ADDDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

POPULATION STATUS, STRUCTURE AND DIURNAL ACTIVITY PATTERN OF MOUNTAIN NYALA (*Tragelaphus buxtoni*) IN THE BALE MOUNTAINS NATIONAL PARK, ETHIOPIA

BEFEKADU REFERA

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BEFEKADU REFERA SORETA

A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT FOR THE DEGREE OF MASTER OF SCIENCE IN ECOLOGICAL AND SYSTEMATIC ZOOLOGY,

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DEDICATION

This work is dedicated to my son Natnael Befekadu and my wife Alemitu Zerfu.

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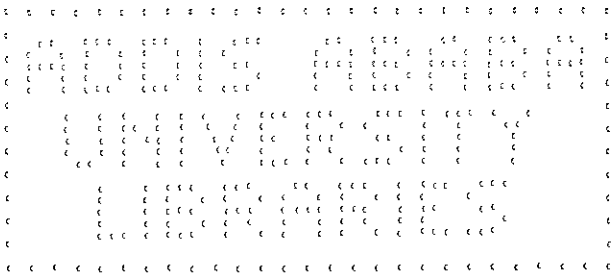

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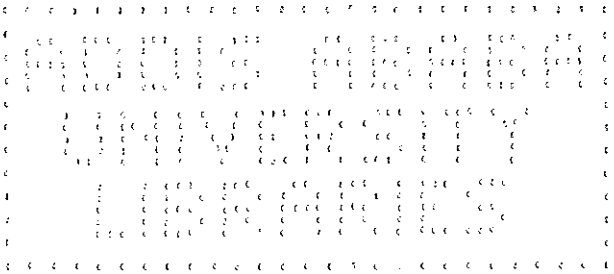

ABSTRACT

The study on the population status, structure, and diurnal activity pattern of Mountain Nyala (Tragelaphus buxtoni) was carried out in the Bale Mountains National Park, Ethiopia for four months that included wet and dry seasons. Ground total counts were carried out in an area of 13.1 km^2. The study showed that the endangered Mountain Nyala in the Bale Mountains National Park consisted of about 704 individuals. The Male to female ratio is unequal. Females comprise 62.9% whereas male 27.4% and the calves possessed the 9.7% of the sex ratio. Mountain Nyalas' are mainly browsers. The group structure of the animal varied with season, forming large herds during the wet season and dispersing in to smaller groups during the dry season. Territorial behaviour was not observed. The population trend of the animal from 1975-1990 indicated a recovery and increase. But between 1990-1995 a population showed a continuous and steep decline. However, between 1995-2000 the population trend showed a tendency toward recovery. The diurnal activity pattern of the animal showed two feeding peaks early morning and late afternoon. The peak resting time was in the middle of the day. Group size changed seasonally. 7 to 12 members in a group are common during dry and wet season, and the maximum group size observed was 62 during wet season. The vegetation type utilization and distribution of the animal indicated a marked preference for woodland habitat. However, there was a seasonal change in preference of habitat. The study established that the main threats of Mountain Nyala are habitat destruction, disturbance, livestock abundance, hunting and predation.

1. INTRODUCTION AND LITERATURE REVIEW

1.1. Introduction

Africa, compared to other continents, has the largest number of endemic families and genera of big games. This high degree of endemism is one of the reasons for African fauna to be so interesting and spectacular (Delany and Happold, 1979). The variation in the topography might have played a role in the diversification. Over eighty percent of Africa's Afro-mountain and Afro-alpine biomass above 3,000 meters above sea level is located in Ethiopia (Yalden, 1983). Ethiopia's geographical location and physical feature has resulted in the diversification of wildlife (Alem Berhanu, 1976; Yalden, 1983; Houerou, 1986; Shibru Tedela, 1995).

Though Ethiopia may not match some other African countries in display of animal abundance, given its isolation and former contacts with both Africa and Eurasia, it has an interesting and diverse fauna (Parker, 1988). The high incidence of endemism has been attributed to the vast extent of highlands of Ethiopia compared to the rest of Afrotropical region (Delany and Happold, 1979; Yalden, 1983). The wildlife species are confined to the montane extremes of the Simen Mountains and Bale Mountains, and the Arid Lowlands of the Rift Valley (Delany & Happold, 1979; EWCO, 1985). Much of the diversity of Ethiopian wildlife occurs at high altitudes but only 179 km^2 of Ethiopia's mountain area (Simien Mountains National Park) have so far been gazetted (Stephens et al., 1997). According to Hillman (1993), two hundred and seventy-seven mammalian species are known in Ethiopia of which thirty-one mammals species are endemic (Appendix 1). One of these endemics is the Mountain Nyala.

The Mountain Nyala (*Tragelaphus buxtoni*) Lydekker, Yedega agazen (in Amharic), and Gedemsa (in Afan Oromo) is a spiral-horned antelope that belongs to sub-family Tragelaphinae. It is the largest and the finest of the mammals found in the highlands of Ethiopia. It also has the distinction of being the last major species of African ungulate to be discovered (Brown, 1969; Ansell, 1971; Safari club international (SCI), 1987). Major Ivor Buxton brought it to the notice of science in 1908.

The common name of Mountain Nyala is wrongly associated to the common Nyala (*Tragelaphus angasi*) of South Africa (Hillman & Hillman, 1987; SCI, 1987). Mountain Nyalas are similar in color and general appearance to the Greater Kudu (*Tragelaphus strepsiceros)* (Carter, 1959; Parker, 1988; Macdonald, 1984; Hillman & Hillman, 1987; SCI, 1987; Estes, 1991). But it can be distinguished by the presence of single spiral horns and the absence of white stripes on the body. In many ways, Mountain Nyala resembles Greater Kudu than Nyala (Parker, 1988; Macdonald, 1984).

It is evident that very great changes have occurred in the distribution of Mountain Nyala in the Bale Mountains over the last 35 years since Brown (1966) made his observation. Earlier accounts of species support Brown's findings that they occupied the Heather and Afroalpine moorland (Sanford & Legendre, 1930; Carter, 1959; Bolton, 1974). He recorded them from summit of Mount Abaro near Shashemene. According to Carter (1959) Mountain Nyalas were also found around Kaka Mountains (Arsi).

The status of the Mountain Nyala has been obscure since World War II and it was considered to be an endangered species by IUCN. Brown (1969) remarked that the

Mountain Nyala was not in immediate danger of extinction. Though its range has been reduced, the earlier survey showed that there were 4,000-5,000 individuals in Bale and 400-550 in Arssi (Brown, 1971; Waltermire, 1975).

Brown (1971) reports that the range of Mountain Nyala was 2,910 square km^2 in Bale and 2,050 km^2 in Arssi. Together with other isolated areas, the potential range was about 5,200 km^2. Increasing population pressure has resulted in cultivating more land including the heath zone. Increased burning and herding livestock at higher altitudes has limited the ecological preference of the species resulting in range constriction to 2,150 km^2 (Fig. 1). Destruction of potential forested habitat has been even worse in the Chercher highlands around Gugu and Asebe Teferi. The forest as a result has been reduced to a few patches on hill tops (Brown, 1971).

The occurrence of Mountain Nyala has been reported at Adola (Brown, 1966). Other possible locations included the isolated highlands in the northeast Sidamo, (Brown, 1969; Yalden, et al., 1984).

According to Mesfin Woldemariam (1972), the highlands of Ethiopia are among the most densely populated agricultural areas in Africa. The problems of fragmentation and human population pressure are persistent and concentrated in the North of the country but spreading South rapidly (Hurni, 1986). Unlike the northern highlands, the Bale highlands were not previously heavily populated (Sillero-Zubri & Gotteli, 1991).

Since its discovery (1908), Mountain Nyala has declined substantially in numbers and distribution, mainly because of uncontrolled hunting and clearing of forests and burning of heaths for agricultural purposes (Yalden, et al., 1984). Recently Mountain Nyala has become more localized occurring in isolated population between the Chercher and Bale Mountains. In Arsi, the population is now reduced to a remnant (Hillman, 1988). Total numbers were estimated to be 7,000-8,000 in the 1960s (Brown, 1969), but the situation has continued to deteriorate.

Sighting of Mountain Nyala in the northern Afro-alpine zone (around Gaysay/Adelay) was unusual and brief. Buer (1971) rarely observed more than 25 Mountain Nyala in the same area. However, Hillman (1986) estimated 1,100 Mountain Nyala for Gaysay/Adelay area (Northern Afro-alpine zone) and the total population of Mountain Nyala in the Mountain area could be as high as 150-300. This gives an overall population estimate of 1,250-1,400 for the Bale Mountains National Park.

Around 1984-1985 a fence was erected in the northern Gaysay area to exclude livestock. This has allowed Mountain Nyalas favored habitat to recover from overgrazing by domestic sheep and goat. Twenty-five years ago, no more than a few Mountain Nyalas were seen in this area.

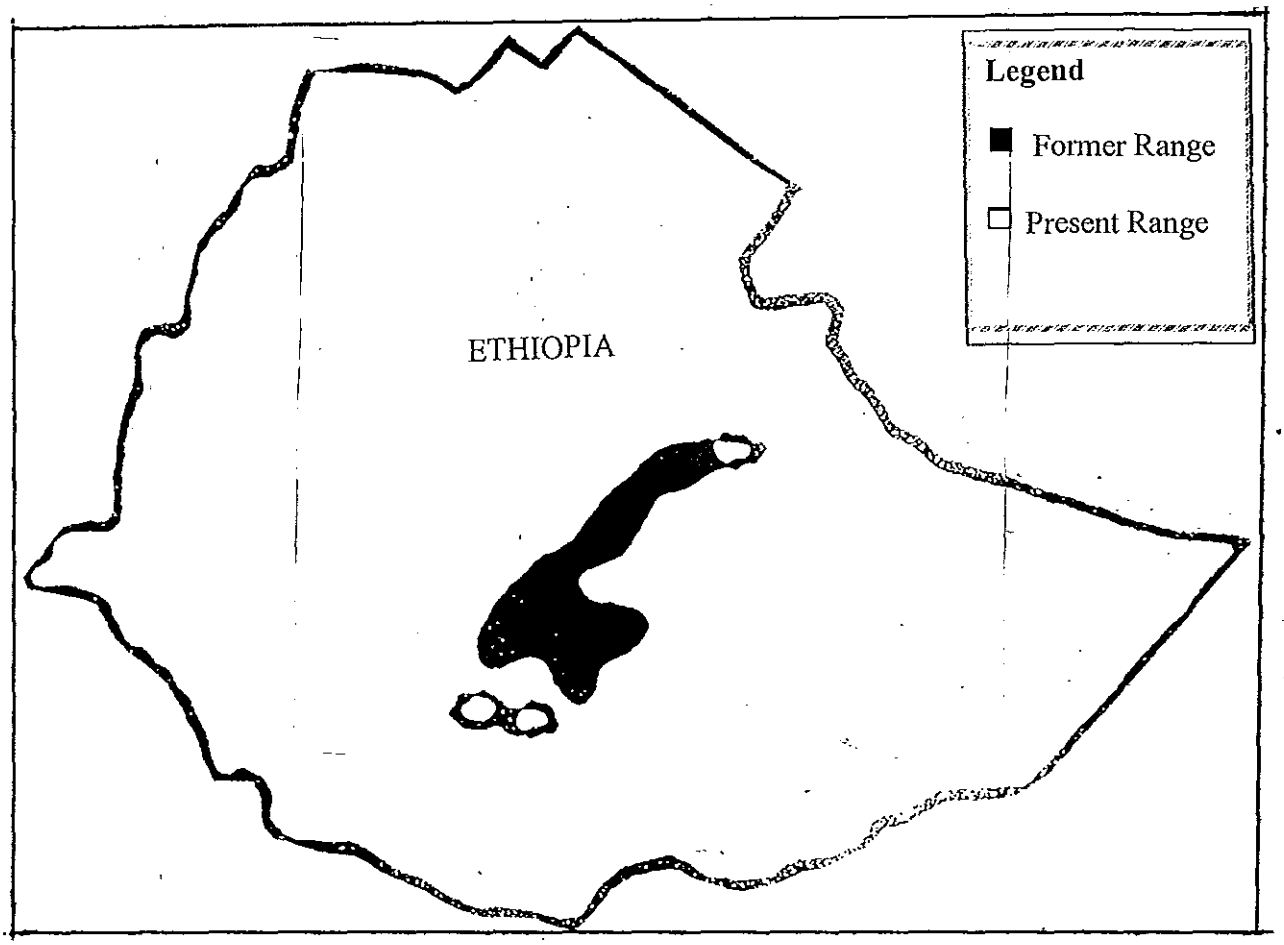

Figure 1 Map showing past and present distribution of Mountain Nyala

In1989, in one afternoon, more than 500 animals within an area of 12 km^2 were observed (Hillman, 1993). This impressive come back has been mainly due to the action taken by the Ethiopian Wildlife Organization (EWCO) on maintaining this Mountain Nyala Sanctuary.

Considerable damage was incurred at the time of change of government in Ethiopia in May 1991. This affected all of the livestock control fences in the optimum Mountain Nyala habitat at Gaysay/Adelay in the North, and all the existing outposts in that area were destroyed (Hillman, 1993). This was followed by short period of lawlessness before the new transitional government could restore order (Stephens, et al., 1997). Poaching activities by local people became dramatic, especially on Mountain Nyala and Ethiopian Wolf (*Canis simensis*). Mountain Nyalas were killed for meat, skin and horn tips. Meat of Mountain Nyala was sold in Hotels around Adaba and Dodola Towns. They were also killed purposely to provide meat for wedding ceremony and holidays instead of beef meat (Woldegebriel Gebre Kidan, 1996).

Based on Hillman (1986), Gaysay/Adelay area census projected the number of Mountain Nyala to reach over 3,500 by 1995. At the end of 1994, a census result of Mountain Nyala at Gaysay/Adelay and Headquarter population was between 150 and 260. And the overall population for the whole Bale Mountains National Park was between 350 and 560 animals (Woldegebriel Gebre Kidan, 1996).

At present, Mountain Nyalas are not maintained in captivity to act as a breeding stock in case something happens to the wild population. However, if the condition continues, it may push the animals toward extinction unless and otherwise an immediate and effective conservation measures are taken. Intensive work is essential to assess the present population status and distribution of Mountain Nyalas in the Bale Mountains National Park. At present, due to lack of research information, the population status and distribution is not well known. Habitat loss increased human pressure and poor management of the Park has contributed to dramatic decline of the species. Therefore, it was crucial to study the population status, population structure, and diurnal activity pattern of Mountain Nyala and assess the attitude of the local people towards the conservation effort.

1.2. Literature review

Serious attempts at wildlife conservation were not initiated in Ethiopia until the mid-1960s (Blower, 1969; Brown, 1969; Bolton, 1973; Lewis & Wilson, 1979). Brown (1969), Hillman (1985, 1986, and 1993) and Woldegebriel Gebre Kidan (1996) have carried out field studies on Mountain Nyala at different times.

Records of Mountain Nyala have been obtained from Mount Gugu (08^0 15' N, 39^0 55' E), Southwest Chilalo and Kaka ranges (07^0 N, 39^0 E), and in the Bale Mountains South of the headwaters of the Wabishebele (06^0 N, 39^0 E) (Maydon, 1932; Rosen, 1953; Carter, 1959; Brown, 1965). The species has also been recorded from Gara Muleta Mountains, 09^0 N, 41^0 E, (Brown, 1925; and Hillman, 1986) and at Din Din Mountains (Harare) by SCI, (1987).

