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Population Status and Distribution of Artiodactyls in the Awash National Park with Special Reference to Beisa Oryx (*Oryx beisa*)

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ACRONOMY

EWCO	Ethiopian Wildlife Conservation Organization
CDC	Conservation and Development Center
IUCN	International Union for Conservation of Nature and Natural Resources
ANP	Awash National Park
FAO	Food and Agriculture Organization of United Nations
CARE	Cooperative for Assistance Relief Everywhere
IBA	Important Bird Areas

ABSTRACT

Population count of beisa oryx (Oryx beisa) and other artiodactyls was conducted in Awash National Park during August 2003 - February 2004, which includes wet and dry seasons in the area. Both sample and total count methods were used to determine the current population size, seasonal distribution, habitat association and sex and age structure of beisa oryx population, as well as to assess the population status of other artiodactyls. Data on sex and age structure, habitat association, and seasonal variation in population size was analyzed using SPSS computer software package and compared using one-way analysis of variance (ANOVA).

The estimated population of beisa oryx was 446 individuals. Their population has declined by 88.9% and 52% compared to the 1969 and 1992 estimates, respectively. Beisa oryx population as determined from total count was 272 and 227 individuals during the wet and dry seasons respectively. Among them, 93% and 98% were encountered south of the Metahara-Awash highway during wet and dry seasons, respectively. They were seen concentrated in Ilala Sala grassland area during wet season and move to the Awash River and Kudu Valley in search of water during dry season.

Observations on habitat association of beisa oryx indicated a marked preference for grasslands during wet season and shrubby grasslands during dry season. The distribution of beisa oryx during the study period was not uniform in the study area.

The relative abundance of green forage, vegetation cover, water, seasonal livestock and human disturbances were the major factors governing their distribution. Age structure was dominated by adults, which constituted 76.31% of the total population. Sub-adults and calves together accounted for 23.69% of the population. Relatively low proportion of the sub-adult and calves indicated a

declining feature of the population. In addition to beisa oryx, 65 Soemmerring's gazelles, 413 lesser kudus, 492 warthogs and 2770 Salt's dikdiks were estimated to be present in this area. The population estimate for other artiodactyls showed a drastic decline compared to the 1969 survey. Findings from ground survey and socio-economic survey have revealed that competition from livestock, settlement, poaching, predation, road kill and bush encroachment were the main threats for the drastic decline of wildlife in Park area. Immediate conservation measures are essential to halt the severe decline of artiodactyl populations in ANP.

Key words: *Artiodactyls, Awash National Park, beisa oryx, population status*

1. INTRODUCTION AND LITERATURE REVIEW

1.1. Introduction

Ethiopia is known for its wide variety of habitats and topography, which ranges between 110 m below sea level in the Afar depression to mountains up to 4620 m asl at Ras-Dejen. As a result of extensive variation in climate, vegetation and terrain, Ethiopia has long been recognized for its prosperity of natural resources and endemic fauna and flora (Yalden *et al.*, 1984; Hillman, 1993a; 1993b; Shibru Tedla, 1995; Tilahun *et al.*, 1996; Jacobs and Schloeder, 2001). These diversity and endemism make Ethiopia to be one of the most diverse countries in Africa. To conserve these prestigious natural resources, Ethiopia has established 57 National Forest Priority Areas and 38 wildlife conservation areas, representing different biomes. However, all these conservation areas are under constant threat of human activities (Jacobs and Schloeder, 1993; Hillman, 1993a; 1993b, 2000; Stephens, *et al.*, 2000; EWCO/CARE, 2001, 2002).

Awash National Park (ANP), which was established on 6 January 1969 (Negarit Gazeta, 1969) was primarily created due to its high population of herbivores and absence of settled human population. The major artiodactyls recorded in the Park are Swayne's hartebeest (*Alcelaphus buselaphus swaynei),* klipspringer *(Oreotragus oriotragus*), Salt's dikdik *(Madoqua saltiana),* waterbuck (*Kobus ellipsiprymnus),* reedbuck *(Redunca fulvorufula),* Soemmerring's gazelle *(Gazella soemmerringi),* beisa oryx *(Oryx beisa),* lesser kudu *(Tragelaphus imberbis),* greater kudu (*Tragelaphus strepsiceros),* bushbuck (*Tragelaphus scriptus)* and waterbuck (P*hacochoerus aethiopicus*) Park records show that some of the herbivores such as bush duiker *(Sylvicapra grimmia),* oribi *(Ourebia ourebi),* African buffalo *(Syncerus caffer),* Grevey's zebra *(Equus grevyi),*

EWCO/CARE (2001) noted that the population of Soemmerring's gazelle has declined from the 1992 report of 215 to 178, lesser kudu from 995 to 178, Salt's dikdik from 5297 to 59 and warthog from 955 to 188 heads. Nevertheless, defassa waterbuck, grater kudu and Swayne's hartebeest were not encountered during both 2001 and 2002 aerial surveys. As a result, it was recommended to conduct a detailed ground survey to confirm their status in the Park.

Most artiodactyls in the ANP are adversely affected with serious degradation, depletion and fragmentation of their habitats, because of continuous human pressure and livestock ranging, almost 77% of the original Park area is occupied by various human activities. Most of the Park's wildlife resources, particularly the beisa oryx and Soemmerring's gazelle, occur in the core area of the Park, in the southeastern part, where human impact is negligible (Berihun G/Medhin, 2000; CDC, 2002).

There was no systematic ground surveys conducted in ANP since 1992, except an ecological investigation on Soemmerring's gazelle (Berihun G/Medhin, 2000). Thus, for better comparison and understanding of the population trend of artiodactyls, comparable data are lacking for the area. The 1969 and 1992 data were obtained using ground surveys conducted along the predetermined transects, but the 2001 and 2002 data were based on aerial counts. Data obtained by different methods could not be compared and hence it is difficult to draw conclusions regarding population trend of wild animals (Norton-Griffiths, 1978).

Furthermore, the population status and ecology of beisa oryx and other herbivores in ANP are not clearly known (Hillman, 1993a; 1993b; Jacobs and Schloeder, 1993; CDC, 2002). Grimsdell (1978) noted that monitoring of the population structure of key species that are important for tourist viewing is indispensable in view of eco-tourism development. The future survival of wildlife depends on effective conservation measures that are appropriate for specific conservation areas. Understanding

the biology and ecology of wildlife is essential for effective conservation and management intervention (Sinclair and Grimsdell, 1978). Thus, the present investigation was conducted as part of monitoring of artiodactyl populations in ANP to document population structure and their distribution with particular emphasis on beisa oryx population.

1. 2. Literature review

East Africa has long been recognized for its diversity and abundance of larger herbivores. The order artiodactyla comprises even-toad herbivores including antelopes, cattle, sheep, goat, deer, giraffe, camel, pig, chevrotain and hippopotamus. Artiodactyls satisfy their nutritional requirements by seasonally shifting between habitats and selecting variety of edible plant species (Lamprey, 1963; Jarman and Mmaari, 1972). Thus, the seasonal distribution and migratory patterns of artiodactyls depends up on the availability of required resources.

The ever increasing human and livestock population pressure, habitat fragmentation, introduction of exotic species and other adverse human activities have altered the seasonal migration and movement pattern of artiodactyls (East, 1996). As a result of these problems, artiodactyls populations have been declining in number if not already extinct (Caughley and Sinclair, 1994). Beisa oryx is one of the artiodactyls, which is facing continued decline in their population (Jacobs and Schloeder, 1993; EWCO/CARE, 2001, 2002; Fanuel Kebede and Mizuno, 2000; CDC, 2002).

1.2.1. Beisa oryx (*Oryx beisa* Rüppell, 1835)

1.2.1.1. Taxonomy

The beisa oryx belongs to the Family Bovidae, Subfamily Hipotraginae and Genus *Oryx*. The word "Oryx" is from the Greek word "Orux", means "gazelle" or "antelope". The taxonomy of *Oryx* tribe is not yet clear. Ansell (1971, in Vaughan, 2000) recognized three species of the genus *Oryx*. They are *Oryx dammah* (scimitar-horned oryx), *Oryx leucoryx* (Arabian oryx), *and Oryx gazella* (gemsbok, beisa, and finger-eared oryx).

Three subspecies are believed to exist in Ethiopia. These are:

Oryx gazella beisa, Oryx gazella gallarum and Oryx gazella annectens: Oryx gazella beisa is found in the northern part of Ethiopia and in northern Somalia. *Oryx gazella gallarum* is distributed from central Ethiopia to Southeast Sudan, Uganda and perhaps Central Somalia, and *Oryx gazella annectens* is known to occur in northern Kenya, southern Ethiopia and in southern Somalia.

1.2.1.2. General description and ecology

Kingdon (1997) described the physical appearance of beisa oryx as a large antelope with compact and muscular body, long and patterned ears, thick neck and large face. The horns are long, straight, and vertically parallel and grow from 75 to 120 cm. The tail of the species is long that terminates in a tuft of black brush like hairs. Oryx has strong but slender legs that terminate in black and large hoofs. The species is active, alert, and wary and keen sighted (Walther, 1978). Beisa oryx is physically different from its congeners by having a thick black stripe running from the base of the horns through the eye to the lower cheek. A patch on the forehead and a bell-shaped nose patch are some of the conspicuous facial marks. The males have a tuft of hairs on the throat. Females have

longer and slender horns than those of males. Their home range varies from 200 to 300 km^2 for females and from 150 to 300 km^2 for males (Field, 1975; Nowak, 1991; Kingdon, 1997). Sexes may be equally balanced but usually in favour of females. The estimated gestation period is 265 days. Normally they have non-seasonal breading cycle. Females can provide calves at about nine month interval and gestation period is eight and half months (Walther, 1978). Calves join other young groups to form peer groups and may stay up to one year. Female could be fertile within 18-24 months. Oryx is known to live about 22 years in captivity (Kingdon, 1997).

Beisa oryx is adapted to survive in arid areas and deserts, and has exceptional ability to withstand overheating, more than 45°C for 12 hours by raising body temperature above 45°C (Taylor, 1969; Field, 1975; Vaughan *et al.*, 2000). Thus, rainfall and temperature appears to have no significant influence on the biomass of oryx and gazelle (East, 1984; Vaughan *et al.*, 2000). Such extreme body temperature would kill most mammals, but the specialization of circulatory system has enabled oryx to survive under such high temperature. They are active in early morning and late afternoon hours and in moonlight. Water requirement could be satisfied with its food, which includes grasses and leaves of shrubs, by feeding during the period of maximum relative humidity between midnight and dawn (Taylor, 1969; King *et al.,* 1975). Thus, oryx is a good example of artiodactyls, which has successfully adapted to overcome harsh conditions of intense heat, little or no water and dispersed food (East, 1984).

1.2.1.3. Distribution and population status

Historically, beisa oryx had a wider distribution including Djibouti, Eritrea, Kenya, Ethiopia,

Southeast Sudan and Northeast Uganda. It is a species of arid savanna, open scrub and semi-desert countries. However, currently the species is wiped-out from majority of its former range (Kingdon, 1997; Vaughan *et al.*, 2000). Only little is known regarding the current population status and seasonal distribution of beisa oryx. However, it is known that their population has declined in their ranges, particularly in Sudan, Uganda and Tanzania. In Somalia and Uganda, its extensive range was reduced to fragments as progressively taken over by livestock. However, they are, at present, not endangered in the rest of the east African countries (Kingdon, 1997).

In Ethiopia, beisa oryx is found in a wide area from sea level up to 1700 m altitude in eastern and southern part of the country (Yalden *et al.*, 1996; East, 1997). Significant populations of them can be seen in conservation areas including Mago and Omo National Parks (Lamprey, 1994; Graham *et al.*, 1996, 1997) and in Omo-west, Murule and Borena Controlled Hunting Areas (Thouless, 1995a; Cherie Enawgaw *et al.*, 1999). They are also common throughout the Awash Valley (Robertson, 1970; Jacobs and Schloeder, 1993; Thouless, 1995b; EWCO/CARE, 2001, 2002; CDC, 2002). The estimated total population of beisa oryx in Ethiopia is believed to be between 4000-5000 with steadily declining herds (East, 1997).

Beisa oryx were once common in most of the plain areas in ANP, such as Sabober, Sabure and Ilala Sala plains. ANP had the highest concentration of the beisa oryx population compared to other areas. Robertson (1970) estimated 4020 individuals in the whole area of the ANP and Sabober plain was known to inhabit over half of the oryx population in the 1960s. Jacobs and Schloeder (1993) estimated only 923 individuals in ANP, which is only 23 % of the 1969 estimate. However, aerial surveys conducted in 2001 and 2002 revealed the presence of 692 and 1395 individuals, respectively, and their distribution is restricted to the core area in the southeastern corner of ANP

(EWCO/CARE, 2001, 2002; CDC, 2002). This shows that there is no clear information regarding the present population number of beisa oryx in ANP. It is also evident that, they have been exterminated from most of its former ranges in the western and northern parts of the Park.

1.2.2. Other Artiodactyls found in Awash National Park

The other common artiodactyls of ANP are Soemmerring's gazelle, greater kudu, lesser kudu, defassa waterbuck, Swayne's hartebeest, Salt's dikdik and warthog. Their population status and distribution are described in the following sub-sections.

Soemmerring's gazelle (*Gazella soemmerringi* Cretzschmar, 1828): Soemmerring's gazelle is endemic to the horn of Africa and found in Sudan, Ethiopia, Somalia, northern Kenya, and in Djibouti. However, this species is currently exterminated over the greater part of its former ranges and categorized as threatened (IUCN, 1996). The species favors rough hilly country, with scattered evergreen thickets and open short grassy plains.

