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Department of Animal Science and Food Processing in Tropics and Subtropics (DASFPTS)

Spatial distribution and population dynamics of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park, Ethiopia

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1. Introduction: Methods of mapping and population assessment
2. Aim of the Thesis
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    a. Site description – Nech Sar, Ethiopia
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4. Results
5. Discussion

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Thesis Declaration

I hereby declare that I have authored this thesis independently and without use of others that the indicated resources.

All passages which are literally or in general manner taken out of publications or other resources are marked as such.

Date	Signature
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Table of content

1. Abstract

<u>Title:</u> Spatial distribution and population dynamics of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park, Ethiopia

<u>Author:</u> Bc. Pavla Vymyslická

<u>Abstract</u>:

Ethiopia is one of the few countries in the world, which possess a unique and characteristic fauna with a high level of endemicity. It is ecologically diverse country and home of several unique habitats. 277 mammalian species are known in Ethiopia of which 31 mammal species are endemic - Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) is one of them.

By the 1960s Swayne's hartebeest was thought to be extinct in Somalia and remained in only very limited numbers in Ethiopia. The Swayne's hartebeest are in greater danger of extinction now than any other time in the past, because of spatial competition between them and agricultural expansion. Unfortunately, very few is known about this subspecies.

This study was carried out in Nech Sar National Park in Ethiopia. The total number of 35 hartebeests was counted, 23 of them formed the main herd, 3 males stayed together in temporary herd and 9 were solitary males. In the population were counted 18 males and 17 females, whereas the main herd consisted of 17 females (11 adult, 3 sub-adults, 1 juvenile, 2 calves) and 6 males (1 dominant adult male, 3 sub-adult males, and 2 calves). The temporary herd consisted of 1 adult male and 2 sub-adult males.

Behaviour of hartebeest in Nech Sar can be divided in to three parts. In the morning and evening, they were usually more active. Principal activities were grazing and moving. During the day, they mostly stayed calm and were chewing. From spatial distribution study is demonstrable that hartebeests prefer area without human activities or with minimum human interference as well as cattle interference.

Although the number of Swayne's hartebeest in Nech Sar during summer 2007 was higher than in previous year, it does not mean any valuable success. The population still needs to be deeply studied and above all protected from human impact, especially cattle pastures that change and destroy their habitat.

<u>Keywords:</u> Swayne's hartebeest, *Alcelaphus buselaphus swaynei,* population structure, behaviour, Nech Sar National Park

1. Abstrakt

Téma: Prostorové rozšíření a populační dynamika buvolce Swayneova (*Alcelaphus buselaphus swaynei*) v Národním parku Nech Sar, Etiopie

Autor: Bc. Pavla Vymyslická

Abstrakt:

Etiopie je jedna z mála zemí světa, která nabízí jedinečnou faunu s vysokým množstvím endemických druhů. Je to ekologicky velmi rozmanitá země, což dokazuje přítomnost 277 druhů savců, z čehož je 31 endemitů - buvolec Swayneův (*Alcelaphus buselaphus swaynei*) je jedním z nich.

V 60. letech 20. století vyhynul buvolec Swayneův v Somálsku a následně byla jeho přítomnost potvrzena jen v malých počtech v Etiopii. V dnešní době je jeho existence ohrožena více než kdy předtím, jelikož je postupně vytlačován ze svého přirozeného prostředí stále expandujícími zemědělskými aktivitami, především pastvou dobytka. Bohužel je o tomto poddruhu buvolce dostupných stále jen velmi málo informací.

Tato studie probíhala v Národním parku Nech Sar, v Etiopii od června do září 2007. Celkem bylo napočítáno 35 jedinců: 9 solitérních samců, 23 jedinců tvoří hlavní stádo a 3 samci jsou seskupeni v dočasném stádě. Populace se skládá z 18 samců a 17 samic. Všechny samice jsou součástí hlavního stáda (11 dospělých, 3 subadultní, 1 juvenilní, 2 mláďata), které je doplněno 6 samci (1 dospělý, 3 subadultní, 2 mláďata). Dočasné stádo je tvořeno 1 dospělým a dvěma subadultními samci.

Chování buvolců v Národním parku Nech Sar můžeme rozdělit do tří časových úseků. V ranních a večerních hodinách jsou převážně aktivnější, převažuje pasení a různé druhy pohybu. Přes den jsou většinou klidnější a převažující aktivitou je přežvykování. Ze studie prostorového rozšíření je patrné, že buvolci preferují prostory bez nebo s minimálním zásahem člověka, stejně tak dobytka.

Celkový počet buvolců Swayneových v Národním parku Nech Sar, který je v roce 2007 vyšší než v předchozím roce, není zárukou úspěchu. Populace vyžaduje další studie a měla by být chráněna před aktivitami člověka, především vlivem pastvy dobytka.

Klíčová slova: buvolec Swayneův, *Alcelaphus buselaphus swaynei,* struktura populace, chování, Národní park Nech Sar

2. Introduction

A population is composed of the individuals of a single species within a given area. A population's boundaries may be natural ones imposed by the geographic limits of suitable habitat, or they may be defined arbitrarily for the purposes of scientific study. In either case, a population has a population structure, which includes features such as the density, spacing, and movement of individuals, the proportion of individuals in different age classes, genetic variation, and the arrangement and size of areas of suitable habitat, all of which may vary in space and time (Ricklefs *et al.*, 1999).

Ecologists study populations for many reasons. Population studies hold the key to saving endangered species, controlling pest populations, and managing fish and game populations. They also offer clues to understanding and controlling disease epidemics. Finally, the greatest environmental challenge to biological diversity and the integrity of the entire biosphere is at its heart a population problem – the growth of the human population (Molles, 2008).

At present populations of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) are found only in three localities in Ethiopia, namely Senkelle Swayne's hartebeest Sanctuary, Nech Sar National Park and Mazie National Park. The Status of the animal is classified as "imminent danger of extinction" by IUCN (IUCN, 2007). With the lack of information about this species, it is the reason for detailed studies of hartebeest and their behaviour to gain detailed studies about their life and needs to save them from extinction.

In spring 2007, I got the chance to study one of the last living populations of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park in Ethiopia.

My study is based on the data collected during the survey from 23rd June to 11th September 2007 and it is an overview of population structure, age and sex determination as well as spatial distribution and diurnal activities of the Swayne's hartebeest in Nech Sar. Basically, I search for available information about this species and with results gained after processing data gotten during the field survey I have review of the Swayne's hartebeest population in the park and I am be able to understand some of their behavioural patterns.

I believe that he accomplishment of this work will be helpful for the park management and its decisions on the population of Swayne's hartebeest in the park as well as for persons interested in Swayne's hartebeest problematic not only in Nech Sar National Park.

3. Aim of the Thesis

In my work, I focused on two basic tasks: monitoring of the population and understanding of home range/habitat utilization and animal movements. These tasks were for better lucidity divided as written bellow.

3.1 Monitoring of the Population

- Confirmation of the population size of Swayne's hartebeests in NSNP
- Determination of age and social structure of the population
- Population dynamics estimation
- Identification of individuals in the population

3.2 Understanding of home range/habitat utilization and animal movements

- Study of diurnal activities
- Study of spatial distribution and habitat use of Swayne's hartebeest in NSNP
- Study the interactions between Swayne's hartebeests and external factors who can influenced their distribution:
    - Cattle or other livestock
    - Other wildlife – zebras, gazelles…
    - Road (influence by tourism, cars, peoples, etc…)
    - Presence of local inhabitants in the field

4. Literature overview

4.1. Study area

4.1.1. Basic information

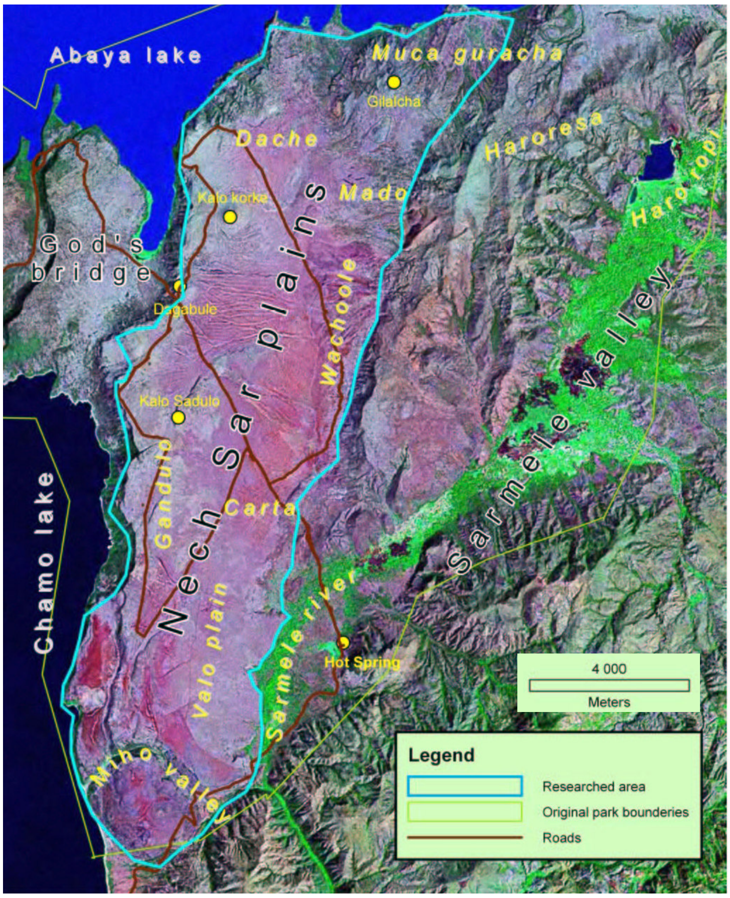
Ethiopia experienced colonialism only for five years (1936-1941). Although international conservation agencies have supported its wildlife management financially and technically, it has been the Ethiopian government that mainly planned its conservation policy. Most conservation areas were set up in the socialist regime (1974-1991). It had provided no means for the local people to maintain access to the land and manage natural resources in the conservation areas. This has contributed to the destruction of conservation facilities, mostly at the hands of the local people when the socialist regime was toppled in 1991. Since then, the local people have competed with the conservation agency, especially with Ethiopian Wildlife Conservation Organisation (EWCO), over land and natural resources. There have been few case studies and conservation projects focusing on the community where people are living in the vicinity of the conservation areas (Nishizaki, 2004).

Map 1 Location of Nech Sar National Park in Ethiopia

Nech Sar National Park (NSNP) is located in the Southern Nation Nationality and Peoples Regional State (SNNPRS) of Ethiopia, right after the eastern edge of Arba Minch town, at about 510 km south of Addis Ababa, along the main road to Jinka (Map 1). The park lies within the floor of the Great Rift Valley and extends from 5°51´ N to 6°50´ N and 37°32´ E to 37°48´ E with an elevation varying between 1 108-1 650 meters above sea level. It covers an area of 514 km^2 of which 85% is land and 15% is water (African Parks (Ethiopia) Ltd., 2007).

NSNP can be characterized by relatively hotter climatic conditions, where lower and unevenly distributed rainfall pattern and regularly higher temperature are typical. Annual rainfall follows bi-modal systems and averages 880 mm, mostly falling in March, April and May (long season) and between September and November (short season). The temperature ranges from 12,2 to 34,3 °C. The soil type in most parts of the low lying grassy plains, forest and bush land habitats are black cotton where as the rugged mountainous parts have brown calcareous loam soil derived from volcanic rock (African Parks (Ethiopia) Ltd., 2007).

Map 2 Nech Sar National Park - basic orientation map (location of key areas and spots)



Nech Sar is fortunate in possessing a number of water basins, which by and large contribute to the diversity of the wildlife resources. It is bounded by Lake Abaya (1200 km^2, largest in the Rift system of the country, murky brown water) to the north and by Lake Chamo (328 km^2, biologically most productive, blue water with white sand) to the south. The park incorporates the shore of these two lakes (78 km^2) for the conservation of aquatic biodiversity. Besides, there is a small fresh water lake located in the northeastern part of the park locally called Haroropi, “Lake of Hippo”. There are also different tributary rivers and streams to the lakes that support the park wildlife. The eastern border of the park extends to include the Nech Sar plains (Map 2) and Sermelle Valley at the foothills of the spectacular Amaro Mountains (African Parks (Ethiopia) Ltd., 2007).

4.1.2. History

Nech Sar National Park was designated by the Ethiopian Government in 1974 and has a great diversity of habitats and vegetation, including a small but biologically rich groundwater forest. The forest surrounds a series of natural springs that supply water to the town of Arba Minch and flow into the savannah, bush land and lowland gallery forest of the Sermelle Valley. The Nech Sar Plains at the heart of the park are covered in open grassland and acacia savannah. The steep escarpments and ridges to the east of the park – the Amaro Mountains – mark the fault lines and volcanic extrusions associated with the formation of the Rift Valley. The wetlands along the shores of Lakes Abaya and Chamo support herbaceous freshwater swamps and aquatic vegetation. The town of Arba Minch, with a population approaching 100 000, is situated directly to the west of the park's boundary. The tribal associations of the communities most closely connected with the park are the Kore and the Guji (African Parks (Ethiopia) Ltd., 2007).

In 1967, a proposal was made to establish Nech Sar National Park. The park was never gazetted but has operated as de facto National Park since then. It is an area of great natural beauty and consist of important wildlife resources, the attractive land formation lakes Abaya and Chamo, the ecological features of the valleys of the Kulfo and Sermelle rives, the aquatic flora and fauna of parts of lakes Abaya and Chamo, 9,8 km^2 of lowland riverine forest and the springs that give Arba Minch ("Forty Springs") its name (Freeman, 2006).

At the time of the park's formation there were only few people living within its boundaries. Shortly after the Park was formed, few Ganta farmers returned to their communities in the Gamo Highlands, while the small numbers of Guji and Kore continued to live and farm in and around the Park (Freeman, 2006).

During the 1980s, the military regime forcefully evicted people from the park. Houses were burned and property was destroyed. But when the regime collapsed in 1991, people were quick to return to the park. Large numbers of Guji and Kore people entered the park during the tie of transition and this sudden increase in the number of people in the park began to have adverse effects on the park's ecosystem. In 1994 the Federal Government of Ethiopia signed a financing agreement with the European Union for project worth 16 million to rehabilitate three parks in Southern Ethiopia, including Nech Sar. The project would proceed if a number of preconditions were fulfilled on the Ethiopian side. These include, among other things, the resettlement of the now quite sizeable communities living in the park (approximately 500 Guji families and 500 Kore families, representing a total of some 7000 people). Various studies were carried out at this time regarding proposed resettlement plans for Guji and the Kore. But the people themselves, particularly the Guji, were strongly against any resettlement. No agreement could be reached and eventually the resettlement plans slowly died. The EU project was never implemented and the park remained in much the same stage of poor management throughout the 1990s (Freeman, 2006).

In February 2004 African Parks took over a management contract for Nech Sar Park. The agreement was signed between the Southern Nations, Nationalities and Peoples` Regional State (SNNPRS), the Government of the Federal Democratic Republic of Ethiopia (represented by the Ministry of Agriculture) and African Parks (Ethiopia) Ltd. The agreement states the rights and responsibilities of African Parks include park management and also community involvement and development. The responsibilities of the Government include resettling people living in the park (Freeman, 2006).

Although the agreement was signed in February 2004, it was agreed that it would only be implemented once Government had completed the resettlement of the people from the park. The SNNPRS were responsible for resettling the Kore people and any other people from Southern Region, while Oromia Region was responsible for resettling the Guji Oromo people (Freeman, 2006).

During 2004, the Kore people were resettled in Albudo and Alfecho, some 15 km south of the park. The resettlement of the Guji people is taking somewhat longer and they are still currently residing in the park. However, on the basis that the resettlement had started, African Parks agreed to take over management control of the park on 1st February 2005 (Freeman, 2006).

When African Parks assumed management for Nech Sar, its environment was highly degraded. The Nech Sar Plains and surrounding woodlands had been excessively encroached by invasive plant species and the small but rare groundwater forest had been subjected to unsustainable illegal harvesting of wood for use as fuel and construction material. In addition, over fishing in Lake Chamo was having a devastating effect on the wellbeing of aquatic life, including the Nile crocodile, wetland birds and fish, which are an indispensable natural food base for these species (African Parks (Ethiopia) Ltd., 2007).

According to APF report from 7th December 2007 African Parks Network has decided to terminate its management activities in Nech Sar National Park. In the first two years of the APF's project in Nech Sar the authorities made little progress with negotiating an acceptable compromise to the mutual benefit of both the community and the park. Therefore this year (2007) African Parks decided to make a concerted effort to negotiate, with independent specialist advice, an agreement with the Guji on the limits of use of the park. External organisations were invited to participate in and witness the negotiations. To an extent this process was successful, and a formal agreement was reached on 30th September 2007 with the Guji defining a core area which would be free from both people and cattle, with use permitted in the remainder of the park. The authorities were requested to recognise this agreement as an acceptable and practical compromise for the benefit of both people and nature. This recognition has not been forthcoming. Therefore African Parks has decided that it shall terminate all operations in Nech Sar (African Parks Foundation, 2007).

4.1.3. Vegetation

The park can be categorized in to five major habitats based on the dominant vegetation type.

From eastern shores of the lakes, there is an abrupt rise into the "white grass" plains that are the dominant feature of the park, cover an area of 10 000 ha and are covered by the grass *Chrysopogon aucheri* that whitens during the dry season and grows on friable black cotton soils. These larger, central plains support a population of zebra, Swayne's hartebeest, gazelle and other plains game (African Parks (Ethiopia) Ltd., 2007).

To the east of the plains, the country gradually changes to a zone of dry *Acacia* savannah and then to the thickly wooded valleys and foothills of the Amaro Mountains that are the eastern wall of the Great Rift Valley. The park boundary runs along the top of the first string of piedmont hills. At the foot of Mount Yero (Mome) there are hot springs that are regularly visited by local people (African Parks (Ethiopia) Ltd., 2007).

The third major habitat is the unusual evergreen groundwater forest in the western sector, which supports an exceptionally diverse range of species. This habitat is dominant by *Ficus sycamorus* trees that are up to 30 m tall. This forest is said to be unique in Africa. On the western edge of the forest, at the foot of the western escarpment, are the series of freshwater springs – locally known as "Arba Minch", meaning "Forty Springs" (African Parks (Ethiopia) Ltd., 2007).

The forth major habitat in the park is made up of a narrow isthmus of land, about 3,5 – 6 km wide separating the two lakes. The isthmus is mostly composed of old lava flows and is covered by dense thickets that in places are almost impenetrable. This is the main habitat in the park of Guenther's dik dik, warthog, bush pig, and bushbuck. It is also an excellent habitat for black-rhino – among the best in Ethiopia (African Parks (Ethiopia) Ltd., 2007).

Lastly, the fifth on consists of the aquatic fauna and flora associated with the areas, in and around Lakes Chamo and Abaya, as well as Kulfo River that flows through the north of Arba Minch town and then cuts across the neck of land between the two lakes and ends in a swamp on the shore of Lake Chamo. Haroropi, a small lake found in the north-eastern part of the park, falls in this category of habitat as well (African Parks (Ethiopia) Ltd., 2007).

4.1.4. Fauna

Because of its geographical isolation and wide variety of ecological environment, Nech Sar supports a variety of wild animals.

Although some of the larger mammals are locally extinct there are still more than 90 larger and smaller mammals recorded in the different habitats of the park. Out of the one larger species Swayne's hartebeest and four different rodent species are endemic to the country. The park supports the country large population of Burchell's Zebra (*Equus burchelli*), Hippopotamus (*Hippopotamus amphibius*), grant's gazelle (*Gazella granti*) and greater kudu (*Tragelaphus strepsiceros*). Other large mammals currently common are Günther's Dik-dik (*Madoqua guntheri*), defassa waterbuck (*Kobus ellipsiprymnus defassa*), bushbuck (*Tragelaphus scriptus*), klipspringer (*Oreotragus oreotragus*), mountain reedbuck (*Redunca fulvorufula*), warthog (*Phacochoerus africanus*) and bush pig

(*Potamochoerus larvatus*), olive baboon (*Papio anubis*), colobus monkey (*Colobus guereza*), grivet monkey (*Chlorocebus aethiops*), aardvark (*Orycteropus afer*), civet cat (*Civetticus civetta*), serval cat (*Leptailurus serval*), Egyptian mongoose (*Herpestes ichneumon*) and white tailed mongoose (*Ichneumia albicauda*), spotted hyena (*Crocuta crocuta*) and black-backed (*Canis mesomelas*), side stripped (*Canis adustus*) and golden (*Canis aureus*) jackal. Lions (*Panthera leo*) and leopard (*Panthera pardus*) are also occasionally seen (Duckworth *et al.* , 1992, African Parks (Ethiopia) Ltd., 2007).

