



POPULATION STATUS AND HABITAT ASSOCIATION OF SWAYNE'S HARTEBEEST (*Alcelaphus Buselaphus Swaynei* (Sclater, 1892)) IN MAZE NATIONAL PARK, SOUTHWEST ETHIOPIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

We investigated the population status and habitat association of the endemic and emblematic Swayne's Hartebeest (*Alcelaphus buselaphus swaynei*) in Maze National Park, Southwest Ethiopia. Line-transect sampling method was used for the population estimation, while habitat association was made based on the abundance of counted individuals in each habitat. Data were analyzed using descriptive statistics and compared with the χ^2 test. The counted population of Swayne's Hartebeest in the study period were 1456 and 1492 during wet and dry seasons, respectively showing no seasonal variation. Of these, 31.03% were adult males, 38.53% adult females, 13.95% sub-adult males, 15.96% sub-adult females, and 0.53% young. The number of adult females was higher than in the other age groups followed by adult males in both seasons. Significant differences were observed among age and sex structure during both seasons (wet season: $\chi^2=58.423$, $df=3$, $P < 0.05$; dry season: $\chi^2=534.08$, $df=4$, $P < 0.05$). The maximum group size was 36 and the minimum was 1. The ratio of adult males to adult females was 1:1.24 and 1:1.24, sub-adult males to sub-adult females were 1:1.16 and 1:1.12, adult males to sub-adult males was 1:0.36 and 1:0.56, adult females to sub-adult females was 1:0.33 and 1:0.49 in the wet and dry seasons, respectively. The male to female ratio was 1:1.22 and 1:1.19 during wet and dry seasons as well. The population trend among ten years were significantly differed ($\chi^2=1.71$, $df=9$, $P < 0.05$). The Swayne's Hartebeest was distributed in three habitat types (grassland, riverine forest, and scattered trees) with significant differences ($\chi^2=1109.94$, $df=3$, $P < 0.05$). The grassland was most preferred by the animal followed by the scattered tree habitat. Managing its habitats is recommended for sustaining the population of the animal.

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since this endangered and endemic wildlife is found only in two protected areas in Ethiopia of which Maze National Park harbors an increasing population trend in the last decade.

Keywords: Abundance; age structure; endemic; habitat preference; seasons; sex ratio.

1. INTRODUCTION

Ethiopia's jagged topography and varied climatic conditions have gifted the country with enormous wildlife species [1]. The country is known for a high rate of faunal and floral endemism and diversity, comprising at least 55 endemic mammals [2,3]. There are eight subspecies of hartebeests in the world [4]. Among them Ethiopia is home for the three subspecies (i.e. *Alcelaphus buselaphus lelwel*, *Alcelaphus buselaphus tora* and the endemic *Alcelaphus buselaphus swaynei*) which are categorized as endangered. The Swayne's Hartebeest (SHB) is an endemic antelope having long-face, a rich chocolate brown coloration [1] with fine spots and white tips on its hairs. It has chocolate band below the eyes and shoulders while upper part of the legs is black [5].

The habitats of SHB have been confined by high human settling and associated livestock populations. The competition with the cattle for grass has increased in all the protected areas (PAs) that in turn deteriorated the growth of palatable grasses but increased the shrubby and other unpalatable grasses [6]. Due to the intensive agriculture, livestock grazing, human settlement within and around the PAs including Maze National Park which alters critical habitats the conservation of wild animals has become a problem [1]. SHB is an endangered and endemic antelope found only in Senkele sanctuary and MzNP. This calls for continues assessment of its population status, habitat association and other ecological aspects such as age structure and sex ratio to ensure its sustainable existence. A research that focused on the population status and habitat association of the animal in MzNP was conducted [7] ten years ago. The habitat of the species has been under pressure since the people living adjacent to the park are dependent on the resources inside the park and given the endangered and endemic nature of the species, there is a need to have a recent scientific evidence on SHB and its habitat. An investigation of populace patterns is basic to relieve the decline of biodiversity, and essentially, species-habitat affiliations are a principal figure of its environment and critical for directing natural life administration [8]. Thus, knowledge of the current population size, age and sex structures of the species and its habitat preference would have great value for effective and sustainable conservation. Therefore, the aim of this study is to determine the

current population size, population structure and the habitat association of SHB in the study area.

