

Slender-horned Gazelle *Gazella leptoceros* Conservation Strategy 2020-2029



Conservation Strategy for the Slender-horned Gazelle



The designation of geographical entities in this book, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of any participating organisation concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The views expressed in this publication do not necessarily reflect those of IUCN or other participating organisations.

Compiled and edited by

David Mallon, Violeta Barrios and Helen Senn

Contributors

Teresa Abaigar, Abdelkader Benkheira, Roseline Beudels-Jamar, Koen De Smet, Husam Elalqamy, Adam Eyres, Amina Fellous-Djardini, H la Guidara-Salman, Sander Hofman, Abdelkader Jebali, Ilham Kabouya-Loucif, Maher Mahjoub, Renata Molcanova, Catherine Numa, Marie Petretto, Brigid Randle, Tim Wachter

Published by

IUCN SSC Antelope Specialist Group and Royal Zoological Society of Scotland, Edinburgh, United Kingdom

Copyright

 2020 IUCN SSC Antelope Specialist Group

Reproduction of this publication for educational or other non-commercial purposes is authorised without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Recommended citation

IUCN SSC ASG and RZSS. 2020. Slender-horned Gazelle (*Gazella leptoceros*): Conservation strategy 2020-2029. IUCN SSC Antelope Specialist Group and Royal Zoological Society of Scotland.

Cover photos

Front and rear cover:   Renata Molcanova

We are also grateful to IUCN's Centre for Mediterranean Cooperation for supporting the development of the strategy since 2016, and for facilitating communications with key regional partners. We thank Violeta Barrios for preparing the maps, and the Royal Zoological Society of Scotland for the layout.

Slender-horned Gazelle
Gazella leptoceros
Conservation Strategy 2020-2029



CONTENTS

■	CONTENTS	5
■	1. INTRODUCTION	9
■	2. SLENDER-HORNED GAZELLE	10
	2.1. Nomenclature	10
	2.2. Taxonomy	10
	2.3. Description	12
	2.4. Biology	12
	2.4.1. Habitat	12
	2.4.2. Diet	12
	2.4.3. Ecology and behaviour	13
■	3. DISTRIBUTION AND STATUS	14
	3.1. Overview	14
	3.2. Morocco	14
	3.3. Algeria	14
	3.4. Tunisia	17
	3.5. Libya	18
	3.6. Egypt	19
	3.7. Mauritania	20
	3.8. Mali	20
	3.9. Niger	20
	3.10. Chad	20
	3.11. Sudan	20
	3.12. Transboundary status	20
	3.13. Population size	20
■	4. THREATS	21
	4.1. Poaching	21
	4.2. Habitat degradation	22
	4.3. Climate change	22
	4.4. Hybridization	22
	4.5. Fragmentation	22
	4.6. Disturbance	22
	4.7. Constraints	22
■	5. CONSERVATION MEASURES	23
	5.1. International designations	23
	5.2. Legal status	23
	5.3. Protected areas	23
	5.4. <i>Ex situ</i> populations	24
■	6. CONSERVATION OPTIONS	26
	6.1. Determining current status in the wild	26
	6.2. Strengthening protection of known sites	26
	6.3. Enhancing <i>ex-situ</i> populations	26
	6.4. Strengthening the policy framework	27
	6.5. Strengthening awareness of slender-horned gazelle conservation	27
	6.6. Taxonomy	27
	6.7. Reintroduction and reinforcement of populations	27
	6.8. Implementation	27
■	7. PLANNING LOGFRAME 2020-2029	28
■	8. REFERENCES	32

ACKNOWLEDGEMENTS

We are grateful to all the following for their participation in the planning sessions on slender-horned gazelle at the SSIG meetings and their contributions to the development of the strategy:

Teresa Abaigar, Walid Algadafi, Omar Attum, Violeta Barrios, Abdelkader Benkheira, Roseline Beudels-Jamar, Jelle Boef, RoxAnna Breitigan, Jane Budd, Kevin Budd, Salih Buirzayqah, Koen De Smet, Marc Dethier, Kara Dicks, Husam Elalqamy, Ibrahim Elkahwage, Adam Eyres, Amina Fellous-Djardini, Hugo Fernandez, Tania Gilbert, H la Guidara-Salman, Jens-Ove Heckel, Sander Hofman, Abdelkader Jebali, Ilham Kabouya-Loucif, Yasmina Khaznawi, Gavin Livingston, Maher Mahjoub, Renata Molcanova, Catherine Numa, Marie Petretto, Thomas Rabeil, Brigid Randle, Helen Senn, Latifa Sikli, Steve Shurter, Teresa Silva, Brandon Speeg, Tim Thier, Paul Vercaemmen, Tim Wachter, Souad Zerrouki



Male slender-horned gazelle (photo: A. Fellous-Djardini).

1. INTRODUCTION

The slender-horned gazelle (*Gazella leptoceros*) is endemic to the Sahara Desert. It formerly occurred in sandy areas from Algeria west to the Nile Valley in Egypt. The former area of distribution is not known in detail and there are some large gaps between confirmed sites. Numbers have been reduced mainly due to excessive, uncontrolled hunting and the species has disappeared from several areas, including most of those in the eastern part of the range. Currently the only certainty is that slender-horned gazelles in the two great ergs of Algeria and Tunisia, although a few individuals could persist in the Western Desert of Egypt and Libya, and no other localities have been confirmed. Numbers in the wild are estimated to be in the low hundreds. The *ex situ* population is very small and is descended from a tiny number of founders. The species is listed as Endangered on the IUCN Red List.

Since 2016, the slender-horned gazelle situation has been discussed annually at a special session in the margins of the annual meetings of the Sahelo-Saharan Interest Group (SSIG), involving the main stakeholders. The aim of the sessions was to update the species' status and agree priority actions.

In view of the precarious situation, it was agreed in May 2019 SSIG meeting in Tunis to develop a 'Slender-horned gazelle conservation strategy' to provide a framework to guide actions needed to conserve and restore populations, both *in situ* and *ex situ*, as well as to aid the development of National Action Plans. The roadmap was discussed further with government agencies and NGOs during the IUCN North Africa Regional Conservation Forum in Monastir, Tunisia, in June 2019.

2. SLENDER-HORNED GAZELLE

2.1 Nomenclature

Gazella leptoceros F. Cuvier, 1842

Synonyms: *Antilope leptoceros*, *Leptoceros abuharab*, *Leptoceros cuvieri*, *Gazella loderi*, *Gazella subgutturosa loderi*

Common names:

Arabic:

ريم ، الغزال الأبيض Reem (Algeria, Tunisia), Ghazal abiad (Egypt, Libya, Tunisia)

Tamasheq/Tamahaq:

Adam

English:

Slender-horned gazelle, Reem, Rhim, Loder's gazelle, Sand gazelle

French:

Gazelle leptocère, Gazelle des sables, Gazelle des dunes, Gazelle blanche, Gazelle à cornes fines, Rhim, Rim

Spanish:

Gacela de las dunas, Gacela de astas delgadas

German:

Dünengazelle

Note that the first published account of the species in English referred to "reem" (Loder 1894). The later spelling 'rhim' appears to be an error in transliteration, since the Arabic word does not contain the letter 'h'. Reem (English) and rim (French) are regarded as more correct.

2.2. Taxonomy

The type specimen was brought to Paris by James Burton in 1833 with the locality listed as Sennar (south-east Sudan), but this was later corrected to 'the desert between Giza and Wadi Natron, Lower Egypt' (Flower 1932). Specimens obtained in northern Algeria in 1894 were described as larger in size with

shorter horns and named as a separate species *G. loderi* (Thomas 1894). Later this was classified as a subspecies of *G. leptoceros*. Gentry (1971) said there were no good reasons to consider that *loderi* merited subspecies status. The difference between the two forms has been subject to extremely limited genetic analysis (see below). Animals in Egypt and north-eastern Libya are usually considered *G. l. leptoceros* and those in Algeria and Tunisia and western Libya *G. l. loderi* (e.g. in Beudels & Devillers 2013). However, the geographical boundaries between the two forms have not been defined.

The taxonomic position of *Gazella leptoceros* has also been debated. Ellerman and Morrison-Scott (1951) included *G. leptoceros* in *G. [subgutturosa] marica* from the Arabian Peninsula which also prefers sand dune habitat and has the same Arabic name 'reem'. Groves (1988) retained both taxa as separate species and included *G. leptoceros* and *G. subgutturosa* in the subgenus *Trachelocele*. In addition, Hammond *et al.* (2001) in an analysis of mtDNA found a close affinity between *G. leptoceros* and Arabian sand gazelle *G. marica*. Several other analyses of mitochondrial DNA (mtDNA) have indicated that *G. leptoceros* and *G. cuvieri* are monophyletic (Rebholz & Harley 1999; Wacher *et al.* 2010; Wronski *et al.* 2010; Lerp *et al.* 2011).

Recent genetic analyses of 327 samples based on mitochondrial DNA (cytochrome B) and five nuclear gene fragments confirmed that *Gazella cuvieri* and *G. leptoceros loderi* form a single monophyletic group and the lack of genetic differentiation between these taxa suggests they should be combined into *G. cuvieri* (Silva *et al.* 2015, 2017; Silva 2018).

Only two samples of *G. leptoceros leptoceros* from Hatiyat Umm Ghuzlan (western Egypt) have undergone genetic analysis (Wacher 2010, Lerp 2011, Silva 2018, GENBANK ID "JN410346" and "JN410347"). One of these samples shows 1.4 % divergence at Cytochrome B compared to the *G. leptoceros loderi* / *Gazella cuvieri* complex. Although the difference is higher than that within the *G. leptoceros loderi* / *Gazella cuvieri* complex, it represents a low level of divergence. Currently, scale of sampling and low resolution of the genetic analyses of *G. leptoceros leptoceros*, so far, are insufficient to

confirm that a subspecies status for *G. leptoceros leptoceros* would be merited. Morphological differentiation between *G. leptoceros leptoceros* and *G. leptoceros loderi* is very limited (see below).

Despite their lack of genetic differentiation, *G. leptoceros* and *G. cuvieri* have morphological differences and they occupy very distinct ecological niches. *G. leptoceros* prefers sandy deserts and dunes, while *G. cuvieri* is an upland species, occurring in the Atlas Mountains up to 3,300 m, where it occupies open Mediterranean forests with *Pinus halepensis* and *Juniperus phoenicea*, *Quercus ilex* and *Q. suber* as well as maquis, and grassy slopes. *G. cuvieri* also occurs in arid mountains and desert hamada (IUCN SSC Antelope Specialist Group 2016a, 2016b, Herrera-Sanchez *et al.* 2020).