The bird life on the lakes and different habitats is very striking with 351 species recorded. Birds constitute biodiversity indicators of the certain area. This means that birds are abiding the park ecosystem for the diverse numbers of insects and plants species on which they feed on and there are also a large number of predators who are attracted by the birds themselves. Thus the presence of 41% of birds found in the country in such confined area makes NSNP as one of the most biodiversity rich place. Besides, Nech Sar is classified as one of the sixty-nine Important Bird Areas in Ethiopia (African Parks (Ethiopia) Ltd., 2007).

Among the birds so far recorded in the park one of them being endemic to the country and the park called Nech Sar nightjar *Camprimulgus solala* (known from only one record of broken wing found on the plains in 1990). The particularly special migratory species (globally threatened species) are Lesser Kestrel (*Falco naumanni*), Pallid Harrier (*Circus macrourus*) and Lesser Flamingo (*Phoenicopterus minor*) on the lakes. The open plains support three species that are little known in Ethiopia, they are an isolated population of White-tailed Bush-Lark (*Mirafra albicauda*), White-fronted Black-chat (*Myrmecocichla albifrons*) and the rare Star-spotted Nightjar (*Caprimulgus stellatus*). Kori Bustard (*Ardeotis kori*), Senegal Bustard (*Eupodotis senegalensis*), Secretary Bird (*Sagittarius serpentarius*) and Abyssinian Ground-hornbill (*Bucorvus abyssinicus*) are also famous features of Nech Sar plains. Special species of the bush lands and thickets are the Black-billed Wood-hoopoe (*Phoeniculus somaliensis*), Taita Fiscal (*Lanius dorsalis*) and the Boran Cisticola (*Cisticola bodessa*). There are also a numbers of other special bird species (Duckworth *et al.*, 1992, African Parks (Ethiopia) Ltd., 2007).

4.2. General species information

4.2.1. Taxonomy

Class: *Mammalia*

Order: *Artiodactyla*

Family: *Bovidae*

Subfamily: *Alcelaphinae*

Genus: *Alcelaphus*

Species: *A. buselaphus* (Wilson 2005)

4.2.2. *Alcelaphinae*

GENUS *Alcelaphus*

- SPECIES *A. buselaphus* (Hartebeest)
  - SUBSPECIES *A. b. buselaphus* (Bubal hartebeest)
  - SUBSPECIES *A. b. cokii* (Coke's hartebeest)
  - SUBSPECIES *A. b. lelwel* (Lelwel hartebeest)
  - SUBSPECIES *A. b. major* (Western hartebeest)
  - SUBSPECIES *A. b. swaynei* (Swayne's hartebeest)
  - SUBSPECIES *A. b. tora* (Tora hartebeest)
- SPECIES *A. caama* (Red hartebeest)
- SPECIES *A. lichtensteinii* (Lichtenstein's hartebeest)

GENUS *Beatragus*

- SPECIES *B. hunteri* (Hirola)

GENUS *Connochaetes*

- SPECIES *C. gnou* (Black wildebeest)
- SPECIES *C. taurinus* (Blue wildebeest)

GENUS *Damaliscus*

- SPECIES *D. korrigum* (Korrigum)
- SPECIES *D. lunatus* (Tsessebe)
- SPECIES *D. pygargus* (Bontebok)
- SPECIES *D. superstes* (Bangweulu Tsessebe) (Wilson 2005)

The subfamily *Alcelaphinae* contains wildebeest, hartebeest, bonteboks and several similar species. Overall, it contains 10 species in 4 genera, although *Beatragus* is sometimes considered a subgenus of *Damaliscus* (Wilson 2005).

A century ago, alcelaphines ranged the entire continent except for the deserts, forests, and high mountains. Today there are none north of the Sahara, several thousand black wildebeests are all that remain of the millions that once roamed South Africa's Highveld and Karroo, and the others are greatly reduced in range and abundance. The wildebeest and topi remain dominant herbivores in acacia savannah and plains but only in a few places as Serengeti National Park and Southern Sudan to they approach their former abundance. Once the hartebeest had the widest distribution of any open-country antelope, and the hirola, found only in northeastern Kenya and adjacent Somalia, had one of the smallest (Estes, 1991).

All of the species in this subfamily are specialized grazers, adapted to living at high population densities and utilizing an abundant but unstable food supply. While the *Alcelaphinae* ranged across much of Africa in huge herds few centuries ago, their present numbers and distribution have been reduced at the hands of humans. Only the wildebeest and topi populations in East Africa approach their former number (Huffman, 2001).

Acelaphinae are large and medium-sized antelopes, with high forequarters and sloping backs, vary in weight from 60 kg bontebok to 230 kg blue wildbeest with horns in both sexes, subequally developed in females. *Alcelaphus* and *Damaliscus* have elongated, norrow muzzle, horns ringed, lyrate, or complexly recurved. They have short coat, glossy, plain tan to chestnut rump, dark and white markings. Members of the genus *Connochaetes* have broad muzzle and smooth horns, hooked forward or sideward, with knobby bosses. The coat is short and glossy with mane, beard and facial tufts. The colour is dark brown – black with white tail (Estes, 1991).

Among the *Alcelaphinae*, there is little sexual dimorphism aside from size: males tend to be 10-20% larger than females. All species have a gawky, awkward appearance. The legs are long and thin, being well adapted for a cursorial existence on the open plains. Pedal scent glands are found in the forefeet only. Preorbital glands are well-developed in both sexes (Huffman, 2001).

The young of all species are born a light tan colour and are precocious "followers" (sticking close to their mothers after birth). In several species (notably the wildebeests, *Connochaetes* sp.) neonates never have a "hiding" phase and can keep up with their mothers within a day of being born. Several species of *Alcelaphinae* antelope are used extensively in game ranching, including the red hartebeest, blue wildebeest, and blesbok (Huffman, 2001).

As a rule alcelaphines prefer the openest available landscapes with the shortest grass. The largest populations occur in the transition zones between savannah and arid biomes, where the animals move seasonally between biomes in large, mobile aggregations. Wildebeests are the most and hartebeest the least migratory/nomadic members of the tribe. Hartebeest are the most and black wildebeest the least tolerant of woodland and high grass. The hartebeest penetrates farthest into arid country and has the lowest water consumption. The topi, which tends to dominate floodplain herbivore guilds, is the most water-dependent. However, as nearly pure grazers, no alcelaphine is desert-adapted to the extent that most gazelles, the eland, and the oryx are. As a rule migratory alcelaphines utilize arid lands only during the rains and concentrate around permanent water in higher rainfall areas during the dry season. Yet hartebeest and wildebeests manage to live in waterless regions of the Kalahari by eating melons and digging up water-storing roots and tubers (Estes, 1991).

Like most grazers, alcelaphines feed day and night, but are generally less active when it is dark and predation risk is greatest. Areas with little vegetation to obstruct vision are favoured for resting sites (Estes, 1991).

The main gaits of alcelaphine antelopes are an ambling walk and galloping, with horizontal neck and a muzzle painting downwards. Trotting in this tribe is usually performed as an alarm signal and in play; it is emphasized by raising the legs high and tail-lashing (Estes, 1991). When hartebeest are surprised, they suddenly throw up their heads, snort loudly and raise one of their fore limbs from the ground before galloping away (Girma, 2002).

The wildebeest, topi and blesbok are among the most gregarious and socially advanced ungulates, forming the largest migratory herds of all antelopes. Their armies often include all the animals from a wide region, which have concentrated in a limited area. But other populations and subpopulations of these same species are resident and live in the usual sedentary/dispersed pattern prevalent in the hartebeest. In resident populations, herd of 2-10 females (occasionally more) and their offspring occupy the best available range, which is partitioned into territories whose owners exclude other sexually mature males. Associated females establish dominance hierarchies and resist attempts by outsiders to join their herd. Male (and sometimes female) offsprings are cut out by territorial bulls as yearlings (wildebeest and Damaliscus) or 2-years-oldds (hartebeest) and thereafter live in bachelor herds until mature (3-5 years) are ready to become territorial. Bachelor herds in this tribe also contain mature and old males that have lost, abandoned, or temporarily left their territories (Estes, 1991).

Depending on the seasonal availability of good pasture and of water, every gradation from completely sedentary to completely nomadic habits and social organisation can be found in different populations or in the same population at different times. Populations tend to be most sedentary and herds most stable in composition during the rains and most unstable in the dry season, when both sexes congregate on the best available pastures and when the territorial network partially or completely breaks down (Estes, 1991).

4.2.3. Natural history of Swayne's hartebeest

4.2.3.1. History

The hartebeest was first named by Pallas in 1766. The hartebeest is described as probably the strangest looking antelopes as they appear to be part buffalo, part horse, and part antelope. It is no wonder that its scientific name is derived from the Greek word alke (the elk), elaphos (a deer) and bous (a cow), aptly reflecting the strange appearance of the *Alcelaphinae* antelopes (Refera, 2005).

Herds of thousands of individuals were observed by Brigadier-General Swayne, who first reported them in 1891-1892 south of the Golis range of Somaliland (Last, 1982). It is now reduced to isolated populations in four known localities in the southern Rift Valley of Ethiopia. The main population occurs in Senkelle Wildlife Sanctuary. Despite the unfavourable location of this sanctuary, which is unfenced and situated on heavily settled and cultivated plain, the Senkelle population increased from 400-500 in early 1970s to about 1700 in the mid-1980s and 2400 in 1989 under the protection of Ethiopian Wildlife Conservation Organisation (EWCO). During the 1991 disturbances when law and order broke down widely in Ethiopia, the facilities and infrastructure for protecting the

Senkelle sanctuary were destroyed almost completely, cultivators settled within the sanctuary, livestock grazing and tree felling became very common and the hartebeest were persecuted and scattered widely (East, 1998).

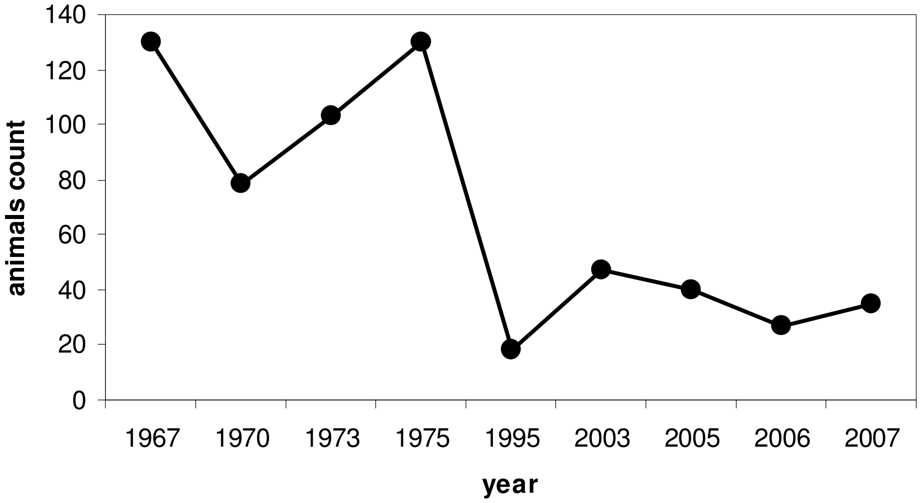
By 1995, about 200 hartebeest survived at SSHS and poaching was continuing. Attempts were being made to reinstate protection of the sanctuary in collaboration with the local community but the conflict between conservation and the activities of local people remained unresolved. In mid-1998, there appeared to have been no further decline in the Senkelle hartebeest population since 1995 and poaching did not appear to be major problem, but there was little patrolling of the sanctuary and it had been invaded by large numbers of cattle. The effective size of the sanctuary has been reduced from 59 km^2 to 36 km^2 by the encroachment of settlement and agriculture, and local people fell tree within the sanctuary and extract fuelwood without restriction (East, 1998).

Smaller numbers of Swayne's hartebeest survive in Nech Sar National Park, where the estimated population decreased from 150 in 1991 to 40 in 1995 but may have stabilized at this lower level, Mazie Controlled Hunting Area and Awash National Park. Mazie Controlled Hunting Area has now been taken over for farming. The awash population, which originated from the reintroduction of animals from Senkelle in 1974, numbered 30 in 1985 but had decreased to only 5 animals in 1995. Swayne's hartebeest also persisted in small numbers in Yabelo Wildlife Sanctuary at least until 1990 when group of 4 was seen, but repeated searches during 1990-94 did not produce any further sightings. Action to prevent the extinction of Swayne's hartebeest is a high international priority in antelope conservation (East, 1998).

A small group of Swayne's hartebeest is found at the interior area of grass plains in Nech Sar. There are evidences that a small population of this animal survived on this plain during the operation of translocation in 1974. Surprisingly, at present it is not clear weather the surviving population is the original one or re-introduced form from Senkelle Swayne's Sanctuary. Anyhow, the existing population is resident on the plains throughout the year (Demeke, 1997).

From available data on population size was elaborated graph 1 that is showing development in numbers of Swayne's hartebeest in Nech Sar National Park since 1967 until 2007. Important is the change in numbers between years 1974 and 1991. In 1974, 120 animals were translocated from Senkelle Swayne's hartebeest Sanctuary to Nech Sar. In this year started the socialist regime in Ethiopia, that was toppled just in 1991, when most of the conservation facilities were destructed by local people and their activities and numbers of hartebeest in Nech Sar declined dramatically.

Graph 1 Development of population size of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park (on the base of data in Appendix 11)



4.2.3.2. Ecology

Swayne's hartebeest ("Korkey" in Amharic), is a subspecies of the widespread African Antelope, *Alcelaphus buselaphus* (Gebre, Yirgá, 2004). According to Messana, Netsereab (1994) it is a medium to large sized antelope in which breeding males weigh between 150 and 180 kg while females weigh an average 5-10% less than males (Demeke, 1997). Both sexes of them have horns, which spread into wide brackets, but they are heavier and have more pronounced knobs in the males. The general body colour is chestnut brown, whereas the rump, hind legs and the lower half of the fore legs are brown. The tail tuft is black, and has a black stripe extending from the shoulder to just above the knee (Gebre, Yirgá, 2004).

They show less sexual dimorphism. Swayne's hartebeest are largely grazers with occasional browsing. Herds (females and their young) are led by a bull except in breeding time when an old female takes the role. Most commonly, herds may comprise 20 to 50 animals (Demeke, 1997). Males are territorial particularly in the mating season. They have sub-glandular secretions that can easily be detected by other intruder hartebeest from distance. These hartebeest live socially intermingled with other plain species like oryx, gazelle and zebra (Bolton, 1973).

Swayne's hartebeest are independent from water, instead they could get all water they require from the vegetation they eat (Bolton, 1973). During the middle of the day, this hartebeest seek shade. This is probably due to need to conserve water by reducing their heat from direct sunrays and thermoregulatory water losses (Demeke, 1997).

The diurnal activity pattern of *Alcelaphus buselaphus swaynei* follows the general pattern of ruminants in the tropics with peaks in feeding in the early morning and late afternoon and an increase in resting (standing and lying) in the middle of the day (Gebre 2000).

The gestation period of Swayne's hartebeest is to be about eight months and the intercalving interval in the population is about 12 months. This indicates that a female comes into oestrus about 4 months after parturition when the calf has been weaned and is almost completely dependent on grass for food. December to February is the marked calving season. In general female starts breeding at 33 months old (Demeke, 1997). Instead of calving in open plains, the hartebeest female isolates herself in scrub areas to give birth and leaves the calf "lying out" and hidden for a fortnight, only visiting briefly to suckle (Gebre, 2000).

4.3. Counting animals

Populations of conservation concern are small, or declining. Mutation, migration, selection or change determines evolution in both small and large populations. However, change has a much greater impact and the selection is less effective in small populations than in large populations. Small populations of threatened and endangered species are so more prone to extinction than large stable populations. Population size is the most influential of the five criteria for listing species as endangered under the International Union for Conservation of Nature (IUCN) system. Species whose adult population sizes are less than 50, 250 or 1000 are respectively critically endangered, endangered and vulnerable (Frankham, 1995; IUCN, 2007).

The study of numbers of animals is a particularly useful aspect of ecology as it makes possible the description of many events in an exact way. The population can be estimated at different times and changes in its numbers recorded. The density of a population at any one time is the result of various factors operating upon it. Broadly these can be divided into those favouring increase (mostly concerned with additions through reproduction) and those favouring decrease which are mostly associated with various causes of mortality. The effects of these components can be quantified so as to ultimately produce a comprehensive and numerically accurate breakdown of the factors involved in the maintenance of a species population (Delany, Happold, 1979).

Although some species are easily seen, many species are highly secretive, often hidden from view. A number of the mammal species that attract most conservation interest occur in low densities. Those species that are both secretive and occur in low densities are extremely difficult to census. Many larger mammals can be simply counted. Unfortunately, numerous studies have shown that many individuals are missed and as a result considerable thought needs to be put into minimizing and qualifying such bias (Sutherland, 1996).

As part of research projects, researchers often need to have an estimate for the number of animals of various species in an area.

Actually counting every animal in a large survey area would be extremely difficult, time consuming and expensive, so a number of techniques have been developed which allow researchers to survey a smaller area and then use the results to provide an estimate for the number of animals in the entire study area (May, 2007).

Direct Count

The term direct refers to counting the animal itself rather than some related object such as tracks. This is the most obvious way to determine the number of individuals in a population. An attempt is made to count all individuals and this type of complete count is called a census (May, 2007).

A spatial census is one in which a count is made of all the animals in a specified area at a specified "point" in time. Included in the spatial census are drive counts and territory mapping methods. Territory mapping has been used for wild turkey, quail, song birds and ruffed grouse. In some cases, this is the mapping of a true territory, which in the definition of behaviourists means a defended area. In other situations, it involves mapping something intermediate between a home range and a territory. A temporal census is one in which the spatial dimension is a "point" and the count is made of all animals passing the point during some interval of time (May, 2007).

Quadrate sampling (also called block sample counts)

In this technique, the study area is divided into a grid. A number of grid squares are chosen at random and these squares are surveyed with the numbers of plants or animals of the species being counted that are spotted within the squares being recorded. These results can then be used to estimate a total figure for the entire study area (May, 2007).

This technique allows an estimated population figure to be obtained without the time and expense of surveying the entire study are, but is less effective with animals than with plants or trees as animals move in and out of survey squares and thus distort the results (May, 2007).

Strip Transect Sampling

This technique uses the same principles as Quadrate sampling but instead of dividing the area up into squares to survey it uses long narrow strips. The person doing the survey travels along the centre of the strip and counts the number of animals of the relevant species on either side, within the width of the strip. Any animals outside the strip are ignored and not recorded (May, 2007).

Line Transect Sampling

As with strip transect sampling, the observer travels along a line. Whereas in strip transect sampling the observer only records sightings within the width of the strip, in line transect sampling, all sightings are recorded along with the perpendicular distance from the survey line to where the animal was sighted. By using mathematical equations and statistical analysis, the population density and overall population count for the area can be obtained (May, 2007).

Alternatives to counting animals directly

In some cases, the animals being surveyed may be difficult to spot - for instance if they are secretive in their habits or are nocturnal. In this situation alternative methods of counting can be used. In the case of apes, a researcher might choose to count the number of their nests. Another option for a number of species is to count dung. For this to be effective it is necessary to first have information about the frequency that the animal deposits fresh dung, to know how long the dung will still be visible in the particular environmental conditions of the study site, and to be able to distinguish between the dung of the target species and that of other species found in the area. By using this data and a count of the amount of dung found in the survey, then an estimated figure for the number of animals of that species in the study area can be obtained (May, 2007).

Aerial surveys

Aerial surveys require the aircraft to have certain special modifications. Standard aircraft instruments measure the aircrafts height above sea level, but for aerial surveys (particularly strip transect surveys) it is important to keep the aircraft at a fixed height above the ground rather than above sea level. A radar altimeter accurately measures the exact height above the ground when flying at low level, which allows the pilot to maintain a constant height above the ground (May, 2007).

Normal doors and windows in a light aircraft tend to have very limited visibility when looking down and to the sides of the aircraft. To make survey work more practical, special observer doors and windows can be installed to improve visibility (May, 2007).

Aerial surveys vs. ground surveys

Surveys can be carried out either on the ground (on foot or in a vehicle) or by using aircraft. Each method has its own advantages and disadvantages and these have to be considered when designing a survey to choose the best option (May, 2007).

Aerial surveys

- Faster than ground based surveys
- Able to cover large areas easily
- Better for uneven terrain where ground surveys would be difficult
- Expensive due to costs of aviation fuel and general aircraft running costs

Ground surveys

- Cheaper than aerial surveys
- Slower than aerial surveys
- Better than aerial surveys in densely wooded areas which restrict the visibility from the air
- Better suited for small animals
- Better suited for plant/tree surveys as the observer can move at a slower pace and spend more time distinguishing plant or tree species from other similar species.