There has been considerable disagreement regarding the classification of genus *Tragelaphus*. According to Ansell (In Meester & Setzer, 1977), both *Tragelaphus* & *Taurotragus* comprise medium-sized to large antelope with variously developed face and body pattern of white spots and stripes. The tail is relatively short in subgenus *Tragelaphus*. The twisted horns are present only in the males of the subgenus *Tragelaphus* but in both sexes of *Boocerus* & *Taurotragus*. The genus *Tragelaphus* differs in having the horns in an open spiral, no dewlap, and feet that are non-ox like and more elliptical (Nowak, 1991) (Fig. 2). The bushbuck, sitatunga, and nyala are particularly close, and the bongo resembles an overgrown bushbuck or sitatunga (Haltenorth and Diller, 1980; Estes, 1991).

The color of the Mountain Nyala is grayish-brown with white markings. These markings consist of a chevron between the eyes, patches on the throat and lower neck, 3 or 4 indistinct vertical stripes on the sides and a longitudinal series of spots on the slides and flanks. Hence the antelope's first English name was 'spotted kudu' (Carter, 1959; Brown, 1969). Young females are red-brown, becoming browner and then greyer as they age increases, but are never as dark as an old male (Brown, 1969). The adult male weighs about 280 kg and stands as high as 150 cm at the shoulder and the adult female weighs about 200 kg and lighter in color (Brown, 1969; Parker, 1988 Hillman & Hillman, 1987).

The feeding niches of African ruminants have been classified in terms of the quality, quantity and principal composition of the vegetation (Gordon & Illus, 1996). Mountain Nyala are mainly browsers, feeding on herbs and bushes with occasional grass, lichens and ferns (Brown, 1969; Hillman, 1986, 1987, &1993).

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). The seasonal variations in the availability of the required resources affect aspects of ungulate ecology such as its population distribution (Sinclair, 1983; Fryxell, 1987) habitat preference and activity patterns (Duncan, 1983). The seasonal distributions of animals are linked with shifting distribution of critical resources (Inglis, 1976). The local practice of burning giant heath (*Erica arborea*) every dry season is altering the whole ecology of the area and causing serious damage to the Mountain Nyala habitat (Blower, 1971). The optimum habitat of Mountain Nyala appears to be the Northern Woodland and grasslands (Gaysay/Adelay). In the dry season and early wet season (Nov-Mar/Apr), when vegetation is in poor condition, many Mountain Nyalas leave the Gaysay area, moving up into wooded and forested areas, and into the thick heather moorlands (Hillman, 1986).

The population of a herbivore in a particular area may fluctuate in the long term response to changes in structure and biomass of both plant and animal communities with variations in the balance between water and soil nutrient availability (Bell, 1971).

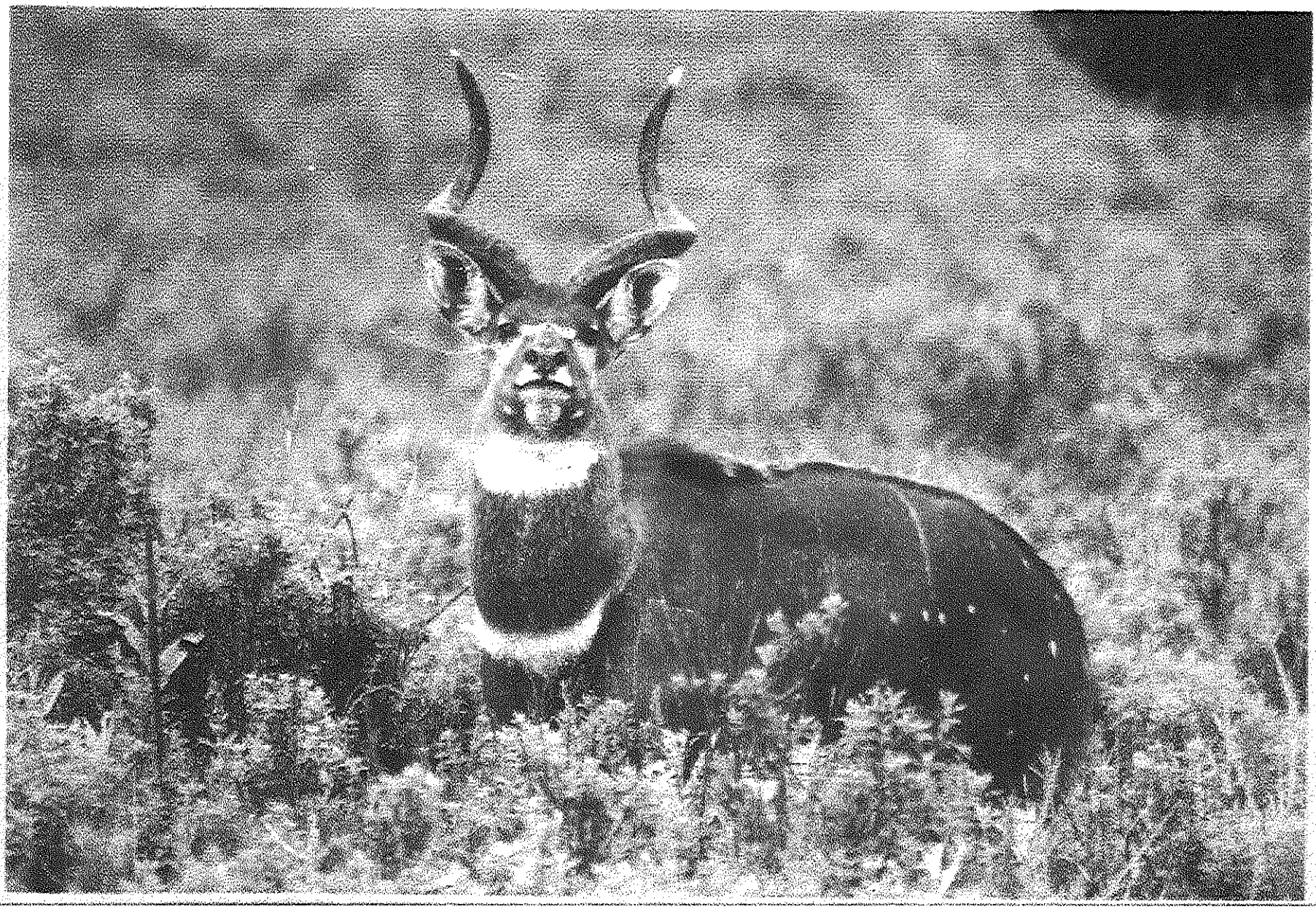

Figure 2: A fully mature adult male

The reproductive behaviour of Mountain Nyalas (pre-mating and intense following of female by males) was observed from October to December. December is a mating peak and single young is born after 8-9 months gestation at the end of wet season (Hillman, 1986 and 1987; Kingdon, 1997).

Tragelaphines are hiders and calves lie out for two weeks in dense cover. The mother retrieves the calf for suckling and can prompt it to rise with special contact (Estes, 1991).

There is a dominance hierarchy, maintained in the younger males by horn tussling and pushing, and older males by ritualized displays (Hillman, 1986, 1987). Mountain Nyalas when resting as a herd look in all directions, so that one can instantly give the alarm at any danger and it is difficult to approach unobserved (Brown, 1969). Mountain Nyalas are rarely found alone (Hillman, 1986). The basic social grouping comprises an adult female, her calf of previous year and the current year. Males occur in bachelor and or family groups, up to 13 together. They are not territorial, but exhibit a dominance hierarchy (Hillman, 1986, 1987, 1988; Kingdon, 1997). Males are less numerous in the mixed sex group during the dry season. Young males leave their mothers at about 2 years old and join the bachelor group (Hillman & Hillman, 1987).

Natural habitats around the world are lost at faster rates as an ever-expanding human population converts them to agriculture, 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 (Fryxell and Sinclair, 1988; Wilson, 1989).

One of the biggest threats to wildlife resource is war and civil strife, which can cause damage to them and their habitat (Tesfaye Hundesa, 1997). The large-scale introduction of firearms inevitably led to uncontrolled hunting (Blower, 1970). In East Africa, there is a growing problem concerning the conflict between wildlife and human interests particularly on the boundaries of protected areas (Sinclair, 1977). Exploitation of forest for timber, firewood and charcoal, as is currently practiced all over Ethiopia is generally wasteful and destructive. In the Chercher Mountains, forest exploitation even to the summit of mountains is followed by agriculture, subjecting the soil to extreme denudation and forcing the Mountain Nyala to its doom (Andeberhan Kidane, 1982).

Previously, Mountain Nyala was not recorded in IUCN Red Data Book as endangered species since the Park has secured its population. Hillman (1988) considered Mountain Nyalas as **rare** species. However, the 1990 IUCN Red Data Book, listed *Tragelaphus buxtoni*: Mountain Nyala as **ENDENGERED** species (IUCN, 1990). The species is so localized, that it is very vulnerable to both ecological and political upheavals (Kingdon, 1997). The range of the species is threatened and very localized by human interference. This intervention is still continuing.

1.3. Objectives

General objective

To assess the current population status of Mountain Nyala in the Bale Mountains National Park.

Specific objectives

- To assess the distribution pattern of the animal.
- To describe the diurnal activity pattern of the animal.
- To determine the population structure.
- To suggest a possible conservation strategy.

2. DESCRIPTION OF THE STUDY AREA

2.1. Location and Topography

The Bale Mountains National Park (BMNP) was established in 1971 following the recommendations made in 1964/65 by two commissions of UNESCO and later survey of the mountains (WWF, 1987/88).

BMNP is located between $6^0$29' and $7^0$10' North, and between $39^0$28' and $39^0$58' East. The area of BMNP as designated in 1974 is 2, 200 km^2, varying in altitude from 1,500 m to 4,377 m above sea level (Hillman, 1986).

The Bale Mountains in the southeast Ethiopia bear a variety and large number of wildlife, some of them endemic. Scenically splendorous, these mountains are ecologically very important, as they comprise Afro-alpine moorlands, rare in Africa, montane grasslands and moist lowland forests. The BMNP has a vital role to play in the sustainable use of natural resources in surrounding areas and a center of endemicity that represents an important gene reservoir. The mountains conserve a major water catchment area important to both Ethiopia and Somalia (Hillman, 1988).

2.2. Ecology and vegetation

Brown (1969) discussed the vegetation zones in the Bale Mountains during his pioneering census of the Mountain Nyala. Lisanework Admasu and Mesfin Taddese (1988) developed a detailed account of zonation in the Harena Forest. The BMNP contains five ecological

zones (Fig.3). The northern grassland, the northern woodlands, and heather moorlands forming a mosaic between 3,100 and 3,400 m a.s.l. The treeless Afro-alpine grassland and moorland above 3,400 m, and the southern Harena Forest between 1,500 and 3,200 m. Each of these different vegetation zones harbors many flora and fauna of which some are endemic to Ethiopia. Record show that the Park harbors 900 plant species of which more than 17 species are recognized to be endemic and confined toNorthern grassland and woodland and Harena Forest of the park (Hillman, 1986).

2.2.1. Gaysay-Adelay Area

Northern grassland: - is a very small, but very important zone. It comprises the flat land along both sides, of the Gaysay River, and on the west bank of the Weyib River. The area occurs at the extreme north of the Park between Gaysay Mountain and the Adelay Ridge (Fig. 3). These grasslands lie on almost flat land, whose drainage is poor, and inundation is frequent in the wet season. Many places are, therefore, dominated by swamp grasses and sedges, especially of *Cyperus* and *Scirpus* genera. Higher parts are covered in low bush vegetation, dominated by *Artemesia afra* and *Helichrysum splendidum*. The grassland area contains expanse of sagebrush (*Artemesia afra)*, red-hot poker (*Kniphofia foliosa*) and *Nepeta biloba.*

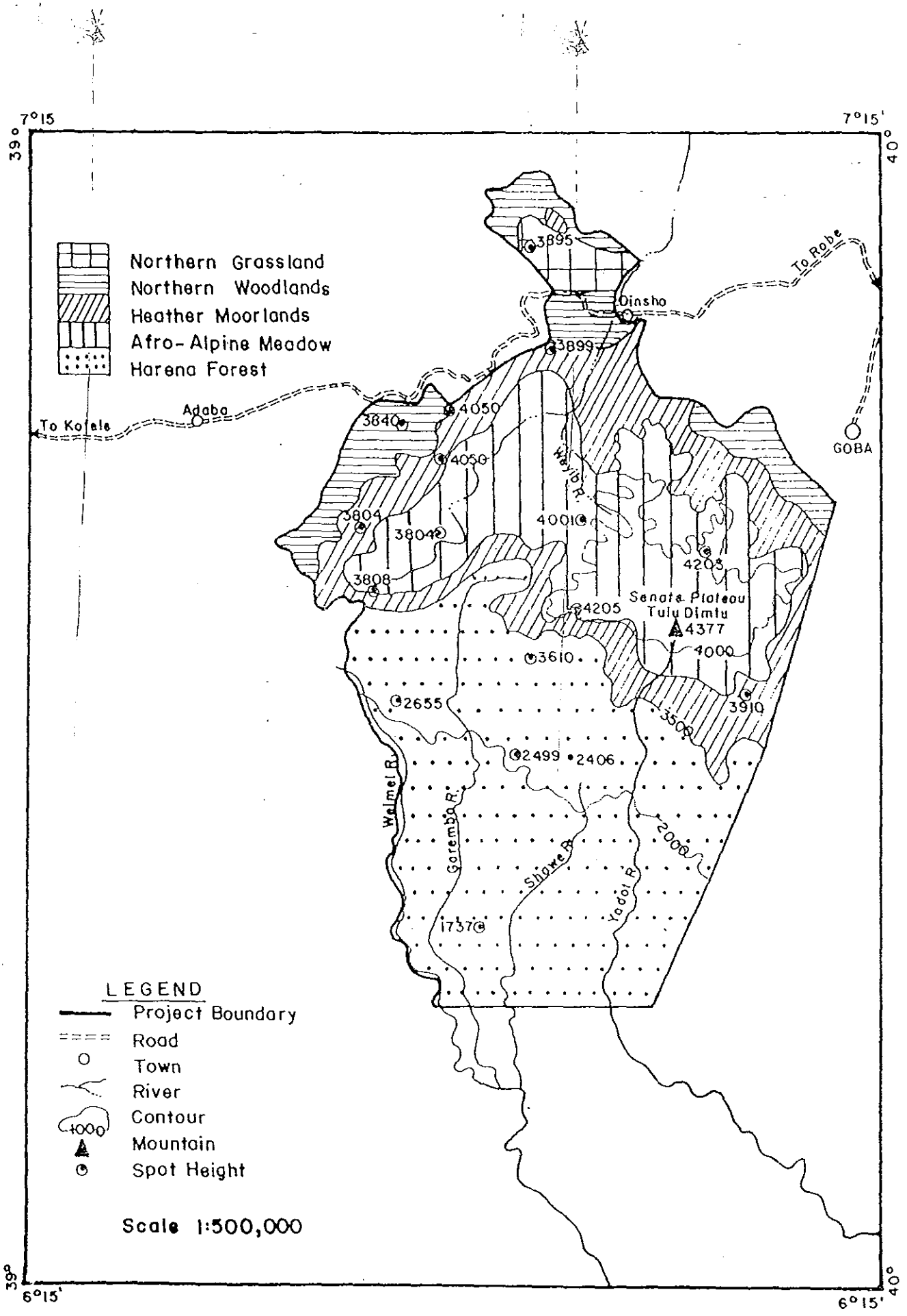

Figure 3: Map showing the five main vegetation zones of Bale Mountains National Park

Source: Woldegebriel Gebrekidan

2.2.2. Northern woodland

This vegetation occupies a narrow belt in the northwest, north and northeast of the Park. The upper limit is the tree line at 3,400 m. The species that dominate the northern woodlands are the trees *Hagenia abyssinica* and *Junipers procera*. Most of the *Junipers procera* are relatively small (15-20m tall), since the area is the upper limit to the species growth, and few are found near the upper tree line. *Hypericum revolutum* produces a dense bush growth at the upper treeline. Extensive grass areas occur within the woodlands especially on the steepest slopes. These contain similar species to the flat areas below, with the exception of sedges. Tree heather (*Erica arborea)* is found at about 3,500 m. At altitudes greater than 3,800 m, heather is only found in small sheltered areas, and the more typical alpine flora becomes dominant.

