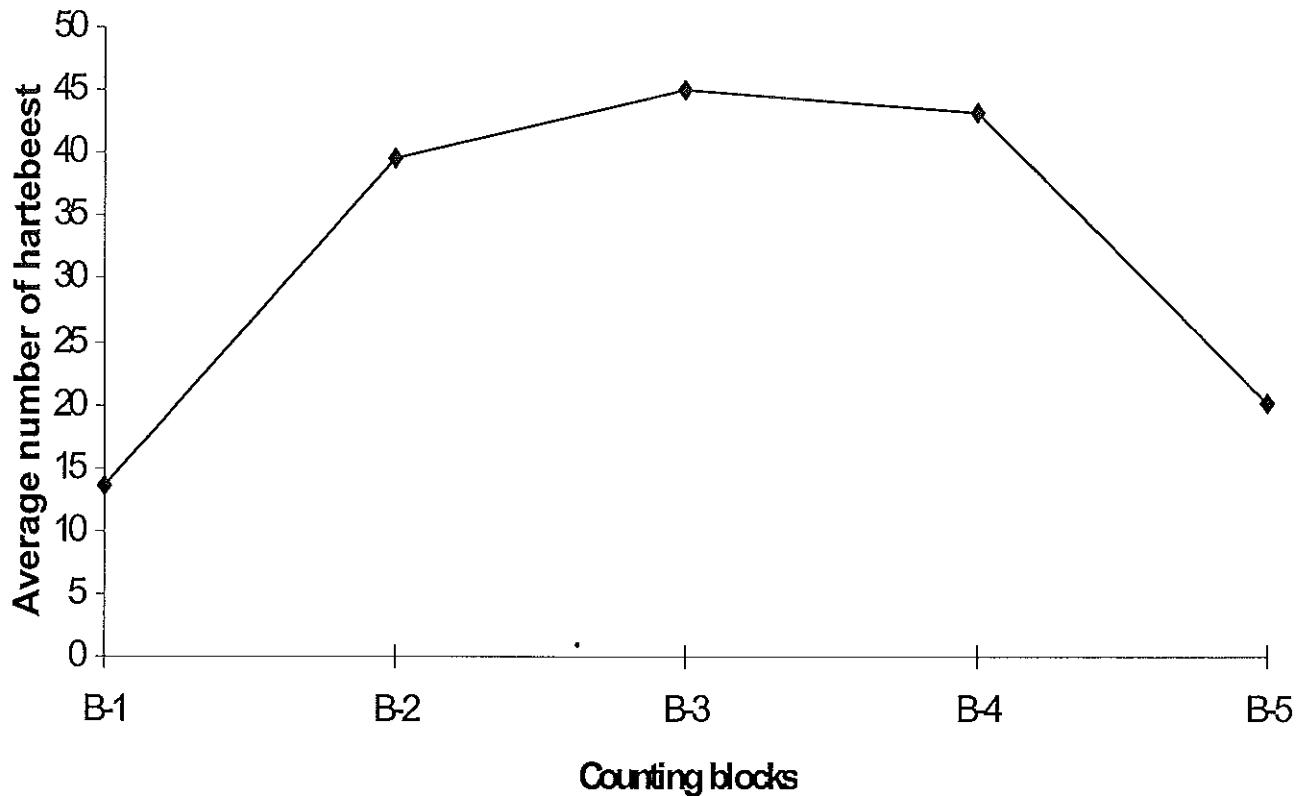


Figure 10: Comparison of Swayne's hartebeest in each counting blocks.

4.1.2. Population trends

In the present study, only an average of 161 hartebeests were observed (Fig. 11). Near the end of the last century, vast numbers of Swayne's hartebeest occurred in Somalia, with perhaps a dozen herds in sight at one time and each herd composed of 300-400 individuals (Swayne, 1903). Shortly afterwards these stocks were decimated by rinderpest and the race is now extinct in Somalia. In the Ethiopian Rift Valley it is reduced to an estimated maximum of 800 animals concentrated in just four Known localities (Bolton, 1973).

Bolton's initial counts in 1972 revealed nearly 200 hartebeest in Senkele. Lewis recorded 285 hartebeests at Senkele in December 1973. Stephenson (1975) recorded a total of 394 animals in this area. During the November to December counting, Hunting Technical Services (1976) recorded a total of 442 animals. As the past records made by different researchers indicate, the Senkele hartebeest had grown much more in the mid-seventies. By 1981, 1020 animals were counted (Solomon Yirga, 1981) and Fekadu Kassaye and Messana (1984) estimated about 1773 hartebeests. The population size at Senkele had increased to 2379 animals in 1988 (Messana, 1993). Following the downfall of the Derge regime in 1991, the hartebeest population has been drastically reduced through systematic poaching and competition with livestock to an estimated 626 animals (EWCO source). According to Leykun Abunie (1996), the population size of Swayne's hartebeest had continued declining and a maximum of 300 hartebeests were estimated in the Sanctuary.

The population trend of Swayne's hartebeest seemed to decline rapidly after years of increase before 1991 (Fig. 11). This alarming decline of hartebeest in SSHS is mainly due to the increased number of livestock, construction of huts inside the Sanctuary, poaching and the use of the Sanctuary for farm by the local people. The number of livestock in the area during the study period was greater than any other time in the past. An increase in human population and construction of huts within and around the Sanctuary has lead to a need for more land for the hartebeest, livestock and local people. These have resulted in intense competition between the hartebeest and the livestock. The reduced space and poor quality of the grazing has forced the livestock and hartebeest into close contact and competition, to the detriment of hartebeest. Swayne's hartebeest in SSHS are in greater danger of extinction due to the rapid decline of the population.

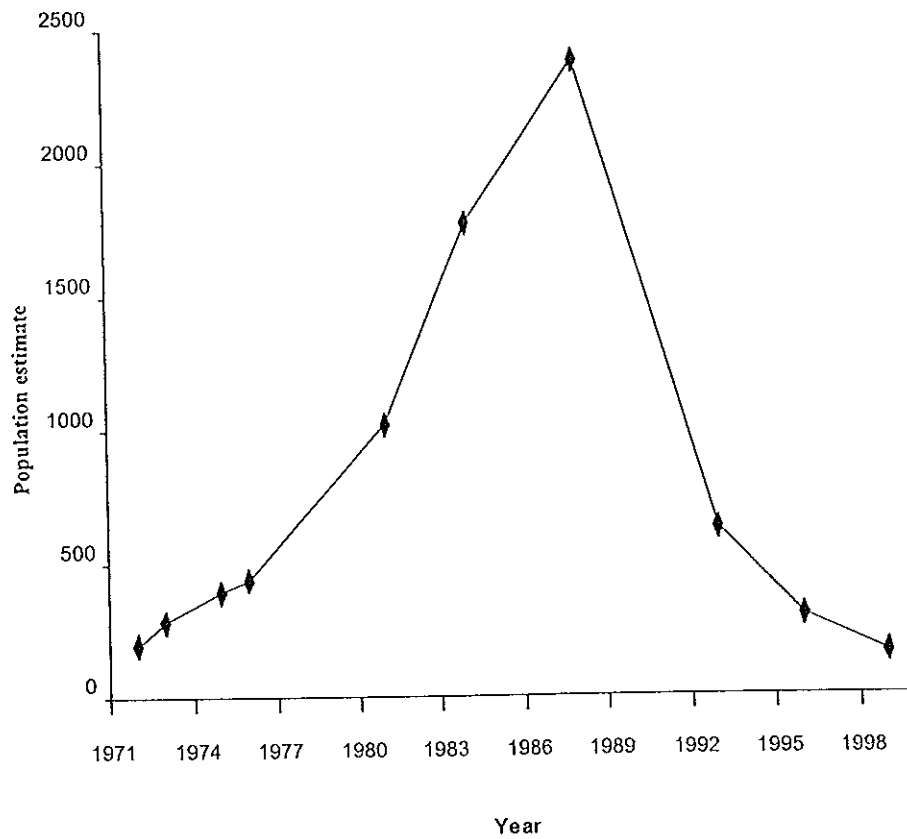


Figure 11: Population trend of Swayne's hartebeest in SSHS (1972-1999).

4.2. Age and sex structure

The age and sex of individuals counted during the census of July 1999, and November 1999, is given in Table 5.

Table 5: Age and sex structure of Swayne's hartebeest in dry and wet season

Season	Adult Male	Adult female	Sub-adult Male	Sub-adult Female	Young*	Total
Dry	32	49	22	39	29	171
Wet	29	42	17	35	22	145
Average	30.5	45.5	19.5	37	25.5	158
Percent	19.3	28.8	12.3	23.4	16.1	99.9

Young*: Calves + Yearlings

The age and sex of 142 and 123 individuals in the dry and wet seasons respectively was determined. On the average, 83.8% of all the Swayne's hartebeest observed were comprised of adults and subadults while 16.1% were young individuals. Among the adults and sub-adults, females

constituted 52.2% while adult and sub-adult males constituted 31.6% of the population observed (Table 5). Number of adults, subadults and young varied in the seasons. Adults, subadults and young were greater in number in the dry season than the wet season (Fig. 12). The small proportion of young Swayne's hartebeest indicated the presence of problems and decreasing population. It was not possible to sex young's (Calves + Yearlings) as their primary sexual characteristics were not observable in these categories. The sex of subadult Swayne's hartebeest was relatively difficult to determine compared to the adult, as their horn shape and thickness do not show significant variation. Although males tend to be of dark body color and to have thicker horns than females these characteristics were far from uniformity. As a result, positive identification of the sex was made only when the primary sexual characteristics could be distinguished. The report of Hunting Technical Services (1976) has also shown this truth.

