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Population estimate and habitat association of Grant's gazelle (*Nanger granti* Brooke, 1872) in the Ene Forest of Dale Sadi district, western Ethiopia

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Abstract

Grant's gazelles (*Nanger granti*) are classified as of least concern by the IUCN, although their number is declining due to several factors. A few research studies have been conducted on Grant's gazelle in Ethiopia. Thus, the present study was carried out to determine the population size and habitat association of Grant gazelle in the Ene Forest of western Ethiopia, comprising the dry and wet seasons. The study area was stratified into four habitats: woodland, mixed woodland, riverine forest, and grassland habitats. The data were collected using the direct observation technique. The data were analyzed using descriptive statistics and Pearson's chi-square (χ^2) test. The average estimated Grant gazelle population was 136 ± 23 individuals, with a density of $9/km^2$. The adult maleto-adult female sex ratio was 1:1.40 and 1:1.26 during the wet and dry seasons, respectively. The largest herd size (N=6) was observed during the wet season, and the smallest (N=4) was observed during the dry season. The highest numbers of Grant gazelles were observed in the grassland habitat during the wet season and in the woodland during the dry season. More Gazelles (N=65) were observed in the woodland habitat compared to the other habitat types. The continued existence of the Grant's gazelle population in the area and the suitability of the environment depend significantly on ongoing assessments of habitat change and management intervention.

Keywords Conservation measures, Habitat types, Herd size, Population density, Sex ratio

Introduction

Ethiopia is known to contain a great diversity of mammalian species [1]. More than 60% of the mammal species in the country are large-sized; of these, 57 mammalian species are endemic (i.e., 36 rodents, 10 shrews, three bats, two primates, five artiodactyls, and one carnivore) [2, 3]. The Grant's gazelle (*Nanger granti*) is a member of the genus Gazella, which is found north of Lake Ziwai in the Ethiopian Great Rift Valley, where its altitude ranges from 400 to 1600 m [4]. These animals are typically found in dry, open savannah grasslands and shrub environments and are widely dispersed across the eastern African ecosystems [5–7].

Grant's gazelles can survive in areas with limited water sources and are often drought-tolerant [8, 9]. In areas where resources are abundant, they frequently congregate with other ungulates to forage food and protect themselves from predators [10]. Compared to other Gazelle species, they are larger in size [7]. They are



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migratory and terrestrial animals [6]. Despite having sizeable and stable populations in the wild, Grant's gazelles are becoming less common in most of their habitats due to overhunting and habitat deterioration [11]. These factors have reduced once plentiful Gazelles to dispersed remnant populations, despite the IUCN's [12] designation of "Least Concern," demanding a rigorous examination of the species' long-term survival [13].

Large mammals provide a huge contribution to the conservation efforts of other species and ecosystems. They are good indicators of the value of their habitat and serve a specific role in sustaining critical ecological functions [14]. Monitoring populations of wild animals is essential for sustainable management [15]. Thus, the main aim of the current study is to provide information on the Grant's gazelle population size and habitat association in the Ene Forest in the Kelem Wolega Zone, Western Ethiopia. To achieve the aforementioned objective, the study tried to answer the following basic research questions: (i) What is the population size of Grant's gazelles in the Ene Forest? (ii) What are the age and sex structures of Grant's gazelles during the wet and dry seasons in the study area? (iii) In which habitat types are Grant's gazelles most abundant in the Ene Forest?

Materials and methods

The study area

Ene Forest was established as a protected forest in 2015 and is located around Haro Sabu Town in the western lowlands of Oromia Regional State. It is located at 8° 42' 25" N to 9° 7'00" N and 35° 5' 45" E to 35° 18' 28" E, which is about 610 km southwest of Addis Ababa, the capital city of Ethiopia (Fig. 1). It has 1,600 ha. The Ene protected forest and surrounding area are intact forests and have huge potential for the conservation of mammals in western Ethiopia. The forest is located midway between the two zones: the Kelem Wolega Zone to the northeast and the Illuababora Zone to the southwest. It is bordered by the three woredas: Laloqile, Chanka, and Dale Sadi.