It was common in all plain areas of ANP along with beisa oryx population. Its present distribution is limited to the core area of the Park and their population declining steadily. Robertson (1970) noted 1701 and Jacobs and Schloeder (1993) came across 215 individuals. On the other hand, the 2001 and 2002 aerial survey estimated 178 and 97 individuals, respectively in ANP (EWCO/CARE, 2001, 2002). However, systematic ground survey conducted in 1999/2000 revealed the presence of only 41 individuals (Berihun G/Medhin, 2000).

Greater kudu *(Tragelaphus strepsiceros* Pallas, 1766*)*: this species occurs throughout the Ethiopian lowlands and foothills (Hillman, 1988). It persists in low to moderate number around the

Awash River Valley. According to Thouless (1995b), the species occurs within the Afdem-Gewane Controlled Hunting Areas. This species was seen within ANP in the Kudu Valley, Fentale Mountain, and Awash River canyon. In 1992 ground survey, 84 individuals were encountered within ANP (Jacobs and Schloeder, 1993), but no sighting of the species was recorded during both 2001 and 2002 aerial surveys (EWCO/ CARE, 2001, 2002). However, there is no current information available regarding the present population status of this species. Their population is believed to have declined drastically.

Lesser kudu (*Tragelaphus imberbis* Blyth, 1869): The distribution of lesser kudu includes horn of Africa, Eastern Ethiopia up to 1300 m altitude and the lower regions of Kenya and Tanzania. Lesser kudu inhabits deciduous bushland and thickets dominated by *Acacia* and *Commifora* spp. The species could move from more deciduous upper slops in the wet season to low laying evergreen belt in the dry season.

Lesser kudu population is distributed throughout the bushland habitats of Ethiopia's eastern and southern lowlands (Hillman, 1988; Thouless, 1995a, 1995b; East, 1997). It occurs in moderate to low density throughout the southern part of the Awash River Valley, close to Somalian border in the Ogaden region. Considerable numbers of lesser kudus occur in most of the protected areas in southern Ethiopia, including Omo and Mago National Parks, Omo-west and Murule Controlled Hunting Areas (Hillman, 1990; Jacobs and Schloeder, 1993; Thouless, 1995b; Graham *et al.,* 1996, 1997). The lesser kudu population in Mago National Park was affected by the outbreak of rinderpest in 1999/2000 and has wiped-out more than 2200 individuals (Leykun Abune, *et al.,* 2000). According to East (1997), the population of lesser kudu could exceed 50,000 individuals. Shyness and preference to thick cover enables it to withstand hunting pressure.

In ANP lesser kudu is distributed in the deciduous woodland and thickets dominated by *Acacia* species. During the dry season, the species apparently relies on succulent plants like *Euphorbia* species and *Salvadora persica*. Lesser kudu occasionally feed on green and fresh grass. Adult males do not range more than 2.2 km^2 (Kingdon, 1997).Their present population status in ANP is not clear. It is believed to decline from 3800 (Robertson, 1970), 995 in 1992 survey (Jacobs and Schloeder, 1993) and recently to less than 200 individuals (EWCO/CARE, 2001, 2002).

Defassa waterbuck (*Kobus ellipsiprymnus* Ogilby, 1833): Defassa waterbuck is distributed in well-watered Valleys, mainly in tropical Africa. In Ethiopia, the species occurs in better-watered regions but not in high altitude areas. It is common in Nechsar, Omo and Mago National Parks, Awash Valley and Afdem-Gewane Controlled Hunting Areas (Thouless, 1995b). Within ANP, the species is found around Filwuha and along the Awash River canyon. Limited records available in the Park show that the population has declined dramatically. Robertson (1970) and Jacobs and Schloeder (1993) estimated 263 and 200 individuals, respectively in ANP. There was no record during both 2001 and 2002 aerial surveys (EWCO/CARE, 2001, 2002). No scientific ground survey was conducted since Jacobs and Schloeder (1993) survey to confirm the present status of them in ANP.

Swayne's hartebeest (*Alcelaphus buselaphus swaynei* Sclater, 1892): *Alcelaphus buselaphus swaynei* had wide distribution in Ethiopia and Somalia. Their population has declined rapidly mainly due to rinderpest outbreak, but were common in Awash Valley up to the 1940s. The population gradually declined in early 1960s, mainly due to human population growth, agricultural expansion, hunting and other exogenous factors, and has become localized to Senkele and Siraro plains (Bolton, 1973).

In early 1974, EWCO translocated 87 individuals of Swayne's hartebeest from Swayne's Hartebeest Sanctuary to ANP and 129 to Nechsar National Park, in response to the sever decline of its population. At present, the species is found in small numbers only in ANP, Nechsar National Park, Senkele Swayne's Hartebeest Sanctuary, Maze Wildlife Reserve, and probably in Yabelo Wildlife Sanctuary (Leykun Abune, 1991; Hillman, 1993a; Birhanu Gebre, 1998). Out of the 87 individuals translocated to ANP, 30, 19, 13 and 5 individuals were counted in 1983, 1986, 1990, and 1993, respectively. Nevertheless, no individuals were encountered during both 2001 and 2002 aerial surveys.

Salt's dikdik (*Madoqua saltiana* Desmarest, 1816): This species is distributed in evergreen and semi-deciduous bushland and thickets in the horn of Africa. The population is not endangered (IUCN, 1996), but has declined around densely settled areas. The species occurs in the northern and eastern lowlands and is common throughout the bushland of the Awash Valley (Hillman, 1988). The species in ANP is distributed widely in bush, shrub and in thickets. However, its population has declined from 9000 heads (Robertson 1970) to 5297 (Jacobs and Schloeder, 1993).

Warthog (*Phacochoerus aethiopicus* Pallas, 1767): The distribution of warthog is scattered across tropical Africa, ranging from sea level to up to 3800 m altitude. It can occur in cold uplands as well as in hot lowlands, but can not tolerate low humidity or prolonged solar radiation (Kingdon, 1997). Warthog inhabits open and wooded savanna habitats. The population status of warthog is listed as widespread and abundant (IUCN, 1996) and well represented in numerous National Parks. However, its population has been eliminated from all intensively farmed areas, both as nuisance and as reservoir of livestock diseases. In ANP the species is distributed through the shrubland, bushland and thickets. Its population number has declined from 1050 in 1969 to 955 in 1992.

1.3. Justification

Wildlife resources are essential for conservation of biodiversity, ecosystem stability and human economic gains. International, national and local conservation organizations and even communities are interested to ensure the continued existence of wildlife (East, 1996). To realize these goals, endangered, threatened or flagship species are to be regularly monitored for their population status. Such updating about species status is indispensable to take remedial measures in case of major population fluctuations and on occasions of major calamities. Inglis (1976) noted that species fluctuations are common and are usually interrelated with the conditions in the habitat. Thus, data on population status and trends of major wildlife forms are indispensable for the managers, in order to understand the causes of population fluctuations and to take proper and timely management decisions.

At present, only little is known about the current population size and seasonal distribution patterns of beisa oryx and other artiodactyls in ANP. Investigations conducted since the establishment of the Park show that there is a significant change in population size of beisa oryx and other artiodactyls.

Most of the artiodactyls were not accounted during 2001 and 2002 aerial surveys. In general, there was no systematic ground survey on artiodactyls in ANP since the last survey of Jacobs and Schloeder (1993). Effective and sound conservation measures cannot be achieved successfully without having clear information about the species status, distribution and causes for population decline. Thus, it was crucial to conduct a detailed ground survey to evaluate the present population status and distribution of beisa oryx and other artiodactyls in ANP. The present investigation was

undertaken to fulfill this lacunae and to update scientific data essential for management and conservation activities.

1.4. Objectives of the study

General objective

- The major objectives of the present investigation was to determine current population status, seasonal distribution patterns, herd structure and demographic composition of beisa oryx population and other artiodactyls in ANP and to identify the major factors influencing their population and distribution.

The Specific objectives

- To study the current age and sex structure of beisa oryx in ANP and to compare the results with previous records,
- to analyze the habitat association of beisa oryx in its ranges in ANP
- to study the populations of other artiodactyls in ANP and to identify the major threats influencing their population,
- to recommend possible options for better coexistence of human and wildlife in ANP, through sound management practices.

2. THE STUDY AREA AND METHODS

2.1. The study area

2.1.1. Location and topography

The present investigation was conducted in Awash National Park, which is located in the northern part of the northeast Rift Valley of Ethiopia, approximately 215 km east of Addis Ababa on the main road to Djibouti. The Park lies between 08°45' - 09° 15' N latitude and 39°40' - 40°10'E longitude. It covers an area of 756 km^2 on the north side of the Awash River. Altitude ranges from 550 m asl at Awash Gorge to 2007 m asl at Mt. Fentale. The Park is bordered by the western edge of Sabober plains in the west, Addis - Djibouti highway and the Awash River in the south and southeast and the Kesem River and Filwuha Hot spring on the north (Fig. 1).

The main study area (Ilala Sala plains) is located in the southeast part of the Park and north of the Awash River. The Addis Ababa-Djibouti high way and the parallel railway pass through the main study area (Fig. 2).

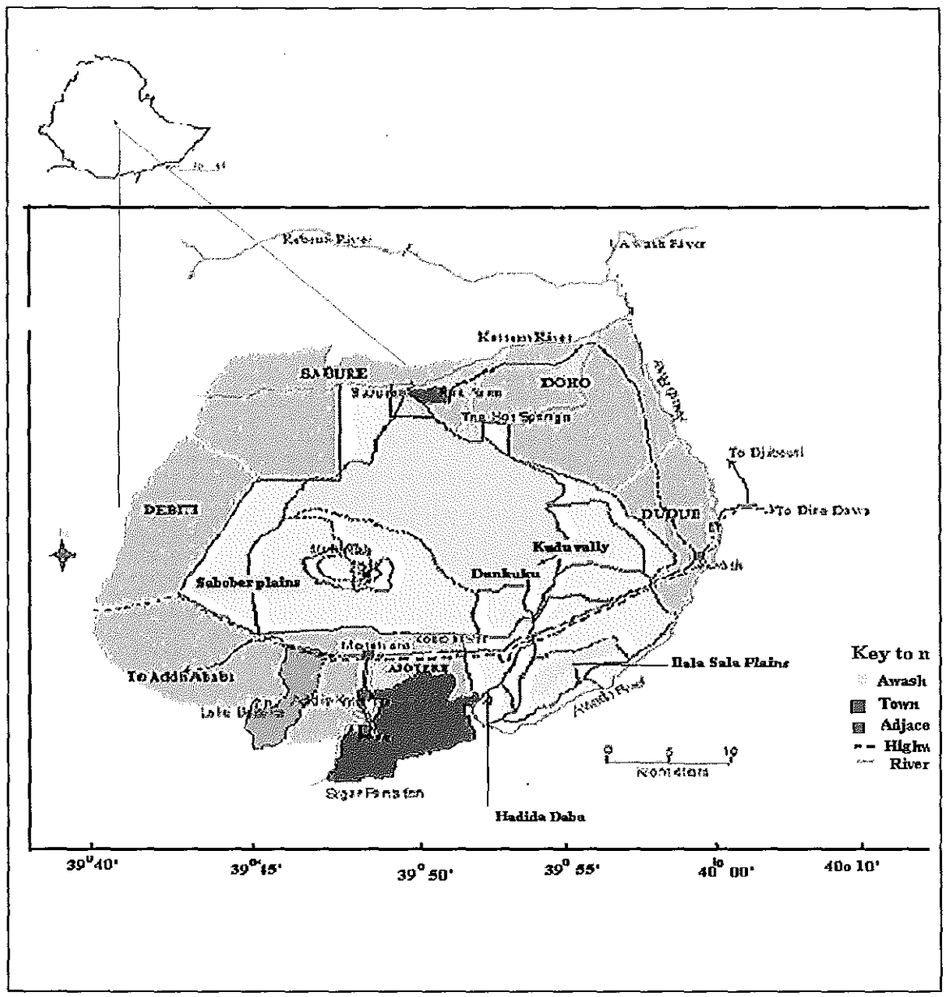

Figure.1 Location Map of the study area.

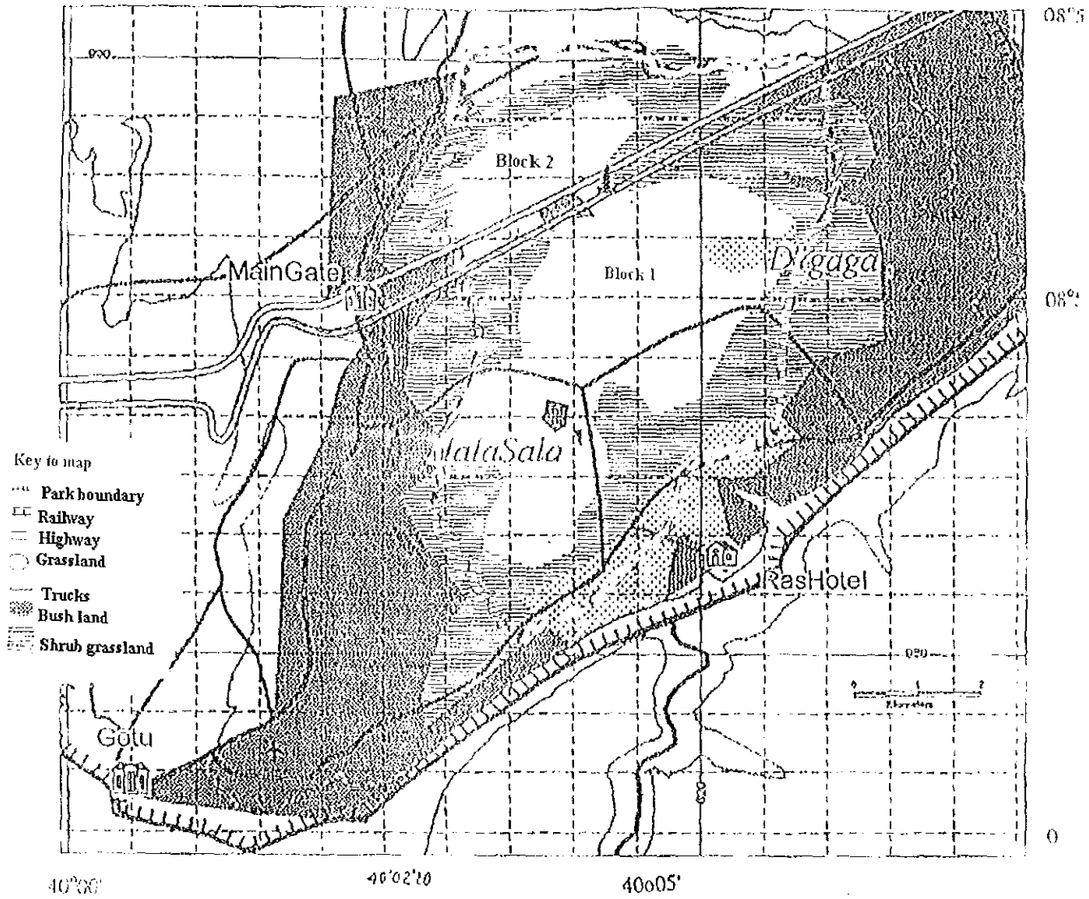

Figure 2. Map of Ilala Sala Plains (The main study area)

2.1.2. Climate

The climate of the study area is under the influence of the Inter-Tropical Convergent Zone (ITCZ) that causes to have both temporal and spatial variation (Daniel Gemechu, 1977). The study area is semi-arid. Data collected at Metahara sugar cane plantation show that the average rainfall is 475.62 mm (Fig. 3). The mean annual rainfall in the area is in the range of 276-634 mm. The least rainfall is

in December and January. ANP is generally known for scanty and erratic rainfall of high variation. The area is affected by frequent droughts.

