EFFECTS OF HUMAN ACTIVITIES AND ENVIRONMENTAL VARIABLES ON THE DISTRIBUTION OF THE CUVIER'S GAZELLE (*GAZELLA CUVIERI*) IN THE SAÏDA REGION, NORTHWESTERN ALGERIA

BOUHENNI, A.[1*] – MOSTEFAI, N.[1] – EDDINE, A.[2] – BENTABET, K.[1]

[1]*Laboratory of Water Conservatory Management Soil and Forest, Faculty of Nature and Life Sciences, Earth and Universe Sciences, University of Tlemcen, Tlemcen, Algeria (e-mail: nordine.mostefai@univ-tlemcen.dz, khadidja.bentabet@univ-tlemcen.dz)*

[2]*University of Setif 1 Ferhat Abbas, Setif, Algeria (e-mail: eddine.ahmed@univ-setif.dz)*

[*]*Corresponding author e-mail: abderrahmane.bouhenni@univ-tlemcen.dz; phone: +213-658-382-560*

(Received 6th Oct 2025; accepted 23rd Dec 2025)

Abstract. Cuvier's gazelle (*Gazella cuvieri*), an endangered antelope endemic to the Maghreb region, is known for its high selectivity in habitat use. The factors that shape its occurrence and distribution was poorly identified. In this work, data from field surveys were used to examine the effect of ecological and anthropogenic factors on the Cuvier's gazelle occurrence and to determine priority conservation areas in the Saïda region, Northwestern Algeria, using correspondence factorial analysis and Hierarchical ascendant classification. Our results showed that the greater distance from paved roads and urban areas to the sample sites, food availability and moderate accessibility were favorable factors for the gazelle' distribution. The limiting factors were represented by high altitude, dense vegetation and intense human activity but it did not appear to be disturbed by livestock. Overall, the occurrence of Cuvier's gazelle is determined by interplay of human pressures and environmental variables. Conservation strategies should prioritize habitat connectivity, reduce human pressure in critical ranges and extend the biological corridor in this area toward the southeast as functional habitat links.
Keywords: *Gazella cuvieri, distribution, anthropogenic pressure, habitat variables, conservation, Algeria*

Introduction

Cuvier's gazelle (*Gazella cuvieri*, Ogilby 1840), an endemic species of North Africa, is commonly found in the high plateaus, steppe regions, and mountainous areas of the Atlas mountain ranges from Morocco to Tunisia.

Since the 1950s, the population of Cuvier's gazelle has experienced a sharp decline (Beudels-Jamar et al., 2006). This decrease is primarily due to excessive hunting, habitat degradation from agricultural expansion, overgrazing by domestic livestock, and increasing human disturbances, particularly from off-road motorized vehicles (Cuzin, 2003; IUCN, 2018; Moreno et al., 2020; Meliane et al., 2023).

Its current distribution is now limited to small areas in Morocco, Algeria, and Tunisia (Aulagnier and Thevenot, 1986). Beudels-Jamar et al. (2006) estimated the total population at 1450–2450 individuals, while Mallon and Cuzin (2008) reported 1750–2950 individuals. The most recent estimates suggest a population of 2360–4560 individuals, with the majority located in Morocco (IUCN, 2016).

Although *Gazella cuvieri* is currently classified as "Vulnerable" by the IUCN (2016), in Algeria, it remains a highly threatened species. Among gazelles, it is known for its high selectivity in habitat use (De Smet, 1991b; Cuzin, 2003; Beudels-Jamar et al., 2006;

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

IUCN, 2016), typically inhabiting mountain ranges and their associated plateaus, including semi-arid open Mediterranean forests, steppes, maquis or scrubland, and even cereal fields (Cuzin, 2003; Beudels-Jamar et al., 2013; Bounaceur et al., 2016; Boualem, 2017; El Alami, 2018).

In Algeria, Bounaceur et al. (2016) mapped the distribution of *Gazella cuvieri* between 2012 and 2014, showing its presence across all previously described habitats in 13 wilayas, except in areas where it has significantly retracted due to habitat destruction.

Cuvier's gazelle is almost absent in the northeastern coastal areas, up to the limits of the steppe and arid zones. Its distribution seems restricted beyond certain latitudes, particularly in the semi-arid zones and steppes, such as M'sila, Biskra, southern Batna, southern Khenchela, and southern Tébessa. In contrast, in western Algeria, the species appears present beyond the Tellian Atlas (e.g., in Chlef and Relizane), about 100 km south of the Mediterranean coast, and extends to regions like Tiaret and Mascara (where it occupies the entire territory), and to the south of Sidi Bel Abbès, Saïda, and Tlemcen, where it uses diverse habitats (IUCN, 2018).

In 1991b, De Smet estimated the national population at a minimum of 560 individuals: 235 in the Tellian Atlas, 140 in the Saharan Atlas, 135 in the East, and 50 in the central Mergueb group. Although current data are lacking, the Algerian General Directorate of Forests (D.G.F) reports 500–560 individuals across the national territory (IUCN, 2018).

Knowledge about wild populations of Cuvier's gazelle remains scarce and is mostly limited to general distribution and conservation status (De Smet, 1988, 1991a; Sellami et al., 1990; Loggers et al., 1992; Aulagnier et al., 2001), and to biology and ecology in limited areas, such as the Mergueb Reserve in Algeria (Sellami, 1998) and southern Morocco (Cuzin, 2003).

Recently, Benamour et al. (2025) and Bensahroui et al. (2024) investigate the effect of environmental variables on the distribution of *G. cuvieri* in some localities in Northwestern Algeria.

Critical and detailed data for conservation, such as population numbers, trends, connectivity between subpopulations, and specific biological and ecological parameters, are still lacking (IUCN, 2018). This gap in knowledge is partly due to the difficulty of monitoring this elusive species, which lives in mountainous areas in small family groups (Abaigar and Cano, 2005).