The study area's maximum monthly temperature ranged from 29 °C (which is in April) to 34 °C (March), and the minimum temperature ranged from 21 °C (July) to 25 °C (August) [18]. The study area has received rainfall ranging from 1200 to 1500 mm. According to the data from the Dale Sadi Agricultural Office, the region has received the highest rainfall, 1500 mm, from June to September and the lowest (1200 mm) from November to February.



Fig. 1 Maps of the study area

Methods

A reconnaissance survey was carried out in the study area in January 2020. The actual data collection was conducted from February to July 2020, comprising the dry and wet seasons. The study area was divided into four habitat types: woodland (5.5 km^2), riverine forest (3 km^2), grassland (3 km^2), and mixed woodland (4.5 km^2).

The total count method was applied based on the silent detection method [16, 17]. The counting was carried out with the help of binoculars and/or the naked eye when the animals were most active and with good visibility during 06:00 to 10:00 h in the morning and 15:00 to 18:00 h in the afternoon. Each total count was completed within three hours of the start of the day, using twelve well-trained scouts. A total of 18 censuses were carried out both during the wet and dry seasons (three days per month for six months). To avoid double counting, four selected habitat types (woodland, riverine forest, grassland, and grassland with scattered trees) were designed. Besides, double counting has also been avoided using recognizable features of the studied animal groups, such as group size, group composition, and distinct individuals with deformities on their body parts [7, 18, 19]. The distance between consecutive habitat types varied depending on the vegetation cover.

During the census of Grant's gazelle, observation of the entire herd was carried out. This enabled us to categorize the population according to their respective age groups: adult male, adult female, sub-adult male, subadult female, juvenile, and unidentified sexes. Individuals were considered to be members of the same group if the distance between them was less than 50 m. A direct count method was used to estimate the herd size. Herd size data from all observations were collected, tabulated, and calculated. Accordingly, the male Grant's gazelle is larger in size and has longer, thicker, and highly ringed horns. While a female Grant's gazelle is smaller in size, has short, thin hair, and has no ringed horns.

Data analysis

Descriptive statistics were used to report Grant's gazelle population size. Other explanatory variables were explored using simple descriptive statistics like tables and figures. The seasonal variation and block differences were compared using chi-square tests. Pearson's chi-square (χ^2) test was used at a 95% confidence level to determine

Table 1	Population size of	Grant's gazelles	in Ene Forest during
the wet a	and dry seasons		

Habitat types	Season	Mean	
	Wet	Dry	
Woodland	38 ± 1.86	30 ± 1.41	34 ± 1.64
Riverine forest	39 ± 1.87	30 ± 1.79	34.5 ± 1.83
Grassland	32 ± 1.75	28 ± 2.81	30 ± 2.28
Grassland with scattered trees	48 ± 2.09	31 ± 1.94	39.5 ± 2.02
Mean±SD	39.5 ± 1.89	29 ± 1.99	34 ± 1.94
Total	N=157	N=119	N=138

 Table 3
 Observed sex and age ratios of Grant's gazelles during the wet and dry seasons

Season	Age and sex ratio						
	AM: AF	SAM: SAF	AF: SAF	AM: SAM			
Wet	1:1.4	1:1.05	1:0.4	1:0.5			
Dry	1:1.26	1:1	1:0.31	1:0.39			

the level of statistical significance, with a p-value of 0.05. SPSS software version 20 and Microsoft Excel were used to analyze the data. The population density was determined by dividing the number of individuals observed by the total study area.

Results

A total of 157 and 119 individuals of Grant's gazelle were recorded during the wet and dry seasons, respectively, with a mean and standard deviation of 34 ± 1.94 individuals in the four habitat types (Table 1). The estimated population density was $9\pm3/\text{km}^2$. There was no significant difference in population sizes between the dry and wet seasons (χ^2 =7.7, df=1, p>0.05).

The age structure and sex ratio of the Grant's gazelle population during the wet and dry seasons were females accounted for 52.2% (n=144) of the individuals, while males accounted for 45.3% (n=125), and unidentified sex were 2.5% (n=2.5) in both seasons (Table 2).