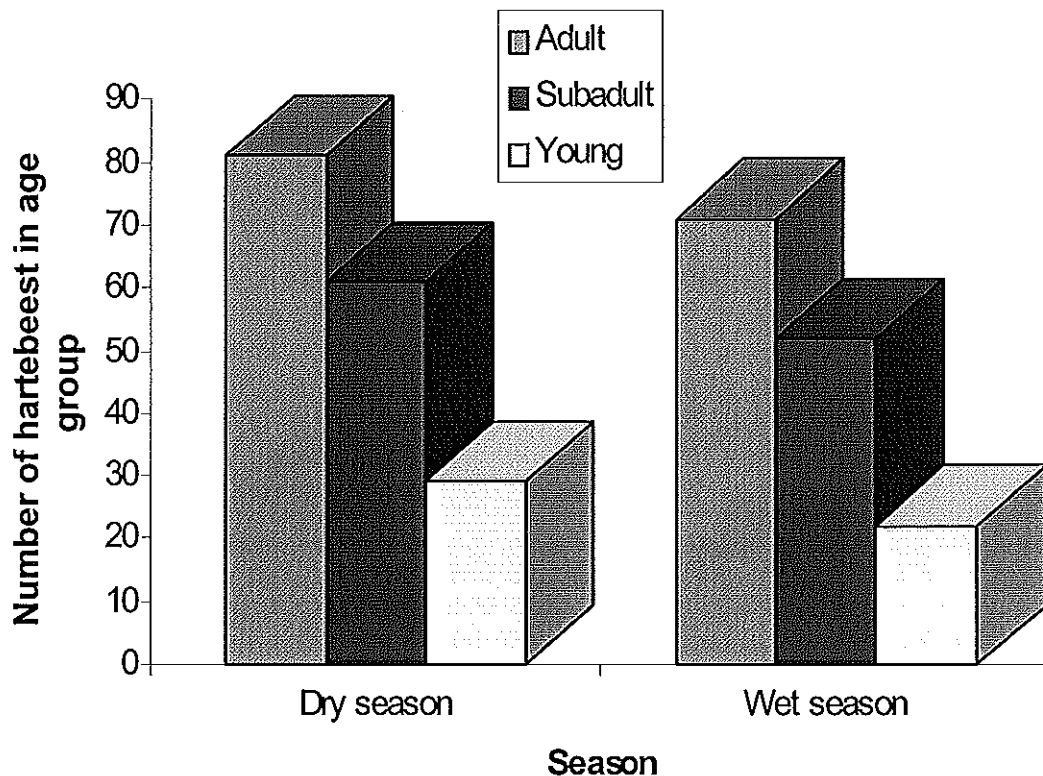


Figure 12: Number of Swayne's hartebeest in each age group during dry and wet seasons.

4.2.1. Sex ratio

The adult and subadult sex ratios calculated from Table 5 are shown in Table 6. It shows that there is an unequal sex ratio in the population, the females being more numerous than the males. The sex ratio for the adults was 1:1.5 and for the subadults it was 1:1.9. The structure of individual herds varied. However, most had a similar structure to the one found for the sampled population (Table 6). The male to female ratios found in the Senkele population of Swayne's hartebeest was different from what was found by Bolton (1973) in the Nechsar population (103 animals) of the same subspecies, which was approximately 1:5. A similar study made by Messana (1993) on the Swayne's hartebeest at Senkele showed an equal sex ratio of 1:1.

The reasons for these variations are uncertain. Equal natal sex ratios have been recorded for Coke's hartebeest (Gosling, 1974) and for many other antelopes. Possible reasons for an unequal post natal sex ratios, discussed by Bergerud (1974) and Estes (1974), were an increased predation pressure on males due to greater boldness and the emigration of subordinate males to less favorable habitats that probably applies to Swayne's hartebeest in SSHS.

Table 6: Adult and sub-adult sex ratios in Swayne's hartebeest (Male to Female)

<u>Age group</u>	<u>sex ratio</u>
Adult	1:1.5
<u>sub-adult</u>	<u>1:1.9</u>

Estes (1974) pointed out that in most gregarious antelopes adult sex ratios generally vary from 1:1.5 to 1:2 in favor of females as was also found true for hartebeests during the present study. However, in wildebeest (*Connochaetes taurinus*), one of the most gregarious antelopes, there are more males than females (Talbot and Talbot, 1963).

The theory of increased predation pressure on males might well be applicable to the hartebeest at Senkele. It is possible that when the rut occurs those males which are unable to establish a territory are forced out into the less favorable periphery areas near human habitation and become more susceptible to human and other predation.

4.3. Group size

Total number of groups, the group sizes and the mean group size of Swayne's hartebeest, based on total counts throughout the study period are shown in Table 7. Group size ranged 1-45 individuals, which is different from the record of Lewis and Wilson (1979). They reported that hartebeests were congregated in large groups numbering up to 180 animals. The mean group size was highest in February and lowest in August (34.4 and 11.5 respectively). Distribution of individuals aggregated in groups of different size differed among habitats in each season. In the dry season (Feb., Mar, Nov. and Dec., 1999), the average percentage distribution of individuals in groups observed in the woody cover was greater (72.3%) than the average of the wet season in the same habitat (15.8). The plain was characterized by carrying the highest proportion of the number of hartebeest individuals in the wet season (84.2%). The largest total number of groups recorded were 13 in August, which

is in the wet season, and the lowest 5 in February, which is in the dry season. Kingdon (1982) reported this fact in which most *Alcelaphinae* form large aggregations during the dry season. As the wet season begins, the large groups of hartebeests were split into smaller groups and distributed widely in the open plain. This is in agreement with observations made by Yakub (1999) for Hunters' hartebeest (*Damaliscus hunteri*).

Table 7: Group size of Swayne's hartebeest in different months

Month	Total No. of hartebeest	Total No of groups	Range of group size	Habitat Type		Mean group size
				woody cover (%)	open plain (%)	
February	172	5	(1-45)	70	30	34.4
March	169	6	(2-36)	65	35	28.2
May	156	7	(1-35)	20	80	26.6
June	149	9	(1-24)	15	85	16.6
July	145	12	(1-20)	10	90	12.0
August	150	13	(1-16)	18	82	11.5
November	171	8	(2-38)	79	21	21.4
December	179	7	(1-40)	75	25	25.6
Average:						
(Dry season)	172.8	6.5	-	72.3	27.7	27.4
(Wet season)	150	10.3	-	15.8	84.2	16.8

4.4. Distributions and vegetation type utilization

The relative use of different vegetation communities by the hartebeests is indicated by the number of the animals observed in each vegetation communities during the monthly observation periods (Table 8). Use of the habitat types available to Swayne's hartebeest varied with season. 62.5% of the hartebeests utilized the PG community in the dry season, and 77.2% of hartebeest utilized the same vegetation community in the wet season. The P2 community was utilized almost twice as much more in the dry season (Fig. 13). The reason for this could be probably most of this vegetation community is found in the woody cover which probably help the grass not to be dry and thus be more palatable. Feeding on this vegetation community in the woody cover may help to overcome the heat in the dry season which is important to conserve body water lose that can be additional reason for more utilization of the P2. The distribution and utilization of different habitats by large mammals can be determined by climatic condition (Pennycuick 1975; Kutilek, 1979). In both seasons, the hartebeests utilized the MG vegetation community only to a little extent since this vegetation type, which is found near the human settlements covers only a small area which is mostly inaccessible to the hartebeest (Fig. 6). This variation is due to the fact that the vegetation type conditions and forage quality vary in the seasons. This seasonal variation in vegetation type utilization has been reported by Murry and Brown (1993) and Yoaciel (1981) for non-migratory herbivores in general and by Yakub (1999) for Hirola (*Damaliscus hunteri*) in particular. A decrease in feeding time with decreasing food availability in the dry season has been reported for several African grazers including hartebeest (Owen-Smith, 1982).

Plants (grass) commonly eaten by hartebeests were found to be distributed in each vegetation communities though not in equal proportion. However, during the dry season, there is a shortage of food everywhere in the Sanctuary. During this study period the animals were observed to frequent areas which were burnt as was also noted by Messana and Bereket Netsereab (1994). This observation also seemed to agree with the study of Peterson and Casebeer (1972) on Wildebeest (*Connochaetes taurinus* Burchell). It appears that Swayne's hartebeest move to these burnt areas, which make green feed if just a minimum of rain follows burning. As soon as the rain falls, regeneration of vegetation is observed over all burnt areas, which are greatly utilized by these animals.

The hartebeest distribution showed a very high utilization for short grass in each vegetation communities. This utilization of the short grass is very different from the habitat preference of Cocker's hartebeest (*Alcelaphus buselaphus cockei*), which are shown to utilize medium to long grass communities (Gosling, 1974). The reason for the Swayne's hartebeest utilization of short grass areas might be to avoid the unpalatable tall grass *Pennisetum schemperi*.

Personal observation and interviews made with local people indicated that Swayne's hartebeest do not drink water in both seasons. The ability to live with out access to free water has been also reported by Hunting Technical Services (1976), Lewis and Wilson (1979), and Solomon Yirga (1981). These authors confirmed that the animals could get all the water they require from the vegetation they eat. During the dry season, when the vegetation is drier, Swayne's hartebeest sought shade in the middle of the day (Lewis and Wilson, 1979).

Table 8: Percentage of total hartebeest observed on different vegetation communities.

Month	Estimation of total count	Vegetation Community					
		PG		P2		MG	
		No	%	No	%	No	%
February	172	139	80.7	24	13.8	9	5.5
March	169	128	75.7	27	16.2	14	8.1
May	156	117	74.8	26	16.6	13	8.5
June	149	112	75.2	25	16.8	12	8
July	145	115	79.3	25	17.2	5	3.4
August	150	119	79.3	24	16.0	7	4.7
November	171	85	50.0	66	39.0	20	11
December	179	78	43.6	87	48.6	14	7.8
Average:							
Dry season	172.8	107.5	62.5	51	29.4	14.0	8.1
Wet season	150	115.8	77.2	25	16.6	9.2	6.2