The mean minimum and maximum annual temperature ranges from 13.12°C- 21.7 °C to 31.3 - 36.97°C, respectively. The lowest monthly temperature occurs during December and the highest temperature occurs during May.

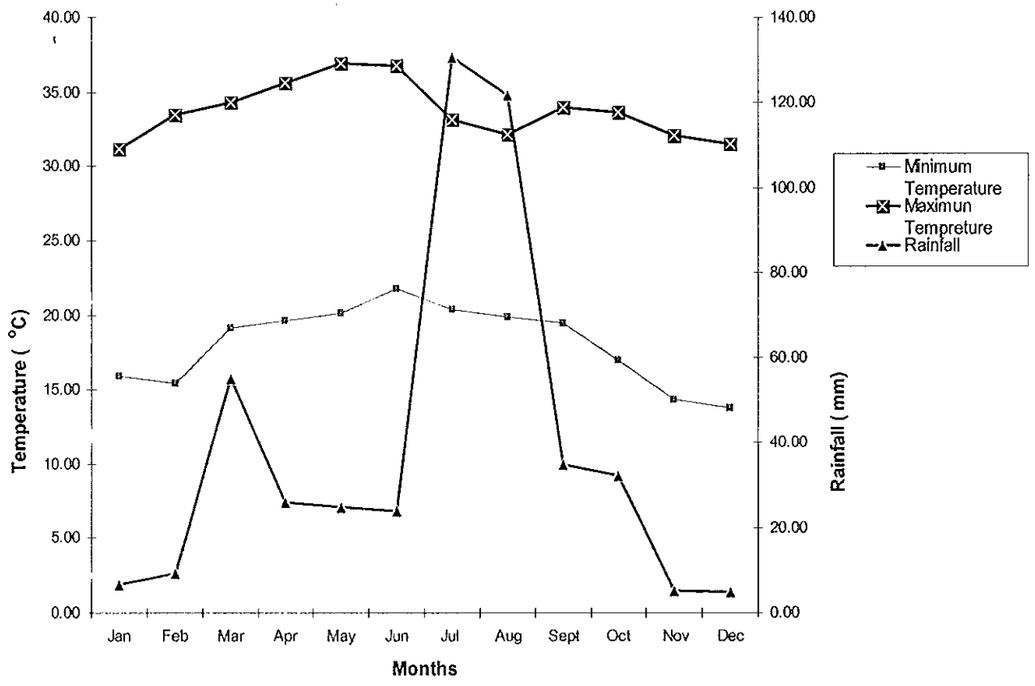

Figure 3. Climate data of Metahara meteorological station, southwest of Awash National Park (1994-2003).

Source: Addis Ababa Meteorological service Agency.

2.1.3. Hydrology

The Awash River and its tributaries drain the area. The Park is located in the upper valley of the Awash River basin catchments area. The Awash River starts from the highlands west of Addis Ababa and traverses southwards to join Koka Dam reservoir; then flows to north and turns to eastwards through the rift Valley and finally terminates in the Lake Abe. There are several tributaries that join the Awash River, within the study area. However, during the dry season, most of them dry-out before joining the River. The Kesem River, which is one of the biggest tributaries of the Awash River in the study area, drains the northern part of the Park. The water from this River is also used for irrigation by the communities around the Tadecha Melka and Awash Melka plantation (Jacobs and Schloeder, 1993).

Lake Beseka, which is the fastest growing lake in the area, has considerable influence on the environment and people living in the Awash Valley. This lake is located west of ANP along Addis Ababa-Djibouti highway, south of Fentale Mountain. It has increased from 3.3 km^2 in the early 1970s to 35 km^2 in the early 1990s. The increase of the size of the lake has resulted in loss of dry season grazing area of Kereyu pastoralists (Jacobs and Schloeder, 1993).

2.1.4. Soils

The soils of the study area are grouped into three major types based on the parent materials from which they were derived. However, one can find a mixture of several types in different locations starting with an extensive under layer of dense welded tuft, which has since then covered by either a thin coating of fine, wind blown dust of lacustrine origin, thick layers of alluvial and colluvial deposits, and denser layer of ash and volcanic debris (FAO, 1965).

FAO (1965) classified the soil types of the study area into three major types based on the parent material from which they were derived. These are:

Soils of volcanic origin: This soil type includes regosols and andosols. They are soils derived from basalt gravel of colluvial origin due to the eruptive nature of parent rocks. These soil types are found in the base of mount Fentale and throughout the Metahara area.

Ancient alluvial and colluvial soils: This comprises two soil types, solonchaks and histosols. solonchaks occurs on alluvial and colluvial slops and are found in the marsh area of hot-spring. Histosol are found in the Ilala-Sala plain and in the permanent swaps and in marshes. Histosols are known to contain thick organic horizon.

Recent alluvial soil: These comprise fluvosol, which is developed from recent alluvial deposits, found along the banks of Awash River and in irrigated farms.

2.1.5. Vegetation

Jacobs and Schloeder (1993) identified eight major vegetation types using spot satellite imagery and through ground survey. These vegetation types are grassland, open grassland, low vegetation cover, shrubland, bushland, woodland, dense tree canopy and wooded grassland.

Grassland/Open grassland: A grassland area is a habitat where grasses are the dominant vegetation cover but trees and bushes may also occur. However, their canopy cover may not exceed 2%. It occurs on alluvial soils and on the slops of Mount Fentale. The dominant species are *Chrysopogon plumulosus* and *Bothriocloa radicans* in the lower elevation and *Hypharrenia hirta* and *Themeda triandra* at higher elevations. In o*pen grassland* no trees and shrubs are seen and predominantly covered by grasses.

Low vegetation cover: This is a habitat where soils may not be suitable for vegetation growth or this may be an area denuded by overexploitation.

Shrub grassland: Shrub grasslands are habitats with a stands of shrubs but not greater than 6 meters in height. The canopy cover in such habitat is more than 20 %.

Shrubland: The shrubland type occurs in areas where there is moderate to heavy grazing pressure. The dominant shrubs include *Acacia nubica, A. senegal, A. mellifera, Dichrostochys cineri and Grewia* species.

Bushland/woodland: this type of vegetation is typically found on shallow alluvial and colluvial soils. The dominant species are *Acacia* spp. and *Balatines aegyptica.* In bushland, trees and shrubs are common, but in woodland trees up to 20 meters are common and have a canopy cover of 20 %.

Dense tree canopy: This includes gallery forested, *Acacia* dense canopy. Such habitat occurs in ancient watercourses, seasonal flooding areas, reverine woodland and in ravine areas.

Wooded grassland: wooded grasslands are habitats with grouped or scattered and conspicuous trees, with canopy cover of less than 20 %.

The vegetation cover of Ilala Sala is dominated by open grassy plains, with various types of bush grassland, shrub grassland, wooded grassland, bushland and shrubland.

2.1.6. Fauna

The ANP is known to contain several endangered and vulnerable mammalian and avian species (CDC, 2002). The Park supports 85 species of mammals and 467 species of birds (Hillman, 1993; Jacobs and Schloeder, 1993; Tilahun *et al*., 1996; CDC, 2002). Over 50% of the total bird species listed in Ethiopia is found in ANP. ANP has also been designated as the second Important Bird Area (IBA). According to IUCN (1996), ANP inhabits one critically endangered and endemic mammal species of Ethiopia, Swayne's hartebeest (*Alcelaphus biselaphus swaynei),* five vulnerable species (Lesser horse-shoe bat, *Rhinolophus hiposiderose minimus*, Trident leaf-nosed bat, *Asellia patrizii,* spot-necked otter, *Lutra macuricollis*, lion, *Panthera leo* and Soemmerring's gazelle, *Gazella soemmerringi*). Beisa oryx (*Oryx beisa*), lesser kudu *(Tragelaphus imberbis)*, greater kudu (*Tragelaphus strepsiceros) and* defassa waterbuck (*Kobus ellipsiprymnus)* are listed as of low risk, but are conservation dependent. ANP is also surrounded by other wildlife conservation areas, such as the wildlife reserves of Awash-west, Alideghe, Gewani, Mille-Serdo, the Controlled Hunting Areas of Awash-west, Afdem-Gewane, Eror and Gota and farther northeast, Yangudirasa National Park (Hillman, 1993b).

2.1.7. Human, livestock and wildlife range use

A number of ethnic groups are living in and around ANP, and they are practicing a variety of land-use pattern. Among them, the activities of transhumant pastoralists, urban people, plantation workers and other non-pastoral groups have direct impact on conservation of natural resources in the area (Jacobs and Schloeder, 1993; Tibebe Alemayehu, 1997; CDC 2002). Transhumant pastoralists are

pastoralist who are not nomadic; instead, maintain permanent settlements, but who do move their livestock seasonally in order to exploit areas away from the permanent settlement sites. The entire village rarely moves with the herders (Halcrow, 1989, in Jacobs and Schloeder, 1993). The primary economic activity of transhumant pastoralist is livestock production. They live permanently in the Park or enter the Park occasionally.

Pastoralists living within and around the study area belongs to two ethnic groups: the Oromo group of Kereyu and Ittu in the western and southern parts of the Park and Afar group in the eastern and northern parts of the Park. Based on the 1994 population census of Ethiopia and population growth rate of 3%, CDC (2002) estimated the total population of Fentale and Awash Fentale districts, surrounding the ANP, to be 60,428 and 11,832, respectively.

Since the establishment of ANP, the human and livestock populations have increased in the area steadily. Afar and Kereyu pastoralists were the traditional users of the area prior to the establishment of the Park. However, in recent times, Ittu has moved into the protected area (Tibebe Alemayehu, 1997). Pastoralists living within their own village sites with 5-30 houses occupy most part of the conservation areas. Most of these villages are permanent, but livestock would move in search of pasture and water on seasonal basis.

As there are several ethnic groups depending up on ANP for subsistence, their activities have direct effect on conservation of natural resources in the ANP (Jacobs and Schloeder, 1993; Tibebe Alemayehu, 1997). Most pastoralists rely on cattle, sheep, goats and camels. They feed on the variety of vegetation spectrum in the Park that leads to direct conflict with wildlife. Livestock populations in the Park are increasing steadily. In 1992, there were 18,194 cattle, 32001 sheep and

goats, 4288 camels and 557 donkeys. EWCO/CARE (2001) estimated 36,656 cattle, 37,783 sheep and goats, 2600 camels and 751 donkeys. In 2002, EWCO/CARE noted 35,000 cattle, 6100 sheep and goats and 400 donkeys. All data were generated using aerial surveys, which showed that most livestock density was in the Sabober plain and west of Mount Fentale. Livestock density is comparatively less in the eastern part of Mount Fentale and almost negligible in the core area of the Park.

Because of continued human pressure and livestock ranging, more than 77% of the original Park area (752 km^2) is occupied by various human activities, including, settlement, grazing, tree felling, and charcoal making and poaching. The supply and availability of pasture, water and browse, which are scarce resources of pastoralists, depends on the amount of rainfall and the geographical position of the range. Thus, these resources are variable in both space and time. As a result of such variations in the availability of resource, pastoralists are forced to move with their livestock from one area to the other in search of required resources. They could also avoid harmful flies, ticks, mites and mosquitoes seasonally. Jacobs and Schloeder (1993) noted two general regular movement patterns that could be observed among pastoralists. They use the Upper Valley range for wet season grazing and Down Valley range for dry season grazing areas.

Loss of habitat ranges and competition between livestock and wildlife have been responsible for the decline of wildlife populations at an alarming rate in the area (Shibru Tedla, 1995; Berihun G/Medhin, 2000; EWCO/CARE, 2001, 2002; CDC, 2002).

2.2. Methods

Field research in ANP was conducted during the period from August 2003 to February 2004 so as to cover both wet (July-September) and dry (December to February) seasons in the area. Although the

whole area was surveyed to find out the distribution of larger artiodactyls, the intensive field survey was conducted on beisa oryx population in the Ilala Sala plains (Fig. 2). Population size of artiodactyls was determined by using ground survey techniques (Norton-Griffiths, 1978; Buckland *et al.*, 1993; Sutherland, 1996; Wilson *et al.*, 1996; Ruette, Stahl and Albaret, 2003). In addition to the field survey, data on population trend of these wild animals was elicited from literatures. A questionnaire interview was also conducted to find out the impact of adverse human activities on wildlife population in ANP (Appendix 1).

