

**Third Regional Seminar on the Conservation and Restoration of
Sahelo-Saharan Megafauna**

Agadir, Morocco, 14 – 16 March 2023

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SAHELO-SAHARAN MEGAFUNA ACTION PLAN
(Prepared by the Secretariat)

Background

1. At its 13th meeting (COP13, Gandhinagar, 2020), the Conference of the Parties adopted Concerted Action 13.4 for Sahelo-Saharan Megafauna. The Concerted Action mandated activities and expected outcomes are as follows:

Concerted Action 13.4

(v). Activities and expected outcomes:

B. Proposed Activities

During the period 2020-2023, the following activities are proposed:

2. Prepare an updated action plan for Sahelo-Saharan megafauna;

C. Expected Outputs

2. An updated action plan for the Sahelo-Saharan megafauna;

D. Description of Activities

Activity 2. Prepare an updated action plan

An updated action plan for the conservation of Sahelo-Saharan megafauna and its habitats will be developed, building on the existing Sahelo-Saharan Antelope Action Plan. This action plan was initially developed in 1998 and updated in 2003. Since then, there have not been any updates.

Since the last revision of the Sahelo-Saharan Antelope Action Plan in 2003, various status reports and action plans have been prepared for the species under the Concerted Action. In 2006, for example, the report on the conservation status of the six Sahelo-Saharan Antelopes was prepared under the Sahelo-Saharan Antelope Concerted Action. Subsequently, the following new species action plans have been prepared:

- a. IUCN (2014) Conservation Review of the Dama Gazelle (*Nanger dama*);
- b. Noé (2017) Plan d'Action Régional Addax et Gazelle Dama 2018 -2022; and
- c. IUCN (2018) Conservation Strategy and Action Plan for Cuvier's Gazelle (*Gazella cuvieri*) in North Africa 2017-2026;

The updated action plan for the Sahelo-Saharan megafauna will consider these existing action plans, incorporating the best available knowledge on the conservation status of the species.

To address multiple pressures having an impact on the survival of the Sahelo-Saharan megafauna, including an ecosystem approach in the action plan may prove more effective than solely species-specific efforts. Habitat restoration, in addition to habitat conservation, could also be part of the strategies to restore and conserve the species.

2. The Summary of proposed activities under the Sahelo-Saharan Concerted Action (2020-2023) places the responsibility of completing Activity 2. *Preparation of an updated action plan* on the CMS Secretariat in consultation with: Range States; and relevant stakeholders (IGOs, NGOs, academia, private sector).

Activities to Complete Activity 2 of Concerted Action 13.4

3. The CMS Secretariat enlisted the support of the Co-Chairs of the IUCN Species Survival Commission (SSC) Antelope Specialist Group (ASG) in May 2022 to develop the updated action plan.
4. In June 2022 the CMS Secretariat introduced the Co-Chairs of the IUCN SSC ASG to the CMS National Focal Points of the Concerted Action Range State Parties to CMS, and to the CITES Management and/or Scientific Authorities of the Concerted Action Range State Non-CMS Parties. The Range States were requested to provide information on past and ongoing activities on the Concerted Action species that would inform the development of the action plan.
5. The Co-Chairs of the IUCN SSC Antelope Specialist Group, as foremost experts in this field, engaged their vast networks within IGOs, NGOs, academia and the private sector to collect additional information that informed the development of the action plan.

Discussion and Analysis

6. A regional action plan for Sahelo-Saharan megafauna has not been developed since 2003 when the Sahelo-Saharan Antelope Action Plan was revised at the 2nd Regional Seminar on the Conservation and Restoration of Sahelo-Saharan Antelopes in Agadir, Morocco.
7. All eight Concerted Action species have declined significantly in range and numbers, in some cases catastrophically and all are threatened on the IUCN Red List.
8. The main threats to the Concerted Action species are direct killing, habitat degradation, overgrazing, wood collection, climate change, insecurity, and armed conflicts, all against a background of severe development pressure, as well as under-resourcing and lack of awareness.
9. Considering the above, an updated action plan was developed, which can be found in the Annex to this document.

Recommended Actions

10. Third Regional Seminar on the Conservation and Restoration of Sahelo-Saharan Megafauna is recommended to:

endorse the draft Action Plan contained in the Annex to this document.

ANNEX

SAHELO-SAHARAN MEGAFUNA ACTION PLAN

DRAFT

The designations employed and the presentation do not imply the expression of any opinion whatsoever on the part of the CMS Secretariat or contributory organisations concerning the legal status of any country, territory, city or area in its authority, or concerning the delimitation of its frontiers or boundaries.

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Abbreviations

ANEF	Agence Nationale des Eaux et Forêts (National Water and Forests Agency - Morocco)
ASG	Antelope Specialist Group
ATNNR	Aïr and Ténéré National Nature Reserve
AZA	Association of Zoos and Aquariums (US)
BEF	Bureau des Eaux et Forêts
C2S2	Conservation Centers for Species Survival
CA	Concerted Action
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CNODC	China National Oil and Gas Development Corporation
CNPC	China National Petroleum Corporation
CRDA	<i>Commissariat Régional au Développement Agricole</i> (Regional Commission for Agricultural Development - Tunisia)
CSIC	<i>Consejo Superior de Investigaciones Científicas</i> (Spanish National Research Council)
DCFAP	<i>Direction de la Conservation de la Faune et des Aires Protégées</i> (Directorate for Wildlife Conservation and Protected Areas - Chad)
DFCPR	<i>Direction de la faune, de la chasse, des parcs et des réserves</i> (Directorate of Wildlife Hunting and Parks and Reserves - Niger)
DFPP	<i>Direction de la Faune, de la Pêche et de la Pisciculture</i> (Niger)
DGF	<i>Direction Générale des Forêts</i> (General Directorate of Forests)
EAD	Environment Agency Abu Dhabi
EAZA	European Association of Zoos and Aquaria
EEP	European Ex situ Programme
EEZA	<i>Estación Experimental de Zonas Áridas</i> (Arid Zones Experimental Station)
ESIAs	Environmental and Social Impact Assessments
GBF	Global Biodiversity Framework
GIS	Geographic Information Systems
IFC	International Finance Corporation
IGO	Inter-governmental Organizazion
IPCC	Intergovernmental Panel on Climate Change
IRSNB	<i>Institut Royal des Sciences Naturelles de Belgique</i> (Royal Belgian Institute of Natural Sciences)
IUCN	International Union for the Conservation of Nature
NBSAPs	National Biodiversity Strategy and Action Plans
NGO	Non-governmental Organization
OROA	Ouadi Rimé-Ouadi Achim Faunal Reserve (Chad)
PA	Protected Area
PSC	Production Sharing Contract
PVA	Population Viability Analysis

RZSS	Royal Zoological Society of Scotland
SC (SCF)	Sahara Conservation (formerly Sahara Conservation Fund)
SCBI	Smithsonian Conservation Biology Institute
SMART	Spatial Monitoring and Reporting Tool
SMNP	Souss Massa National Park
SPA	Source Population Alliance
SSC	Species Survival Commission
SSIG	Sahelo-Saharan Interest Group
SSMF	Sahelo-Saharan Megafauna
SSP	Species Survival Plan
SZP	<i>Société zoologique de Paris</i> (Zoological Society of Paris)
TTNNR	Termit Tin Toumma National Nature Reserve
UGAP	<i>Unité de Gestion de l'Aire Protégée</i> (Protected Area Management Unit - Niger)
UNEP	United Nations Environment Programme
UNHCR	UN Refugee Agency
WAC	Wildlife Africa Conservation
WWF	World Wildlife Fund
ZAA	Zoo and Aquarium Association Australasia
ZIMS	Zoological Information Management System
ZSL	Zoological Society of London

1. Introduction

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) initiated the Sahelo-Saharan Megafauna (SSMF) Concerted Action (CA) in 1994 at the 4th Meeting of the Conference of the Parties held in Nairobi, Kenya, which adopted [Recommendation 4.5](#) recommending the development and implementation of a plan of action for the conservation of six Sahelo-Saharan threatened ungulate species listed in Appendix I of CMS. These species were the Addax (*Addax nasomaculatus*), Scimitar-horned Oryx (*Oryx dammah*), Dama Gazelle (*Nanger dama*), Slender-horned Gazelle (*Gazella leptoceros*), Cuvier's Gazelle (*Gazella cuvieri*), and Dorcas Gazelle (*Gazella dorcas*). The Range States of the SSMF CA are Algeria, Burkina Faso, Chad, Egypt, Eritrea, Ethiopia, Libya, Mali, Mauritania, Morocco, Niger, Nigeria, Senegal, South Sudan, Sudan, and Tunisia.

In 1996 comprehensive status reports on the six species were compiled in a project financed by CMS, and co-ordinated by the Institut Royal des Sciences Naturelles de Belgique (IRSNB), based on the most recent survey information and input from experts from the Range States, Non-governmental Organizations (NGOs) and Inter-governmental Organizations (IGOs).

In 1998, a Seminar on the Conservation and Restoration of Sahelo-Saharan Antelopes took place in Djerba, Tunisia, at the invitation of the Government of Tunisia. The seminar was organised by the CMS Secretariat and IRSNB and attended by representatives of the Range States along with aridland experts and representatives of international organisations. The Seminar produced the "Djerba Declaration", adopted the Sahelo-Saharan Antelope Action Plan, and appealed to the Range States, international NGOs, and experts to assist in its implementation.

In 2003 the Action Plan was revised at the 2nd Regional Seminar on the Conservation and Restoration of Sahelo-Saharan Antelopes in Agadir, Morocco. In 2006 *Sahelo-Saharan Antelopes - Status and Perspectives* was published, detailing the updated conservation status of the six species (Beudels-Jamar et al. 2005). In 2008 at the 9th Meeting of the Conference of the Parties to CMS in Rome, Italy, the Sahelo-Saharan Ungulates Concerted Action was reformulated as the Sahelo-Saharan Megafauna Concerted Action. At the 13th meeting of the Conference of the Parties to CMS in Gandhinagar, India, in February 2020, two species (*Eudorcas rufifrons*, *Ammotragus lervia*) were added to the Concerted Action which was renewed for 2020-2023 ([Concerted Action 13.4](#)).

This updated Action Plan has been developed as part of the implementation of [Concerted Action 13.4](#), funded through the CMS Project "Addressing disturbance and illegal killing of Sahelo-Saharan Megafauna", by the Government of Germany.

The updated Action Plan follows the format of the 1998 Action Plan in presenting actions needed at regional level and actions for each species. Addressing the multiple pressures impacting negatively on the survival of the Sahelo-Saharan Megafauna and restoring these species to substantial parts of their former range, is a long-term endeavour that will involve habitat restoration at landscape scale and cross-sectoral efforts to address human development, insecurity, and climate change. In the short-term, urgent action is required to prevent further extinctions and improve the status of all eight SSMF species.

2. The Sahelo-Saharan Megafauna Region

The original Concerted Action region extended west-east from the Atlantic to the Red Sea and north from the Mediterranean coast to the southern edge of the Sahel. The addition of Red-fronted Gazelle (*Eudorcas rufifrons*) extends the area into the Sudanian savanna zone and the Sudd grasslands. The whole SSMF region covers an area of 14,590,203 km². It is varied in character and is composed of several 'ecoregions' (ecologically and geographically defined areas that contain characteristic and distinct assemblages of natural communities and species) as described by the World Wildlife Fund (WWF) (Olson et al. 2001; Burgess et al. 2004; Dinerstein et al. 2017).

The Sahara encompasses 10 ecoregions which total 7,313,376 km² in area and the Sahel ecoregion covers 3,645,327 km², amounting to a combined 11,854,503 km² of 'Sahelo-Saharan' habitats. In addition are the Mediterranean ecoregion (780,000 km²) and three areas of flooded grassland and savanna (Nile Delta, Inner Niger Delta, Lake Chad Basin; 115,800 km² in total). The West and East Sudanian Savannas and the Sudd grasslands cover a further 2,755,700 km². Detailed descriptions of the 11 'Sahelo-Saharan' ecoregions, including vegetation, climate, fauna, threats, and protection status are provided by Naia and Brito (2021).

2.1 SAHARA

The topography of the Sahara includes gravel plains, stone sheets, sand dunes, wadis (dry riverbeds), and salt flats, as well as several mountain massifs (highest point: 3,415 m in the Tibesti). Settlement is concentrated in a few scattered oases which support extensive date groves and some agriculture. The interior is hot and hyperarid, precipitation is low and unpredictable, with some places receiving no rain at all for several years. The northern and southern margins receive a little more rain, up to 350 on the northern margins. The Atlantic coastal desert is a little cooler due to the oceanic influence.

Vegetation cover is low to very low. Sparse trees grow in the northern subdesert steppes (*Acacia* spp, *Balanites*, spp.) while characteristic plants include the grass *Retama raetam* and the desert melon *Citrullus colcynthis*, a valuable source of moisture. The mountains include the Hoggar (550,000 km²), Adrar Atar, Adrar des Ifoghas (250,000 km²), the Termit and Air massifs, Jebel Uweinat, Ennedi, the Red Sea Hills, and some smaller ranges. These mountains receive more rainfall, up to 150 mm annually at higher elevations, and support more vegetation. Trees include relict species such as Saharan cypress (*Cupressus dupreziana*) and wild olive (*Olea lapperinii*), as well as doum palm (*Hyphaene thebaica*), and *Salvadora persica* (Burgess et al. 2004, Naia and Brito 2021).

Addax and Dorcas Gazelle once frequented almost all the Saharan plains. Slender-horned Gazelle is found in the dunes and sandy deserts of the North. Barbary Sheep occurs on all the rocky massifs. Addax also use wadis on the lower slopes for shade and food in the hot summer season. Two of the remaining Dama Gazelle populations are found in the Termit and Air massifs, respectively, but these may be suboptimal habitat and represent a refuge from persecution. Scimitar-horned Oryx also use the southern subdesert steppes bordering the Sahel.

2.2. SAHEL

The Sahel ecoregion extends from Senegal to northern Eritrea and extreme north-west Ethiopia. Annual rainfall averages 257 mm (ranging from approx. 10mm in the north to 1000 mm in the south) (Naia and Brito 2021). Precipitation and vegetation both increase along a north-south latitudinal gradient. The northern Sahel north consists of dry semidesert and steppe, transitioning to shrubland and light woodland with *Acacia* spp., baobab *Adansonia*

digitata, *Faidherbia albida* etc. The tussock grass *Panicum turgidum* is a characteristic species. This an important region for the SSMF, with six species occurring there.

2.3. MEDITERRANEAN

This zone consists of coastal plains, mountains, woodlands, and scrub in North Africa, mainly in Morocco, Algeria, Tunisia, with one patch, Jebel Akhdar, in Libya. The Atlas ranges rise to 4,165 m at Jebel Toubkal. Annual precipitation is 500-600 mm mainly falling in winter. There are extensive areas of Mediterranean scrub, montane grasslands, and forests containing, evergreen oak *Quercus* spp., *Pinus halepensis*, and *Juniperus* spp. Cuvier's Gazelle is endemic to this region. Dorcas Gazelle once occurred widely north of the Atlas but now only in small remnants. It is still present on the southern side where the region merges into the subdesert steppes. Barbary Sheep is distributed widely on the higher, rockier slopes.

2.4. SUDANIAN SAVANNA AND SUDD

The East and West Sudanian savannas extend across the region to the south of the Sahel. Tropical savanna with a marked wet season from May to September. Rainfall ranges 600-1,000 mm. Drier woodland in the north, species of *Anogeissus*, *Acacia*, *Balanites*, *Terminalia* and *Combretum* dominate further south. Tall *Hyparrhenia* grasses are widespread. Red-fronted Gazelle is the only SSMF species inhabiting this zone. The Sudd ecosystem lies mainly in South Sudan, extending into the Gambela region of extreme western Ethiopia. The grasslands surrounding the central swamps are seasonally flooded and are home to large numbers of Mongalla Gazelle (*Eudorcas rufifrons albonata*).