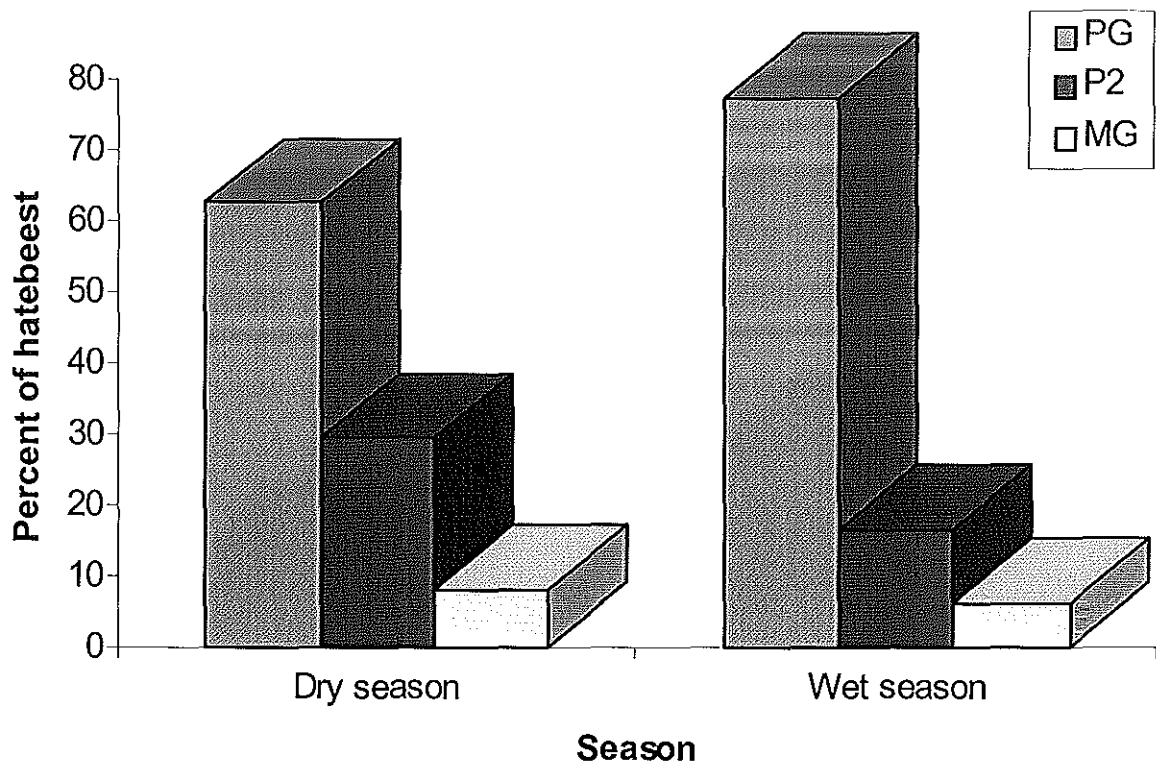


Figure 13: Percentage of total hartebeests observed on different vegetation communities

4.5. Movement and Home range

The home range size estimated by MCP method varied between the seasons. The proportion of home range, which is utilized, is considerably greater during the wet season (16 km²) because of the availability of palatable grasses all over the Sanctuary at this time of the year. In the dry season, when the plain grasses are dry, the hartebeest tends to occupy only the part of its home range in close vicinity to Borena Mountain in the woody cover, which is about 9 km² (Fig. 14). However, during the dry season, when the people and livestock migrate, the Swayne's hartebeest move out of the Sanctuary to the fallow area in the State Farm (Fig. 15). From this, it is possible to state that

without the people and livestock, Swayne's hartebeest could occupy a wider home range area than expressed in Fig. 14. The wet season home range area also would have been larger than 16 km² if the influence from people and livestock could be avoided. This difference can be related to the environmental conditions described earlier, wet season providing generally more favorable conditions for the hartebeests than the dry season. The need for adequate grazing conditions is often cited as a major cause of movement in Wildebeest (Talbot and Talbot, 1963) Zebra (Bell, 1971) and Caribou (Miller, 1974) and other large ungulates, as the case is for Swayne's hartebeest. The range area is very similar with what has been reported for Hirola by Yakub (1999) in that the Hirola range area was smaller during the dry season. Spatial use of home range varies throughout the year in response to concentrations of seasonally available food (Jonkel and Cowan, 1971).

Very often, the hartebeests were observed to move in a circle, and returned to the point from which they started. The animals often remained in the same general area for prolonged periods. For the most part, hartebeests move slowly in the Sanctuary, feeding as they go. Only occasionally do they walk in a deliberate fashion. The typical pattern observed during feeding is to spend long periods grazing while moving slowly but steadily over the grasslands. During the dry season, the hartebeests spend less time grazing, and they move very small distance compared to the wet season. The Swayne's hartebeest at Senkele were reasonably tame and if care was taken, it was possible to approach within 40 m without disturbing them (Lewis and Wilson, 1979). However, in the present study such distances varied between 50 m and 150 m.