It is important to highlight that there could be epigenetic effects and/or phenotypic selection which could maintain these distinct ecotypes without divergence across the genome and only functional genomics would help to clarify this in detail (Silva *et al.* 2017; Silva 2018). Establishing the taxonomic relationships within this group of species (*G. leptoceros*, *G. cuvieri*, *G. marica*) is a high priority. Nonetheless, *G. leptoceros* and *G. cuvieri* are distinct ecotypes and should, therefore, be considered separately in conservation planning (as recommended by Silva *et al.* 2017; Silva 2018). Figure 1 shows the areas of distribution of *G. leptoceros* and *G. cuvieri* in North Africa as well as *G. dorcas*.

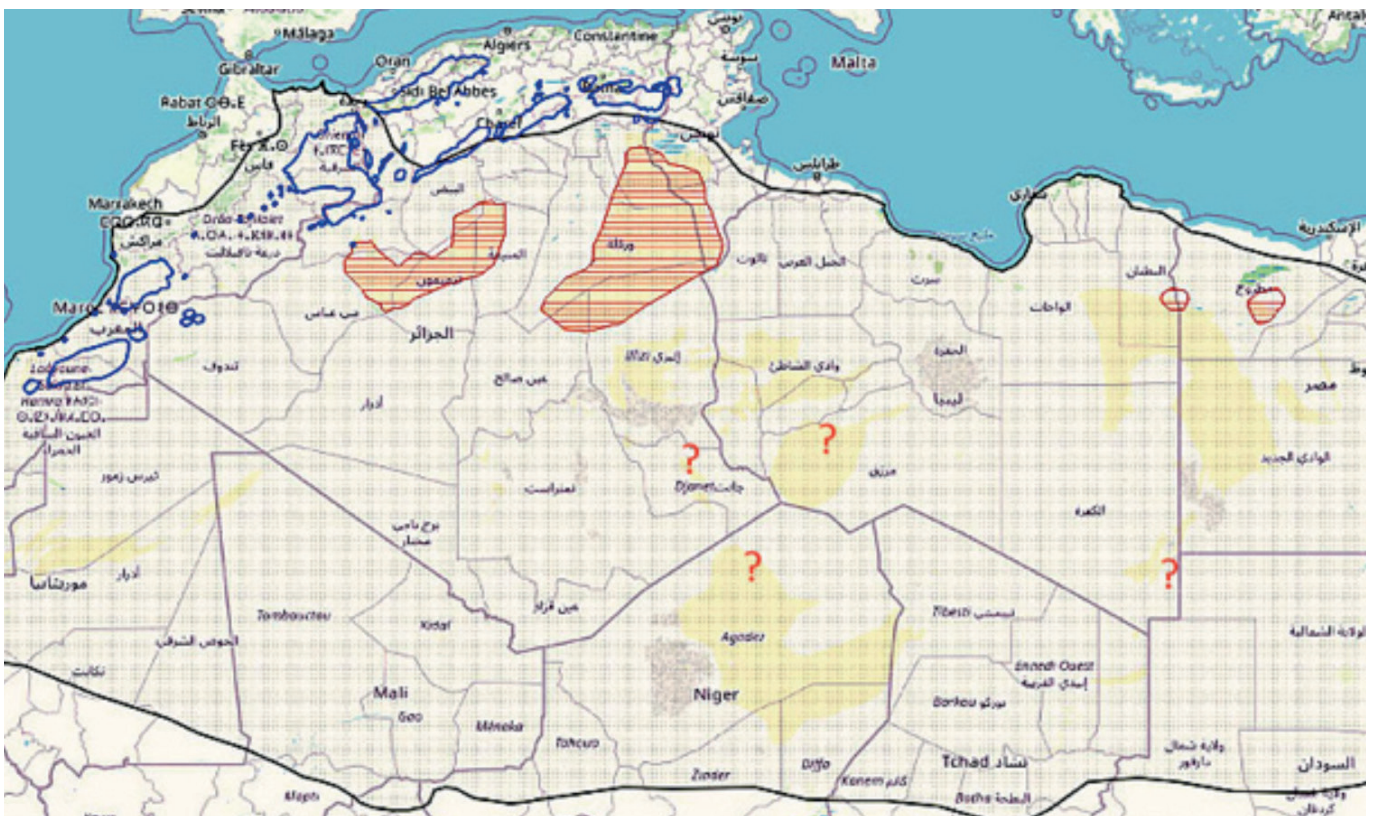


Figure 1: Recent distribution of *Gazella leptoceros* (red); *G. cuvieri* (blue) and *G. dorcas* (black line) in North Africa. Maps for *G. cuvieri* and *G. dorcas* are based on the IUCN Red List (www.iucnredlist.org).

2.3. Description

G. leptoceros is a medium-sized gazelle, 65-72 cm in height at the withers and weighing 24 (20-27) kg (males) and 16 (14-18) kg (females). Its coat is pale brown in colour, with white undersides and rump. The facial markings are faint. The tail is short, with a black terminal tuft. Horns are long, up to 35-40 cm in length and nearly straight though not always symmetrical in both sexes, with 20-25 well-defined rings. The longest horns recorded are 41.2 cm from Egypt (Beudels and Devillers 2013). Horns are appreciably thicker and longer in males. The dorcas gazelle *G. dorcas* has richer brown pelage and usually shows a clear dark brown band on the flanks, though some very pale individuals of dorcas gazelle have been observed in Tunisia (Marwell Wildlife 2019) as well as in Chad and Niger. The horns of dorcas gazelle are thicker and lyrate in form. Tracks of *G. leptoceros* are narrower and more pointed than those of *G. dorcas* (Figures 2 & 3).

2.4. Biology

2.4.1. Habitat

The species mainly occurs in sand deserts and areas of dunes (Devillers et al. 2006; Beudels & Devillers 2013). In Egypt, the species occupies sandy margins of oases and interdunal depressions with acacias (Osborn & Helmy 1980). An ongoing study in the Great Western

Erg of Algeria has found that in autumn, winter and spring, solitary males, small family groups and especially females with young have often been observed in the extensive stony (reg) and rocky (hamada) plains adjoining the erg, sometimes more than 40 km away from the dune systems (A. Fellous *in litt.* 2020).

2.4.2. Diet

The slender horned gazelle feeds on *Aristida (Stipagrostis) pungens*, *Anabasis articulata*, *Arthrophytum schmittianum*, *Helianthemum kahiricum*, and the fruits of *Colocynthis vulgaris*, to meet its water needs (Heim de Balsac 1936, Kacem *et al.* 1994, Beudels & Devillers 2013). In the Great Western Erg, it consumes *Helianthemum lipii*, *Bassia muricata*, *Eremobium aegyptiacum*, *Euphorbia guyoniana*, *Mecomischus latifolius*, *Moltikiopsis ciliata*, *Neurada procumbens*, *Salsola vermiculata*, *Danthonia forskahlii*, *Ephedra alata alenda*, *Genista saharae*, *Launea mucronata*, *Retama raetam* and *Traganum nudatum* (Fellous 2012). Observations in the Great Eastern Erg of Algeria suggested preference for *Oudneya africana*, *Echiochilon fruticosum*, *Helianthemum sp.*, *Euphorbia guyoniana* and *Stipagrostis acutiflora* (and some evidence of avoidance of *A. pungens*) (Fellous *et al.* 2009). In Egypt, the species feeds on *Acacia raddiana*, *Nitraria retusa*, *Calligonum comosum*, *Cornulaca monocantha* and *Pituranthos tortuosus* (Osborn & Helmy 1980).



Figure 2: Tracks attributed to *G. leptoceros* (left) and *G. dorcas* (right) in Senghar-Jabbes N.P. (photo: Tim Wachter).



Figure 3: Hooves of *G. leptoceros* (photo: A. Fellous-Djardini).

Observations (feeding signs, droppings, and tracks) made on surveys conducted in spring 2004 in part of the western erg during the study to classify the Taghit-Guir protected area attest to the preference of the species for *Ephedra alata*, *Aristida pungens* et *Genista saharae* (A. Benkheira, pers. comm. 2017).

2.4.3. Ecology and behaviour

The slender-horned gazelle is mostly crepuscular and nocturnal, feeding and moving during the cooler times of the day, and resting during the hot hours in the shade or in hollowed-out depressions (Osborn & Helmy 1980), although it is can also frequently be observed during the day. Daily activity is probably influenced by season and the level of disturbance. It lives in small groups of 3-4, consisting generally of an adult male, several adult females and their offspring. Solitary individuals, pairs, and groups of young males are also observed (Devillers *et al.* 2006). In Egypt (as well as in Algeria; A. Fellous pers. comm. 2019), it gives birth in winter or early spring to one, sometimes two, young after a gestation period of 167 days (Flower 1932). At Sidi Toui in Tunisia, births are concentrated between February and April and twins are frequent (M. Petretto, pers. comm. 2020). The birth of twins could be related to the quality of the diet; 33% of births were reported in October-November (R. Molcanova, pers. comm. 2020). During winter, before the rut, vegetation torn off by the horns has been found in the Great Western Erg indicating signs of territorial marking (Abaigar *et al.* 2009a, Fellous *et al.* 2009).

Slender-horned gazelles are highly nomadic and move frequently in search of food (Saleh 1987, Kacem *et al.* 1994). Prolonged droughts may cause them to undertake longer movements, sometimes taking them northwards towards the Saharan Atlas (Heim de Balsac 1928, 1936). Even outside periods of drought, slender-horned gazelles may leave the Great Western Erg to vary their usual diet with other plants in the pre-Saharan steppe zone. Local communities believe that the species is seeking plants rich in mineral salts that are lacking in the dune environment (A. Fellous, *in litt.* 2020).

3. DISTRIBUTION AND STATUS

3.1. Overview

G. leptoceros is distributed in the Sahara, from about longitude 4°20'W in north-west Algeria to the river Nile in Egypt. The original distribution is poorly known and there are several gaps in distribution in apparently suitable habitat. It is not known if these represent a lack of information or genuine absence.

Presence is confirmed in Algeria, Tunisia, Libya, and Egypt and reported from northern Chad and Niger. However, the southern limits of the range are unclear. There are no records from the extensive areas of dunes in south-west Algeria or in Mauritania.

On the southern side of the Sahara their presence is reported from around the Air massif in northern Niger and north of Tibesti in Chad, but there appears to be no confirmed information (animals shot, photos). In Tanoust (1930) considered that the species did not occur in French West Africa or French Equatorial Africa and said that nomads told him it was only found "in the country of the Chaamba", a region now covering northern edge of the Algerian Sahara, including the two ergs. The possibility of confusion with very pale individuals of dorcas gazelle cannot be excluded.

In the last 20 years, slender-horned gazelle presence has been confirmed only in the Great Western and Great Eastern Ergs of Algeria and Tunisia, and the northern part of the Western Desert along the Egypt/Libya border (Figure 4). There is additional evidence from poachers but without precise localities. Further details are contained in the national summaries, below.

3.2. Morocco

A report from the region of Boumia, south-east of the High Atlas, during the 1950s (Loggers et al. 1992) is unconfirmed and likely misidentified (Aulagnier et al. 2001).