3. The Sahelo-Saharan Megafauna Species

The eight species covered by the SSMF CA comprise seven antelopes and one caprin. An overview is presented here, with more detail in the species summaries.

3.1. TAXONOMY

CMS follows the classification in *Mammalian Species of the World* (Wilson & Reeder 2005). Subsequent genetic research has provided many insights leading to proposed taxonomic changes. Two issues affect the SSMF at species level. Red-fronted Gazelle (*Eudorcas rufifrons*), regarded as a single species by Wilson & Reeder 2005) is provisionally split into three species in the *Mammals of Africa* (Groves 2013), an arrangement followed by the IUCN Red List of Threatened Species. Recent genetic analyses also indicate that *Gazella cuvieri* and *G. leptoceros* should be considered a single species although they form distinct ecotypes (Silva et al. 2015). They are provisionally treated separately here, following the IUCN Red List.

Five SSMF species have several named 'subspecies' (see the species summaries for details). These have all been based on variation in coat colour and/or size and shape of horns, and they are perhaps more accurately viewed as geographical forms. There is no supporting genetic evidence, the boundaries between named forms sometimes overlap or are not defined, and in the open desert environments of the Sahara and Sahel there are few natural biogeographic barriers that might isolate populations and promote variation.

Molecular analyses conducted so far have shown that phylogenetic structure in Dorcas Gazelle is weak or absent (Lerp et al. 2013) and that the three subspecies of Dama Gazelle are not supported by genetic evidence (Senn et al. 2014). Further genetic and especially genomic analyses are needed to clarify relationships and identify the key conservation units for planning purposes. Table 1 summarises the main taxonomic and genetic issues, and the measures needed.

Table 1. Taxonomic and genetic issues concerning SSMF species

Species	# Sub-species	Notes	Needed	Urgency
<i>Addax nasomaculatus</i>	0	No issues	N/A	-
<i>Oryx dammah</i>	0	No issues	N/A	-
<i>Nanger dama</i>	3	Genetic evidence does not support the 3 described subspecies structure	Identify conservation units (1-3)	H
<i>Gazella leptoceros</i>	2	Insufficient genetic evidence to support 2 subspecies;	Genomic analysis to confirm whether the species should be combined	M
		Analyses indicate monophyly with <i>G. cuvieri</i>	Genetic/genomic analyses of the relationship to <i>G. marica</i>	
<i>Gazella cuvieri</i>	0	Unclear relationship to <i>G. marica</i> Analyses indicate monophyly with <i>G. leptoceros</i> ;	Decision on treatment as two ecotypes	
<i>Gazella dorcas</i>	5	Two analyses show very weak phylogeographic structure;	Identify conservation units	M
		Geographic boundaries between subspecies are unclear		
<i>Eudorcas rufifrons</i>	3	Isolating barriers are absent Provisional arrangement, no genetic evidence available	Clarify relationships between the 3 subspecies and other members of genus <i>Eudorcas</i>	H
<i>Ammotragus lervia</i>	5	No genetic evidence to support the named subspecies	Identify conservation units Phylogenetic analysis to establish intraspecific relations and structure	H
		Boundaries between 'subspecies' unclear	Identify conservation units	

3.2. STATUS AND DISTRIBUTION

All eight species are adapted to arid conditions to a greater or lesser extent, and all are threatened on the IUCN Red List, except one subspecies. All eight SSMF species have declined significantly in range and numbers, in some cases catastrophically. Estimated range losses for seven species between 1800 and 2000 were from 66% to 100% (Durant et al. 2014; summary in Table 2). *Oryx dammah* became extinct in the wild around the year 2000 but has been successfully reintroduced into Chad, beginning in 2016. Numbers have grown steadily and a reassessment as 'Endangered' has been submitted to IUCN.

Table 2. Reduction in range size of SSMF species (from Durant et al. 2014)

Species	Range size		% loss
	(year) 1800	(year) ~2000	
<i>Addax nasomaculatus</i>	6,911,931	47,155	>99
<i>Oryx dammah</i>	1,543,784	0	100
<i>Nanger dama</i>	3,616,260	23,720	>99
<i>Gazella leptoceros</i>	1,298,549	182,005	86
<i>Gazella cuvieri</i>	279,525	96,330	66
<i>Gazella dorcas</i>	9,739,599	1,357,723	86
<i>Eudorcas rufifrons</i>	NA	NA	NA
<i>Ammotragus lervia</i>	2,361,570	535,031	77

Addax and Dama Gazelle have both lost more than 99% of their range and with very small numbers remaining they both are close to becoming extinct in the wild. Red-fronted Gazelle is assessed as three species on the Red List: one is Endangered, one Vulnerable, and one Least Concern (*E. r. albonotata*). Note that if these three taxa were assessed together as a single species, the Red List category would be Least Concern, driven by the very large numbers of *E. r. albonotata* (270,000). However, the last census of this species took place in 2007 and its area of distribution is affected by the recent conflicts in South Sudan, so current population size may be much lower. On the other hand, the population size of Dorcas Gazelle (12,000) is likely to be an underestimate.

Populations of all species are declining except the reintroduced *Oryx dammah* which is increasing steadily, though as a single population it remains susceptible to random threats. Obtaining accurate population estimates for species that are sparsely distributed across vast areas is methodologically and logistically problematic and much work needs to be done to improve the accuracy of current estimates. Table 3 shows the countries of occurrence of each species. Three species occur or once occurred in countries outside the SSMF CA, while the Barbary Sheep, has substantial introduced populations outside the original range. The Red List status, CMS status, CITES status, and population estimates are summarised in Table 4.

Table 3. SSMF species and occurrence by country (green = extant; brown = extinct)

	<i>Addax nasomaculatus</i>	<i>Oryx dammah</i>	<i>Nanger dama</i>	<i>Gazella dorcas</i>	<i>Gazella leptoceros</i>	<i>Gazella cuvieri</i>	<i>Eudorcas rufifrons</i>	<i>Ammotragus lervia</i>
SSMF Concerted Action Range States								
Algeria								
Burkina Faso								
Chad	(R)	R			?			
Egypt								
Eritrea								
Ethiopia								
Libya								
Mali								
Mauritania								
Morocco	(R)							
Niger						?		
Nigeria							?	
Senegal		SC	SC					
South Sudan								
Sudan						?		
Tunisia		SC						
Range States outside SSMF Concerted Action								
Cameroon				?				
Central African Republic								
Djibouti								
Ghana								
Israel								
Jordan								
Somalia								
Togo								
Extralimital countries								
Croatia								I
Slovenia								I
Spain								I
USA								I

R – reintroduced; (R) reintroduction initiated; I = Introduced; SC = semi-captive; ? = unconfirmed

Table 4. Summary of the status of the eight SSMF species.

Species	IUCN Red List		CMS	CITES	Population estimates		
	Cate- gory	Year			Appendix	In situ ¹	Year
Addax <i>Addax nasomaculatus</i>	CR	2016	I	I	<100	2020	5,020
Scimitar-horned Oryx <i>Oryx dammah</i>	EW ³	2016	I	I	575	2022	15,268
Dama Gazelle <i>Nanger dama</i>	CR	2016	I	I	<150	2021	2,772
Cuvier's Gazelle <i>Gazella cuvieri</i>	VU	2016	I	I	2360- 4560	2016	124
Slender-horned Gazelle <i>G. leptoceros</i>	EN	2016	I	I	<1000	2016	170
Dorcas Gazelle <i>G. dorcas</i>	VU	2016	I ⁴	III ⁴	50,000	2022	5,384
Red-fronted Gazelle <i>Eudorcas rufifrons</i>	N/A ⁵	N/A	I	-	284,500- 285,000	2007- 2016	41
Red-fronted gazelle <i>E. r. rufifrons</i>	VU ⁶	2017	-	-	12,000	2016	-
Mongalla Gazelle <i>E. r. albonotata</i>	LC ⁶	2016	-	-	270,000	2007	-
Heuglin's Gazelle <i>E. r. tilonura</i>	EN ⁶	2016	-	-	2,500- 3,000	2016	-
Barbary Sheep <i>Ammotragus lervia</i>	VU ⁶	2020	II	II	5,000- 10,000	2020	3,762

¹IUCN Red List or later; ²2022, see also Table 6; ³Reassessment as Endangered submitted;

⁴NW Africa only; ⁵Taxon not assessed; ⁶Taxon assessed as a species.

3.3. PARTIES' OBLIGATIONS UNDER CMS

Parties to the Convention on the Conservation of Migratory Species of Wild Animals (CMS) have certain legal obligations to comply by. Migratory species threatened with extinction are listed on Appendix I of the Convention. Range State Parties of CMS Appendix I species have a legal obligation to strictly protect these animals, conserve or restore their habitats, mitigate obstacles to migration and control other factors that might endanger them as stipulated in Article III paragraphs 4 and 5 of the convention text (see text box 1).

Article III
Endangered Migratory Species: Appendix I

...

4. Parties that are Range States of a migratory species listed in Appendix I shall endeavour:

- a) to conserve and, where feasible and appropriate, restore those habitats of the species which are of importance in removing the species from danger of extinction;
- b) to prevent, remove, compensate for or minimize, as appropriate, the adverse effects of activities or obstacles that seriously impede or prevent the migration of the species; and
- c) to the extent feasible and appropriate, to prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or controlling or eliminating, already introduced exotic species.

5. Parties that are Range States of a migratory species listed in Appendix I shall prohibit the taking of animals belonging to such species. Exceptions may be made to this prohibition only if:

- a) the taking is for scientific purposes;
- b) the taking is for the purpose of enhancing the propagation or survival of the affected species;
- c) the taking is to accommodate the needs of traditional subsistence users of such species; or
- d) extraordinary circumstances so require;

provided that such exceptions are precise as to content and limited in space and time. Such taking should not operate to the disadvantage of the species.

...

Text Box 1. Article III paragraphs 4 and 5

Range State Parties of CMS Appendix II species have a legal obligation to cooperate internationally for their conservation and management while giving priority to species with unfavourable conservation status as stipulated in Article IV paragraphs 4 and 5 of the convention text (see text box 2).

Article IV
Migratory Species to be the Subject of AGREEMENTS: Appendix II

- 1. Appendix II shall list migratory species which have an unfavourable conservation status and which require international agreements for their conservation and management, as well as those which have a conservation status which would significantly benefit from the international cooperation that could be achieved by an international agreement.**
- 2. If the circumstances so warrant, a migratory species may be listed both in Appendix I and Appendix II.**
- 3. Parties that are Range States of migratory species listed in Appendix II shall endeavour to conclude AGREEMENTS where these should benefit the species and should give priority to those species in an unfavourable conservation status.**
- 4. Parties are encouraged to take action with a view to concluding agreements for any population or any geographically separate part of the population of any species or lower taxon of wild animals, members of which periodically cross one or more national jurisdiction boundaries.**
- 5. The Secretariat shall be provided with a copy of each AGREEMENT concluded pursuant to the provisions of this Article.**

Text Box 2. Article IV

Considering the above the Range States of the Concerted Action on Sahelo-Saharan Megafauna species have legal obligations as stipulated in the convention text to strictly protect and cooperate in their conservation and management. These obligations should be reflected in national legislations and policies and these laws and policies should be applied and implemented strictly.

3.4. THE NATIONAL LEGISLATION PROGRAMME

Parties are not just under an obligation to implement the Convention, the implementation of the Convention through national legislation and other domestic measures is also key to achieving conservation and sustainable management of species. Therefore, the Conference of the Parties at its 12th meeting (Manila, 2017) adopted [Resolution 12.9](#) to establish a [National Legislation Programme](#) to strengthen the implementation of the Convention through national legislation and support Parties, if needed, in developing or improving relevant national legislation. In line with [Resolution 12.9](#), Parties are encouraged to submit to the Secretariat information regarding their legislation and other domestic measures relating to implementation of Article III, paragraph 4 a) and b) and paragraph 5 of the Convention through a questionnaire. The responses in the questionnaires, as well as information from the inventories, contributed to National Legislation Profiles provided by the Secretariat, including findings and recommended actions, to facilitate the identification of inconsistencies in the implementation of Article III.5. Of the fourteen Range States of the Concerted Action on Sahelo-Saharan Megafauna that are Parties to the CMS, three (Algeria, Eritrea and Mali) are participating in the National Legislation Programme.

3.5. PARTIES' OBLIGATIONS UNDER CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I lists the most endangered species and prohibits international trade except when the purpose is not commercial, for instance for scientific research. In these exceptional cases, trade must be authorized by both an import permit and an export permit (or re-export certificate). Appendix II lists species that are not necessarily now threatened but may become threatened unless trade is closely controlled. International trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate. No

CITES import permit is necessary. Permits or certificates should only be granted if the relevant authorities are satisfied that trade will not be detrimental to the survival of the species in the wild. Appendix III lists species at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation.

4. Threats

The main threats to SSMF are direct killing, habitat degradation, overgrazing, wood collection, climate change, insecurity, and armed conflicts, all against a background of severe development pressure, as well as under-resourcing and lack of awareness.

4.1. DIRECT EXPLOITATION

Uncontrolled, unsustainable hunting is the principal cause of the massive declines in SSMF species, particularly during the 20th century, when the advent of modern firearms and all-terrain vehicles greatly increased the destructive impact and geographical reach of hunting activities, simultaneously enabling access to previously remote areas and the killing of multiple animals at one time (Newby various, Dragesco-Joffe 1993; Mallon & Kingswood 2001; Beudels et al. 2005; Brito et al. 2014; Duncan et al. 2014; Durant et al. 2014; Newby et al. 2016). Large-scale killing for ‘sport’ and its impact on local antelope populations, was already recorded by In Tanoust (1930) and these activities accelerated throughout the 20th century. Except for some extensive dune fields, almost all parts of the region can now be accessed by vehicle. The availability of cheap motorcycles and quad bikes has further facilitated access to desert areas, especially dunes. Oil and mineral exploitation facilities have also increased access and facilitated poaching in some places (Brilo et al. 2014; Duncan et al. 2014). Hundreds of photographs posted on Facebook and other social media between 2009 and 2020 showed hunters in North Africa with gazelles and Barbary Sheep they had killed, sometimes displaying up to 20 dead animals on a single vehicle (IUCN SSC ASG and RZSS 2020). The tradition of hunting is long-established and deeply embedded throughout the region and represents a major obstacle to conserving remaining populations and restoring SSMF species at landscape scales. Awareness-raising campaigns are urgently needed to achieve changes in attitude. Conflicts and insecurity increase the availability of weapons and inhibit and prevent effective law enforcement. But in any case, the logistical difficulties involved in patrolling to protect biodiversity over such a vast region should not be underestimated. Professional trophy hunting companies are currently advertising hunts for Barbary Sheep and Heuglin’s Gazelle (*Eudorcas rufifrons tilonura*) on their websites. While trophy hunting can be a conservation tool if rigorously managed (IUCN SSC 2012), there is no evidence to show that these hunts or quotas are based on scientific population assessments.

4.2. HABITAT LOSS AND DEGRADATION

Overgrazing, wood collection, conversion to farmland, and exploitation of natural resources are considered serious threats to Sahara-Sahel biodiversity (Beudels et al. 2005; Brito et al. 2014; Duncan et al. 2014). Expansion of livestock into new areas brings disturbance, competition for grazing, reduces the availability of palatable species, and carries the risk of overgrazing.

Degradation also results from a drying climate. Cutting of trees and collection of shrubs removes food and an important source of shade in the hot season. Overgrazing and competition with domestic livestock are exacerbated by drilling of new water wells that enable permanent occupation and disrupt seasonal grazing patterns. The Sahelian steppes have been particularly subject to growing pressure by livestock and agricultural conversion (Beudels-Jamar et al. 2005). Beyond the immediate impact on SSMF species, habitat loss and degradation pose major threats to agricultural productivity and food security for millions of people.