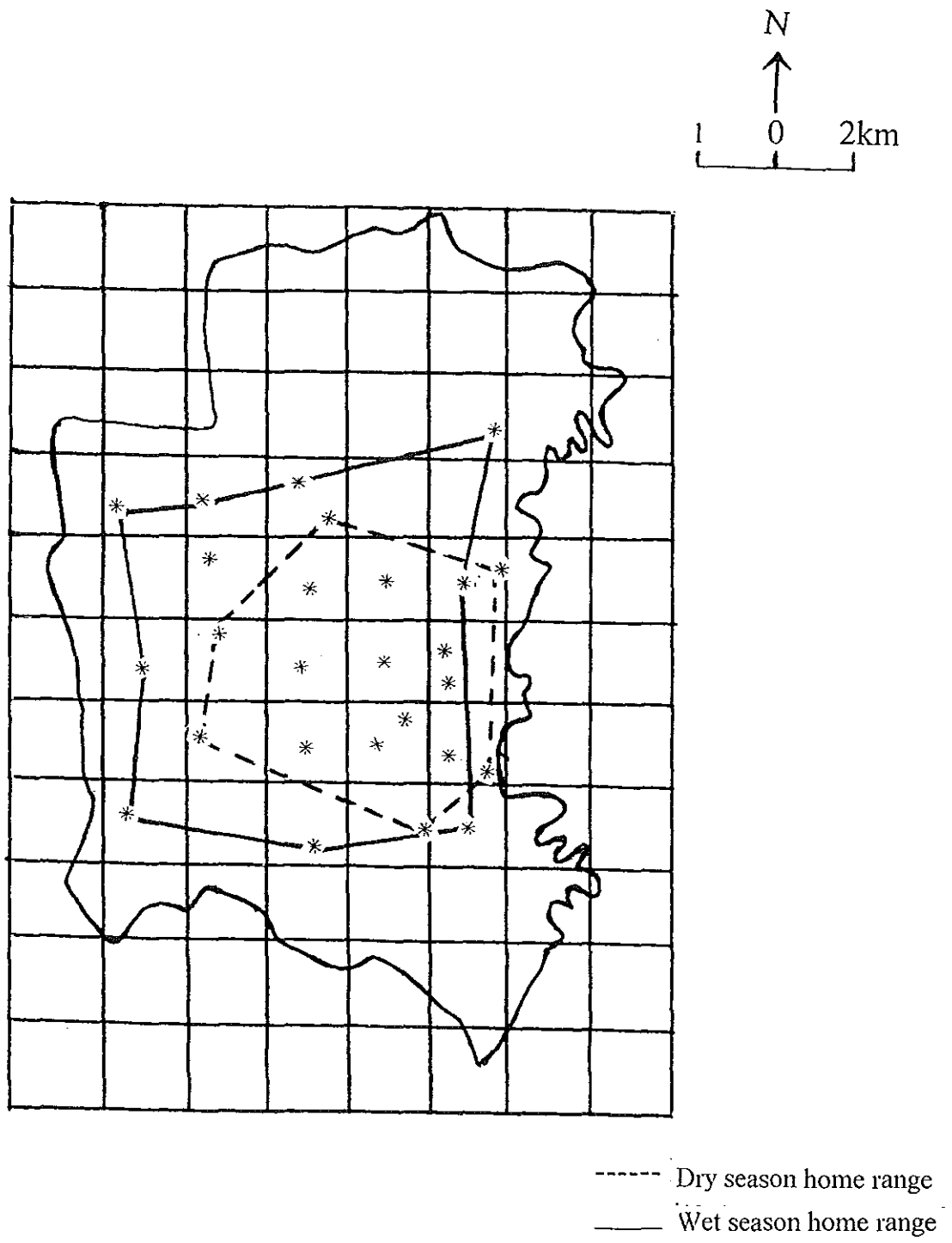


Figure 14: Dry and wet seasons home range size

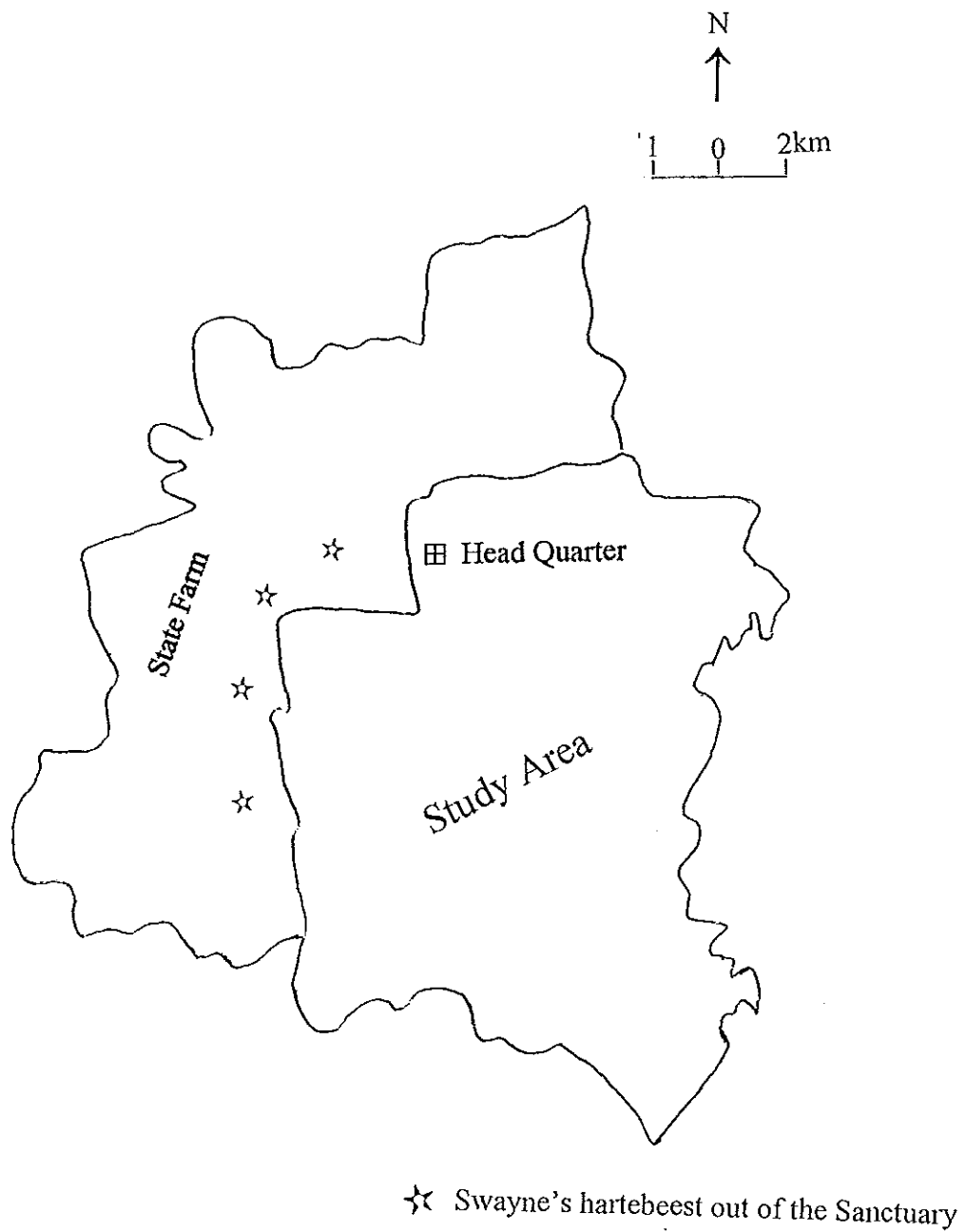


Figure 15: Movement of Swayne's hartebeest out of the Sanctuary

4.6. Diurnal activity pattern

The data from Table 9 are used to show the percentage of Swayne's hartebeest observed in different activities at different times of the day. Feeding peaks in the early morning and late afternoon. Resting (standing and lying) increase in the middle of the day as observed in Godard (1967), Wyatt and Eltringham (1974), and Seidensticker (1976) for different animals. On the average about 48.9% of hartebeests day time were spent in feeding. This is also evident in Fig. 16, which shows the various activities according to the time of the day. The feeding may take place at all hours but there is a drastic reduction in feeding activity between 1100 and 1400 hours. There were two distinct peaks in feeding, one in the early hours of the day light between 0700 and 1000 hours, and another in the afternoon between 1400 and 1800 hours. The feeding activity drops to a slow rate before the Swayne's hartebeest stand or lie down.

Around the middle of the day, hartebeests pass some hours (38.6%) in rest i.e., standing and lying. Probably the main purpose of this rest is to avoid the heat of the day so as to conserve water loss. This is also related with the fact that the grass loses more water during the noon hours, and under such a situation it is important to wait without feeding, until the grass absorbs water in late afternoon hours. Most of the hartebeests under observations lie down on their sides under trees mainly in the dry season. The whole herd seldom lies down at the same time as there are always individuals who rise for short periods to scratch or lick their bodies or just to change their positions. During resting, hartebeests tend to stand and/or lie down more during the dry season than the wet season. The morning and the late afternoon activity peaks were most obvious during the dry season, with most animals remaining inactive during the noon hours which are the hottest hours of

the day. Similar observations were reported by Lewis and Wilson (1979) and for other herbivores by Spinage (1968); Clough and Hassam (1970).

Table 9: Diurnal activity pattern of Swayne's hartebeest.

Time	Activity (% of Hartebeest observed)				
	Feeding	Standing	Lying	Walking	Other activities
0600-0700	66.8	5.6	11.7	7.0	8.8
0700-0800	67.7	3.5	11.2	6.8	10.8
0800-0900	65.0	5.5	11.8	9.0	8.7
0900-1000	60.9	9.6	15.6	7.1	6.8
1000-1100	37.3	28.4	22.9	5.7	5.7
1100-1200	26.0	31.8	33.2	4.5	4.5
1200-1300	25.4	35.0	32.4	3.6	3.6
1300-1400	17.0	44.0	33.0	2.6	3.4
1400-1500	28.3	37.2	26.6	3.6	4.3
1500-1600	44.8	21.8	17.8	8.8	6.8
1600-1700	65.0	9.0	7.9	9.4	8.6
1700-1800	82.4	3.1	5.3	4.6	4.6
Average	48.9	19.5	19.1	6.0	6.4

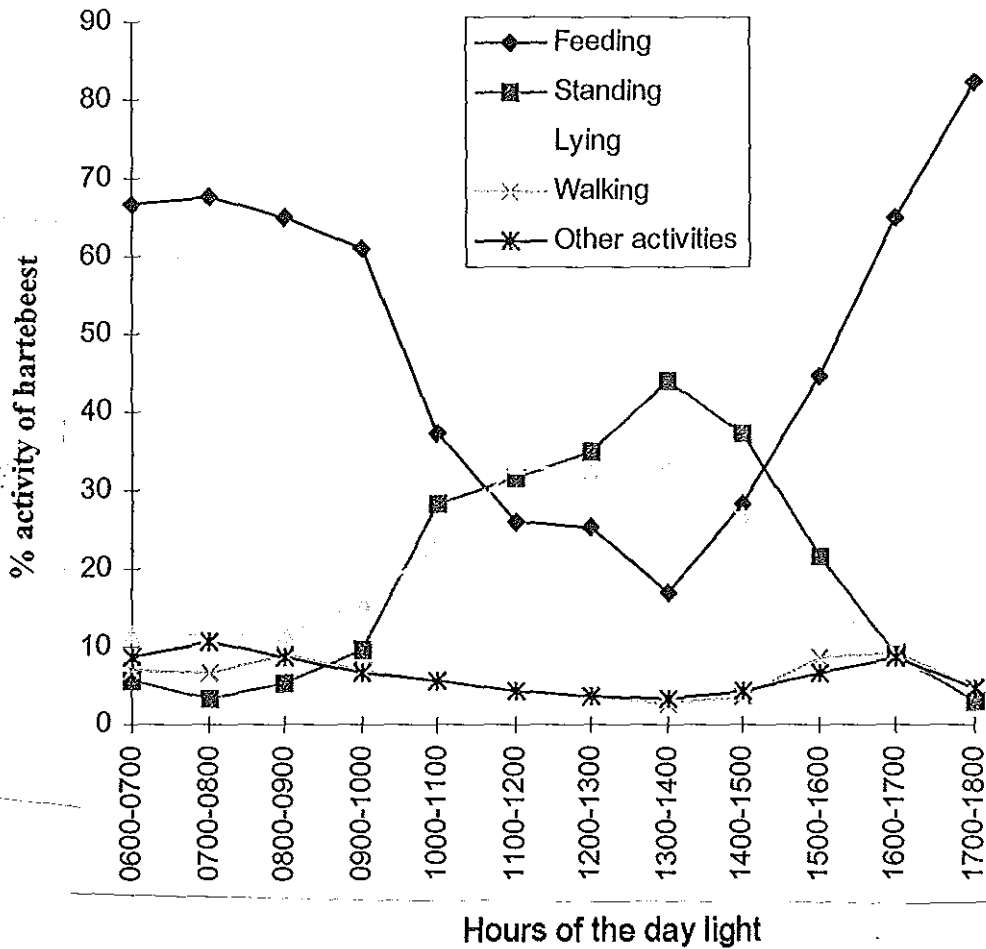


Figure 16: The variation in activities shown by Swayne's hartebeest during the hours of the day

4.7. Assessment of the impact of local people

The field study and discussions held with the local communities (Plate 1) made it possible to understand the communities' activities and needs that bring about impacts on the Sanctuary. Consequently, the following factors affect the status of Swayne's hartebeest in the area.

4.7.1. Destruction of habitats

It is clear that destruction of the habitat, especially in the last eight years, has been the prime cause of reduction of the range and number of Swayne's hartebeest. According to Bolton (1971), the hartebeests were occurring in area of about 200 km² where there was an undulating grassland and acacia savanna. However, some of this area has been taken over by the State Farms and individual farmers and the total of this area has diminished to about 28 km² at present (Table 2). An ever increasing population pressure seems to push people into the remaining Sanctuary area (Table 10 and Table 11). Tree cutting for fuel and construction associated with the new settlement in the interior and in the vicinity of the Sanctuary have also resulted in the deterioration of the vegetation cover which serves the hartebeests as a shelter particularly during the dry season. There is high percentage of recruitment of acacia seedlings in grassland habitat that indicates a trend giving way to bush encroachment. This should undoubtedly lead to deterioration of the productivity of the grazing land. Similar destruction of habitat has been reported in many savanna ecosystems, threatening the existence of grassland species (Yoaciel and Orsdol, 1982).



Plate 1. Discussion held with local people.

4.7.2. Disturbance

The daily activities of the people in the vicinity and the on going human settlement in the area caused great disturbance to the wildlife, particularly to the hartebeest in the area. As observed in the present study, up to December 1999, settlers from the surrounding farmer's associations and other areas have constructed about 900 huts inside and on the border of the Sanctuary. Leykun Abunie (1996) in his survey reported the establishment of 277 new huts in SSSHS. By growing maize and potato, the local people have also taken over the southern part of the Sanctuary. These expansionist activities of the farmers in the area is a potential threat to the Sanctuary. Mesfin Admasu (1996), in his survey report expressed his views about the expansion of the farm lands and the destruction of the Sanctuary.

A large number of tracks mark the routes by which mainly the women with their donkeys cross the length and width of the Sanctuary. Every afternoon dozen of donkeys laden with wood can be seen on the tracks leaving the Sanctuary. Most females of the area spend their time collecting trees/twigs in the Sanctuary. Each house hold on the average goes to the Sanctuary twice or 3 times/week and spend half of a day in one trip for collecting trees/twigs (Nishizaki, 1999). Eight peasant associations composed of 11902 people as estimated by Messana and Bereket Netsereab (1994) surround the Sanctuary (Fig. 4). The population estimate obtained from the Siraro Woreda Agricultural Office shows that there are 16834 people all together surrounding the Sanctuary (Table 10). The number of people increased by about 29% compared to Messana and Bereket Netsereab (1994) estimation (Table 11). These people have permanent settlements elsewhere, and in addition they practice seasonal migration with their cattle from even more than 100 km in search of grazing land to the Sanctuary.

Table 10: Number of human population around SSHS (1999)

Source: Siraro Woreda Agricultural Office, 1999.