3.3 Algeria

There are confirmed records in the Great Western Erg and Great Eastern Erg plus a few verbal reports from Erg Admer in southern Algeria (De Smet 1989, Kowalski & Rzebiak-Kowalska 1991). Map Fig. 5. Several individuals were shot in 1894 in dunes near Oued Souf, c. 160 km south of Biskra, at the northern end of the Great Eastern Erg (Loder 1894; Pease 1896). Several later authors also report the species present from in Great Eastern Erg without specifying localities (Heim de Balsac 1936, Devillers et al. 2005, and references therein). Kowalski

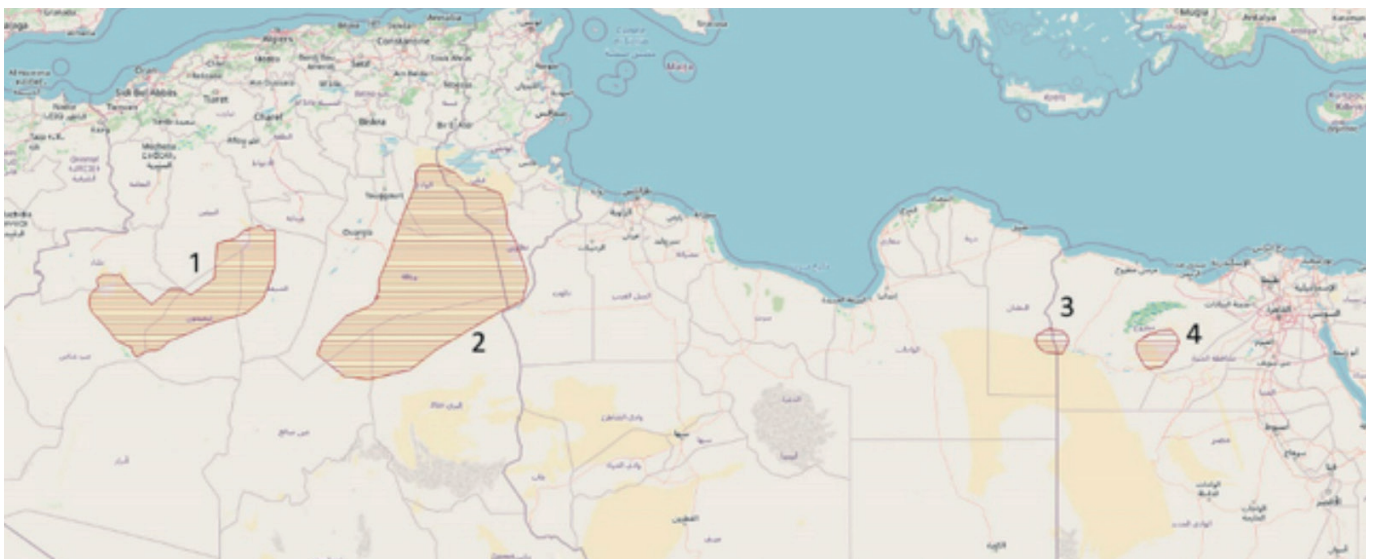


Figure 4: North Africa: the main areas of sand dunes (yellow); sites where *G. leptoceros* has been confirmed in 1990-2020 (hatched). 1. Great Western Erg; 2. Great Eastern Erg; 3. Siwa-Jaghboub; 4. Qattara Depression.

& Rzebik-Kowalska (1991) listed two specimens from the Great Western Erg. It was also reported there by Hartert (1913), Lavauden (1926), Joleaud (1929) and Dupuy (1967a). Heim de Balsac (1936) said that in years of drought these gazelles may move north as far as the Saharan Atlas. In 2004, some individuals were observed in the El Khala depression south of Taghit during surveys conducted during the study to classify the Taghit-Guir protected area (A. Benkheira pers. comm. 2004). Recent surveys conducted by the Directorate-General of Forests in the south-west of the wilaya of Bechar, more particularly in the Erg Er Raoui, led to the identification of nucleus of modest size inhabiting this area (A. Benkheira, pers. comm. 2017).

The Great Western Erg lies in north-west Algeria to the south-east of the Saharan Atlas, between Wadi Saoura in the west and Ghardaia. It covers about 80,000 km² (Callot & Fortugne 2008). A survey in March 2007 along the northern margin confirmed the presence of slender-horned gazelles in at least three separate locations in the eastern, central, western and southern zones (Fellous & Siga 2007, De Smet et al. 2009), indicating an extensive distribution (Fig. 6). On a survey between Oued Es Segguer and Oued Zeghoun none were seen but some tracks and droppings were found (Abáigar *et al.* 2009a).

An ongoing study indicates that in the northern part edge of the Great Western Erg the population could be around 250 (A. Fellous *in litt.* 2020). The year 2009 received a lot of autumn and winter rain which led to an increase in the quantity and quality of vegetation cover over the whole study area and many water resurgences in low-lying zones particularly in the delta of the Oued Gharbi.

An article on population density, group size and composition in this area is in the process of finalization (A. Fellous, *in litt.* 2020). Populations of slender-horned gazelle in the northern part of the Western Erg seem to be protected by the difficult access compared to the Great Eastern Erg whose landscape is more open and easier to access by vehicles, hence the lower number of gazelles.

Erg Erraoui lies west of the Great Western Erg and adjacent to Erg Cherch and Erg Iguidi which cover a large part of southwest Algeria. Lavauden (1926) and

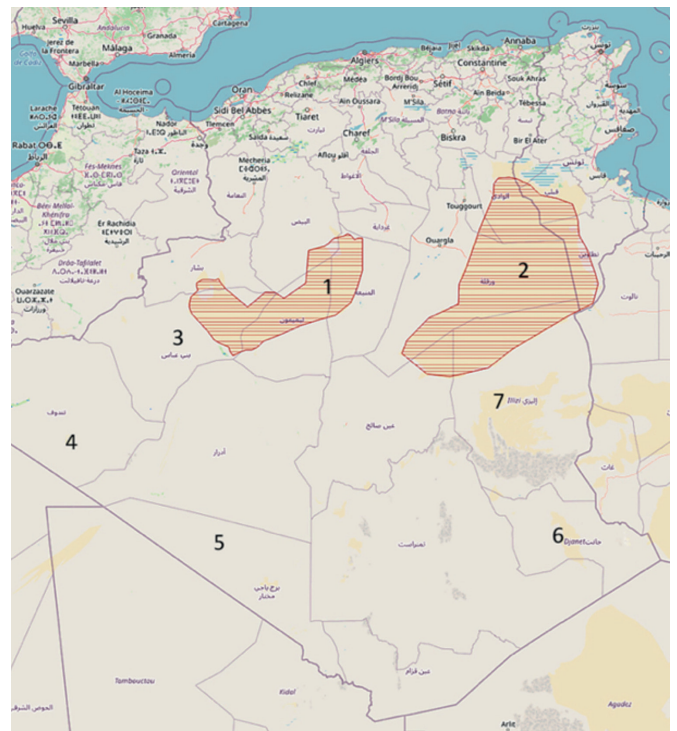


Figure 5. Confirmed distribution of *G. leptoceros* in Algeria (hatched) and the main ergs. 1. Great Western Erg; 2. Great Eastern Erg; 3. Erg Er Raoui; 4. Erg Iguidi; 5. Erg Chech; 6. Erg Admer; 7. Erg Issaouane.

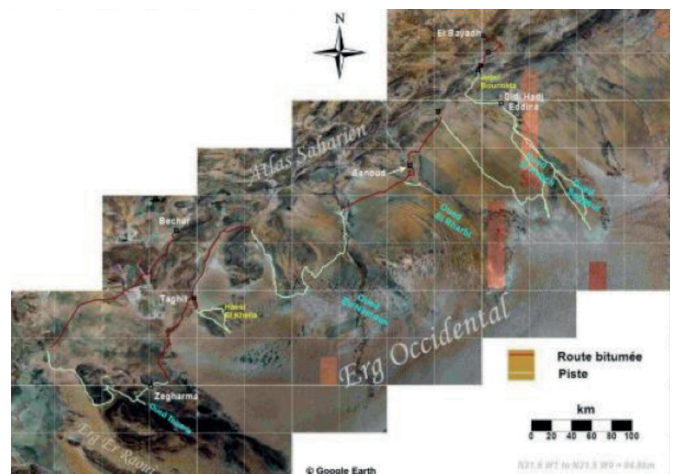


Figure 6: Survey routes in the Great Western Erg, 2009 (De Smet *et al.* 2009).



Figure 7: Great Western Erg (photo A. Fellous-Djardini).

Joleaud (1929) said slender-horned gazelle was rare in Erg Erraoui, but Heim de Balsac (1936) said it did not occur there. Dupuy (1967b) agreed and said its distribution did not extend west of Wadi Saoura, the western boundary of the Great Western Erg, which lies at about 4°20'W. Local informants said that the species once occurred in Erg Issaouane, south of Tihret, where it was known in Tuareg as 'adam' (K. De Smet, pers. comm. 2020). Research is under way to confirm the existence of slender-horned gazelle in these regions within the Tindouf Cultural Park, and in the southern part of the Adrar region in the Touat-Gourara Tidikelt Cultural Park (A. Fellous *in litt.* 2020).

The Great Eastern Erg covers about 190,000 km² (Fellous *et al.* 2009). It extends for c. 600 km north-south from near El Oued to Ghadames and the Tihret Plateau and 200 km west to east, extending into southern Tunisia. A field survey of the north-eastern sector in Algeria in May 2009 saw four animals and 12 sets of field signs, with the first sighting 86 km south-east of El Oued (Fellous *et al.* 2009).

Erg Admer covers approx. 15,000 km² and lies south of the Tassili N'Ajjer mountains and within the Tassili N'Ajjer Cultural Park. Lavauden 1926a and Dupuy 1967b said *G. leptoceros* occurred in Erg Admer but no observations have been made for more than



Figure 8: Tunisia. The Great Eastern Erg (yellow) and Jbil N.P and Senghar-Jabbes N.P.

40 years in the Hoggar and Tassili protected areas, including Erg Admer, and the species is certainly extinct there (K. De Smet, pers. comm. 2020).

3.4. Tunisia

Slender-horned gazelles formerly occurred across the desert zone south of the Chott el Jerid (Sclater & Thomas 1897, Cornetz 1898, Schomber and Kock 1961, Smith et al. 2001). They are still present in the Tunisian part of the Great Eastern Erg whose eastern edge runs down the western half of southern Tunisia. There are sightings from in and around Jbil National Park (Wacher *et al.* 2006, 2007; Jebali, 2012; Petretto 2019) and Senghar-Jabbes NP where slender-horned gazelle groups were seen twice (6 & 2) and fresh tracks and signs were found in 10 out of 16 10x10km grid squares surveyed (Wacher *et al.* 2011; Jebali 2012). Local reports suggest they also occur more widely in the Great Erg (M. Petretto, pers. comm. 2019). Densities are low, and numbers in Tunisia may possibly be in the low hundreds (Wacher *et al.* 2008). In the last few years, the species has been subject to persecution by poachers using quads, motorbikes, and all-terrain vehicles, especially in the desert around Douz (A. Jebali, *in litt.* 2019). Map Fig. 8.