A localised threat, particularly in parts of north-west Africa, is increased recreational use of sand dunes by local people and tourists. Quad bikes are widely available at tourism centres. Unregulated vehicle access to dunes damages the fragile vegetation and causes disturbance or even more direct threats if gazelles are chased for so-called 'sport'.

4.3. FRAGMENTATION

The remaining populations of the seven species of antelopes are small and scattered (except for Mongalla Gazelle which occurs in a single very large population), while Barbary Sheep are restricted to rocky hills and mountains, so their populations are naturally isolated. Small populations are inherently more at risk from stochastic events such as disease and extreme climate events. Lack of dispersal between populations increases the risk of inbreeding. Small populations are also vulnerable to the loss of diversity through genetic drift, inbreeding depression, Allee effects, and demographic stochasticity. When combined, these factors reduce population size even further, and may eventually lead to an 'extinction vortex' (Gilpin and Soulé, 1986). These factors apply in particular to the Addax and Dama Gazelle, with their tiny remnant populations, and potentially to the Scimitar-horned Oryx. There are few anthropogenic barriers in the region that prevent movements and migrations altogether, and isolation is due more to distance and a hostile landscape matrix with a high risk of poaching. However, road corridors, associated settlements, and oil extraction facilities cause disturbance and likely further increase the isolation of populations. It has also been suggested that the Great Green Wall habitat restoration initiative might disrupt movements by some wild species (Naia et al. 2021).

4.4. DROUGHT AND CLIMATE CHANGE

Many changes to the climate and vegetation of the Sahara have taken place over the last 500 million years, with a drying phase over the last few thousand years (Le Houérou 1997). Parts of the Sahara are hyperarid, receiving small and unpredictable amounts of rain; some sites may have no precipitation for several years. The Sahel experienced several intense periods of drought at the end of the 1970s and the 1980s, resulting in reduced winter grazing, loss of shade trees, and disappearance of vital water resources (Newby 1988, 1989). A recent study showed that during 1950–2015, the Sahara expanded its area by 8% and its southern boundary advanced 100 km southwards, with these trends projected to continue in 2015–2050 (Liu and Xue 2020). Several climate change predictions indicate even higher temperatures and the potential for local adaptation to alleviate their impacts may be limited (Loarie et al. 2009; Grigg & Buckley 2013; Vale & Brito 2015).

On the other hand, the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 6, and the IPCC Atlas (<https://interactive-atlas.ipcc.ch/regional-information>) contain projections that suggest rainfall may actually increase in some parts of the Sahara and Sahel. However, these predictions are based on sparse local climatic data, and even if annual rainfall doubles throughout the rest of this century, the region is likely to remain very arid. A separate study of vegetation changes in Ouadi Rime-Ouadi Achim Faunal Reserve in Chad over the period 1982–2008, indicates a trend of increasing plant cover in the wetter Sahelian habitats in the south of the reserve, but a reduction in the Saharan northern part (Fremantle et al. 2013). At a region-wide level, the warming trend seems clear, but the effects and their intensity can be expected to vary at site level, influenced in part by the interaction of higher temperatures and changes in the amount and frequency of precipitation.

4.5. ARMED CONFLICT AND INSECURITY

Armed conflicts and insecurity have negative impacts on wildlife globally and there is an urgent need to implement effective policies to reduce these impacts (Brashares et al. 2014; Douglas & Alie 2014; Gaynor et al. 2016). Extensive parts of the SSMF region have been affected, and

continue to be affected, by insecurity and armed conflicts for several decades (Brito et al. 2014, 2017; OECD-SWAC 2014). The main effects on SSMF species are direct killing of animals for meat and inability to patrol or apply the law effectively. There are of course much wider and more serious social effects, through displacement, food insecurity, migration, and higher dependence on natural resources. The absence of a secure and stable political environment deters many international donors from making long-term investment and prevents implementation of conservation measures (for example, vast parts of the Sahara-Sahel are classified as red zones by many western governments). The role of insecurity in wildlife declines in the Sahara-Sahel, and recommendations for effective conservation policy were discussed by Carvalho (2018).

The civil war in South Sudan posed the largest threat to large mammals, due to hunting by armed forces and local communities, but the intensity and impact will be difficult to assess until the security situation improves. The number of conflict events in the Sahara-Sahel countries has escalated since 2011 (Weiss 2016; Brito et al. 2017).

According to the UN Refugee Agency (UNHCR), internal displacement in the Sahel increased tenfold from 217,000 in 2013 to 2.1 million by late 2021, due in part to a surge in violent attacks across the region in 2021¹. These conflicts, food insecurity, and the impacts of climate change, have caused widespread displacement. Most migration through the Sahel is intraregional and legal thanks to free movement protocols that apply to most states in West Africa. However, the Sahel has become a key corridor and departure point for people trying to reach Europe, frequently relying on people smugglers, traffickers, and other clandestine groups²³.

The consequences of displacement may include increased dependence on shrubs and trees for fuel and on other natural resources.

4.6. OIL AND MINERAL EXPLOITATION

Oil and other mineral extraction take place in several SSMF countries. These activities are not intrinsically incompatible with the persistence of wild ungulates, provided that animals are not directly persecuted. However, extraction and processing facilities result in increased accessibility, contribute to range fragmentation, and are often associated with illegal killing (Duncan et al. 2014; Brito et al. 2018).

4.7. CONSTRAINTS

In addition to the direct and indirect threats to SSMF species and their habitat, additional political, socio-economic, and other factors influence the effectiveness of conservation actions. All Sahara-Sahel range countries are developing nations and several of them are ranked as Low Human Development countries (UNDP 2016). High birth rates add to development pressure.

The region as a whole has suffered from a lack of attention and funding from international donors (Durant et al. 2012) and several countries are among the 40 most underfunded countries for biodiversity conservation (Waldron et al. 2013). Government agencies are underfunded, and protected area staff frequently lack sufficient vehicle and motor bikes to patrol effectively and apprehend poachers. There is a region-wide lack of resources and trained capacity to protect biodiversity effectively, let alone to reverse the rapidly declining trends in SSMF species.

¹ <https://www.unhcr.org/uk/news/briefing/2022/14/Jan/2022>

² <https://www.csis.org/programs/humanitarian-agenda/archive/conflict-sahel>

³ <https://acleddata.com/10-conflicts-to-worry-about-in-2022/sahel/mid-year-update>

There is not enough recognition of the importance and the serious situation of SSMF species at all levels. Awareness programmes, especially those targeted at hunters and attitudes to hunting, are of the highest importance.

There are many information gaps, such as accurate estimates of population size globally and at site level as well as details of current distribution over extensive areas. These present a serious obstacle to effective conservation planning.

5. Conservation Measures

5.1. SPECIES PLANNING

Between 2013 and 2021, species-specific conservation strategies have been developed for Dama Gazelle, Cuvier's Gazelle, and Slender-horned Gazelle, as well as a Regional Action Plan for Addax and Dama Gazelle in Chad and Niger, and a national action plan for Barbary Sheep in Tunisia (Table 5). These plans were all developed following IUCN planning guidelines (IUCN 2017) through a participatory process involving governments, NGOs, researchers, and other stakeholders.

Table 5. Strategies and action plans developed for SSMF species.

Species	Plan and duration	Reference
Addax, Scimitar-horned Oryx, Dama Gazelle, Slender-horned-Gazelle, Cuvier's Gazelle, Dorcas Gazelle	Action plan for conservation and restoration of Sahelo-Saharan antelopes ¹	UNEP/CMS (1999)
Dama Gazelle <i>Nanger dama</i>	Conservation strategy, 2014-2018 ¹	Royal Zoological Society of Scotland (RZSS) & IUCN Species Survival Commission Antelope Specialist Group (IUCN SSC ASG) (2014)
Dama Gazelle <i>Nanger dama</i>	Conservation strategy, 2019-2028 ¹	Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland (2019)
Dama Gazelle <i>Nanger dama</i>	Conservation strategy, 2019-2028; 2.5-year Review ¹	Al Ain Zoo, IUCN SSC ASG and RZSS (2021)
Addax <i>Addax nasomaculatus</i> and Dama Gazelle <i>Nanger dama</i>	Regional Action Plan, Chad and Niger, 2018-2022 ²	DCFAP et DFCPR (2017)
Cuvier's Gazelle <i>Gazella cuvieri</i>	Conservation strategy and Action Plan 2017-2026 ¹	IUCN (2018)
Slender-horned-Gazelle <i>Gazella leptoceros</i>	Conservation Strategy 2020-2029 ¹	IUCN SSC ASG and RZSS (2020)
Barbary Sheep <i>Ammotragus lervia</i>	National Action Plan, Tunisia, 2018-2027 ²	DGF and IUCN (2017)
Addax, Oryx, Gazelle dama mhor, Gazelle	Stratégie et plan d'actions des ongulés sauvages ²	ANEF (2007-2021)

Dorcas, Gazelle Cuvier et
Mouflon à manchettes

All SSMF CA species

Sahelo-Saharan

Megafauna Action Plan

CMS (2023)

¹available in English and French; ²available in French

5.2. LEGAL

SSMF species are protected by law in most countries, but the level of enforcement varies greatly, and is ineffective across many parts of the region, exacerbated by insecurity and chronic underfunding of government agencies, who frequently lack enough vehicles, motorcycles, or trained staff.

5.3. *EX SITU* STATUS

Ex-situ populations can play a valuable role as an insurance against complete extinction and in providing stock for reintroduction or reinforcement. The value of these has already been demonstrated in the case of *Oryx dammah* and *Addax nasomaculatus*. SSMF species are held in a range of settings, including captive and semi-captive animals held inside the region and in the Middle East, animals in zoological institutions outside the region, and on private ranches in the USA, especially Texas. Three species are represented in large numbers in the USA. Many of the *ex-situ* populations in Europe and the USA are managed in cooperative programmes. The Source Population Alliance (SPA) is a group of private landowners, conservation centres, and zoos who combine their *ex-situ* populations in the USA, Canada, and Australia to create a larger 'metapopulation' for use as a resource for reintroductions and to insure against extinction. The SPA holds important populations of Addax, Scimitar-horned Oryx, and Dama Gazelle

Total numbers held *ex situ* range from 41 Red-fronted Gazelles to over 15,000 Scimitar-horned Oryx (Table 6). The Zoological Information Management System (ZIMS) records animals held by registered institutions, while figures are also available for animals in managed breeding schemes. However, there is some overlap, some institutions do not submit figures for their holdings, nor do some private holders. No single database contains all the *ex situ* animals. The figures in Table 6 are compiled from all available sources and represent the Antelope Specialist Group's best estimate in early 2022.

Table 6. *Ex situ* populations of SSMF species

Species	Zoos outside the SSMF region	SSMF Region	Middle East	USA ranches	Total
<i>Addax nasomaculatus</i>	1,184	536	1,500	2,800	5,020
<i>Oryx dammah</i>	3,465	800	4,000	7,000	15,265
<i>Nanger dama</i>	807	170	285	1,510	2,772
<i>Gazella leptoceros</i>	65	59	?	-	124
<i>Gazella cuvieri</i>	120	50	?	-	170
<i>Gazella dorcas</i>	554	4,800	?	?	5,384
<i>Eudorcas rufifrons</i>	41	-	?	?	41
<i>Ammotragus lervia</i>	2,845	917	?	?	3,762

5.4. REINTRODUCTION

Reintroduction can be a valuable conservation intervention. Its use in the region is essential because remaining populations of some species are too small and fragmented to act as a source for natural recolonisation. Several reintroductions have already taken place, notably

the operation to re-establish the Scimitar-horned Oryx to the wild in Chad. Similar operations involving Addax are under way in Morocco and Chad. Smaller operations based on metapopulation models are proceeding in Tunisia, and Scimitar-horned Oryx, Dama Gazelle, Dorcas Gazelle, Cuvier's Gazelle, and Barbary Sheep have been reintroduced in Morocco, Senegal, and Tunisia. Details can be found in the species summaries.

5.5. PROTECTED AREAS

Relatively large protected areas (PAs) have been established (up to 7.4% of the Sahara-Sahel; Brito et al. 2016) some of them aimed to conserve SSMF species (e.g. Air-Ténéré and Tin Toumma, Niger). Protected areas of importance to SSMF are referred to in the species accounts.

6. Updated Action Plan Objectives and Actions

The eight species in the Sahelo-Saharan Megafauna Concerted Action have undergone catastrophic declines in range and population size: one species became extinct in the wild, two are currently very close to extirpation, and all the others have lost more than 60% of their former range. Conserving the populations that remain, and restoring these species to large parts of their historic areas of distribution, will require measures to be taken across vast landscape scales. These, however, face huge challenges - climate change, prevalent attitudes to hunting, habitat degradation, and insecurity, as well as the effects of the recent COVID-19 pandemic. Large parts of the SSMF region are affected by armed conflict and insecurity which creates an unsafe environment for government agencies to work, deters international donors and investment, and hinders international cooperation.

The social and political background is inescapable. National governments across the region have to balance the need for economic growth to raise living standards with the demands of biodiversity conservation, and finding land to house and feed their populations, many of whom depend on livestock grazing and other natural resources to maintain themselves and their families. The scale of all these issues, and the solutions, go well beyond the needs of biodiversity conservation, requiring cross-sectoral initiatives and massive investment.

In the long-term, ecosystem-level restoration and conservation programmes will be needed, but these are unlikely to be feasible over parts of the Sahara-Sahel at the moment. In the short term, conservation measures focused on species and key sites in order to stabilise, then reverse species declines. This course of action also enables countries to act according to local conditions and the specific needs of SSMF species at national level.

Nine strategic directions are identified at regional level:

- | | |
|-------------------------|----------------------------|
| 1. Policy and Legal | 6. Education and Awareness |
| 2. Ecosystem Management | 7. Climate Change |
| 3. Site Protection | 8. Capacity Building |
| 4. Species Action | 9. Regional Cooperation. |
| 5. Community Engagement | |

Updated Action Plan implementation will be added following discussions with the Range States. An initial set of actions is proposed, to be supplemented and refined following inputs from all the Range States.

Objectives and actions are presented for each of the eight SSMF species. Dama Gazelle, Slender-horned Gazelle, and Cuvier's Gazelle are covered by existing conservation strategies agreed by governmental and non-governmental stakeholders. The timescales covered by these strategies are still current, so the objectives and actions for these three species are included here. Implementation of the Dama Gazelle strategy is coordinated by the Dama Gazelle Network and Royal Zoological Society of Scotland (RZSS).

A global roadmap for the Addax has been developed in parallel to this process. Objectives and Actions for the four remaining species (*Ammotragus lervia*, *Eudorcas rufifrons*, *Oryx dammah*, *Gazella dorcas*) have been developed, based on the population status and addressing the threats faced by each one.

This Updated Action Plan aims to provide a global framework for conservation of all SSMF species, in all settings in which they occur (wild, reintroduced, semicaptive, and captive), aligned with the strategies already developed for some species.