Farmer's Association	Number of males	Number of females	Total people
Bitena Kubi	1138	1142	2280
Sifo	1215	965	2180
Shewako	910	1136	2046
Tesisa	846	1096	1942
Kela	864	158	1022
Kite	757	1588	2345
Loke Kencha	1236	1224	2460
Lencho	1262	1297	2559
Total	8228	8606	16834

Table 11: Number of human population around SSHS (1994)

Source: Messana and Bereket Netsereab, 1994.

Farmer's Association	Number of males	Number of females	Total people
Bitena Kubi	625	669	1294
Sifo	825	925	1750
Shewako	549	867	1416
Tesisa	398	562	960
Kela	798	890	1688
Kite	315	661	976
Loke Kencha	912	995	1907
Lencho	953	958	1911
Total	5375	6527	11902

4.7.3. Livestock Abundance

The number of livestock in the area during this study was by far greater than what was estimated in other previous studies. The data obtained from Siraro Woreda Agricultural office (1999) shows that there are about 52263 animals (Table 12). Messana and Bereket Netsereab (1994) estimated 24868 animals (Table 13). The comparison of the two data showed the number of livestock increased by 47% within 4 years. As the diets of the cattle and the hartebeest are overlapping, the hartebeests obviously suffer from feeding competition by being excluded from the important forage sources due

to their over-exploitation by the large number of livestock. The effect of over grazing due to livestock population abundance over the past 8 years, have resulted in significant change of the vegetation cover especially in the eastern and southern parts of the Sanctuary. The open grasslands have been thinned out considerably and are being replaced by different species of acacia (Plate 2). The vegetation changes may have contributed to substantial decrease in the number of the Swayne's hartebeest. Stanley-Price (1974) has shown that the competition from cattle has a direct effect on the hartebeest existence and the expansion of cattle in Africa is almost certainly the primary cause of the subspecies' decline. The hartebeests change their direction of movement according to the position of the livestock. Generally, they avoid approaching the livestock.



Plate 2: The newly growing acacia species

Table 12: Number of livestock in peasant associations surrounding the Senkele sanctuary (1999)

Source: Siraro Woreda Agricultural Office, 1999.

Farmer's Association	Cattle	Horses	Mules	Donkeys	Sheep	Goats
Bitana Kubi	3992	78	15	400	942	1012
Sifo	4565	72	12	356	1544	844
Shewako	4633	42	14	280	1256	604
Tesisa	3212	70	9	350	839	1523
Kela	4774	81	10	408	1222	1031
Kite	4892	41	8	286	1103	792
Loke Kencha	2781	79	11	360	998	655
Lencho	3885	91	6	405	1122	558
Total	32734	554	85	2845	9026	7019

Table 13: Number of livestock in 8 peasant associations surrounding the Senkele sanctuary (1994)

Source: Messana and Bereket Netsereab, 1994.

Farmer's Association	Cattle	Horses	Mules	Donkeys	Sheep	Goats
Bitana Kubi	2485	59	4	300	184	206
Sifo	2412	54	3	267	178	306
Shewako	1736	30	3	210	180	312
Tesisa	2268	53	3	267	182	302
Kela	2506	61	3	300	203	252
Kite	1764	32	2	215	289	279
Loke Kencha	2704	62	3	270	184	299
Lencho	2589	68	3	310	174	292
Total	18464	419	24	2139	1574	2248

The over grazing of the area by cattle has pushed away the hartebeest from the suitable grazing habitat. In addition to this, the harassment and poaching perpetrated by the pastoralists contributed to limiting the area occupied by the hartebeest. Within four years the number of livestock increased by about 47% and the number of people by about 29%. These are considered to be the major causes of the reduction in hartebeest number, since there is nowhere else for the hartebeest to go. Domestic cattle, partly because of controlled movement, use an area more evenly than do wild herbivores (Taylor and Walker, 1978).

Generally, humans and cattle affect the status of Swayne's hartebeest in its existing and potential range in two ways:

a/ The occupation or destruction of suitable habitat by the pastoralists to the exclusion of the hartebeests. No hartebeest was observed living close to the areas used for grazing occupied by the Arsi tribesmen.

b/ the constant passage of parties of human beings through the area forces the hartebeest to avoid the suitable areas of grazing.

By far, the main threat of wildlife anywhere in the world is loss of their habitats (Pryde, 1986). Decline of wildlife in Ethiopia is associated not only with the habitat destruction, but also with the introduction of firearms, which greatly facilitated poaching (Andebrhan Kidane, 1982).

4.7.4. Hunting

Theoretically, the Ethiopian Government prohibits hunting the Swayne's hartebeest. However, in the absence of any protection, the general unawareness of the protective legislation by the local people, and due to the failure of the officials to make any serious attempt to enforce the law, the hartebeests continue to decline. The local people are engaged in hunting Swayne's hartebeest for meat. Similar activities of the local people were documented by Bolton (1973). Despite these statements, little direct evidence of hunting was obtained in the present study period. One peasant had the head of the animal mounted above his door on one of the huts situated just near the head quarter of the Sanctuary. On several occasions, rifle shots were heard around Borena and Lalima hills probably fired at Swayne's hartebeests. On different occasions, men armed with rifles were observed moving into the Sanctuary. Hunters were observed selling meat of Swayne's hartebeest at

Bilito Market, located about 18 km from the Sanctuary (Pers. Comm.).

From discussions made with the local farmers it became clear that the damage caused by the hartebeests on their crops was considered to be the reason which forced them to poach. In the wet season, farmers must keep continuous evening vigils from very small huts constructed over their maize crop farm to prevent damage by the animals. Most of the damage occurs in fields within 1.5 km from the present Sanctuary boarder to the western side and local measures such as shouts and flashlights were used to frighten away the hartebeests. As repeatedly observed in SSHS and NNP by Messana and Bereket Netsereab (1994) and Gameda (Pers. Comm.), hartebeest killing was largely caused as they moved into the surrounding farm fields. Generally, the local people dislike the hartebeest and want to eliminate them from the area. They believe that the elimination of Swayne's hartebeest from the Sanctuary enables them to take over the Sanctuary for farming as well as grazing land for their livestock.

4.7.5. Predation

Both large and small carnivores are presumed to affect the status of Swayne's hartebeest and other wild herbivores in the area. Messana and Bereket Netsereab (1994) have shown that the possible natural enemies of Swayne's hartebeest are spotted hyena (*Crocuta crocuta*) and common jackal (*Canis aureus*). Spotted hyena frequents the whole of the Swayne's hartebeest habitat and the surrounding area in large numbers. Every night the sound of whooping hyenas were heard and their feces were found in the Sanctuary, particularly in the dry seasons. In November and December 1998, EWCO Scouts killed 12 hyenas to reduce the predator pressure. In addition, due to the

increment of hyena's number in the area, 6 hyenas were poisoned at Borena hill. As a result, about 25 birds have died of feeding on the dead hyenas. Common jackals were repeatedly observed in areas where Swayne's hartebeest frequent and said to kill the Swayne's hartebeest calves and domestic animals in the area.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

The distribution and utilization of different vegetation communities by hartebeest could be explained in terms of seasonal changes. During the dry season, resources were scarce and the animals showed restricted distribution in the woody cover. As the wet season progressed, however, the animals were scattered in the open plain where the resources were abundant. This fact was also reported by Jarman and Mmaari (1972) for many other ungulates and by Messana and Bereket Netsereab (1994) for Swayne's hartebeest. Based on these, it is possible to conclude that the vegetation type for food and shelter is decisive to determine the distribution and vegetation type utilization of the hartebeest. However, the degree of disturbance by livestock, harassment and poaching by the local people seems to contribute much in this respect.

Some of the observed changes in group size with seasons coincided with changes in habitat use patterns. Comparatively larger group sizes were recorded during the dry season when large percentages of animals were observed on the woody cover. The largest mean group size was recorded on the woody cover in the dry season.

The diurnal activity of Swayne's hartebeest seemed to depend on the climatic condition. The time devoted to feeding was highest in the early morning and the late afternoon hours and it was minimum in the middle of the day. On the contrary, standing and lying were highest in the mid-day. The activity pattern of all mammals is adapted to their daily mode of life. It may be

influenced by wide range of factors such as food availability, climatic conditions, nutritive demand and protection from predation (Delany and Happold, 1979).

The fact that the number of Swayne's hartebeest was found to decrease steadily after 1991, since the changeover of government, showed that their population is not building up again in such circumstances. The present study showed an average of only 161 individual Swayne's hartebeest in the area. Compared to the pervious population estimates, for example, 2379 individuals by Messana (1993), the present number is alarmingly too low. The reason for their low numbers is thought to be mainly the lack of space and human harassment. The situation at Senkele at present is very precarious from the hartebeest's point of view and it is felt that there is no long-term future for the animals in their area. The small proportion of the young of Swayne's hartebeest indicated the decline in population and therefore the presence of a problem in the area.

5.2. RECOMMENDATIONS

The present study has shown the need for proper management of this unique animal. Although a full-scale management program can only be developed in the course of time, certain recommendations that require urgent task that emanated from the study are forwarded.

- The Swayne's hartebeest population at SSHS appears to be the only viable population left in Ethiopia. The survival of Swayne's hartebeest and its habitat ultimately depends on the local people. Immediate protective steps for the Sanctuary must be accompanied by measures, which improve the

living standard of the local people, without further disrupting the environment. Some of the measures suggested are:

- ◆ Providing farm and grazing land from the State Farm which is left uncultivated at present and keeping them away from the Sanctuary.

- ◆ Solving the water problem of the local people.

- Prohibiting farming, grazing and construction of huts within the Sanctuary.
- An integrated approach to better wildlife research and management in all wildlife areas in Ethiopia, particularly in SSS, is needed. First and for most, the Federal government needs to take charge of wildlife conservation and coordination of wildlife management activities. This action could be a signal to wildlife professionals and concerned individuals that the government is concerned about the future of this country's wildlife. This gives the local people, the impression that the central government is serious about conservation of the wildlife.
- The use of firearms by the people living close to the Sanctuary should be controlled strictly.
- The boundary of the Sanctuary should be re-demarcated and the sides bounded by the local people should be fenced.
- The Sanctuary should be up-graded to a Park level

- In order to meet the hartebeest's nutritional requirements, there must be an intensive program of habitat manipulation, primarily through burning on annual basis, coupled with initiation of a special program to reduce the newly growing acacia.