Data on animal densities are often collected without direct animal observations. Although such data can provide valuable insight into the species that exist in an area, they can not tell about how animals behave, or the details of the life of an individual animal. In order to understand which factors affect the behaviour of an animal it is necessary to spend time observing the animal and recording its interactions with its habitat, other members of its society and other animal species. Observing animal behaviour in their natural habitat can provide information which will directly affect management of the population by enabling you to understand the animal's needs (White, Edwards, 2000)

4.4. Age determination

An enormous amount of detailed laboratory research has highlighted how age affects physiology, but it is unclear how these findings map onto animals living in the natural world. Virtually all measures of life history, morphology, and physiology show age dependent changes in fundamental rates (survival, reproduction, and growth), in structure, and in function (Baker *et al*., 2003).

The age distribution of population reflects its history of survival, reproduction, and potential for future growth. Population ecologist can tell a great deal about a population just by studying its age distribution. Age distribution indicates periods of successful reproduction, periods of high and low survival, and whether the older individuals in a population are replacing themselves or if the population is declining (Molles, 2008).

Populations can be divided into three ecologically important age classes or stages: prereproductive, reproductive, and post reproductive. How long individuals remain in each stage depends largely on the life history of the organism. Among annual species, the length of the prereproductive stage has little influence on the rate of population growth. In organisms with variable generation times, the length of the prereproductive period has a pronounced effect on the population's rate of growth (Smith, Smith, 2006).

Determining the age structure of a population requires some means of obtaining the ages of members of a population. Age data for wild animals can be obtained in a number of ways, the method varying with the species (Smith, Smith, 2006). For Hartebeest four age groups can be distinguished, calf, juvenile, sub-adult and adult according to horn development. Hartebeest horns do not have a twist up till an age of 12 months. Between 12 and 24 months an upright twist is developed in the horn. After this the horns diverge to the side and the top of the horns strongly points backwards (Gebre, 2000).

4.5. Population dynamics

In nature populations are in continuous flux and their patterns of distribution and abundance result from a dynamic balance between factors that add individuals to populations, immigration and births, and factors that remove individuals from populations, deaths and emigration. The dynamic population processes underlying distribution and abundance is a part of ecology called population dynamics, which is concerned with the factors influencing the expansion, decline, or maintenance of populations. This is one of the most important areas of ecology, since it holds the key to understanding and, hopefully, preventing the decline and extinction of endangered species, the control of noxious pest species, including parasites and pathogens, and maintenance of economically or culturally important animal or plant populations (Molles, 2008).

Population dynamics can be influenced by a variety of factors, including demographic stochasticity, environmental stochasticity, disruption of social structures that influence mating, feeding, and defence, and lost of genetic diversity (Smith, Smith, 2006).

The stochastic (or random) variations in birth and death rates that occur in populations from year to year are called demographic stochasticity and cause population to deviate from predictions of population growth (Smith, Smith, 2006).

In addition to demographic stochaticity, random variation in the environment, such as annual variations in climate (temperature and depreciations) or the occurrence of natural disasters such as fire, flood, and drought, can have a direct influence on birth and death rates within the population. Such variation is referred to as environmental stochasticity (Smith, Smith, 2006).

4.5.1. Survival patterns

There are three main ways of estimating patterns of survival within the population. The first and most reliable way is to identify a large number of individuals that are born at about the same time a keep records on them from birth to death. A group born at the same time is called a cohort. A life table made from data collected in this way is called cohort life table. While understanding and interpreting a cohort life table may be relatively easy, obtaining the data upon which a cohort life table is based is not. Imagine very long-living species such an approach is impossible within a single human lifetime or if the species is mobile, such as whale, the problems multiply. In such circumstances populations biologist usually resort to other techniques (Molles, 2008).

A second way to estimate pattern of survival in wild populations is to record the age at death of a large number of individuals. This method differs from the cohort approach because the individuals in the sample are born in different times. This method produces a static life table. The table is called static, because the method involves a snapshot of survival within a population during a short time interval (Molles, 2008).

The third way of determining patterns of survival is from the age distribution. An age distribution consists of the proportion of individuals of different ages within a population. An age distribution can be used to estimate survival by calculating the difference in proportion of individuals in succeeding age classes. This method, which also produces static life table, assumes that the difference in numbers of individuals in one age class and the next class is the result of mortality. This method requires that the population is neither growing nor declining and that it is not receiving new members from the outside or losing members because they migrate away. Since most of the assumptions are often violated in natural populations, a life table constructed from this type of data tends to be less accurate than a cohort life table. Static life tables are often useful, however, since they may be the only information available (Molles, 2008).

4.5.2. Sex ratio, effective population size

Sex ratios in a population may shift with age. Populations of sexually reproducing organism in theory tend toward a 1:1 sex ratio (the proportion of males to females). The primary sex ratio (the ratio at conception) also tends to be 1:1. This statement may not be universally true, and it is, of course, difficult to confirm (Smith, Smith, 2006).

In most mammalian populations the secondary sex ratio (the ratio at birth) is often weighted toward males, but the population shifts towards females in the older age groups. Generally, males have shorter life span than females. The shorter life expectancy of males can be a result of both physiological and behavioural factors (Smith, Smith, 2006).

All of the adverse genetic consequences of small populations depend on the effective population size (N_e). Further, most of the theoretical predictions in conservation genetics are couched in terms of effective population size. Thus, it is fundamentally important to have clear understanding of the concept of effective population size and how it differs from census size (Frankham *at al.*, 2003).

The effective population size is defined as the number of individuals that would give rise to the calculated loss of heterozygosity, inbreeding or variance in allele frequencies if they behaved in the manner of an idealized population (Frankham *at al.*, 2003).

Factors, which have an impact on the effective population size are an unequal sex ratio, fluctuations in the number of individuals in the group and a non-random distribution of offspring. The conditions that would result in a population having the highest possible effective population size would be if the sex ratio was exactly equal, and the population size remained high and constant over time and if every individual in the group produced an equal number of offspring (Galbraith, 1999).

Of course, in a natural population, this will not be the case. In an infinitely large population, the sex ratio will approach equality but in a small population the chance that the ratio will be exactly equal is extremely unlikely. In addition to this, both environmental and anthropogenic effects on plant and animal populations generally result in the size of the group to be rather eradic. To contribute to the problem, it does not often occur in a natural population that every individual is able to produce the same number of offspring. For example, there will undoubtedly be some in the group who are sterile and others who die before sexual maturity. These individuals are effectively removed from the breeding population. In addition to this, there are always some in the group who are able to produce a greater number of offspring because of their high degree of fertility or their social status in the population (Galbraith, 1999).

The census population size (N) is usually the only information available for most threatened species. However, it is the effective population size that determines loss of genetic diversity and inbreeding. Consequently, it is critical to know the ration of the effective population size (N_e/N), so that effective size can be inferred (Frankham *at al.*, 2003).

In many wild populations, the number of breeding females and males are not equal. Many mammals have harems (polygamy) where only one male mates with many females, while many other males make no genetic contribution to the next generation. In a few species the situation is reversed (polyandry). The equation accounting for the effects of unequal sex-ratio is:

$$N_e = 4\, N_{ef}N_{em}/(N_{ef} + N_{em}) \text{ (approx.)}$$

where N_{ef} is the effective number of breeding females and N_{em} the effective number of breeding male parents. This is the single generation effective population size due to this factor alone; other characteristics are assumed to be as in an idealized population (Frankham *et al.*, 2003).

Sex-ratios can be destroyed by the mating system, by sex determining mechanism, that result in more of one sex than the other, by small population size, or even by human action (Frankham *et al.*, 2003).

4.6. Identification of individuals

For many studies, being able to identify individuals is essential. Only by identifying and watching individuals has it become clear that individuals in a species do not behave in the same "species-typical" way. On the contrary, marked intra-specific variations in behaviour have been described for many species, and many of these differences make functional sense (Martin, Bateson, 1993).

Method using visible species with individual variation involves creating a cataloque of all the individuals and their identification features. Photographs are very useful but can be very time-consuming to obtain. The approach is to provide a record card for each individual with an outline of the species on which identification features may be drawn and any changes are noted. In some species only part of the body may be used. For some species it is necessary to use range of characters, that include whether any digits are missing, size, colour, and face shape (Shutherland, 1996).

Advantage of this method is that data on movement and population dynamics can be collected at the same time. Members of the public often show great interest in the history of known individuals and are often prepared to provide sponsorship for named individuals (Shutherland, 1996).

4.7. Studying behavioural patterns

In addition to intrinsic interest, the study of behaviour is intellectually challenging and practically important (Martin, Bateson, 1993).

Observing animal behaviour in their natural habitat can provide information, which can directly affect management of the population by enabling understanding the animal's needs (Martin, Bateson, 1993).

Animals use their freedom to move and interact, both with their environment and with one another, as one of the most important ways in which they adapt themselves to the conditions in which they live (Martin, Bateson, 1993).

Even though much is already know about such adaptations and the ways in which are refined as individuals gather experience, a great deal remains to be discovered about the diversity and functions of behaviour (Martin, Bateson, 1993).

For ethological data evaluation could be used regression analysis to get outputs in the form of graphs.

The regression analysis is the part of Statistics that analyzes the relationship between quantitative variables. It helps predict the reaction of a variable when a related variable varies (Bass, 2005).

The objective of Regression analysis is to build a mathematical model that will help make accurate predictions about the impact of variable variations (Bass, 2005).

Regression analysis is a statistical technique used to explore the extent to which factor, called the independent variable (usually symbolized X) determines the value of another variable, which is called the dependent variable (usually represented by the symbol Y). In regression analysis, we construct X-Y plots. However , regression analysis is used to determine the equation for a line called a regression line, that best fits the relationship between X and Y follows a straight line, the regression equation takes the following form:

$$Y = bX + a$$

In this equation, *a* is the point at which the line crosses the Y axis, which is called the Y intercept, and *b*, which is the slope of the line, is the regression coefficient (Molles, 2008).

When building a regression model, if more than one independent variable is being considered, we call it a multiple regression analysis, if only one independent variable is being considered, the analysis is a simple linear regression (Bass, 2005).

4.8. Home range and animal movements

All populations share several characteristics. The first is its distribution. The distribution of the population includes the size, shape, and location of the area it occupies. A population also has a characteristic pattern of spacing of the individuals within it. It is also characterized by number of individuals within it and their density, which is the number of individuals per unit area (Molles, 2008).

The numbers of individuals in a particular area are related to the resources of that area and the biomass may change seasonally depending on the conditions of the habitat. A consequence of the ecological characteristics is that every individual needs a particular restricted living space, which contains all its requirements for survival. This space is the "home range" and it can be defined as the area which is habitually used by the individual during its lifetime, and which contains all the resource requirements for survival and reproduction (Delany, Happold, 1979).

Field studies of animals commonly record the locations where individuals are observed. In many cases these point data, often referred to as "fixes", are determined by radio telemetry. These data may be used in both "basic" and "applied" contexts. The information may be used to test basic hypotheses concerning animal behaviour, resource use, population distribution, or interactions among individuals and populations. Location data may also be used in conservation and management of species (Rodgers *et al.*, 1998).

There are two different perspectives that a researcher can take on an animal's movements: home ranges or animal movements. Home ranges are the aggregated movement patterns of the individual animal (Keenan, 2005).

Accurate estimation of the size of home range is an important prerequisite to a better understanding of the behavioural ecology of any species and for its management (Gebre, Yirgá, 2004).

Animal movements can be classified as either daily movements (local movements) or seasonal movements (migrations or dispersal) (Keenan, 2005).

Local population changes may be due to the movement of individuals among populations. Such movement is frequently referred to as dispersal or, when discussed with respect to a particular population, as emigration (movement out of a population) or immigration (movement into a population) (Stenseth, 1992). The movement of young animals from their place of birth is called natal dispersal (Ricklefs, 1999).

Dispersal, particularly over long distances, is difficult to measure directly because detection of such movements requires marking and recapturing individuals. Many estimates of dispersal distances come from studies of population genetics, in which investigators wish to determine the genetic structure of a population (Richlefs, 1999)..

Population ecologists describe dispersal with a number of mathematical indices, each of which reflects different assumptions about the structure of the population (Porter, 1993). The simplest model describes dispersal as random movement through a homogenous environment (Richlefs, 1999).

Very important for understanding animal behaviour is to conceive their movements. Why study animal movements?

1. Better understanding of biology.
2. Increase in knowledge of habitat use.
3. Creation of wildlife corridors.
4. Understand effects of human influences on wildlife. (Keenan, 2005)

Analysis of movements:

This accounts for the various components of the home range.

1. Distances
    - Measure from point A to B.
    - Many of these measurements are used for home range calculation.
2. Times

3. Speeds

- Calculated simply as the distance over time.

Daily Movements

- It is used when looking at daily patterns of individuals (Keenan, 2005).

In summary, there is no single 'best' method. Suggestion is made to use multiple methods to get an idea of a home range. Each study needs to pay attention to the various methods available to give the best predictions available with the type of data collected and type of study being conducted (Keenan, 2005).

Depending on the general treatment of point location estimates, home range analysis models can be classified into four fundamentally different approaches; minimum convex polygons, bivariate normal models (Jennrich-Turner estimator, weighted bivariate normal estimator, multiple ellipses, Dunn estimator), nonparametric models (grid cell counts, Fourier series smoothing, harmonic mean), and contouring models (peeled polygons, kernel methods, hierarchical incremental cluster analysis). All of these methods can be used to estimate areas occupied by animals, but some have been developed to specifically elucidate characteristics of home range shape (e.g., bivariate normal models) or structure (e.g., contouring models). If home range size is combined with information about home range shape, then it is possible to estimate resources available to individuals in a population. Consideration of home range shape may also allow identification of potential interactions among individuals. Analytical models developed to examine home range structure may be useful in the identification of areas within home ranges that are used by individuals for specific purposes such as nest sites or food caches. However, home range analysis may involve more than just estimating the characteristics of areas occupied by animals. Researchers often want to know about the distances, headings, times and speed of animal movements between locations. They may also want to assess interactions of animals based on areas of overlap among home ranges or distance between individuals at a particular point in time. Thus, home range analysis comprises a wide variety of techniques and approaches (Rodgers *et al.*, 1998).

Minimum Convex Polygons

Minimum convex polygons (MCPs) are constructed by connecting the peripheral points of a group of points, such that external angles are greater than 180° (Mohr, 1947). "Percent" minimum convex polygons (%MCPs) (Michener, 1979) can be generated for a subset of fixes using one of several percentage selection methods. These methods include both the exclusion of points from a calculated (e.g., mean) or user-specified (e.g., nest site) location, and an ordering criterion based on the amount of area each point contributes to the %MCP (White, Garrott, 1990).

Kernel Methods

Kernel analysis is a nonparametric statistical method for estimating probability densities from a set of points. Kernel methods have only been used in home range analysis for less than a decade (Worton, 1989). In the context of home range analysis these methods describe the probability of finding an animal in any one place. The method begins by centring a bivariate probability density function with unit volume over each recorded point. A regular grid is then superimposed on the data and a density estimate is calculated at each grid intersection. The density estimate at each intersection is essentially the average of the kernel ordinates at that point. A bivariate kernel density estimator is then calculated over the entire grid using the density estimates at each grid intersection. The resulting kernel density estimator will thus have relatively large values in areas with many observations and low values in areas with few. Home range estimates are derived by drawing contour lines (i.e., isopleths) based on the volume of the curve under the utilization distribution. Alternatively, isopleths can be drawn that connect regions of equal kernel density. In either case, the isopleths define home range polygons whose areas can be calculated (Rodgers *et al.*, 1998).

4.9. Small populations

Habitat fragmentation reduces population sizes and increases isolation of population fragments. Completely isolated population fragments suffer elevated rates of inbreeding and loss of genetic diversity, and consequently have elevated extinction risks, compared to single population of the same total size. The impact of population fragmentation depends critically on population structure and gene flow (Frankham *et al.*, 2003).

Small populations are more susceptible to extinction than larger populations due to a variety of factors that directly influence the rates of survival and birth. If only a few individuals make up the population, the fate of each individual can be crucial to the survival of the population. In addition, declining population size may directly influence birth rates as a result of life history characteristics related to mating and reproduction (Smith, Smith, 2006).

In many cases, small population size may result in the breakdown of social structures in species that practice facilitation or cooperative behaviours relating to mating, foraging, or defence. Many gregarious species live in herds or packs that enable the individuals to defend themselves from predators or find food. Once the population is too small to sustain an effective herd or pack, the population may decline from increased mortality due to predation or starvation (Smith, Smith, 2006).

Another factor that has been suggested as a potential cause of extinction in a small population is reduced genetic diversity. Just a matter of chance, small populations will support less genetic variation than larger populations, and this reduced genetic variation may influence the ability of the population to adapt to exposure to a new disease, predator, or chances in the physical environment, such as climate. There are two mechanisms operating in small populations that can function to reduce genetic variation: genetic drift and inbreeding (Smith, Smith, 2006).

The random change in the frequency of alleles (alternative form of a gene) within the population as a result of chance is called Genetic drift. It occurs in all populations and represents one of the mechanisms of evolution. This loss of variation can result in a gene being fixed (Smith, Smith, 2006).

Although the process of genetic drift occurs in all populations, it occurs at a faster rate in small, isolated populations. Through time, some genes become fixed or homozygous for one allele. If the genes involved are maladaptive, the small population may become extinct (Smith, Smith, 2006).

When populations are small, the choice of mates can be also limited, creating the potential for mating between relatives, inbreeding (Smith, Smith, 2006).

With inbreeding, mates on average are more closely related than they would be if they had been chosen at random from the population (Smith, Smith, 2006).

Inbreeding can be detrimental. Rare, recessive, deleterious genes become expressed. They can cause decreased fertility, loss of vigour, reduces fitness, and even death (Smith, Smith, 2006).

Inbreeding is of profound importance in conservation biology as it leads to reductions in heterozygosity, to reduced reproduction and survival (inbreeding depression) and to increased risk of extinction (Frankham *et al.*, 2003).

Natural populations have many different structures and breeding systems that have different consequences. Further, species vary in mating systems (e.g. monogamy, harems), and from approximately random mating to selfing and asexual reproduction. The same number of individuals may result in very different genetically effective population sizes, depending on population structure and breeding system (Frankham *et al*., 2003).

When dealing with small population with high risk of extinction, the inadequacy of the traditional approach to population dynamics becomes apparent. In 1970, Richard Levins coined the term metapopulation to describe a population consisting of many local populations, in the same sense in which a local population is a population consisting of individuals. According to the classical metapopulation concept, which Levins established, all local populations have a substantial probability of extinction, and the long-term persistence of the species can only occur at the regional or metapopulation level (Hanski, 2003).

5. Methodology

The study is based on direct observations of Swayne's hartebeest from 23rd June – 11th September 2007 in its natural environment in Nech Sar National Park, Ethiopia. For the data collection was used Swarovski telescope ATS-80 (provided by the APF office in Arba Minch), binoculars, Dell PDA with Cyber Tracker software (special database created for our purposes), digital camera Canon IXUS 50, Bushnell Yardage Pro Sport 450 Laser Rangefinder, compass, paper and pencil.

5.1. Confirmation of the population size of Swayne's hartebeests in NSNP

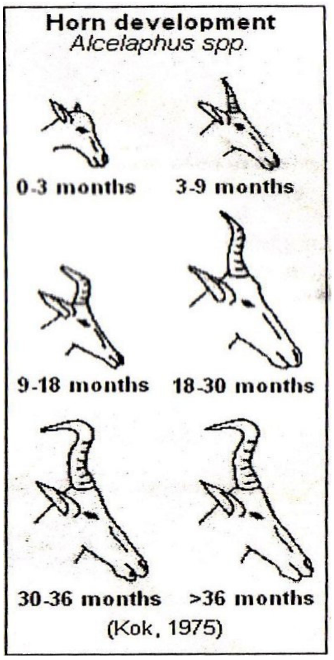
The observation of hartebeest population was conducted in the morning (7 – 8.30 am) or evening time (6 – 7 pm), when the animals are more active and the weather conditions are more suitable for telescope observations (heat does not influence the vision).

The counting was done always in the most suitable place, Kalo Sadulo hill, from which is good view to large surroundings and with the telescope, it was possible to cover whole area, where hartebeests could be seen. All counted hartebeests were sighted in the same time, so there is no possibility of double counting. In a case of some doubts about presence of hartebeests (e.g. very far location, so could be possible to mistake hartebeest for other presented objects such as trees or stones), the observed object was always checked directly by walking to its position.