The present study aims to fill these knowledge gaps by analyzing the occurrence patterns of Cuvier's gazelle in relation to habitat and anthropogenic variables in the Saïda region of northwestern Algeria. Specifically, it pursues two main objectives:

1. To identify the key ecological and anthropogenic factors influencing the spatial distribution of Cuvier's gazelle in the study area.
2. To determine priority conservation areas that can support the development of targeted management and conservation strategies for the species.

Material and methods

Study area

Our study area is located in the northwest of Algeria and it covers an area of 6765 km² (*Fig. 1*). It occupies a distinctive geographical position, situated between the Tell Atlas to the north and the Saharan Atlas to the south (S.R.A.T. H.P.O., 2008).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

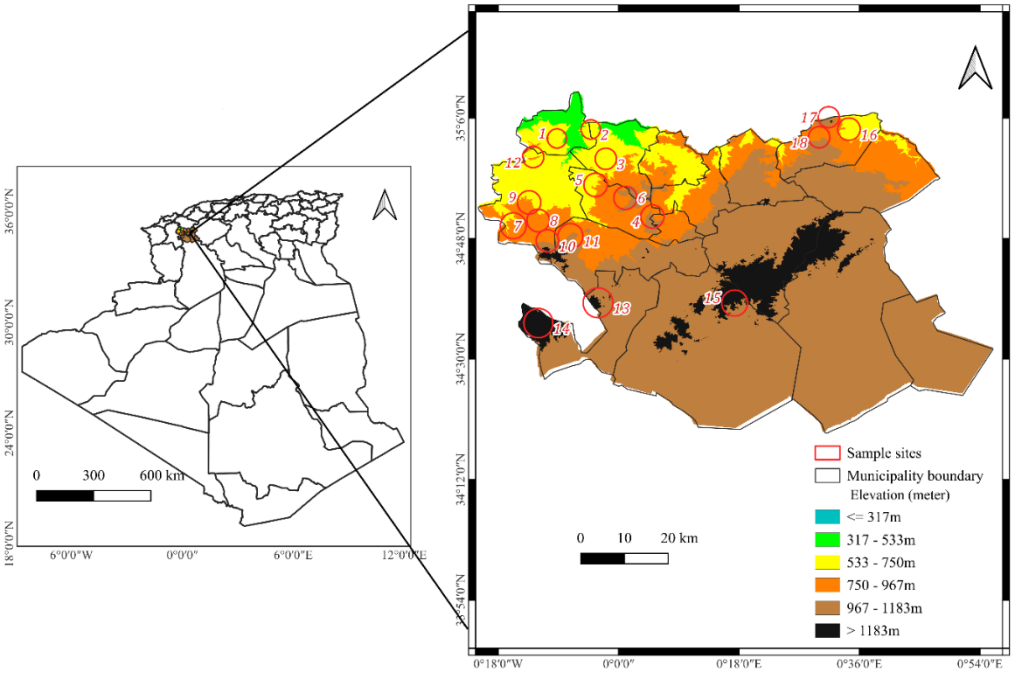

Figure 1. *Geographical location of the study area*

The landscape is characterized by a high steppe plain in the south and relatively mountainous terrain in the north, consisting mainly of the Daïas and Saïda mountain ranges (D.G.F., 2007).

The climate is semi-arid, with cool winters. Annual rainfall is typically less than 300 mm, while the average annual temperature exceeds 17 °C (Arabi, 2020).

Vegetation is generally dominated by four major formations: Aleppo pine forests, holm oak scrub, *Tetraclinis articulata* coppices, and patches of short perennial grasses (*Fig. 2*) (Terras, 2010).

Figure 2. *Experimental site number 12*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

Over the past two decades, the rural population has begun to stabilize and settle more permanently due to improved living conditions which represent 19.24% in 2008 from the total population (300501 inhabitants) (Kefifa, 2014). This has led to the expansion of agricultural lands and rangelands at the expense of forested areas (Kefifa, 2014). According to data provided by the D.P.A.T. (2020), Saida region has a total agricultural area of 511,523.81 ha, in 25.2% of the utilised agricultural area (UAA).

Sampling methods

Field surveys were conducted between 2022 and 2023 where eighteen random walking transects, of 3 km each, were established and surveyed three times per year, once in winter, spring, and autumn. Fieldwork was avoided during the summer months due to extreme temperatures and restricted access during fire-risk periods.

Survey sessions were carried out in collaboration with forest officers and local residents, primarily in the early morning or late afternoon, when Cuvier's gazelles are most active (Chammem et al., 2008). We recorded two types of data:

1. Direct observations: These included sightings with the naked eye and the use of binoculars. Giotto et al. (2008), recommend fixed observation points, which we favored because of the gazelle's camouflage coloration and the difficulty of moving discreetly on the rocky terrain.
2. Indirect observations: These included signs such as tracks and droppings of Cuvier's gazelle.

Following the methods used by of De Smet (1989, 1991a) and Sellami et al. (1990), each contact involved recording GPS coordinates and the number of observed gazelles. To avoid double counting, we considered the highest number of individuals observed, and any population observed over more than 20 km during 12-hours survey was treated as a separate population (Cuzin, 2003). During each field session, we also recorded:

- Livestock density (LVSTCK): number of sheep and goats;
- Plant cover rate (P-COV); visual estimation of the percentage of the covered ground by vegetation in randomly selected quadrats at each sampling site (Kennedy and Addison, 1987);
- Human activities intensity (H-FQ) (Chammem et al., 2008; Nagy et al., 2022).

Based on the 21 plant species consumed by Cuvier's gazelle (Talbi, 1989), we estimated the percentage of available forage (FOOD-A) within each transect. Using QGIS and Google Earth, we also calculated:

- Average altitude (ALT) for each transect;
- Distance to the nearest urban area (D-URB);
- Distance to the nearest paved road (D-ROAD);
- Access mode (ACC-MODE);
- Water availability (WATER-A).

Data analysis

In the first step, the collected data were categorized into quantitative variables represented in *Table 1*.