2.3. Fauna

The Bale Mountains National Park encompasses a broad range of habitats between 1,500 and 4,377 m altitude. These provide a large number of niches for animals and as a result the diversity of the fauna is high. A large proportion of the Bale Mountains fauna is endemic. Yalden and Largen (1984) underline the importance of the Bale Mountains as center of endemicity and reservoir of unknown genetic resources.

67 mammal species are known of which 18 species are endemic to the country and five are known only from the Bale highlands. More than 260 bird species have been recorded. These include 6 of the 16 species endemic to the country (Appendix 1).

The Gaysay grassland supports a selection of animals, including the endemic Mountain Nyala (*Tragelaphus buxtoni*), Reedbuck (*Redunca redunca*), Menelik's bushbuck (an endemic sub-species, *Tragelaphus scriptus meneliki*), Grey duicker (*Sylvicapra grimmia*), Warthog (*Phacochoerus aethiopicus*), Olive baboon (*Papio anubis*), Ethiopian wolf (*Canis simensis*), Colobus monkey (*Colobus gureza*), Golden jackal (*Canis aureus*), Spotted hyaena (*Crocuta crocuta*), and Serval cat (*Felis serval*) (Appendix 2).

2.4. Rainfall

The rainfall of the park area is characterized as continuous eight-month rainy season (March to October), followed by a four-month dry season (November-February). The lower altitude of the Park receives 600-1000 mm annual rainfall and the higher altitude areas obtain 1000-1400 mm annual rainfall (Daniel Gemechu, 1977). Rain is received from two different sources at different times of the wet season: the equatorial westerlies and the Indian Ocean monsoons. The climate of the Afroalpine belt is influenced by desiccating northeasterly winds and Orographic rains, showing a marked seasonality. Dampening mists and rains sweep the area daily during eight months of the rainy and intermediate seasons (Hillman, 1986; Miehe and Miehe, 1994).

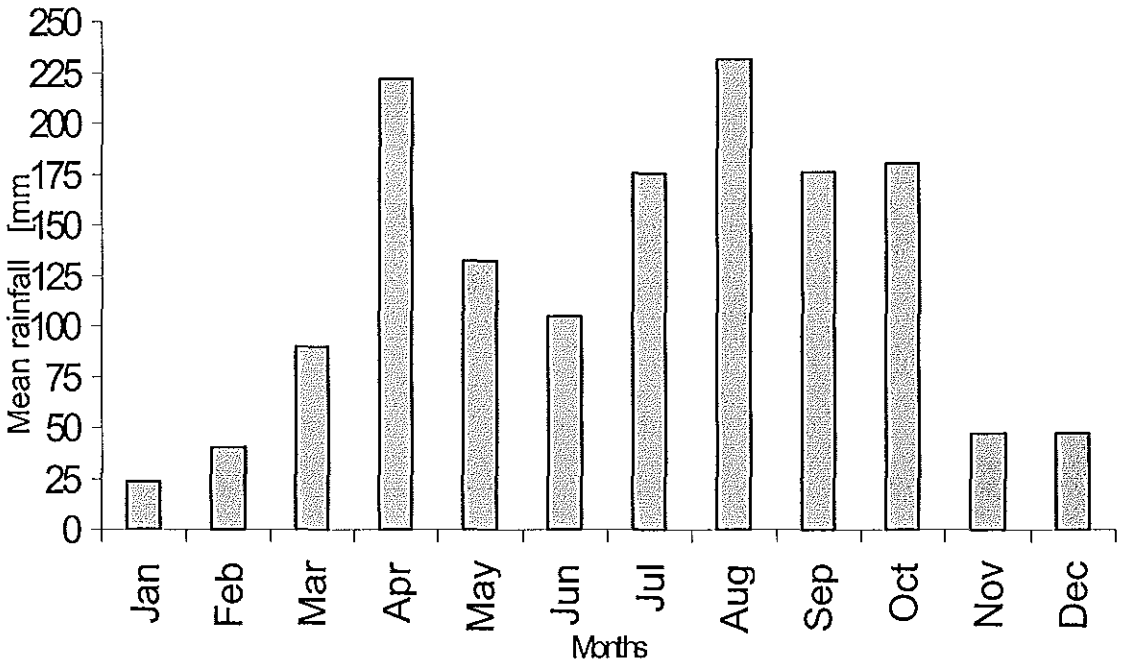

Figure 4. **Monthly mean rainfall of Dinsho Area from year 1983-2000**

Source National Meteorological Services Agency (NMSA).

Based on 18 years rainfall data (1983-2000), Dinsho area experiences two rainy seasons (Fig. 4). Heavy rain from (July to October), with the highest peak in August and the small rain (March to June), with the highest peak in April. Rainfall is prevalent throughout the year even during the dry season (November to February).

2.5. Temperature

Based on 18 years record at Dinsho (1983-2000), monthly maximum and minimum temperature data are given in Figure 5. The lowest temperature occurs at night in the dry season 1.4 ^{0}C (January) and the highest temperature during the same season is 18.4^{0}C (February). Frost is regularly experienced in the Dinsho area at night, particularly in the dry season.

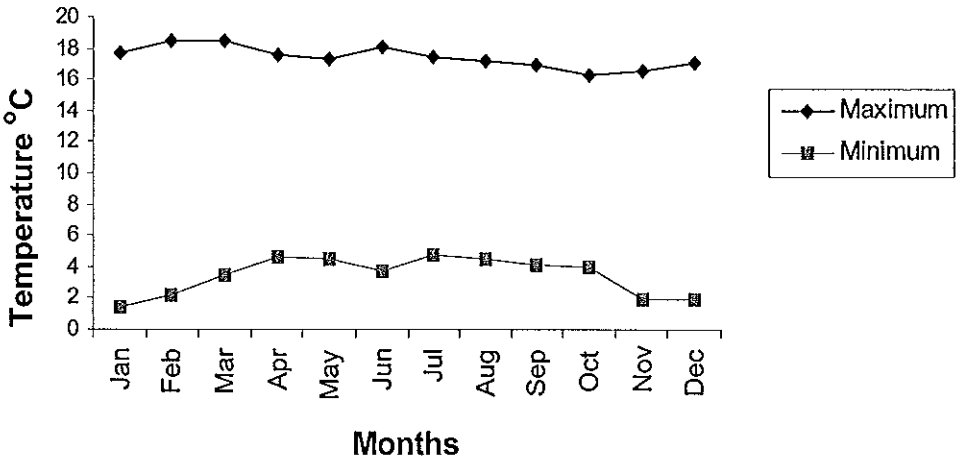

Figure 5. Monthly temperature of Dinsho area from year 1983- 2000

Source National Meteorological Services Agency (NMSA).

2.6. Soil and Geology

The geology of the Bale Mountains comprises volcanic origin resulting from the Oligocene eruptions of the Trappean lava which cover the Mesozoic marine sediments and underlying pre-Cambrian rocks after Eocene uplifting of the Ethiopian highlands (Mohr, 1963). As the upper geological strata of the Bale Mountains are entirely volcanic, the soils mainly

derived from the basaltic and trachytic parent rock, are fairly fertile silty loams of reddish-brown to black colour (Morton, 1976; Miehe & Miehe, 1994). During the Plio-Pleistocene rifting phase, the Arsi-Bale massif was separated from the north west Ethiopian mountains by the Rift Valley system which also isolated the South West Arabian part of this land mass. The Bale Mountains show distinct signs of recent glaciation (Smedes, 1959 & Hedberg, 1978).

2.7. Human Settlements and Land use system

Before the establishment of the park in 1970 there were a limited number of settlers in the present protected areas (Shibru Tedela, 1995). In 1984 permanent settlement in the park was estimated by an aerial survey at 2,500 people (Hillman, 1986). The people living in the park are Oromos.

There are three kinds of use of the park area:

1. Permanent settlement and associated crop cultivation.
2. Temporary (nomadic) use of some grazing and the "horas"(mineral springs) and
3. A source of wood (timber and fuel wood).

Traditional hunting of wild animals for their skins, horns and meat are practiced to a limited extent, but was excessive immediately after the change of government (Shibru Tedela, 1995).

As Hillman (1986) describes, the permanent settlement mainly concerns three areas; the upper Weyib Valley, the western boundary and the Harena Escarpment areas. The settlement in the upper Weyib valley and parts of Sanetti plateau practice pastorialism

(Gotteli and Sillero-Zubri, 1990). The broad open valley is used as grazing land, by people from the designated settlement areas of Hora Soba, Geremba Dima and other areas (Hillman, 1986). In areas below 3,500 m livestock is combined with cultivation. Permanent human population on the Sanetti plateau was limited to small settlements scattered at the rim of plateau (Gotteli and Sillero-Zubri, 1990).

For the purposes of utilizing "Horas" (mineral springs), large numbers of livestock enter the park that are located in Hora Soba, Wasama, Worgona and upper Weyib valleys. Temporary-use houses are constructed at high altitudes near the horas, and these people also use caves as shelter. Livestock kept in the vicinity for several days severely affect the habitat. The people regard the park areas an infinite resource of natural products but do not realize the role it plays in maintaining natural processes (Hillman, 1986).

3. MATERIAL AND METHODS

3.1. Duration of the study

A study was carried out from August 1 to 30 and 14 October to 12 November 2000 (wet season I and II). From 20 December 2000 to 21 January 2001 and 24 February to 25 March 2001 (dry season, I and II). A total of four months comprising wet and dries seasons was spent in data collection. These four periods represent the three seasons experienced in Bale, the heavy rain, small rain, and dry season and thus give representative samples for the whole year. Quantitative data were obtained for both wet and dry seasons. In both seasons, data on the population size, structure, vegetation types, utilization and distribution, and diurnal activity pattern of Mountain Nyala were gathered. The impact of

the local people on the Bale Mountains National Park was also assessed. Records of rainfall, relative humidity, maximum and minimum daily and monthly temperatures were obtained from the National Meteorological Services Agency (NMSA).

3.2. Division of the Study area

Reconnaissance survey was conducted prior to the field work on July/ 2000. The survey and the previous workers revealed that vegetation cover and topography of the area was not homogenous. The Mountain Nyalas were found on three separate areas, namely at Gaysay/Adelay, at the Headquarter of the park (Sanctuary) and at the Gassore / Kilebochissa (nearby mountains).

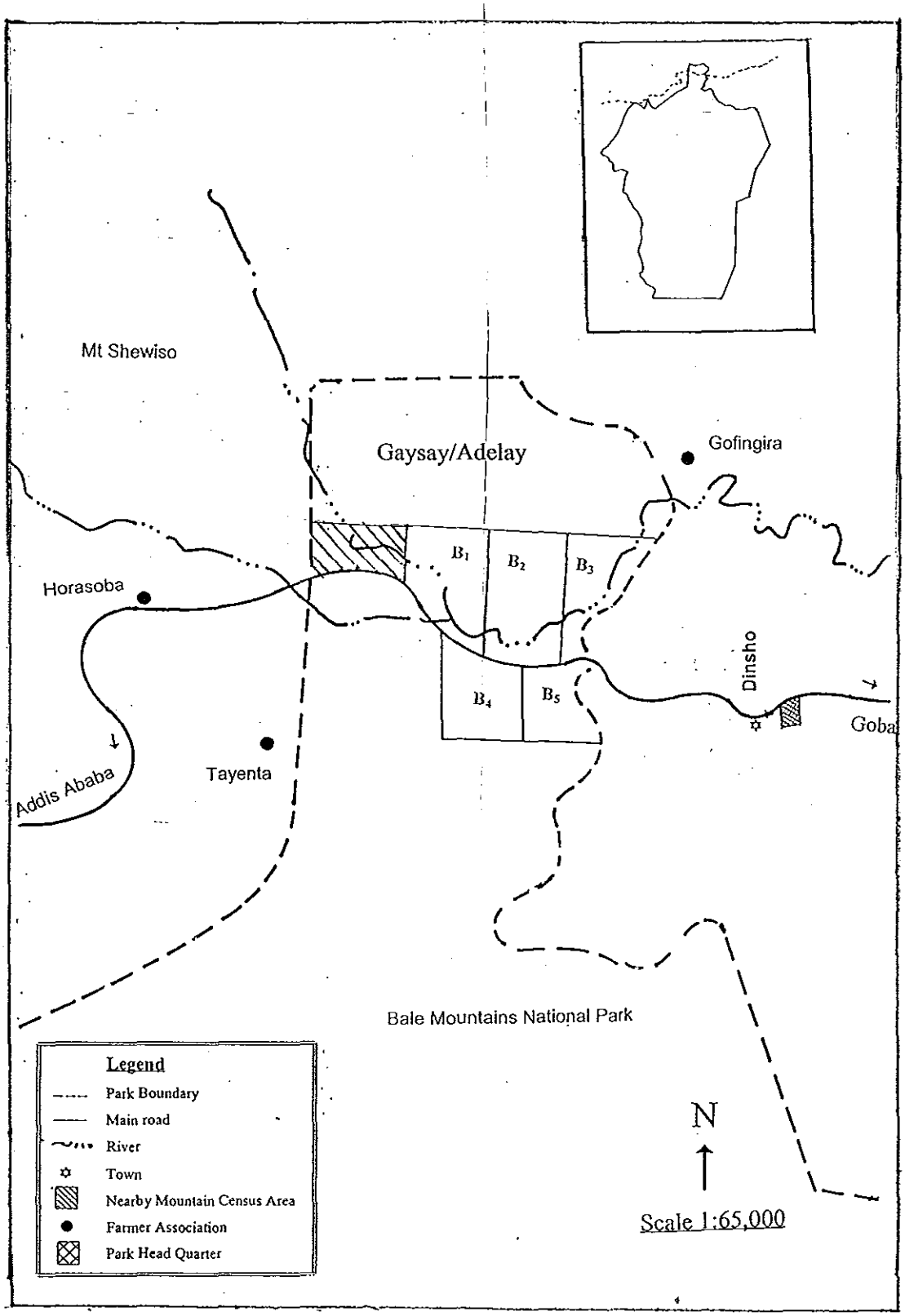

Figure 6. Map showing the study area

Table 1. The size of the area of each study site

Study Site	Area (km^2)
1.Gaysay/Adelay	
Block-1	2.08
Block-2	3.28
Block-3	1.58
Block-4	1.32
Block-5	2.04
2.Nearby Mountains Census Zone	1.6
3.Park's Headquarter	1.2

Based on natural boundaries like rivers, mountains, small hills and artificial boundaries like the main road and bridges; the Gaysay/Adelay Mountain Nyala population study area was divided into five counting blocks (Fig.6 & Table 1). The distance and expanse of the consecutive counting blocks vary depending upon the natural boundaries and the topography of the area. 'Blocks' in this context refer to small areas with natural and artificial boundaries that can easily be identified on the map as well as on the ground.

Dividing the headquarter in counting blocks was not used because the area was so small (1.2 km^2) and very rugged since it was easy for the animals to mix. However, by studying the main routes of the Mountain Nyala population, the sanctuary was divided into three main routes. For the nearby mountains, since the study area was small, it was considered as one separate counting block.