5.2. Determination of age and sex structure in the population

The age and sex structure determination was done by visual identification. Total number in the population, number of animals in the herd, number of males and females and age categories were determined. The age of every individual was conducted during every observation of diurnal activity and determined by stage of animal horns' development. Four age groups were recognized: calf (0 – 9 months), juvenile (9 – 18 months), sub-adult (18 – 30 months) and adult (over 30 months). In this case I used the same methodology as Dik Eenink and Richard van Sluis, who did their research in Nech Sar National Park (NSNP) during November 2006. (Eenink, Sluis, 2006 according to Gebre, 2000, Kok, 1975)

Figure 1 Horn development of Swayne's Hartebeest (Eenink, Sluis, 2006 according to Kok, 1975)



Sex specification was based on direct observation. Males can be distinguished from females through primary sex characteristics like scrotum or penis sheath.

Results that were got during first observations were verified during all next observation to be sure that the determination is right.

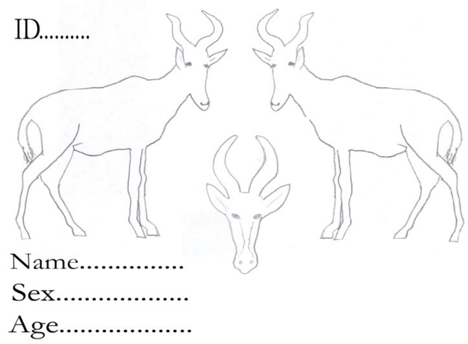
5.3. Population dynamics estimation

Data about the population size and structure were recorded in the field and the pattern of survival was determined from the age distribution using known data from previous years and estimated data for future years. We got static life table, where the difference in numbers of individuals in one age class and the next class is the result of mortality.

5.4. Identification of individuals in the population

Detailed data on individual identifications were obtained during the whole study, using telescope or binoculars. Every observed animal was described in detail and in a case of any individualistic marks that can help with later recognition; a silhouette form (Figure 2) was used for better description. These marks were most often black spots on hind legs and flanks.

Figure 2 Example of a silhouette form (by author)



5.5. Study of diurnal activities of Swayne's hartebeest

For studying diurnal activity was used the technique that involves defining classifying the behaviour into a number of specific activities (Appendix 5) and writing down time and short cut of the activity every 10 minutes in a case of herd scanning (Martin, Bateson, 1993).

These observations were always done in one day, from 7 am until 7 pm with some variation caused by difficulties with finding the animals or weather conditions.

Data were recorded in the field using Dell PDA with Cyber Tracker software (database developed specially for this purpose) (Cyber Tracker software) and then statistically analyzed (Statistica 2008, version 8.0, GLM analysis, regression analysis).

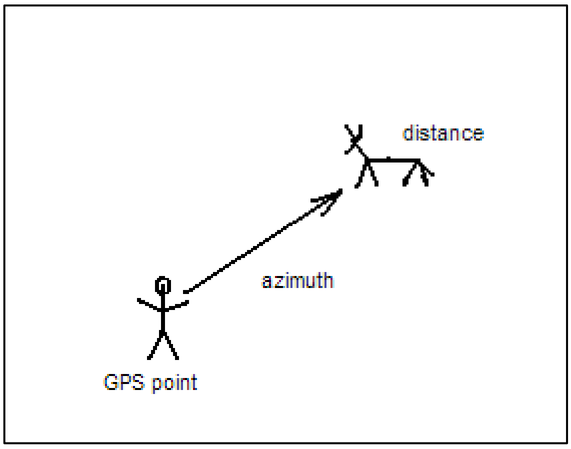
5.6. Study of spatial distribution of Swayne's hartebeest

Data on movements and home range size of the Swayne's hartebeest were obtained from ground observation of all the groups or individuals of Swayne's hartebeest in the park.

During the animal's observations the locations by GPS was taken to get the position of each solitary animal or herd. It was based on taking a GPS point of observer's actual location, the distance and the bearing of a focused animal (Figure 3) and than using specialized software (Arc View software) to extrapolate the real position of the animal.

We obtained the locations of all herds and solitary males during the study. Because of problems with GPS, some positions were described using our detailed knowledge of the site and already known points in the Nech Sar plains, and then adjusted according to satellite images and maps. Thus we were able to calculate home range of each herd and solitary males from these data. Kernel home range analysis in Arc View software was used (Rodgers, *et al.*, 1998).

Figure 3 Drawing of extrapolation (by author)



6. Results

During the study were done 21 days of focal animal, 17 days of herd scanning and 6 home range observations (Appendix 6, 7).

6.1. Updating the population size of Swayne's hartebeest in NSNP

The total number of 35 hartebeests was counted, 23 of them formed the main herd, 3 males stayed together in temporary herd and 9 were solitary males.

Not all animals were sighted each observation, the total number is based on the maximum number of animals sighted on several days (Table 1). The number of 35 hartebeest was counted twice, on 18th and 30th August 2007.

Table 1 Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) (SH) population count observation during summer 2007 in Nech Sar National Park

date	number of SH
5.8.2007	32
12.8.2007	35
17.8.2007	33
18.8.2007	34
30.8.2007	35
1.9.2007	31

6.2. Determination of age and sex structure in the population

In the population were counted 18 males and 17 females, whereas the main herd consisted of 17 females (11 adult, 3 sub-adults, 1 juvenile, 2 calves) and 6 males (1 dominant adult male, 3 sub-adult males, and 2 calves). The temporary herd consisted of 1 adult male and 2 sub-adult males (Table 2, 3).

Table 2 Sex and age determination of Swayne's hartebeest population in NSNP in September 2007 (Abbreviations: H1 – main herd, H2 – temporary male herd, S – solitary male, A – adult, S – sub-adult, J – juvenile, C – calf, M – male, F – female) Introduced names were given according to visible marks or special body characteristics.

number	*classification*	*age group*	*sex*	*name*
1	H1	A	M	Bango
2	H1	A	F	
3	H1	A	F	
4	H1	A	F	
5	H1	A	F	
6	H1	A	F	
7	H1	A	F	
8	H1	A	F	
9	H1	A	F	
10	H1	A	F	
11	H1	A	F	
12	H1	A	F	
13	H1	SA	M	
14	H1	SA	M	
15	H1	SA	M	
16	H1	SA	F	
17	H1	SA	F	
18	H1	SA	F	
19	H1	J	F	Sara
20	H1	C	M	
21	H1	C	M	
22	H1	C	F	
23	H1	C	F	
24	H2	A	M	
25	H2	SA	M	
26	H2	SA	M	
27	S	A	M	Stripe
28	S	A	M	Pale
29	S	A	M	Misha
30	S	A	M	Neville
31	S	A	M	Black
32	S	A	M	
33	S	A	M	
34	S	A	M	
35	S	A	M	

Table 3 Overview of age groups of Swayne's hartebeest in NSNP

sex	*age group*	*number*
male	adult	11
	sub-adult	5
	juvenile	0
	calf	2
female	adult	11
	sub-adult	3
	juvenile	1
	calf	2

6.3. Estimation of population dynamics

In comparison with last year report (Eenink, Sluis, 2006) there is visible difference in the number of animals (Table 4, 5). For better imagination there are added tables with numbers of hartebeests in NSNP from both years.

Table 4 Comparison of main herd structure of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park in summer 2006 and 2007

age group	*sex*	*2006*	*2007*
Adult	male	1	1
	female	7	11
Sub-adult	male	0	3
	female	5	3
Juvenile	male	0	0
	female	0	1
Calf	male	1	2
	female	4	2
total		**18**	**23**

Table 5 Comparison of numbers of Swayne's hartebeests (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park in 2006 and 2007

Eenink, Sluis,summer 2006

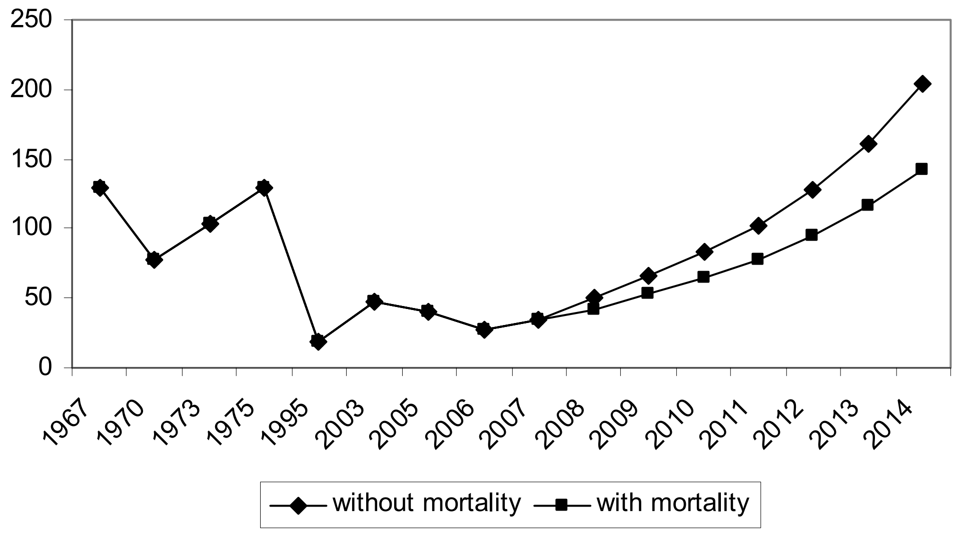
sex	*age group*	*number*
male	adult	7
	sub-adult	0
	juvenile	0
	calf	1
female	adult	8
	sub-adult	7
	juvenile	0
	calf	4
total		27

Vymyslická, summer 2007

sex	*age group*	*number*
male	adult	11
	sub-adult	5
	juvenile	0
	calf	2
female	adult	11
	sub-adult	3
	juvenile	1
	calf	2
total		35

From these tables is visible clear difference in numbers of Swayne's hartebeest in Nech Sar. Regardless, data got in last year vary in all age groups; therefore, it was difficult to elaborate the population dynamics estimation without exact percentage of mortality in each age group. I used mortality of 50% for new born females calves and 10% mortality for adult females and got graph 2 that is showing estimation of population size development within the years 1967 and 2014, comparing development without and with mortality included. This is just estimation with only mortality included and no other factors are included, but are discussed later.

Graph 2 Estimation of population growth of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park within the years 1967 and 2014, comparing development without and with mortality included (based on Appendix 12).



To know effective population size of the Swayne‘s hartebeest in the park I used equitation from Frankham (   ). The number of breeding females and males are not equal, so I used the equation accounting for the effects of unequal sex-ratio

$$N_e = 4\, N_{ef} N_{em} / (N_{ef} + N_{em}) = 4 * 11 * 1/(11 + 1) = 3{,}75$$

Thus the effective population size of Swayne’s hartebeest in Nech Sar is 3,75, approximately 11% of the actual size of 35.

6.4. Identification of individuals in the population

In consideration of common description of Swayne’s hartebeest (Dorst, Dandelot, 1970; Girma, 2002) it was not possible to recognize all animals in the population individually due to low variability and visibility of particular marks. 7 animals were recognized individually (5 solitary males and 2 individuals from the herd H1). For these animals the silhouette forms were drawn with all distinguishing marks completed by photography. On this basis identification cards were created (Appendix 8). In the herd H1, Bango, the dominant male, and Sara, the only juvenile, were identified due to their specific position in the herd.

Other solitary males were also recorded and got their names as well, but these names are reporting the place of their most frequented occurrences and are not based on any sustainable characteristics. That is the reason why no identification cards were created

6.5. Study of spatial distribution of Swayne’s hartebeest

The extrapolated points of position of each studied individual or herd were processed by Arc View software (Kernel home range analysis, MCP 100%, Rodgers *et al.*, 1998) and maps of home range were worked up (Appendices 2, 3, 4). These maps are showing seasonal home range/habitat utilization of whole Swayne’s hartebeest population as well as each solitary male or herd. Seasonal home range map of herds (Appendix 2) shows place of abundance of temporary herd a main herd. Main herd changed its location in between July and August 2007.

Seasonal home ranges of solitary males are displayed in Appendix 3. Important, is that few of these home ranges are overlapped not only in place but also in time.

Appendix 4 is showing seasonal home range of all hartebeest in the park, area of the plains grazed by cattle and hartebeests in unusual positions to compare their spatial distribution. During our survey few times happened that was taken a position of a solitary male without any possibility of detailed identification of the animal. Positions of these non-identified hartebeest are included in home range analysis of whole population of Swayne's hartebeest in Nech Sar.

6.6. Study of diurnal activity of Swayne's hartebeest

During the study there were many factors affecting hartebeest activities such as weather, daytime and interaction between herd and weather. A General Linear Modelling (GLM) analysis (Statistica 2008, version 8.0) was used to evaluate the influence of these factors on herds' behaviour, respectively on several activities (Table 6).

Table 6 Results of GLM analyses of different effects (month (July/August), day time, herd (H1/ H2), weather, and interaction herd*weather) on behaviour of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park during summer 2007.

BEHAVIOUR	EFFECT	DF	F	P-VALUE
Grazing	Month	1	171,8	**0,000***
	Day time	1	48	**0,000***
	Herd	1	10,4	**0,001***
	Weather	2	35,2	**0,000***
	Herd*weather	2	9,4	**0,000***
Ruminating	Month	1	69,29	**0,000***
	Day time	1	96,55	**0,000***
	Herd	1	3,87	**0,049***
	Weather	2	3,86	**0,021***
	Herd*weather	2	9,2	**0,000***
Comfort behaviour	Month	1	7,63	**0,006***
	Day time	1	50,92	**0,000***
	Herd	1	0,52	0,470
	Weather	2	8,73	**0,000***
	Herd*weather	2	20,25	**0,000***
Social behaviour	Month	1	2,313	0,129
	Day time	1	0,367	0,545
	Herd	1	6,325	**0,012***
	Weather	2	3,217	**0,041***
	Herd*weather	2	1,213	0,298
Standing	Month	1	32,92	**0,000***
	Day time	1	32,37	**0,000***
	Herd	1	6,72	**0,010***
	Weather	2	8,41	**0,000***
	Herd*weather	2	11,17	**0,000***
Lying	Month	1	40,86	**0,000***
	Day time	1	77,05	**0,000***
	Herd	1	0	0,969
	Weather	2	9,84	**0,000***
	Herd*weather	2	9,43	**0,000***
Movement	Month	1	0,47	0,493
	Day time	1	0,679	0,410
	Herd	1	1,202	0,273
	Weather	2	4,455	**0,012***
	Herd*weather	2	0,666	0,514
Excretion	Month	1	3,397	0,066
	Day time	1	1,23	0,268
	Herd	1	4,594	**0,032***
	Weather	2	0,007	0,993
	Herd*weather	2	1,065	0,345

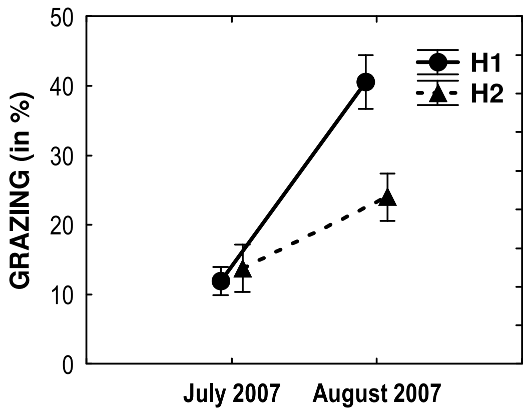
DF – degree of freedom; F – F-statistics. Data in bold characters had significant effect at the level p<0.05, data in italics had significant effect at the level p<0.10.

Results from this table for graphs elaboration comparing main herd (H1) and temporary herd (H2) were used.

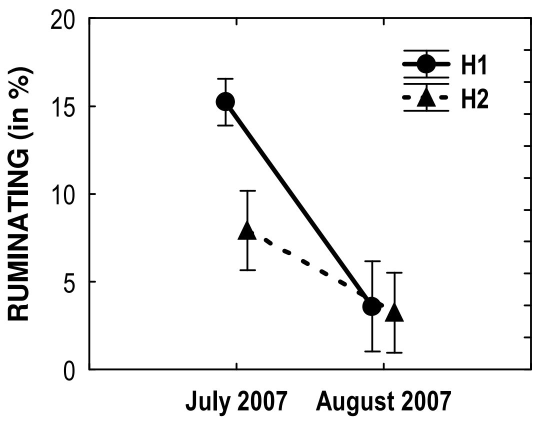
For expression of influence of month change (July/August) on percentage proportion of each activity were elaborated scatter graphs with deviation segments and trend line for better illustration of changes in activity percentage proportion.

From the graphs is visible that the percentage proportion of activities for main and temporary herd has the same trend except of social behaviour and excretion, where is detectable lack of initial data for temporary herd.

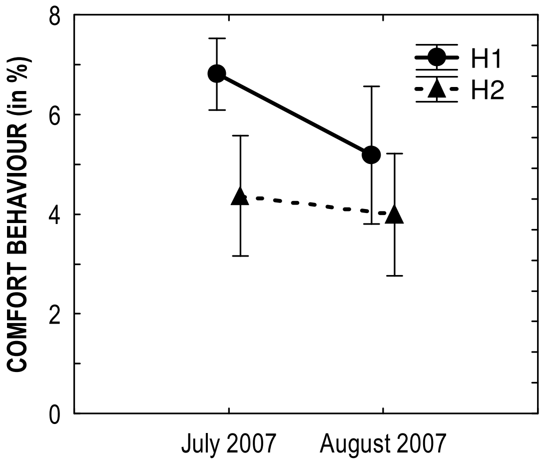
Graph 3 Change in grazing percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



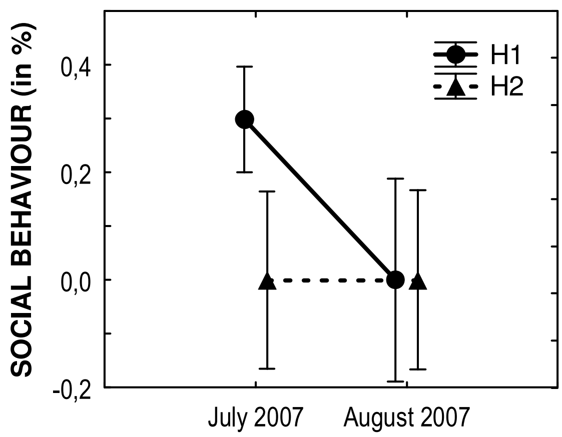
Graph 4 Change in ruminating percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



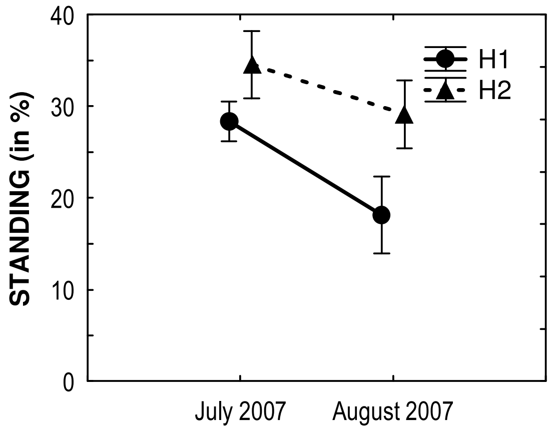
Graph 5 Change in comfort behaviour percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



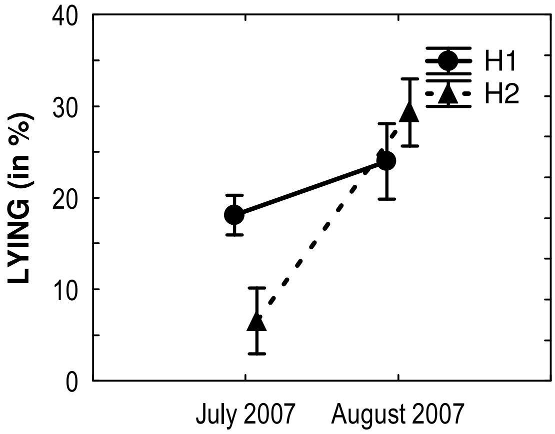
Graph 6 Change in social behaviour percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



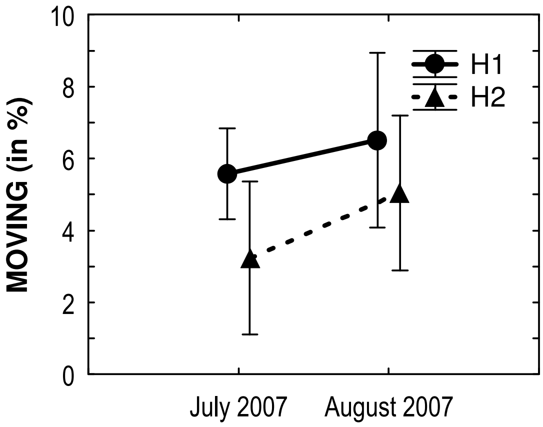
Graph 7 Change in standing percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