In the second step, to analyze the effects of habitat characteristics and anthropogenic pressures on the occurrence of Cuvier's gazelle, all collected data were organized into a contingency table. A Factorial Correspondence Analysis (FCA) was performed using RStudio. Additionally, an Ascending Hierarchical Clustering (AHC) was carried out with

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

the same software to group similar surveyed stations and assess habitat suitability more effectively.

Table 1. *Description of the habitat and human variables used in data analysis*

Parameters	0	1	2	3	4
LVSTCK	Absence	Grazing presence	Small ruminants <50	50–100 small ruminants	>100 small ruminants
P-COV	Bare land (0%)	Degraded maquis (<10%)	Maquis (10-50%)	Degraded forest (50-70%)	Dense forest (>70%)
H-FQ	No human presence	Low	Moderate	Frequent	Very frequent
ACC-MODE	Inaccessible	Pedestrian access only	Motorcycle access	4WD access	All vehicle access
ALT	0 m	<700 m	700-900 m	900-1000 m	>1000 m
FOOD-A	0%	<19%	19-52.4%	52.4-76.1%	>76.1%

Results

More than 54 km of transects were surveyed, and gazelles were detected at 11 of the 18 study sites, with an occupancy rate of 61.1%. A total of 16 individuals from three populations were sighted (*Fig. 3*). The sampling site 12 is home to the largest number of individuals (six) compared to the other sites.

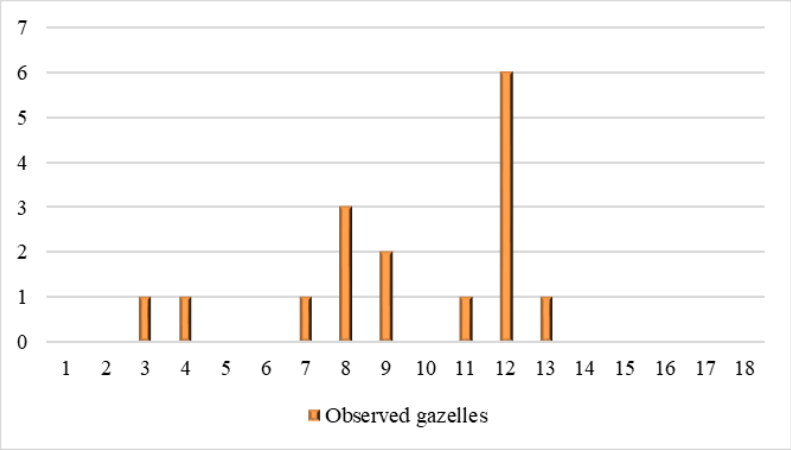

Figure 3. *Number of observed Cuvier's gazelles in study sites*

Our investigation revealed that the current distribution differs from that reported by Talbi (1989). Currently, Cuvier's gazelle is only found in west of Saïda, where it follows a natural corridor links six municipalities: Doui Thabet, Sidi Boubker, Ain El Hadjar, Youb, Tafissour (Sidi Bel Abbès region) and Moulay Larbi, but it is completely absent in the eastern and southern part of the study area (*Fig. 4*).

Analysis of field observations carried out a clear association between the occurrence of Cuvier's gazelle and vegetation cover (*Fig. 5*). The gazelle was often found in maquis formations characterized by low to moderate cover (10–50%), as well as in degraded forest sites of vegetative cover of 50–70%. Nevertheless, Cuvier's gazelle was absent in habitat types under extreme conditions of structure, which included open bare ground,

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

severely degraded maquis, and dense forest stands. These findings suggest a preference for semi-open habitats that provide a balance between forage availability and refuge from disturbance.

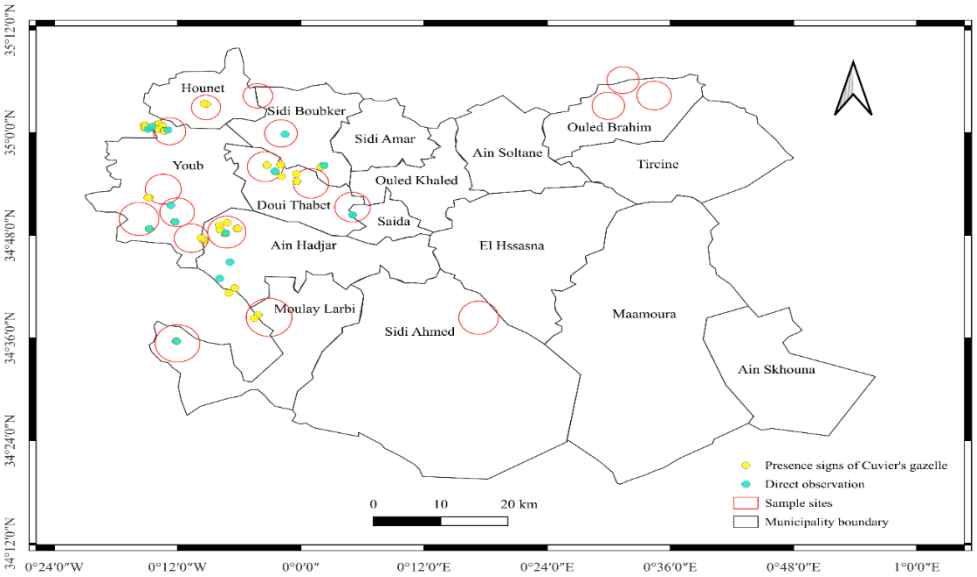

Figure 4. *Current distribution of the Cuvier's gazelle the Saida region, Northwestern Algeria*

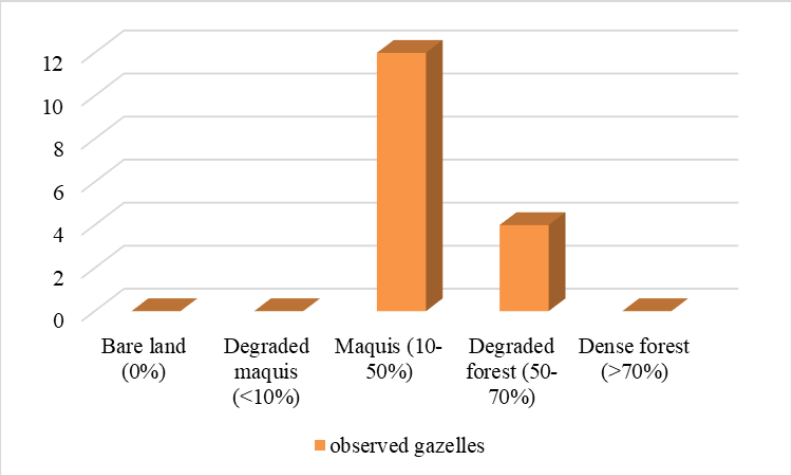

Figure 5. *Number of G. cuvieri in different land cover classes*

The FCA projection shows that the first two principal axes, Dim 1 and Dim 2, represent 67.52% of the total inertia of the dataset across the 10 generated axes (*Fig. 6*).