3.3. Population Census

Total count method was applied throughout the study period to estimate population size of Mountain Nyala as it was adopted by Harper (1967); Martinka (1969); Leuthold and Sale (1973); Mukinya (1973); Atwall and Bains (1974); Norton-Griffith (1978); Wilson (1979); Melton (1983); Caughley and Sinclair (1994); Sutherland (1996); Wilson et al., (1996) for different animals in different habitats.

Data on population census were collected by direct observation of free-ranging animals with unaided eye and / or 8x30 binoculars. All population censuses of Mountain Nyala were made on foot.

Following the assumptions suggested by Norton-Griffiths (1978); Lehner (1996); Sutherland (1996); for 'closed' population, the entire study area was searched (not sampled); all the animals in the study area were spotted and none of them were counted twice. The census was conducted over a short duration of time and it was assumed there

were no immigration, emigration, or deaths through natural processes during the population census. But it is not always possible to meet these requirements.

Six total counts for each Gaysay/Adelay and the Headquarter Mountain Nyala population were conducted in the wet season (3 times per month). And four total counts were carried out for nearby Mountain Nyala population (twice per month). The same procedure was also used in the dry season. The census was conducted when Mountain Nyalas were most active and good visibility from 0730-1030 h in the morning and from 1600-1800 h in the late afternoon. Each total count was completed within 2-2½ hours in a day with the help of 4 well-experienced and responsible scouts. During each count, data were recorded on recording sheet (Appendix 3). During the census; sighting records of sympatric herbivores, carnivores and domestic stocks were made on separate notebook.

3.4. Sex and age structure

During the census of Mountain Nyala, detailed observations of the entire herd were collected (Appendix 3). This enabled to categorize them into their respective age groups. The categories used were adult male and female, sub-adult male and female, and juvenile male and female and unidentified juvenile sex. To categorize the animals into such groups, the works of Brown (1969), Knight (1970), Bergerud (1971), Kitchen (1974), Lewis and Wilson (1979), Bowyer (1984), Hillman (1986), Balakrishnan and Ndhlovu (1991), Kingdon (1997) were referred.

It was possible to sex Mountain Nyala quite accurately with binoculars at a distance of 1-1.5 km range. Only Males have large twisted horns, large in size, have a mane of shaggy hair and dark gray colour. While the adult females are small in size, no horns, no mane and have smooth hair and red-brown in colour. Sub-adult males have straight spike horns (not twisted), medium sized and brownish in colour. Sub-adult females were differentiated from adult females by their small size and reddish color. Juvenile (calves) males and females were differentiated by focussing at horn growing area whether there is small growing horn buds or not.

Sex ratios for the herds were obtained from direct count of the animals using the methods of Woolf and Harder (1979), Melton (1983), Hillman (1986), Mumin (1999).

3.5. Group size

During each total count, the total number of herd (group) size was recorded first before further sub-dividing into each sex categories. Following Lewis and Wilson (1979), Hillman (1986 &1987) and Borkowski & Furubayshi (1998) for the study of different animals; individuals were considered as members of the same group if the distance between them was less than 50 m. The location of every group was plotted on the map of the study area.

3.6. Utilization and distribution of Vegetation type

Determining the diet is often a central to understanding animals' habitat requirement (Sutherland, 2000). On the basis of criterion developed by Andere (1981), vegetation type 'utilization' defined as areas where the animals were observed feeding at a definite time

whether in a single or groups. During the total counts, use on type of plant species was recorded. The plants consumed by animals were carefully observed. This method enabled to identify the various types of grass and shrub species consumed by Mountain Nyala. Within the study area, five vegetation associations were identified (Appendix 3). The location of each herd and individual at each vegetation type was recorded. The method of Larson et al., (1978) and Norton-Griffiths (1978) was used to describe the dry and wet seasons distribution and the vegetation type utilization of the animal. By taking each group or individual sighting as scores with respect to habitat types and comparing their frequencies to the relative availability of vegetation type, it was possible to detect the utilization of vegetation type and distribution.

3.7 Diurnal Activity Pattern

Observations of diurnal activity pattern of Mountain Nyala were made using unaided eye and/or 8X30 binoculars. All sightings were made by selecting suitable vantage points. Mostly hilltops were selected for vantage points where available. For observation Gaysay/ Adelay Mountain Nyala population during the dry season, a vehicle was also used because the animals give less attention to an automobile than to a walking man. When the animals move from the observer more than 150 m, they were followed from a distance of 50-100 m.

Because of easy accessibility, two groups from each Gaysay/Adelay and Headquarter Mountain Nyala population were chosen to display variability in activity levels between groups. Following the methods of Talbot & Talbot (1963); Spinage (1968); Leuthold (1971); Jarman (1973); Kitchen (1974); Hirst (1975); Guy (1976); Mitchell (1977);

Kuteilek (1979); Irby (1982), a recording sheet (Appendix 4) was prepared for detailed behavioural notes. Various workers have used different time intervals (from 4 to 5 minutes) for studying the diurnal activity pattern of different animals. For Mountain Nyala, five minutes recording interval was applied. At every 5 minutes interval, the appropriate activity was ticked off on the sheet. When unique activity was observed, it was recorded on separate notebook. Observation was carried out from 0600-1800 h for consecutive 5 days for each study season. A total of 20 days was used for the whole study period. Observation distance varied from 20-500 m according to the topography of the habitat. These diurnal activities were categorized as follows: '*feeding*' (by noting whether the animal is grazing or browsing), '*standing*' (but was not engaged in any other activity). '*Walking*' (if the Mountain Nyalas were walking at a steady pace) and *'resting'* (Sleeping in the open or in the shade), *'watching'*, and '*other activities'* (includes scuffling, sniffing of genitalia, suckling, social activities, etc.) (Appendix 4). The distinction between these categories was not always clear-cut since they were engaged into 2 or more activities simultaneously. Notes that were recorded in the field were later transcribed into data forms.

3.8. Assessment of the impact of the local people

In order to address the study objectives, discussions were carried out with the local people. The discussion was based on the questionnaire prepared for the study (Appendix 5). In line with the guidelines, local government and non-governmental officials, school communities, park warden, scouts, field guides, respected elderly people, members of the community including herd boys took part in the discussion. The discussion was made directly by using questionnaire and a sort of meeting and at any opportunities during the study period.

4. RESULTS

4.1 Population Census

The maximum number of Mountain Nyala population counted was 694 during the wet season I and the lowest number was 647 during dry season II (Table 2).

Table 2. Total counts of Mountain Nyala at both seasons

Season	B-1	B-2	B-3	B-4	B-5	**Sub-Total**	HQ	Nearby Mountains	Total
Wet season I	63	120	36	54	79	352	216	126	694
Wet season II	58	91	40	69	107	365	204	111	680
Dry Season I	52	75	50	63	79	319	209	127	655
Dry Season II	42	68	37	67	87	301	214	132	647
Total	215	354	163	253	352	1337	843	496	2676
Average	53.8	88.5	40.8	63.3	88	334.3	210.7	124	669

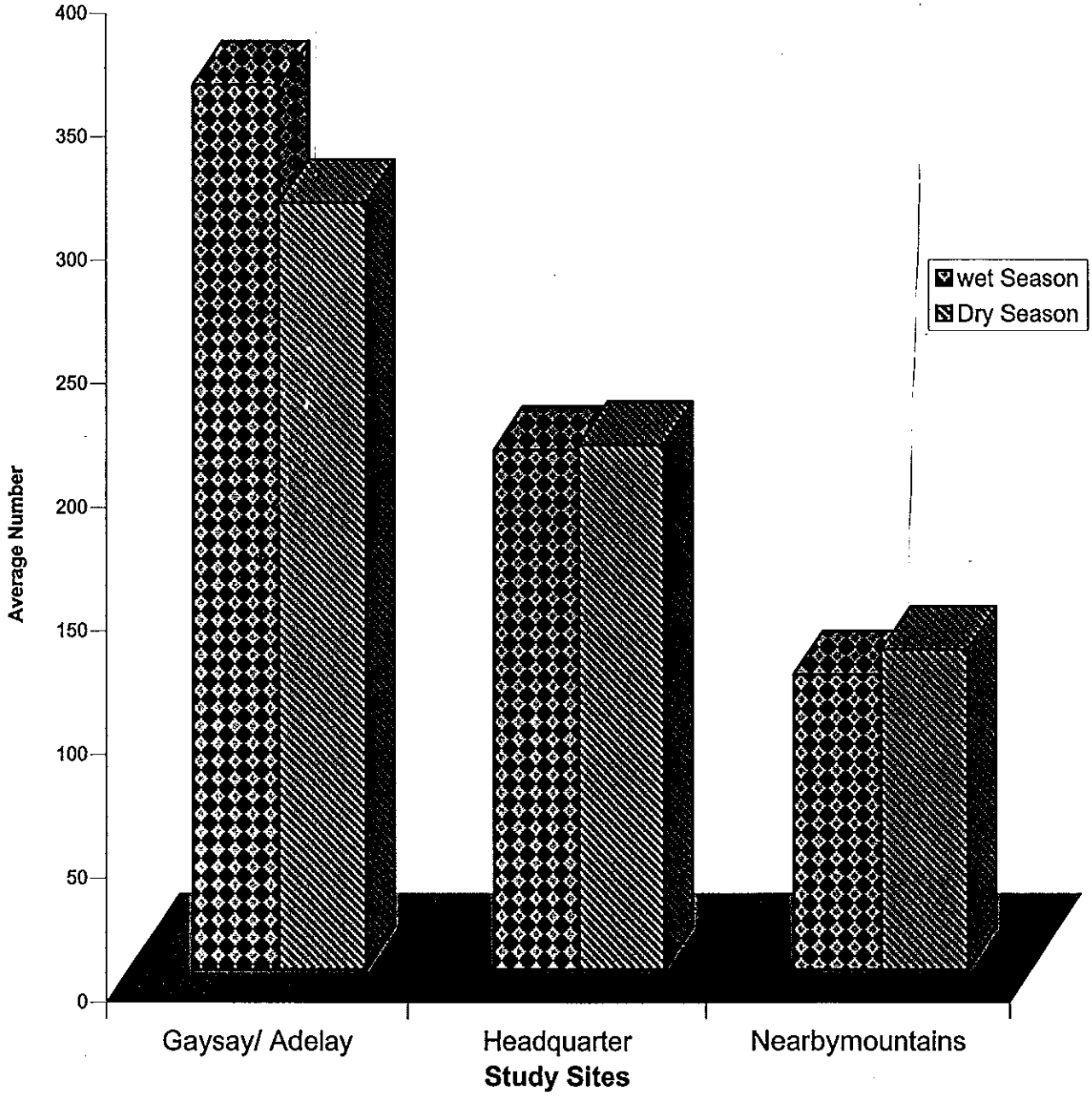

Figure 7 Wet and dry season average total count of Mountain Nyala

During each census season, fluctuation in number of Mountain Nyalas in each counting block was observed (Table 3). From Gaysay/Adelay Mountain Nyala population, the highest counted average number was 88 in Block-2 and 5. The lowest counted average was 41 in Block-3. But if we consider each census season, the highest counted average was during the wet season 105 in Block-2 and the lowest was 38 in Block-3 (Table 2). While during the dry season the highest counted average was 83 in Block-5 and lowest number recorded in Block-3 is 44. Even though there is small increase in number wet season, at 95% confidence interval by 2-tailled significance test, p-value (0.320) indicated that there was no significant difference between wet and dry seasons.

Table 3. Average number of Mountain Nyala during wet and dry seasons

	Gaysay/Adelay							
Season	B-1	B-2	B-3	B-4	B-5	**HQ**	**Nearby Mountains**	**Total**
Wet	61	105	38	62	93	210	118	**687**
Dry	47	71	44	65	83	212	129	**651**
Average	54	88	41	63.5	88	211	123.5	**669**
%	8.1	13.2	6.1	9.5	13.1	31.5	18.5	**100**

The area of Park's Headquarter (sanctuary) is only 1.2 km^2. But this small area comprised the 31.5% of the total Mountain Nyala population. The density of Gaysay/Adelay nearby

mountains is 38.2/km^2. While the Headquarter Mountain Nyala density is 175.8/km^2. Being localizing in small area has greater risk to disease and other human impacts.

4.2. Population Trend

Even though the methods used by the previous workers was not the same with the present work, the past and present trend of population of Mountain Nyala shows irregularity based on the conservation effort made during each particular period of time (Table 4 and Fig. 8).

Table 4 Past and present population number of Mountain Nyala around BMNP.

Year	1963-1966	1970	1975	1985	1990	1995	2000
Total number of Mountain Nyala	4000-5000	1000	500	1,400	2,000	600	704

In the present study (2000/ 2001), the average of dry and wet seasons total count at the study area was 669. The average number of wet and dry seasons count at Gaysay/ Adelay and the nearby mountains was only 334. Outside the study area, 35 Mountain Nyalas are recorded. The total number of Mountain Nyalas in the Bale Mountains National Park is 704 and 95% these are in the study area (based on Hillman, 1986; Woldegebriel Gebrekidan, 1996; Stephan et al., 1997; pers. Comm. Game scouts, present study).

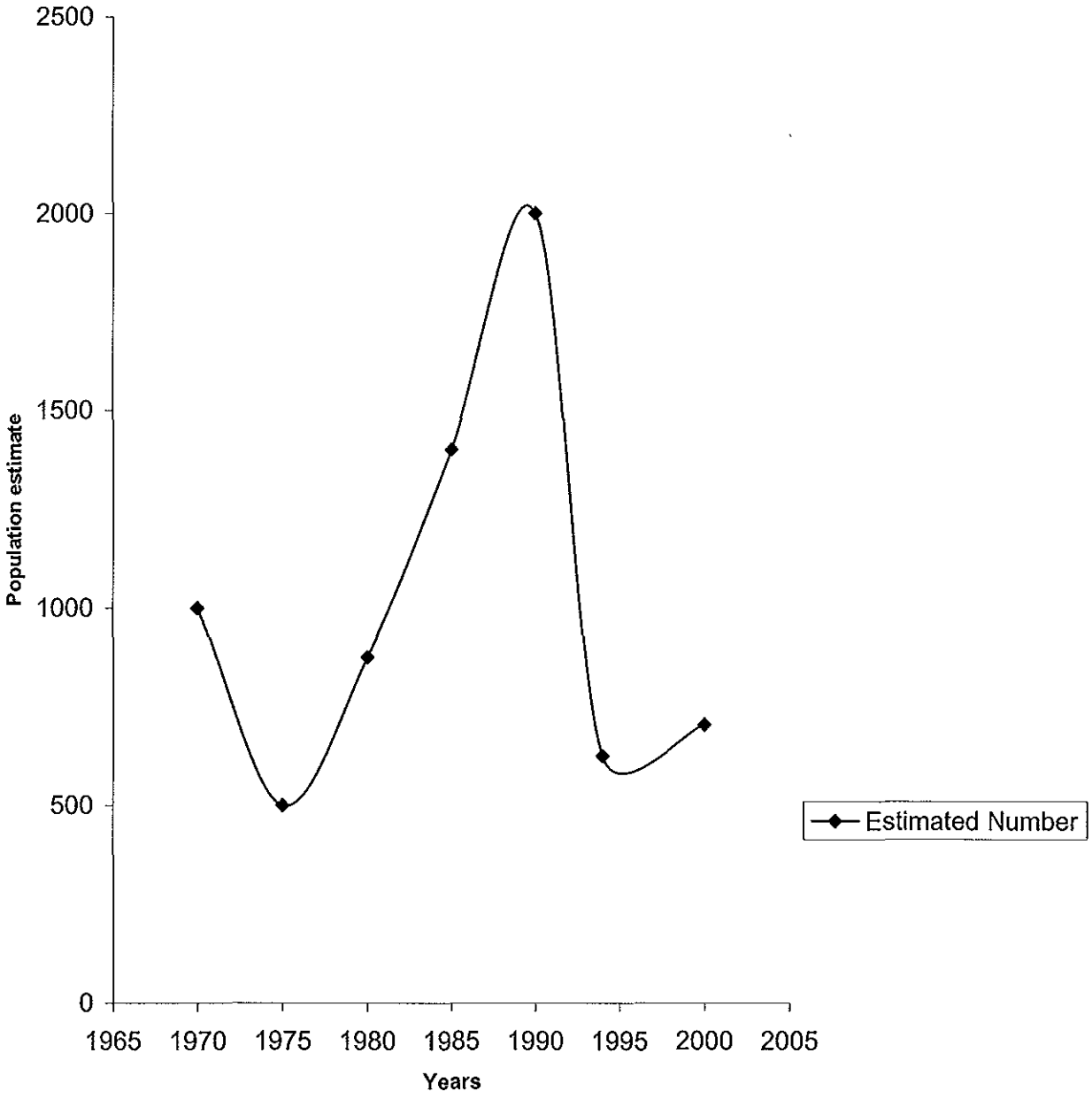

Figure 8 Population Trend of Mountain Nyala in Bale Mountains National Park

4.3. Age structure of Mountain Nyala

The breakdown of age and sex ratio given in Table 5 and Fig. 9 shows that there is unequal sex ratio in the population. The ratio of adult male to adult females was 1: 2.4 (wet season) and 1:2.5 (dry season). The ratio of sub-adult males to females was 1: 1.7 (wet season) and 1: 2.4 (dry season). At 95% confidence interval, the 2-tailed significance test for adult female p-value (0.88) and adult male p-value (0.3) showed that there is no significant difference between wet and dry seasons. However, for sub-adult female and sub-adult male at 95% confidence interval, p-values (0.000) and (0.005) respectively showed that there is a significant difference between wet and dry seasons. This difference may be because of predation and they may grow and enter the adult stage. During the wet season, adult females comprised 42.5% and sub-adult females 18.6% of the sexes. Excluding juvenile sex, females accounted the 61.1 % of the total population during wet season. While adult males and sub-adult males together comprised the 28.7 % share of sex categories.