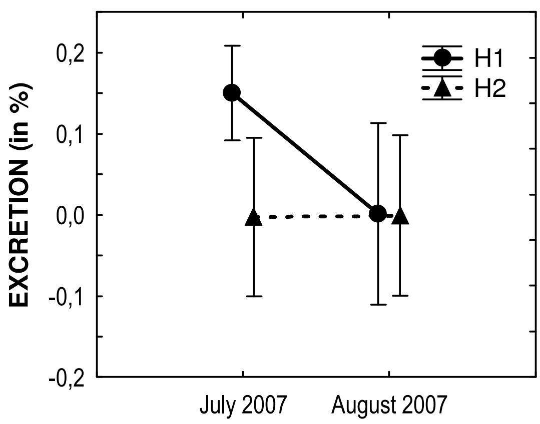
Graph 8 Change in lying percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



Graph 9 Change in moving percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



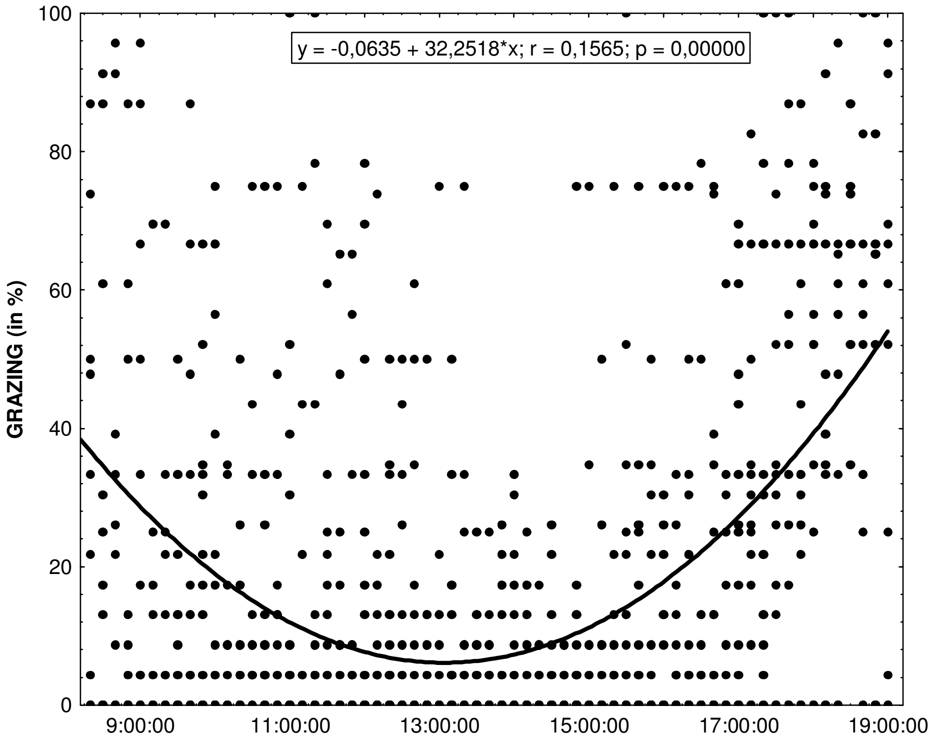
Graph 10 Change in excretion percentage proportion of H1 and H2 of Swayne's hartebeest between July and August 2007 in NSNP (H1 – main herd, H2 – temporary herd)



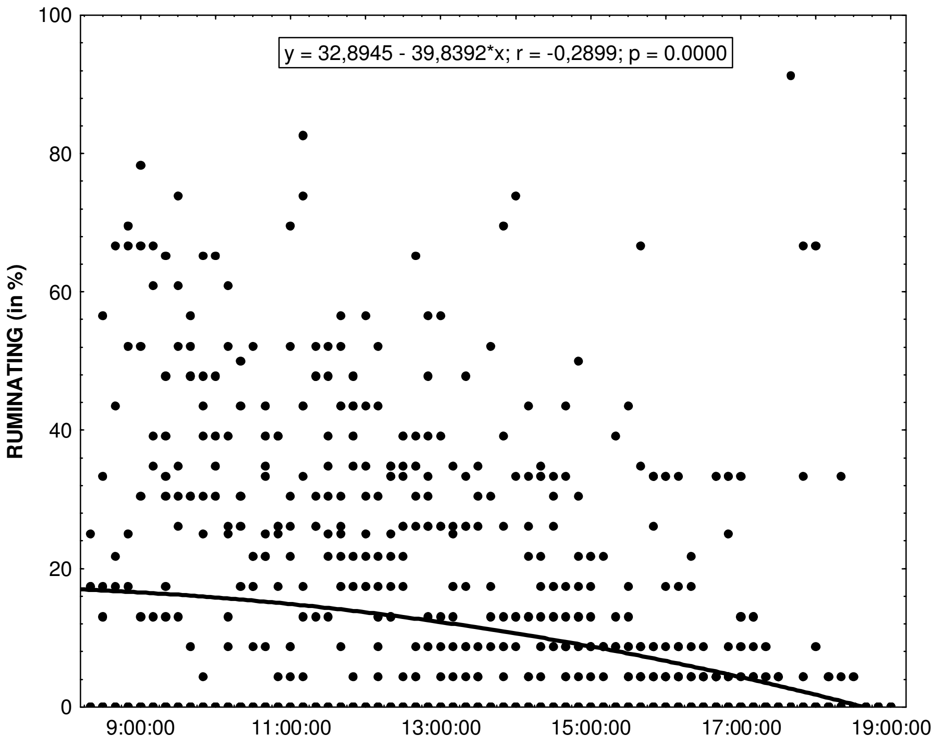
Using regression analysis, we got graphs showing the percentage proportion of activities due to the day time.

Graphs 11, 14, 15 and 16 show dependence between resting, movement and looking for food. Whereas they are mostly standing or lying during the midday, in the morning and evening hours they are more active and are usually grazing. Percentage proportion of ruminating (Graph 12) and comfort behaviour (Graph 13) is decreasing with crescent time.

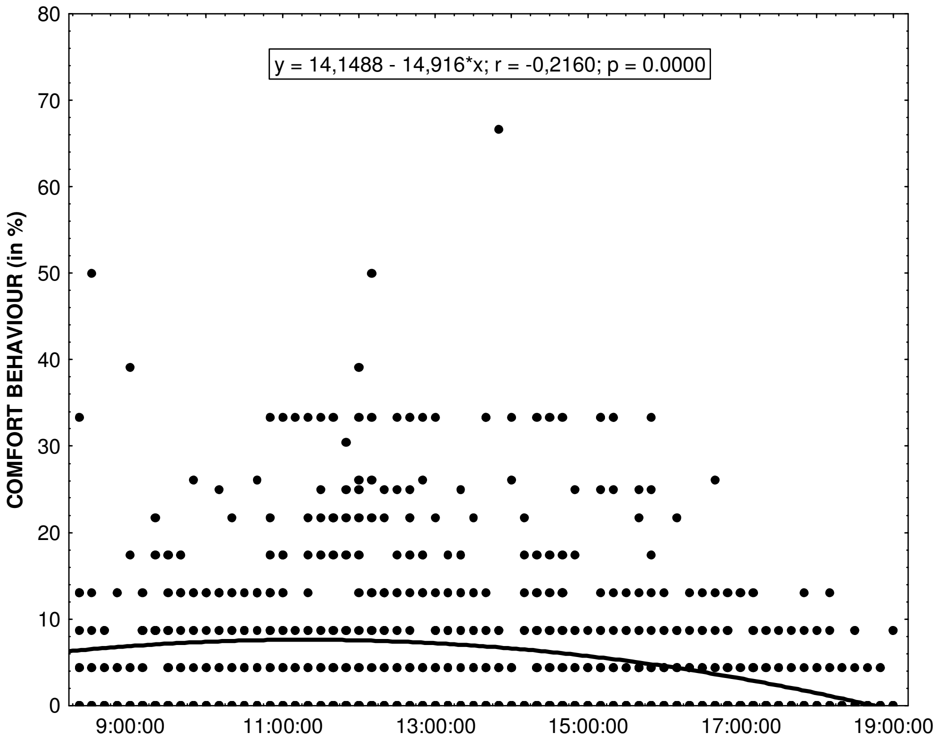
Graph 11 Day time influence on percentage proportion of grazing by Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007



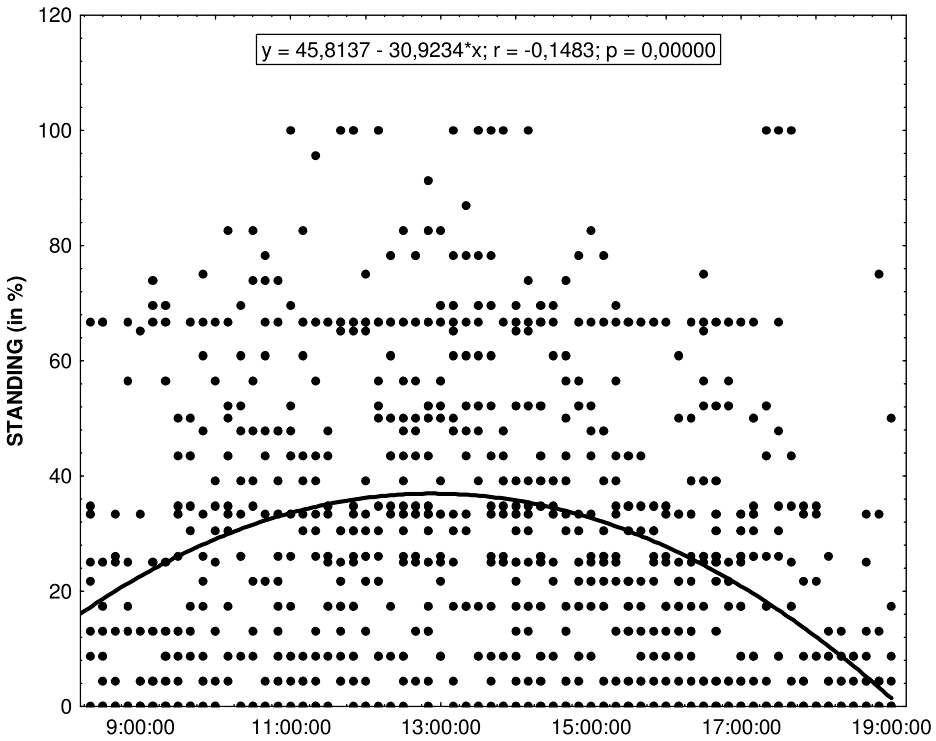
Graph 12 Day time influence on percentage proportion of ruminating of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007



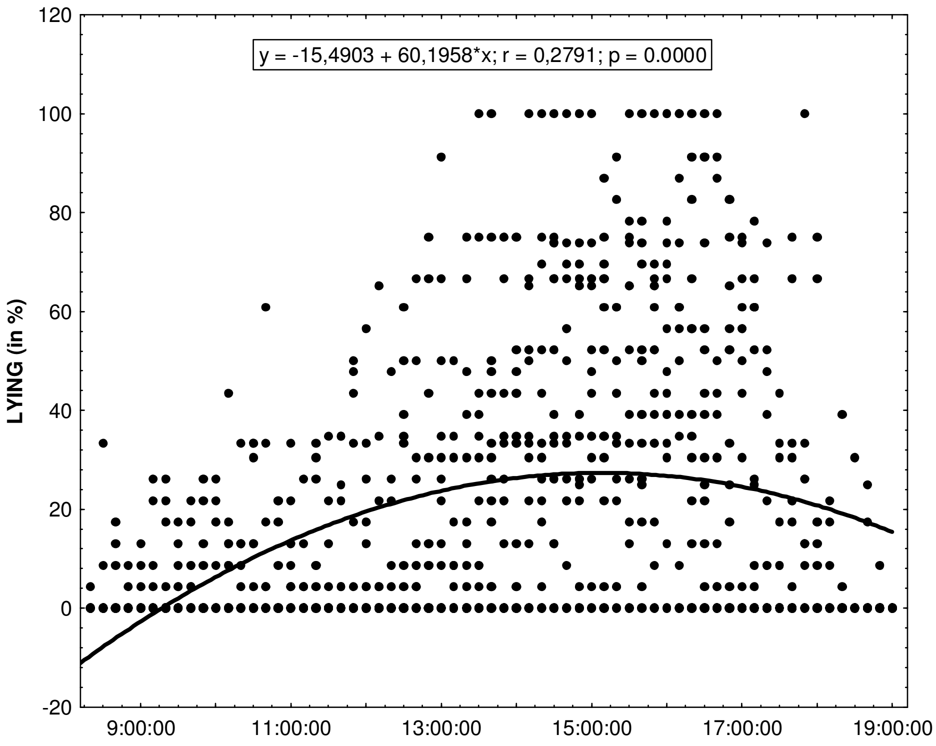
Graph 13 Day time influence on percentage proportion of comfort behaviour of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007



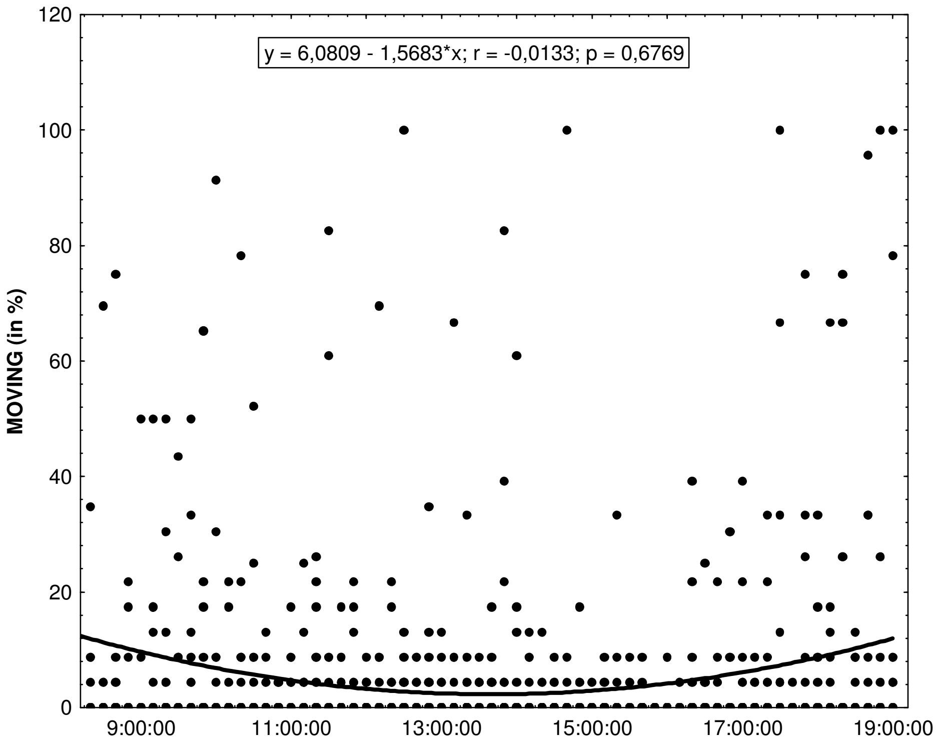
Graph 14 Day time influence on percentage proportion of standing of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007



Graph 15 Day time influence on percentage proportion of lying by Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007



Graph 16 Day time influence on percentage proportion of moving by Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007

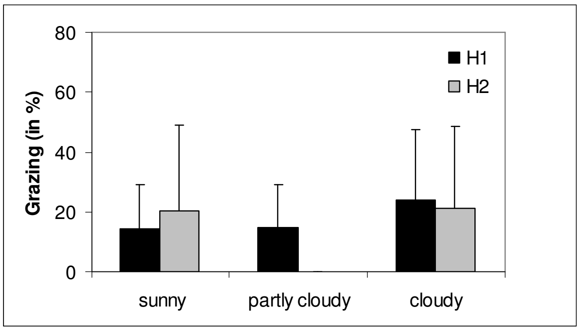


Column graphs with deviation segments were used for expression of dependence between weather and percentage proportion of activities for main herd and temporary herd.

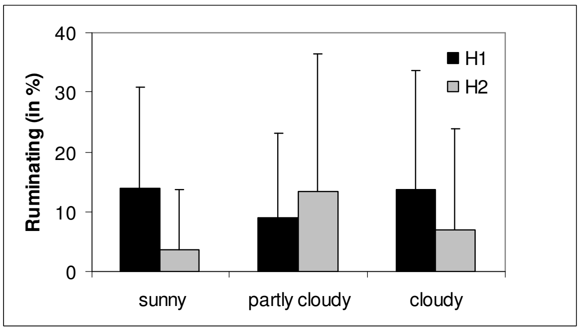
The weather was divided into three categories:

1. sunny — stands with temperature >35°C
2. partly sunny — stands with temperature 25 – 35°C
3. cloudy — stands with temperature < 25°C

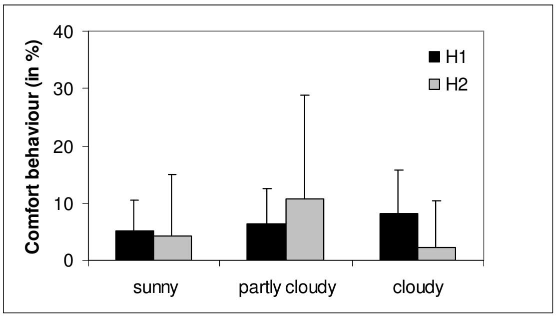
Graph 17 Weather impact on grazing of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



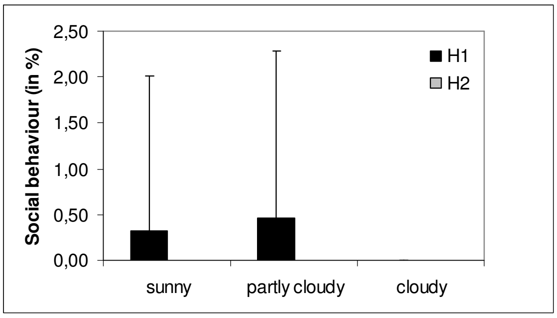
Graph 18 Weather impact on ruminating of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



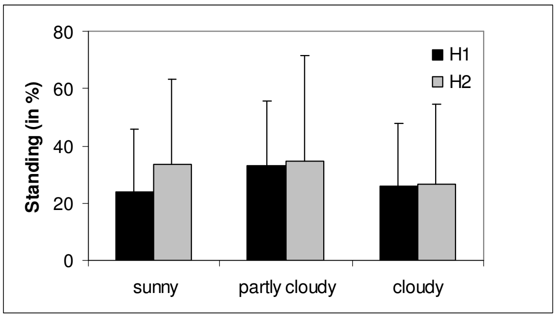
Graph 19 Weather impact on comfort behaviour of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



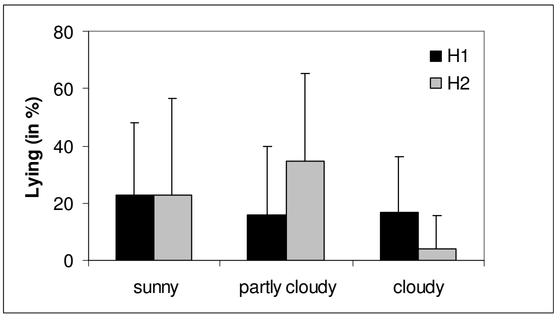
Graph 20 Weather impact on social behaviour of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



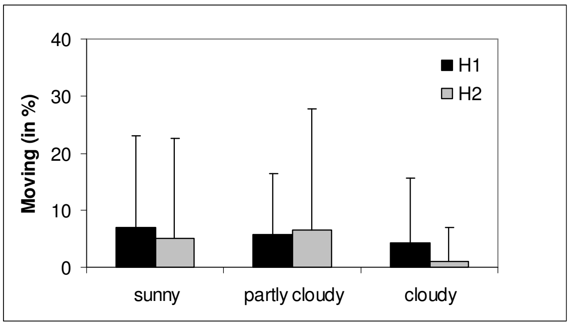
Graph 21 Weather impact on standing of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



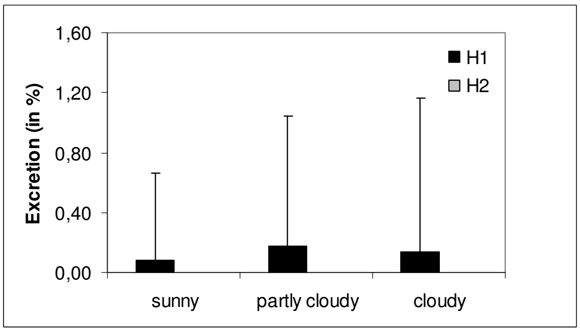
Graph 22 Weather impact on lying of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



Graph 23 Weather impact on moving of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



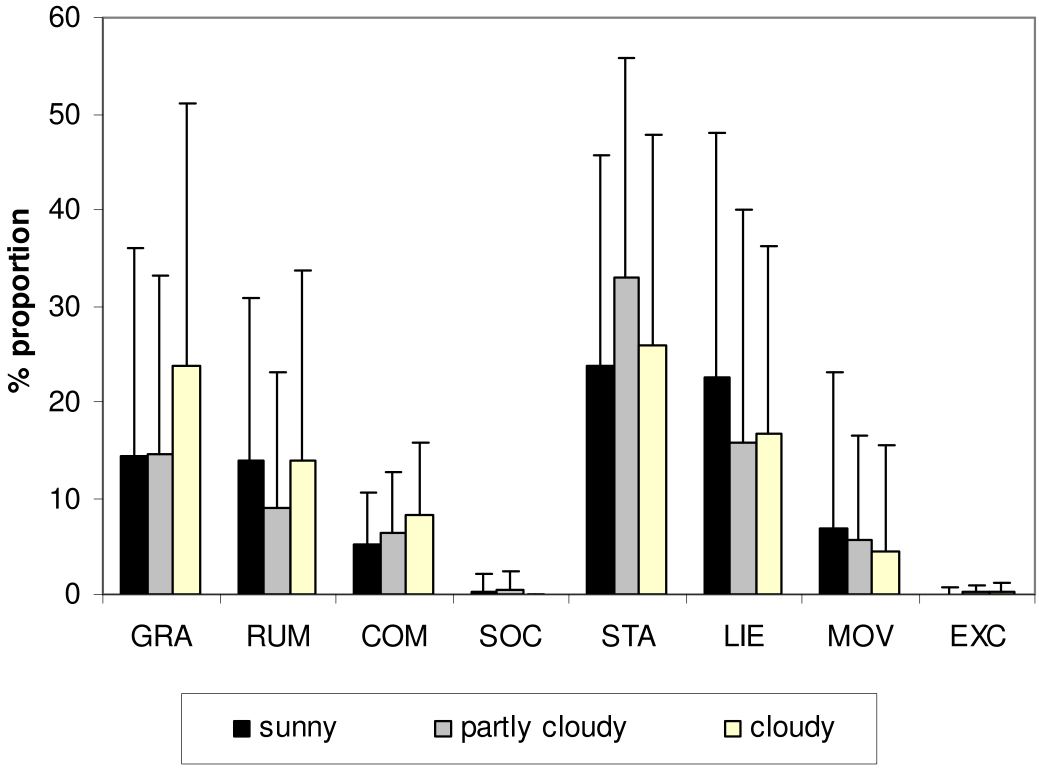
Graph 24 Weather impact on excretion of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007 (comparison of herds) (H1 – main herd, H2 – temporary herd)



Last column graph compares percentage proportion of all activities in different weather conditions.