Based on the distribution of the 18 stations along these two axes, and our knowledge about the spatial distribution of Cuvier's gazelle within the study area, we were able to identify the key environmental and anthropogenic factors influencing and limiting its presence. At first glance, the projection reveals both associations and contrasts between stations and selected factors. Four main groups can be identified:

- Group 1: Gazelles are more abundant in stations 7, 8, 9, 12, 13, and 14, which are located farther from paved roads and urban areas and offer greater food availability.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

- Group 2: Indirect signs of gazelles were recorded in stations 3, 5, and 10, which are more accessible due to forestry developments such as trail openings and temporary forest pathways (TPFs).
- Group 3: Gazelles are absent in stations 4, 17, and 18, characterized by altitudes above 1000 m and dense to moderately dense vegetation cover.
- Group 4: Stations 15 and 16, also devoid of gazelles, are marked by very high human activity.

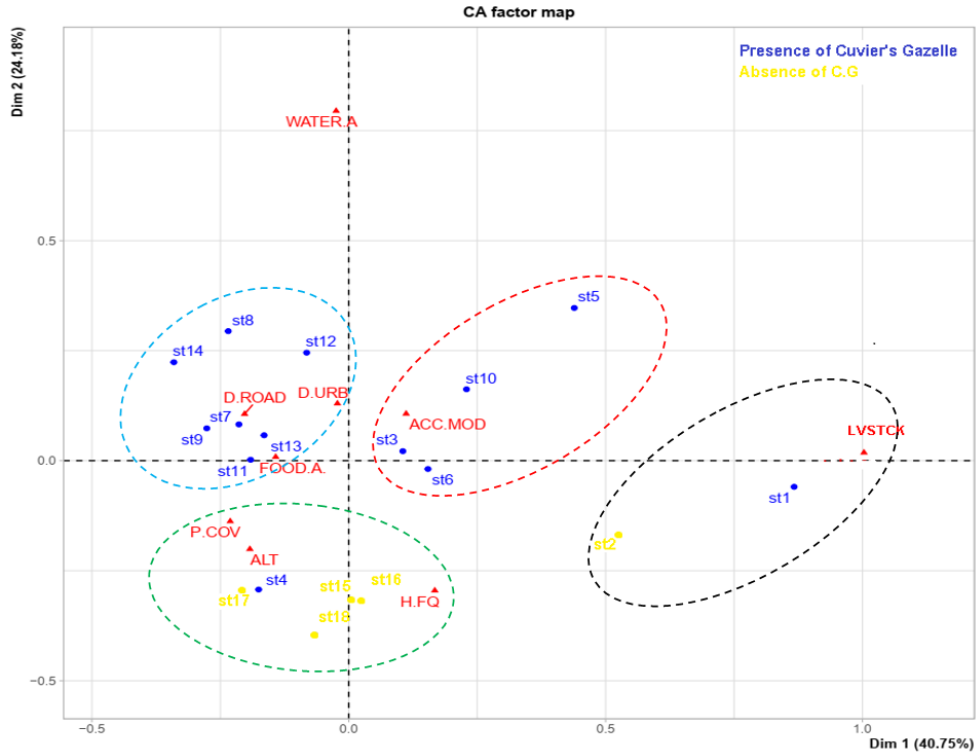

Figure 6. *FCA results showing the relationships between the occurrence of the Cuvier's gazelle and selected humans and environmental factors. Abbreviations: st (station); D. Road (the distance from the paved road); D-URB (the distance from the nearest urbanization); ACC-MODE (the access mode); WATER-A (the water availability); LVSTCK (Livestock); P-COV (the plant cover rate); H-FQ (the intensity of human frequentation); Alt (the average altitude of each transect) and FOOD-A (the percentage of the food availability)*

Axis 1, which accounts for 41.09% of the total variance, clearly contrasts stations with gazelle presence (3, 5, 7, 8, 9, 10, 11, 12, 13, 14) with those showing no signs of presence (2, 6, 15, 16, 17, 18). This axis also differentiates favorable factors for gazelle distribution (such as distance from paved roads and urban areas, food availability, and moderate accessibility) from limiting factors like high altitude, dense vegetation, and intense human activity.

These results suggest that gazelles tend to avoid areas with high human presence but do not appear to be disturbed by livestock presence. This is supported by the presence signs recorded at station 1, where livestock activity is observed. Water availability does not appear to have a significant impact according to the FCA projection.

The Ascending Hierarchical Classification (AHC) presents a classification of the 18 surveyed stations based on habitat characteristics, anthropogenic variables, and the

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

occurrence of Cuvier's gazelle. This classification is illustrated by the dendrogram in *Figure 7*. The analysis done revealed four main clusters:

- Cluster A includes stations 14, 8, 12, 11, 13, 7, and 9.
- Cluster B groups stations 3, 5, 6, and 10.
- Cluster C consists of stations 1 and 2.
- Cluster D includes stations 15, 4, 17, 16, and 18.

These groupings are consistent with the results of the FCA, particularly in terms of distinguishing suitable habitats for Cuvier's gazelle (Cluster A), which are characterized by food availability and low human disturbance, from less suitable or unsuitable areas (Clusters B, C, and D), which are marked by high altitude, dense vegetation cover, easy accessibility, and high levels of human activity.