- When present in large numbers, Spotted hyenas (*Crocuta crocuta*) and common Jackals (*Canis aureus*) can cause a serious Swayne's hartebeest mortality. Therefore, their numbers should be kept under control until the hartebeest population reaches at the carrying capacity of the Sanctuary.

- Accurate records of the Sanctuary are vital for research and management. It is essential that a diary of events on the Sanctuary be kept and that monthly and annual reports be prepared.

- It seems that the SSHS has the habitat which is most preferred by the Swayne's hartebeest. Therefore, efforts to stabilize this population in this location should be taken as one of the solutions for their survival in the future.

- The participation of local people in design, planning, implementation and evaluation is an essential element of any community wildlife conservation program (IIED, 1994). Therefore, these needs to build into the measures that would be taken to solve the problems of Swayne's hartebeest from the outset. The participatory process must include all interest in a way that enables the local people to feel they are pursuing their interests effectively, and seeing the benefits of what they are doing.

6. References

- Adams, L. and Davis, S. D. (1967). The internal anatomy of home range. *J. Mamm.* **48**:529-536.
- Allsopp, R. (1979). Roan Antelope population in the Lambwe Valley, Kenya. *J. Appl. Ecol.* **16**:109-115.
- Andebrhan Kidane (1982). Wildlife Management problem in Ethiopia. *Walia* **8**:7-8.
- Andere, D. K. (1981). Wildebeest *Connochaetes taurinus* (Burchell) and its food supply in Amboseli Basin. *Afr. J. Ecol.* **19**:239-250.
- Anderson, D. J. (1982). The home range: a new nonparametric estimation technique. *Ecology*, **63**:103-112.
- Balakrishnan, M. and Easa, P. S. (1986). Habitat Preferences of Large Mammals in the Parambikulam Wildlife Sanctuary, Kerala, India. *Biol. Conserv.* **37**:191-200.
- Balakrishnan, M. and Ndhlovu, D. E. (1991). Large herbivores in Upper Lupande Game Management Area, Luangwa Valley, Zambia. *Afr. J. Ecol.* **29**:93-104.
- Bell, R. H. V. (1971). A grazing ecosystem in Serengeti. *Scient. Am.*, **225**:86-93.
- Bere, R. M. (1962). *The Wild Mammals of Uganda*. East African National History Series, London.
- Bergerud, A. T. (1971). The Population Dynamics of Newfoundland Caribou. *Wildl. Monogr.* **25**:1-55.
- Bergerud, A. T. (1974). *Rutting behavior of Newfoundland Caribou*. Geist and Walther pp 395-435.
- Blower, J. (1969). Wildlife Conservation in Ethiopia. *Walia* **1**:15-23.
- Bolton, M. (1971). Ethiopia: Last chance of Swayne's hartebeest. *Biol. Cons.* **3**(2): 147-149.
- Bolton, M. (1973). Hartebeest in Ethiopia. *Oryx* **12**: 99-108.
- Borkowski, J. and Furubayashi, K. (1998). Seasonal and diet variation in group size among Japanese Sika deer in different habitats. *J. Zool. Lond.* **245**:29-34.

- Bowyer, R. T. (1984). Sexual segregation in southern Mule Deer. *J. Mamm.*, **65**(3):410-417.
- Burnham, K. P.; Anderson, D. R. and Lake, J. L. (1980). Estimation of density from line transect sampling of biological population. *Wildl. Monogr.* **72**:1-202.
- Campton, B. B.; Mackie, R. J. and Dusek, G. L. (1988). Factors influencing distribution of white-tailed deer. *J. Wildl. Manage.* **52**(3):544-548.
- Catt, D. C. and Staines, B. W. (1987). Home range use and habitat selection by Red deer (*Cervus elaphus*) in a Sika spruce plantation as determined by radio tracking. *J. Zool., Lond.* **211**:681-693.
- Caughley, G. (1977). *Analysis of Vertebrate Population*. A Wiley-International, Toronto.
- Caughley, G. and Sinclair, A. R. E. (1994). *Wildlife Ecology and Management*. Blackweel Science, USA.
- Cederlund, G. N. and Okarma, H. (1988). Home range and habitat use of adult female Moose. *J. Wildl. Manage.* **52**(2):336-343.
- Clough, G. and Hassam, A. G. (1970). A quantative study of daily activity of the warthog in the Queen Elizabeth National Park, Uganda. *E. Afr. Wildl. J.* **8**:19-24.
- Cowan, D. P. (1987). Group living in the European rabbit (*Oryctolagus cuniculus*): Mutual benefit or resource localization. *J. Ani. Ecol.* **56**:779-795.
- Craighead, J. J.; Craighead, F. C.; Ruff, R. L. and O'Gara, B. W. (1973). Home Ranges and Activity Patterns of Non-migratory Elk of the Madison Drainage Herd as Determined by Biotelemetry. *Wildl. Monogr.* **33**:1-49.
- Deduldung, H. L. (1981). Summer home range of Mule deer fawns. *J. Wildl. Manage.* **45**(3):726-728.
- Delany, M. J. and Happold, D. C. D. (1979). *Ecology of African mammals*. Longman, London.
- Dinerstein, E. (1979). An Ecological Survey of the Royal Karnali-Bardia Wildlife Reserve, Nepal.

Part-III: Habitat/Animal interactions. *Biol. Conserv.* **16**:265-300.

Don, B. A. C. and Rennolls, K. (1983). A home range model incorporating biological attraction points. *J. Ani. Ecol.* **52**:69-81.

Drake-Brockman, R. E. (1909). The Fauna of Abyssinia. *J. Soc. Pres. Fauna Emp.*, **5**:110-113.

Duncan, P. (1983). Determinants of the use of habitat of horse in a Mediterranean Wetland. *J. Ani. Ecol.* **52**:93-109.

Eberhardt, L. E.; Hanson, E. E. and Cadwell, L. L. (1984). Movement and activity patterns of Mule deer in the Sagebrush- steppe region. *J. Mamm.*, **65**(3):404-409.

Elkan, P. and Tchamba, M. N. (1995). Status and trends of some large mammals and ostriches in Waza National Park, Cameroon. *Afr. J. Ecol.* **33**:366-376.

Eltringham, S. K. (1977). The number and distribution of elephant *Loxodonta africana* in the Rwenzori National Park and Chambura Game Reserve, Uganda. *E. Afr. Wildl. J.* **15**:19-39.

Estes, R. D. (1974). Social Organization of the African Bovidae. In: *the behavior of ungulates and its relation to management* 166-205. Geist, V. and Walter, F. (Eds.). IUCN Publ. No. 24, Morgse, Switzerland.

Estes, R. D. (1991). *The Behavior Guide of African Mammals*. University of California Press, Berkeley.

Ethiopian Wildlife Conservation Organization (EWCO) (1985). Wildlife Conservation in Ethiopia and development properties. Mimeo. EWCO, Addis Ababa.

Ethiopian Wildlife Conservation Organization (EWCO) (1990). Wildlife Conservation Areas Summary Sheet. Mimeo. Pp. 33.

Fekadu Kassaye and Messana, G. G. (1984). Report to Ethiopia's Wildlife Conservation Organization on the Sanctuary of Senkele and Swayne's hartebeest. Mimeo. Pp. 25.

Fritz, H. and Garine, W. M. D. (1996). Foraging social antelope: effect of group size on foraging

- choice and resource perception on Impala. *J. Ani. Ecol.* **65**:606-620.
- Goddard, J. (1967). Home range, Behavior, and Recruitment Rates of two Black Rhinoceros populations. *E. Afr. Wildl. J.* **5**:133-150.
- Gordon, I. J. and Illus, A. W. (1996). The nutritional ecology of African ruminants: a reinterpretation. *J. Ani. Ecol.* **65**:18-28.
- Gosling, L. M. (1974). The social behavior of Coke's hartebeest (*A. b. cokei*). In: the Behavior of Ungulates and Relation to Management, eds. V. Geist and F. Walther, pp. 167-205, Vol. 1. IUCN Morges, Switzerland.
- Grzimek, B. (1972). *Animal Life Encyclopedia*. Van Nostrand Reinhold Company, New York.
- Haltenorth, T. and Dilldr, H. (1977). *A field Guide to the Mammals of Africa including Madagascar*. Collins, London.
- Hanley, T. A. (1982). Cervid activity patterns in relation to foraging constraints. In: Seasonal and diet variation in group size among Japanese Sika deer in different habitats. *J. Zool. Lond.* **245**:29-34.
- Harper, J. A.; Harn, J. H.; Bentley, W. W. and Yacom, C. F. (1967). The Status and Ecology of the Roosevelt Elk in California. *Wildl. Monogr.* **16**:1-49.
- Hayne, D. W. (1949). Calculation of size of home range. *J. Mamm.* **30** (1):1-18
- Helland, J. (1976). The Human Ecology of the Senkele plain. Report to EWCO. Mimeo. PP. 9.
- Hillman, J. C. (1987). Group size and association patterns of the common eland (*Tragelaaphus oryx*) *J. Zool., Lond.* **213**:641-663.
- Hillman, J. C. (1993). *Ethiopia. Compendium of Wildlife Conservation Information*. EWCO, NYZS.
- Hirst, S. M. (1975). Ungulate-habitat relationship in a South African Woodland/Savanna Ecosystem. *Wildl. Monogr.* **44**:1-60.

- Hirth, D. H. (1977). Social behavior of White-tailed deer in relation to habitat. *Wildl. Monogr.* **53**:1-55.
- Houerou, H. (1986). An Ecological glance at Ethiopia. *Walia* **9**: 6-10.
- Hudson, R. J. and Karstad, E. L. (1984). Census of the Mara River hippopotamus (*Hippopotamus amphibius*), Southwest Kenya, 1980-1982. *Afr. J. Ecol.* **22**:143-147.
- Hunting Technical Services Ltd. (1976). Swayne's Hartebeest: a preliminary study of its status in Ethiopia and recommendations for Future Management. Report to EWCO Boreham Wood, Herts, UK.
- IIED (International Institute for Environment and Development) (1994). *Whose Eden? An Overview of Community Approaches to Wildlife Management*. Russel Press, Uk. pp 70-73.
- Infield, M. (1988). Attitudes of a Rural Community towards Conservation and a Local Conservation Area in Natal, South Africa. *Biol. Conserv.* **45**:21-46.
- IUCN (1972). *Red Data Book*. **12 (4)**: IUCN, Morges,.
- IUCN (1984). A preliminary report on threatened and endemic vertebrate species in Ethiopia. IUCN Monitoring Center. Cambridge, UK.
- Jackson, P. F. R. (1974). National Park in Ethiopia Urged for Rare Antelope. *Biol. Conserv.* **6**: 224-225.
- James, F. (1969). Wildlife endanger. *The Viking Press*, New York.
- Jaremovic, R. V. and Croft, D. B. (1987). Comparison of Techniques to determine Eastern Grey Kangaroo home range. *J. Wildl. Manage.* **51(4)**:921-930.
- Jarman, P. J. (1974). The social organization of antelope in relation to their ecology. *Behavior* **48**:215-267.
- Jarman, P. T. and Mmaari, P. E. (1972). Seasonal distribution of large mammal population in the flooded Zambezi Valley. *J. Appl. Ecol.* **9**:277-293.