Standing was the most represented activity in all weather conditions, whereas for social behaviour and excretion are insufficient data. Comfort behaviour and grazing are two activities that increase with worsening weather on the other side percentage proportion of moving is decreasing. Lying is mostly represented in sunny conditions and ruminating reaches the top values in sunny and cloudy conditions.

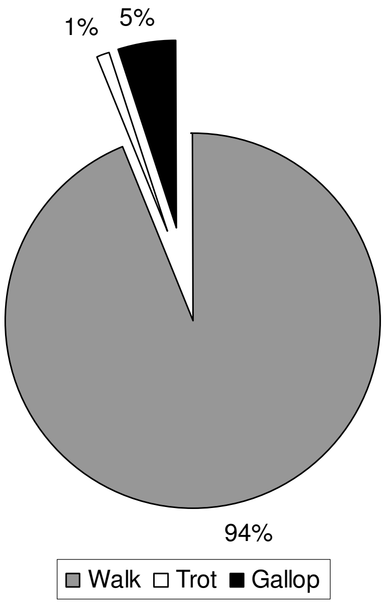
Graph 25 Comparison of percentage proportion of all activities of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in different weather conditions in Nech Sar NP during summer 2007 (GRA – grazing, RUM – ruminating, COM – comfort behaviour, SOC – social behaviour, STA – standing, LIE – lying, MOV – moving, EXC – excretion)



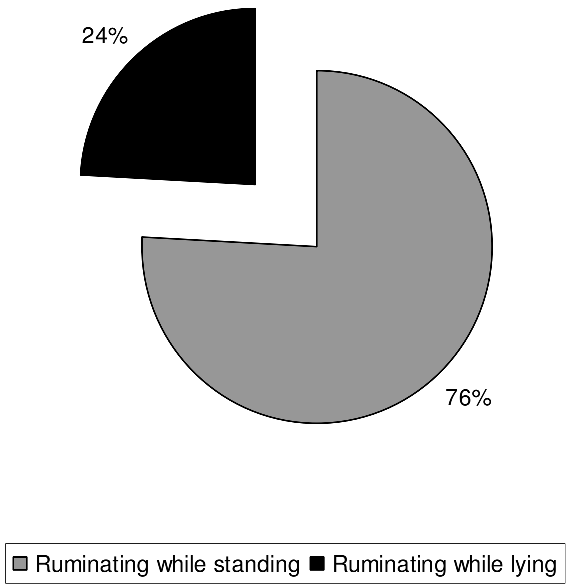
Data about percentage proportion of subactivities were used for elaborating pie graphs.

Movement of hartebeests (Graph 26) is mostly (94%) represented by walk, only 6% fall on gallop and trot. Ruminating (Graph 27) is divided into three subactivities, ruminating while standing, ruminating while lying and ruminating while moving. Last mentioned subactivity was not recorded in hartebeest population in Nech Sar, ruminating while standing is represented by 76%, ruminating while lying by 24%.

Graph 26 Percentage proportions of subactivities of moving for Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007

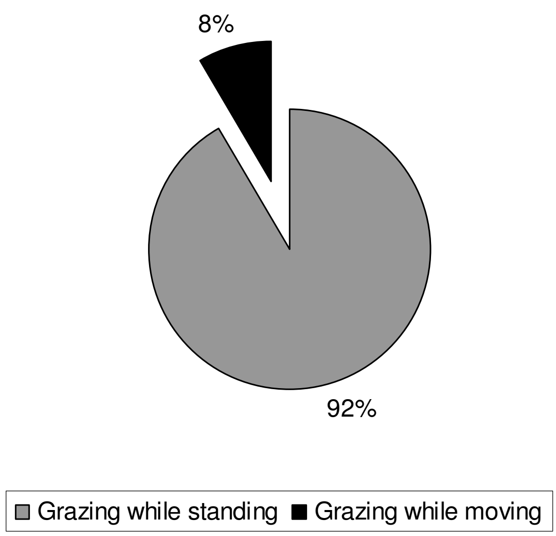


Graph 27 Percentage proportions of subactivities of ruminating for Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007

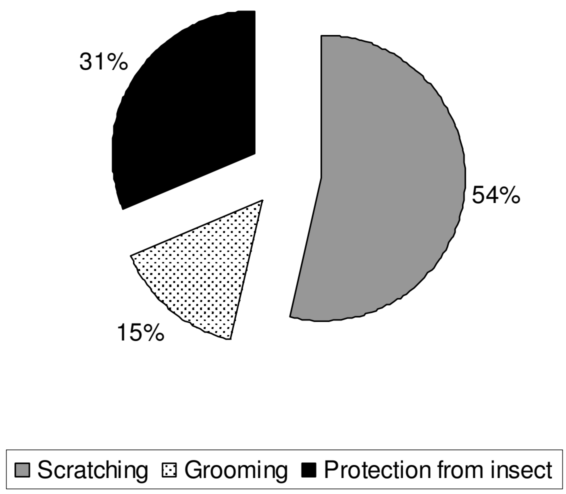


Grazing (Graph 28) is mostly represented by subactivity grazing while standing. Only the rest of 8% belongs to subactivity grazing while moving. Comfort behaviour (Graph 29) is divided into three subactivities: scratching (54%), protection from insect (31%) and grooming (15%).

Graph 28 Percentage proportions of subactivities of grazing for Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007

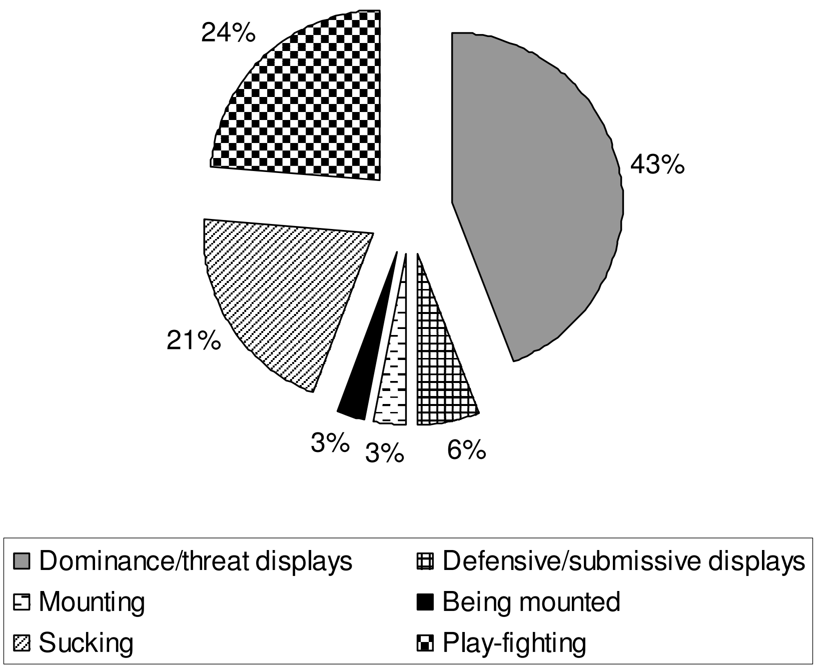


Graph 29 Percentage proportions of subactivities of comfort behaviour for Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007



The last graph shows percentage proportion of subactivities of social behaviour (Graph 30), where dominance/threat displays are the most expressed. Important role in display of social behaviour pertains to sucking and play-fighting which are represented by more than 20%. 6% belongs to defensive/submissive displays and by 3% are demonstrated by two subactivities: mounting and being mounted.

Graph 30 Percentage proportions of subactivities of social behaviour for Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar NP during summer 2007



7. Discussion

The aim of this thesis was general monitoring and understanding of the home range/habitat utilization and movements of the population of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park.

During summer 2007, using the direct count of animals from one point, 35 hartebeests were counted. During first few days, after proper exploration of the park, I found out that hartebeest are located only in the middle of the plains, so I was able to count them from Kalo Sadullo hill that is situated right in the middle of this area. This method appeared to be the best method of counting compared with previous year. African Parks used the method of aerial survey and counted 29 animals (Derek Clark – manager of Nech Sar, 2007 per. com.). Dutch students, Eenink and van Sluis (2006), counted 27 individuals using vehicle for direct ground survey intend on counting from north of the plains to the south.

Important is the development of numbers of Swayne's hartebeest in the past (Appendix 11) and comparison of animals increase in these years. From available data it is known that during an extensive survey from 1971 to 1973 by M. Bolton, hartebeest were located in significant numbers in only two areas (Senkelle Swayne's hartebeest Sanctuary and Nech Sar National Park) (Tischler, 1975). In 1973 in Nech Sar were counted 103 (Bolton, 1973), but during next year the number decreased dramatically to very low numbers and in the same year 120 animals were translocated from Senkelle Swayne's hartebeest Sanctuary. This translocation was not successful since only very few of the translocated animals had survived. In September 1974, only 87 animals from translocated animals were observed in Nech Sar on the central plain and they did not join the original population, which was located in the southern section of the park and were easily distinguished by their lighter colour (Tischler, 1975).

This experience could be benefit for the park management. It is very important to focus on local population and its development before the translocation of other animals, where the success is not warranted and could be very difficult to achieve such success because of many factors. One of them could be the adaptation (especially feeding habits) on local condition and difficult adaptation to another condition.

During the study population structure was determined (Table 2, 3). After comparison with results gained by Eenink and Sluis in summer 2006 (Table 4, 5) I got different numbers.

In 2006, 8 solitary males were missed and there was high mortality in age group of calves. From 5 calves born in 2006 has survived just one. Interesting could be the difference in numbers of sub-adult males. I observed 5 of them (3 in a main herd, 2 in temporary herd consisted only of males). That could be caused by shorter time spent by observations in 2006 by Dik Eenink and Richard van Sluis, who did not have so much time for population structure observation as me. Another reason could be effect of different observer and in some cases general difficulty in age group determination, especially between adult and sub-adult group.

In spite of these differences in numbers and difficulties with mortality percentage presumption, I was able to estimate the population growth in next years using simplified method for population growth estimation (Graph 2, Appendix 12). I focused on the time that would be needed for recovery of the population size on the level from 1975 before the socialist regime in Ethiopia was toppled. In this time, the population counted 130 animals and did not suffer from extinction like in these days. Firstly, I estimated the population growth without including the mortality. In this case, the recovery of the population would be achieved very quickly, in 2012 it would count 128 animals. Including mortality and maximum level of protection of the population, this process would take two years longer, in 2014 the population would count 142 animals. Regrettably, this simple life table method includes only the mortality and no other aspects of population size changes, such as genetic loss caused by inbreeding, low founder effect, receiving or losing animals because of migration, higher mortality due to predation and poaching or natural disasters. Therefore, we cannot predict, that the population of Swayne's hartebeests in Nech Sar will be increasing.

This prognosis is sustained by comparison of effective population size in 2006 and 2007. Whereas the ratio of effective population size and census was in 2006 approximately 1:8, in 2007 this ratio was 1:9.3. The effective population size in 2006 formed 12.6% of the real population, in 2007 the percentage decreased to 11%. The decreasing tendency is visible, although we are not supposed to draw conclusions using data from only 2 years.

The social structure of herd according to Demeke (1997) consists of females and their young that are led by a bull. This ordering is broken only in breeding season when an old female takes over the role of the leader. Our study took 2 months and during this time was confirmed the structure of the herd besides the breeding season. The herd consisted of 11 adult females, 3 sub-adult females, 1 female juvenile and 2 female calves. Males were represented by the main bull, 3 sub-adult males and 2 male calves. Here arises the need of longer-term study.

Identification of individuals in the population was not easy due to low sexual dimorphism (Demeke, 1997). 7 identification cards were elaborated, but only 5 of them are based on differences in body marks, such as black stripes and spots or some other distinguishing marks. Identification cards of Bango and Sara were created because of their specific position in the herd. This is probably useless for next year's identification, because their position in the herd could be easily changed in next few months.

The photographs of animals were used for better visualisation of identification features. It was difficult to take pictures of animals, because of their shyness and insufficient photographical equipment. Therefore, I would consider these identification cards as a simple base for future identifications with recommendation for using superior equipment.

Spatial distribution of Swayne's hartebeests in the park is displayed on enclosed maps (Appendices 2, 3, 4). For elaborating maps of seasonal home ranges of herds and solitary males (Appendices 2, 3) was used the Kernel method for estimating probability densities from a set of points. From this method, we got the probable size of seasonal home range of hartebeests in the park using 90% and 10% probability of appearance. Appendix 9 compares these home range sizes using Kernel method and Minimum convex polygons method (MCP), which is based on connecting peripheral points of a group of points, such that external angles are greater than 180° (Rodgers *et al.*, 1998).

In between July and August 2007 the main herd changed its location and moved from their usual place to another, where they stayed till the end of the study, both areas as well as the area of temporary herd distribution are visible in the Appendix 2. Comparing the area of seasonal home range of main herd in July and August 2007, the area is more extensive in August.

Very important on spatial distribution of main herd is its location comparing with other hartebeest location. Never happened that main herd shared its area with any other hartebeest. On the other site, temporary herd of three males familiarly shared its area with one of the solitary males in space and in time as well. The main herd sustains the role of uniqueness as the only reproductive unit.

Appendix 3 shows map of spatial distribution of solitary males. According to Kernel analysis the home range size vary from 6 335 m^2 to 61 461 m^2 with 90% probability of appearance and from 113 481 m^2 to 1 785 140 m^2 with 10% probability of appearance. From this map is visible space overlapping of solitary male home ranges. This overlapping is not only in space but in time as well. According to Bolton (1973) and Estes (1991), males are territorial, but this statement was not confirmed in this study. During the study happened that 3 to 5 solitary males were seen together in the same area in the same time. This could be caused by insufficient space in the park preferred by hartebeest.

Appendix 4 consists of map displaying distribution of cattle and hartebeest in the Nech Sar National Park. Cattle occupy most of the north part of the plains as well as the way to the drinking point used probably by hartebeests. Although Bolton (1973) states that Swayne's hartebeests are independent from water (instead they could get all water they require from the vegetation they eat), from the personal communication with scouts of African Parks, Wondmagegn Tamiru and Mengesha Maricho I found out that time to time hartebeests are moving to the northern part of the plains. This could be because of supplement of water loss. This could be proved by records of hartebeest positions in unusual area, where they were seen just once during the study (Appendix 4).

On 22nd July in the early morning the herd was found in unusual location far away from the regular position and spent there most of the day. The position is considered to be unusual because it is very close to roads that the herd usually avoid and because the herd has not be seen there any more time. On 22nd July, in evening hours, they moved back to their ordinary place. From this experience I suppose that they were on the way form the northern part, respectively from the drinking point.

Once the position of solitary male was recorded in the north of the plains (displayed on the map in Appendix 4). This is considered to be unusual as well, because no more hartebeest were seen in this location anymore and it is confirming the theory with their occasional movement to the drinking point.

Maps of seasonal home ranges of hartebeests in the park are not important for the size of home ranges, for example the home range of "Beda" was done on the base of only 3 points and that is insufficient amount of initial data. For proper home range evaluation would be needed more record of hartebeests position. These maps are important for vivid spatial distribution of Swayne's hartebeest in the park according to human activities.

Appendix 4 shows spatial distribution not only of hartebeest but also of cattle on the plains. Although the other species such as zebra or gazelle are familiarly seen grazing in the same area as cattle, hartebeest are purposely avoiding these areas. It is probably due to long-term poaching of hartebeest in the park that should be eradicated in these days, but probably in lower exposure still appears. This was confirmed by personal communication with local people, especially scouts of Nech Sar.

For studying behavioural patterns were used different factors, such as weather, day time and change of the month, that can significantly influence the behaviour.

According to Gebre (2000), the diurnal activity pattern of *Alcelaphus buselaphus swaynei* follows the general pattern of ruminants in the tropics with peaks in feeding in the early morning and late afternoon and increase in resting (standing and lying) in the middle of the day. This statement was confirmed using regression analysis (Graphs 11 – 16).

Scatter graphs (Graph 3 – 10) with trend lines were elaborated for illustration of change in percentage proportion of each activity with change of the month (July/August). In these graphs is compared main herd with temporary herd, the trend of percentage proportion is the same for both, main and temporary herd except of social behaviour and excretion, where is not sufficient amount of initial data.

Important is change in percentage proportion of activities for the main herd, because of the change of its position in between the two months. The reason of the change is unclear, but is proved turnover of weather that could influence not only the percentage proportion of activities, but could be the reason for location change. Whereas the weather in July was mostly sunny, during August was more frequently partly cloudy and cloudy with occasional rains.

Animals' activity increase would be expected with colder weather condition. This was verified by increase in percentage proportion of movements and decrease in a case of standing. Proportion of comfort behaviour, social behaviour and excretion had decreasing trend in a case of main herd, but this should not be considered as decisive, because these are short-term activities, that are usually in a case of herd scanning missed in between recording intervals.

The effect of weather on proportion of main activities is displayed in column graphs (Graphs 17 – 24), where is proved significant effect on all activities except of excretion. In this case, we used the division of weather into three categories: sunny, partly cloudy and cloudy, that stand with temperature above 35°C for sunny, in between 25 and 35°C with partly cloudy and below 25°C stands with cloudy. This does not have to be the right division, it is based only on my own experience, but should express the weather manifestation.

Anyway, the influence of weather was not confirmed. For gaining valuable results would be needed more and detailed records of weather conditions documented by temperature changes during the day.

Last part of the thesis is focused on percentage proportion of subactivities in the main activity. From these graphs is visible that walk is the most preferred way of movement, gallop forms 5% and trot is very rare. That verify the statement of Estes (1991) that the main gaits of alcelaphines are walk and gallop. Ruminating proved to be mostly represented while standing, probably because of better control of surroundings. Comfort behaviour and social behaviour are influenced by low numbers of initial data, but it is clear that scratching is most represented activity from comfort behaviour and in the case of social behaviour it is dominance/threat displays, that was often used by the dominant bull to maintenance of its position.

The aims of the thesis were fulfilled except of the last point, study of interaction between Swayne's hartebeest and external factors. Results on these interactions were not gained due to very low numbers of interaction record. It is needed more time than just two months, to get detailed information about factors that are influencing hartebeests behaviour.