The Tunisian sector of the Great Eastern Erg covers about 30,000 km². Large areas remain well vegetated with *Retama raetam*, *Stipagrostis pungens* and other plants and are not heavily grazed by livestock, probably due to the lack of available water and low accessibility. The extreme south contains many petroleum and gas facilities and is crossed by an extensive network of tracks. There are few vegetated inter-dunal zones and these are exploited by camels or used for recreational activities (M. Petretto, *in litt.* 2020).

Jbil N.P. (1,761 km²) was designated in 1994 especially for the conservation of the species (Kacem *et al.* 1994) and lies at the northern end of the Great Eastern Erg. Senghar-Jabbes NP (2,804 km²) was established in 2010 and lies at the southern end of the Erg. Jbil N.P. consists mainly of sand dunes (c. 90%) and about 180 km² of gravel plains and hills (Wacher *et al.* 2011). The landscape is however changing due to the movement of mobile dunes. Senghar-Jabbes N.P. is dominated by gravel plains (c. 90%) which contain extensive fields of low dunes) with some

flat-topped limestone hills. The remainder, along the western and northern margins, comprises high dune systems at the margin of the Great Eastern Erg (Wacher *et al.* 2011). The national park lies 160 km from the administrative headquarters in Tataouine. It contains no settlements but is used seasonally by pastoralists (sheep/goats and camels). A system of oil and gas pipelines, with associated manned pumping stations, crosses the park from south to north, from the oil field at El Borma (Wacher *et al.* 2011). Fig. 9 shows the results of monitoring surveys in the Great Eastern Erg of Algeria and Tunisia in 2006-2009.

In October 2019, no gazelles were observed during three days of aerial monitoring in the far south of Tunisia. Tracks of ungulates were seen at two sites. Although it was not possible to be certain that these were gazelle tracks, information collected simultaneously on the ground confirmed the presence of individuals or a small group of gazelles. Locals report a strong decrease in numbers over the previous 8 years. Observations are now very rare, but some people have suggested the possibility, so far unconfirmed, of seasonal presence, with notably increased numbers of pregnant females in the dunes

areas during the months when sandstorms occur (M. Petretto, *in litt.* 2020). During the same period, several videos were published on social media of hunting of slender-horned gazelles in southern Tunisia, probably in the Douz region, indicating the presence of the species in areas north of Senghar-Jabbes N.P. and including Jbil N.P. This zone is subject to less industrial disturbance (M. Petretto, *in litt.* 2020).

3.5. Libya

The status of slender-horned gazelle in Libya is poorly known. Lavauden (1926) reported it in the Erg Edeyen (Idhan Awbari) in the centre-west; Toschi (1951) listed a few localities in Fezzan and adds (Toschi 1954) "that it is very rare and not easily found. It may be encountered by chance in the region of Edri, Ouadi Sciati, Ouadi Bergiug and in the desert of Murzuch and Marada". Misonne (1977) found three skulls near Jebel Uweinat in the south-east corner of the country close to the border with Egypt and Sudan. Hufnagl (1972) said it was very rare and only known in recent years from near Dahra, north of Zella in north-central Libya. Essghaier (1980) said it occurred south of Jaghboub on the eastern border, where groups of 10-20 were seen in the 1970s.

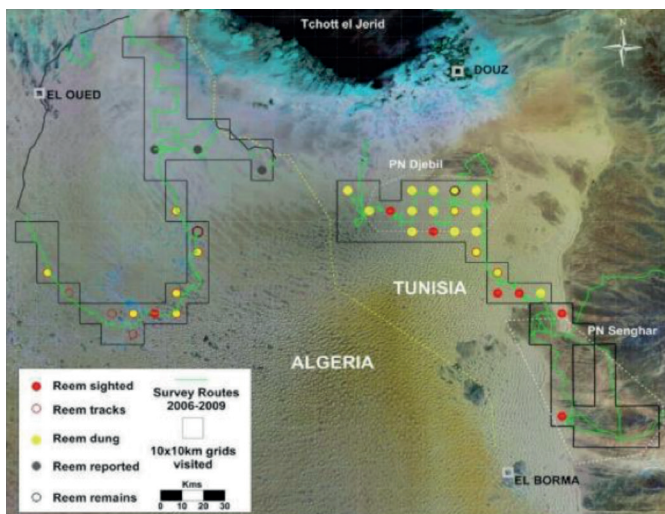


Figure 9: Location of observations and field signs of *G. leptoceros* in the Grand Erg Oriental 2006-2009: El Oued region (Algeria); Jbil and Senghar-Jabbes N.P.s (Tunisia) (Wacher *et al.* 2011).



Figure 10: Libya: The main sand dune areas (yellow) and localities mentioned in the text.

There are four large areas of sand dunes in Libya: the Kalanshiyu sand sea (c. 62,000 km²) in northeastern Libya which is connected to the Great Sand Sea in Egypt; Ramlat Rabbianah (65,000 km²) in the south-east; Idhan Awbari (58,000 km²) in the centre-west, and Idhan Murzuq (58,000 km²) in the south-west, all of which may provide suitable habitat (Khattabi & Mallon 2001). The species may be still present, but the Libyan Desert is hyperarid and could be inhospitable even for such a desert-adapted species. Map Fig. 10.

3.6. Egypt

Slender-horned gazelle formerly occurred in the northern part of the Western Desert and possibly also in the vicinity of Gebel El Uweinat on the south-eastern border with Libya and Sudan (Flower 1932, Osborn & Helmy 1980). Recorded localities include: Siwa and the Qattara Depression in the northwest; dune systems between Faiyum and Qattara; Bahariya and Kharga Oasis, Wadi Natroun and Wadi El Rayan near El Faiyoum on the lower Nile (Osborn & Helmy 1980, Saleh 1987, 2001).

There has been a considerable decline in numbers and range (Saleh 1987, 2001). In the 1980s, the species was considered extinct in five out of six known localities in the eastern part of the Western Desert and was very rare in the last one, Wadi El Rayan and its extension, Wadi Muweilih, where a small group of about 15 animals survived until the late 1980s but was then extirpated by hunters (Saleh 2001). In the western part of the Western Desert, surveys in 1997 around Lake Shiyata, west of Siwa, found many tracks and a few individuals including at Umm El Ghozlan, El Megharba, Qieqab, Shiyata and Tabaghabagh (Wacher 1997). Map figure 11.

El Alqamy & Baha-ud Din (2006) said the current range was limited to the Qattara Depression and localities north-west and south-west of Siwa Oasis and estimated the extent of occurrence at only 3,674 km². A survey by rangers of the Siwa Protected Area showed concentrations of the species around Shiyata and in El Gerba, west of Siwa and local Bedouins reported that poachers had killed about 12 Slender-horned gazelles at Talh El Fawakheer near the Qattara Depression in 2004 (El Alqamy & Baha-ud Din 2006). In 2015, signs of slender-horned gazelle were confirmed in Talh El

Fawakeer, but the Qattara Depression and adjoining area were inaccessible due to the security situation (H. Elalqamy *in litt.* 2019). An old horn was found in Wai El Rayan in 2006 but the population has been extirpated; a few may remain around Siwa, but this area has seen a lot of smuggling activity over the previous five years (O. Attum *in litt.* May 2016). There are also a few records in 1997-2005 from the area around Farfara Oasis. Photographs of dead gazelles have been posted by hunters on Facebook. These include 38 in 2014-2016 from eastern Libya, close to the Egyptian border (A. Eldin *in litt.* May 2016). There are three protected areas within the former range (Table 1). It possible that the species was once present in Gilf El-Kebir N.P.

Recent fieldwork in Siwa, Shiyata, and Gerba found no sign of presence; reports from local rangers suggest that the more southerly oases in the Western Desert have more potential (H. Elalqamy *in litt.* December 2019).

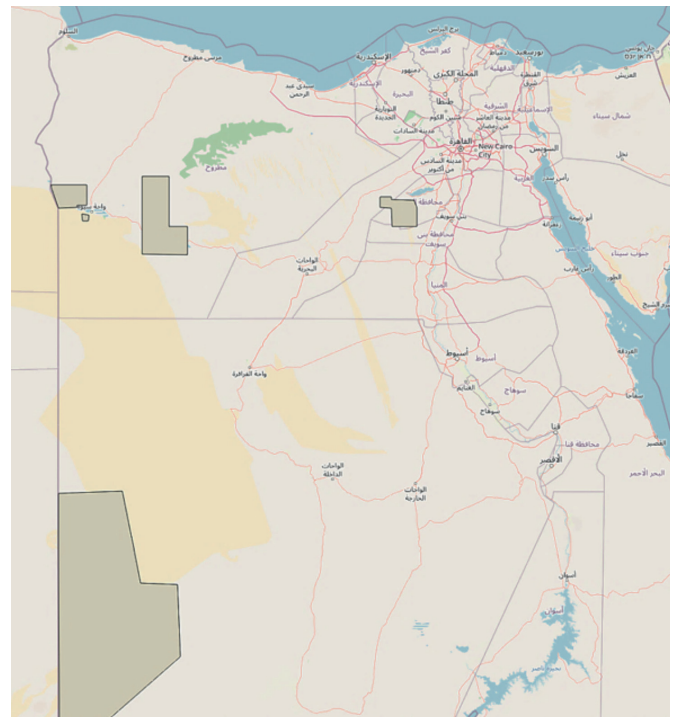


Figure 11: Egypt showing the main localities mentioned in the text. 1. Siwa Protected Area; 2. El Qattara Depression Protected Area; 3. Wadi El Rayan Protected Area; 4. Gilf El Kebir N.P.; 5. Farfara oasis (unprotected). Protected areas polygons from UNEP-WCMC and IUCN (2020).

3.7. Mauritania

Sournia & Verschuren (1990) state that it may have once occurred in the Erg d'Iguidi in the north-east 'where it occurs on the Algerian side' - however, it does not occur there according to Kowalski & Rzebik-Kowalska (1991). There is no evidence of occurrence in the country.

3.8. Mali

Sayer (1977) and Sidiyène & Tranier (1990) said it was absent from the entire country. According to Heringa (1990), numbers were likely to be very low, if not already extinct. There is no evidence of occurrence in the country.

3.9. Niger

Described as very rare and seen occasionally in the desert around the Air Massif (Grettenberger & Newby 1990). There are no recent sightings from the country (T. Rabeil pers. comm. 2019).

3.10. Chad

Malbrant (1952) said it occurred only near Bardai and Soborom to the north and north-east of the Tibesti massif. There are no subsequent records (Thommassey & Newby 1990). There are no specimens or confirmed records of occurrence.