- Jones, E. N. and Sherman, L. J. (1983). A comparison of Meadow vole home ranges derived from grid trapping and radiotelemetry. *J. Wildl. Manage.* **47**:558-561.
- Jonkel, C. J. and Cowan, I. M. (1971). The black bear in the Spruce-fir forest. *Wildl. Monogr.* **27**:57 pp.
- Kangwana, k. (1996). *Studying Elephants*. African Wildlife Foundation. Nairobi, Kenya.
- Kingdon, J. (1982). *East African Mammals. An atlas of evolution in Africa*. Volume-III Part-D (Bovids). Academic Press, London.
- Kingdon, J. (1997). *The Field Guide to African Mammals*. Academic Press, London.
- Kitchen, D. W. (1974). Social Behavior and Ecology of the Pronghorn. *Wildl. Monogr.* **38**:1-96.
- Knight, R. R. (1970). The Sun River Elk Herd. *Wildl. Monogr.* **23**:1-66.
- Koeppel, J. W.; Slade, N. A. and Hoffmann, R. S. (1975). A bivariant home range model with possible application to ethological data analysis. *J. Mamm.* **56**:81-90.
- Kutilek, M. J. (1979). Foraging habitat of non-migratory African ungulates in response to seasonal rainfall. *J. Wildl. Manage.* **43**(4):899-908.
- Lagory, K. (1986). Habitat, group size, and the behavior of White-tailed deer. *Behavior* **98** (1-4): 168-179.
- Lamprey, H. F. (1963). Ecological separation of the large mammal species in the Tarangire game reserve, Tanganyika. *E. Afr. Wildl. J.* **1**:63-92.
- Larson, T. J.; Rongstad, O. J. Terbilcox, F. W. (1978). Movement and habitat use by White tailed deer in South-central Wisconsin. *J. Wildl. Manage.* **42**(1):113-117.
- Last, J. (1982). *Endemic Mammals of Ethiopia*. Ethiopian Tourism Commission, Addis Ababa.
- Lealem Berhanu (1974). Operation Swayne's Hartebeest. *Oryx* **12**:556-558.
- Leuthold, W. (1972). Home range, movements and food of a buffalo herd in Tsavo National Park. *E. Afr. Wildl. J.* **10**:233-243.

- Leuthold, W. and Sale, J. B. (1973). Movement and patterns of habitat utilization of elephants in Tsavo National Park, Kenya. *E. Afr. Wildl. J.* 11:369-384.
- Lewis, J. G. and Wilson, R. T. (1977). The Plight of Swayne's Hartebeest. *Oryx* 13: 490- 494.
- Lewis, J. G. and Wilson, R. T. (1979). The Ecology of Swayne's Hartebeest. *Biol. Cons.* 15:1-12.
- Leykun Abunie (1996). Study Report on Senkele Swayne's Hartebeest Sanctuary. EWCO, Addis Ababa. Mimeo. PP. 14.
- Lindzey, F. R. and Meslow, E. C. (1977). Home range and Habitat use by black bears in southwestern Washington. *J. Wildl. Manage.* 41(3):413-425.
- Martinka, C. J. (1969). Population Ecology of Summer Resident Elk in Jackson Hole, Wyoming. *J. Wildl. Manage.* 33(3):465-481.
- Massei, G.; Genove, P. V.; Staines, B. W. and Gorman, M. L. (1997). Factors influencing home range and activity of wild boar (*Sus scrofa*) in a Mediterranean coastal area. *J. Zool., Lond.* 242:414-423.
- Melton, D. A. (1983). Population dynamics of Waterbuck (*Kobus ellipsiprymnus*) in the Umfolozi Game Reserve. *Afr. J. Ecol.* 21:77-91.
- Mesfin Admassu (1996). Socio-Anthropological Survey on Abijata-Shala Lakes National Park and Senkele National Sanctuary. FTTP of SUAS Sponsorship. Addis Ababa, Ethiopia. PP. 35.
- Messana, G. G. (1993). The reproductive ecology of Swayne's hartebeest. Unpublished Ph. D. Thesis, University of Cambridge.
- Messana, G. G. and Bereket Netsereab (1994). The Senkele Swayne's Hartebeest Sanctuary Management Plan. EWCO, Addis Ababa.
- Miller, D. R. (1974). Seasonal changes in the feeding behavior of barren ground Caribou on the Tagia Winter Range. In: *The behavior of ungulates and its relation to its management*, ed. by V. Geist and F. Walther, 744-55. IUCN Publication, New Ser. No. 41.

- Mills, M. G. L. (1982). Factors affecting group size and territory size of the Brown hyaena, *Hyaena brunnea* in the southern Kalahari. *J. Zool., Lond.* **198**:39-51.
- Mitchell, A. W. (1977). Preliminary observation on the daytime activity pattern of Lesser Kudu in Tasavo National Park, Kenya. *E. Afr. Wildl. J.* **15**:199-206.
- Mukinya, J. G. (1973). Density, distribution, population structure and social organization of the black rhinoceros in Masai Mara Game Reserve. *E. Afr. Wildl. J.* **11**:385-400.
- Murray, M. G. (1982). Home range, dispersal and the clan system of impala. *Afr. J. Ecol.* **20**:253-269.
- Murray, M. G. and Brown, D. (1993). Niche separation of grazing ungulates in the Serengeti, an experimental test: *J. Anim. Ecol.* **62**: 380-389.
- Myers, N. (1983). *A wealth of wild species*. Boulder, Westview Press.
- Nelson, M. E. and Mech, L. D. (1981). Deer Social Organization and Wolf Predation in Northeastern Minnesota. *Wildl. Monogr.* **77**:1-53.
- Nishizaki, N. (1999). Social Anthropology of people around Senkele. A Report Submitted to the Ministry of Agriculture and the Ethiopian Wildlife Organization. Mimeo. Paper.
- Norton-Griffiths, M. (1978). *Counting Animals*. 2nd Ed. Africa Wildlife Leadership, Nairobi, Kenya.
- Nowak, R. M. (1991). *Walker's Mammals of the World*. (5th ed). V-II. The Johns Hopkins University Press, London.
- Ono, Y.; Doi, T.; Ikeda, H.; Baba, M.; Takeishi, M.; Izawa, M. and Iwamoto, I. (1988). Territoriality of Gunther's dikdik in the Omo National Park, Ethiopia. *Afr. J. Ecol.* **26**:33-49.
- O'Shea, T. J.; Correa-Viana, M.; Ludlow, M. E. and Robinson, J. G. (1988). Distribution Status and Traditional Significance of the West Indian Manatee, *Trichechus manatus* in Venezuela.

Biol. Conserv. 46:281-301.

Owen-Smith, N. (1982). Factors influencing the consumption of plant products by large herbivores.

In: *Ecology of Tropical Savannas* eds. B. J. Huntley and B. H. Walker, PP. 359-404.
Springer-Verlag, Berlin.

Pennycuik, L. (1975). Movements of the migratory wildebeest population in the Serengeti area between 1960 and 1973. *E. Afr. Wildl. J.*, 13:65-87.

Peterson, J. C. B. and Casebeer, R. L. (1972). *Distribution, population status and group composition of Wildebeest (Connochaetes taurinus Burchell) and Zebra (Equus burchelli Gray) on the Athi-Kapiti Plains, Kenya.* Food and Agriculture Organization of the United Nation Nairobi, Kenya.

Philip, S. (1961). *Vanishing animals. Preserving Nature's Rarities.* Faber and Faber, London.

Plessis, S. S. DU. (1972). Ecology of Blesbok with Special Reference to Productivity. *Wildl. Monogr.* 30:1-69.

Pryde, P. R. (1986). Strategies and Problems of Wildlife Preservation in the USSR. *Biol. Conserv.* 36:351-374.

Rollinson, D. H. I.; Harker, K. W.; Taylor, J. I. and Leech, F. B. (1956). Studies on the habitat of Zebu cattle. IV Errors associated with recording technique. In: Wyatt, J. R. and Eltringham. The daily activity of the elephant in the Rwenzori National Park, Uganda. *E. Afr. Wildl. J.* 12: 273-289.

Ruxton, A. E. and Schwartz, E. (1929). On hybrid hartebeest and on the distribution of the *Alcelaphus buselaphus* group. *Proc. Zool. Soc. London.* pp. 567-586.

Sale, J. B. and Berkmuller, K. (1988). *Manual of Wildlife Technique for India.* Wildlife Institute, India.

Samson, F. B. and Knopf, F. L. (1996). *Ecosystem Management: Selected readings.* Springer-

Verlag, New York.