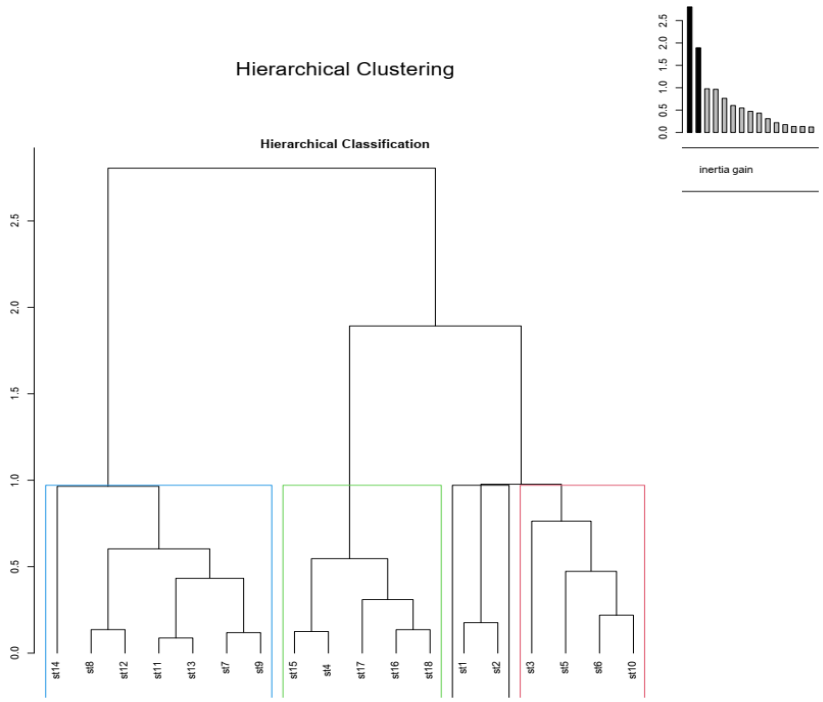

Figure 7. *Hierarchical ascendant classification (cluster analysis) based on correspondence factorial analysis representing similarity of the stations*

Discussion

The current study confirms a marked contraction in the distribution of *Gazella cuvieri* within the Saida region, now limited to the western boundary of the study area. This finding supports earlier reports by Talbi (1989) and De Smet (1991), and aligns with more recent observations of regional declines in western Algeria (Zahafi et al., 2016; Bounaceur et al., 2016). Similar patterns have been documented in Morocco and northern Algeria, where populations are increasingly confined to rugged, mountainous terrain offering refuge from anthropogenic pressures (Bousadik et al., 2022).

Our observations indicate that *G. cuvieri* persists in relatively undisturbed forested areas dominated by *Pinus halepensis*, where we identified three small groups of five to six individuals. These groups are likely connected, as suggested in earlier ecological assessments (De Smet, 1991b; Abaigar and Cano, 2005). This distribution pattern

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

supports the idea that remnant populations rely heavily on spatial refuges with minimal human activity.

In line with previous studies (Festa-Bianchet and Jorgenson, 1998; Pettorelli et al., 2007), the availability of high-quality forage in cluster A appears to be a critical driver of gazelle presence and reproductive success. During periods of food scarcity, interspecific competition with livestock or other herbivores may increase, pushing gazelles toward suboptimal habitats, a mechanism also observed in Morocco by Segura and Moreno (2024).

The species is widely considered a mixed feeder (Talbi, 1989; Sellami, 1999; Benamor et al., 2021a; Herrera-Sánchez et al., 2023), a dietary flexibility that enhances its resilience to seasonal resource fluctuations. This is consistent with findings from the Sahara, where *G. cuvieri* adapts its diet to browse-dominant resources such as acacias (Bousadik et al., 2023), in contrast to our study area where grazing still constitutes over 25% of intake (Hofmann and Stewart, 1972; Schwartz and Ellis, 1981).

Vegetation cover emerged as a significant factor influencing habitat selection. Our results reveal a negative correlation between plant density and gazelle occurrence, in agreement with observations of Cuzin (2003), and the analysis of Bensahroui et al. (2024) who noted the absence of *G. cuvieri* in dense forests and its prefers cultivated areas (cropland) over forests, grasslands and shrublands. Similarly, Beudels-Jamar et al. (2006) and Herrera-Sánchez et al. (2020) report that gazelles tend to avoid highly productive habitats due to increased anthropogenic pressures, such as grazing competition and livestock encroachment, conditions reflected in cluster D.

This trend is consistent with other studies across North Africa. For instance, Dorcas gazelles (*G. dorcas*) in Tunisia and Niger also exhibit negative correlations between NDVI (Normalized Difference Vegetation Index) values and abundance, preferring sparse vegetation where human and livestock disturbances are minimal (Stabach et al., 2017; Nagy et al., 2022). These findings reinforce the hypothesis that habitat selection is not only driven by food availability, but also by the trade-off between resource quality and disturbance risk.

The altitude and slope also appear to influence habitat preference. Our study area, located at relatively low elevation, matches the species' reported preference for gentle terrain (Abaigar et al., 2005). Previous research indicates that *G. cuvieri* may occupy altitudes ranging from 60 to 2600 m, but tends to favor hills and slopes during warmer months to avoid heat stress and human activity (De Smet, 1991b; Kacem et al., 1994; Cuzin, 2003). This is consistent with the difficulty we encountered in observing the species during warm periods.

Although several permanent water points exist in the area, gazelle tracks were not detected in these locations, likely due to disturbances from humans, livestock, and potential predators. This behavior is in line with Letnic et al. (2015), who suggest that gazelles often meet their hydration needs through moisture-rich food rather than direct water sources, especially when such sources are risky.