Table 5 Wet and Dry season sex categories

Season	Adult male	Adult female	Sub-adult male	Sub-adult female	Juvenile male	Juvenile female	Juvenile unidentified	Total
Wet	122	292	75	128	6	11	53	**687**
Dry	128	323	41	100	6.7	3.6	49	**651**
Total	250	615	116	228	13	14.6	102	1338
Average	125	307	58	114	7	7	51	669
Percent	18.7	45.9	8.7	17	1	1	7.7	100

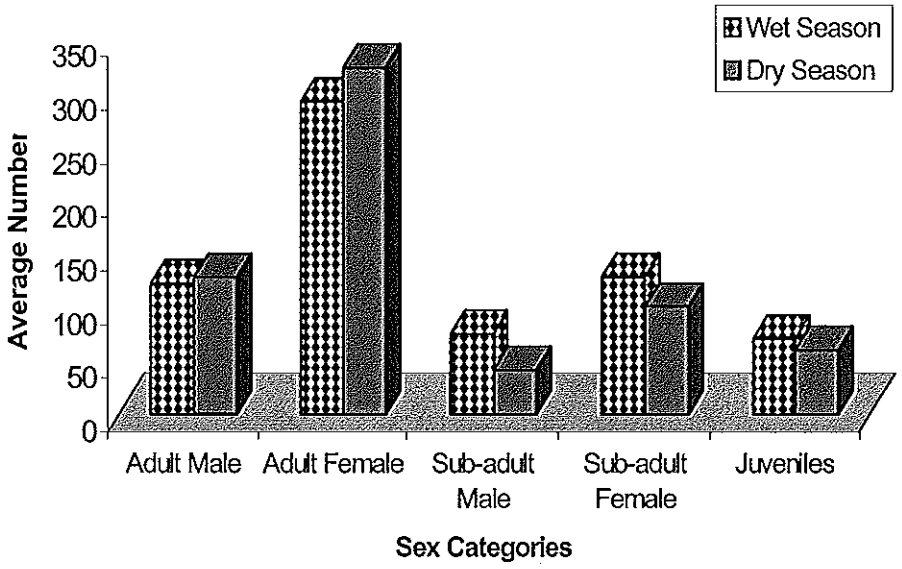

Figure 9 Sex Categories of Mountain Nyala

4.4. Group Size

The average number of group size for each wet and dry season is given in Table 6. The herds are normally composed of adult and sub-adult females, and may or may not have adult or sub-adult males. The Mountain Nyala group is matriarchal. Adult (alpha) female leads the group member. The females age and size determine the dominance hierarchy. Male Mountain Nyala live with the herds until they become adult males. Old males are usually solitary and young adults may form small groups. Males are less vocal than female. In woody habitat, at Adelay Mountains, and headquarter 8-10 old adult males were

observed to live in-groups. Size, age and heavy horn tussling determined their dominance hierarchy.

Table 6. Group size of Mountain Nyala at different seasons

Season	Total Number	Total groups	Range of group size	Mean group size
Wet Season	687	67	1-62	10.3
Dry Season	651	84	1-48	7.7
Average	669	75.5	1-55	8.9

Group sizes, composition and structure changed with the season. The group size during wet season ranged from 1-62 and during dry season, it ranged from 1-48 (Table 6).

There was a difference in grouping characteristics between groups containing cows and calves and those containing only bulls. Cow and calf groups were consistently larger than bull groups. Small groups containing between 2 and 10 animals were most common throughout the year. The average number of wet season total counts (687) was grouped in 67 herds (groups) and the mean group size is 10.3. The total counts of dry season (651) were grouped into 84 herds and the mean group size is 7.7. In August-September, up to 62 animals were congregated in large groups. By December-March, they split-up into smaller units.

The most frequently observed group size was 12 animals (wet season) and 7 animals (dry season). A herd of more than 12 is rare.

4.5. Utilization and distribution of vegetation type

The Gaysay/Adelay and Nearby Mountains Mountain Nyala population are distributed into five vegetation communities (Table 7). While the Headquarter population was distributed into four vegetation communities (Fig.10). The distribution of the animal varied according to the season. For both localities, utilization of the grassland vegetation decreased from wet season to dry season.

Woodland vegetation type utilization at park headquarter is 48.9%. This is because larger trees like *Juniperus procera* and *Hagenia* abyssinica mainly dominate the habitat. The tendency of population distribution toward bush shrubland and shrub grassland increased during dry season, while in woodlands the distribution is the same.

The distribution of animals for wet and dry seasons was not homogenous (Table 7 & Fig.10). During the wet season, the distribution of Mountain Nyala population at Gaysay/Adelay and the nearby mountains in grassland and woodland vegetation type was comparable. But during the dry season, the distribution of animals in grassland was reduced and the distribution in woodland increased. This is mainly because of shifting of their habitat from grassland to woodland due to local migration.

Mountain Nyalas are mainly browsers feeding on herbs, shrubs and also on tree foliage. The twisted horns of the adult males serve to hook down the branches of *Juniperus procera* and *Hypericum revolutum* plants to the level at which they can eat the leaves.

The most significant food plants of Mountain Nyala recorded during the study period are:

Hypericum revolutum, *Hagenia abyssinica* (mainly eaten as fallen leaves on the ground), *Artemesia afra*, *Kniphofia foliosa*, *Solanum sessilisellatum*, *Helichrysum splendidum*, *Lobelia rhynclopetalum*, and *Alchemila rothii*. Among the *Poaceae*, they consume forest grass *Koleria*, *Agrosti* and *Poa*. They also consume ferns, tree trunk and lichens.

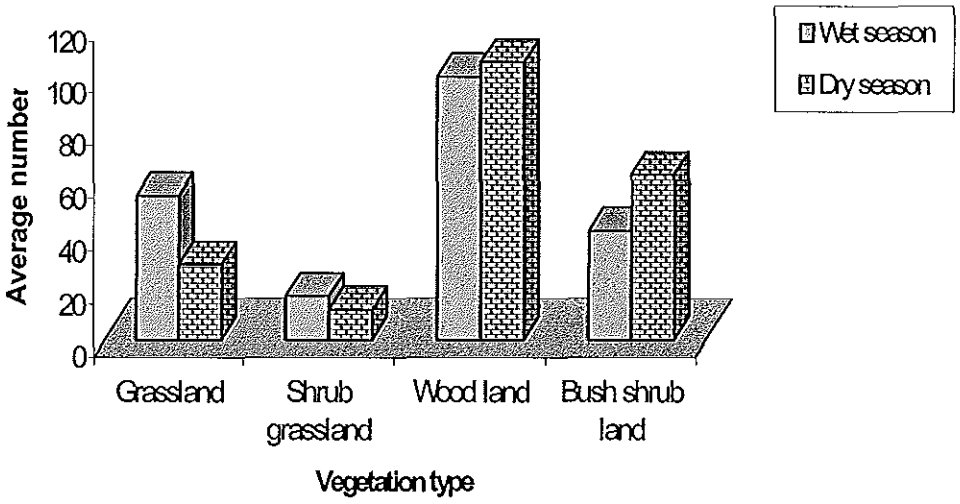

Figure10 Average number of Headqurter Mountain Nyala population observed in different vegetation communities

The favorite feeding localities for Mountain Nyala are woody plants (Table 7 & Fig. 10). Browsing comprises 61.1% of the diet and grazing 38.9%.

Table 7. Average number of Gaysay/Adelay and Nearby Mountains population observed in different vegetation communities

Season	Grassland	Shrub-grassland	Woodland	Bush shrub land	Riverine	**Total**
Wet season	115	69	163	85	43	**475**
Dry season	70	49	194	73	57	**443**
Total	**185**	**118**	**357**	**158**	**100**	**918**
Average	**92.5**	**59**	**178.5**	**78.5**	**50**	**459**
%	**20.2**	**12.9**	**38.9**	**17.1**	**10.9**	**100**

Mountain Nyalas are regularly seen drinking water between 1100-1200 hours (wet season) and 1030-1150 hours (dry season) at the junction of Gaysay-Dalecha and Denka-Weyib Rivers. The animals at the headquarter were drinking from water tanker purposely prepared for wild animals.

4.6. Diurnal Activity Pattern

Data on the various activities recorded throughout the study period have been condensed from 7 to 5 major activity states namely *feeding* (grazing or browsing), *standing*, *resting* (in the open or in the shade), *walking* and *other activities*. Data from 20 days (wet and dry seasons) continuous contact provide 240 hours of quantified observation. 2,880 activity records were analyzed. The five minutes records have been grouped into 60 minutes. The mean numbers of animals engaged in various activities for the whole day have been expressed as percentage as given in Table 8 and Fig 11.

4.6.1 Feeding

Unless the temperature is very cold and rainy, Mountain Nyalas commence feeding before 0600 h. This activity continued for a variable length of time until 1000 h when most animals start lying down (rest) on the ground on selected suitable cover and then ruminate. Resting is not continuous, but interrupted by brief feeding activity. There were two peaks in feeding, one between 0600-1000 h and the other between 1600 and 1800 h. At about 1600 h the resting period diminishes step by step and all members become engaged in feeding activities sporadically until dusk.

Table 8. Diurnal activity patterns of Mountain Nyala

Time	Feeding	Standing	Resting	Walking	**Other Activities
0600-0655	62.0	3.7	0	25.0	9.3
0700-0755	52.8	0.9	11.1	26.9	8.3
0800-0855	61.1	4.6	9. 3	12.0	13
0900-0955	46.3	5.6	24.1	11.1	13
1000-1055	42. 6	7.4	34.3	1.9	13.9
1100-1155	36.1	7.4	38.9	2.7	14.8
1200-1255	41.7	8.3	25.9	6.5	17. 6
1300-1355	25.0	11.1	47.2	4.6	12
1400-1455	46.3	4.6	28.7	7.4	13
1500-1555	40.7	7.3	24.1	14.8	13.9
1600-1655	61.1	7.4	12.0	9.3	10.2
1700-1755	53.7	3.7	10.2	13.9	18.6
Mean	**47.5**	**6**	**22.1**	**11.3**	**13.1**

4.6.2. Resting

The amount of time spent resting in the shade or in the open increase from the early morning (0930 hours) toward the mid-day and early afternoon. This decreases towards the night. More time is spent resting between 1000 to 1200 hours. Too few social activities like grooming were seen during this time. During the wet season, the amount of time spent for browsing and grazing increases except during extreme cold and heavy rain. The amount of time spent in open decreases as the day becomes warmer, and there was a corresponding increase in time spent resting in the shade when warm.

4.6.3. Walking

Animals were recorded as walking when they walk at steady pace. The animals walk for shorter distances and recommence feeding after 3-5 minutes. Females often initiate walking. When the animals are disturbed, they retreat to thick bush cover or woodlands or move away and hide themselves for a while.

4.6.4. Other activities

During resting period, individuals in a herd look in all directions. When they spot a man or any other intruder, they watch it continuously for more than 15 minutes. When they feel that there is no danger, they continue their usual activities. If they feel that there is danger, they produce an alarming call "brrumphh" and run away.

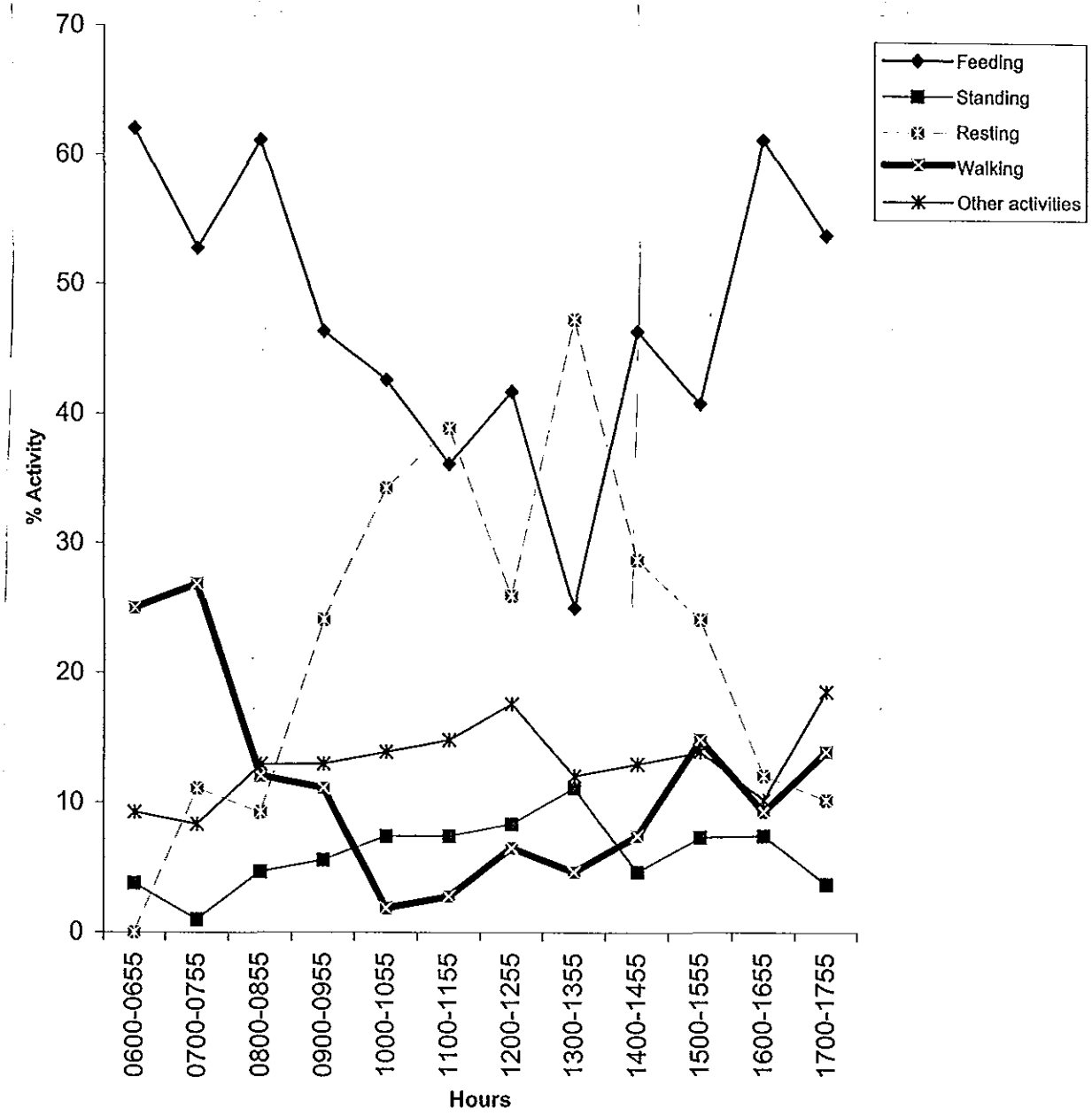

Figure 11 The Variation in activities of Mountain Nyala at the specified hours

Other activities include grooming, watching, social activities, etc. as described in (Appendix 5). These activities were observed dominantly when the herd is at rest or standing at 1000-1200 hours and in the early afternoon from 1400-1500 hours. During these hours, two female Nyalas lick each other turn by turn and the mother brushes her child by her tongue. They also use the hind leg for scratching purposes. Fighting among the member of the group was not common.