2. MATERIALS AND METHODS

2.1 Study Area

The Maze National Park (MzNP) is located at 460 km southwest of Addis Ababa along the Wolaita Sodo-Sawla road in SNNPR. The park lies between 06° 03' to 06° 30' N latitude & 37° 25' to 37° 40' E longitude. Its altitude ranges from 900 to 1200masl and covers total area of 202 km² [9]. The study area lies in semi-arid agro-ecological zone of Ethiopia. The annual rainfall ranges between 843 and 1321 mm [10]. The rainy season in the area extends from March to October, while the dry season is from November to February [1, 10]. The lowest temperature in the wet season is 15.3°C in June and the highest (33.5°C) is in February for the dry season [11].

The Park is named after the river Maze, which traverses through its length and rises from southern parts of the surrounding highland and passes through the park from south to north direction and drains into Omo River. The park is surrounded by five districts of Gamo and Gofa zones. These are Daramalo in the south and southeast, Qucha in the northern part, Qucha Alfa in the northwest, Zala in the Southwest and Kamba in the South (Fig 1).

2.2 Fauna and Flora

About 39 species of large and medium mammals and 196 bird species are found in the Park [12]. The Park is also known for harboring the endangered and endemic sub-species of Swayne's hartebeest. The existence of these types of wildlife provides high opportunity for MzNP to develop ecotourism since wild animals are the major natural attractions for ecotourism development [13].

Most of the plains of the MzNP are covered by *Combretum-Terminalia* wooded grasslands [14, 15]. An occasional variant of woodland vegetation is usually associated with riverine habitats. Combretum dominated wooded grasslands occupy well-drained sites on the upland. This includes the higher ridges and side slopes. It is fire-induced type that replaced a true Combretum woodland or evergreen bush land forest. There are at least 146 plant species were

recorded in the Park [15]. Various tree, shrub [16], herb and grass species [17] exist in the park.

2.3 Sampling Design

Based on the major vegetation cover we stratified the study area into four habitat types as grassland, riverine forest, scattered trees and bushland. Line-transect sampling method was used to collect data [16, 18, 19, 20]. We laid a total of ten transects (5 in grassland; 2 in riverine forest; 2 in scattered trees; 1 in bushland) randomly (Table 1). Transects length varied from 4.0 to 5.0 km at a distance of 0.5 to 1.5 km between the two consecutive transects. Initial points were located using hand-held GPS. The end point of all transect was found to be reasonably far from their respective habitat edge to avoid the edge effect.

2.4 Data Collection

2.4.1 Population census

The individuals of the population of Swayne's Hartebeest were counted using a line transect method [18, 21] from October 2018 to April 2019 in the study area for both the wet and the dry seasons. Two independent observers counted the animals from the left and the right side of transects. Whenever the animal is observed in individual or in group, total

number, sex/age group, date, time, altitude, habitat type, and GPS location were recorded. Each habitat type was visited 12 times within a study period. Data were collected twice a day (in the early morning: 06:30 - 10:30 & afternoon to evening: 14:00 - 18:00) when the animals are active [19, 22, 23, 24]. Natural (e.g., group size, age/sex ratio) and artificial markings (e.g., different tags fixed on large plants along transect) were considered to reduce double counting [25, 22]. Secondary data were used to observe the population trend of the animal for a decade i.e. from 2010 to 2019 [1, 7, 26, 27].

2.4.2 Population structure

Age and sex composition of individual or herd of the animal were recorded as adult male (AM), adult female (AF), sub-adult male (SAM), sub-adult female (SAF) and young (Yg) [28]. Age and sex were determined based on body size, size and shape of the horns and body color [29, 30]. With Small body size individuals were recorded as young whereas medium body size individuals were identified as sub-adult male or sub-adult female. Large body size individuals were recognized as adult male or adult female [31]. During each count, the size of each group was recorded before classifying them into their respective sex and age categories. Individuals were considered as members of the same group if the distance between them was less than 50 m [32].