3.11. Sudan

The status of the species in Sudan is unclear and there are no confirmed records. Malbrant (1952) said it is known from Nubia and Sennar. Misonne (1977) found three skulls in extreme south-eastern Libya in the Jebel Uweinat massif, which lies on the border with north-west Sudan and south-west Egypt) so the species may once have occurred in north-west Sudan. Setzer (1956) was doubtful that it was reached as far south as Sudan, and that if it occurred it was probably only in the extreme north-west. Hillman and Fryxell (1988) said it once occurred in the north-western desert. Wilson (1980) said that reports of its presence in Sudan derived from an optimistic interpretation of second-hand data from Chad, according to Devillers *et al.* (2005).

3.12. Transboundary status

Some subpopulations have a transboundary character such as in the Grand Erg Oriental (Algeria and Tunisia) and The Western Desert between Siwa in Egypt and Jaghboub oasis in Libya.

3.13. Population size

No reliable estimates of population size have been made. Slender-horned gazelle appears to have been much more abundant at the end of the 19th and beginning of the 20th centuries, at least in the Great Ergs of Algeria and Tunisia. Large numbers were reported by several authors (Sclater & Thomas, 1898; Heim de Balsac, 1928, 1936). Horns of the species used to be common in shops (Spatz 1928). Lavauden (1926) said the species was still common in the Grand Erg Oriental; and that "the horns that were formerly found in great abundance, and are still found, though in much fewer numbers, in the markets of Biskra, Touggourt and Ouargla". Numbers have certainly been greatly reduced since then. East (1999) suggested that were unlikely to be more than several thousand and maybe only a few hundred. Hufnagl (1972) described it as 'very rare' in Libya. The current IUCN Red List assessment is based on a population size of more than 250 but less than 2,500 'mature individuals', implying a maximum total population of 350–4,200, but estimates that numbers are only in the low hundreds (IUCN SSC Antelope Specialist Group 2016a). However, in the northern part of the Great Western Erg there are probably more than 250 (A. Fellous in prep.), which indicates a higher population than elsewhere.

4. THREATS

4.1. Poaching

The primary cause of the decline is excessive, uncontrolled illegal hunting which affects all antelope species across the region (Saleh 1987, 2001; Kacem *et al.* 1994; Devillers *et al.* 2006; Jebali 2012, Beudels & Devillers 2013). The species is protected in all countries, but poaching continues nevertheless carried out by local hunters, oil workers, VIP hunting groups from the Gulf region, and well-to-do people from the cities. The availability of cheap motorcycles and quad bikes has further facilitated access to desert areas. Hundreds

of photographs were posted on Facebook and other social media between 2009 and 2020 showing hunters in North Africa together with gazelles they had killed (Anon. 2014, Jebali *in litt.* January 2015, Petretto *in litt.* 2020) and such sites are still active. These photos feature up to 20 dead gazelles displayed on a single vehicle on several occasions; (Fig. 12). Some of the dead gazelles are identifiable as *G. leptoceros* but the precise localities where they were killed are unknown (Anon. 2014). In May 2020, news online videos showing hunting, including a group of 6 individuals. A regrettable but widespread issue is weak enforcement



Figure 12: Photo posted on Facebook in 2012.

of the law, partly because rangers do not have enough vehicles or motorbikes to patrol regularly. In addition, poaching offences are not always treated seriously by the courts, with a reluctance to prosecute or small fines administered. Attitudes to hunting and poaching are deeply held, and awareness-raising campaigns are needed to achieve a real change in attitude. In Tunisia, a campaign between the DGF and a citizen monitoring platform 'STOP! Poaching' has engaged local people in monitoring incidents of bird poaching using mobile phones and GPS tagging. While in Algeria, under a framework agreement between the national gendarmerie and the Direction-General of Forests, several national and regional information and awareness workshops on anti-poaching were held in 2017 and 2018, bringing together all stakeholders, to ensure rigorous application of the law in force and to raise awareness of the negative impacts of poaching.

4.2. Habitat degradation

Overgrazing is widespread problem across the region, but some large areas of intact sand dune habitat remain. In the far south of Tunisia, where oil and gas exploration and extraction are well developed, there is a strong human presence in the inter-dunal zones, notably those with vegetation. It is probably this fact that supports observations by local people of gazelles around pumping stations or military guard posts. The risk from poaching to these animals which tolerate the presence of people has not yet been assessed.

4.3. Climate change

The Sahara is already an extreme environment so further increases in temperature or reduction in the sparse rainfall can be expected to impact negatively on the vegetation and therefore on herbivores.

4.4. Hybridization

A case of natural hybridisation between dorcas gazelle and slender-horned gazelle was reported by Loche (1858) and also by local people who give it the name of "cherki", denoting 'hybrid' (A. Fellous, *in litt.*). Some introductions of *Gazella marica* from the Arabian Peninsula to North Africa have been reported in recent years. Given that the species *G. marica* and *G. leptoceros* are genetically very close it is likely that they have crossed. It is important to avoid imports of this species to North Africa to prevent hybridization of *G. marica* (species endemic to the Arabian Peninsula) with

G. leptoceros (endemic to North Africa). Conversely cases where the two species are kept together because of failure to recognise any difference have also been detected in some private *ex situ* captive situations (see below). In 2017 the IUCN SSC Antelope Specialist Group produced a brief guide (in Arabic, French and English) to the gazelles of North Africa and those of the Arabian Peninsula. This guide aims to strengthen knowledge of the different species of antelope native to the two regions (IUCN/SSC Antelope Specialist Group 2017).

4.5. Fragmentation

The remaining populations of *G. leptoceros* are small and isolated to a greater or lesser extent. Lack of dispersal between the populations has implications for loss of genetic diversity and the risks this brings in terms of fitness and persistence. Small populations are inherently more vulnerable to stochastic risks.

4.6. Disturbance

Recreational use of sand dunes is increasing, and off-road vehicles and quad bikes are widely available at tourism centres. Unregulated vehicle access to dunes brings the risk of disturbance or even more direct threats if gazelles are chased for so-called 'sport'. These activities also damage the fragile vegetation and may destroy the burrow systems of small mammals, reptiles, and arthropods.

4.7. Constraints

As well as the direct threats to the species and its habitats there are a number of constraints that hamper effective conservation action. The lack of information on population size overall and at site level as well as distribution such as limits of current presence and numbers present a serious obstacle to effective conservation planning. Establishing numbers, density, carrying capacity, and population trends are high priorities. There is a widespread lack of awareness of the rarity of this species. Government agencies are underfunded, and protected area staff frequently lack sufficient vehicle and motor bikes to patrol effectively and apprehend poachers. Overall, there is not enough recognition of the importance of species like the slender-horned gazelle at the level of local communities, the authorities, and the public in general. Awareness programmes are of the highest importance and are becoming urgent.

5. CONSERVATION MEASURES

5.1. International designations

CITES:

Listed on Appendix I

CMS:

Listed on Appendix I; Included in the Concerted Action for Sahelo-Saharan Megafauna and in the CMS Action Plan (Beudels *et al.* 1998)

IUCN Red List:

Endangered
(IUCN SSC Antelope Specialist Group 2016a)

5.2. Legal status

Legally protected in Algeria, Egypt, Libya, Niger, Tunisia.

5.3. Protected areas

There are several protected areas (PA) within the former and current range in Algeria, Egypt, Niger and Tunisia (Table 1). The only PAs where slender-horned gazelle is currently known to occur today are: in Tunisia, Jbil NP, which was designated especially for the conservation of the species and Senghar-Jabbes NP; in Algeria, the Taghit-Guir NP, Touat-Gourara Tidikelt Cultural Park and possibly Tindouf Cultural Park, especially the ergs in its northern and eastern parts (presence to be confirmed) and Egypt (Qattara Depression).

Site	Size (km ²)	Date Established	UCN category	Presence
Tunisia				
Jbil National Park	1,761	1994	II	Present
Senghar-Jabbes National Park	2,804	2010	II	Present
Algeria				
Taghit-Guir NP	2,500	2020	-	Present
Tassili N'Ajjer Cultural Park	138,000	1972	-	Extinct
Touat-Gourara Tidikelt Cultural Park	38 740	2008	-	Present
Tindouf Cultural Park	168 000	2008	-	To be confirmed
Egypt				
Wadi El Rayan National Park	1,759	1989	II	Extinct
Siwa Protected Area	7,800	2001	VI	To be confirmed
El Qattara Depression	22,102	1999	-	Present
Gilf El Kebir National Park	48,523	2007	-	Unconfirmed
Niger				
Aïr & Ténéré National Nature Reserve	64,560	1998	IV	?

Table 1. Protected areas within the current and former range of *Gazella leptoceros*

5.4. *Ex situ* populations

The global *ex situ* population is very small, especially in comparison to other Sahelo-Saharan antelopes. In the USA there are 91 animals (May 2019) living in 10 facilities. Nine of these are members of the American Zoo Association (AZA) and one is a private facility, which holds the largest single group.

In Europe (EAZA) there were seven animals (1.6) in November 2019 at Planckendael Zoo in Belgium. The last male died at the end of November and three females died in January 2020 from an unknown disease. Mating continued until the male died. The three remaining females were born in 2009, 2010 and 2017, so only one is like to be of reproductive age (S. Hofman, *in litt.* 2019).

The entire captive population in North America and Europe is descended from three founders (1 male, 2 female) captured in Tunisia in 1965 (Correll 2011). The international studbook is maintained at the Living Desert (USA) and the latest edition was published in 2016 (Randle 2016). The captive population is highly inbred.

In Algeria, the Brezina Gazelle Breeding Centre lies 130 km south of El Bayadh. It was built in 2000 and now covers 120 ha. Local people donated two wild-caught females to the centre in 2000, then a subadult male and female in 2001. There were 11 animals in 2006, and 5 (1.4) in 2008 (Abáigar *et al.* 2009b) and 37 (10.27) on 2 May 2019 (A. Fellous pers. comm. 2019). It is not known if additional wild caught animals have been added or these are all derived from the original founders.

Recommendations on husbandry and management of the Brezina centre were made by Abáigar *et al.* (2009b). The Directorate-General of Forests is making sustained efforts to render operational the breeding centre at El Menea dedicated to Sahelo-Saharan antelopes, for which a section will be reserved for breeding slender-horned gazelle *ex situ* (A. Benkheira pers. comm. 2014).

In Tunisia, captive group is maintained at the Bir Turki enclosure in Sidi Toui NP in south-east Tunisia near the Libyan border. It was established in 1993 and covers 6135 ha. The captive slender-horned gazelle population descends from a single wild male (it was found as a calf was in 1997 in the dunes west of Tataouine after its mother was killed by poachers.



Fig. 13: The first calf born in Sidi Toui, 2000 (photo: R. Molcanova).



Figure 14: *G. leptoceros* in the enclosure at Sidi Toui N.P. in November 2011 (photo: T. Wacher).