The group was peaceful and territorial behaviour was not seen. Sometimes, heavy fighting or horn wrestling was observed between adult males.

4.7. Assessment of Impact of the Local People

Discussion with the local people and local governmental and non-governmental officials made it possible to understand the public opinion toward the park and particularly to conservation activities of Mountain Nyala. As a result, the following factors affect the status of Mountain Nyala population in the study area.

4.7.1. Destruction of Habitat

Increasing population pressure has resulted in the range constriction and occupation into a heath zone above 3,400-m a.s.l. (Table 9). Nomadic pastoralists and settled agriculturists are the major causes for destruction of forests. The total number of permanent settlement in the park in 1986 was about 2,500 people with 10,500 livestock (Hillman, 1986). But, in the 1992 census it was estimated that at least 7,000 individuals live within eight recognized settlements and 15 more are within 5 km of the park boundary. In 1994, in Dinsho Wereda alone 15,521 peoples possessed 45,564 livestock Bale Zone Statistical Office, 1994) (Table 9).

Table 9. Human and livestock population between 1986-2000

	Years			
Population	**1986**	**1994**	**2000**	**%increment between1994 & 2000 (around Dinsho)**
Human	2,500	15,521	23,604	52.1
Cattle	8,300	19,374	61,443	217.1
Pack-animals, Sheep and Goat	2,300	26,190	58,504	123.4

Source: Hillman, 1986; Bale Zone Statistical Office, 1994; and Dinsho Agricultural Development Center, 2001.

In 2000-2001 the number of people increased to 23,604 (in Dinsho area only). The population number increased by 52.1% compared to 1994 estimate. The increase number of permanent settlers in the park from time to time led to increasing demand for arable land. Cultivation up to 3,450 m is a common practice in and outside the park for barley, wheat and garlic cultivation. Cultivation of extremely steep slopes is now common in many areas of the mountains. Forest clearing for the sake of fuel wood and for timber production is common practice around the optimal habitat of Mountain Nyala (Northern

grassland and woodland). Around Gaysay/Adelay area seeing donkeys and horses carrying fuel wood to Dinsho town have been a common practice. Removal of fuel wood for commercial purposes is also common on the Goba to Dollo Mena road and Goba markets. Lorries also transport fuel wood to other towns.

Illegal forest users, like small-scale furniture makers have flourished in Goba, Dinsho, Robe and Adaba towns. These illegal forest users mainly utilized the indigenous trees like *Juniperus procera* and *Hagenia abyssinica.* Both trees are used as food and shelter for Mountain Nyala.

Fire is a serious problem during the dry season (Hillman, 1986). Fire was set deliberately by the people living in or around the forest to expand the arable land, get fuel wood and shorten the giant Erica (heath) to grazable size for their cattle. Although Mountain Nyala was observed to feed in recently burned heaths, frequently burned heath was not attractive for Mountain Nyala. In Gojera area only six Mountain Nyalas were recorded.

4.7.2. Livestock Abundance

The presence of livestock was one of the most important factors influencing the density and distribution of Mountain Nyala. Cattle were very common along the study area. The livestock distribution influenced Mountain Nyala during wet season at counting Block-3 near Gofingira Kebele and Block-5 near Gojera Kebele. The dominant large herbivores over the whole study area are cattle, horses and sheep (Fig.12). Ubiquitous presence of thousands of livestock competes on the same area with Mountain Nyala for food especially

at Gofingira and around Weyib Bridge. Livestock distribution throughout the park increases especially during the wet season because many of the dwellers of Dinsho and surroundings were involved in fattening of cattle and sheep to sell for New Year (September) and also high during Christian and Muslim holidays. During evening of the wet season, observing thousands of cattle and sheep grazing inside the park was common even though the park game scouts tried to control this illegal utilization.

The human pressure in the park pushed the traditional grazing lands into cultivable lands even though frost and chill is common at higher altitudes. The size of grazing lands decreased and overgrazed. As a result, water logged marshy area and unpalatable plants are left. This may push the livestock to penetrate into the park boundary.

4.7.3. Predation

The natural enemies of the Mountain Nyala are spotted hyaena (*Crocuta crocuta*), leopard (*Panthera pardus*), common jackal (*Canis aureaus)* and Serval cat (*Felis serval*). Spotted hyaena is a frequently observed and sporadic wanderer at the study area and a big threat to Mountain Nyala. Domestic dogs (*Canis familiaris)* were present throughout the Bale Mountains National Park and were particularly common around Dinsho village and in the Web Valley. Many of them are feral and live on offal and carrion. Domestic dogs that are kept to guard livestock from spotted hyaenas are also a direct threat to Mountain Nyala and other antelopes. Around Gaysay/Adelay area, they were observed hunting in packs. Many are free ranging and are known to Kill Mountain Nyala calves each year (Woldegebriel Gebrekidan, 1996).

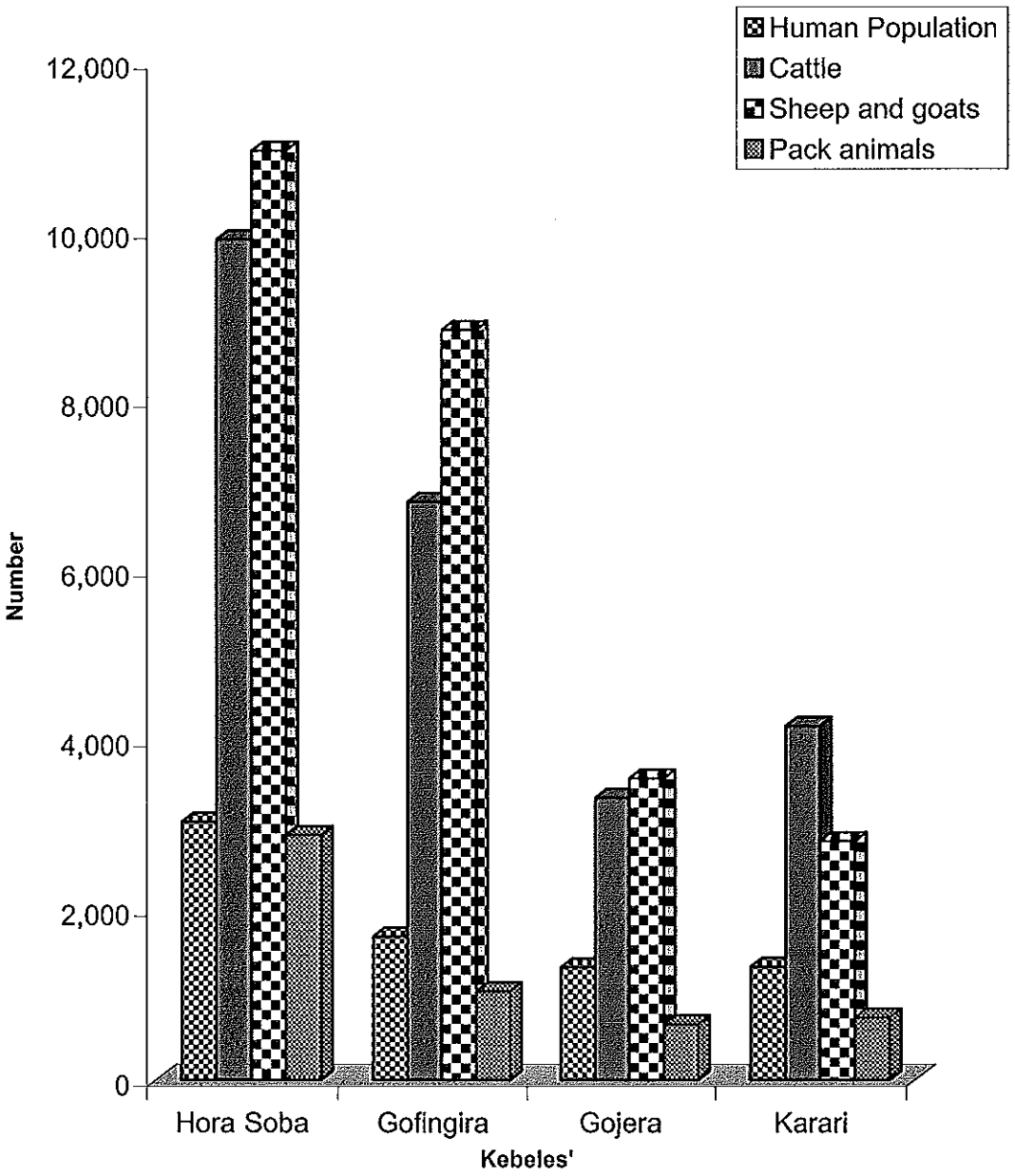

Figure 12 The number of human and livestock population in four Keble's around the study area

During the study period, two juvenile Mountain Nyala have been killed by a pack (9) of feral dogs. They have also been seen chasing adult male Mountain Nyala in Adelay area (Woldegebriel Gebrekidan, 1996 and Ermias Admassu, Pers. comm.). An adult bull weighing 200-280 kg is a larger animal than the possible predators and immune from attack.

4.7.4 Hunting

The park has only 11 permanent game scouts to protect the 2,200-km^2 park area (Table 10). The small number of game scouts may be one of the cause of ineffectiveness to protect the animal from illegal hunters. At the same time, the concerned officials are also reluctant to enforce the law.

Licenses are being issued by Agricultural Bureau of Oromia Regional State to sport hunters without the knowledge of the status of Mountain Nyala population. One of the two assigned controlled hunting areas is at the boarder of the park. These sport hunters even cross the park boundary to kill adult male Mountain Nyala (pers. comm. of the game scouts).

Table 10. The Bale Mountains National Park Staff (permanent) Members

Item	Years	
	1986	**2001**
Park Warden	1	1
Assistant Park Warden	1	-
Biologist	1	-
Others	4	3
Game Scouts	18	11
Total	**25**	**15**

Source Hillman (1986) & The Bale Mountains National Park Office (2001)

4.7.5 Disturbance

Disturbance through the habitat and the constant passage of local people on horseback and on foot by uttering and shouting along the length and width of the park is common. This constant passage has a greater effect on the behaviour and survival of the animal. Newly built huts at higher altitude are common around Gojera and Gassore peaks. Re-settlers around Gojera are expanding new areas for farming from day to day. Wild animals including the Mountain Nyala leave the sanctuary during night and enter the re-settlers farmland. To chase away the wild animals from their farms, the settlers use whistling, shouting and also wire trap for snaring. During the study period, two adult females have

been observed having wire rope hung on their neck. Farmers also used spear to protect their crops. During the study period, two adult males have been killed by spear. Re-settlers have taken the potential habitat of Mountain Nyala in every direction and have affected the freedom of animals to move freely.

5. DISSCUSSION

Direct total counting method was applied in censusing the population of Mountain Nyala. This method was the most appropriate in view of the small size of the study area resulting in a reasonable degree of accuracy. No significant difference was observed between the counting of dry and wet seasons. However, there is small increase in number during wet season than dry season. This difference may be due to the abundance and palatability of the food and peak birth of the animals during the wet season. The population trend of Mountain Nyala shows that there was a considerable variation from 1970-2000. The great reduction in the number noticed during the change of Government in 1991 due to excessive illegal hunting.

The potential range of Mountain Nyala that was described by Brown (1969) has been converted to agriculture in many parts of the country (Arsi, Harar, and Bale). Recently, the species is localized in the Bale Mountains National Park around the northern grassland and woodland. Thirty-two years ago (Brown, 1969), sighting of Mountain Nyala around Gaysay/Adelay area was rare. The total number counted by Buer (1971) was 25. Hillman (1986) counted over 500 animals in a single afternoon at the present study area. This shifting of the animals' habitat from high mountain peak to Northern grassland and

woodland shows that their potential natural habitat has been occupied by pastoralists and highland cultivators, forcing them to leave their prior range. In 1985, the number of Mountain Nyala increased around Gaysay/Adelay area because of the increased conservation effort by EWCO. In 1990 their number reached 2,000 throughout the park.

The present study shows that the male to female ratio was unequal, which is 1: 2.3. This is almost similar to the Mountain Nyalas' probable immediate precursor, Greater Kudu's (*Tragelaphus strepsiceros*) sex ratio which was 1:2.4 (Wilson, 1965). Brown (1969) reported that 14.7% were males and 67.5% were females and 17.4% were calves. The 9.7% calf population compared to Brown's 17.4% shows that the population is still declining. More conservation measure should be taken to alleviate this problem.

Adult female accompanied by one or two generations of young are very frequent but form temporary associations with other young groups. Mountain Nyala practice matriarchal society. In mixed herds, it is mostly the alpha females that alarm the group. This goes in line with the suggestions of Brown (1969), and Hillman, (1986). Most of the time, the adult males are solitary. During the reproductive season, adult males get mixed with the group. When they feel that there is danger, they were observed bolting without giving any alarm call to the group. Older nyala (*Tragelaphus angasi*) males tend to live alone for most of the year but attempted to join groups that contained females in estrus (Estes, 1991). This trend has also been observed in the Mountain Nyala.

The sympatric herbivores, Bohr reedbuck, Warthog and Menelik's bushbuck and Common bushbuck lived peacefully at the same area by occupying different sites of the study area.

The Gaysay grassland area is mainly occupied by Bohr reedbuck and the Mountain ridge by Menelik's bushbuck, Warthogs and grey duicker occupy the area mostly uninhabited by Mountain Nyala. A herd of the Mountain Nyala usually has members monitoring in all directions. Any one of a group member gives alarm when they feel threatened. The group members are also alarmed by sympatric herbivores like Bohr reedbuck, Menelik's Bushbuck and birds species like Quail and Frankolin.

The distribution and utilization of vegetation type of the Headquarter population, Gaysay/Adelay and nearby Mountain Nyala population were considered separately. This is because the Headquarter Mountain Nyala populations occur in small fenced area (1.2 km^2) with high density. While the Gaysay/Adelay and nearby mountains populations are distributed in their natural habitat. Their habitat is not fenced and they freely move from one place to other. As a result, the utilization of vegetation type was described separately.