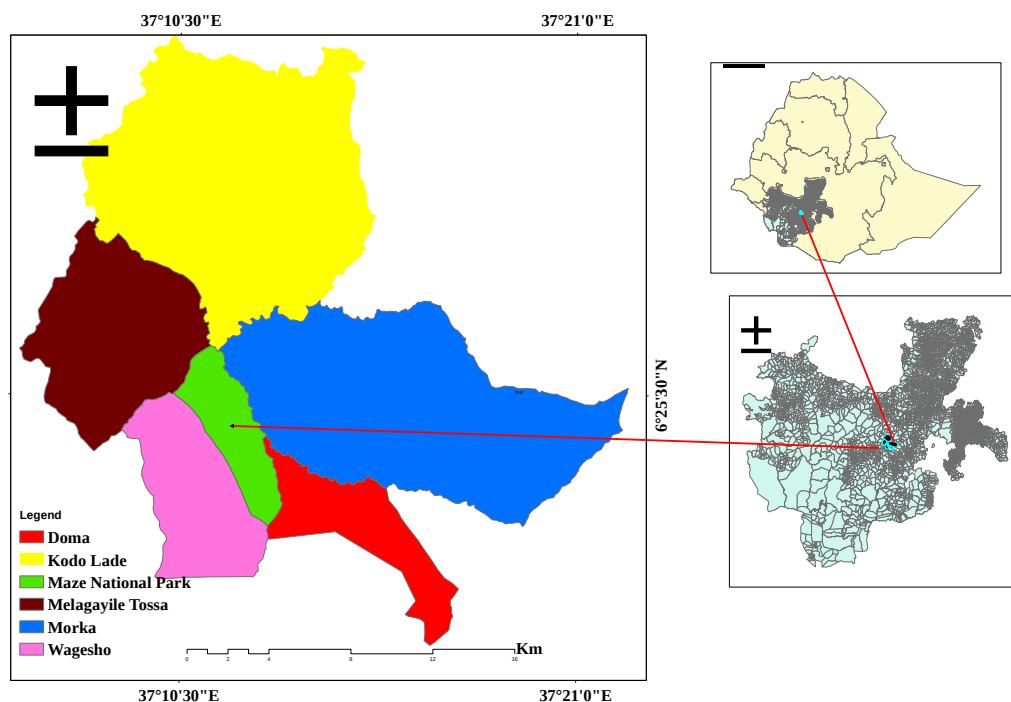


Fig. 1. Map of Maze National Park

Table 1. Description of transects in the study area

Habitat type	Number of sampled transects	Length of each transect (km)	Width of each transect (km)
Grassland	5	5	1
Riverine forest	2	5	0.5
Scattered trees	2	4	0.5
Bushland	1	4	0.5
Total	10	18	

Table 2. Number of individuals in each age and sex categories during wet and dry seasons

Age & sex structure	Season		Mean (SD)	Percentage		
	Wet	Dry		Wet	Dry	Mean
Adult male	481	433	457 (33.94)	33.04	29.02	31.03
Adult female	598	537	567.5 (43.13)	41.07	36.00	38.53
Sub-adult male	174	238	206 (45.25)	11.95	15.95	13.95
Sub-adult female	203	268	235.5 (45.96)	13.94	17.96	15.96
Young	-	16	8 (11.31)	-	1.07	0.53
Total	1456	1492	1474 (25.45)	100	100	100

Table 3. Age and sex ratio of Swayne's Hartebeest between seasons

Season	Age and Sex Ratio				
	AM:AF	SAM:SAF	M:F	AM:SAM	AF:SAF
Wet	1:1.24	1:1.16	1:1.22	1: 0.36	1:0.33
Dry	1:1.24	1:1.12	1:1.19	1:0.54	1:0.49

AM: adult male; AF: adult female; M: male; F: female; SAM: sub-adult male; SAF: sub-adult female.

2.5 Data Analysis

Data were analyzed using SPSS version 20 program and Microsoft excel. Total population was estimated in each habitat [18]. Number of counted animals during different seasons in each habitat, age and sex category, herd size were computed using χ^2 test. Other data were presented descriptively using tables and figures. Sex ratios for the herds were obtained from direct count of the animals [33].

3. RESULTS

3.1 Population Estimation and Structure

The number of Swayne's Hartebeest recorded in the wet and dry seasons was 1456 & 1492, respectively with no seasonal variation ($\chi^2 = 0.44$, $df = 1$, $P \geq 0.05$). The age structure showed a mean of 31.03% adult males, 38.53% adult females, 13.95% sub-adult males, 15.96% sub-adult females and 0.53 young (Table 2). The number of adult females was relatively higher than in the other age groups followed by adult males in both seasons. There was significant difference among age and sex structure of population size during both seasons (wet: $\chi^2 = 58.42$, $df = 3$, $P < 0.05$; dry: $\chi^2 = 534.08$, $df = 4$, $P < 0.05$).