2.2.1. Population estimate

Both sample and total counts were used to determine beisa oryx population size in ANP. All animal observations were made in the morning (06:30-10:30h) and late in the afternoon (16:00-18:30h) for three days per month during August - September (wet season) and December -February (dry season) with the help of trained and experienced Scouts in the ANP.

2.2.1.1. Sample count

Ground survey was conducted by vehicle using established transects of Ilala Sala, Hadida Daba, Dunkuku and Sabober, following similar methods used by Robertson (1970) and Jacobs and Schloeder (1993). The total length of the four predetermined transects are 133 km and the observed area covers about 14% of the total area. All transects were assessed two times during wet and dry seasons to know the current population status and distribution of artiodactyls in ANP. However, more detailed wildlife survey was conducted in the Ilala Sala plain, as beisa oryx population and other wildlife species in ANP were concentrated in this part of the Park. Other part of the Park, particularly Sabober plains, was highly distracted as a result of adverse human activities. As a result, it is excluded from population density estimation in the present survey.

The survey was conducted using a four-wheel drive vehicle driven slowly at an average speed of 20 km per hour. Wildlife, livestock, settlements and other human activities encountered during each survey were recorded in the observation sheet. Whenever beisa oryx or any other artiodactyls species was encountered, the time of observation, kilometer traveled, perpendicular distance from the sight of observation to the animal, number of individuals in the group, activities, sex and age class of the species, habitat type and other parameters were recorded on wildlife census sheet (Appendix II).

A GPS was used to note the observation coordinates and a pair of binocular was used for proper sex and age identification. A Cannon SLR Camera with 70 mm telescope was used to take pictures of some special features encountered in the study area. Census was repeated for dry and wet seasons, in order to achieve representative population estimate and seasonal distribution of wild animals in the area.

2.2.1.2. Total count

The total population of beisa oryx in the core area was determined based on total counts done on the Ilala Sala plains, following the method described by Norton-Griffiths (1978) and Caughley and Sinclair (1994). The Addis Ababa - Djibouti highway and the parallel railway, which cuts oryx habitat, influence the distribution and free movement of beisa oryx population between the two blocks. Hence, the main study area was divided into two main Blocks, Block 1 (south of the highway) and Block 2 (north of the highway). The survey was conducted two times during wet and dry seasons. Four people were involved in the count. Transects were selected randomly from one end of the plain and drove to north and south direction. The count was done simultaneously on the same day from 0630 to 1200 hours to avoid double counting. Group size, age, total number in the herd and other special features of the animal encountered were used to avoid double counting. All

relevant information gathered, during surveys, were recorded in the field notebook and transferred in to the observation chart.

2.2.2. Population structure

Group size, age and sex composition of the wild animals observed were carefully recorded in order to monitor the influence of season on beisa oryx group structure. The relative body size, horn size, pelage and external genitalia were used as clues to determine the age and sex of the individuals (Sinclair and Grimsdell, 1978). The age categories were determined following the methods described by Grimsdell (1978) and Balakrishnan, and Ndhlovu (1991) for categorizing herd structure of different species. Information on the approximate demographic composition and structure, such as age class and sex ratio, were used to predict general trend of beisa oryx population so as to understand whether it is declining, increasing or stable. Population trend of artiodactyls was determined by comparing the present findings with the previous findings of different researches conducted in ANP.

2.2.3. Distribution and habitat association

Seasonal distribution and habitat association of beisa oryx in the study area was determined from the data obtained during the wet and dry season observations. The average size of herds observed in different habitat types and localities during wet and dry seasons were taken to compare the distribution in different habitats. Further information on seasonal distribution of artiodactyls was also gathered from experienced local elders, wildlife experts and from questionnaire interview. The habitat selection of beisa oryx in ANP was determined from the relative frequency of observations of the species in each vegetation type during wet and dry seasons.

2.2.4. Human impacts on wildlife population

A questionnaire interview was conducted to gather information from households pertaining to the natural and human factors, such as availability of water, forage, number of livestock, seasonal grazing area and human settlements, which may have influence on the observed wildlife population size and seasonal distribution. The interview was conducted using a predetermined and tested questionnaire (Appendix 1). Further, discussions were held with selected elders from the local communities, who have better knowledge of the area, as well as with the Park Warden and experienced Park Scouts. The responses given by each of them were recorded on separate sheets to compare the views, to analyze findings and relate with the actual observations.

The questionnaire had two types of questions; precise and closed, with the list of possible answers and grouped and open-ended questions. The questionnaire was structured into four sections. The first part was designed to provide background information including age, sex, level of education, occupation and source of income. The second part contained questions regarding livestock, population trend, seasonal grazing area, and the effect of drought on wildlife and livestock, problems encountered during grazing time in and around ANP and future plans. The third portion was on information pertaining to Park - people interaction *vis-à-vis,* the access of local people to Park resources, level of interactions with the Park staff, historical distribution, current population status of herbivores and factors influencing wildlife population, as well as options towards future conservation. The fourth section was with general questions regarding the current attitude of randomly selected households on conservation of wildlife resources in ANP.

In addition to these, all wildlife mortality encountered during the study period, due to vehicle collision, were recorded and compared with the earlier data available within the park. The number of vehicles passing through the main study area was counted for four days in October and November to

know the current traffic pressure and compare with the long-term record of wildlife mortality. Vehicle number was also compared with the findings of Jacobs and Schloeder (1993). Informal discussions were conducted with some drivers to know their level of awareness and attitude towards wildlife.

2.2.5. Analysis of the data

Pupation density of beisa oryx in ANP was estimated using transect count and fixed width method was used being the appropriate method for open area (Norton-Griffiths, 1978; Dawson and Deker, 1992) Population density was calculated using the formula:

$$D = n/2L \times SW$$

Where: D: Population density

n: number of sightings

L: Transect length

SW: Strip width

The mean number of animals of each species observed per transect was used to calculate population density. All sightings were pooled together to find out the overall density estimate for the whole study area. Some species seen rarely during the study period were excluded from the analysis. The total biomass of artiodactyls was calculated using mean weights given by Kingdon (1997) and the results of the present survey.

Population estimate of artiodactyls was made by applying similar methods used by Robertson (1970) and Jacobs and Schloeder (1993). Population estimates for beisa oryx and Soemmerring's gazelle was made using Ilala Sala transects with a total transect length of 22 km and an area of 43 km^2. The transect width for both species was 400 m. Population estimates of lesser kudu and Salt's dikdik

were calculated using Ilala Sala and Hadida Daba transects covering 31 km transect length. But the transect width was 100 m for lesser kudu and 30 m for Salt's dikdik due to their body size and visibility of the area. Where as population estimate for warthog was made from Ilala Sala and Dunkuku transects, with 35 km transect length and strip width of 30m (Jacobs and Schoeleder, 1993).

Age and sex ratio of beisa oryx was assessed based on close observation of the species. Data on sex and age structure, habitat association, and seasonal variation in population size were analyzed using SPSS computer software package and compared using one-way analysis of variance (ANOVA).

3. RESULTS

3.1. Population estimate of beisa oryx

3.1.1. Sample count

The results of sample counts of beisa oryx population for dry and wet seasons are given in Table 1. Its population was more during wet season than in dry season. A total of 182 and 126 individuals were recorded during wet and dry seasons, respectively. This gives a mean of 154 beisa oryx individuals in the study area. The total population estimate for wet and dry seasons were 446 and 310 heads with 95% confidence interval of 295 - 596 and 208 - 410, respectively. The total population size estimated from mean population density was 378 individuals with 95% confidence interval of 291- 464. There was no significant difference in the number of animals observed during the two seasons ($p= 0.081$). The mean group sizes in wet and dry seasons were 11 and 12 heads, respectively. The group size during wet and dry seasons was not significantly different ($p > 0.05$).

Table 1. Population density and estimate of beisa oryx in ANP based on sample counts (Mean ± SE).

Season	Mean individuals observed	Group size	Mean population density	Population estimate
Wet	181.5 ± 23.80	11 ± 0.58	10.36 ± 1.36	446 ± 58.38
Dry	125.83 ± 15.96	11.83 ± 0.71	7.18 ± 0.91	310 ± 39.18
Mean	153.67 ± 16.04	11.41 ± 0.45	8.77 ± 0.91	378 ± 39.32

3.1.2. Total count

The data on total count of beisa oryx population obtained during the present investigation are given in Table 2. The highest number observed was 272 heads in wet season and the lowest observed was 227 in dry season in the two blocks of the current habitats of beisa oryx. The mean population of wet and dry season counts was 250 individuals. The findings of total population count in Ilala Sala plains can be taken as a total count, as no beisa oryx population are left in their former ranges of the northern and western part of the Park. No beisa oryx was encountered outside the Ilala Sala plains during the present investigation. Moreover, local communities and Park Scouts witnessed its absence from the aforementioned areas. The herd size encountered during wet season ranged from a single male individual to 165 heads. However, during dry season, the maximum number encountered in one herd was 65 individuals. The highest population size was encountered south of Metahara - Awash highway during both seasons. Among the total, 93.3% and 98.2% of beisa oryx population were observed south of the highway during wet and dry seasons, respectively.

Table 2. Total counts of beisa oryx population in ANP during wet and dry season.

Transect number	Wet season			Dry season			Mean of wet and dry season count
	Block1 (11km^2)	Block 2 (32 km^2)	Total	Block1	Block 2	Total	
Transect 1	0	0	0	0	0	0	0
Transect 2	4	14	18	7	0	7	12.5
Transect 3	45	3	48	143	4	147	97.5
Transect 4	33	1	34	64	0	64	49
Transect 5	172	0	172	9	0	9	90.5
Total	**254**	**18**	**272**	**223**	**4**	**227**	**249.5**

3.2. Population structure

The beisa oryx populations were categorized into sex and age groups based on the observations during transect counts (Table 3). All unidentified individuals were adults, but sex identification was not possible due to the difficulty in spotting their genital organs at far distance. They were commonly observed in large groups composed of several males, females and sub-adults. Females with calves and juveniles were seen in groups.

3.2.1. Sex and age structure

Out of an average of 133 individuals sighted during the present observation period, 102 were adults of both sexes and others were sub-adults and calves (Table 3). The sex ratio of adults was female biased (1:2.46). The ratio of sub-adult to adult was 1:6.08 and calf to others was 1:8.18. There was no difference in the sex ratio observed during different seasons.

Table 3. Sex and age structure and ratio of beisa oryx population.

Categories	Number of animals (mean ± SE)		
	Wet Season	Dry Season	Average
Male-adult	33 ± 5.43	21.5 ± 5.87	27.25 ± 5.65
Female-adult	73.5 ±13.19	60.75 ± 12.44	67.13 ± 8.73
Sub-adult of both sexes	16.25 ± 2.89	17.25 ± 7.23	16.75 ± 3.6
Calf of both sexes	16.25 ± 2.25	12.75 ± 2.56	14.87 ± 1.13
Unknown	10.25 ± 1.71	4.75 ± 2.63	7.5 ± 2.38
Calf: other	1:8.18	1:8.18	1:8.18
Sub-adult: adult	1:7.18	1:5.04	1:6.08
Male: Female	1:2.23	1:2.83	1: 2.46

On average, 76.5% of the total population was adults and 23.5% constituted immature ones (calf and sub-adult). Sub-adults accounted for 10.6% and 14.25% during wet and dry seasons, respectively. Calves accounted for 10.89% of the total population (Table 3 and Fig. 4). Analysis of age structure revealed that there was no significant difference in age distribution during the wet and dry seasons ($p > 0.05$).

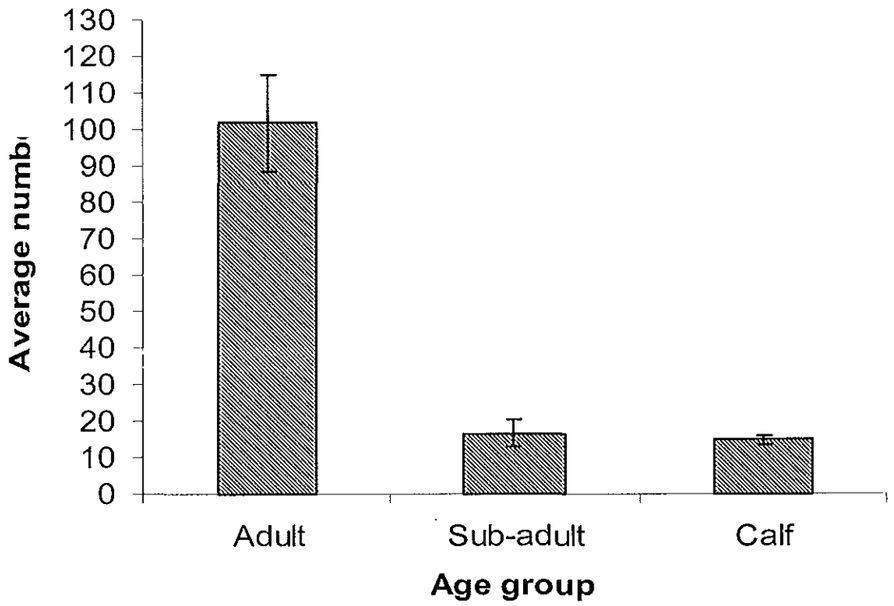

Figure 4. Age structure of beisa oryx population in ANP.