6.1 REGIONAL LEVEL ACTIONS

1. Policy and legal	Indicators	Actors
<p>1.1. Review legal frameworks and hunting regulations and align with CMS obligations, also working through the CMS National Legislation Programme.</p> <p>1.2. Include needs of SSMF species and their habitats in the National Biodiversity Strategy and Action Plans (NBSAPs) – the Convention on Biological Diversity’s (CBD) national implementation instruments.</p> <p>1.3. Mainstream SSMF conservation across all appropriate government sectors, including development, agriculture, infrastructure, mining/excavation, water, tourism, defence</p> <p>1.4. Comply with CMS and CITES obligations on harvest, use and trade</p>		
2. Ecosystem management		
<p>2.1. Ensure that important SSMF habitats are under integrated land use planning (CBD Global Biodiversity Framework (GBF) Target 1)</p> <p>2.2. Include important SSMF sites in CBD ecosystem restoration targets (GBF Target 2) and in line with CMS obligations</p> <p>2.3. Identify important habitats and corridors and map on geographic information systems (GIS)</p> <p>2.4. Develop integrated grazing management schemes with local communities at key sites</p> <p>2.5. Restrict digging of new water wells in PAs and other sites important for SSMF species</p> <p>2.6. Engage mineral extraction and other commercial sectors in field conservation projects in their areas of operations</p> <p>2.7. Conduct all Environmental and Social Impact Assessments (ESIAs) for major infrastructure projects according to CMS obligations and International Finance Corporation (IFC) standards</p>		

3. Site protection

- 3.1. Review protected area networks for adequate coverage of SSMF populations and important corridors
- 3.2. Include areas containing important SSMF populations in protected area expansion to meet CBD GBF Target 3
- 3.3. Develop or update PA management plans relevant to SSMF species
- 3.4. Zone relevant protected areas to include buffer and/or multi-use zones where local communities can benefit from natural resources

4. Species action (GBF Target 4)

- 4.1. Take urgent action to prevent extinctions (Addax, Dama Gazelle, Scimitar-horned Oryx)
- 4.2. Protect known populations of all species effectively
 - 4.2.1. Identify key populations and corridors
 - 4.2.2. Enhance patrolling capacity and frequency
 - 4.2.3. Involve military personnel in anti-poaching where needed
 - 4.2.4. Utilise anti-poaching monitoring tools such as Spatial Monitoring and Reporting Tool (SMART)
- 4.3. Establish the current status of all species
 - 4.3.1. Resolve outstanding taxonomic and genetic issues
 - 4.3.2. Identify conservation units for each species
 - 4.3.4. Adopt standardised survey and monitoring methods across the SSMF region
 - 4.3.5. Conduct field surveys (air, ground, questionnaire)
- 4.4. Reintroduce or reinforce depleted populations
 - 4.4.1. Support existing operations
 - 4.4.2. Follow international guidelines on all operations
- 4.5. Adopt the One Plan approach to *ex situ* and *in situ* management

5. Community engagement

- 5.1. Maintain and renew all existing community programmes on SSMF species
- 5.2. Investigate perceptions of SSMF fauna by local communities
- 5.3. Include local knowledge of SSMF species and habitats in project activities and databases
- 5.4. Work with local community leaders on co-management grazing agreements in key sites
- 5.5. Recruit community rangers and provide local employment on field projects
- 5.6. Establish community programmes in areas of new operations

Outreach meetings held All

6. Education and awareness

- 6.1. Conduct local awareness campaigns for rural communities on the SSMF and the need for conservation of species and habitats in all key zones
- 6.2. Conduct public awareness campaigns on the SSMF and the need for conservation of species and habitats through the press, TV, radio, and social media
- 6.3. Work with the hunting and tourism sectors on the on the SSMF and the need for conservation of species and habitats
- 6.4. Raise awareness of SSMF species among regional officials, police, customs, and military

7. Climate Change

- 7.1. Conduct climate change vulnerability assessments for SSMF species
- 7.2. Identify potential climate refugia for SSMF species
- 7.3. Monitor IPCC predictions and scenario modelling
- 7.4. Research the adaptive capacity of SSMF species to extreme climatic conditions

8. Capacity building

- 8.1. Ensure all countries have adequate equipment and technology to conserve SSMF species effectively
- 8.2. Organise training courses on:
 - 8.2.1. Survey and monitoring of species (“Distance sampling”, camera traps, tracks, GIS)
 - 8.2.2. Species and habitat management
 - 8.2.3. Husbandry and management *ex situ*

9. Regional cooperation

- 9.1. Collaborate bilaterally or trilaterally on conservation of transboundary populations
- 9.2. Establish regional information exchange mechanisms
- 9.3. Ensure all relevant materials and documents are available in French and English
- 9.4. Establish an SSMF species database

7. Species Summaries and Action Plans

ADDAX - *ADDAX NASOMACULATUS* (DE BLAINVILLE, 1816)

TAXONOMY

The genus *Addax* comprises a single species, *Addax nasomaculatus* (De Blainville, 1816). The species was originally described as *Cerophorus nasomaculata* de Blainville, 1816 but no type locality was described. Grubb (2005) considered that it was likely to be in the Tunisian Sahara. No subspecies are recognised (Newby 2013).

COMMON NAMES

Arabic: 'Agas , Akash, Abu-Akach, Anjidohl, Auel, Bakra el Ouash, Begaar el Ouach

English: Addax

French: Addax, Antilope addax, Antilope de Mendès

Spanish: Addax

Tamashek: Immellal

Toubou: Turbu, Trowi tchongi

The Addax probably takes its name from the vernacular 'agas or 'adas. The specific name means 'spotted nosed' and refers to the contrasting white patches on the otherwise darker head (Newby 2013).

GENETICS

Hempel et al. (2021) investigated the population history of the Addax, by assembling one nuclear genome and generating 10 complete mitochondrial genomes from historical samples from across the historical range. The results showed that both mitochondrial and nuclear diversity were low compared to other African bovids. Analysis of the mitochondrial genomes showed weak phylogeographic structure, suggesting past gene flow and a high degree of mobility across its extensive former range. The results also indicated that effective population size declined continuously since ~2 million years ago and that there was a major bottleneck in the Late Pleistocene. The Addax seems to have already had low population sizes in historical and prehistoric times before more recent human interference (Hempel et al. 2021). A second analysis of the control region that incorporated additional contemporary samples, from both the wild and captive populations, supported the lack of geographic signature (Dicks et al. 2022).

Dicks et al. (2022) analysed 29 faecal samples collected from the wild population in Termit & Tin Toumma in Niger between 2012 and 2017 and three samples from Chad collected in 2001. Eleven mtDNA haplotypes were detected, nine from Tin Toumma, and two from Chad. Eight haplotypes were identified from 327 captive individuals (in Europe, North America, and UAE) and the reintroduced population in Tunisia (which is descended from captive Addax). Only one haplotype was detected in both the wild and ex situ/reintroduced populations. The genetic diversity within the managed populations is relatively low and the wild population contains unique genetic diversity. The genetic diversity (allelic diversity, heterozygosity and additive genetic variation) remaining in the global Addax population probably represents only a small fraction of the historical diversity which limits the species' adaptive potential and increases its extinction risk (Dicks et al. 2022).

HABITAT

Addax are adapted to life in very hot and hyperarid environments. Although frequently associated with sandy areas, they have been recorded a wide range of habitats: dunes, sandy sheets, gravel plains, salt pans and wadis (Beudels-Jamar et al. 2005; Krausman and Casey 2007; Newby 2013). Addax prefer areas of harder sand and the beds of inter-dunal depressions with perennial vegetation (Newby 2013). Addax avoid mountains but use wadis

in the piedmont or lower slopes to obtain food or shade in the hottest season (April-August) and they may move south into the subdesert zone to access rain-fed grazing (Newby 2013).

DIET

Addax graze on perennial desert grasses such as *Stipagrostis vulnerans* and the succulent *Cornulaca monacantha*. In the hot season they move to subdesert steppes or mountain fringes where they feed on species including *Panicum turgidum*, *Aristida pungens*, *Stipagrostis plumosa*, *Cyperus conglomeratus*, various leguminous plants and sometimes browse on shrubs (*Capparis decidua*, *Maerua crassifolia*, *Acacia tortilis*) (Beudels-Jamar et al. 2005; Krausman and Casey 2007; Newby 2013). Sporadic rainfall in the Sahara supports ephemeral and sometimes extensive pastures known as *jizu*, which attract Addax and other herbivores (Newby 2013). Addax can survive for long periods without drinking but they seek out the desert melon *Citrullus colocynthis* which provides a valuable source of moisture, and plants with surface hair or glands that trap night-time dew, such as *Tephrosia vicoides*, and it seems that the Addax can make use of viscous liquids at high osmotic pressure (Gillet 1969; Newby 2013). However, they may not be able to survive under a combination of very high temperatures and poor-quality grazing (Beudels-Jamar et al. 2005; Krausman and Casey 2007; Newby 2013).

SOCIAL BEHAVIOUR AND REPRODUCTION

Addax usually live in small herds of up to 15 animals composed of males and females of all ages but in the past larger groups up to several hundred, sometimes occurred and were probably seasonal congregations in areas of exceptional grazing (In Tanoust 1930; Monod 1990; Newby 2013).

ADAPTATIONS

The Addax displays anatomical and physiological, and behavioural adaptations to life in a hot environment, including pale colouration to reflect radiant heat, pelage length and density to assist with thermoregulation, splayed hooves for moving in sandy environments and a highly efficient moisture extraction and retention system (Gillet 1965; Newby 2013). Addax seek shade under trees, rock outcrops, or large tussocks of grass, particularly in the hot season, and they may use their horns or hooves to excavate hollows behind vegetation or in dunes (Dragesco-Joffe 1993; Newby 2013).

MIGRATIONS

Addax are highly mobile and nomadic, moving throughout the year in response to unpredictable rains and the ephemeral grazing they generate, and in the hottest season to the presence of shade (Newby 1984; 2013) On the southern side of the Sahara, Addax formerly made more regular seasonal movements in response to local climatic and vegetation conditions, e.g., north-south between desert and subdesert; east-west between the Ténéré desert and the wooded wadis of the Termit massif in Niger (Newby 2013) and NW-SE between the Mreyye dunes and the wooded Aklé region of Mauritania (Lamarche 1987). The former population on the Majabat al Koubra was considered to be transboundary between Mauritania and Mali and the long distances covered by Addax made individual transboundary movements likely in many other places (Lhote, 1946; Kowalski and Rzebik-Kowalska, 1991; Dragesco Joffé, 1993). The remnant wild population in the Ténéré Desert likely extends across the Niger-Chad border.

DISTRIBUTION AND STATUS

Historic range

The Addax is assumed to have occurred across the whole Saharan region between the Atlantic and the River Nile, and south of the Atlas mountains to the northern edge of the Sahel (Beudels-Jamar et al. 2005; Newby 2013). The extent of the range in the year 1800 was estimated at 6,911,931 km² (Durant et al. 2014). Addax range probably began to shrink along with the progressive drying of the Sahara (Gillet 1969). It was reported to be still widespread

in the 1840s (Dragesco-Joffé 1993) but disappeared from the northern part of the range by the end of the 19th century (Kowalski and Rzebiak-Kowalska 1991; Newby 2013). The decline accelerated during the 20th century, and even more so during 1920-1940. Addax remained widespread and locally abundant in the centre and the south of the range until the 1970s but then suffered a precipitous decline (Newby 1986, 2013). More details are provided in the country summaries.

Current range and status

Since 2000, confirmed Addax distribution has been restricted to a narrow band of desert in eastern Niger and western Chad, apart from one record from Central Mauritania in 2007, and with sporadic reports of solitary animals or small groups to the west of Termit, towards the Air Mountains of Niger, and north to the border with Algeria (Newby 2013). Durant et al. (2014) estimated that Addax currently occupy less than 1% of their historic range. Three reintroductions are in various stages of implementation in Morocco, Chad, and Tunisia.

Niger

The only population considered viable is found in the Tin Toumma desert, from the eastern side of Termit Tin Toumma National Nature Reserve (TTNNR) eastwards to the Chad border and a short way inside Chad and numbered around 200 individuals (Wacher et al. 2004). In September 2004, 128 Addax were observed in an area of 9300 km² (SOS Faune du Niger/DFPP/SZP mission). Despite all the measures that have been taken since 2002 to safeguard the Addax, the situation has deteriorated considerably. A monitoring mission in 2007 observed 71 Addax and several sightings of Addax in the eastern part of Termit Tin Toumma National Nature Reserve were made in 2010-2012 (Figure 1).

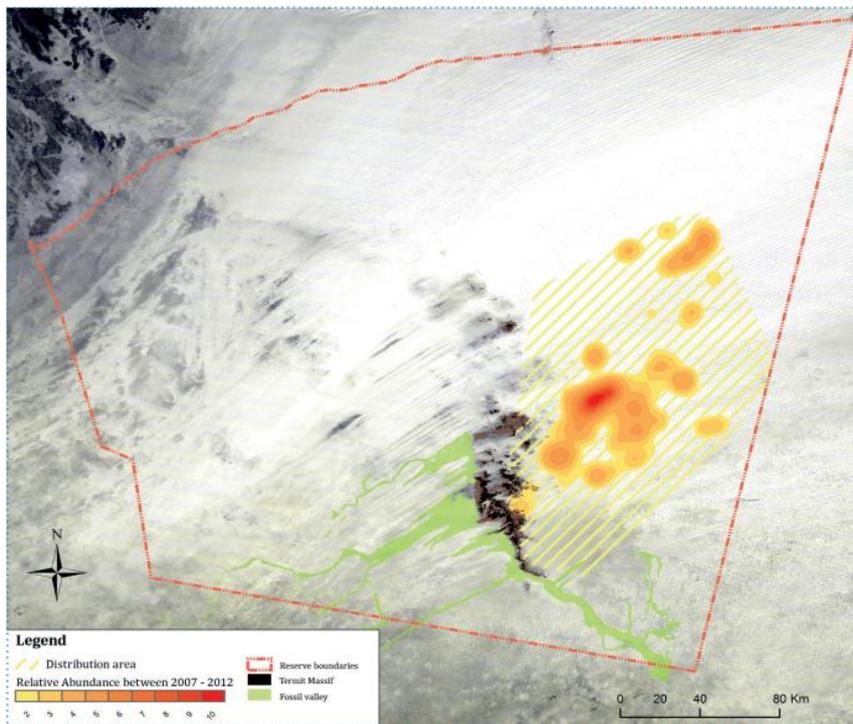


Figure 1. Distribution of Addax in Termit Tin Toumma National Nature Reserve in 2010-2012 (map: T. Rabeil/SCF).

However, since then the number of direct and indirect observations has decreased dramatically (Figure 2). The population has been subjected to considerable disturbance and illegal hunting following an intensification in human activity, oil exploration, and increased use of the main roads by leading to opportunistic hunting by traffickers. In June 2015, no animals

were observed during a thorough ground monitoring mission (Rabeil 2015). In April 2016, a census both by land (700 km of transects) and by air (3,200 km overflown) observed only three live animals, while remains of Addax left by poachers were also found (Rabeil et al. 2016). In April 2017, a monitoring mission carried out by Noé's Corridor Project and the Niger wildlife authorities, with technical support from the Sahara Conservation Fund, recorded six Addax, including a young animal, in the Tin Toumma Desert after an intense search. In 2018-2022, only small numbers have been observed by the Direction de la Conservation de la Faune et des Aires Protégées (Directorate for Wildlife Conservation and Protected Areas - DCFAP) and Noé patrols, e.g., one group of 13 was seen in 2019. The population may now number only 50-100 (IUCN SSC Antelope Specialist Group 2020).