The ratio of adult male to adult female was equally recorded in both seasons, while a slight difference was observed in ratio of sub-adult male to sub-adult female between seasons (Table 3).

3.2 Habitat Association

We observed the Swayne's Hartebeest in three habitat types i.e. grassland, scattered trees and riverine forest (Table 4) the maximum being in grassland (wet: 79.05%; dry: 70.97%). The smallest number was recorded in riverine forest (dry: 1.2%) with no record in wet season. reflecting significant variation between habitat types ($\chi^2 = 1109.94$, $df = 3$, $P < 0.05$).

The group size also differed with habitat type. The maximum number of individuals in a group was recorded in grassland followed by scattered tree, while the least was recorded in riverine forest i.e. 36, 17 & 23, 25, 5 in wet and dry season, respectively. On the other hand, the minimum group size that revealed in all types of habitats was the solitary male. The group size was differed significantly with habitat types in dry season ($\chi^2 = 13.736$, $df = 1$, $P < 0.05$) and not in wet season. On other hand, significant differences were detected between maximum and minimum group size between seasons within each

habitat type; grassland (wet: $\chi^2 = 33.11$, $df = 1$, $P < 0.05$; dry: $\chi^2 = 20.167$, $df = 1$, $P < 0.05$); scattered trees (wet: $\chi^2 = 14.22$, $df = 1$, $P < 0.05$; dry: $\chi^2 = 22.154$, $df = 1$, $P < 0.05$) whereas, in riverine forest small number was recorded only in dry season.

3.3 Population Trend

An increasing trend of population was showed among all study years Fig. 2. Significant difference was observed among ten years of population trend ($\chi^2 = 1.708$, $df = 9$, $P < 0.05$).

4. DISCUSSION

4.1 Population Abundance and Structure

Our findings showed more adult females (38.5% mean population size) than adult males (31.0). This is at odd with other studies, which reported more adult males Swayne's Hartebeest consisting 48% of the total population in the same park [1]. Similarly, a male-biased population structure was reported in Nech Sar National Park, which accounted for 50%

adult males and 40% adult females [34] in the past, though its local extinction is reported [35] latter. On the other hand, our result was in line with [7] who reported 24.5% adult males and 34.1% adult females at MzNP, and that of [36, 29, 37] who reported more females than males in Senkele Swayne's Hartebeest Sanctuary. Many male individuals were seen solitary during our study. This may expose male individuals to predation and human attack which could lead them to a low abundance. Our age structure investigation of the animal showed a low abundance of young individuals. We were able to detect them only in the dry season. This may be due to the dry season being the breeding season for Swayne's Hartebeest. In addition, a slight increase in population size of the animal in the dry season in the present study might be due to their better visibility in the dry season than in the wet helps for effective sampling. Moreover, since the dry season is the breeding season of the animal we might count newborn calves. The same trend was reported by Owen-Smith [37] that months of peak lactation match with the most favorable period of the year associated with the grassland and which ranges between December and February [38].

Table 4. Habitat and Seasonal estimate of Swayne's Hartebeest population

Season	Type of habitat							
	Grassland	(%)	Scattered tree	%	Riverine forest	%	Bushland	Total
Wet	1151	79.05	305	20.94	-	-	-	1456
Dry	1059	70.97	415	27.81	18	1.2	-	1492
Mean $\pm$ SD	1105 $\pm$ 65.1	75	360 $\pm$ 77.9	24.4	9 $\pm$ 12.72	1.2	-	1474 $\pm$ 25.5

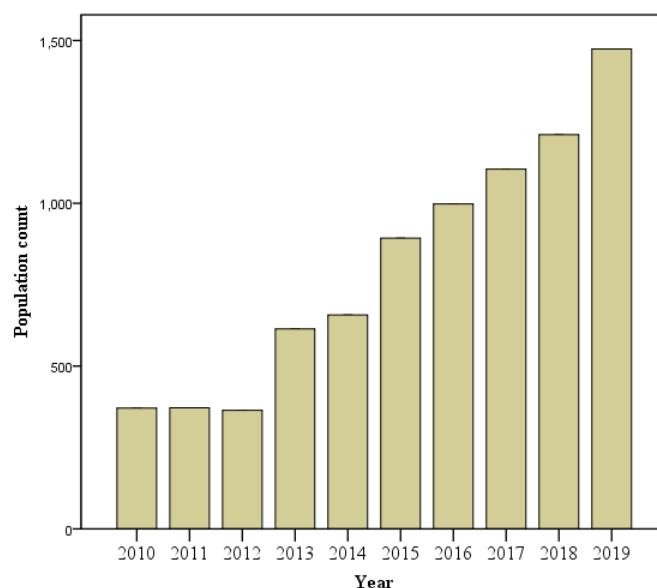


Fig. 2. Population trend of Swayne's Hartebeest for a decade (2010 - 2019) in the MzNP.