The male-to-female sex ratio was 1.00:1.4 in the wet season and 1:1.26 in the dry season, which indicated that the higher number of Grant's gazelles were female. The ratio of sub-adult males to sub-adult females was 1:1.05 and 1:1 during both the wet and dry seasons, respectively. This result indicated that the majority of Grant's gazelles were sub-adults. During the study period, some of the individuals' sexes were not identified (Table 3).

 Table 2
 Age and sex structures of Grant's gazelles during the wet and dry seasons

Season	Age categories								
	AM	AF	SAM	SAF	JU	UN	M±SD	Total	
Wet	40±1.1	55 ± 6	20 ± 1	21 ± 1.1	18±1.7	3±0.53	26.17 ± 1.91	157	
Dry	31±8.4	39 ± 1.1	12 ± 1.1	12 ± 0.55	21 ± 1.6	4±0.79	19.83 ± 2.26	119	
Mean	35.5 ± 4.75	47 ± 3.6	16±1.1	16.5 ± 0.8	19.5 ± 1.65	3.5 ± 0.66	23 ± 2.09	138	

Note AM=adult male, AF=adult female, SAM=sub-adult male, SAF=sub-adult female, JU=juvenile, and UN stands for unidentified sex

The number of groups observed and the number of individuals in each group were different during the wet and dry seasons. An average of 24 ± 3.74 and 41 ± 2.86 herds was identified during the wet and dry seasons, respectively. The mean group size range is $2-13\pm2.02$, and the mean group size was 5 ± 0.91 . In the wet seasons, a number of animals congregate in groups. During the dry season, they divided into smaller groups. The largest group size was observed in the riverine forest, and the smallest were in the woodland habitat. There was a significant difference in the mean herd sizes between the wet and dry seasons ($\chi 2=41.813$, df=1, p < 0.05) (Table 4).

The maximum average number of Grant's gazelles was recorded in the woodland (65 ± 4.01), whereas the minimum average number was recorded in the grassland (18.5 ± 1.74). The riverine forest (52 ± 4.55) was the most utilized habitat, while the grassland (9 ± 1.05) was the least utilized during the dry season. During the wet season, woodland (89 ± 4.71) was the most utilized habitat, while riverine forest (6 ± 1.26) was the least. The number of Grant's gazelles observed in different habitat types was significantly different ($\chi^2=85.5$, P<0.05) (Table 5). The woodland habitat was relatively the most suitable habitat compared to other habitat types during the wet season and the riverine forest during the dry season.

Discussion

Monitoring wild populations is vital for sustainable management and wildlife conservation [20]. In the Ene Forest, a significant number of Grant's gazelles were counted during both the wet and dry seasons. However, given that there was minimal difference in population between the wet and dry seasons, it can be said that the Ene Forest can reliably provide the Gazelles with the ecological conditions they need. Some of the Grant's gazelles may have spent the dry season in the forests. Grant's gazelles are less likely to be difficult to observe during the census period's dry season, which affects the population's size. Similarly, the study in Abijata-Shalla Lakes National Park, Ethiopia, described that the maximum number of Grant's gazelles was recorded during the wet season [21].

According to the current study's findings, the population has a high number of females. Male Gazelles tend to be less vigilant, spend more time alone, and are generally in poorer condition than females, all of which can raise their vulnerability to predators [22]. The bachelor males might also be forced to move to less favorable areas with poor food quality by rival males, putting them in danger from hunters and predators. A similar finding was recorded [21], in which the adult females were more abundant than the other age groups, followed by the adult males. Besides, the previous study indicated the presence of a relatively high proportion of females in the population of Grant's gazelle in the Nechisar National

Table 4	Herd	sizes o	f Grant's	gazelles	during	the we	et and	dry
seasons	in the	Ene Fo	rest					

Season	Abundance	Num- ber of herds	Herd size range	Aver- age herd size	Mean ± SD
Wet	157±9.08	24±3.74	2- 18±2.83	7±0.98	51.5±4.16
Dry	119±8.11	41 ± 2.86	$2 - 8 \pm 1.21$	3 ± 0.84	42.8 ± 3.26
Mean	138±8.59	33±3.3	2- 13±2.02	5±0.91	47.3±3.71