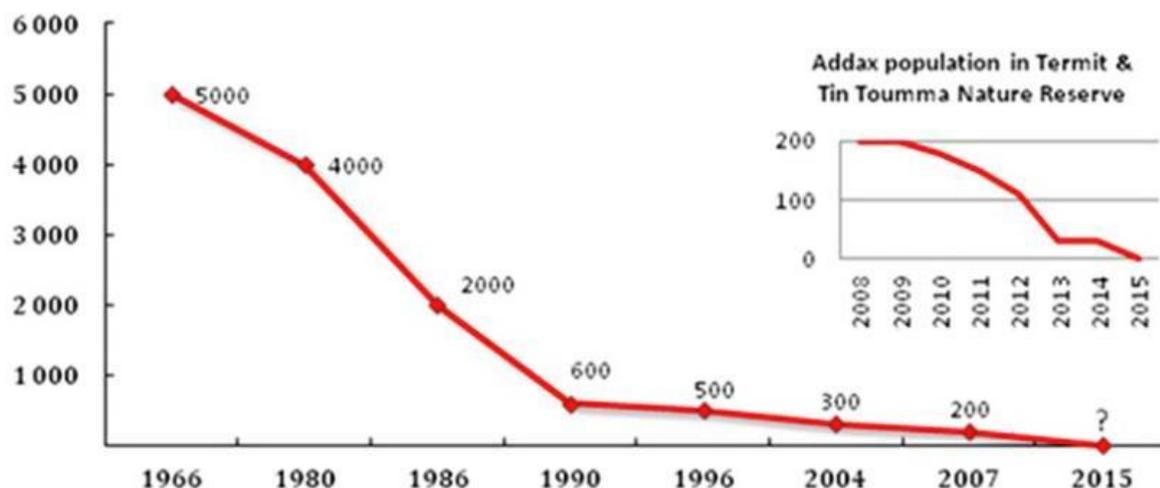


Figure 2. Decline of the Niger Addax population up to 2015 (Sources: Dolan 1966, Newby 1981, Newby & Grettenberger 1986, Beudels et al. 2005, Wacher et al. 2008, Rabeil et al. 2016).

Three oil exploration and exploitation blocks (Agadem, Bilma, and Ténéré) in the Tin Toumma desert overlap the eastern part of Termit and Tin-Toumma National Nature Reserve (TTNNR). On 23 November 2003, the State of Niger signed an agreement with the China National Petroleum Corporation (CNPC) on the exploration and development of the Bilma Block (60,884 km²) and the Ténéré Block (71,155 km²). Seismic surveys and exploratory drilling in both blocks began in 2005. In 2008, the State of Niger signed a Production Sharing Contract (PSC) with the China National Oil and Gas Development Corporation (CNODC) in the Agadem block. The PSC was confirmed by Decree No. 2008-177/PRN/MME of 2 June 2008 for a period of 25 years (until June 2033). Phase I of the Agadem Integrated Project began on 28 November 2011 and involves production wells and associated infrastructure, roads, an airstrip, as well as a refinery in Zinder and a 462.5-km long pipeline linking Agadem to the refinery. The pipeline crosses the south-eastern part of the Reserve for nearly 100 km. It is planned to link this pipeline to the Benin pipeline to enable oil exports (IUCN SSC Antelope Specialist Group 2020). However, according to Article 17 of the 2012 Decree on the creation of the reserve, "All research or mining and petroleum exploitation activities in the TTNNR are subject to the legal and regulatory provisions relating to environmental impact studies".

To resolve the contradiction between the 2008 PSC and the Decree of March 6, 2012 designating TTNNR, on 26 June 2019, the Government of Niger announced the modification of the boundaries of TTNNR, declassifying approximately 50,000 km² of the eastern part of the Reserve, excluding from it the three oil blocks, as well as most of the Tin Toumma desert and about 65% of the Termit massif. To compensate for the declassification and to maintain the approximate original size of TTNNR new areas were designated to the west and north of the Termit Massif (Figure 3). The eastern boundary of the reserve was modified a second time in 2021. It now includes the whole of the Termit massif and runs within 5 km of the western oil block. As a result, most of the Tin Toumma Desert now lies outside the protected area.

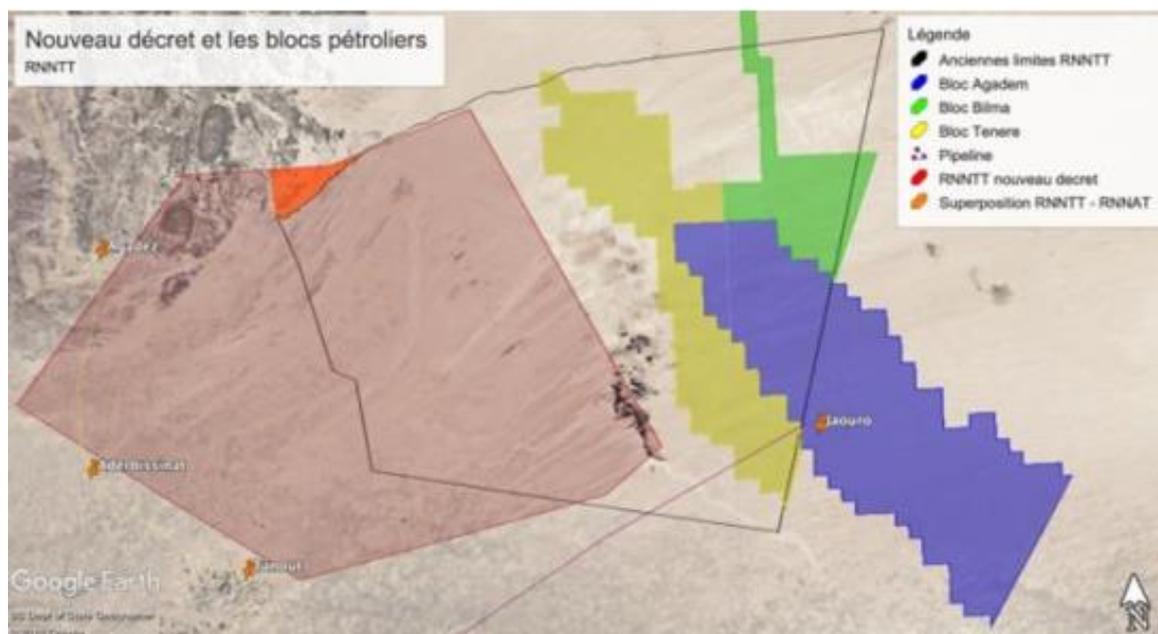


Figure 3. Original (2012) boundary of Termit Tin Toumma National Nature Reserve (black line); revised boundary in 2019 (pink/grey polygon); three oil blocks (yellow, purple, green polygons). Note: the eastern boundary now runs within 5 km of the western oil block. Map: Noé)

Chad

A small population of Addax in Eguey, western Chad, may until recently have been contiguous with the population in Termit (Newby 2013). Two individuals were observed north of Eguey in September 2001 (Monfort et al. 2003) and a group of nine individuals and tracks of 1–6 were observed there in November 2005 (Beudels et al. 2006). An aerial and ground mission in 2016 did not observe any Addax, but visibility was very poor. However, local informants reported seeing groups of 3 and 8 Addax in and around the Eguey dunes, and several groups about 40 km from the Siltou (Sountou) wells near the border with Niger (Figure 4) Numbers in Eguey were tentatively estimated at 15-30, with a larger population near the border (Rabeil et al. 2016). It is possible that Addax around Sountou are part of, or have dispersed from, the Tin Toumma population in Niger.

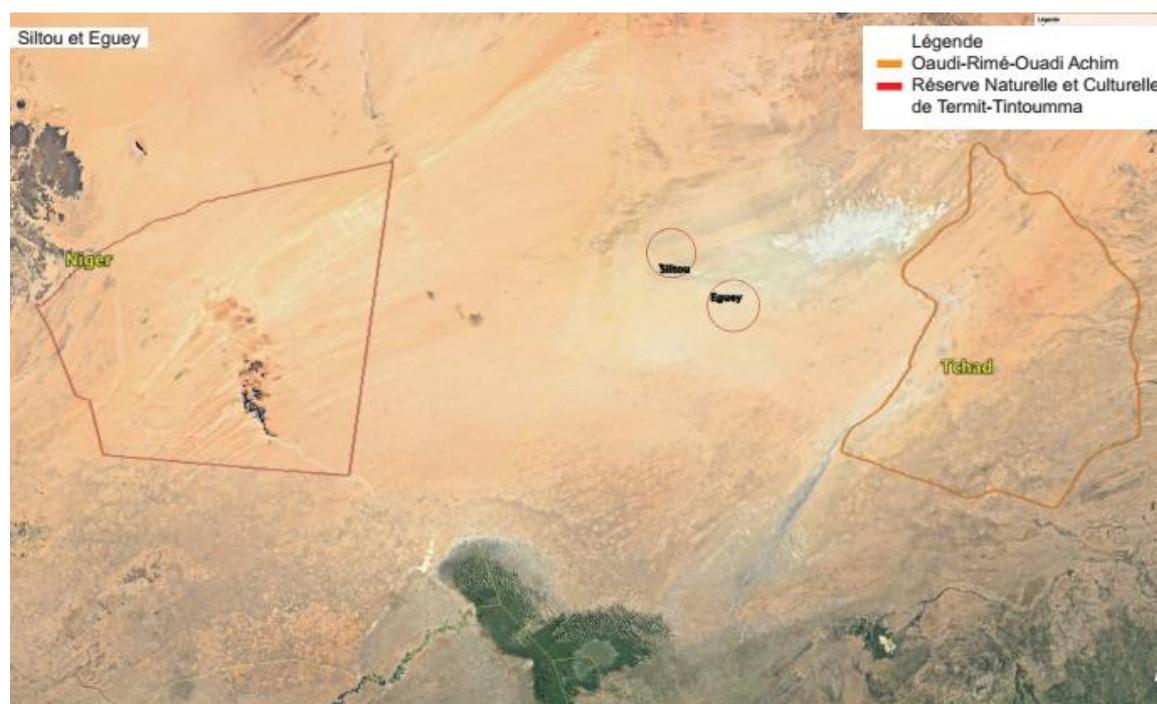


Figure 4. Reported recent locations of Addax in Chad: circled black polygons: Siltou (left) and Eguey (right). The large polygons outlined in red are Termit Tin Toumma National Nature Reserve, Niger (west) and Ouadi Rimé-Ouadi Achim F.R., Chad (east).

Mauritania

Fresh tracks of about 15 Addax were photographed in March 2007 by Robert Vernet in the centre of the country in an area where they had not been reported for over 20 years (Vernet 2008; Newby 2013). Brito et al. (2022) found Addax horns in the desert that they estimated to date from 1980-1999 according to the state of decomposition. Brito et al. (2022) also considered that Addax were extant in Mauritania and they assessed the species as nationally Critically Endangered. Extensive habitat still exists in the Erg Ourane–Majabat Al Koubra region on the eastern border but there have been no confirmed sightings or signs in the country since 2007.

Reintroduced populations

Addax have been reintroduced to sites in Morocco and Chad, a third reintroduction is under way in Tunisia and another is planned in Eastern Chad (details in section 5.4).

Morocco: The first group of 15 Addax were released into a 4,600 km² site inside a protected area running from the M'hamid El-Ghizlane Reserve to Iriqui National Park in south-eastern Morocco (Amhaouch and Sikli 2019). Eighty Addax have been released so far and the animals have moved over an area of approximately 580 km² and dispersed up to 136 km from the release site (WAC 2022) (Figure 5).

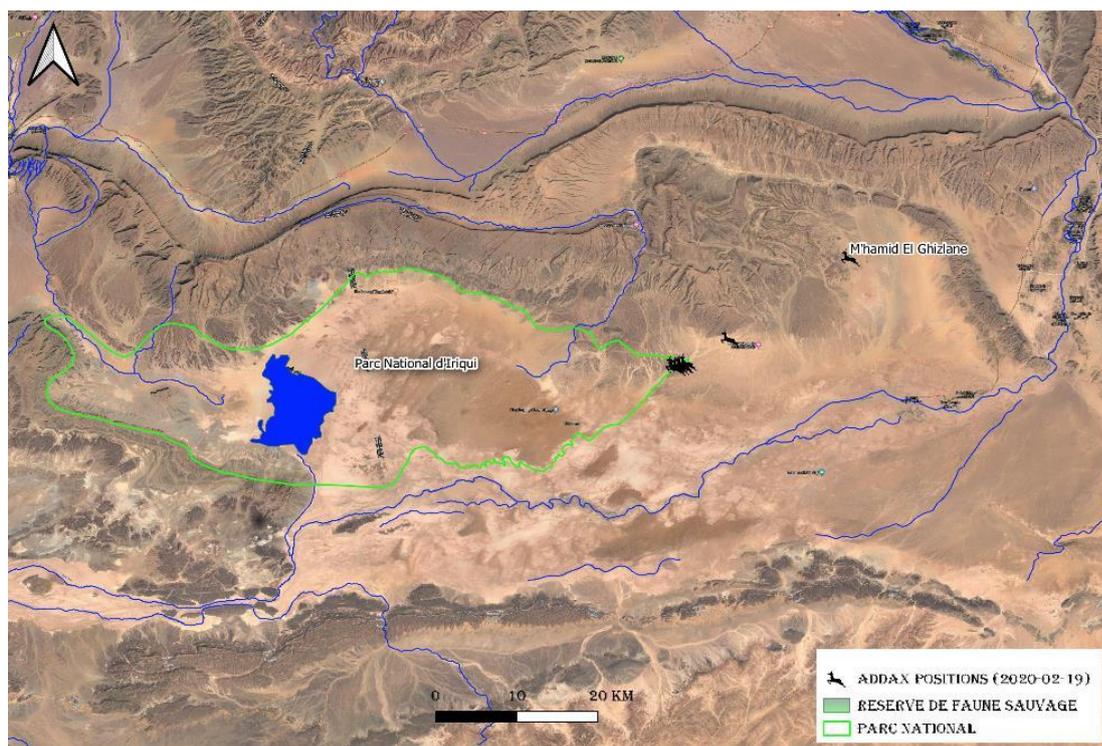


Figure 5. Positions of released Addax in February 2020. The green line delineates Iriqui National Park (Map prepared by Z. Amhaouch/ANEF).

Chad: Addax have been released into Ouadi Rimé-Ouadi Achim Faunal Reserve (OROA) as part of the Scimitar-horned Oryx Project, commencing in March 2020 (Newby 2021). 65 Addax had been reintroduced by March 2022 (Barrios 2022). Daily monitoring results indicate 130 free-ranging Addax present in OROA in September 2022 (Wacher 2022). Reintroduction of Addax to Ennedi Natural and Cultural Reserve (50,000 km²) in Eastern Chad has been proposed by African Parks which has held a devolved management agreement for the site since February 2018 (<https://www.africanparks.org/the-parks/ennedi>).

Tunisia: The first Addax were released into a fenced part of Bou Hedma N.P in 1985 and later transferred to Haddej, another fenced area within National Park. In 2007, Addax were translocated to enclosures in Senghar-Jabbes National Park and Jbil National Park, both in the Great Eastern Erg of southern Tunisia. Addax in both national parks have experienced some issues and numbers have not increased (Petretto et al. 2020, 2022).

Population size

Genomic analysis suggests that that Addax numbers were always low (Hempel et al. 2021) but no estimates of the historic population size have been reported. Addax were described as 'numerous' across the whole southern edge of the Sahara and present in 'fair numbers' up to the early 1970s (Brocklehurst 1931; Lhote 1946, Audas, 1951; Gillet 1969, Lamarche 1987; Heringa 1990; Newby 2013). Large herds, probably representing aggregations at exceptionally good pastures, were still seen in Mauritania, Mali, and Chad. For example, Monod (1961) observed the tracks of an estimated 5,000 Addax in a single day, and 11,000 over the course of a week, in the Majabat Al Koubra, Mauritania.

Chad remained the stronghold for the Addax and several thousand were still present in the early 1970s, but the situation deteriorated sharply by 1990 (Thomassey and Newby, 1990). Numbers dwindled rapidly during the 1970s-1980s and estimates of the total Addax population were <4,000 (Newby 1981), <2,000 (Newby 1986) and no more than a few hundred (East (1999). Recent estimates of the wild population are <300 individuals in all, of which 200 in the Termit and Tin Toumma area (Newby 2013). This population, probably the only remaining wild

remnant has been further depleted and dispersed and may number no more than 50-100 (IUCN SSC Antelope Specialist Group 2020). There were an estimated 20-30 in the Eguey region in 2016 (Rabeil et al. 2016).