- Samuel, M. D. and Garton, E. O. (1985). Home Range: A weighted normal estimate and tests of underlying assumptions, *J. Wildl. Manage.* **49(2)**:513-519.
- Samuel, M. D.; Pierce, D. J. and Garton, E. O. (1985). Identifying areas of concentrated use within the home range. *J. Ani. Ecol.* **54**:711-719.
- Sanderson, G. C. (1966). The study of mammal movements-a review. *J. Wildl. Manage.* **30(1)**:215-235.
- Schaller, G. B.; Talipu, L. H.; Hua, L.; Junrang, R.; Mingjiang, Q. and Hibian, W. (1987). Status of Large Mammals in the Taxkorgan Reserve, Xinjiang, China. *Biol. Conserv.* **42**:53-71.
- Schoen, J. W. and Kirchhoff, M. D. (1985). Seasonal distribution and home range patterns of Sika black-tailed deer on Admiralty Island, *J. Wildl. Manage.* **49(1)**:96-103.
- Sciater, P. C. and Thomas, O. (1984). *The "book of antelopes"*. Potter, R. H., London.
- Sciater, P. L. (1892). On a new antelope from Somaliland and on some other specimens from the same country. *Proc. Zool Soc London*. Pp. 98-102.
- Seidensticker, J. (1976). Ungulate population in Chitawan Valley, Nepal. *Biol. Conserv.* **10**:183-210.
- Shibru Tedla. (1995). Protected Areas Management Crises in Ethiopia. *Walia* **16**:17-30
- Sinclair, A. R. E. and Gwynne, M. D. (1972). Food selection and competition in the East African Buffalo. *E. Afr. Wildl. J.* **10**:77-89.
- Singer, F. J.; Otto, D. K.; Tipton, A. R. and Hable, C. P. (1981). Home ranges, movements, and habitat use of European wild boar in Tennessee. *J. Wildl. Manage.* **45(2)**:343-353.
- Solomon Yirga (1981). Swayne's hartebeest in Senkele. Unpubl. Report.
- Southwood, J. R. E. (1978). *Ecological Methods with particular reference to study Insect*

populations. Chapman and Hall, USA.

- Spinage, C. A. (1968). A quantitative study of the daily activity of the Uganda defassa waterbuck. *E. Afr. Wildl. J.* **6**:89-93.
- Stanley-Price, M. R. (1974). The feeding ecology of Coke's hartebeest, *Alcelaphus buselaphus cokei* Gunther, in Kenya. In Kingdon (1982). East African Mammals. An Atlas of Evolution in Africa. Volume III Part D (Bovids). Academic Press, London.
- Stanley-Price, M. R. (1977). The estimation of food intake and its seasonal variation in the hartebeest. *E. Afr. Wildl. J.* **15**:107-124.
- Stanley-Price, M. R. (1978). The nutritional ecology of Coke's hartebeest (*Alcelaphus buselaphus cokei*) in Kenya. *J. Appl. Ecol.* **15**(1):33-40.
- Stelfox, J. G.; Pedan, D. G.; Epp, H.; Hudson, R. J.; Mbudua, S. W.; Agastiva, J. L. and Amuyunzu, C. L. 1986. Herbivore dynamics in southern Narok, Kenya. *J. Wildl. Manage.* **50**(2):339-347.
- Stephenson, J. G. (1975). An investigation into with recommendation on the status of Swayne's hartebeest in the Shashemene area. EWCO, Addis Ababa. Mimeo. pp. 7.
- Stewart, D. R. M. and Stewart, J. (1970). Food preference data by fecal analysis for Africa plains ungulates. *Zoologica Africana* **15**:115-129.
- Sutherland, W. J. (1996). *Ecological Census Technique*. A handbook Cambridge University Press, United Kingdom.
- Swayne, H. G. C. (1903). *Seventeen Trips through Somaliland and a Journey through Abyssinia*. Rowland Ward, London.
- Talbot, L. M. and Talbot, M. H. (1963). The Wildebeest in Western Masailand, East Africa. *Wildl. Monogr.* **12**: 1-88.
- Taylor, R. D. and Walker, B. H. (1978). Comparisons of vegetation use and herbivore biomass on a

- Rhodesian Game and Cattle Ranch. *J. Appl. Ecol.* **15**(2):565-581.
- Tischler, T. H. (1975). Reprive for Swayne's Hartebeest. *Walia* **6**:12-13.
- Van Vuren, D. (1983). Group dynamics and Summer home range of Bison in southern Utah. *J. Mamm.*, **64**(2):329-332.
- Van Winkle, W. (1975). Comparisons of several probabilistic home range models. *J. Wildl. Manage.* **39**:118-123.
- Wilson, D. E.; Cole, F. R.; Nichols, J. D.; Rudran, R. and Foster, M. (1996). *Measuring and Monitoring Biological Diversity. Standard Methods for Mammals*. Smithsonian Institution Press, Washington.
- Wilson, E. O. (1989). Threats to Biodiversity. *Sci. Am.* **261**:108-112.
- Wilson, V. J. (1966). Observation on Lichtenstein's hartebeest, *A. b. lichtensteini*, over a 3-year period, and their response to various testes control measures in Eastern Zambia. *Arnoldia, Rhodesia* **12**:1-14.
- Woolf, A. and Harder, J. D. (1979). Population dynamics of a captive white-tailed deer herd with emphasis on reproduction and mortality. *Wildl. Monogr.* **67**:1-53.
- World Conservation Monitoring Center (WCMC) (1991). *Biodiversity Guide to Ethiopia*. Cambridge, UK.
- Wyatt, J. R. and Eltringham, S. K. (1974). The daily activity of the elephant in the Rwenzori National Park, Uganda. *E. Afr. Wildl. J.* **12**:273-289.
- Yakub, M. D. (1999). Population size and seasonal distribution of the hirola (*Damaliscus hunteri*) Unpubl. MSc. Thesis, Addis Ababa University.
- Yalden, D. W.; Largen, M. J. and Kock, D. (1984). Catalogue of the mammals of Ethiopia. 5. Artiodactyl. *Monitor. Zool. ital. (NS) Supp.* **19**:67-221.
- Yoaciel, S. M. (1981). Changes in the population of large herbivores and in the vegetation

community in Queen Elizabeth National Park, Uganda. *Afr. J. Ecol.* **19(4)**:303-312.

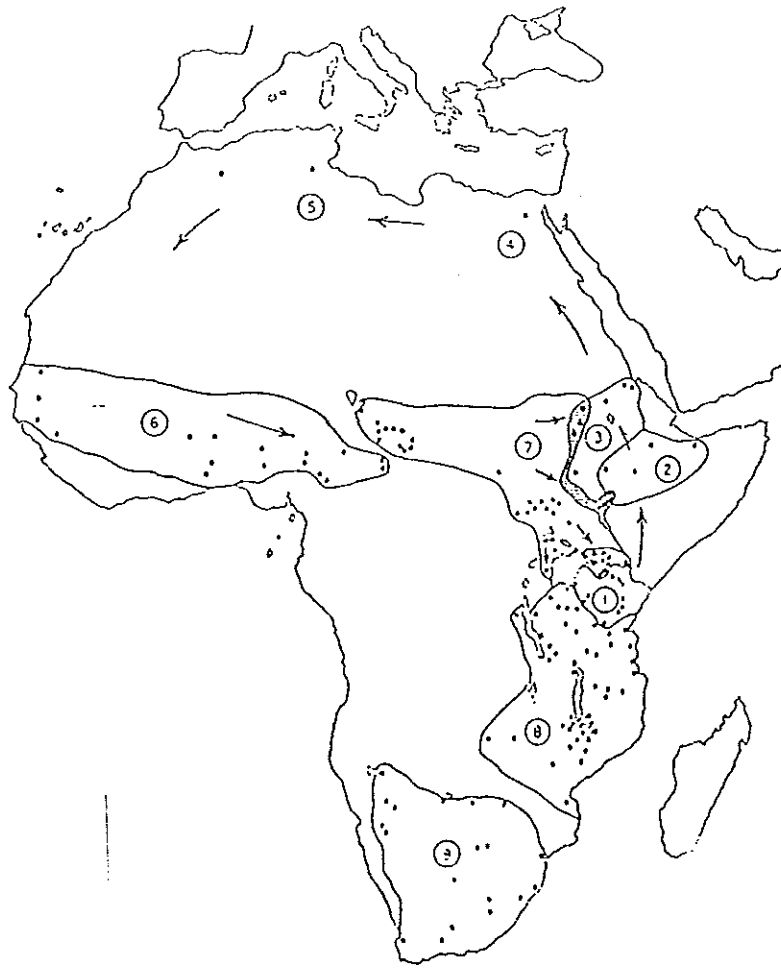
Yoaciel, S. M. and Van Orsdol, K. G. (1982). The influence of environmental changes on an isolated topi (*D. lunatus jimela*) population in the Ishasha Sector of Rwenzori National park, Uganda. *Afr. J. Ecol.* **9**:167-174.

7. APPENDICES

Appendix 1: Summary statistics of the wildlife of Ethiopia (Hillman, 1993).

Group	Number of species	Number of endemic species	% total
Mammals (terrestrial)	277	31	11.2
Birds	861	28	3.3
Reptiles	201	9	4.5
Amphibians	63	24	38.1
Freshwater fish	150	4	2.7
Butterflies	324	7	2.2
Plants	5,712-6,034	-1,150	-20.0

Appendix 2: The distribution of *Alcelaphus buselaphus* (Aftre Ruxton and Schwartz, 1929).



Key:

1. *Alcelaphus buselaphus cokei*
2. " *swaynei*
3. " *tora*
4. " *bubastis**
5. " *buselaphus**
6. " *major*
7. " *lehwei*
8. " *lichtensteini*
9. " *caama*

*extinct

Appendix 4: Questionnaire/interview addressed to people living around Senkele Swayne's hartebeest Sanctuary.

1. How long you lived here? (months/years).....
2. Do you know this animal? Showing a colored picture of the Swayne's hartebeest. (Y/N)
What you call in your language?.....
3. What other animals do you see in your surroundings?.....
4. Where can be Swayne's hartebeests be found during
 - a/ wet season.....
 - b/ dry season.....
 - c/ whole year.....
5. Do you find the Swayne's hartebeest come through the community? (Y/N).....
6. What are the main crops grown by the people around this area?.....
7. Have Swayne's hartebeest ever eaten or destroyed your crops? If yes what kind of crops were destroyed? At what time of the day/night? Why they prefer this time?.....
8. Can you evaluate roughly how much damage do these animals cause?.....
9. What control measures have been taken to safe guard the crops?.....
10. Do you think the Swayne's hartebeest population is increasing, stable, or decreasing? Please give your reasons for thinking so.....
11. Why are live stocks not endangered of extinction while they are being utilized continuously? Why are then hartebeests endangered?.....
12. What are the common causes of the death to Swayne's hartebeest in this area?
 - a/ hunters b/ predators c/ disease (name).....d/ others.....
13. What animals do people hunt inside the Sanctuary? What are the hunted animals used

for?.....

14. Do you think that the Sanctuary is important for this area? Should the hartebeests be conserved? If yes how?.....

15. Is it would be good to give the conservation area to people who need land?.....