The animal was confiscated and raised in a small pen at Bir Turki. Two captive born females donated by Planckedael Zoo were transported to Sidi Toui NP to establish a breeding group in Spring 1999 (Molcanova *et al.* 2001). This breeding group was considered as a reproductive nucleus for future reintroduction in other protected areas (Direction Générale des Forêts, 2001). At first, the group bred successfully. There were two births in 2000, 7 individuals in 2001, 10 (3,4,3) in 2002, and 16 (7,5,4) in 2004. In 2008 there were 12 individuals, 14 (3.8.3) in 2010, 18 in 2011 (R. Molcanova, pers. comm. 2020) and 16 (4.8.4) in 2012 (Jebali 2012). Numbers increased to 22 in April 2020, held in two groups 10 (2.5.3) and 12 (1.6.5) including 8 young born in spring; one of the four males had to have a hind foot amputated, so its reproductive capacity needs to be assessed (M. Petretto pers. comm. 2020). The DGF is planning to move some of these gazelles to a new breeding centre at El Gonna, near Sfax.

In October 2017 a training workshop course was jointly organized by the IUCN Centre for Mediterranean Cooperation and the Direction of Forests, Algeria (DGF), with the collaboration of the Experimental Station for Arid Zones (EEZA-CSIC), Barcelona Zoo and Marwell

Wildlife (IUCN, DGF Algeria, EEZA-CSIC, Barcelona Zoo, & Marwell Wildlife 2018). The main aim of the workshop was to transfer scientific and technical knowledge on captive management of threatened gazelles in North Africa. The workshop was attended by 45 participants from Algeria, Morocco, and Tunisia, representing several parks and reserves, breeding centres, and government conservation agencies. The workshop took place in Tlemcen in Algeria (Fig. 15).

Slender-horned gazelles may occasionally be obtained by private collections in the Middle East. Some were observed on private property in Riyadh Saudi Arabia in the mid-1990s, which were misidentified as Arabian Sand Gazelles *G. subgutturosa marica*. On the same property eight were identified (by appearance and subsequent DNA testing) among a recent import of 12 immature gazelles from Tunisia identified as dorcas gazelles (Wacher 2007). In 2017, 16 suspected slender-horned gazelles were tested in the UAE, but they exhibited a mixture of *Gazella bennettii* and *G. gazella* mtDNA haplotypes.

Any captive individual that is not related to the animals currently in the USA or Europe would be a priority for breeding because of their genetic value.



Figure 15: Participants at the training workshop in Tlemcen (photo: IUCN-Med).

6. CONSERVATION OPTIONS

The main strategic directions identified are: establishing current status in the wild, protecting known sites, enhancing *ex-situ* populations, raising awareness of slender-horned gazelle conservation, strengthening the policy framework, reintroduction/reinforcement, taxonomy, and implementation of the roadmap, including building capacity.

Field actions at present for the wild population can be considered in four 'management units':

Great Western Erg (Algeria); Great Eastern Erg (Algeria); Great Eastern Erg (Tunisia); Qattara-Siwa (Egypt – if any gazelles remain). Further management units can be identified in Libya once the status of the species in the country is clarified.

The *ex-situ* population is also currently managed in four units: Brezina (Algeria); El Gonna-Sidi Toui (Tunisia); USA (AZA-SPA-private); Europe.

6.1. Determining current status in the wild

Effective planning depends on reliable knowledge of current status. The most important information gaps are:

- Great Western Erg: limits of distribution, key zones, density, population estimate, extent of threats;
- Great Eastern Erg (Algeria): limits of distribution, key zones, density, population estimate, extent of threats;
- Great Eastern Erg (Tunisia): population estimates in Jbil and Senghar-Jabbes NPs; extent of distribution inside Senghar-Jabbes; extent of distribution outside the two NPs; extent of threats;
- Egypt: establish the status of the species in the Western Desert;
- Libya: collate and map all recent reports of presence and conduct field surveys where possible;

6.2. Strengthening protection of known sites

Ensuring effective protection of surviving populations is critical to halt the further loss of individuals and allow recovery.

- Increase protection inside Protected Areas (PAs) where the species is known to occur

- Provide PA management with adequate staff and vehicles to patrol effectively
- Identify key localities outside PAs
- Work with government agencies to recommend new PAs
- Establish 'safe zones' in key areas outside the PA network through targeted patrolling
- Liaise with tourism operators on monitoring and control of disturbance
- Establish networks of citizen monitors to monitor poachers
- Engage local communities in conservation projects through incentives such as sustainable tourism

6.3. Enhancing *ex-situ* populations

The biggest risk to the *ex situ* population outside North Africa is the small number of founders and consequent genetic effects. Supplementing with new wild founders is highly desirable, but at present, veterinary restrictions prevent the import of animals or even gametes from Africa into the USA or the EU.

In Tunisia, and likely elsewhere, young gazelles are occasionally captured in the desert while hiding, soon after birth, or they may be caught when a female is poached. These animals are then kept as pets and are sometimes available for sale in towns such as Douz. Confiscating these animals and transferring them to a local breeding centre would increase the number of founders and the potential for growth.

The *ex-situ* community could play an important role by supporting captive breeding in North Africa through funding, training on population management (genetic and demographic), gazelle husbandry and education. Slender-horned gazelles have bred successfully in captivity in many collections, especially in North America. There is also extensive experience and expertise available from captive breeding of one of the species' closest relatives, *G. marica*. For example, in Saudi Arabia in 1989-2004 c.500 *G. marica* across 40 enclosures at the King Khaled Wildlife Research Centre were intensively managed, including annual capture of all animals, veterinary screening, and breeding group management. This population has provided animals

for several successful reintroductions into the wild. Among the lessons learned from these experiences

- Support captive facilities in Algeria (Brezina) and Tunisia (El Gonna, Sidi Toui) in husbandry and management through training programs and advice on enclosure design based on successful examples from North America, Europe and the Arabian Peninsula (currently under way).
- Confiscate unauthorized captive animals and include them in breeding programmes
- Conduct population viability analysis (PVAs) and develop breeding plans and projections)
- Develop a cooperative breeding plan between Brezina and the Tunisian centres, including exchange of animals as appropriate
- Maintain and develop the SSP in the USA
- Review the best option for the remaining animals in Planckendael Zoo.

6.4. Strengthening the policy framework

While activities on the ground are principally carried out at national level, bilateral measures are needed for transboundary populations. Regional cooperation is also important. In North Africa the IUCN Centre for Mediterranean Cooperation can play a key coordinating role, and at range-wide level the CMS Concerted Action for Sahelo-Saharan Antelopes.

6.5. Strengthening awareness of slender-horned gazelle conservation

It is essential to raise awareness on the local regional importance of slender-horned gazelle and its current plight at all levels: governments, local administration, local communities, hunting associations, tourism operators, zoos, the public and international donor organizations.

6.6. Taxonomy

The recent genetic evidence points to *G. leptoceros loderi* and *G. cuvieri* being a single species. However, they are distinct ecotypes and are treated separately for conservation planning. A full genomic analysis is required to finally delineate the phylogenetic relationships between *G. leptoceros leptoceros*, *G. l. loderi*, *G. cuvieri*, and *G. marica*.



Figure 16: Young male *G. leptoceros* in the Great Western Erg (photo: A. Fellous-Djardini).

6.7. Reintroduction and reinforcement of populations

The potential for these options is limited at the present time because the captive population is small and has low genetic diversity. First of all is necessary to increase the number of gazelles in the two existing breeding centres in North Africa and the metapopulation in North America. The species usually gives birth to twins so under experienced management in adequately sized facilities, it should be possible in future to produce stock for return to the wild. Any future release site must contain an adequate area of suitable habitat and be under strict protection before any operation takes place. The eastern form (*G. l. leptoceros*) is not found in captivity so any operations to restore populations in Egypt or eastern Libya would rely on animals from the western part of the range. Habitat modelling studies should be conducted to identify candidate sites for reintroduction.

6.8. Implementation

The most important aspect of any conservation strategy or recovery plan is effective implementation of the recommended actions. A programme to coordinate and monitor the roadmap is essential and to revise as appropriate.

7. PLANNING LOGFRAME 2020-2029

Objective	Action	Indicator	Implementation
1. Current status in the wild is established	1.1. Conduct feasibility study on aerial surveys of Great Western Erg and Great Eastern Erg (Algeria)	Study reports completed	DGF (agency responsible), ANN
	1.2. Conduct ground surveys in the Great Western Erg and Great Eastern Erg (Algeria)	Survey reports completed	DGF (agency responsible), ANN
	1.3. Carry out interview surveys with local communities in Erg Erraoui, Erg Cherch, Erg Iguidi, Region of Tadmaït, Erg Issaouene (Algeria)	Surveys completed	DGF (agency responsible), ANN
	1.4. Conduct aerial survey of Great Eastern Erg (Tunisia)	Survey reports completed	DGF, Marwell Wildlife
	1.5. Conduct ground surveys in the Great Eastern Erg (Tunisia)	Surveys completed	DGF, Marwell Wildlife
	1.6. Conduct questionnaire and field surveys in Egypt	Surveys completed	Government agency, Nature Conservation Egypt (NGO)
	1.7. Collate reports of SHG in Libya and conduct questionnaire and field surveys where feasible	Information available Survey results available	Government agency, Alhaya organisation
	1.8. Collate historic reports of SHG in Sudan	Information available	Government agency, NGOs
	1.9. Collate reports of SHG in countries south of the Sahara	Information available	Government agencies, NGOs
	1.10. Monitor poaching reports on social media with the support of anonymous volunteers	Monitoring in place with regular reports coordinated with the roadmap	
	1.11. Carry out a study to characterise poaching through enquiries on the ground and administration archives	Report available	Proposed by TWCS to the DGF (Tunisia)
	1.12. Develop standardized survey and monitoring methods	Methods developed and in use	All
	1.13. Develop an identification card (SHG and dorcas gazelle) Arabic/ French/English	ID card produced and available online	ASG, IUCN-Mediterranean
	1.14. Maintain an updated status summary	Running update maintained	ASG, Living Desert
	1.15. Establish a central database and national databases to store records	Databases set up	Government agencies
	1.16. Organise courses and training in field survey, identification of gazelles, census techniques and site management	Staff trained	ASG, IUCN-Med, others

Objective	Action	Indicator	Implementation
2. Protection of known populations is enhanced	2.1. Provide adequate vehicles and equipment for anti-poaching activities to key PAs	Key PAs are adequately equipped Poaching reduced	DGF (agency responsible), ANN
	2.2. Support anti-poaching measures at key points in the Great Western and Great Eastern Ergs	Anti-poaching patrols in place Poaching reduced	DGF (agency responsible), ANN
	2.3. Ensure that legal penalties for poaching are applied effectively	Poachers successfully prosecuted Poaching reduced	Law enforcement agencies, judicial authorities
	2.4. Engage citizen scientists in monitoring poaching activity	Citizen science networks operating	Government agencies, NGOs
	2.5. Avoid imports into North Africa of non-indigenous gazelle species.	No further imports of non-indigenous gazelles	DGF, Marwell Wildlife