Human infrastructure, particularly roads, emerged as a major driver of habitat avoidance. Gazelles were absent or rare near roads and vehicle-accessible areas (clusters C and D), confirming findings by Herrera-Sánchez et al. (2020) in Morocco, where *G. cuvieri* distribution was significantly influenced by road proximity. Roads serve as vectors for tourism, grazing, mining, and hunting, and are consistently identified as major disturbance factors for ungulates (Stabach et al., 2017; Soultan et al., 2021; Nagy et al.,

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

2022; Liang et al., 2024). In addition, off-road vehicle activity contributes to vegetation degradation and reduced floristic diversity (Marei et al., 2004).

Cluster B stations, although easily accessible, showed only indirect signs of gazelle presence (tracks, feces), suggesting avoidance behavior. Similar patterns have been observed in other species such as *G. dorcas* and *G. dama*, where accessibility strongly predicts population density (Mallon and Kingswood, 2001; Nagy et al., 2022).

Domestic dogs, commonly associated with rural settlements, may also play a role in limiting gazelle distribution. De Smet (1991a) and Cuzin (2003) documented gazelle mortality due to dogs, and a failed reintroduction attempt in Massa National Park, Morocco, was reportedly caused by dog predation (Loggers et al., 1992).

Nonetheless, some tolerance to human activity was noted, especially in stations from cluster C, where gazelles were observed foraging in proximity to livestock. These interactions suggest that while the presence of small ruminants does not prevent gazelle occurrence, it may limit their abundance. Benamor et al. (2021b) also reported moderate dietary overlap between livestock and *G. cuvieri*, and similar conclusions have been drawn for *G. dorcas* populations (Chammem et al., 2008; Attum and Mahmoud, 2012; Nagy et al., 2022).

Finally, poaching and habitat degradation remain serious concerns. Our recent field observations indicate a surge in illegal hunting activities at several sites, threatening the survival of these already-fragile populations.

Conclusion

Our results corroborate established ecological traits of *Gazella cuvieri* populations in North Africa, particularly their marked dependence on remote, low-disturbance habitats, trophic flexibility enabling persistence in semi-arid to arid environments, and pronounced susceptibility to anthropogenic pressures such as infrastructure expansion and habitat fragmentation. In the Saïda region, conservation initiatives have evolved over time, from the early yet discontinued attempt in 1992 to classify the El Auch area as natural reserve, to the establishment in 2015 of a 66,000-hectare protected area via Wilaya (Department) Decree No. 935, designating El Auch as its 1500-hectares core zone (Mostefaï and Eddine, 2021).

Recent proposals by Mostefaï and Eddine (2021) to designate the northwestern Saïda region as a biological corridor under the framework of Algerian Law 02-11 (Article 13) reflect a spatially informed strategy for *G. cuvieri* conservation. This corridor links four municipalities (Doui Thabet, Sidi Boubker, Ain El Hadjar, and Youb) regularly used by the species. Our spatial and ecological data substantiate the ecological relevance of this corridor and further suggest extending it toward the southeast, incorporating Moulay Larbi and Tafissour (Sidi Bel Abbès region) as functional habitat links, there by reinforcing landscape connectivity.

These converging lines of evidence highlight the necessity for integrated conservation planning at the regional scale. This includes the formal expansion and functional zoning of protected areas, legal recognition and management of biological corridors, enhanced anti-poaching enforcement, and long-term monitoring of population dynamics and human–wildlife interfaces. Such measures are essential to ensuring the viability of *G. cuvieri* populations facing increasing environmental and anthropogenic pressures.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

Acknowledgments. We sincerely thank the staff of the Forestry Conservation of Saida, particularly Mebrouki H. and Thabti R., and the staff of the Forestry District, including Larfi A., Boukheddimi D., Bouchikhi A., Medjahed H., and Hellal B., for their professional support. We are also grateful to Mr. Sehibi A., President of the *Affak Tanmyat El Mouhit* Association, for his generous help for our field surveys and data collection.

REFERENCES

[1] Abaigar, T., Cano, M. (2005): Management and Conservation of Cuviers's gazelle (*Gazella cuvieri*) in captivity. – International Studbook. Instituto de Estudios Almerienses. Almeria.

[2] Abaigar, T., Cano, M., Ensenat, C., et al. (2005): Habitat use and spatial distribution of Cuvier's gazelles (*Gazella cuvieri*) in a semi-captive population. – Journal of Arid Environments 60(1): 183-193.

[3] Arabi, R. (2020): Dynamique de l'espace et perspectives d'écodéveloppement. Cas des monts de Saida. – Mémoire Master. Université de Saida.

[4] Attum, O., Mahmoud, T. (2012): Dorcas gazelle conservation in Egypt: A species on the edge. – Oryx 46(4): 561-564.

[5] Aulagnier, S., Thévenot, M. (1986): Catalogue des Mammifères sauvages du Maroc. – Travaux de l'Institut Scientifique Rabat, Série Zoologie 41: 1-164.

[6] Aulagnier, S., Cuzin, F., Loggers, C., et al. (2001): Morocco. – In: Mallon, D. P., Kingswood, S. C. (eds.) Antelopes. Global survey and regional action plan. Chapter 3. Part 4: North Africa, the Middle East, and Asia, I.U.C.N, Gland, Switzerland, pp. 13-21.

[7] Benamor, N., Oussedik, R., Boughrara, M. (2021a): Feeding ecology of the Cuvier's gazelle in the Sahara Desert. – African Journal of Ecology 59(2): 237-247.

[8] Benamor, N., Bounaceur, F., Aulagnier, S. (2021b): Dietary overlap of wild ungulate Cuvier's gazelle with livestock (sheep and goats) in Djebel Messaâd Forest, Algeria. – Russian J. Theriol 20(1): 31-43. https://doi.org/10.15298/rusjtheriol.20.1.05.

[9] Benamor, N., Achour, H., Bounaceur, F., Aulagnier, S. (2025): Predicting habitat suitability and range dynamics of the vulnerable *Gazella cuvieri* in Northwest Africa under climate change. – Environ Monit Assess 197: 1217. https://doi.org/10.1007/s10661-025-14556-8.