3.3. Distribution and habitat association

The distribution of beisa oryx was commonly in open grassland habitat of Ilala Sala plains in wet season. But during dry season, its distribution was extended to shrubby, wooded and bush grassland habitats. Similar distribution pattern was observed during total count as well. A comparison of the seasonal changes in habitat association shows that beisa oryx has high preference for grassland in wet season and shrubby grassland during dry season. The mean population size was 156.50 ± 28.05 and 22.5 ± 4.24 in grassland and 6.67 ± 2.26 and 71.17 ±14.28 in shrub grassland habitats in wet and dry seasons, respectively (Fig. 5).

During August and September, beisa oryx population was observed in grassland habitats. During December and January, oryx was observed more in shrubby grassland ($p = 0.001$). There was no significant difference in their occurrence in other habitat types ($p > 0.05$). However, they were observed moving to the Awash River through the bush habitat after mid-day through the airstrip and west of Kereyu lodge to drink water in dry season (November to February). In dry season, five individuals were seen heading to the Kudu Valley in December 2003. Following rains in January, oryx returned back to the grassland habitat. In February, Ilala Sala was very green and no movement of beisa oryx to Awash River was encountered.

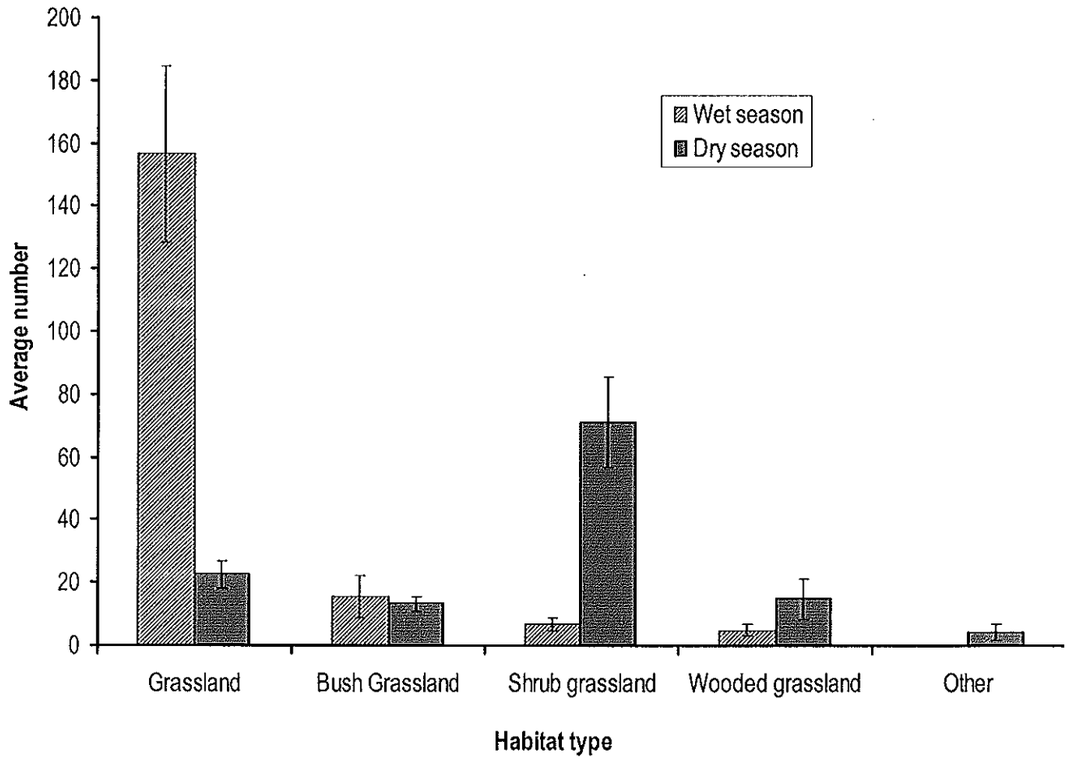

Figure 5. Observation of beisa oryx in different habitat types in ANP during wet and dry seasons.

3.4. Population trend of beisa oryx and other artiodactyls

3.4.1. Population trend of beisa oryx

Figure 6 gives trend of beisa oryx population during 1969 to 2003. During the 1969 survey, estimated population was 4020, whereas it was 446 in 2003. Its population declined at an annual rate of 3.35% between 1969 an 1992 and 8.23% per year between 1993 and 2003. Out of the biomass of artiodactyls (2244 kg/km^2), 80% accounted for beisa oryx population alone, followed by warthog

(11%) and lesser kudu (5%) (Table 5). During the present study, no beisa oryx was encountered along Hadida Daba and Dunkuku and Sabober transects, where they were present earlier. The overall population decline since 1969 is 89%, which is 2.6% per year.

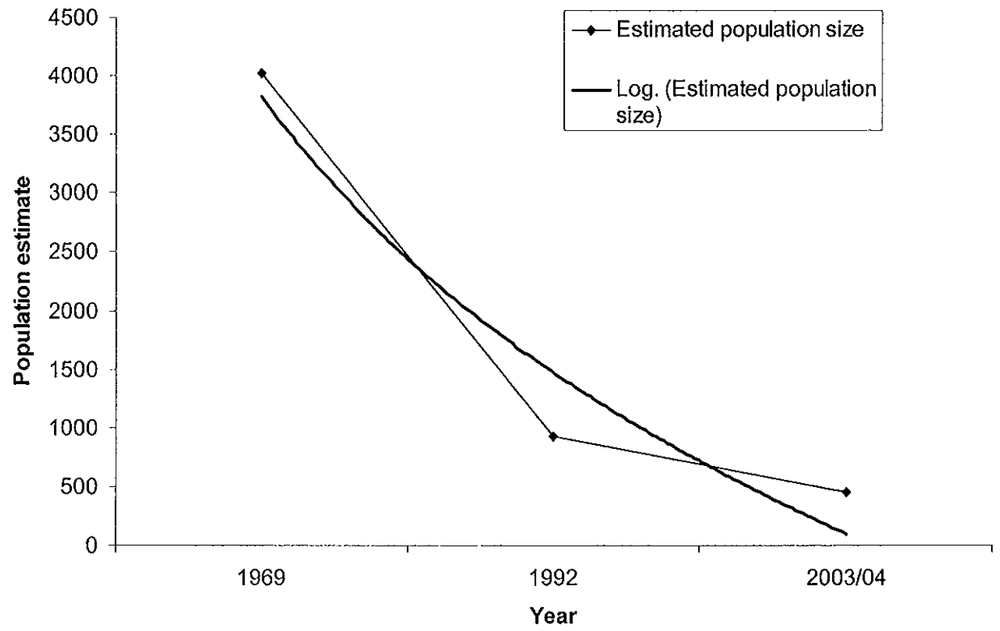

Figure 6. Population trend of beisa oryx based on population estimate from transect counts.

Figure 7 shows Population trend of beisa oryx in Ilala Sala plains based on maximum group size recorded since 1967. The total population of beisa oryx in the Ilala Sala plains is declining at a lower rate. The maximum number counted in Ilala Sala plains was 320 in 1967, 467 in 1969 and 272 in 2003. This shows that its population has declined by 15% and 42% compared to 1967 and 1969 records, which is 0.4% per year and 1.23% per year, respectively.

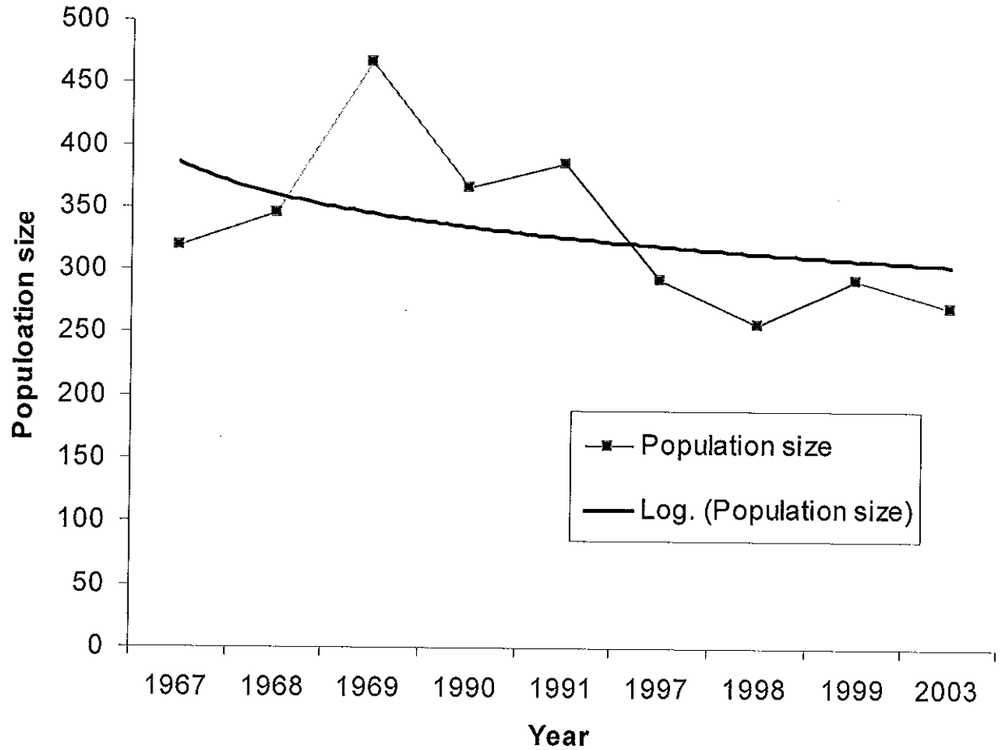

Figure 6. Population trend of beisa oryx based on observations of maximum numbers in the Ilala Sala plains since the late 1960s.

3.4.2. Comparison of age and sex structure of beisa oryx population

Comparisons of age and sex structure of beisa oryx populations of 1969 survey, 1992 survey and of the present survey (2003-04) are given in Figure 8. The age structure of the present population shows slight difference with the earlier findings. More adult males and less adult females have been recorded in the present survey compared to 1992 survey. However, less adult males and more adult females were recorded compared to 1969 survey. The proportion of sub-adults was comparatively less from both previous surveys.

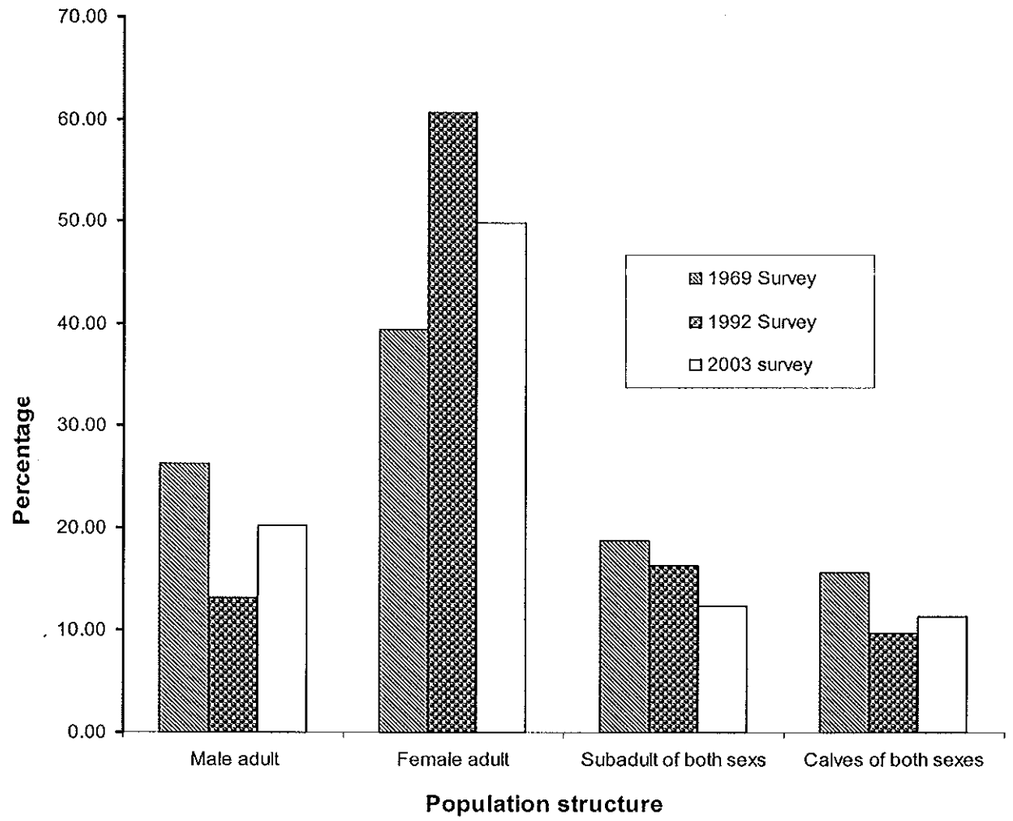

Figure 8.Comparison of age and sex structure of beisa oryx populations recorded during 1969, 1992 and the present surveys.

3.4.3. Population estimate, density, biomass and population trend of other artiodactyls

Table 4 shows population estimates of artiodactyls other than beisa oryx in ANP. Only four species were observed along transects. No population estimate was done for species observed rarely.

Table 4. Population estimates of artiodactyls other that beisa oryx in Awash National Park.

Species	Season	Average number seen	Population estimate ± SE
Soemmerring's gazelle	Wet	29.67	73 ± 12.98
	Dry	23.17	57 ± 12.11
	Average	26.42	65 ± 8.79
Lesser kudu	Wet	8	485 ± 60.61
	Dry	9	364 ± 69.99
	Average	8.5	413 ±52.14
Salt's dikdik	Wet	5.67	2990 ± 176
	Dry	4.83	2550 ± 440
	Average	5.25	2770 ± 231.44
Warthog	Wet	7	569 ± 92. 60
	Dry	5	412 ± 61.24
	Average	6	491 ± 60.84

***Soemmerring's gazelle*:** Soemmerring's gazelle was sighted only in Ilala Sala plains. During the present survey, the population estimate was 73 and 57 individuals in wet and dry seasons respectively. The average population size was 65 individuals (Table 4). Their biomass contribution was only 3.33% (Table 5). Their distribution was limited to the core area of the Park alone. The population trend shows that there was a major decline of 87% of the population during 1969-1992. Compared to the 1992 survey, the present population had declined by 70%.