Objective	Action	Indicator	Implementation
3. The status of captive populations is improved	3.1. Manage breeding centres according to the best international standards	Breeding plans developed Enclosure designs optimized Gazelles tagged to allow identification Veterinary protocols in place Parasite loads monitored and controlled	Government agencies, Managers, Experts
	3.2. Algeria (Brezina Breeding Centre): Monitor numbers, sex/age ratios, reproductive success	Monitoring carried out annually Studbook developed	ANN
	3.3. Tunisia (Sidi Toui breeding centre): Monitor numbers, sex/age ratios, twinning rates, reproductive success, annually	Monitoring carried out Animals tagged to allow identification Studbook developed	DGF
	3.4. Tunisia: Construct a new breeding facility at El Gonna and provide equipment and trained staff	Centre constructed and operational Studbook developed	DGF, Marwell Wildlife
	3.5. Develop protocols to confiscate privately owned animals in range states	Protocols developed Confiscated animals transferred to official centres	ANN, DGF (Algeria), DGF (Tunisia), TWCS
	3.6. Provide training in techniques of gazelle husbandry and captive management	Staff in all centres trained	BEF (HCEFLCD), IUCN-Med, EEZA, Marwell
	3.7. Produce guidelines on husbandry and management (EN and FR)	Guidelines available in both languages	AZA, EAZA, ZSL, EEZA, Marwell Wildlife
	3.8. Review options to expand the US breeding program	Review completed; Recommendations made	AZA, managers
	3.9. Review the future of the European population	Decision made	EAZA
	3.10. Continue attempts to obtain new founders	Genetic diversity increased	Government agencies, AZA
	3.11. Develop a captive management plan across all populations	Integrated management plan developed	All

Objective	Action	Indicator	Implementation
4. Policy framework strengthened	4.1. Develop National Action Plans or work plans, based on the regional roadmap (Algeria, Tunisia, Egypt, Libya)	National action Plans developed and available online	State agencies, in collaboration with national stakeholders
	4.2. Contribute to the CMS Concerted Action for Sahelo-Saharan Megafauna and revised Action Plan	Revised AP developed	CMS, all

Objective	Action	Indicator	Implementation
5. Awareness of slender-horned gazelle conservation enhanced	5.1. Messages distributed through the press, TV and social media	Messages and articles published in the media and on social networks	All
	5.2. Raise awareness of the status of SHG among local communities in all key zones	Outreach sessions organized	Government agencies, NGOs
	5.3. Raise awareness of the status of SHG among hunting organizations	Joint meetings held	Government agencies, NGOs, hunting associations
	5.4. Raise awareness of the situation of slender-horned gazelle among regional officials: Customs, Gendarmerie and military		Government agencies, NGOs

Objective	Action	Indicator	Implementation
6. The taxonomic relationships of <i>G. leptoceros</i> are clarified	6.1. Conduct a genomic analysis to confirm the taxonomic relationships between <i>G. leptoceros</i> , <i>G. cuvieri</i> and <i>G. marica</i> , including specimens from Egypt and from museums	Analysis of results available	RZSS

Objective	Action	Indicator	Implementation
7. Reintroduction and reinforcement	7.1. Carry out a feasibility study on reintroduction and reinforcement of wild populations (depends on success of actions under Objective 3.	Study conducted Potential release sites identified	Government agencies, NGOs,

Objective	Action	Indicator	Implementation
8. The road map is coordinated and implemented	8.1. Review progress at regular intervals	Reports produced	Government agencies, IUCN/SSC ASG, NGOs
	8.2. Provide adequate capacity and resources to ensure conservation of SHG	Resources and capacity provided	All partners
	8.3. Maintain communication between all stakeholders	Club Leptocère email list maintained with regular communication	ASG, Living Desert

8. REFERENCES

- Abáigar, T., Belbachir-Bazi, A. & Cano, M. 2009a. Inventaire de reconnaissance de la gazelle dorcas (*Gazella dorcas*) et la gazelle leptocère (*Gazella leptoceros*) entre l'Oued Es Segguer et l'Oued Zergoun – Grand Erg Occidental (Wilaya d'El Bayadh, Algérie). Projet de coopération internationale hispano-algérienne (AECI-MESRS) Réf : A/011012/07. Rapport scientifique-technique. Almería (Espagne) et Bejaïa (Algérie), avril 2009.
- Abáigar, T., Belbachir-Bazi, A. & Cano, M. 2009b. Proposition d'aménagement et de gestion d'un centre d'élevage de gazelles en captivité. Projet de coopération internationale hispano-algérienne (AECI-MESRS) Réf : A/01101/2017. Rapport scientifique-technique. Almería (Espagne) et Bejaïa (Algérie), avril 2009.
- Anon. 2014. [Slaughter continues]. *Sandscript* 12: 4.
- Aulagnier, S., Cuzin, F., Loggers, C.O. & Thévenot, M. 2001. Chapter 3. Morocco. in "Global survey and regional action plans: Antelopes. n°4: North Africa, the Middle East, and Asia". D.P. Mallon & S.C. Kingswood (eds.), IUCN, Gland. pp. 13-21.
- Beudels, R.C. & Devillers, P. 2013. Slender-horned gazelle *Gazella leptoceros*. Pp. 352-355 in: J. Kingdon and M. Hoffmann (eds), *The Mammals of Africa. Volume VI. Pigs, hippopotamuses, chevrotain, giraffes, deer and bovids*. London: Bloomsbury Publishing.
- Beudels, R.C., Devillers, P. & Lafontaine, R.-M. 1998. Plan d'action pour la conservation et la restauration des antilopes sahélo-sahariennes 1998. Bonn, Germany : UNEP/CMS Secretariat. CMS Technical Series Publication N°4.
- Callot, Y. & Fontugne, M. 2008. Les sites lacustres d'âge holocène dans l'est du Grand Erg occidental (nord-ouest du Sahara algérien) : interprétation géomorphologique et paléoclimatique. *Géomorphologie : relief, processus, environnement* 3: 187-200.
- Cornetz, V. 1898. La faune et la chasse au Sahara tunisien. *Bulletin de la Société de Géographie d'Alger*. Troisième année, 3e et 4e trimestre, pp. 153-168.
- Correll, T. 2011. *Slender-horned gazelle* *Gazella leptoceros*. *International Studbook*. Tulsa Zoo, Tulsa, OK, USA.
- De Smet, K. 1989. The distribution and habitat choice of larger mammals in Algeria, with special reference to nature protection. PhD. Thesis, University of Ghent.
- De Smet, K., Maziz, S.B., Fellous, A., Belbachir, F., Belbachir-Bazi, A., Commizoli, P. & Wacher, T. 2009. Inventaire de la faune sauvage des zones désertiques en Algérie (Grand Erg Occidental). Rapport de mission 3-15 mars, 2007. Sahara Conservation Fund.
- Devillers, P., Beudels-Jamar, R.C., Lafontaine, R.-M. & Devillers-Terschuren, J. 2006. *Gazella leptoceros*. In: R.C. Beudels, P. Devillers, R.M. Lafontaine, J. Devillers-Terschuren & M.O. Beudels (eds), *Sahelo-Saharan Antelopes. Status and Perspectives. Report on the conservation status of the six Sahelo-Saharan Antelopes. CMS SSA Concerted Action*. 2nd edition. CMS Technical Series Publication N°11. Bonn, Germany : UNEP/CMS Secretariat.
- Direction Générale des Forêts. 2001. *Stratégie Nationale Tunisienne pour la Conservation et la Restauration des ASS et de leurs habitats 2001-2020*. Tunes: Ministère de l'Agriculture.
- Dupuy, A. 1967a. La faune menacée de l'Algérie et sa répartition. *Bulletin de la société des sciences naturelles et physiques du Maroc* 47: 329-354.
- Dupuy, A. 1967b. Répartition actuelle des espèces menacées de l'Algérie. *Bulletin de la société des sciences naturelles et physiques du Maroc* 47 : 355-385.
- East, R. 1999. *African Antelope Database 1998*. Gland, Switzerland and Cambridge, UK : IUCN.
- El Alqamy, H. & Baha El Din, S. 2006. Contemporary status and distribution of gazelle species (*Gazella dorcas* and *Gazella leptoceros*) in Egypt. *Zoology in the Middle East* 39 : 5-11.
- Ellerman, J.R. & Morrison-Scott, T.C.S. 1951. *Checklist of Palaearctic and Indian Mammals 1758 to 1946*. London: British Museum (Nat. Hist.).
- Essghaier, M.F.A. 1980. A plea for Libya's gazelles. *Oryx* 15 : 384-385.
- Fellous, A. 2012. Premières données sur la distribution et l'utilisation de l'habitat par les gazelles dorcas (*Gazella dorcas*) et leptocères (*G.leptoceros*) dans le Sud Ouest algérien. USTHB/FSB, Laboratoire de Recherche sur les Zones Arides Colloque Algéro-Francais Alger: 5-6 Juin 2012.

Fellous, A. & Siga, A. 2007. Mission d'investigation sur la faune saharienne menacée en particulier les ongulés sauvages. Ghardaïa–Laghouat. Rapport non publié.

Fellous, A., Wachter, T., De Smet & Comizzoli, P. 2009. *Inventaire de la faune sauvage des zones désertiques d'Algérie*. Switzerland : Sahara Conservation Fund (SCF). www.saharaconservation.org

Flower, S.S. 1932. Notes on the recent mammals of Egypt, with a list of the species recorded from the Kingdom. *Proceedings of the Zoological Society of London* 102: 369-450.

Gentry, A.W. 1971. Les Gazelles. In: J. Meester and H. W. Setzer, eds. *The mammals of Africa: an identification manual*. Washington DC : Smithsonian Institution Press.

Grettenberger, J.F. & Newby, J.E. 1990. Chapter 5: Niger. Pp 14-22 in R. East, ed. *Antelopes. Global survey and regional action plans. Part 3. West and Central Africa*. Gland: IUCN.

Groves, C.P. 1988. A catalogue of the genus *Gazella*. Pp. 193-198 in A. Dixon & D. Jones, eds. *Conservation and biology of desert antelopes*. London: Christopher Helm.

Hammond, R.L., Macasero, W., Flores, B., Mohammed, O.B., Wachter, T.W. and Bruford, M.W. 2001. Phylogenetic re-analysis of the Saudi gazelle and its implications for conservation. *Conservation Biology* 15: 1123-1133

Hartert, E. 1913. Notes on ruminants and other large mammals of the central western Sahara. *Novitates Zoologicae* 20 : 33-37.

Heim de Balsac, H. 1928. Notes sur la présence et la répartition de quelques grands mammifères dans le sud-Oranais et le Maroc oriental. *Revue française de Mammologie* 1: 83-92.

Heim de Balsac, H. 1936. Biogéographie des mammifères et des oiseaux de l'Afrique du Nord. *Bulletin Biologique de France et de Belgique*. Suppl. 21.