In 2022, the reintroduced populations numbered 130 in Chad and 82 in Morocco. In addition, there are 440 in semicaptive or managed conditions in Morocco and 96 in Tunisia. The global ex-situ population includes 1,184 registered on the ZIMS the Zoological information Management System (ZIMS) database (December 2022), at least 2,800 on private ranches in Texas, and possibly 1,000 in the Middle East.

Table 7: Estimated numbers of Addax

Situation	Estimate	Notes
Wild		
Niger (Tin Toumma)	50-100	Current estimate
Chad (Eguey)	20-30	2016 estimate
Mauritania	?	Last sighting in 2007
Subtotal	70-130	
Reintroduced		
Morocco	82	WAC (2022)
Chad	130	Wacher et al. (2022)
Subtotal	212	
Managed – region		
Tunisia	96	Petretto et al. (2022)
Morocco	440	(Amhaouch 2020).
Subtotal	536	
Managed outside region		
ZIMS	1,184	December 2022
Middle East	1,000	ASG Estimate
USA ranches	2,800	Texas only (Wildt et al. 2021)
Subtotal	4,984	

STATUS BY COUNTRY

Algeria

Until the middle of the 19th century, Addax occupied the whole of the Algerian Sahara, south of the Atlas. Recorded sites and date of the last record were mapped by Kowalski and Rzebik-Kowalska (1991). [[The last animals in the north-west Sahara, on Erg Raoui, became extinct in 1905 (Grenot, 1979). Lavauden (1926) said that Addax were extinct on the Grand Erg Occidental but still present in limited numbers in the Grand Erg Oriental. Lhote (1946) reported the species in 1938-1939 in the Hamada de Tinrhert, the Ténéré Erg on the Niger-Algeria border, and near the Mali border, to the north of the Adrar des Ifoghas. Heim de Balsac (1948) obtained skins and skulls in 1930 from Erg Iguidi in the south-west. Addax were reported around the Hoggar massif, in the Tassili des Ajjers, Erg Ténéré, and the Hamada de Tinrhert up to the 1970s-1980s (De Smet, 1988; Kowalski and Rzebik-Kowalska 1991). There were anecdotal reports of Addax from Libya in the Grand Erg Oriental in 1952 and 1959, one Addax killed near In Amenas not far from the border with Libya in 1970 and Addax were still present on Erg Issaouene (Kowalski and Rzebik-Kowalska, 1991). The Addax is now considered extirpated in Algeria, except perhaps for vagrants from Niger.

Chad

The Addax was formerly widely distributed and locally abundant north of the Eguey and Bodélé (Kanem), east of the Mourdi depression and farther east in Ennedi (Gillet, 1969; Newby, 1974). For several decades, Chad remained the most important stronghold for Addax. In the early

1970s, several thousand were still present, but the situation had deteriorated sharply by 1990 (Thomassey and Newby, 1990). In the 1970s, there were still an estimated 800 Addax in the north of Ouadi Rimé -Ouadi Achim Faunal Reserve and these animals moved north towards Tibesti during the rainy season (Thomassey and Newby, 1990). Aerial and ground surveys in 1990 and 1991 and ground observations in 1995 observed small groups of Addax in Ouadi Achim, the Mourdi depression the Oued Chili, between Kalaït and Fada, and in the east of Ennedi, between Bao Bilia and the Sudanese border (Pfeffer 1995). A small number of Addax may survive in Eguey and in the far west of Chad close to the border with Niger (section 3.2.2.). Addax have been reintroduced into Ouadi Rimé-Ouadi Achim Faunal Reserve and reintroduction to Ennedi Reserve in eastern Chad has been proposed (see section 5.4).

Egypt

Addax formerly ranged over the Western Desert, and were considered 'numerous' up to the 1870s, with records from the large oases and depressions, particularly Siwa, Jaghbub, the Qattara Depression, Faiyum, Bahariya, Farafara, Dakhla, and the Kharga complex (Osborne and Helmy 1980; Saleh 2001). Addax once also occurred in the extreme north-eastern part of the Mediterranean coastal desert, in the Nubian Desert south-west of Bir Kiseiba, and in the region of Jebel Uweinat (Osborn and Helmy, 1980). The latest reports refer to animals killed 65 km west of Alexandria in 1900 (Flower 1932), and in Scheb in 1931 (Osborn and Helmy 1980).

Libya

Six Addax specimens were obtained in 1938 on the Hamada al Hamra in the north-west and are in Tripoli Museum (Hufnagl 1972). There are scattered records of former occurrence from Wadi Ali north of Gikherra; Haruj al Aswad; Ain Mazzar, near Kufra in the south-east, and Jebel Uweinat, on the border with Egypt and Sudan (Hufnagl 1972; Misonne 1977). In 1956, three Addax were seen and one was shot in the dunes of Idhan Murzuq in the south-west (Le Houérou 1991). Two Addax 'from Libya' were sighted in the Grand Erg Oriental of Algeria in 1952 and 1959 (Kowalski and Rzebik-Kowalska 1991). Some Addax were shot on the eastern slopes of Haruj al Aswad, north of Thamad bu Hashisha, and brought to an oil camp at Samah in 1966, (Hufnagl 1972). This appears to be the last confirmed record in the country.

Mali

Addax were once widespread in the desert zone, south to 17–19°N, but by the end of the 1980s they were confined to the western border and possibly the Adrar des Ifoghas, due to uncontrolled hunting (Heringa 1990). There have been no reports since then (Beudels-Jamar et al. 2005).

Mauritania

Addax occurred widely in the desert zone until the 1940s when the range contracted markedly, and by 1980, they were restricted to the Mreyye area, east of Majabat al Koubra, on the border with Mali (Lamarche 1987, Beudels-Jamar et al. 2005). There may have been several hundred Addax in the early 1980s but fewer than 50 remained by 1990 (Sournia and Verschuren 1990). There have been unconfirmed reports of Addax along the Mali/Mauritania border and tracks were photographed in 2007. Brito et al. (2022) considered the Addax was extant in Mauritania.

Morocco

The last herd in Morocco was eliminated in 1942 (Beudels-Jamar et al. 2005). Addax from European Zoos have been released into the Rokkein enclosure inside Souss Massa National Park (SMNP), which lies outside the historic range, to serve as a breeding population. The semi-captive population in 2022 was around 350 in the Rokkein enclosure. Addax from Souss Massa have been released into M'hamid El-Ghizlane Reserve in the south-east (Amhaouch and Sikli 2019). See below.

Niger

The Addax was formerly widely distributed in the desert zone, and large populations existed in the Ténéré desert, the piedmont slopes of the Aïr massif and the Termit massif, but it has been eliminated from most of its former range (Grettenberger and Newby, 1990). At the end of the 1980s it was still present in the east and north-east of the Termit region, the Ténéré desert, and in the northwest near the Algerian border (Grettenberger and Newby, 1990). An Addax Sanctuary was created in 1988 inside Aïr-Ténéré National Nature Reserve (RNNAT; 77,360 km²), but after the outbreak of an armed rebellion in the area in the 1990s, the species began to decline. Despite the establishment in 2010 of the Unité de Gestion de l'Aire Protégée (Protected Area Management Unit - UGAP) at Ifrouane and the implementation of an ecological monitoring system since 2013, there has been no confirmed presence of Addax in the sanctuary since the early 2000s (Newby 2013). The only remaining population is in the Termit Desert, extending from the eastern side of TTNNR to the Chad border.

Sudan

Addax were once widely distributed in the desert zone of northern Kordofan and northern Darfur, west of the River Nile (Wilson 1980; Hillman and Fryxell 1988) and described as quite common in the 1900s and still widespread, even locally abundant, until the 1930s (Brocklehurst 1931; Shaw 1936). By the end of the 1930s, numbers had diminished considerably in Kordofan (Audas 1951) and from the 1950s onwards, information becomes rare (Wilson 1980). No signs of Addax were recorded during aerial surveys in the 1970s (Lamprey 1975; Wilson 1980), though the species reportedly survived in small numbers in Darfur until the end of the 1970s (Beudels-Jamar et al. 2005). The North Darfur Wildlife Administration said that a group of Addax was seen near the border with Chad in 1992 and the animals ran westwards into Chad when disturbed (East 1999).

Tunisia

Addax formerly occurred in the south, north as far as the Chott El Djerid at about 34°N. In the late 19th century Addax were still present in the vicinity of what is now Djebil National Park but were extirpated around 1932 (Kacem et al. 1994; Smith et al. 2001). A reintroduction plan began in 1987 and Addax are present in fenced areas inside Haddej, Djebil, and Senghar-Jabbes national parks.

THREATS

The main drivers of the catastrophic decline in Addax range and numbers are indiscriminate poaching, drought, civil unrest and insecurity, overgrazing, and the extension of pastoralism into deserts, exacerbated by increased digging of new wells, particularly during the 1980s and 1990s (Beudels-Jamar et al. 2005, Newby 2013).

Direct mortality

The primary factor in the decline of Addax is uncontrolled hunting and poaching over many years, a process accelerated by the lethal combination of modern firearms and the availability of off-road vehicles which facilitate access to previously remote regions (Beudels-Jamar et al. 2005; Newby 2013).

Extensive declines were already noted from the 1930s, e.g., In Tanoust (1930) said that the Tanezrouft was once a sanctuary for the Addax but construction of a new road allowed people to pursue the animals in their vehicles, killing them through exhaustion for 'sport' and leaving the bodies to desiccate in the desert. Entire herds were sometimes destroyed in a single hunt (Lhote 1946; Gillet 1969). The Addax is particularly sensitive to disturbance and if chased, it gallops until exhaustion (Dragesco Joffé 1993). Hunting of the sparse remaining populations continues, e.g., in Termit, 11–14 Addax were reported killed in August 2002, and 3–5 in 2003 (SOS Faune du Niger; Greth et al. 2003). Horns and carcasses of Addax have been found in Niger in 2016-2022.

Antipoaching patrols are conducted in Tin Toumma, but the Addax are dispersed over a very extensive area. Reintroduced Addax are all in protected areas which are patrolled and monitored, and local herder communities are engaged, so the threat of poaching to these population is currently considered to be low, but this risk will increase as Addax disperse farther away from the core zones. Poaching of large mammals is a constant threat across the whole Sahelo-Saharan region and represents a major obstacle to re-establishment of Addax and other species across wider landscapes.

Habitat loss and degradation

Overgrazing, and competition with domestic livestock has been exacerbated by drilling of new wells that enable permanent occupation and disrupt seasonal grazing patterns. The north Sahelian steppes are also subjected to growing pressure by livestock which impacts Addax movements to access seasonal grazing (Beudels-Jamar *et al.* 2005).

Drought and climate change

Although a desert-adapted species, intense periods of drought and desertification, especially from at the end of the 1970s and early 1980s, contributed to the decline of Addax populations through reduced winter grazing, scarcity of dry season grazing, loss of shade trees, and overall disappearance of vital water resources (Newby 1988, 1989). At a range-wide scale, the impact of global warming is clear, and a recent study showed that during 1950–2015, the Sahara Desert expanded its area by 8% and its southern boundary advanced 100 km southwards, with these trends projected to continue in 2015–2050 (Liu and Xue 2020). On the other hand, the IPCC Assessment Report 6, and the IPCC Atlas⁴ project changes that suggest rainfall may in fact increase in some parts of the Sahara and Sahel. These predictions are, however, based on sparse local climatic data, and even if annual rainfall doubles throughout the rest of this century, the region is likely to remain very arid. A study of vegetation changes in Ouadi Rime-Ouadi Achim Faunal Reserve in Chad over the period 1982–2008, indicates a trend of increasing plant cover in the wetter Sahelian habitats in the south of the reserve, but a reduction in the more Saharan northern part (Fremantle *et al.* 2013).

Small population size

Very small populations are intrinsically at higher risk from random or unpredictable environmental events (climate, disease, etc.) and are vulnerable to the loss of genetic diversity through drift, inbreeding depression, Allee effects, and demographic stochasticity. When combined, these factors reduce population size even further, even leading to an 'extinction vortex' (Gilpin and Soulé, 1986).

CONSERVATION MEASURES

International designations

The Addax is listed on CMS Appendix I and CITES Appendix I. Addax is one of the eight species included in the CMS Sahelo-Saharan Megafauna Concerted Action (SSMF).

The Addax is assessed as Critically Endangered on the IUCN Red List (IUCN SSC Antelope Specialist Group 2016).

Legal

Addax are legally protected in all range countries.

Strategies and action plans

The Addax is one of six species covered in the ASS-CMS Action Plan (Beudels *et al.* 1998). National strategies for antelope restoration, including Addax, have been developed for Tunisia (DGF 2001) and Morocco 2007-2021 (Cuzin *et al.* 2007a, 2007b). A regional action plan for

⁴ <https://interactive-atlas.ipcc.ch/regional-information>

the wild populations of Addax and Dama Gazelle in Chad and Niger for 2018-2022 has been developed (DCFAP & DFCPR 2017).

Reintroductions

Addax have been reintroduced to the wild in Morocco and Chad, a reintroduction project is under way in Tunisia, and a reintroduction project is planned in eastern Chad.

Morocco

In 1994-1996, an antelope restoration programme was initiated by the Moroccan government. As part of this, 70 Addax from several European Zoos were released into the Arrouais enclosure in Souss Massa National Park to serve as a breeding nucleus. This population has increased steadily and numbered ~400 individuals in 2019 (Amhaouch and Sikli 2019). Morocco's national strategy for the conservation of wild ungulates (Cuzin et al. 2007) envisaged the reintroduction of Addax into its former habitat. A 10-year plan (2015-2024) was developed to reintroduce a viable population of Addax into south-eastern Morocco by 2025. In March and October 2019, 30 Addax were transferred from SMNP to an acclimatization and pre-release enclosure at the release site south of Zagora, to allow them to adapt to local conditions. On 23 November 2019, the first 15 Addax were released into a 4,600 km² site inside a protected area running from the M'hamid El-Ghizlane Reserve to Iriqui National Park (Amhaouch and Sikli 2019). The aim of the project is to establish a population of 150 Addax by 2024 (Amhaouch 2020).

In the year before release, the Department of Water and Forests conducted a program to raise awareness and secure engagement of the local population. Three awareness-raising and coordination workshops were held with the local authorities and local actors including the Rural Municipality of M'hamid El-Ghizlane, nature conservation NGOs, the tourism sector (Provincial Council of tourism, tourism operators), Workshops and direct meetings were also held with the nomads living in and around the reintroduction area to gain better involvement and participation in the monitoring and guarding programme. A local committee was established to monitor the reintroduction, consisting of authority agents, local elected officials, local NGOs, and provincial council of tourism. Six fixed monitoring stations and 7 mobile units were also set up (Amhaouch 2020). In a parallel pilot project, about 60 Dorcas Gazelles (*Gazella dorcas*) were released at the same site, an operation which received a positive welcome from local communities (Amhaouch and Sikli 2019).

In 2020, another 20 Addax were translocated from SMNP, all fitted with GPS collars. In December 2021 a third translocation was carried out, involving 20 Addax (12 females, 8 males) (WAC 2022). Thirteen animals were fitted with GPS collars with the support of the National Geographic Society. In total, 80 Addax have been released into the reserve, with 31 individuals fitted with GPS collars. At least 21 (67.7%) collared animals had survived to the end of 2022, with 10 confirmed mortalities. The released animals have moved over an area of approximately 580 km² and dispersed a maximum of 136.3 km from the release location. Six births and four deaths were reported in 2022 (WAC 2022).