[10] Bensahraoui, M., Benamor, N., Bounaceur, F. (2024): Conservation priority of the vulnerable *Gazella cuvieri* (Mammalia: Bovidae) in Northwestern Algeria: Insight from ecological niche modelling and geographical analysis. – Frontiers in Ecology and the Environment 44(6): 1207-1213. https://doi.org/10.1016/j.ecofro.2024.07.002.

[11] Beudels-Jamar, R. C., Devillers, P., Lafontaine, R-M., et al. (2006): Les Antilopes Sahélo-Sahariennes Statut et Perspectives. Rapport sur l'état de conservation des six Antilopes Sahélo Sahariennes. Action Concertée CMS ASS. 2e édition. – CMS Technical Series: Publication N°11. UNEP/CMS Secretariat, Bonn, Germany.

[12] Beudels-Jamar, R. C., Devillers, P., Cuzin, F. (2013): *Gazella cuvieri* Cuvier's gazelle. – In: Kingdon, J., Hofmann, M. (eds.) Mammals of Africa: Pigs, Hippopotamuses, Chevrotain, Girafes, Deer and Bovids. Vol. VI., pp. 349-352. Bloomsbury Publishing, ISBN: 978-1-4081-2256-3 (print); 978-1-4081-8995-5 (ebook).

[13] Boualem, A. (2017): Distribution spatiale, structure des populations, écoéthologie et conservation de *Gazella cuvieri* (Mammalia, Bovidae) dans la région de Tiaret. – PhD Thesis, Université de Tiaret, Algérie.

[14] Bounaceur, F., Aouad, B., Benamor, N., Fellous, A., Benkheira, A., Zohra, B. F., Aulagnier, S. (2016): Updated distribution and local abundance of the endangered Cuvier's gazelle (Mammalia, Bovidae) in Algeria. – Folia Zoologica 65(3): 233-238. https://doi.org/10.25225/fozo.v65.i3.a9.2016.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

[15] Bousadik, H., Ait Baamrane, M., El Alami, A., et al. (2022): Monitoring threatened ungulates in the semi-arid North African Nador Mountains. – Biodiversity and Conservation 31(2): 185-199.
[16] Chammem, M., Selmi, S., Nouira, S., Khorchani, T. (2008): Factors affecting the distribution of Dorcas Gazelle. – Journal of Zoology 275: 146-152. https://doi.org/10.1111/j.1469-7998.2008.00421.x.
[17] Cuzin, F. (2003): Les grands mammifères du Maroc méridional. – PhD thesis, Université de Montpellier II, France.
[18] D.P.A.T (2020): Les données de l'annuaire statistique 2019. – Direction de la Planification et de l'Aménagement du Territoire. Statistical Yearbook 2019.
[19] Direction générale des forêts (DGF) (2007): Politique forestière nationale et stratégie d'aménagement et de développement durable des ressources forestières et alfatières. – FAO/TCP/ALG/3101.
[20] De Smet, K. (1989): Distribution and habitat choice of the larger mammals in Algeria with special reference to nature protection. – PhD thesis, State University of Gent, Belgium (in Dutch).
[21] De Smet, K. (1991a): Status of antelopes in Algeria. – Global Environment Monitoring System 21: 31-39.
[22] De Smet, K. (1991b): Cuvier's Gazelle in Algeria. – Oryx 31: 99-104.
[23] El Alami, A. (2018): A survey of the vulnerable Cuvier's gazelle (*Gazella cuvieri*) in the mountains of Ait Tamlil and Anghomar, Central High Atlas of Morocco. – Mammalia 83: 74-77. https://doi.org/10.1515/mammalia-2017-0112.
[24] Festa-Bianchet, M., Jorgenson, J. T. (1998): Selfish mothers: reproductive expenditure and resource availability in bighorn ewes. – Behavioral Ecology 9(2): 144-150.
[25] Giotto, N., Laurent, A., Mohamed, N., Prevot, N., Gerard, J. F. (2008): Observations on the behaviour and ecology of a threatened and poorly known dwarf antelope: the beira (*Dorcatragus megalotis*). – European Journal of Wildlife Research 54: 539-547. https://doi.org/10.1007/s10344-008-0177-8.
[26] Herrera-Sánchez, F. J., Gil-Sánchez, J. M., Álvarez, B., et al. (2020): Identifying priority conservation areas in a Saharan environment by highlighting the endangered Cuvier's Gazelle as a fagship species. – Scientific Reports 10: 8241. https://doi.org/10.1038/s41598-020-65188-6.
[27] Herrera-Sánchez, F. J., Garrido, O., Rodriguez-Siles, J., et al. (2023): Feeding Ecology of the Cuvier's Gazelle (*Gazella cuvieri*, Ogilby, 1841) in the Sahara Desert. – Animals 13(4): 567. https://doi.org/10.3390/ani13040567.
[28] Hofmann, R. R., Stewart, D. R. M. (1972): Grazers and browsers: A classification based on the stomach structure and feeding habits of East African ruminants. – Mammalia 36: 226-240.
[29] IUCN (2016): *Gazella cuvieri*. – UICN SSC Antelope Specialist Group, The IUCN Red List of Threatened Species. https://doi.org/10.2305/IUCN.UK.2016-2.RLTS.T8967A50186003.
[30] IUCN (2018): Stratégie et plan d'action pour la conservation de la gazelle de Cuvier (*Gazella cuvieri*) en Afrique du Nord 2017–2026. – https://doi.org/10.2305/IUCN.CH.2018.02.
[31] Kacem, S. B. H., Müller, H. P., Wiesner, H. (1994): Gestion de la faune sauvage et des parcs nationaux en Tunisie : Réintroduction, gestion et aménagement. Tunis. – Direction Générale des Forêts, and Eschborn: Deutsche Gesellschaft fur Technische Zusammenarbeit.
[32] Kefifa, A. (2014): Contribution à l'étude et à la cartographie de l'impact des pressions anthropozoogènes et climatiques sur les ressources naturelles des monts de Saïda (Algérie). – PhD thesis. Université de Tlemcen, Algérie.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