8. Conclusions

The objectives of the study were to determine the population size and structure and to describe spatial distribution and further to understand habitat utilization of one of the last living population of Swayne's hartebeest in its natural environment in Nech Sar National Park in Ethiopia.

Gaining these data is very important for knowledge about *Alcelaphus buselaphus swaynei*, because generally is very few know about this species. This work extends information about Swayne's hartebeest in Nech Sar and could be also a good information source for people interested in hartebeest in general.

During the study the individuals in the population were counted and the age and sex structure was determined. From total count of 35 animals, 11 were adult females, 3 sub-adult females, 1 female juvenile and 2 female calves. The rest of 18 animals were males, 11 adult, 5 sub-adult and 2 calves. The population consists of main herd, that involves all females, one dominant bull, 3 sub-adult males and 2 male claves, and small temporary herd that is composed of one adult male and 2 sub-adult males.

Population dynamics estimation was done, using simple method of population growth estimation without effect of different factors except of predefined mortality in females calves and adult females. Due to this method, the population size is increasing, but it would be possible only in ideal condition, that means without the effect of genetic loss caused by inbreeding, low founder effect, animals migration, predation, poaching or natural disasters. According to gained information about the effective population size from 2006 and 2007 the population is decreasing. This is more probable tendency, although follow results got from data just from 2 years would not be valuable.

The diurnal behavioural pattern of Swayne's hartebeest were confirmed to be the same like pattern of ruminants in tropics, with most demonstrable activity in the morning and evening hours and with dominant resting activities during the midday.

Spatial distribution of hartebeest in the park proved that hartebeest prefer areas without human impact, especially cattle pastures that are ordinarily grazed by other animals of the plains (zebra, gazelle) with cattle together.

Generally, longer study on hartebeest is needed. Two months do not provide sufficient time for detailed observations, especially for population dynamics, where I was compelled to use just the estimation of the population development. It is appropriate to clarify factors such as calves' mortality, impact of inbreeding, predation, poaching or lack of natural habitat that is caused by human activities in the park. In a case of more available data, preparation of population dynamics model that would have more predicative value than the estimation could be elaborated.

This study is just a small step in Swayne's hartebeest observation in Nech Sar and consist of only basic information about hartebeest in the park. The study needs to be extended and intensified during next years to change the decreasing tendency of the population development. Of course, it needs deeper knowledge of observation and analytical methods and last but not least more financial resources. That all could be a challenge for further studies.

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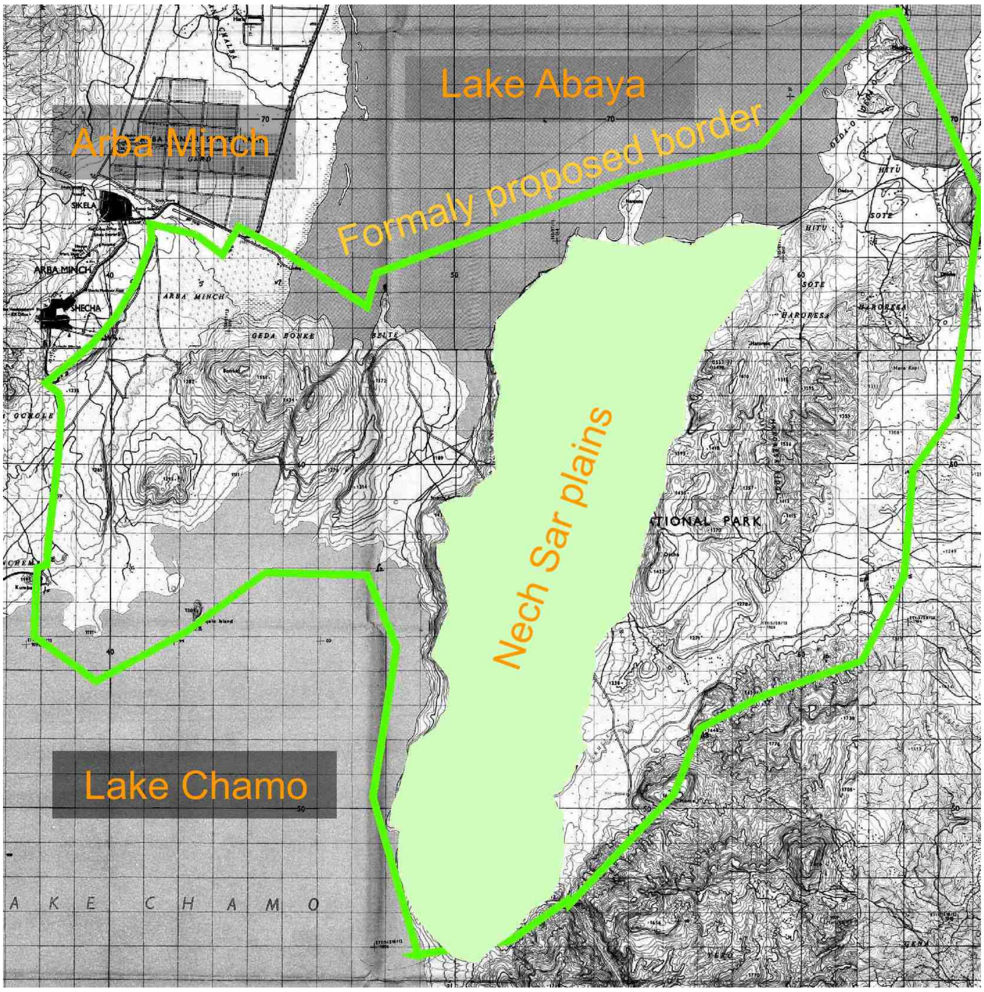
10. Appendices

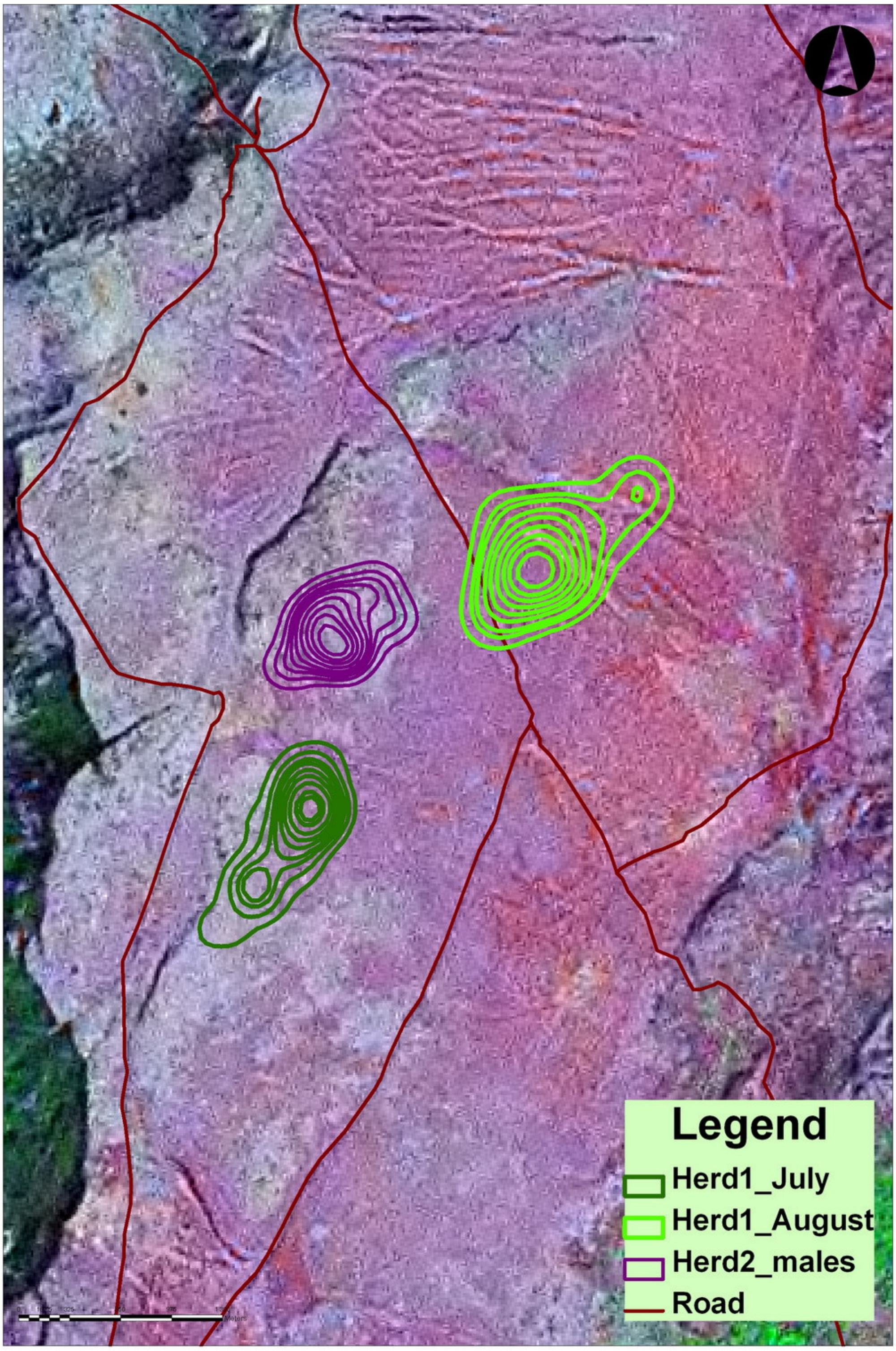
Appendix 1

Map of Nech Sar National Park boundaries



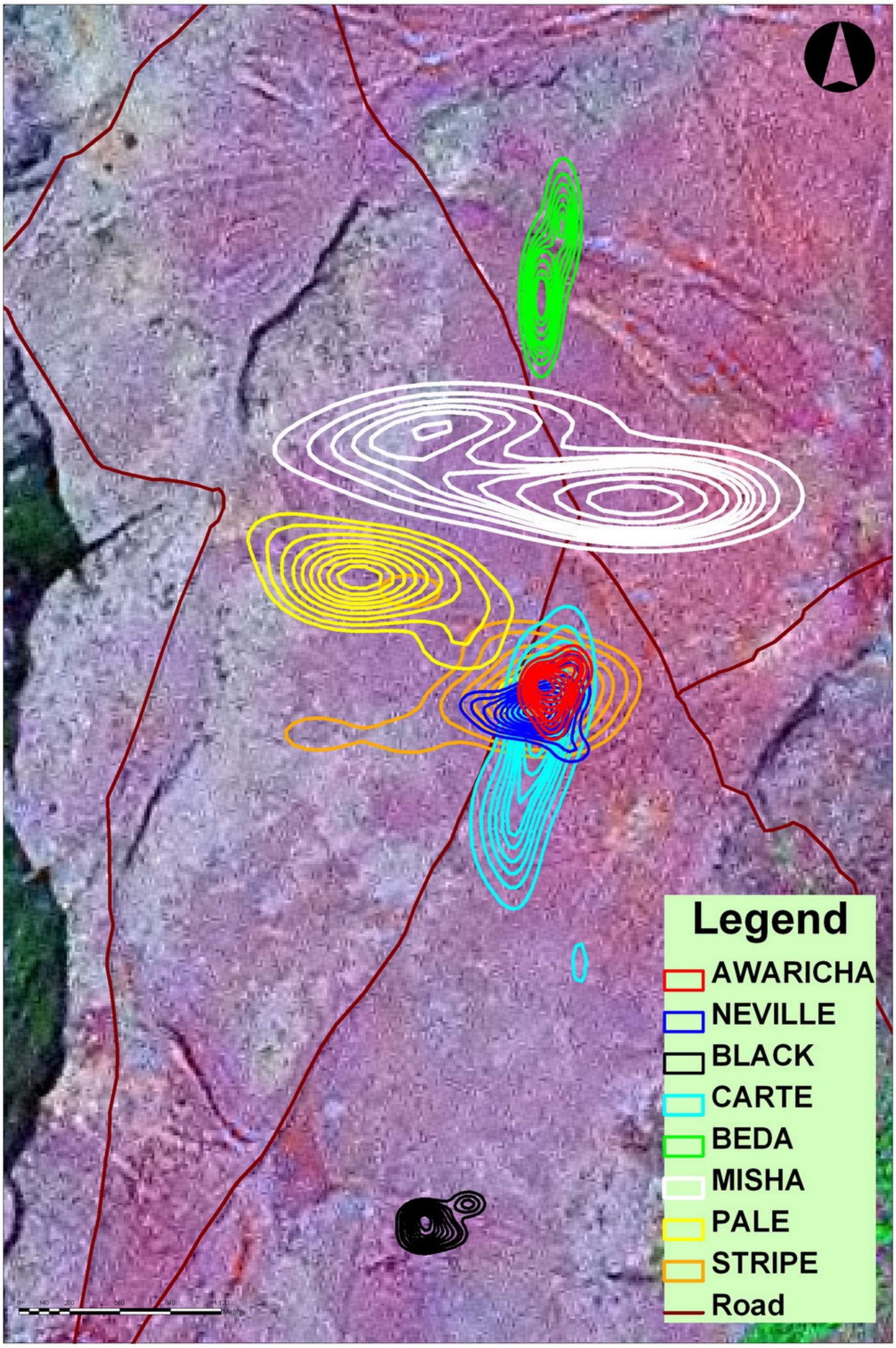
Appendix 2

Map of seasonal home range of main herd and temporary herd of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park (Herd 1 – main herd, Herd 2 – temporary herd) (Kernel home range analysis, Rodgers *et al.*, 1998)



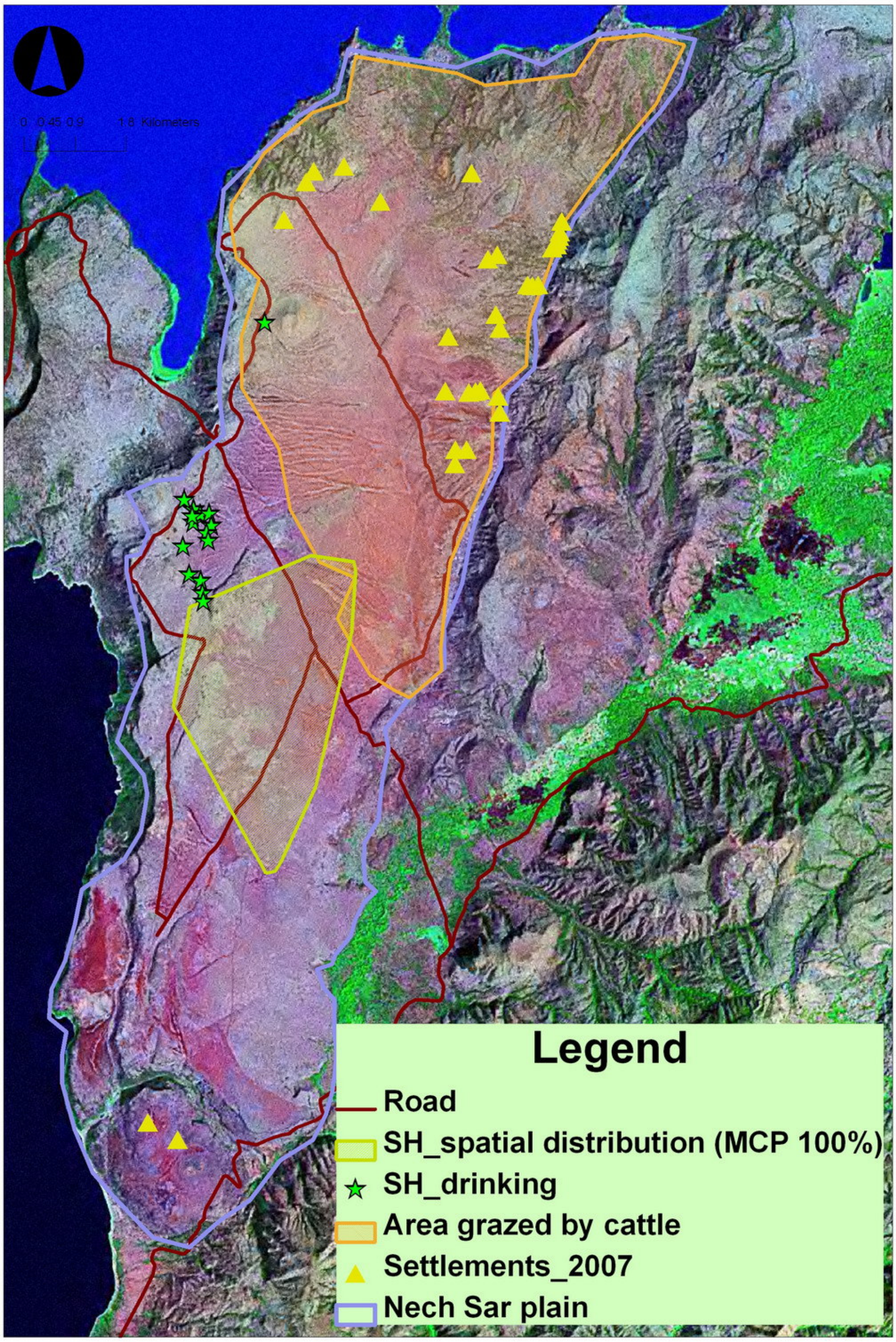
Appendix 3

Map of seasonal home range of solitary males of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park (Kernel home range analysis, Rodgers *et al.*, 1998)



Appendix 4

Map of seasonal home range of all Swayne's hartebeest (*Alcelaphus buselaphus swaynei*), area of the plains grazed by cattle and Swayne's hartebeests in unusual positions in Nech Sar National Park (MCP 100%, Rodgers et al., 1998)



Appendix 5

List of Swayne's Hartebeest (*Alcelaphus buselaphus swaynei*) activities used during study in summer 2007 in Nech Sar National Park

Code 1	Name 1	Code 2	Name 2	Code 3	Name 3
STA	**Standing**	STA1	normal position		
LIE	**Lying**	LIE1	normal position (sternal)		
MOV	**Moving**	MOV1	walk		
		MOV2	trot		
		MOV3	gallop		
		MOV4	jump		
CEW	**Chewing**	CEW1	ruminating while standing		
		CEW 2	ruminating while lying		
		CEW 3	ruminating while moving		
EAT	**Eating**	EAT1	grazing while standing		
		EAT2	grazing while moving		
DRI	**Drinking**	DRI1			
EXC	**Excretion**	EXC1	urination		
		EXC2	defecation		
COM	**Comfort behaviour**	COM1	scratching	*by horn-tips, legs, objects*	
		COM2	grooming	*licking, biting*	
		COM5	protection from insect		
SOC	**Social behaviour**	SOC1	communication	SOC11	social licking
				SOC12	vocal communication
				SOC13	rubbing forehead/nasal brush
				SOC14	sniffing
		SOC2	agonistic behaviour	SOC21	dominance/threat displays
				SOC22	defensive/submissive displays
				SOC23	fighting
		SOC3	sexual behaviour	SOC31	lip-curl (urine-testing)
				SOC32	head-resting
				SOC33	mounting
				SOC34	being mounted
		SOC4	parent/offspring behaviour	SOC41	nursing
				SOC42	sucking
				SOC43	refusing suckling
				SOC44	sucking attempt
		SOC5	play	SOC51	object plays
				SOC52	moving plays
				SOC53	play-fighting
				SOC54	sexual plays
ANT	**Antipredator behaviour**	ANT1	human presence		
		ANT2	animal predator presence		
INT	**Interspecies interactions**		reaction to another animal species		
OUT	**Out of sight**				

Appendix 6

Overview of scan sampling of Swayne's hartebeests (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park (H1 – main herd, H2 – temporary herd)

object of observation	*date*	*time from*	*time to*
H1	7.7.2007	11:40	17:10
	8.7.2007	9:30	17:10
	10.7.2007	11:20	16:30
	11.7.2007	14:40	16:00
	12.7.2007	9:00	17:20
	14.7.2007	10:50	17:40
	17.7.2007	8:30	17:40
	21.7.2007	8:20	19:00
	22.7.2007	6:50	19:00
	24.7.2007	9:20	19:00
	25.7.2007	8:00	13:00
	25.7.2007	16:50	19:00
	27.7.2007	18:30	22:10
	8.8.2007	7:00	19:00
	11.8.2007	7:00	19:00
	13.8.2007	7:00	19:00
	1.9.2007	7:00	12:00
H2	18.7.2007	13:10	18:00
	19.7.2007	11:40	17:40
	22.7.2007	13:30	17:30
	24.7.2007	7:50	13:00
	24.7.2007	15:40	18:40
	25.7.2007	8:20	13:10
	25.7.2007	16:40	19:00
	22.8.2007	7:10	19:00
	31.8.2007	7:20	19:00
	1.9.2007	8:10	19:00

Appendix 7

Overview of focal animal sampling of Swayne's hartebeest (*Alcelaphus buselaphus* swaynei) in Nech Sar National Park

date	time from	time to	sampling length (sec.)
6.7.2007	10:33:33	17:00:00	23187
19.7.2007	10:42:16	18:00:00	29864
21.7.2007	8:23:05	19:00:00	38215
24.7.2007	9:15:35	19:00:00	35065
25.7.2007	8:05:07	13:00:00	17693
25.7.2007	16:51:25	19:00:00	7715
11.8.2007	7:02:33	19:00:00	43047
13.8.2007	7:12:37	19:00:00	42443
14.8.2007	6:59:22	15:00:00	28838
14.8.2007	7:11:45	15:00:00	28095
15.8.2007	15:00:00	19:00:00	14400
15.8.2007	15:20:01	19:00:00	13199
22.8.2007	10:00:00	19:00:00	32400
22.8.2007	7:05:19	19:00:00	42881
22.8.2007	7:00:00	8:26:26	5186
23.8.2007	7:00:00	19:00:00	43200
23.8.2007	7:28:43	19:00:00	41477
24.8.2007	7:09:09	19:00:00	42651
24.8.2007	7:10:07	19:00:00	42593
29.8.2007	7:32:03	19:00:00	41277
29.8.2007	7:29:44	19:00:00	41416
29.8.2007	7:20:52	19:00:00	41948
31.8.2007	7:35:09	19:00:00	41091
31.8.2007	7:36:28	19:00:00	41011
31.8.2007	12:45:22	19:00:00	22478
1.9.2007	7:11:25	10:00:00	10115
total (sec.)			811485
total (hours)			225,4

Appendix 8

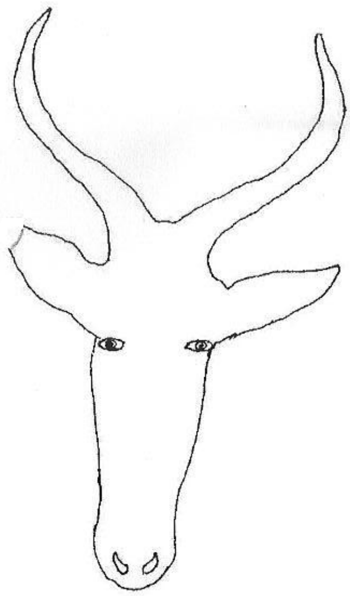
ID cards

Scientific name :	*Alcelaphus buselaphus swaynei*		
English name :	Swayne's Hartebeest	**Sex :**	male
Name :	Bango	**Age group :**	adult
Location :	Nech Sar National Park, Ethiopia		
Animal description : The dominant bull in the main herd.			