Chad

Ouadi Rimé-Ouadi Achim Faunal Reserve

Reintroduction of Addax to Ouadi Rimé-Ouadi Achim Faunal Reserve in Chad began as part of the Scimitar-horned Oryx Project Phase II, 2021–2026. This project is led by the Environment Agency Abu Dhabi (EAD) in cooperation with the Chad Ministry of the Environment and its Wildlife Service and implemented on the ground by Sahara Conservation and partners including Zoological Society of London (ZSL), the Smithsonian Conservation Biology Institute (SCBI), and the Fossil Rim Wildlife Center (SCF 2020). Pre-release enclosures for Addax were built at Oryx Base Camp in spring 2019 and 15 Addax from the EAD collection in Abu Dhabi were translocated to the reserve in November 2019. The animals

were genetically screened, vaccinated, transported by air to Chad and then by truck to the Oryx Basecamp in OROA. The first group of Addax were released into the wild in January 2020, fitted with GPS collars funded by Saint Louis Zoo. By March 2022, 90 Addax from Abu Dhabi had been transferred to OROA, of which 65 have been released into the wild (Barrios 2022). Daily monitoring results indicate that 130 free-ranging Addax were present in OROA in September 2022 (Wacher 2022).

Ennedi (eastern Chad)

Reintroduction of Addax to Ennedi Natural and Cultural Reserve (50,000 km²) is planned by African Parks which holds a devolved management agreement for the site⁵.

Tunisia

The national strategy for restoration of antelopes was set out in 2001 (DGF 2001). The long-term vision is for self-sustaining populations of Scimitar-horned Oryx, Addax, North African ostrich and Slender-horned Gazelle moving freely across large areas of contiguous habitat. The current approach for Addax is regarded as an intermediate step before fully free-ranging herds can be re-established. Addax have been restored to three national parks, led by Tunisia's Direction Générale des Forêts and Marwell Wildlife. The first Addax were transferred from European zoos and released into the fenced Total Protection Zone 1 in Bou Hedma National Park in 1985 and more Addax from North America were added in 1988. This herd was later transferred in its entirety to Haddej, another fenced area within Bou Hedma National Park (Petretto 2022). Haddej lies outside the indigenous range of the Addax, but it is secure, contains good habitat, and provides a source population for translocations to other national parks in the south of Tunisia. In 2007, Addax were translocated from Bou Hedma National Park to fenced enclosures in Senghar-Jabbes National Park and Jbil National Park in the Great Eastern Erg of southern Tunisia. The population in Jbil was augmented later in 2007 with animals from European and North American zoos, and monitored regularly (Molcanova and Wacher 2010, 2011). The populations in both national parks have experienced some issues. At the end of 2021 there were approximately 56 Addax in Haddej, 33 in Senghar-Jabbes National Park and seven in Jbil National Park, so 96 in total in managed or semi-managed conditions in Tunisia (Petretto et al. 2022). Concerns over calf predation and sand piling up against fences in Jbil National Park led to the herd being moved to an acclimatisation enclosure. The Addax in Senghar-Jabbes National Park are also held in an enclosure to protect them from predation and to prevent them from leaving the safety of the national park at points where sand has built up against the fence. A field mission was conducted in December 2021 to assess the status of Addax within the three protected areas and identify changes in management needed to improve the status and condition of Addax. Marwell Wildlife has worked closely with the management team in Jbil National Park to address key issues impacting the Addax, including nutrition and capacity building. The Direction Générale des Forêts (General Directorate of Forests - DGF) plans to release Addax into the wider fenced area within the national parks, but it seems unlikely that the population will recover without addition of more animals. The feasibility of further translocations will be assessed once the management concerns have been resolved (Petretto et al. 2022).

Protected areas

The last wild Addax population in Niger now occurs mainly outside the protected area network, but some animals may reach the eastern edge of the revised boundaries of TTNNR. The management of the TTNNR was delegated to the NGO Noé on 5 November 2018 for a period of 20 years. A reserve headquarter has been constructed, the airstrip restored, and staff engaged, including 42 rangers seconded from the DCFAP.

⁵ <https://www.africanparks.org/the-parks/ennedi>

The reintroduced Addax populations in Chad, Morocco, and Tunisia are all in protected areas. Air Ténéré NNR (77,360 km²) in Niger and Ahaggar (44,000 km²) and Tasilli (11,400 km²) reserves in Algeria lie within the historic range and formerly harboured Addax.

Ex situ

There are an estimated 5000 Addax held *ex situ*. Within Addax range countries, a captive breeding herd of Addax is maintained in the Rokkein enclosure (1500 ha) inside Souss-Massa National Park, Morocco. This herd numbered about 350 in 2022.

Also, since 2022, a semi captive population of around 350 animals exists in the Leghchiwat and Safia reserves.

Some Addax are also held in a private site in the North of Mauritania. In Niger, one female, captured while young and purchased by an NGO is held at a facility in Kelle.

Outside the range countries, Addax have been maintained in global zoological institutions since 1920 (Krause 2015). In December 2022, the ZIMS database listed 1184 Addax held in 95 institutions and five regions. The three largest populations in ZIMS are located in the United Arab Emirates (564), including Al Ain Zoo (286) and Environment Agency – Abu Dhabi (144), then Europe (207), and North America (242).

The European and North American populations are managed within coordinated breeding programmes, the European *Ex situ* Programme (EEP) within the European Association of Zoos and Aquaria (EAZA) and the Species Survival Plan® (SSP) within the Association of Zoos and Aquariums (AZA), respectively (Dicks et al. 2022).

There are estimated to be several thousand unregistered Addax on ranches in the USA and in private collections in the Arabian Peninsula, including over 2,800 on Texas ranches alone (Wildt 2021). Addax is one of the four original species covered by the Source Population Alliance (SPA), a group of private landowners, conservation centres, and zoos who combine smaller *ex-situ* populations in the USA, Canada, and Australia to create a larger 'metapopulation' as a resource for potential reintroductions and as an insurance against extinction.

The total *ex situ* Addax population is many times larger than the remnant wild population, but it originates from a low number of founder animals (Krause 2015) which, combined with subsequent inbreeding and drift, has reduced the amount of genetic diversity available (Dicks et al. 2022).

Field projects

Government agencies

The *Direction de la faune, de la chasse, des parcs et des réserves* (Directorate of Wildlife, Hunting, Parks, and Reserves, Niger - DFCPR) and *Direction de la Conservation de la Faune et des Aires Protégées* (Directorate for Wildlife Conservation and Protected Areas, Chad-DCFAP) are fully engaged in patrolling, anti-poaching, and other Addax conservation initiatives.

Sahara Conservation (SC)

Formerly Sahara Conservation Fund (SCF). Active for a long time in Niger and Chad. Instrumental in the establishment of Termit Tin Toumma National Nature Reserve, conducted several air and ground monitoring missions for Addax; currently leading implementation of the reintroductions in OROA (Chad).

Noé

Noé has a devolved management agreement for Termit Tin Toumma NNR. Conducts vehicle patrols in conjunction with DCFAP, and organises 2-person patrols on camels to collect field data. Community rangers are employed in Niger and Chad. Cooperation agreements have been signed with local communities in Niger.

IUCN

An IUCN mission visited Niger in January 2020 to discuss Addax conservation and the future of the Termit and Tin Toumma National Nature Reserve with the authorities and the principal local actors. Eight recommendations were made on conservation of the remaining Addax and the future of TTNNR (IUCN SSC Antelope Specialist Group 2020). A small cross-IUCN team (Global Species Programme, SOS, IUCN-Niger Office, IUCN Business and Biodiversity Unit, IUCN-China office, Antelope SG) meets monthly online to follow up on the mission, coordinate responses, and attempt to engage with the oil companies.

ACTION PLAN AND CONSERVATION PRIORITIES

The Action Plan aims to provide a global framework for conservation of the Addax in all settings in which it occurs (wild, reintroduced, semicaptive, and captive). This format is in line with similar strategies developed for other SSMF species and reflects the very different circumstances surrounding these different settings.

The last wild population is very small and scattered and the Addax is now on the verge of extinction in the wild. Emergency rescue measures are needed: drastically improving operational capabilities, safeguarding the last individuals, and conserving their irreplaceable genetic diversity. Such measures include various options that may or may not be combined, including satellite collaring, intensified protection, and establishment of a core group of captive individuals in Niger. Close coordination between actors at all levels is needed, including the major oil companies working in the Ténéré Desert. It should be emphasised that Addax conservation and oil activities are not incompatible, provided that there is full and effective protection against poaching and excessive disturbance.

Natural recolonisation of the indigenous range will be impossible without reintroductions. Three operations are under way and a fourth is planned. Addax roam widely so conservation must operate at landscape scales. This in turn means reducing hunting pressure across the region to a significant extent. The Tunisia metapopulation management model may be an example of an interim solution that could be applied in other countries.

The *ex-situ* Addax population contains several thousand animals, providing both a safety net against complete extinction of the species and stock for reintroductions. Coordinated breeding programmes cover many of these animals and extending these programmes to as many Addax as possible is desirable. Finding a way to integrate the unique genetic variation present in the wild Addax into captive breeding management is also urgently needed.

LOGICAL FRAMEWORK

Objective / Action	Indicator	Urgency	Implementation
Objective 1. The Niger Addax population is effectively protected and monitored			
1.1. Establish status			
1.1.1. Conduct regular patrols between Termit and the Chad border (vehicle, camel, air)	Patrol schedule agreed and funded		DFCPR, Noé
1.2.2. Conduct patrols and information collection on the Chad side of the border	Patrol schedule agreed and funded Community reporting system agreed		DCFAP, Noé
1.1.2. Conduct satellite collaring operation in late 2023	- Preparatory survey conducted - Addax collared and monitored		CMS Project, DFCPR, SaharaConservation, Noe
1.1.3. Survey the ergs between TTNNR and Aïr and Ténéré National Nature Reserve (ATNNR) (from the air and on the ground)	Survey reports		
1.1.4. Maintain records on a central database	- Database and map established		
1.2. Enhance the effectiveness of antipoaching			
1.2.1. Increase capacity of BEF	Training sessions for rangers held Sufficient vehicles and motorcycles available Equipment and technology available		DFCPR, Noé, others
1.2.2. Involve the Nigerien military in conservation activities	Inter-ministerial agreement signed		Ministry of Environment, Ministry of Defence
1.2.3. Conduct military patrols along the main highway corridors	Regular patrols take place		DFCPR, Noé, Nigérien army
1.2.4. Provide training for military personnel	Training sessions held		DFCPR, Noé, Nigérien army
1.3. Minimise the impact of oil production on Addax			
1.3.1. Secure a formal agreement with the Ministry of Petroleum and the oil companies on joint activities	Memorandum of Understanding (MoU) signed		Ministry of Environment, Ministry of Petroleum, DFCPR, Oil companies
1.3.2. Assess the potential impacts on the Addax of the proposed route of the Chad-Niger oil pipeline	Impact assessment produced		DFCPR, Noé, SaharaConservation
1.4. Consolidate community engagement			

Objective / Action	Indicator	Urgency	Implementation
1.4.1. Secure agreements with key communities in the Addax zone	Outreach meetings held MoUs signed		DFCPR, Offices of the Préfets, community leaders, Noé
1.4.2. Develop a standardised system of community reporting	Communities actively involved Community reporting system agreed Regular reports submitted		DFCPR, Community rangers, Noé
1.4.3. Work with the Préfets to prevent issue of permits for digging new water wells in key areas			Préfets, communities, DFCPR
1.4.4. Work with the Préfets to destroy unauthorised water wells in key areas	Wells destroyed		Préfets, communities, DFPCR
Objective 2. Status in the wild is established			
2.1. Eguey			
2.1.1. Conduct air and ground surveys	Surveys completed		DCFAP, SaharaConservation
2.2.2. Work with communities on conservation	Outreach meetings held		DCFAP, SaharaConservation
2.2.3. Strengthen capacity of DCFAP	Capacity needs assessment conducted		DCFAP, SaharaConservation
2.2. Siltou			
2.2.1. Conduct air and ground surveys (see also 1.2.2)	Surveys completed		DCFAP, Noé
2.2.2. Work with communities on conservation	Community meetings held		DCFAP, Noé
2.2.3. Strengthen capacity of DCFAP	Capacity needs assessment conducted		DCFAP, Noé
2.3. Mauritania			
2.3.1. Conduct questionnaire and field surveys	Surveys completed		Government Agency, University of Porto
Objective 3. Addax are successfully reintroduced into indigenous range			
3.1. Consolidate reintroduction in Morocco			
3.1.1. Continue the scheduled release programme	Population growth and expansion		BEF, Wildlife Africa Conservation (WAC)
3.1.2. Maintain the monitoring programme	Analysis of results (reproduction, movements, habitat use)		BEF, WAC, SCBI
3.1.3. Consolidate community engagement	MoUs renewed		BEF, community leaders, WAC
3.1.4. Minimise effects of tourist disturbance on Addax	Dune-driving exclusion zones designated Tourism operators engaged		BEF, Tourism operators

Objective / Action	Indicator	Urgency	Implementation
3.2. Consolidate reintroduction in OROA (Chad)	Awareness programmes developed		
3.2.1. Continue the scheduled release programme	Population growth and expansion		DCFAP, Sahara Conservation, EAD
3.2.2. Maintain the monitoring programme	Analysis of results (reproduction, movements, habitat use)		DCFAP, Sahara Conservation, ZSL, SCBI
3.2.3. Consolidate community engagement	MoUs renewed		DCFAP, SC
3.3. Consolidate reintroduction in Tunisia	Population growth and expansion		DGF, Marwell
3.3.1. Resolve current issues at each site	Analysis of results (reproduction, movements, habitat use)		DGF, Marwell
3.3.2. Maintain the monitoring programme			
3.4. Conduct reintroduction in Ennedi (Chad)	Addax released		DCFAP, African Parks
3.5. Conduct feasibility studies on other reintroductions	- Studies completed - Potential release sites identified	L	All
Objective 4. Genetic diversity of Addax is maximised			
4.1. Capture wild individuals to retain their unique genetic diversity	Addax captured and transferred to breeding centre		DFCPR, CMS, Sahara Conservation, Noe
4.2. Establish a captive breeding centre in Niger	- Centre constructed - Staff trained in husbandry - Breeding plan developed		DFCPR, CMS, Sahara Conservation, Noe, others
4.3. Integrate the wild-caught female at Kelle into the breeding programme	Female breeds successfully		SC, DFCPR
4.4. Integrate privately owned captive Addax into the breeding programme	Animals located and integrated		DCFAP, DFPCR
4.5. Continue genetic and genomic research	Analyses conducted		RZSS, SCBI, partners
4.6. Develop a global plan to ensure maximal retention of genetic diversity	Plan completed		RZSS, SCBI, partners
4.7. Prioritise biobanking, cell line generation, reproductive technologies, and movement of germ cells	Strategies developed		RZSS, SCBI, partners
Objective 5. Management of <i>Ex situ</i> Addax populations is optimised to support <i>in situ</i> conservation			
5.1. Maintain and expand coordinated breeding programmes	- Increased number of participating institutions - Increased number of Addax included in programmes		AZA, ZAA (Australia) EAZA, SPA,

Objective / Action	Indicator	Urgency	Implementation
5.2. Integrated <i>in situ</i> and <i>ex situ</i> management under a 'One Plan Approach'	Integrated plan produced		All
5.3. Maintain the Souss-Massa population as a regional source for reintroductions	Breeding continues		BEF
5.4. Improve integration of molecular genetic data into population viability modelling and management strategies	Results incorporated		RZSS, SCBI, Ex situ managers
Objective 6. Local communities are engaged in all Addax conservation projects			
6.1. Maintain existing community programmes	Outreach meetings held		All
6.2. Establish community programmes in areas of new operations	- Outreach meetings held - Community agreements signed		All
Objective 7. Awareness of Addax conservation is raised at all levels			
7.1. Distribute information to the public through the press, TV, and social media	Messages, articles, social media posts published		All
7.2. Raise awareness of Addax conservation among local communities in all key zones	Outreach sessions organized		Government agencies, NGOs
7.3. Raise awareness of the situation of Addax among regional officials, police, customs, and military	Joint meetings held		Government agencies, NGOs
Objective 8. The Roadmap is implemented effectively			
8.1. Review Roadmap progress at regular intervals	Progress reviews conducted regularly (2.5, 5, 7.5 years)		CMS, Government agencies, IUCN, NGOs, all
8.2. Provide adequate resources and capacity to implement the roadmap	- Resources and capacity provided Training sessions held - Projects operate effectively		All
8.3. Maintain communication between all stakeholders	- Information exchange mechanism established Regular reports circulated		CMS focal points, IUCN/SSC ASG, NGOs

SCIMITAR-HORNED ORYX - *ORYX DAMMAH* (CRETZSCHMAR, 1826)

TAXONOMY

No subspecies or geographical variation have been reported.