Table 5. Density and biomass of artiodactyls in ANP.

Common name	Adult mean weight	1992 survey	2003/04 survey	Biomass 2003 (kg/km^2	Contribution (%)
		Density Number/km^2	Density (Number/km^2)		
Beisa Oryx	175	21.46	10.38	1816.5	79.99
Soemmerring's. Gazelle	48	5	1.58	75.68	3.33
Lesser kudu	100	2.64	1.09	109.13	4.81
Salts dikdik	3.25	14.05	7.36	23.92	1.05
Warthog	75	6.43	3.28	246	10.83
Total	401.25	49.58	23.69	2271.23	100.01

Greater kudu: This species was not encountered along any of transects during the present survey. In 1992, 84 individuals were recorded along Ilala Sala and Dunkuku transects. Only three individuals were observed by Park Scouts outside the transect line at the bottom of Fentale escarpment in September 2003. The population of grater kudu had already declined by 87% during 1969-1992 in ANP (Table 6).

***Lesser kudu*:** The population estimate of lesser kudu was 485 in wet season and 364 individuals in dry season (Table 4). The average population estimate was 413 heads. During 1969-1992, the population of this species has declined by 74% and during 1992-2003/04 the population had declined by 48%. Since 1969, lesser kudu population had declined by 89% in ANP (Table 6).

Defassa waterbuck: This species was not encountered along any of the transects during the present surveys. In 1992, 200 individuals were estimated based on the Ilala Sala and Dunkuku transect counts. It is probably near to local extinction from the Awash River canyon. Park Scouts observed only 35 individuals around the hot spring area in September 2003 (Table 6). During 1969 and 1992, their population had declined by 24% (Table 6).

***Swayne's hartebeest*:** During the total and sample counts, only a male individual was encountered in six occasions during both wet and dry season surveys. It was observed in association with beisa oryx. The Park staff agrees that it is the only remaining hartebeest in ANP.

Salt's dikdik: The average number of Salt's dikdik noticed along Ilala Sala, Hadida Daba and Dunkuku transects were 6 and 5 individuals during wet and dry seasons, respectively. The population estimate for the whole preferred habitat of the Park area was 2990 and 2550 individuals during wet and dry seasons, respectively. The average population estimate was 2270 individuals (Table 4). Its population had declined by 41% during 1969-1992 and by and by 48% during 1992-2003/04. The overall decline of their population since 1969 was 69% (Table 6).

Warthog: The total warthog population in wet and dry seasons was 569 and 412 individuals, respectively. The average population was estimated to be 491 individuals for the whole preferred habitat of the Park (Table 4). The warthog population in ANP had declined by 48% during 1992-2003/04 surveys. Since 1969 their population had declined by 53 % (Table 6). They are common around the hot spring areas.

Of all the species encountered in the present survey, beisa oryx had the highest local density, both during wet and dry seasons, followed by Salt's dikdik and warthog during both 1992 and the present survey. The species with the lowest population density was Swayne's hartebeest. Only one male individual of this species was seen during the present survey and hence no population estimation was made for the species (Table 6).

Table 6.The population number and trend of larger artiodactyls in ANP based on transect survey estimates.

Common name	Survey-wise population data					Decline between surveys (%)		
	1969	1992	2001	2002	2003	1969 -1992	1992-2003	1969-2003
Beisa oryx	4020	923	692	1395	446	77	51.68	88.91
Soemmerring's gazelle	1701	215	178	97	65	87.36	69.76	96.18
Greater kudu	670	84	NR	NR	3*	87.46	NPE	NPE
Lesser kudu	3800	995	178	189	413	73.82	58.49	89.13
Defassa waterbuck	263	200	NR	NR	35*	23.95	NPE	NPE
Swayne's hartebeest	-	5**	NR	NR	1**	NR	NPE	NPE
Salt's dikdik	9000	5297	NR	NR	2770	41.14	47.71	69.22
Warthog	1050	955	188	??	491	9.05	48.59	53.24

Note: NR= denotes No Record, NPE= No Population Estimate, * = Species observed by Scouts during the study period. ** = As to observed individuals

3.6. Attitude of local people and their impact on wildlife

3.6.2. Trends of beisa oryx population

Among the 94 selected household respondents, 72% of the people have remarked that the beisa oryx population has declined in ANP, 5% remarked that they have increased, where as 17% of the respondents remarked that there is no change in the population of this species in ANP. Only 6% of the households sampled had no idea on their population trend (Fig. 9).

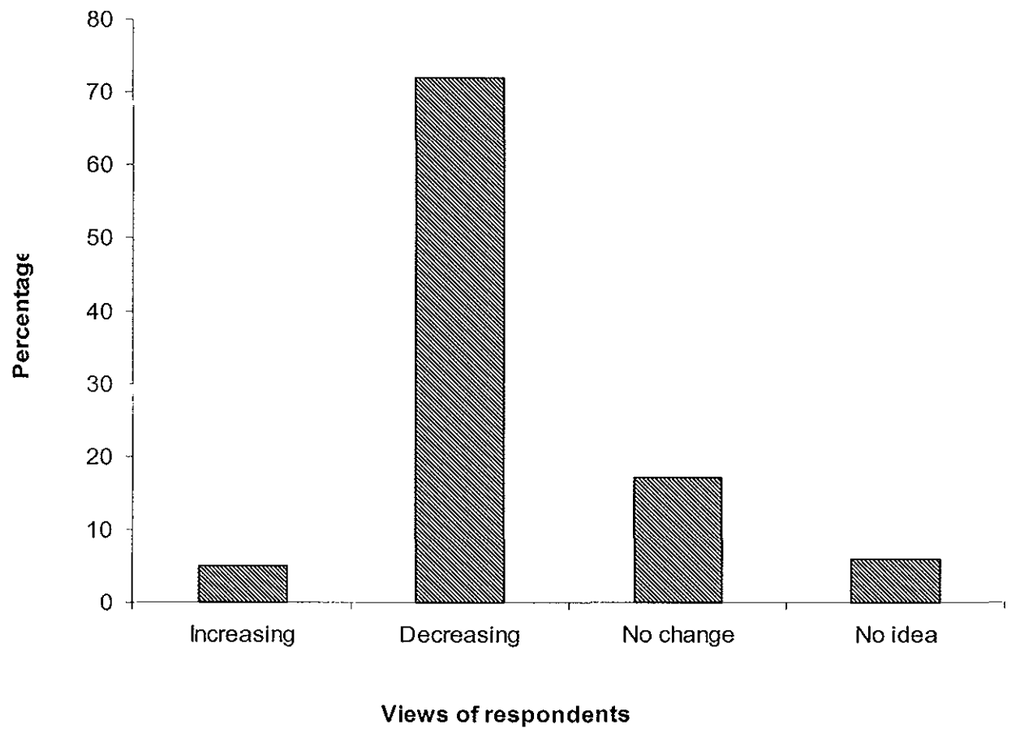

Figure 9.Views of local communities in population trend of beisa oryx in ANP.

3.6.2. Trends of other wildlife populations

Socio-economic surveys in the villages around ANP have revealed the views of villagers on various aspects concerned with wildlife populations in the Park. Most of the respondents (55%) have remarked that wildlife populations have declined in their respective areas. But, 24% of the respondents revealed that there is no change in the wildlife populations. Further, 13% of the respondents remarked that they have no idea about it. Only 7% of the respondents remarked that the wildlife populations have has increased (Table 7). There was no difference among the views of respondents from different villages ($p > 0.05$). Most respondents from the northern part of the Park revealed that most wildlife populations have declined and some like beisa oryx and Soemmerring's gazelle have already become locally extinct. Respondents from Kereyu and Ittu have remarked that these wildlife populations have not seriously declined in their respective areas.

Table 7. Views of local communities on trends of wildlife populations (sample size is given in parenthesis).

Ethnic group	Name of villages	Number of household	Percentage of respondents			
			Increasing	Decreasing	No change	No idea
Afar	Wasero	34	0	83.33 (5)	16.67 (1)	0
	Big Albete	84	0	55.56 (5)	22.22 (2)	22.22 (2)
	Small Albete	56	0	57.14 (4)	14.29 (1)	28.57 (2)
	Doho	251	0	76.67 (17)	13.33 (4)	10.00 (3)
	Dudub	70	12.50 (1)	50.00(3)	25.00 (2)	0
Oromo	Sogido	89	12.50 (1)	50.00(4)	37.50 (3)	0
	Kobo	170	27.27 (3)	54.54 (6)	9.1 (1)	9.1 (1)
	Dhaca Edu	216	0	50.00 (5)	30. (3)	20 (2)
	Galcha	153	15.38 (2)	23.11 (3)	46.15 (6)	15.38 (2)
Total			**7.46.38 (7)**	**55.31(52)**	**24.46(23)**	**12.76(12)**

3.6.3. Problem with Park authorities

Figure 10 shows the views of local communities towards the Park authorities. Among the respondents from Kereyu and Ittu, 41% had conflicts with the Park authorities, mainly related to imposition of fine for cattle grazing in the Park. However, 29% of the respondents have no problem and 27% had no idea regarding such an issue. The conflict in the southern part of the Park is mainly due to palm tree collection for sale and for production of furniture (Fig. 10).

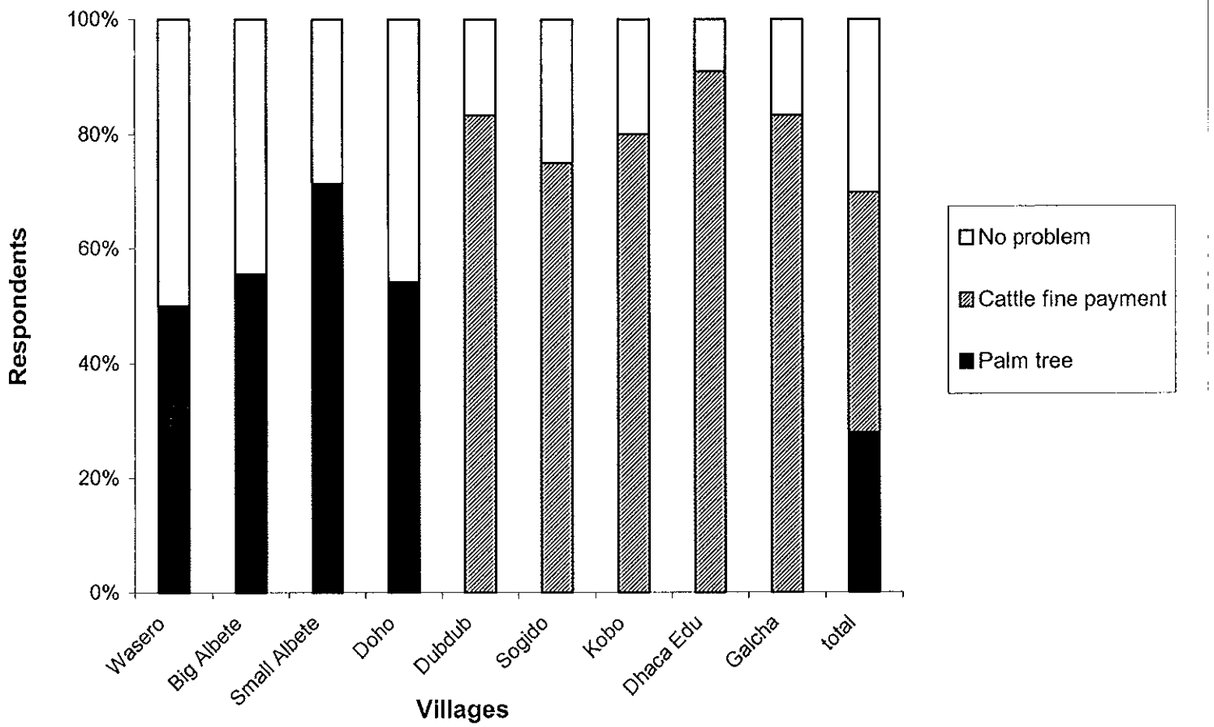

Figure 10.Views of respondents on causes of conflicts with Park authorities

3.6.4. Support for wildlife conservation

Wildlife conservation was supported by most of the respondents (96%) in the study area. Only 3% of the respondents showed negative comments on wildlife conservation. Most of the respondents supporting wildlife conservation were from villages away from the core area of the Park in the northern and eastern part of the Park. People living nearby the core area of the Park did not oppose conservation directly, but they have mentioned that they have problems in relation to fine imposed for cattle grazing illegally in the Park.

4. DISCUSSION

4.1. Beisa oryx population estimate

The result of sample count of beisa oryx population shows a significant decline in size from 4020 heads in 1969 (Robertson, 1970) to 446 in 2003. This shows a downward trend of 2.6% per year. The decline during 1992 to 2003 is more severe (4.6% per year), which is attributed to the influx of modern automatic weapons during the changeover of the military regime. Severe population decline has occurred outside the core area, particularly in Sabober plains, where more than half of oryx population used to live in the area (Robertson, 1970). Currently Sabober plains are overtaken by livestock and settlement.

The group size of beisa oryx in ANP was higher during wet season as reported earlier by other researchers (Robertson, 1970; Jacobs and Schloeder, 1993). The variation observed in the group size during wet and dry seasons was caused by the changes in resource requirements of the species in different habitats (Bergstrom and Skarpe, 1999). The quick growth of grasses and other vegetation communities immediately following rainfall are known to attract and provide sufficient fodder for artiodactyls.