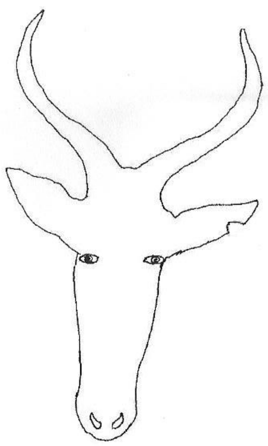
Scientific name :	*Alcelaphus buselaphus swaynei*		
English name :	Swayne's Hartebeest	**Sex :**	male
Name :	Black	**Age group :**	adult
Location :	Nech Sar National Park, Ethiopia		

Animal description :

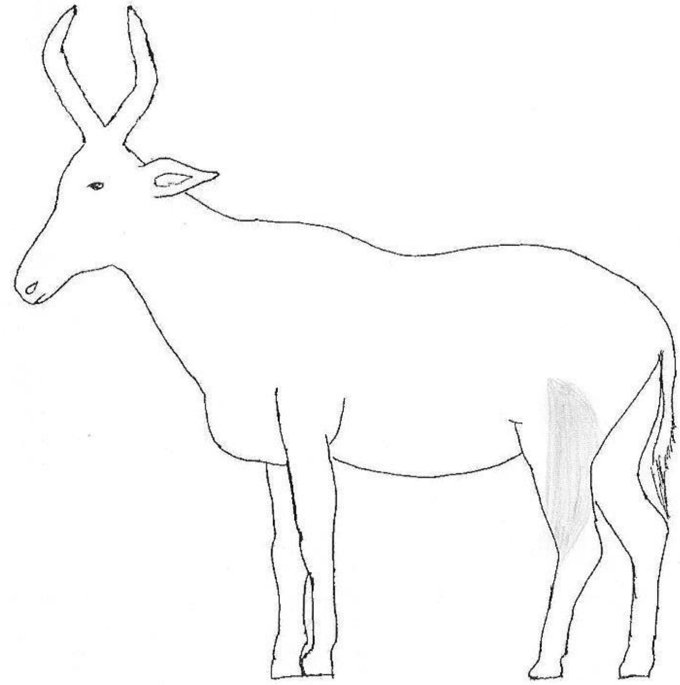
Is darker than Hartebeest usually are, black spots on front legs are disappearing in the dark colour of the body; important mark is missing top of the right ear – visible by telescope for far distance.

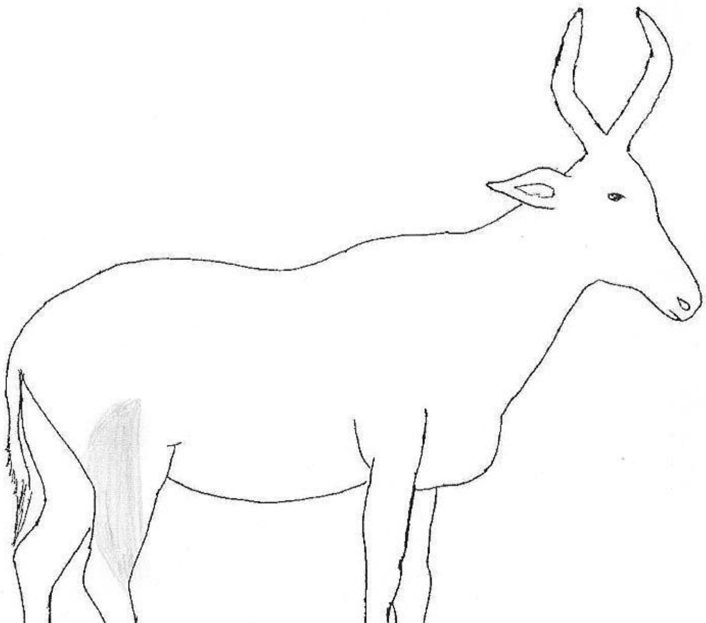


Scientific name :	*Alcelaphus buselaphus swaynei*		
English name :	Swayne's Hartebeest	**Sex :**	male
Name :	Misha	**Age group :**	adult
Location :	Nech Sar National Park, Ethiopia		
Animal description : Older male hartebeest; identification mark is tearing of the left ear			

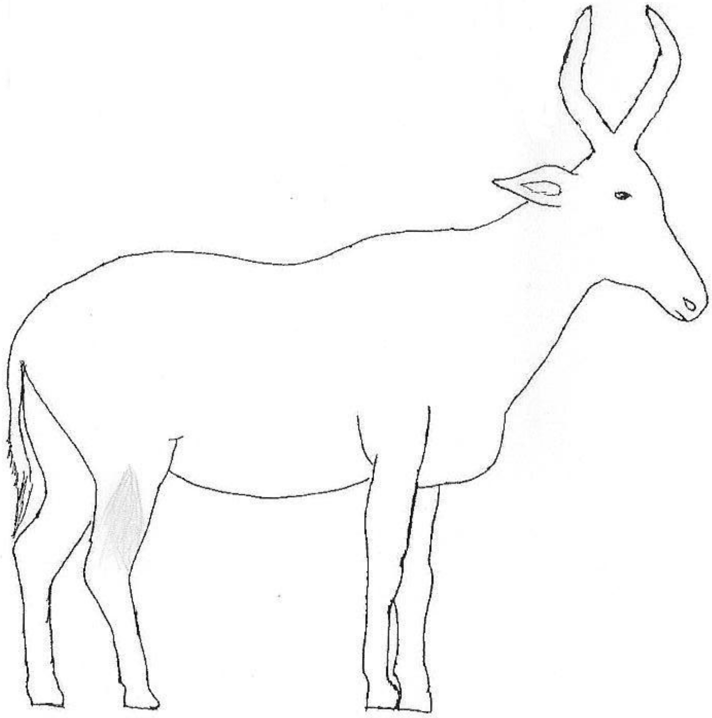


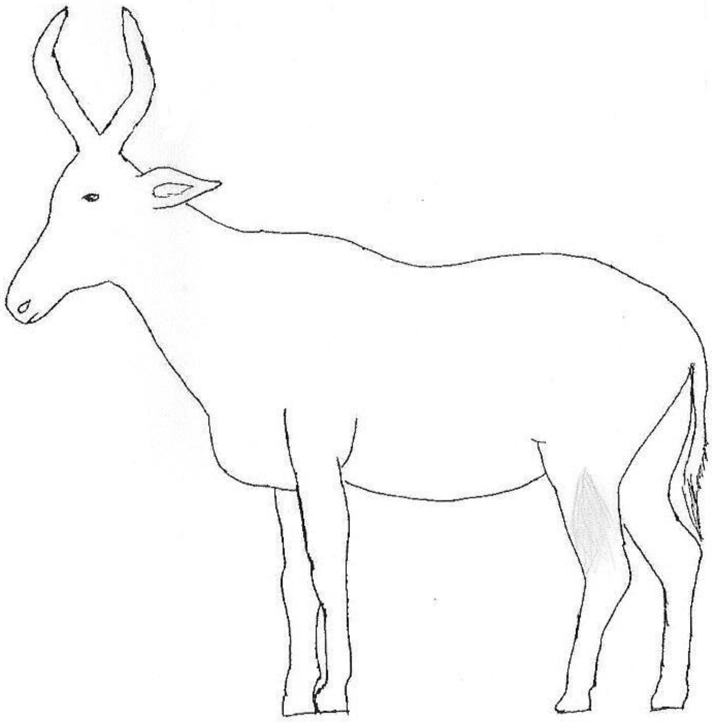
Scientific name :	*Alcelaphus buselaphus swaynei*		
English name :	Swayne's Hartebeest	**Sex :**	male
Name :	Neville	**Age group :**	adult
Location :	Nech Sar National Park, Ethiopia		
Animal description : Longer black spots on the hinders; visible black line dividing dark flank and light abdomen			





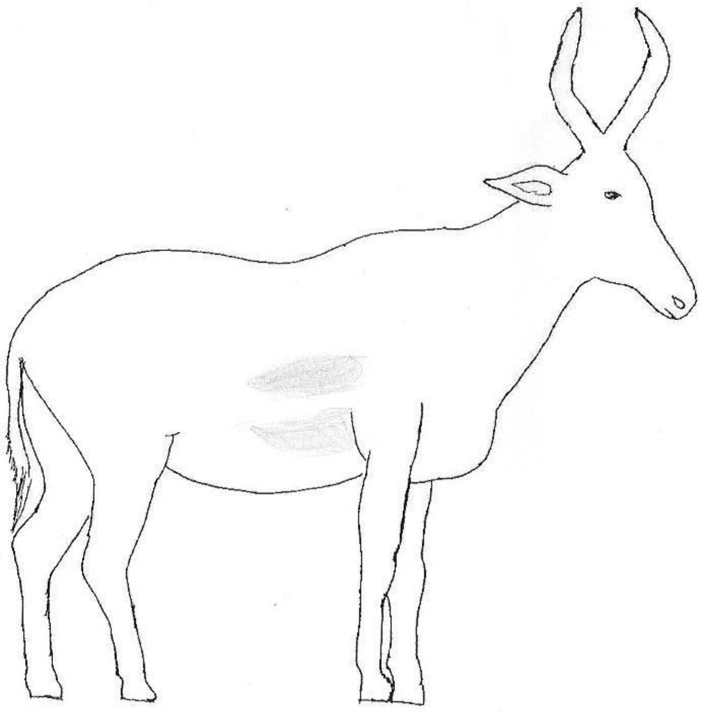
Scientific name :	*Alcelaphus buselaphus swaynei*		
English name :	Swayne's Hartebeest	**Sex :**	male
Name :	Pale	**Age group :**	adult
Location :	Nech Sar National Park, Ethiopia		
Animal description : According to the black marks is not very old – on the flank does not have any, on the hinders just indication of black colour; whole body is pale			

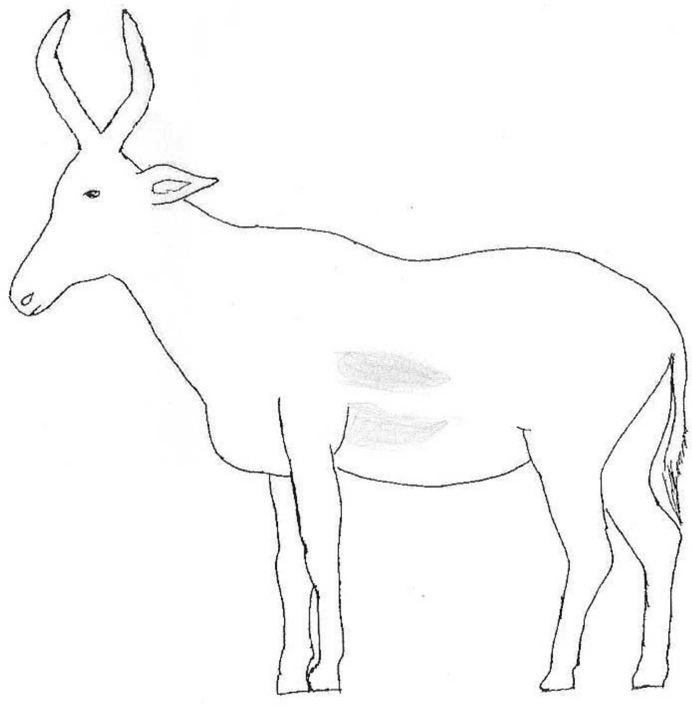




Scientific name :	*Alcelaphus buselaphus swaynei*		
English name :	Swayne's Hartebeest	**Sex :**	female
Name :	Sara	**Age group :**	juvenile
Location :	Nech Sar National Park, Ethiopia		
Animal description : The only juvenile in the herd			

Scientific name :	*Alcelaphus buselaphus swaynei*		
English name :	Swayne's Hartebeest	**Sex :**	male
Name :	Stripe	**Age group :**	adult
Location :	Nech Sar National Park, Ethiopia		
Animal description : Black spots on the flanks are visibly formed in two stripes			





Appendix 9

Comparison of home range area of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park using Kernel analysis (90% and 10% probability of appearance) and MCP 100% analysis in ArcView 3.2 The Home Range Extentions (Rodgers, Carr, 1998) (p.a. – probability of appearance)

name	*Kernel analysis* (m^2)		*MCP 100%* (m^2)
	90% p. a.	10% p. a.	
Awaricha	6 334,51	138 777,28	46 019,57
Beda	11 881,08	266 847,19	7,50
Black	4 231,30	113 480,70	29 168,34
Carte	24 766,32	688 714,23	514 082,16
Misha	61 461,04	1 785 140,16	588 307,34
Neville	7 668,87	244 236,29	126 323,92
Pale	22 067,53	855 021,22	282 171,45
Stripe	24 308,30	837 919,63	698 417,83
H1 July	13 748,45	671 397,57	1 044 751,23
H1 August	36 960,27	1 014 700,61	446 118,49
H2	24 062,59	550 418,16	162 111,83

Appendix 10

Comparison of population structure of Swayne's hartebeest in Nech Sar National Park during summer 2006 and 2007. (H* – head group, S* – subgroup, M* – solitary male, H1 – main herd, H2 – temporary herd, S – solitary male)

Eenink, Sluis, summer 2006

number	*classification*	*age group*	*sex*
1	H01	Adult	Female
2	H02	Adult	Female
3	H03	Adult	Female
4	H04	Adult	Female
5	H05	Adult	Female
6	H06	Adult	Female
7	H07	Adult	Female
8	H08	Calf	Female
9	H09	Calf	Female
10	H10	Calf	Female
11	H11	Calf	Female
12	H12	Calf	Male
13	H13	Sub-adult	Female
14	H14	Sub-adult	Female
15	H15	Sub-adult	Female
16	H16	Sub-adult	Female
17	H17	Sub-adult	Female
18	H18	Adult	Male
19	S01	Adult	Male
20	S02	Adult	Female
21	S03	Sub-adult	Female
22	S04	Sub-adult	Female
23	M01	Adult	Male
24	M02	Adult	Male
25	M03	Adult	Male
26	M04	Adult	Male
27	M05	Adult	Male

Vymyslická, summer 2007

number	*classification*	*age group*	*sex*
1	H1	Adult	Male
2	H1	Adult	Female
3	H1	Adult	Female
4	H1	Adult	Female
5	H1	Adult	Female
6	H1	Adult	Female
7	H1	Adult	Female
8	H1	Adult	Female
9	H1	Adult	Female
10	H1	Adult	Female
11	H1	Adult	Female
12	H1	Adult	Female
13	H1	Sub-adult	Male
14	H1	Sub-adult	Male
15	H1	Sub-adult	Male
16	H1	Sub-adult	Female
17	H1	Sub-adult	Female
18	H1	Sub-adult	Female
19	H1	Juvenile	Female
20	H1	Calf	Male
21	H1	Calf	Male
22	H1	Calf	Female
23	H1	Calf	Female
24	H2	Adult	Male
25	H2	Sub-adult	Male
26	H2	Sub-adult	Male
27	S	Adult	Male
28	S	Adult	Male
29	S	Adult	Male
30	S	Adult	Male
31	S	Adult	Male
32	S	Adult	Male
33	S	Adult	Male
34	S	Adult	Male
35	S	Adult	Male

Appendix 11

Overview of population size of Swayne's hartebeest (*Alcelaphus buselaphus swaynei*) in Nech Sar National Park since 1967 until 2007

Year	Number counted/estimated	Source
1967	130	Blower, 1967
1970	78	Bolton, 1970
1973	103	Bolton, 1973
1975	130	Stephenson, 1975
1995	18	Yirmed, 1995
2003	47	A. Hall-Martin, pers. com., 2006
2005	40	Ersado, Hall-Martin, 2006
2006	27	Eenik, Sluis, 2006
2007	35	Vymyslická, 2007

Appendix 12

Estimation of population growth of Swayne's hartebeest in Nech Sar National Park within the years 2006 and 2013, comparing development without and with mortality included.

	real	real	estimation						
without mortality	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
No of females birth	4,0	2,0	2,0	7,0	7,5	8,5	9,5	13,0	16,8
No of 1 year females	0,0	1,0	2,0	2,0	7,0	7,5	8,5	9,5	13,0
No of 2 years females	7,0	3,0	1,0	2,0	2,0	7,0	7,5	8,5	9,5
No of adult females	8,0	11,0	14,0	15,0	17,0	19,0	26,0	33,5	42,0
No of births total	5,0	4,0	14,0	15,0	17,0	19,0	26,0	33,5	42,0
Birth sex ratio (%)	*50,0*	*50,0*	*50,0*	*50,0*	*50,0*	*50,0*	*50,0*	*50,0*	*50,0*
No of females calves - theoretic	4,0	2,0	7,0	7,5	8,5	9,5	13,0	16,8	21,0
No of males calves- theoretic	1,0	2,0	7,0	7,5	8,5	9,5	13,0	16,8	21,0
No of females total	19,0	17,0	26,0	33,5	42,0	51,5	64,5	81,3	102,3
No of males total	8,0	18,0	25,0	32,5	41,0	50,5	63,5	80,3	101,3
TOTAL	**27,0**	**35,0**	**51,0**	**66,0**	**83,0**	**102,0**	**128,0**	**161,5**	**203,5**

including mortality									
Female calves mortality (50%)		1,0	2,8	3,2	3,4	3,6	4,2	4,9	5,7
No of females birth alive		1,0	2,8	3,2	3,4	3,6	4,2	4,9	5,7
No of 1 year females		1,0	1,0	2,8	3,2	3,4	3,6	4,2	4,9
No of 2 years females		3,0	1,0	1,0	2,8	3,2	3,4	3,6	4,2
No of adult females		11,0	14,0	15,0	16,0	18,8	21,9	25,3	28,9
Adult females mortality 10%									
No of adult females alive		11,0	12,6	13,5	14,4	16,9	19,7	22,7	26,0
No of births total		11,0	12,6	13,5	14,4	16,9	19,7	22,7	26,0
Females total		16,0	17,4	20,4	23,7	27,0	30,9	35,5	40,8
TOTAL	**27,0**	**34,0**	**42,4**	**52,9**	**64,7**	**77,5**	**94,4**	**115,7**	**142,1**