Heringa, A.C. 1990. Chapter 4: Mali. Pp 8-14 in R. East, ed. *Antelopes. Global survey and regional action plans. Part 3. West and Central Africa*. Gland : IUCN.

Herrera-Sánchez, F.J, Gil-Sánchez, J.M., Álvarez, B., Cancio, I., de Lucas, J., Arredondo, A., Ángel Díaz-Portero, M., Rodríguez-Siles, J., Sáez, J.M., Pérez, J., McCain, E., Qninba A. & Abáigar, T. (2020). Identifying priority conservation areas in a Saharan environment by highlighting the endangered Cuvier's Gazelle as a flagship species. *Scientific Reports* 10: 8241. doi. [org/10.1038/s41598-020-65188-6](https://doi.org/10.1038/s41598-020-65188-6).

Hillman, J.C. & Fryxell, J.M. 1988. Chapter 3: Sudan. Pp 5-15 in R. East, ed. *Antelopes. Global survey and regional action plans. Part 1. East and Northeast Africa*. Gland, IUCN.

Hufnagl, I. 1972. *Libyan mammals*. The Oleander Press.

In Tanoust 1930. *La chasse dans le pays Saharien et Sahélien*. Paris : Comité Algérie-Tunisie-Maroc.

IUCN, DGF Algeria, EEZA-CSIC, Barcelona Zoo & Marwell Wildlife. 2018. Gestion en captivité de gazelles Nord africaines menacées. Parc national de Tlemcen, Algérie, 9-11 octobre 2017. Rapport d'atelier. *Non publié*.

IUCN SSC Antelope Specialist Group 2016a. *Gazella leptoceros*. The IUCN Red List of Threatened Species 2016: e.T8972A50186909. <http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T8972A50186909.en>

IUCN SSC Antelope Specialist Group 2016b. *Gazella cuvieri*. The IUCN Red List of Threatened Species 2016: e.T8967A50186003. <http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T8967A50186003.en>.

IUCN/SSC Antelope Specialist Group. 2017. *Antelopes of North Africa and the Arabian Peninsula*. Fact Sheet No. 1. Téléchargeable de : https://www.iucn.org/sites/dev/files/content/documents/2017/en_gacelas_web_160_media_1.pdf https://www.iucn.org/sites/dev/files/content/documents/fr_gacelas_web_160_media.pdf https://www.iucn.org/sites/dev/files/content/documents/iucn_2017_antelopes_nafricaarabia_ar.pdf

Jebali, A. 2012. Recensement et sex-ratio des antilopes Sahélo-sahariennes réintroduites dans les aires protégées du Sud Tunisien. Rapport Technique préliminaire N°1 pour EWA Conservation Committee et DGF.

- Joleaud, L. 1929. Etude de géographie zoologique sur la Berbérie, les ruminants. V. Les gazelles. *Bulletin de la Société Zoologique de France* 59: 438-456.
- 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*. Eschborn: GTZ.
- Khattabi, K. & Mallon, D.P. 2001. Chapter 6. Libya. Pp. 41-47 in: D.P. Mallon and S.C. Kingswood, eds. *Antelopes. Part 4: North Africa, the Middle East, and Asia. Global Survey and Regional Action Plans*. Gland, Switzerland: IUCN.
- Kowlaski, K. & Rzebik-Kowalska, B. 1991. *Mammals of Algeria*. Wrocław, Polish Academy of Sciences.
- Lavauden, L. 1920. *La chasse et la faune cynégétique en Tunisie*. Tunis, Imprimerie Centrale.
- Lavauden, L. 1926. Les gazelles du Sahara central. *Bulletin de la Société d'histoire naturelle de l'Afrique du nord* 17: 11-27.
- Lerp, H., Wronski, T., Pfenninger, M. & Plath, M. (2011) A phylogeographic framework for the conservation of Saharan and Arabian Dorcas gazelles (Artiodactyla: Bovidae). *Organisms Diversity & Evolution* 11: 317-329
- Loder, E.G. 1894. On the "Reem" antelope of Algeria. *Proceedings of the Zoological Society of London* 1894: 473-476.
- Loggers, C., Thévenot, M. & Aulagnier, S. 1992. Status and distribution of Moroccan wild ungulates. *Biological Conservation* 59: 9-18.
- Malbrant, R. 1952. *Faune du centre Africain français. Encyclopédie Biologique XV*. Paris : P. Lechevalier.
- Mallon, D.P. & Kingswood, S.C. 2001. Chapter 41. Regional Action Plan for Antelope Conservation. In: D.P. Mallon and S.C. Kingswood (eds). *Antelopes. Part 4: North Africa, the Middle East, and Asia. Global Survey and Regional Action Plans*, pp. 231-243. Gland, Switzerland: IUCN.
- Marwell Wildlife. 2019. Monitoring de la gazelle leptocère (*Gazella leptoceros*). Rapport de l'étude aérienne préliminaire. Marwell Wildlife, UK.
- Misonne, X. 1977. Mammifères du Jebel Uweinat, désert de Libye. *Musée Royal de l'Afrique Centrale, Tervueren. Série 8^e Sciences Zoologiques* 217: 5-33.
- Molcanova, R., Wakefield, S. & De Smet, K. 2001. Summary of activities in Tunisia since 1999. In: *Proceedings of the Second Annual Sahelo-Saharan Interest Group Meeting 2001*, Almeria, Spain, pp. 18-20.
- Osborn, D.J. & Helmy, I. 1980. The contemporary land mammals of Egypt (including Sinai). *Fieldiana Zoology new series* 5: 1-579.
- Pease, A.E. 1896. On the antelopes of the Aures and Eastern Algerian Sahara. *Proceedings of the Zoological Society of London* 1896: 809-814.
- Randle, B. 2016. Slender-horned Gazelle *Gazella leptoceros* International Studbook. Palm Desert, CA : The Living Desert.
- Rebholz, W. & Harley, E. 1999. Phylogenetic relationships in the Bovid Subfamily Antilopinae based on mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution* 12: 87-94.
- Saleh, M.A. 1987. Decline of gazelles in Egypt. *Biological Conservation* 39 : 283-295.
- Saleh, M.A. 2001. Chapter 7. Egypt. In: D.P. Mallon & S.C. Kingswood, compilers. *Antelopes: Global Survey & Regional Action Plans Part IV: North Africa, the Middle East and Asia*. Pp. 48-54. Gland, Switzerland : IUCN.
- Sayer, J.A. 1977. Conservation of large mammals in the Republic of Mali. *Biological Conservation* 12 : 245-263.
- Schomber, H.W. & Kock, D. 1961. Wildlife protection and hunting in Tunisia. *African Wild Life* 15 : 137-150.
- Sclater, P.L. & Thomas, O. 1897/1998. *The book of antelopes. VOL III*. London : R.H. Porter.
- Setzer, H.W. 1956. Mammals of the Anglo-Egyptian Sudan. *Proceedings of the United States National Museum* 106 : 447-587.
- Sidiyene, E.A. & Tranier, M. 1990. Données récentes sur les mammifères de l'Adrar des Iforas (Mali). *Mammalia* 54 : 472-477.

Silva, T.L. 2018. Biodiversity, evolution and conservation of threatened desert ungulates. PhD Thesis. Universidade do Porto.

Silva, T.L., Godinho, R., Castro, D., Abáigar, T., Brito, J.C. & Alves, P.C. 2015. Genetic identification of endangered North African ungulates using noninvasive sampling. *Molecular Ecology Resources* 15 : 652-661.

Silva, T.L., Vale, C.G., Godinho, R., Fellous, A., Hingrat, Y., Alves, P.C., Abáigar, T. & Brito, J.C. 2017. Ecotypes and evolutionary significant units in endangered North African gazelles. *Biological Journal of the Linnean Society* 122 : 286-300.

Smith T.R., Mallon, D.P. & De Smet, K. 2001. Chapter 3. Tunisia. Pp. 30-40 in D.P. Mallon & S.C. Kingswood, eds. *Antelopes. Global survey and regional action plans. Part 4: North Africa, the Middle East, and Asia*. Gland : IUCN.

Sournia, G. & Verschuren, J. 1990. Chapter 3: Mauritania. Pp 6-8 in R. East, ed. *Antelopes. Global survey and regional action plans. Part 3. West and Central Africa*. Gland : IUCN.

Spatz, P. 1928. Über nordafrikanische Gazellen un Antilopen. *Zeitschrift für Säugetierkunde* 2 : 27-29.

Thomas 1894. On some gazelles brought by Sir E. Loder from Algeria. *Proceedings of the Zoological Society of London* 1894 : 467-472.

Thommassey, J.P. & Newby, J.E. 1990. Chapter 6: Chad. Pp. 22-28 in R. East, (compiler). *Antelopes. Global survey and regional action plans. Part 3. West and Central Africa*. Gland: IUCN/SSC Specialist Group.

Toschi, A. 1951. Mammiferi della Libia. *Ricordi Zoologia Applicata alla Caccia* 2 : 137-177.

Toschi, A. 1954. La chasse en Libye. Pp. 42-43 in : Zürich, S. & Krister (Ed). *Le grand livre de la faune africaine et sa chasse*. Genève. 2V.

UNEP-WCMC and IUCN (2020), Protected Planet: The World Database on Protected Areas. Downloaded on 27 April 2020. Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

Wacher, T.J. 1997. Field Survey to Qattara Depression, Siwa & Wadi El Rayan. Cairo: Egyptian Environmental Affairs Agency. (Unpublished report).

Wacher, T.J. 2006. Inventaire de la gazelle leptocère. Djebil – Bir Aouine. Avril – Mai 2006.

Rapport final. ASS CMS/FFEM Projet 2006-1.

Wacher, T. 2007 Inventaire de la gazelle leptocère, phase 2. Parc National de Djebil, Tunisia.

Octobre 2007. Project CMS/FFEM. Devis Programme 2007-2.

Wacher, T., Wronski, T., Hammond, R.L. et al. 2010. Phylogenetic analysis of mitochondrial DNA sequences reveals polyphyly in the goitered gazelle (*Gazella subgutturosa*). *Conservation Genetics* 12 : 827–831.

Wacher, T., Sassi, M., Guidara, H. & Tahri, J. 2011. *A reconnaissance survey of the Jabbes-Senghar National Park, Tunisia. SCF Pan Sahara Wildlife Survey*. Technical Report No. 9. March 2012. Sahara Conservation Fund.

Wilson, R.T. 1980. Wildlife in northern Darfur, Sudan: a review of its distribution and status in the recent past and at present. *Biological Conservation* 17 : 85-101.

Wronski, T., Wacher, T., Hammond, R.L. et al. 2010. Two reciprocally monophyletic mtDNA lineages elucidate the taxonomic status of Mountain gazelles (*Gazella gazella*). *Systematics and Biodiversity* 8 : 119-129.



Figure 17: Tracks of *G. leptoceros* around *Genista* (photo A. Fellous-Djardini).