The availability of green vegetation during wet season probably caused beisa oryx to spend more time on feeding and roaming in open areas, but spend less time in shades and under trees and bushes, which resulted for variation in group size. The population density of beisa oryx (10.36/km^2) is nearly half of the 1992 estimate of 21.46/km^2 (Jacobs and Schloeder, 1993). The population density was 6.7/km^2 in the 1969 survey (Robertson, 1970). This shows that there was an increase in the density of this species since 1969. But their population has considerably depleted since 1992, to almost

halve the density. All surveys were made using road count method of fixed sighting distance. The lower estimation of density in 1969 survey was due to consideration of all transects for density estimation and total population was estimated using the potential habitat of beisa oryx.

The observation of large groups in the south of the highway during both the wet and dry seasons was attributed to the availability of larger extent of and open plains with comparatively less human interference, and availability of water in the area. Due to the large number of traffic passing through the core area, wildlife species are hardly free to cross the highway during daylight. On an average one vehicle per minute is passing through the core area (Appendix 5). This might also contributed to some extent for the species to remain south of the highway to have easy access to the Awash River, particularly during dry season.

The lower rate of population decline in the Ilala Sala plains (Fig. 7) attributed to effective surveillances from the three outposts (Amareti, Geda and Sogido) and from the main camp. As a result, Ilala Sala is comparatively free from settlement and livestock grazing. However, the Addis Ababa-Djibouti highway and the parallel railway, cause considerable wildlife mortality; an average of 6 animals of different species are killed by road and rail accidents per month (Appendix 4). Thus, it is also responsible for decline of wildlife population.

4.2. Population structure

The relatively high proportion of females in the population shows that beisa oryx has a potential to increase in number. However, low proportion of calf to others (1:8.18.) observed during the present investigation shows a declining trend of beisa oryx population in ANP (Table 3). Comparatively low number of sub-adults and calves were encountered during the present survey. This may be due to the fact that number of calves could be underestimated during surveys. They are also vulnerable to predators, mainly while crossing the bush and shrub habitats between the Ilala Sala plains and Awash River. During the study period, the artificial water well was not functional and large herds of beisa oryx were forced to cross the thicker vegetation cover to reach Awash River for water. In the mean time, particularly the calves and juveniles are susceptible to predators. The grassland habitat is progressively overtaken by the bush encroachment and the remaining habitat lacks proper management. Thus, the grassland habitat may not be suitable for calves and juveniles as well, during the dry months.

4.3. Distribution and habitat association

Water and pasture condition or combinations of them are the major factors determining the distribution of wildlife populations in natural habitats (Western, 1975; Grimsdell, 1978; Balakrishnan and Essa, 1986). Late dry season is the most critical for beisa oryx population when the grass becomes completely dry and temperature becomes very hot. Almaz Tadesse (1997) noted that the crude protein content of grass falls below the maintenance level required for ruminants during dry months. It is also difficult for calves to walk up to the Awash River as predators and human induced factors are risky for them (Fanuel Kebede and Mizuno, 2000)

Data on habitat association of beisa oryx has revealed that they prefer open areas during wet season.

High quality grass food is available immediately after substantial rainfall (Almaz Tadese, 1997; Leuthold and Leuthold, 2001). Beisa oryx population was observed in open grassland areas and they spent most of the wet season in grazing and roaming together, without going to Awash River and Kudu Valley. However, when there is heavy rain, majority of oryx could leave the open grassland and move to the drier parts in the plains. This was confirmed with the observation of lower herd size in August. During the dry season, when the grass dries out, they disperse and form smaller groups. Observations in the month of February from Gotu camp and Ilala Sala plains revealed that beisa oryx form larger groups and return to the plains when there is heavy rain. They are not visiting the River so long as there is green vegetation in the plains. Similar findings was also reported by Jacobs and Schloeder (1993), Fanuel Kebede and Mizuno (2000) and also supported by experienced Park Scouts.

During the dry season, beisa oryx was found distributed widely, extending its range up to the Awash River and Kudu Valley. It was common to observe a significant population of the species in the shrubby grassland during that time. As dry season approaches, the grass gradually losses its moisture and dries up, which causes beisa oryx to look for alternative food sources and shade in the surrounding shrub and bush grasslands. Thus, the seasonal local movements of beisa oryx depends on the availability of water and pasture condition of the area. More than 200 cattle and 350 sheep and goats were observed in the core area of the Park in February 2004. This also affects the distribution of wildlife population in the area.

4.4. Population trend of beisa oryx and other artiodactyls

Beisa oryx was known to occur in large concentration in ANP than elsewhere in Africa (Jacobs and Schloeder, 1993) and found to be a key species in terms of tourist attraction in the area. Only seven

sets of data based on estimation of population size of artiodactyls are available since 1966 other than that of the present study (Robertson, 1970; Jacobs and Schloeder, 1993; Kefyalew Sime *et al.,* 1997; Mohamed Abdi *et al.*, 1998; Fanuel Kebede and Mizuno, 2000; EWCO/CARE 2001, 2002) to analyze population trend of beisa oryx in ANP. However, only Robertson (1970), Jacobs and Schloeder (1993) and the present survey followed comparable methods. Mohamed Abdi *et al.* (1998) and Fanuel Kebede and Mizuno (2000) have employed ground survey techniques but population size and density estimate were not made for beisa oryx populations. Further, EWCO/CARE (2001, 2002) surveys are based on aerial techniques and hence those data can not be compared with the present data.

4.4.1. Population trend of beisa oryx

Interpretations regarding population trend of beisa oryx and other artiodactyls should be done with caution. Robertson (1970) estimated 4020 individuals in 1969. However, total population of beisa oryx was estimated by assuming even distribution of the species throughout potential area (600 km^2) of the Park. Thus, true population size seems to be exaggerated due to the assumption of all potentially available habitats. Jacobs and Schloeder (1993), on the other hand, estimated a total population of 923 heads, which is only 23% of the 1969 estimate. They estimated total population based on the potential oryx habitat in the Ilala Sala plains only, with estimated area of 43 km^2 including grassland, shrub grassland, wooded grassland and bush grassland habitat. They also excluded all transects outside the core area (Jacobs and Schloeder, 1993).

As the present study was based on the same transects used by Jacobs and Schloeder (1993), covering approximately the same area and applying similar methods, it is assumed that the data collected in the present survey have the same level of accuracy and probability of error and thus, are fully comparable. Comparisons made with the findings of Robertson (1970) and Jacobs and Schloeder

(1993) revealed that the severe decline in wildlife population coincides with the influx of automatic rifles among the local communities in the early 1990s. Human settlement, livestock grazing and related activities within the Park have also aggravated the situation (Jacobs and Schloeder 1993; CDC, 2002).

Population of the beisa oryx in the 1970s declined mainly due to high level of poaching around Sabober and Sabure plains and the depletion of habitats around due to intensive domestic livestock and settlement. This was substantiated by interviews and discussions with local communities and wildlife experts in the area.

The present population density of beisa oryx was at a lower level compared to the findings of Robertson (1970) and Jacobs and Schloeder (1993). They used transect count along the predetermined transects and came across 4020 and 923 individuals, respectively. They calculated total population size using fixed width method (Norton-Griffiths, 1978), but the findings were not statistically analyzed. The present survey conducted based on sample count revealed the presence of 446 individuals in the study area, which is 48% of the 1992 population estimate (Table 1).

4.4.2. Population trend of other artiodactyls

A comparison made with the previous findings has revealed that the abundance of all artiodactyls have declined significantly in ANP. All species showed a downward trend of 48% to 70% compared to the 1992 survey (Table 6). Compared to the 1969 estimate, the populations of various species have declined from 53% to 96%. The severe decline of population of Soemmerring's gazelle occurred between 1992 and the present survey shows a downward trend of 6.34% per year. Comparatively less population decline was recorded between 1969 and 1992, with a downward trend

of 3.79% per year (Table 6). Its distribution is currently limited to the Ilala Sala plains, and its population has already exterminated from Sabober plains (Berihun G/Medhin, 2000). Local people remarked that they were abundant in Sabober plains, Dunkuku Valley and around the hot spring and Sabure areas.

Lesser kudu population has also declined alarmingly since the 1969 survey. The population decline is severe in the recent years. During the present survey, this species was frequently observed in the core area of the Park along Dunkuku valley and along Ilala Sala transects. The species is still distributed in all formerly used habitats. Compared to the findings of Jacobs and Schloeder (1993), it is less frequently observed along all transects. Bush encroachment occurring widely in the study area favours bush animals, but its population is declining.

Defassa waterbuck is one of the artiodactyls of the study area suffering from severe population decline and probably near to local extinction from Ilala Sala and Awash River canyon. Only mean of 5, 4 and 1 individuals of them were encountered along Ilala Sala, Hadida Daba and Dunkuku transects, respectively. In contrast to the findings of Jacobs and Schloeder (1993), no observation of the species was made during the present survey along the Ilala Sala, Hadida Daba and Dunkuku transects.

However, Park Scouts have encountered 35 individuals around the hot spring area outside the transect line, which one can observe during early morning and late afternoon. However, from the interviews and discussions made with local communities and the Park Scouts, it is possible to say that the species is no more occurring along the Awash River. Causes of population decline of this are mainly depredation along the Awash River and conflict with the state farm workers, who are responsible for crop protection. Most local communities remarked the decrease of the species due to

the severe drought during 2001-2002 years, particularly when livestock displaced waterbucks from its watering point.

Similarly, greater kudu was not observed along the Ilala Sala, Hadida Daba and Dunkuku transects in recent times. In the 1992 survey, six individuals were encountered, three along Ilala Sala transect and another three along Dunkuku transects. Although there was no observation of grater kudu during the present surveys, Park Scouts have encountered three individuals outside the transect line on the bottom of Fentale escarpment. Few individuals may also occur in the Kudu Valley, the area that was not assessed in detail during the present investigation due to time, financial and logistic constraints.

Warthog has the second largest population size in the ANP as recorded during the present survey. They are common around the hot spring area. The cultural religious taboos might have contributed for better survival of the warthog population in the area. However, they have highly suffered from vehicle accidents (Appendix 4).

4.5. Attitude of local people towards wildlife

The views of local communities revealed during the questionnaire survey are comparable with the findings of the present investigation on the decline of artiodactyls populations in the area. All respondents from the northern part of the Park remarked about such a situation. Major factors revealed by experienced Scouts and local elders as causes for decline of wildlife population are livestock grazing, poaching, settlement, road kill, and bush encroachment.

Attitude of local communities towards wildlife are important elements to ensure the long-term survival of wildlife resources. Their attitude differed widely depending on the species of the animal referred, distance from core area where they live, source of income of pastoralists and the conservation system of the area. The present investigation on human-wildlife interaction has clearly revealed that the semi-pastoralists have been facing crop raiding by wild ungulates and other wild animals. Most of the respondents believe that the decline of artiodactyls is from the northern part of the Park. One of the respondents from Wasero village was sorrowful to see that beisa oryx is vanished from their area. When the respondent was shown a picture of beisa oryx, she hammered her chest to express the intensity of her sadness, but when shown a picture of lion, she hammered the picture of a lion in the book and became annoyed. Most of the respondents feel that the populations of predators, particularly lion, have increased and they are losing their livestock frequently, in recent years.

Conflict with Park administration is related to imposition of fine for cattle grazing in the core area. Most local communities need to graze in the Ilala Sala plains during the dry season, which is the only refugee for beisa oryx and other artiodactyls. There is strong surveillance by Park Scouts, and

hence pastoralists cannot freely graze their cattle during daytime. If they graze within the core area, their cattle would be detained and the Park administration charges 10 birr per cattle to release. However, several livestock were seen grazing in Ilala Sala plains during night time.

No beisa oryx was observed in areas where there is intensive grazing and settlement in the area, as livestock exerts negative impacts on wildlife (de Leeuw *et al.*, 2001). Surprisingly, most local communities, even Kereyu, Ittu and Dudub, who came into conflict with Park authorities, support wildlife conservation.

4.6. Major threats to artiodactyl populations

Habitat loss and fragmentation: The only suitable habitat left for beisa oryx and other artiodactyls is the Ilala Sala habitat, which is not seriously changed over the years, compared to the other part of the Park area. Most of loss of habitat types and species composition occurred mainly due to intensive livestock grazing, which led to disappearance of high forage species and encroachment of shrubs and trees (Jacobs and Schloeder, 1993; CDC, 2002). The expansion of large-scale farm in the upper and middle Awash Valley resulted for a major loss of critical dry season grazing resources for Kereyu, Ittu and Afar pastoralists. This has been responsible for increased livestock pressure in ANP. Lose of grazing land has resulted in overstocking and severe habitat degradation and fragmentation over the remaining grazing areas.

Pastoralists also lost their grazing land due to the expansion of Lake Beseka, which covers over 35 km^2. Recently, there is a plan to drain the lake to the Awash River so as to protect the habitat around the lake from submergence as a result of further expansion of the lake.

Depredation: Depredation is becoming increasingly a serious problem for both livestock and wildlife. During the present investigation, three lions were encountered along the Dunkuku transects. Hyaena calls were common during the study period. It was one of the species frequently killed by vehicles collision along the highway. Droppings were common, on transects, which substantiated its abundance in the area. However, due to the sever decline of artiodactyl populations in the area and other human induced factors the current predator population is likely to decline as well.

Park Scouts remarked that carnivores were observed in the core area of the Park, mostly at the watering routs. As the artificial waterhole is not functional since late 1980s, the chance of depredation of oryx is high on their march in search of water.

***Poaching*:** Poaching, along with physical displacement played a significant role in the reduction of larger artiodactyl populations in ANP (Jacobs and Schloeder, 1993). Discussions with local communities and Park experts have revealed that poaching had a more significant impact for disappearance and population decline of larger artiodactyls n the northern part.