Table 5 Habitat association of grant's gazelles during wet and dry seasons in the ene forest

Season	Abundance habitat typ				
	Woodland	Grass- land with scattered trees	Riv- erine forest	Grassland	Mean±SD
Wet	89±4.71	30±3.58	6±1.26	32±2.42	39.3±2.99
Dry	41 ± 3.31	17 ± 1.94	52 ± 4.55	9±1.05	29.8 ± 2.71
Mean	65 ± 4.01	23.5 ± 2.76	29 ± 2.91	18.5 ± 1.74	42 ± 2.85

Park, Ethiopia [9]. This may indicate that the Grant's gazelle population in the Ene Forest will likely increase in the future. Until they were big enough to move quickly and flee from predators, juvenile Grant's gazelles were typically concealed in the long, dense grasses and shrubs of the plains during the wet season and in nearby bushes during the dry season. Social animals are better at avoiding predation than isolated ones [23]. The number of individuals of any species might reveal information about the state of the habitat [15]. Any species' group size can also reveal information about the condition of its habitat [22]. The distribution pattern of wild animals in their native habitats is influenced by a variety of ecological factors, such as livestock grazing and bush fires [24]. During the present study, the maximum group size of Grant's gazelle was recorded during the wet season compared to the dry season. This might be due to the availability of enough foraging ground for those animals to forage. A similar result was also recorded [21] in Abijata-Shalla Lakes National Park, Ethiopia. The number of animals in the herd decreases periodically as there is less food available in the grassland habitat. The lowlands of the Ene Forest have dry grassland all through the dry season. Grant's gazelles divide into smaller family groups and disperse over the local habitats to satisfy their nutritional requirements [20]. This might help the populace compensate for the lack of food during the dry season.

Associations between animals and specific habitats provide information about the strategies used to ensure their survival and ability to breed [8]. The quantity of grass species in the Nechisar National Park, Ethiopia, increases during the wet season and drops during the dry season [25]. As a result, grassland species struggle with inadequate food quality during the dry season. Artiodactyls from smaller family groups disperse around the surrounding habitat during these times in order to find food. Gazelles move to neighboring bushes and shrubs in order to find adequate dicotyledons that grow outside of their normal habitats [10]. These conditions force Gazelles to seek out food in the neighboring bushes and shrublands in order to survive. To enhance the present population status and create suitable habitat for those animals, community-based conservation measures should be taken.

Implications for conservation

Although Grant's gazelles are still found throughout East Africa and are considered a least-concern species by the IUCN, their number is in decline. Just around 25% of the population is thought to be growing or stable. Numerous risks these animals experience cause their population to decline. They are being driven from their native habitat by human expansion, and they are hunted by humans for their highly valuable meat and hides. The IUCN predicts that this species will eventually become to a near-threatening status if the declining trend of other populations continues.

Recommendations

Based on the findings of the present study, the following recommendations are forwarded:

- Continuous assessment of the habitat change and taking management action is highly appreciated for the continuity of the population of Grant's gazelle in the area.
- The area is populated with a variety of other wildlife. Everybody can visit the area for further studies on the rest of the ecological aspects of terrestrial mammals, including Grant's gazelle.
- Sustainable habitat management should be given priority by increasing the awareness of the surrounding societies to avoid any other anthropogenic factors that may affect the population of Grant's gazelles in the area.

Author contributions

P.B. designed the research, collected data, organized the data on the computer, did the analysis, interpretation, and identification, and wrote the draft manuscript. W.T. proposed the research concept, read the draft, reviewed, edited, supervised, and validated the final manuscript. TD played a critical role during the revision of the manuscript on the data analysis part after the reviewers and editor feedback and validated the final manuscript.

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Data availability

The datasets generated and analyzed during the current study are included in the body of this paper

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki, which provides guidance for researchers to protect research subjects. The study was approved by the Institutional Research Review Board (IRB) of Wolaita Sodo University. Consent to participation isn't applicable to the present article.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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