The 48.9% of headquarter Mountain Nyala populations were found in the woodland habitat. This is because the habitat was mainly dominated by larger *Hagenia abyssinica* and *Juniperus procera* trees. While the 38.9 % of Gaysay/Adelay population occurred at woodland habitat (lesser by 10%). Riverine habitat is not found around the park's headquarter. In both localities, the distribution on the grassland is similar. But, the Gaysay/Adelay area Mountain Nyala population distribution in shrub grassland is high and less in bush shrub land. In contrary, the distribution of the headquarter population around bush shrubland is high and less on the shrubland. The higher ratio in Headquarter and Gaysay/Adelay (38.9 % &48.9 %) indicates that their favorite feeding localities are woody habitats.

Mountain Nyalas are mainly browsers (61.1%) and (38.9 %) are grazers. However, the other *Tragelaphines*, Greater Kudus are mainly browsers (Smithers, 1971), Lesser kudu are exclusively browsers (Nowak, 1991) and Bongos in general are browsers (Nowak, 1991). Brown (1969) and Woldegebriel Gebrekidan (1996) considered Mountain Nyalas as selective feeders. They prefer to feed on herbs, shrubs and leaves of a tree. During the present study, they were also observed feeding on *Solanum sessilisellatum*, which is poisonous to cattle.

Weather affects the feeding behaviour of the animal. This is also observed by Brown, (1969) and Hillman, (1986). Under very strong hot sun and very cold rainy weather they stay under the shade of large *Juniperus* and *Hagenia* trees. During rain, they remain inactive in dense cover, but emerge to feed once it stops raining.

According to Brown (1971) Mountain Nyalas have not been seen drinking water. Nevertheless, during the present study, they have been observed repeatedly drinking water in both wet and dry seasons. Salt licks are scarce and hard to find around the study area. From the information obtained by the local people, game scouts and local field guides; during the night time Mountain Nyalas walk for more than 30 km to seek mineral water "Hora" around Hora Soba, Tianta and Orgona farm villages. This practice is similar to other *Tragelaphines*, like Bongo, *Tragelaphus (Boocerus) euryceros*, also lick salt exclusively at night as described by (Estes, 1991).

During the dry season, Mountain Nyalas were mostly found on woodland habitat. This shows a local migration from Gaysay grassland to Adelay Woodland. This is because of seasonal selection of forage that resulted from the changes in forage nutritional quality and the need for shade from strong radiation of sunlight. Other studies have revealed that ungulate migrations occur as a response to water availability and forage quantity and quality (Bourliere and Hardley, 1970; Pennycuick, 1975).

Detail research on the diurnal activity pattern of Mountain Nyala has not been made. The present study reveals that different proportion of the daylight is used for various activities. Similar to the other antelopes, peak activity period was between 0600- 1000 h in the morning and 1600-1800 h in the late afternoon. Brown (1969) also observed that Mountain Nyalas were most active during early morning and evening. Occasionally, they are also active in the middle of the day especially in relatively undisturbed areas. If Mountain Nyalas were not disturbed in Gaysay/Adelay grasslands, they were usually seen throughout the day by showing their normal activity patterns. On the other hand, the population is mostly seen under the shade of larger trees or hidden in the forest because tourists mostly affect the headquarter area. They leave the fenced area starting 1830 h to feed in the nearby villages to feed on barley and wheat farms. They were forced to change their normal activity to nocturnal life. Woldegebriel Gebrekidan (1996) also explained that when there is peace and no disturbance, they become more active during the day, feeding, warming them and resting in the open grassland. Around Gaysay/Adelay grassland area, they were usually seen throughout the day. On the other hand, where there is disturbance they tend to be more nocturnal. They hide in forest thickets.

As described by Irby (1982) in Kenya and Southern Africa, the Chanler's mountain reedbuck exhibits a general pattern of high activity levels during early morning, low levels during mid-day and increased activity in the late afternoon. The Greater Kudu (*Tragelaphus strepsiceros)* spends 73% of active periods for feeding, 14% for moving, 11% standing alert and 1% grooming, excreting and other social activities (Hillman, 1986). In the present study, Mountain Nyalas spent 47.5 % on feeding.

Fighting in Mountain Nyala is rare and no territorial behaviour is observed. Up to 12 adult male Mountain Nyalas were observed living together. Estes (1991) has also made similar observations for other Tragelaphines.

The habitat destruction is increasing due to the activities of both nomadic pastoralists and ever increasing population. The activity of re-settlers both in expanding cultivation area and herding livestock has modified the vegetation of the study area. This has reduced the area available to Mountain Nyalas and other wild animals. It has restricted the free movement of the animals and modified their behaviour. During the night time, they leave the study area to lick salt and to consume the farmers' barley and wheat. The farmers on the other hand use different mechanisms to chase those wild animals from their farm. During the study period, three adult male Mountain Nyalas deaths were recorded. Of these, two were killed by spears.

During the study period, many domestic animals were observed. The number of cattle, sheep and horse was very high compared to the previous periods (Hillman, 1986, and Bale Zone Statistics Office, 1994). The abundance of domestic animals was the second most

important factor influencing the density and distribution of the animals. During the wet season (August-October, 2000), the cattle and sheep distribution around Block-3 and Block-5 influenced the distribution of Mountain Nyala.

Gojera (around Weyib Valley) was thought to be an important corridor for wildlife particularly for Mountain Nyala between the Northern Gaysay area and the Ericaceous heath along and around the eastern boundary. Between 1986 and 1991, the Gojera area was extended northwards. From collated data of Stephens et al., (1997), over 100 Mountain Nyalas were estimated at Gojera. But during the change of government, people resettled rapidly and started cultivating barley and wheat by clearing the Ericaceous belt and herding a large number of livestocks. In 1997, no Mountain Nyala was seen around Gojera (Stephens et al., 1997) and only six Mountain Nyalas were counted during the study period. Gojera is now heavily settled and overrun by domestic animals and is worthless as a corridor for wildlife. Increasing settlement and livestock numbers have a negative visual impact on tourists.

In addition to the permanent settlement and pastoralists, spontaneous and planned migrations for mineral water 'hora' from far distances was observed. These migrants do not respect the environment and the wildlife as the local residents. As they did not carry enough food with them, they try to fulfill their protein need by hunting wild animals, causing a problem to the environment.

The absence of effective law and regulations to control settlement in the park has resulted in an increase in settlers. If the park is meant to meet the definition of 'park,' it should be

free from human and livestock interference. There is uncontrolled exploitation of forest for fuel wood and construction. The park administration and the local administrators were not seen taking effective and sustained action on these illegal users. However, during the wet season, they were observed forcing those illegal users to pay punishment fee locally called 'afelama'. Since the measure is temporary, so many cattle were observed grazing in the park area.

The discussion held with the local people indicates that they appreciate the existence of the park even though they do not get a reasonable direct benefit from the park. They usually heard to respect the park boundary that had been demarcated during Haileselassie I. However, they blame the evacuation attempts taken during the Derg regime without convincing, educating, and providing due compensation.

During the discussion with the park administration and game scouts, for all activities of the park a budget of less than five thousand Birr per month was allotted. This sum is expected to cover the cost of maintenance of old car, fuel, lubricants, per diem, etc. On the other hand, all revenue collected from the park goes to Agricultural Development Bureau of Oromia Regional State. The Park has no right to administer any of the income generated from the park. The park has one old car, which served for more than 15 years. Because of high depreciation and lack of proper maintenance, it is almost out of use.

Uncontrolled heath burning aimed at securing new forage for their cattle are practiced by settlers. Total stoppage of burning heath may not be necessary because controlled burning may serve for succession of colonizing plants that are favorite food for Mountain Nyala

(Brown, 1969 & Hillman 1986). However, by applying the necessary precaution, the park administrators can practice heath burning when feasible in limited habitats rather than the settlers indiscriminately destroying the area.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

The total number of Mountain Nyala population throughout the country is estimated to be less than 1000. The present study area comprises 95% of the Mountain Nyala population. Thus, the need to protect and safeguard the Mountain Nyala population demands great effort. The concerned people in the park have to take immediate conservation measure to save the animal from extinction. Cutting of trees for fuel, timber and for construction should be curtailed or regulated. The park area should be protected from overgrazing by domestic animals. Protecting the park from any illegal activities and forest fire by regular patrolling inside the park is crucial. Unwillingness to protect the park from possible dangers may result in unrepairable damage to the wildlife. Reluctance of the concerned authorities to take measure on illegal users of the park should be stopped.

The Bale Mountains National Park was nominated by UNESCO as one of the World Heritage Sites in 1979 & 1981. Since the park was not gazetted as legal entity, it lost the opportunity to get support from UNESCO. Till now the park has no legal status to formally request some assistance. During the study period, the activity of the park in reference to the conservation effort was not promising. It was understaffed with only one professional warden. The number of professionals assigned to the park has decreased from previous years. After 1991, no expert was assigned except a transfer of experts from the park to

other areas. Administrating the 2,200 km^2 of the park area without professionals cannot be productive. The concerned officials should give priority in order to solve the trained man power problem of the park.

Most of the activity of the park is limited only around the Park's Headquarter. The game scouts are confined to the headquarter and only conduct foot and horse patrolling. The single old car lacks proper maintenance and mostly nonfunctional. Due to lack of proper maintenance the tracks that once served for patrolling purpose have become useless.

The Federal and Regional States should work in coordination. All development projects should be planned in order to minimize the negative impacts on Mountain Nyala and other wild species. Legislation requiring such coordination should be considered.

The remaining natural forests are restricted only in the park area. Many people consider it as infinite resources and they unwisely use them. Due to human population increases and the expansion of agriculture, the physical environment of Mountain Nyala has changed considerably since Brown (1969) made his observation. A dramatic increase of the animal was observed between 1985-1990. The conservation activity that was made during this period has a good lesson for future work of the conservation activity. If proper care and attention are given to the park, the population is likely to increase. The extinction of Mountain Nyala would mean not only a loss of ecologically unique component of Ethiopian fauna, but also a loss of this beautiful antelope to the world.

6.2. Recommendation

Based on the facts obtained during the present study and review of previous workers, the following points should be considered:

- The Park is not yet gazetted. Gazettment of the park should be given priority. All the necessary legal activities to fulfill this should be carried out as urgently as possible. Effective laws and regulation of the park policy should be practiced. Park wardens and game scouts should get full responsibility to protect the park. Effective control of illegal, destructive and inhumane hunting and enforcement of laws prohibiting hunting should be practiced.
- Conservation of Mountain Nyala should not be looked at as depriving the local people of their livelihood. Re-settlement action should be implemented by taking the needs and aspiration of the local people. Awareness creation should be developed before the accomplishment of any evacuating procedure. Resettlers and new settlers should abandon and move to their original habitat. For those who do not have land in another area, providing comparable land out of the park boundary by fulfilling basic needs like school, clinic and pure water supply sounds acceptable solution.
- Immediate protective steps must be accompanied by effective measures that could improve the living standard of the surrounding people without further disrupting the environment. To reduce the demand of fuel wood, appropriate technology that is cheap and easily acceptable by the people such as kerosene stove, fuel conserving

'Injera' baking stove, and solar stoves need to be introduced. In addition, planting fast growing trees to satisfy the needs of fuel wood and construction to minimize the utilization of *Juniperus* and *Hagenia* trees should be implemented.

- To evacuate and resettle the people outside the park, the community, governmental and non-governmental organizations should cooperate and work hand in hand. The ignorance or reluctance of the concerned higher officials of Federal Government and Oromia Regional State should be replaced by experts who are environmentally conscious.
- Tourists willing to pay high license fee should shoot a limited number of old male in only the Controlled Hunting Areas. The number of old bulls for sport hunting should not be greater than 1% of the total population. Until further detail census is carried out, the number of animals to be shot should not be greater than 7/year. At least 40% of revenue obtained should be shared (local benefit) for the Park to solve the many logistic problems of the park. But, these Controlled Hunting Areas should be far from the park boundary.
- Additional conservation area outside Bale, around Arsi and Haraghe (Kuni Muktar) should be declared if any unexpected hazard happens for the Bale Mountains National Park to act as a reservoir stock.
- Cultivation within the forest areas and in the heath zone above the forest areas should be prohibited.
- A committee, composed of representatives of the government and local community should be established and participate in planning, executing and taking conservation measures by considering the aspiration of the local people into

account. Any income obtained from the park should be shared to the community through social services. A conservation policy that integrates local communities into conservation activities through better education and health programs will bring a considerable change in the attitudes of the people towards the proper conservation of the park.

- More emphasis should be given in inculcating environmental education in the school curriculum and training or updating knowledge of the environment in every society should be strengthened and sustained.
- Professionals in various fields that are important to the park activity should be assigned. Research and regular monitoring and population census of the wild animals should be continued in order to take immediate conservation action when necessary. Further study on Mountain Nyala should continue to get additional information.

7. REFERENCES

Alem Berhanu, (1976). Regional meeting on the creation of a coordinated system of National Parks and Reserves in Eastern Africa. Supplementary paper, number 45. Tanzania, 14-19 Oct 1974.

Andeberhan 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.

Ansell, W. F. H. (1971). Order Artiodactyla (excluding Gazella). In: Meester, J. & Setzer, H.W. *The Mammals of Africa.* An identification manual Part 15. Smithsonian

Atwall, A. S., & Bains, S. S. (1974). *Applied animal ecology*. Rastogi Prabhat Press, Merrut, India.

Balakrishnan, M. & Ndhlovu, D. E. (1991). Large herbivores in upper Lupande Game Management Area, Luangwa Valley, Zambia. *Afr. J. Ecol.* **29**: 93-104.

Bale Zone Statistical Office, (1995). Census Map surveys. Transitional Government of Ethiopia.

Bell, R. H. V. (1971). A grazing ecosystem in Serengeti. *Sci. Am.* **225:** 86-93.

Bergerud, A. T. (1971). The population Dynamics of Newfoundland Caribou. *Wildl. Monogr.* **25**:1-55.

Blower, J. (1969). *Shell Guide to the Wildlife of Ethiopia.* Shell Ethiopia Ltd., Addis Ababa.

Blower, J. (1970). Wildlife conservation in Ethiopia. *Walia*, **1**:15-23.

Blower, J. (1971). Bale Mountains. *Walia,* **3**:22-24.

Bolton, M. (1971). Ethiopia: Last chance of Swaynes' hartebeest. *Biol. Cons.* **3** (2): 147-149.

Bolton, M. (1973). Hartebeest in Ethiopia. *Oryx* **12**:99-108.

Bolton, M. (1974). Mount Abaro Shashemene District. *Walia* **5**:15-16.

Borkowski, J. & Furubayshi, K. (1998). Seasonal and diet variation in-group size among Japanese Sika Deer in different habitats. *J. Zool. Lond.* **245**: 29-34.

Bourliere, F. Hardley, M. (1970). The Ecology of Tropical Savannhas. *Annu. Rev. Ecol. Syst.* **1**:125-152.

Bowyer, R. T. (1984). Sexual Segregation in Southern Mule Deer. *J. Mamm.* **65** (3): 414-417.

Brown, B. (1925). Through the land of Sheba. *Natural History; N.Y.***25** (6): 602-617

Brown, L. H. (1965). *Ethiopian episode.* Country Life: London.

Brown, L. H. (1966). A report on the National Geographic Society. WorldWide Fund Expedition to study the Mountain Nyala, *Tragelaphus buxtoni.* Nairobi. Mimeo, 118 pp.

Brown, L. H. (1969). Observations on the status, habitat and behaviour of Mountain Nyala, *Tragelaphus buxtoni* in Ethiopia. *Mammalia,* **33**:545-597.

Brown, L. H. (1971). The status, habitat and behaviour of the Mountain Nyala (*Tragelaphus buxtoni*). *National Geographic Society Research Reports 1965 projects.* pp 23-24

Buer, C. E. (1971). Report on a survey of the Bale Mountains, 1969-1971, EWCO, Addis Ababa. Mimeo. 31pp.