Discussions with Park experts revealed that "hidden" poaching is conducted in the ANP. No carcasses and signs of poaching were observed during the study period. This does not mean that the animals are not poached in the area. Poachers may hunt wild animals and hide carcasses not to be seen by Park Scouts to minimize conflict with Park authorities. Local communities are engaged in shooting of cope raiding wild animals, which also aggravate wildlife population decline. There was one occasion when the Park Scouts suddenly met with poachers along the Awash River with one hunted beisa oryx (Fanuel Kebede and Mizuno, 2000). Poaching was indirectly substantiated by one of the respondents from Dudub, during the interview, who said that "we lost our pasture because of the establishment of ANP, thus prayed to God to finish all wild animals in the Park so that all Park

authorities would go away and we would get our land back". It is this resentment towards the Park that makes hidden poaching in ANP.

Wildlife - vehicle collision: Amareti highway survey by Jacobs and Schloeder (1993) revealed 482 vehicles per day, which equals to 14,460 vehicles per month. The number of vehicles passing through has increased by nearly three-fold in the recent years, which could cause more wildlife mortality. The mean number of vehicles crossing the core area is 1387 per day, which equals to 41,610 vehicles per months. Most drivers use early morning and late afternoon hours to drive in cooler time, which is also the active time of diurnal wild animals. Records of wildlife mortality show that the number of kills is comparatively less when compared to the earlier data (Appendix 4). But this does not necessarily mean that wildlife mortality due to negligent drivers has reduced.

There are several hypotheses to be drawn for further investigations. The major reasons may be due to the severe population decline of artiodactyls in the area, which reduced the frequency of wildlife-vehicle collision. Public awareness through reminders and advertisements may have resulted in careful deriving at least by some of the drivers. Informal discussions with drivers have revealed that most of them try to save wild animals mainly to avoid possible damage of vehicles. One small truck driver had remarked that large truck drivers are responsible for intentional wildlife kill along the highway. The other reasons could be that wildlife species by experience have learned to save themselves while crossing, and would try to cross the road when traffic is less. It is hardly possible for wild animals to cross the highway, as nearly one vehicle per minute is crossing the core area Appendix 5).

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The present population of beisa oryx is estimated to be 446 ± 58.38 heads. This shows significant decline compared to the previous estimates (Robertson, 1970; Jacobs and Schloeder, 1993). Population decline in the northern and western part of the Park was attributed to high level of illegal poaching and displacement due to intensive livestock grazing and settlement. The population decline in the core area was comparatively less, as there is better surveillance and as the area is comparatively free from human settlement and livestock grazing. However, the population suffers from bush encroachment, vehicle collision, seasonal livestock grazing, depredation and poaching. Kereyu, Ittu and to some extent Dudub pastoralists seasonally graze in the core area and come into frequent conflict with Park authorities.

The relatively high level of breeding females in core area showed that there is high potential for population increase. However, the observation of low percentage of calves revealed that there is high level of calf mortality due to high level of depredation, habitat change, and drought or as a result of cumulative effect of all these factors.

The current population estimate of other artiodactyls found to be 65 Soemmerring's gazelle, 413 lesser kudus, 491 warthogs and 2770 Salt's dikdik. There was no observation of waterbuck and greater kudu along any of these transects during the present survey. Only one hartebeest was encountered during both total and sample counts. Severe decline of all artiodactyls occurred outside the core area.

Discussions with local communities and elders and experienced Park authorities have revealed that livestock grazing, settlement, cultivation, tree cutting, uncontrolled fire and vehicle accidents, were

major problems responsible for population decline. Intensive livestock grazing resulted in overgrazing and competition for food, which eventually led to habitat degradation and bush encroachment. It was evident that the pastoralists see no benefit from the Park. They pay fees when cattle were caught inside the core area, which most pastoralists believe as traditional rotational grazing area for dry and drought seasons. This has aggravated the conflict between pastoralists and Park authorities. They also claim that they have a right to utilize the natural resources in their area.

5.2. Recommendations

- The population status of beisa oryx and other artiodactyls have declined in ANP alarmingly, mainly due to adverse human activities and livestock grazing. Thus, there is an urgent need to take immediate measures against those threats to halt the severe wildlife resource depletion in this well-known and prestigious National Park of Ethiopia.

- The problems of bush encroachment, livestock grazing and settlement are becoming increasingly serious. Thus, conservation efforts should focus on halting further destruction of the habitat, reducing vehicle accidents and should halt further expansion of settlements, to ensure long-term survival of wildlife resources in the area.

- Beisa oryx may also suffer from depredation, mainly as it goes to the Awash River in search of water during the dry season. The nature of the habitat contributes to the hunting success of the predators in the thick bush habitat. Predators could easily trap calves and juveniles. Thus, rehabilitation of the formerly established artificial water well is relevant to secure the survival of the species, particularly, infants. However, care should be taken not to attract domestic livestock into the artificial water well area, when it is reestablished.

- There is only limited data on the population and ecology of most of the artiodactyls in ANP. Constant and long-term investigations on ecology and populations of artiodactyls are essential to pinpoint ecological problems and to safeguard the habitat. Regular monitoring of indicator species is required to establish corrective measures, on time. More detailed investigations are required to determine the contribution of the various human induced factors responsible for the decline of wildlife population in the area.

- Wildlife management should focus in the eastern and southern part of the Park, with well-equipped and trained management staff. It is important to promote income-generating alternatives for the local communities. Bee keeping, wildlife ranching and tourism development could hopefully lift some of the human pressure in the area.

- There is an urgent need to have up-to-date wildlife policy, and relevant legislation and conservation of the Park habitat and wildlife must incorporate law enforcement, awareness raising programs.

- If immediate action is taken to halt the severe decline of artiodactyl population in ANP, most wildlife species are not beyond the limit of recovery, excluding Swayne's hartebeest, as they are well represented in the core area in considerable numbers. If properly managed and wildlife populations increased, income from tourists visiting the Park would enhance and sport hunting around the ANP might generate considerable income in the near future. This could be realized only through sound wildlife management interventions in collaboration with relevant stakeholders, particularly with local communities.

- As ANP is the best refugee for beisa oryx population and other artiodactyls in Ethiopia, as well as the second Important Bird Area of Ethiopia and one of the only two legally gazetted National Parks, which is also easily accessible for tourist viewing, all stakeholders should collaborate to safeguard the diverse habitats and prestigious wildlife resources in ANP.

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APPENDICES

Appendix 1. Questionnaire

1. Background information

1.1. District ----------
1.2. Village---------
1.3. Name of the house hold---------
1.4. Sex
1.5. Age----------
1.6. Ethnic group-------
1.7. Religion-------
1.8. Marital status -----If married, no. of wives---------
1.9. House hold head---------Children grade: 1-3----------; 4-6--------read and write-------Illiterate---
1.10. How long have you lived in the area? ----------
1.11 Occupation--------
1.12. Source of income: 1. Herding----------2. Farming----------3. Trading----------4. 1 & 2-----
5. 2&3---------6. 1&3---7. Selling of firewood and charcoal 8. Others, specify-
1.13. If farming, type of crops ---------- ---------- ----------Size of farm land--------
1.14. Type of farming: 1. Rain fed, 2. Irrigated, 7.3.Both
1.15. Is there any problem related to farming activity? Yes/No If yes what is the problem?----

2. Livestock number and seasonal grazing area

2.1. Do you have livestock? If yes, type and number: Cattle/Sheep/Goat/Camel/Others----
2.2. Have you sold livestock for the last 12 months? Yes/ No. If yes, type and number:
2.3. What is source of meet for the family?
2.4. What was the trend in livestock numbers for the last 10-20 years? Increasing/ Decreasing/Stable. If decreasing, please specify reasons for the decline? Lack of grazing land and watering point/change in vegetation composition, drought /others, please specify.--
2.5. Have you lost livestock recently? If yes, type and number? Cattle/Sheep/Goat/Camel/Others2.6. Do you have grazing land? If yes; communal/private/contractual.

3. Park-people interaction

3.1. What is the impact of the Park on the livestock?
3.2. Access/Reduced livestock grazing land/Predation/Cattle fine payment/ others------
3.3. Is there any benefit obtained from the Park? Yes/No. If Yes, in what form? Employment/Fuel wood collection/ grazing /benefit from tourist income/Others----------
3.4. Do you practice hunting? Yes/No. If Yes, which animal? Why? For what purpose?

3.5. What about at present? Any conflict with the Awash National Park? Yes/No, If yes, please specify the reason. What was the effect of the conflict on the house hold? How was the dispute resolved? ----------

3.6. What do you think to improve Park-people interaction? ----------

3.7. Do you know this animal (show picture of Beisa oryx) in your language? -----

3.8. Where can Oryx be found? Wet season---------Dry season----------The whole year------

3.9. Do you know the reason for their movement? ----------

3.10. Have wild animals ever raid your crops? Yes/No. If yes, which animal? ------Which season? ----------

3.11. What control measures been taken? ----------

3.12. Do you think populations of the following ungulates are increasing? Decreasing? Stable?

Defassa waterbuck----------Reedbuck----------Others--------

3.12. If declining, what do you think the reasons for the population decline? ----------

3.13. Poaching/Predation/car accident/ Lack of space for grazing and watering point/ wildlife vehicle collision/others---------- put in rank from high to low

3.14. Is there any change in population distribution of Beisa oryx compared to 10-20 years back? If yes, please specify their previous distribution and causes for change.

4.4. Attitude of selected household towards wildlife conservation

4.1. Do you think that wild animals should be conserved? If yes, why? ----------

4.2. What are the best mechanisms for managing wildlife? ----------

Appendix 2. Wildlife census sheet

Place: ---------- Date: ---------- Transect number: -----

Starting time: ----------Stopping time: ----------Starting km: ----------Stopping km: ---------

Observers: 1----------2----------3----------

Time	Distance in km	Total seen	Sighting distance (m)	Ma	Fa	Sa	Cf	Un	Habitat type	Activity

(Ma = Male-adult, Fa = Female-adult, Sa = Sub-adult, Cf = Calf, Un= Unknown)

Appendix 3. Analysis of habitat association using descriptive one-way ANOVA.

Habitat type		Sum of Squares	df	Mean Square	F	Sig.
Grassland	Between Groups	53868.00	1	53868.00	22.305	.001
	Within Groups	24151.00	10	2415.100		
	Total	78019.00	11			
Bush grassland	Between Groups	14.08	1	14.08	.094	.766
	Within Groups	1502.16	10	150.21		
	Total	1516.25	11			
Shrub grassland	Between Groups	8979.26	1	8979.26	11.702	.009
	Within Groups	6138.83	8	767.35		
	Total	15118.10	9			
Wooded grassland	Between Groups	259.20	1	259.20	1.820	.219
	Within Groups	996.80	7	142.400		
	Total	1256.00	8			
Others	Between Groups	.000	1	.000	.000	1.000
	Within Groups	158.00	3	52.667		
	Total	158.00	4			

Appendix 4. Wildlife mortality along Metahara Awash highway and year of observations.

Species	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	During the study period 2003
Beisa oryx	9	4	4	6	6	4	2	5	3	5	1	-	4	2
Lesser kudu	4	7	5	-	-	1	4		2	1	-	6	8	3
Soemmerring's gazelle	6	-	-	-	-	-	-	-	-	-	-	1	-	0
Salt's dikdik	10	26	13	2	2	2	3	-	-	-	-	1	1	0
Warthog	25	23	5	6	2	2	6	2	14	8	3	3	5	2

Appendix 5. Number and type of vehicles crossing Ilala Sala plains (compute using descriptive one-way ANOVA.

Time (GMT)	Vehicle type (mean with Standard Error)									
	Passenger cars		Small trucks		Public transport		Larger trucks		unknown	
	Mean	SE	Mean	SE	Mean		Mean	SE	Mean	SE
0-1	1.00		20.00	6.28	0.00		1.75	0.25		
1-2	1.50	0.50	16.50	5.85	0.00		0.85			
2-3	1.00		13.75	2.95	1.00		1.00			
3-4	1.00		10.75	0.75			2.50	0.85		
4-5	1.75	0.47	10.50	1.19	0.50	0.50	6.50	1.32		
5-6	3.75	0.47	15.50	0.96	4.50	0.64	20.00	2.12		
6-7	8.50	1.80	24.00	1.60	7.50	1.04	23.00	2.61		
7-8	8.50	0.64	15.75	2.25	6.25	0.63	26.00	5.59	1	
8-9	14.75	0.63	17.50	3.84	10.50	0.96	27.75	1.11		
9-10	13.75	1.31	22.50	1.76	9.75	1.31	30.00	3.49		
10-11	19.75	2.14	27.75	6.79	13.75	1.49	34.75	5.23		
11-12	19.50	1.55	16.50	4.66	15.50	2.06	39.75	8.46	1.50	0.50
12-13	15.25	2.02	13.00	1.58	13.75	1.55	28.50	5.32		
13-14	11.75	1.44	12.25	2.39	10.50	0.65	20.50	1.55	2.00	0.00
14-15	15.50	2.10	23.00	4.42	8.50	1.71	28.50	0.65	1	
15-16	16.50	0.65	18.50	2.33	6.25	1.55	32.00	2.04		
16-17	16.75	2.63	18.75	2.56	9.00	1.96	29.00	4.34		
17-18	20.50	4.41	23.25	1.75	7.00	0.91	37.00	3.37	1.50	0.50
18-19	11.50	1.85	27.75	3.50	5.00	1.08	48.50	6.59	1	0
19-20	6.00	1.08	27.75	3.45	4.75	0.85	35.50	4.37		
20-21	4.50	1.32	16.75	0.95	3.00	0.58	27.25	1.03		
21-22	1.75	0.75	21.75	5.85	2.00	0.41	26.50	1.66		
22-23	1.50	0.50	19.25	4.39	1.00	14.25	2.87			
23-24	1.00		25.75	4.33	1.00	4.25	0.85			