4.2 Habitat Association

The availability of quality forage and other resources determines the habitat preference and association of ungulates. A similar phenomenon was reported by researchers that habitat requirements of buffalo were closely associated with the availability of surface water, nutritionally rich food, and protection in Chebera Churchura National Park [39]. The present study revealed the same trend that Swayne's Hartebeest was highly associated with grassland, particularly on the newly emerged grass. This might be due to the availability of quality forage in the grassland habitat. This was in line with another study, which reported that the grassland habitat is known for its high grass biomass [40]. It was evident that an increasing number of Swayne's Hartebeest recorded in the scattered trees' habitat in the dry season than in the wet season was due to the availability of fresh grass under tree shades. On the other hand, very small individuals were recorded in the riverine forest. This could be explained in connection to Swayne's Hartebeest ecology. The animal was known for tolerating the dry season. It was stated that Hartebeests are well adapted to hot and dry climates and relatively independent of water, and survived in the absence of a water source in Senkele Swayne's Hartebeest Sanctuary [41]. In line with this, seasonal changes in habitat association of mammals could be forced by their food and water requirements [39]. In addition, it was revealed that most of the environmental influences, such as human activities, unsubscribed fire often occurring in the park, and livestock grazing determine changes in habitat association with the seasons of the animal. Similarly, it was reported that a combination of ecological factors including bush fire and livestock grazing determine the distribution pattern of the animals in their natural habitats [42].

We reported that the highest group size of the animal was recorded in the grassland. This may owe to availability of a quality forage which may play a pulling factor role for gathering of the animal into this habitat type. A similar phenomenon was reported earlier [43] that group sizes of large herbivores are mostly affected by habitat structure. Among the total adult male recorded during the study period, 141 (30.85%) were solitary males. On the contrary, we did not observe a solitary female. A similar observation was reported [7] in Maze National Park, where most of solitary Swayne's Hartebeests were male. However, against the previous report [7], the same author reported a small number of solitary females. Fluctuation in group size with seasons and habitat types might be due to change in habitat quality in seasons because of different environmental factors.

Changes in habitat structure between sites could determine the differences in abundance of animals among habitats in Senkele Swayne's Hartebeest Sanctuary [1].

4.3 Population Trend

Swayne's Hartebeest was locally extinct in some of the protected areas of Ethiopia such as in Awash National Park [1] and Nech Sar National Park [35] while in the Maze National Park the population trend of the Swayne's Hartebeest demonstrated an increasing tendency for the last ten years i.e. between 2010 and 2019. This is a rewarding output for the management of the animal and its home. However, close monitoring of its population status and its habitats are essential since there is an increasing number of livestock population competing the resources together with the endemic, endangered, and emblematic animal. Our population trend analysis revealed that the Maze national park has the potential of good conditions to carry different wild animals, particularly the endemic and endangered species of the Swayne's Hartebeest. This was agreed with another study [1] in Ethiopian protected areas.

5. CONCLUSION

Our findings showed that the age and sex structure of the total population were dominated by more adult females. This indicates a good opportunity for breeding success. Thus, knowledge of the sex ratio and age distribution of individual animals is essential for the evaluation of the viability of a particular species. The population of Swayne's Hartebeest revealed an increasing trend for the last ten years. This testifies that though the park was not free of anthropogenic pressures such as livestock grazing, unsubscribed fire, and settlement, it has the potential for harboring this flagship species. In addition, the habitat preference of SHB indicated a high association with grassland followed by scattered trees. This provides useful information to design an appropriate habitat management strategy. Since the park is located in the human-dominated landscape it is important to consider the human dimension of the wildlife management in the conservation endeavors of this endemic and charismatic animal which may attract tourists from all over the world to Maze National Park. Therefore, community-based conservation and management approach is highly recommended to ensure the development of the ecotourism sector of the country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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