[33] Kennedy, K. A., Addison, P. A. (1987): Some considerations for the use of visual estimates of plant cover in biomonitoring. – Journal of Ecology 75(1): 151-157. https://doi.org/10.2307/2260541.
[34] Letnic, M., Laffan, S. W., Greenville, A., Russell, B. G., Fleming, P. J. S. (2015): Artificial watering points arefocal points for activity by an invasive herbivore but not native herbivores in conservation reserves in arid Australia. – Biodiversity and Conservation 24(1): 1-16. https://doi.org/10.1007/s10531-014-0770-y.
[35] Liang, D., Li, C. (2024): Habitat Suitability, Distribution Modelling and GAP Analysis of Przewalski's Gazelle Conservation. – Animals 14(1): 149. https://doi.org/10.3390/ ani14010149.
[36] Loggers, C. O., Thévenot, M., Aulagnier, S. (1992): Status and distribution of Moroccan wild ungulates. – Biological Conservation 59: 9-18.
[37] Mallon, D., Kingswood, S. (2001): Antelopes. Part 4: North Africa, the Middle East, and Asia. Global Survey and Regional Action Plans. – SSC Antelope Specialist Group. Gland (Switzerland) & Cambridge (UK): IUCN.
[38] Mallon, D. P., Cuzin, F. (2008): *Gazella cuvieri*. – The IUCN Red List of Threatened Species, Ver. 2015.2. Downloaded on 30 June 2015.
[39] Marei, A. H., Khafaga, T., Hatab, A., et al. (2004): Assessment of the impact of Paris-Dakar-Sharm El Shiekh Rally on the floral diversity in Saint Katherine Protectorate, South Sinai, Egypt. – Al Azhar Bulletin of Science 15: 43-60.
[40] Meliane, M. K., Petretto, M., Saidi, A., Riordan, P., Woodfine, T., Guedara, H., Mahdhi, S., Gilbert, T. (2023): Finding slender horned gazelles in the Sahara's Grand Erg Oriental, Tunisia. – Journal of Arid Environments 208: 104874. https://doi.org/10.1016/j.jaridenv.2022.104874.
[41] Moreno, E., Jebali, A., Espeso, G., Benzal, J. (2020): Reintroducing Cuvier's gazelle. Better than expected from captive-bred founders. – Glob. Ecol. Conserv. 23: e01094. https://doi.org/10.1016/j.gecco.2020.e01094.
[42] Mostefai, N., Eddine, A. (2021): Étude de classement de la zone de « Doui Thabet », wilaya de Saida, en aire protégée pour la conservation de la gazelle de Cuvier (*Gazella cuvieri*).
[43] Nagy, A., Mohallal, E. M. E., El-Kafrawy, S., Saber, S. A. (2022): Which is a stronger predictor of the abundance of Dorcas Gazelle, *Gazella dorcas* in the Eastern desert of Egypt: human or natural factors? – Zoology in the Middle East 68(3): 189-197. https://doi.org/10.1080/09397140.2022.2109818.
[44] Pettorelli, N., Pelletier, F., Von Hardenberg, A., Festa-Bianchet, M., Côté, S. D. (2007): Early onset of vegetation growth vs. rapid green-up: Impacts on juvenile mountain ungulates. – Ecology 88(2): 381-390. https://doi.org/10.1890/06-0875.
[45] S.R.A.T. H.P.O (2008): Schéma régional d'aménagement du territoire de la région Hauts Plateaux Ouest à l'horizon 2025. – Ministère de l'aménagement du Territoire et de l'Environnement.
[46] Schwartz, C. C., Ellis, J. E. (1981): Feeding ecology and niche separation in some native and domestic ungulates on the shortgrass prairie. – Journal of Applied Ecology 18(2): 343-353.
[47] Segura, A., Moreno, E. (2024): Foraging habitat use by sympatric Cuvier's Gazelle, Dama Gazelle, and Dorcas Gazelle on a private reserve in Morocco. – Journal of Mammalogy 105(6): 1345-1352. https://doi.org/10.1093/jmammal/gyae079.
[48] Sellami, M., Bourdjeli, H. A., Chapuis, J. L. (1990): Répartition de la gazelle de Cuvier (*Gazella cuvieri* Ogilby, 1841) en Algérie. – Vie et Milieu 40: 234-237.
[49] Sellami, M. (1998): La Gazelle de Cuvier *Gazella cuvieri* (Ogilby, 1841) en Algérie. Statut et premiers éléments d'écologie, données sur le régime alimentaire dans la réserve naturelle de Mergueb (M'Sila). – Thèse Doctorat d'Etat en Science Agronomique, Institut National Agronomique d'Alger, Algérie.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736

[50] Soultan, A., Nagy, A., Attum, O. (2021): Midden site selection in Dorcas Gazelle: Larger is not always better. – Ecology and Evolution. 11: 13661-13667. https://doi.org/10.1002/ece3.8141.
[51] Stabach, J. A., Rabeil, T., Turmine, V., Wacher, T., Mueller, T., Leimgruber, P. (2017): On the brink of extinction: Habitat selection of Addax and Dorcas Gazelle across the Tin Toumma desert, Niger. – Diversity and Distributions 23: 581-591. https://doi.org/10.1111/ddi.12563.
[52] Talbi, K. (1989): Etude éco-éthologique de la Gazelle du Cuvier *Gazella cuvieri* (Ogilby, 1841) dans la zone de Djebel El Ach, Wilaya de Saïda. – Thèse Magistère, Institut National Agronomique d'Alger, Algérie.
[53] Terras, M. (2010): Typologie, cartographie des stations forestières et modélisations des peuplements forestiers. Cas des massifs forestiers de la wilaya de Saida (Algérie). – PhD thesis. Université de Tlemcen, Algérie.
[54] Zahafi, M., Bouslama, Z., Benyacoub, S. (2016): Répartition actuelle de la gazelle de Cuvier en Algérie. – Revue Écologie 71(2): 103-110.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2401_17231736