Carter, T. D. (1959). The Mountain Nyala. *Animal Kingdom,* **62**:118-123.

Caughley, G. & Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science. London.

Caughley, G. (1980). *Analysis of vertebrate population*. A Wily-International, Toronto.

Daniel Gemechu, (1977). *Aspects of climate and water budget in Ethiopia*. Addis Ababa University Press.

Delany, M. J. & Happold, D. C. D. (1979). *Ecology of African Mammals*. Longman, London.

Dinsho Agricultural Development Center (2001). Unpublished Statistical data of Dinsho Agricultural Development Center. Bale, Dinsho.

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

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

Ethiopian Tourism Commission (ETC) (1999). *Ethiopia: Bale highland Wilderness*. Ethiopian Tourism Commission, Addis Ababa.

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

Fryxell, J. M. (1987). Seasonal reproduction of white-tailed kob in Boma National Park, Sudan. *Afr. J. Ecol.* **25**: 117-124.

Fryxell, J. M. and Sinclair, A. R. (1988). Seasonal migration by white-eared kob in relation to resources. *Afr. J. Ecol.* **26**: 17-31.

Gordon, I. J. & Illus, A.W. (1996). The nutritional ecology of African ruminants: a reinterpretation. *J. Anim. Ecol.* **65**: 18-28.

Gotteli, D. & Sillero-Zubri, C. (1990). *The Simien Jackal: Ecology & Conservation.* Report to New York Zoological Society, New York.

Guy, P. R. (1976). Diurnal activity patterns of elephant in Sengwa Area, Rhodesia. *E. Afr. Wildl. J.* **14** (4): 285-295.

Haltenorth, T. & Diller, H. (1980). *A field guide to the mammals of Africa including Madagascar*. Collins, London.

Harper, J. A., Harn, J.H.; Bentley, W.W. & Yacom, C. F. (1967). The status and ecology of the Roosevelt Elk in California. *Wild Monogr.* **16**:1-49.

Hedberg, O. (1978). *Nature in utilization and conservation of high mountains in Eastern Africa, (Ethiopia to Lesotho):* the use of high mountains of lands and survey, Wellington.

Hillman, J. C. & Hillman, S. M. (1987). The Mountain Nyala (*Tragelaphus buxtoni*) & the Simien Fox *(Canis simensis)* in the Bale Mountains National Park. *Walia* **10**:3-6.

Hillman, J. C. (1985). Mountain Nyala. *Acacia, (*Wondo Genet Forestry and Wildlife Resource Institute*)* **6**:39-40.

Hillman, J. C. (1986). Bale Mountains National Park Management Plan. Report to Ethiopian Wildlife Conservation Organization (EWCO), Addis Ababa.

Hillman, J. C. (1988). The Bale Mountains National Park area, southeast Ethiopia, and its management. *Mountain Research and development*, **8**:253-258.

Hillman, J. C. (1993). *Ethiopia: Compendium of Wildlife Conservation Information*. Vol. I. Wildlife Conservation in Ethiopia. Addis Ababa.

Hirst, S. M. (1975). Ungulate-habitat relationship in a South African Woodland/Savanna Ecosystem. *Wildl. Monogr.* **44**: 1-56.

Houerou, H. (1986). An Ecological glance at Ethiopia. *Walia* **9**: 6-10.

Hurni, H. (1986). *Simen Mountains National Park and Surrounding Rural Area Management Plan*. UNESCO, World Heritage Commission, EWCO, Ministry of Agriculture, Ethiopia.

Inglis, P. (1976). Wet season movement of individual wildebeest of the Serengeti migratory herd. *E.Afr. Wildl. J.* **9**: 158-161.

Institute Press, Washington.

International Union for Conservation of Nature (IUCN), (1990). *1990 IUCN Red List of Threatened Animals*. IUCN, Gland, Switzerland and Cambridge, UK.

Irby, L. R. (1982). Diurnal activity & habitat use patterns in a population of Chanler's Mountain reedbuck in the Rift Valley of Kenya. *E. Afr. J. Ecol.* **20**: 169-178.

Jarman M. V. and Jarman, P. J. (1973). Daily activity of impala. *E. Afr. Wildl. J.* **11**: 75-92.

Kingdon, J. (1979). *East African mammals. An atlas of evolution in Africa. Volume III. Part B (Large Mammals)*. Academic Press, London.

Kingdon, J. (1982). *East African mammals. An atlas of evolution in Africa. Volume III. Part C & D (Bovids)*. Academic Press, London

Kingdon, J. (1997). *The Kingdon field guide to African mammals*. Academic press, London.

Kitchen, D. W. (1974). Social behaviour and ecology of the Pronghorn. *Wildl. Monogr.* **38**:1-96.

Knight, R. R. (1970). The Sun River Elk Herd. *Wildl. Monogr.* **23**:1-66.

Kutelik, M. J. (1979). Foraging habitat of non-migratory African ungulates in response to seasonal rainfall. *J. Wildl. Mngt.* **43** (4): 899-908.

Larson, T. J., Rongstad, O. J. Terbilocx, F.W. (1978). Movement and habitat use by White tailed deer in south central Wisconsin. *J. Wildl. Mngt.* **42** (1): 113-117.

Last, J. (1982). *Endemic Mammals of Ethiopia.* Ethiopian Tourism Commission (ETC). Addis Ababa.

Lehner, P. N. (1996). *Handbook of ethological methods 2nd edition.* Cambridge University Press.

Leuthold, W. (1971). Studies on the food habits of Lesser Kudu in Tsavo National Park, Kenya. *E. Afr. Wildl. J.* **9**: 35-45.

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. A & Wilson, R, T. (1979). The Ecology of Swayne's Hartebeest Sanctuary. EWCO, Addis Ababa. Mimeo. Pp. 14.

Lisanework Admasu and Mesfin Tadesse (1988). An ecological study of the vegetation of the Harena Forest, Bale, Ethiopia. Sinet : *Ethiop. J. Sci.* **12** (1): 63-93.

Macdonald, D. (1984). *The Encyclopedia of Mammals: 2.* Allen George and Unwin. London and Sydney.

Martinka, C. J. (1969). Population Ecology of Summer Resident Elk in Jackson Hole, Wyoming. *J. Wildl. Mngt* .**33** (3): 465-481.

Maydon, H. C. (1932). Big game shooting in Africa. Seeley, Service & Co. Ltd. London.

Meester, J. & Setzer, H. W. (1977). *The Mammals of Africa.* An identification Manual. Part 15. Smithsonian Institute Press, Washington.

Melton, D. A. (1983). Population dynamics of Waterbuck (*Kobus ellipsiprymnus*) in the Umfolozi Game Reserve. *Afr. J. Ecol.* **21**:77-91.

Mesfin Woldemariam, (1972). *An introductory geography of Ethiopia*. Birhanena Selam Printing Press. Addis Ababa.

Miehe, S. & Miehe. G. (1994). *Ericaceous forests and heathland in the Bale Mountains of South Ethiopia, Ecology and Man's impact*. Traut Warnke Verlag, Hamburg.

Mitchell, A. W. (1977). Preliminary observation on the daytime activity pattern of lesser kudu in Tsavo National Park, Kenya. *E. Afr. Wildl. J.* **15**:199-206.

Mohr, P. A. (1963). *The Geology of Ethiopia*. Haile Selassie I University Press, Addis Ababa.

Morton, B. (1976). *A field guide to Ethiopian minerals, rock and fossils*. Addis Ababa University Press Addis Ababa.

Mukinya, J. G. (1973). Density, distribution, population structure and social organization of black rhinoceros in Masai Mara Game Reserve. *E. Afr. Wildl. J.* **11**: 385-400.

Mumin, Y. (1999). Population size & seasonal distribution of the Hirola (*Damaliscus hunteri)* in Southern Ganrissa, Kenya. Unpublished, M. Sc. Thesis. Addis Ababa University.

National Meteorological Services Agency (NMSA) (2000). Unpublished meteorological data of Dinsho, Robe & Adaba area. Addis Ababa.

Norton-Griffiths, M. (1978). *Counting Animals. 2nd edn.* Africa Wildlife Leadership, Nairobi, Kenya.

Nowak, R.M. (1991). *Walker's Mammals of the World* (5th ed.) *V-II*. The Johns Hopkins University Press, Baltimore and London.

Parker, I. (1988). Wild and wonderful. *Selamta* **5** (1): 8-14.

Pennycuick, C. J. (1975). Movements of the migratory wildebeest population in Serengeti area between 1960-1970. *E. Afr. Wildl. J.* **13**:65-87.

Rosen, V. B. (1953). *Game animals of Ethiopia*. The Swedish-Ethiopian Co. Addis Ababa.

Safari Club International (SCI) (1987). *SCI record book of the trophy Africa Field ed. 6 Vol. 1*. Tucson, Arizona.

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

Sanford, G. & Legendre, S. (1930). In quest of the Queen of Sheba's antelope. *Natural History*. **30**:17-32.

Shibru Tedela. (1995). Protected Areas Management Crisis in Ethiopia. *Walia* **16**: 17-30.

Sillero-Zubri, C. & Gotteli, D. (1991). Conservation of the endemic Ky Kebero *Canis Simensis*. *Walia* **13**: 35-46.

Sinclair, A. R. E. (1973). Population increases of buffalo and wildebeest in the Serengeti. *E. Afr. Wildl. J.* **11**: 93-107.

Sinclair, A. R. E. (1983). The adaptations of African ungulates and their effects on community function. In: Tropical Savannas (Ed. Bourliere), Elsevier, and Amsterdam.

Sinclair, A. R. E. (1977). *The African Buffalo*. A study of resource limitation of population, Wildlife behaviour and ecology series. University of Chicago Press, Chicago.

Smedes, H. (1959). The Batu Mountains of the Bale Plateau, Ethiopia. *Alpine Journal*, **64**: 217-226.

Smithers, R. H. N. (1971). The mammals of Botswana. *Museum Memoir No. 4*. Mardon Printers, Salisbury.

Spinage, C. A. (1968). A quantitative study of the daily activity of the Uganda Defarsa Waterbuck. *E.Afr. Wildl. J.* **6**:89-93.

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. Mngt.* **50** (2): 339-347.

Stephens, P. A., Candy, A., Leader-Williams, N., Sillero-Zubri, C. (1997). *Large mammals of Bale Mountains, Ethiopia*. University of Oxford, UK.

Sutherland, W. J. (1996). *Ecological Census Technique.* A handbook Cambridge University Press, United Kingdom.

Sutherland, W. J. (2000). *The Conservation, Research, Management and Policy hand book.* Blackwell Science Ltd., Oxford.

Talbot, L. M. & Talbot, M. H. (1963). The Wildebeest in Western Masai Land and, East Africa. *Wildl. Monogr.* **12**:1-88.

Tesfaye Hundesa (1997). Major causes for the loss of wildlife resource in Ethiopia. *Walia*, **18**: 3-6.

Waltermire, R.G. (1975). A National Park in the Bale Mountains. *Walia,* **6**:20-24.

Wilson, D. E., Cole, F. R., Nicholas, J. D., Rudran, R., & Foster, M. S. (1996). *Measuring & Monitoring Biological Biodiversity. Standard methods for mammals.* Smithsonian Institution Press, Washington.

Wilson, E. O. (1989). Threats to Biodiversity. *Sci. Am.* **261**: 108-112.

Wilson, J. V. (1965). Observation on the Greater Kudu (*Tragelaphus strepsiceros*) in Northern Rhodesia. *E. Afr. Wildl. J.* **3**: 27-37.

Woldegebriel Gebrekidan, (1996). The status of Mountain Nyala (*Tragelaphus buxtoni*) in Bale Mountains National Park (1986-1994). *Walia*, **17**:27-37

Woolf, A. & Harder, D. (1979). Population dynamics of a captive white-tailed deer herd with emphasis on reproduction and mortality. *Wildl. Monogr.* **67**:1-53.

WorldWide Fund for Nature (WWF) Year book, (1987/1988). A review of International conservation.

Yalden, D.W., (1983). The extent of high ground in Ethiopia compared to the rest of Africa. *Sinet Ethiop. J. Sci.* **6**:35-38.

Yalden, D.W., Largen, M.J. & Kock, D. (1984). Catalogue of the mammals of Ethiopia (5). Artiodactyla. *Monitor. Zool. Ital. (NS) Supp.* **8**: 1-118.

8. APPENDICES

Appendix 1. Summary statistics of the wildlife of Ethiopia

Group	Number of species	Number of endemic species	% Total
Mammals (terrestrial)	277	31	11.2
Birds	861	16	1.9
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

Source Hillman (1993) with some modification

Appendix 2. Larger and more commonly seen animals of the Bale Mountains

National Park

English	Scientific	Amharic	Afan Oromo
Mountain Nyala	*Tragelaphus buxtoni*	Yedega agazen	Gedemsa
Menelik's Bushbuck	*Tragelaphus scriptus meneliki*	Dekula	Borofa
Bohor Reedbuck	*Redunka redunca*	Bihor	Goda
Klipspringer	*Oreotragus oreotragus*	Saas	Borte
Grey Duiker	*Sylvicapra grimmia*	Medakoa	Kurupe
Warthog	*Phacochoerus aethiopicus*	Karkero	Golja
Ethiopian wolf	*Canis simensis*	Key kebero	Jedalla farda
Golden jackal	*Canis aureus*	Kebero	Jedalla
Spotted Hyaena	*Crocuta crocuta*	Jib	Worabessa
Serval Cat	*Felis serval*	Aner	Dero
Egyptian Mongoose	*Herpestes ichneumon*	Farro	Ama
Olive Baboon	*Papio anubis*	Zinjero	Jaldessa
Colobus Monkey	*Colobus abyssinicus*	Gureza	Weinii
Abyssinian Hare	*Lepus sp.*	Tinchel	Helensa
Rock Hyrax	*Procavia capensis capillosa*	Shikoko	Osole
Giant Molerat	*Tachyoryctes macrocephalus*	Filfel	Xuqaa

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Source: - Ethiopian Tourism Commission (ETC), 1999 with some modification.

Appendix 3. DATA COLLECTION SHEET (POPULATION CENSUS)

Name of Data Collector_____

Date_____ Block (Route) No._____

Name of the place_____

Obs. No.	Total	AM	AF	SAM	SAF	JM	JF	J Ud.	**Habitat Type	Remark

Key: - **AM**....Adult Male **AF**....Adult Female **SAM**....Sub-adult Male

AF....Sub-adult Female **JM**....Juvenile Male

JF....Juvenile Female **J Ud**... Juvenile unidentified

**** HABITAT TYPE**

1.Grassland *2. Shrub Grassland* *3. Wood Land*

4. Bush shrub land *5. Riverine*

Appendix 5. Questionnaire (points of discussion)

Sex_____ Age_____

Occupation_____

Educational background_____ Date_____

1. How long have you lived in Dinsho? _____
2. What was the condition of the area in earlier time?

_____

3. What changes did you observe on the Bale Mountains National Park?

_____

4. What do you feel regarding the presence of Mountain Nyalas in the Bale Mountains National Park? _____
5. Have you faced serious problems because of the presence of Mountain Nyala in this area? If so, how did you overcome these problems?

_____

6. Where have you been during the change of the previous government?

_____

7. What do you remember of the destruction made on the Bale Mountains National Park and its wildlife?

_____

8. What do you think the cause of that destruction?

_____

9. What should be done for the conservation of Mountain Nyala and Bale Mountains National Park?

_____

10. Do you think the surrounding people receive a reasonable benefit from the Park? (Yes or No). If you say no, what do you suggest for future work?

_____

11. Is there any environmental education club (nature club) around Dinsho? If there is, how far is the extent of its activity?