COMMON NAMES

Arabic: Begar al Ouach, Wach

English: Scimitar-horned Oryx

French: Oryx Algazelle, Oryx de Libye

Spanish: Orix de Cimitarra

HABITAT AND ECOLOGY

Scimitar-horned Oryx primarily inhabit sub-desert, arid steppe, and vegetated wadis, rarely entering true desert or dense bush (Devillers and Devillers-Terschuren 2005, Morrow et al. 2013).

MIGRATIONS

In several places Scimitar-horned Oryx were recorded moving north into the desert zone following seasonal rainfall in search of good pastures (East 1999, Devillers and Devillers-Terschuren 2005, Morrow et al. 2013). Several former populations were transboundary.

CURRENT DISTRIBUTION AND STATUS

Scimitar-horned Oryx once occurred throughout most of the Sahel and the subdesert and arid steppe zones to the north of the Sahara. The range in 1800 covered 1,543,784 km² (Durant et al. 2014). The species disappeared from the northern part of its range by the 1940s-1950s, from most of the Sahel in the 1960s-1980s, and the last herds were recorded in the late 1980s or possibly early 1990s (Newby 1988, Morrow et al. 2013).

A successful reintroduction has taken place into Ouadi-Rimé-Ouadi Achim Faunal Reserve, Chad, where oryx were first released into the wild in August 2016, with eight further groups released up to March 2022. In September 2022, the wild population in Chad was estimated at 575 animals (95% confidence interval (227-1452) (Wacher et al. 2022).

Scimitar-horned Oryx have been re-established in two fenced, and two partly fenced protected areas in Tunisia (Bou Hedma N.P. 1985, Sidi Toui N.P. 1999, Oued Dekouk N.R. 1999, Dghoumes N.P. 2007), and two sites in Senegal (Guembeul Faunal Reserve, Ferlo Faunal Reserve 1998) as initial steps in long-term reintroduction programmes. A semi-managed breeding herd is maintained in Souss-Massa National Park, Morocco, to provide stock for future reintroductions.

POPULATION

Iyengar et al. (2007) suggested that the population may have reached 1 million when Scimitar-horned Oryx range was at its maximum during the early Holocene (9500–4500 BP). Until the mid-20th century, the species seems to have remained common in the Sahel, where herds of several hundred, and sometimes several thousand, were recorded, notably in Chad and Niger (Newby 1988). A herd of 10,000 was recorded in Chad in 1936 according to Bassett (1975). In the 1950s and early 1960s, herds of 100 or more were regularly reported in Chad and Niger but only small populations farther west, and a very few in eastern Chad and further east (Gillet 1969, Newby 1988, Dragesco-Joffé 1993). Oryx were estimated to number 4,000–6,000 in the Ouadi Rimé-Ouadi Achim region in 1975-1978, following rigorous anti-poaching measures and several good rainy seasons, but then were reduced following the interruption of protection (Thomassey and Newby 1990). At the beginning of the 1980s, there were <200 in Niger (Grettenberger and Newby 1990) and perhaps a few small groups elsewhere, the last known herds in Chad disappearing in the late 1990s or early 2000s (Newby 1988, Morrow et al. 2013). Currently there are c. 575 in Chad and 15,265 animals in captive or semi-captive conditions.

STATUS BY COUNTRY

Algeria

In Algeria they were once found in the south and vagrants likely occurred north of the Sahara (De Smet and Smith 2001). The species was last recorded in Algeria in the 1960s, apart from two possible vagrants in 1987 (De Smet and Smith 2001).

Burkina Faso

Formerly occurred in the Sahel zone of the north but believed to be extirpated by overhunting in the 1950s, though two were reported on the border with Mali in 1986 (Heringa et al. 1990).

Chad

Formerly abundant across the Sahel and subdesert steppe, e.g., a herd of 10,000 was reported in 1935 (Bassett 1975). By the mid-1970s more than 95% of the remaining global population (several thousand) occurred in Ouadi Rimé-Ouadi Achim Faunal Reserve (Thomassey and Newby 1990). Only a few dozen remained by 1988 and subsequent surveys failed to locate any surviving animals (Newby 1988; Morrow et al. 2013). The recent reintroduction is described above.

Egypt

In Egypt, the historical range included most of the Western Desert, west of the River Nile, but mostly around oases and became extinct in the 1850s-1860s (Osborn and Helmy (1980).

Libya

Reported to occur in the Fezzan (SW) and Kufra (SE), close to known populations in N Chad and W Egypt and also the NE, but there are no confirmed specimens of the species (Hufnagl 1972, Khattabi and Mallon 2001). The species became extinct in Libya in the 1940s (Newby 1988).

Mali

Formerly widespread in the Sahel zone and desert fringe but eliminated by uncontrolled hunting and increased livestock grazing. Considered extinct by the end of the 1970s-early 1980s except for two animals observed in 1986 on the border with Burkina Faso (Heringa 1990).

Mauritania

Formerly may have occurred widely but extirpated out by uncontrolled hunting. The last individuals probably occurred in the Oualata-Nema area in the 1970s (Sournia and Dupuy 1990).

Morocco

Formerly occurred in subdesert steppes. The species became extinct by the 1930s (Aulagnier et al. 2001, Cuzin et al. 2007). A semi-captive breeding population is maintained in the Arrouais enclosure in Souss Massa National Park and numbers around 400 (Amhaouch 2020). Some animals have been transferred to another breeding site at M'cissi in eastern Morocco.

Nigeria

Not recorded by Anadu and Green (1990) but may have occurred seasonally in the Lake Chad Basin in the far north-east (East 1999).

Niger

Formerly widespread across the Sahelian zone, probably reduced to less than 200 by the early 1980s, and very probably extinct by 1990 (Grettenberger and Newby 1990).

Senegal

The Sahel zone of northern Senegal lies at the southern edge of the global range.; the species became extinct here before 1914 (Sournia and Dupuy 1990). Scimitar-horned Oryx have been released into the Katane enclosure (12 km²) in Ferlo Nord Faunal Reserve and now number over 200 and also a small number in Guembeul Faunal Reserve.

Sudan

Formerly occurred in Darfur and Kordofan provinces, west of the river Nile but extinct in the mid-1970s (Hillman and Fryxell 1988; Morrow et al. 2013).

Tunisia

Scimitar-horned Oryx was very rare in extreme southern Tunisia and extinct by 1906 (Lavauden 1920, 1924), although some authors doubt that an established population existed and there are no first-hand reports or specimens (Morrow et al. 2013).

THREATS

The main factors driving the decline and eventual extinction in the wild of Scimitar-horned Oryx were indiscriminate hunting and poaching, habitat loss and degradation through overgrazing, competition with domestic livestock, expansion of grazing aided by drilling of new wells that enable permanent grazing, and periodic droughts; an extended period of civil unrest in the 1980s had a heavy impact on the remaining Scimitar-horned Oryx population in the Sahel (Newby 1988, Devillers and Devillers-Terschuren 2005, Morrow et al. 2013).

Ouadi Rimé-Ouadi Achim Faunal Reserve, Chad, is patrolled and monitored, and local herder communities are engaged in the reintroduction programme, so the threat of poaching here is currently considered to be low, but this risk is likely to increase as oryx disperse farther away from the core zone. Poaching of large mammals is a constant threat across the whole Sahelo-Saharan region and represents a major obstacle to re-establishment of Scimitar-horned Oryx across wider landscapes.

The political instability and insecurity that intermittently affect some parts of region pose further risks to effective law enforcement and large-scale conservation planning. A study of Normalized Difference Vegetation Index changes over the period 1982–2008 at the oryx reintroduction site in Chad indicates a trend of increasing plant cover in the wetter Sahelian habitats in the south of the reserve, but a reduction in the more Saharan northern part (Fremantle et al. 2013).

African Wolves *Canis lupaster* predate and scavenge young Scimitar-horned Oryx in Tunisia, particularly in Bou Hedma National Park, but the extent and impact of predation are unclear (Petretto et al. 2020).

In 2018, exceptionally heavy rains in Ouadi-Rimé-Ouadi Achim triggered a cascade of phenomena including a boom in disease-vector arthropods (both insects and acarids) and nutritional stress. These factors led to severe co-infestations of external and internal parasites and co-infections of bacterial and viral diseases, including Rift valley fever, that killed 44 reintroduced oryx over a period of 40 days (Chardonnet and Nare 2022).

Prior to their extinction in the wild Scimitar-horned Oryx were prized by local people for their meat and hide, used to make ropes, bags, shoes, and shield coverings. They were also targeted by hunters for their horns (Morrow et al. 2013).

CONSERVATION MEASURES

International designations

CMS: Listed on Appendix I

CITES: Listed on Appendix I

IUCN Red List: Extinct in the Wild (a revised assessment as Endangered has been submitted).

Protected areas

The reintroduced population in Chad occurs within Ouadi Rimé-Ouadi Achim Faunal Reserve (77,000 km²). Populations in Tunisia, Morocco, and Senegal are all in protected areas.

Planning

There are national strategies to restore the species in Tunisia (DGF 2001) and Morocco (Cuzin et al. 2007).

Ex situ

There are approximately 800 in semi-managed conditions in, Tunisia, Senegal and Morocco.; In 2018 a breeding site was established in the Timokrarine reserves. There are 2465 in zoological institutions worldwide, about 4000 in the Middle East, and 7000 on ranches in the USA (15,265 in total).

Reintroduction

Chad

An ambitious project to re-establish Scimitar-horned Oryx to the wild began in the early 2000s. A series of surveys to assess oryx status and habitat availability across former oryx range in several states was followed by a preliminary workshop held in Al Ain, UAE in 2009 and a stakeholder workshop in N'Djamena, Chad in 2012. The N'Djamena workshop was attended by a wide range of stakeholders including government officials, local leaders, and international experts. The workshop recommendations included the rehabilitation of Ouadi Rimé-Ouadi Achim Faunal Reserve and reintroduction of Scimitar-horned Oryx, and it received the support of the President of Chad. A technical meeting was held later in 2012 in Abu Dhabi to develop an initial proposal for the reintroduction of Scimitar-horned Oryx into the Ouadi Rimé-Ouadi Achim Faunal Reserve in Chad.

The Scimitar-horned Oryx Reintroduction Programme is a joint initiative of the Government of Chad and the Environment Agency–Abu Dhabi (EAD), implemented on the ground by Sahara Conservation (formerly Sahara Conservation Fund) in partnership with the Ministry for the Environment, Fisheries and Sustainable Development, with technical support from Fossil Rim Wildlife Center, Smithsonian Conservation Biology Institute, Zoological Society of London, and others.

Over 10 years, the genetic diversity present in key source populations was analysed using three genetic datasets (mitochondrial DNA sequence, nuclear DNA microsatellite and SNP markers) taken from over 500 individuals in public and private institutions to ensure that the founders represented the greatest breadth of generic diversity available (Ogden et al. 2020). In March 2016, the first group of captive-bred Oryx was transferred from Abu Dhabi to Chad and placed in a large (46 ha) acclimatisation enclosure constructed in Ouadi Rimé-Ouadi Achim Faunal Reserve. The first release occurred in August 2016 when 21 Scimitar-horned Oryx were released into the wild. The first wild birth was recorded in September 2016. Each released individual was fitted with a GPS satellite collar. Between August 2016 and March 2022, 263 founder animals and 22 young born in the acclimatisation enclosure have been released, in nine groups, making 285 animals released in all. Since the first release into the

wild, some 331 wild-born oryx had been recorded up the end of 2021 (Newby 2021). The wild population estimate in Chad in 2022 is ca. 570 animals (equating to 340-400 mature individuals), but this estimate is accompanied by a very wide 95% confidence interval due to the logistical and statistical issues inherent in censusing widely dispersed and clumped populations in extensive desert ecosystems. The lower 95% confidence limit is ca. 230, which indicates 140-160 mature individuals. The reintroduced population is subject to regular monitoring.

EAD has supported comprehensive genetic studies of Scimitar-horned Oryx at the Royal Zoological Society of Scotland's WildGenes Laboratory as part of establishing and curating the "World Herd" in Abu Dhabi which is assembled from the global ex-situ population. The herd is managed in a purpose-built captive breeding facility to provide genetically diverse source animals for release. EAD also arranges the flights to transport the oryx and supplies to Chad.

The released population in Ouadi-Rimé-Ouadi Achim is protected by government rangers and is monitored through tracking of satellite collars, aerial counts, and ground survey missions.

Oryx intended for release are deparasited on a regular basis and vaccinated between 2 and 6 months before translocation to in Chad against Ovine rinderpest, sheep and goat pox, the Pasteurella / Mannheimia / Clostridium complex, Contagious Caprine Pleuropneumonia, Foot and Mouth Disease and Rift Valley Fever, both for their own protection and to prevent transmission of disease to domestic livestock and other wild animals in Chad (Pesci 2022).

Tunisia

In Tunisia, the Scimitar-horned Oryx metapopulation is estimated at around 200 individuals (a minimum of 60 in Dghoumes National Park, 60 in Sidi Toui National Park, 30 in Oued Dekouk National Reserve, nearly 42 in Bou Hedma National Park, and approximately 22 in Haddej National Park, a separate fenced area of Bou Hedma National Park (Petretto et al. 2022). The number of Scimitar-horned Oryx in each protected area is 20-100 and these populations are considered too small to be individually sustainable in the long-term. The current approach to Scimitar-horned Oryx management in Tunisia follows a metapopulation strategy which is considered the most pragmatic option and an intermediate step before fully free-ranging herds can be re-established. The proposed metapopulation management strategy requires additional translocations of Scimitar-horned Oryx between protected areas (Petretto et al. 2020). Management is carried out by the government agency, the Direction Générale des Forêts (DGF), supported by Marwell Wildlife. The Oryx have been genetically sampled by Marwell Wildlife and the WildGenes Laboratory of RZSS and the results used in Population Viability Analysis (PVA) models to project the impact of different management decisions on population persistence and retention of genetic diversity in individual populations and across the Tunisian metapopulation (Petretto et al. 2020).

Senegal

In Senegal, over 200 Scimitar-horned Oryx are held in the fenced Katane enclosure (12 km²) inside Ferlo Nord Faunal Reserve and a small number at Guembeul Faunal Reserve, with the aim of release into the wild at some point in the future.

Proposed reintroductions

The semi-managed population of Scimitar-horned Oryx in the Arrouais enclosure of Souss-Massa National Park was established to provide stock for reintroductions into the wild, in accordance with the national strategy (Cuzin et al. 2007). Some oryx have been transferred to other breeding and acclimatisation centres in the country in preparation for future releases.

A feasibility study has been conducted on the reintroduction of Scimitar-horned Oryx to Gadabédji Biosphere Reserve, Niger (Lamarque et al. 2009) and implementation of this project is currently under discussion.

LOGICAL FRAMEWORK

Objective / Action	Indicator	Urgency	Implementation
Objective 1. The reintroduced population in Chad is sustainable in the long-term			
1.1. Continue release programme in OROA	Population growth and range expansion Lower category of threat on IUCN Red List		DCFAP, EAD, SC
1.2. Ensure effective protection	Patrol schedule agreed and funded Training sessions for rangers held Sufficient vehicles and motorcycles available Equipment and technology available		DCFAP, EAD, SC
1.3. Increase capacity of DCFAP	Patrol schedule agreed and funded		DCFAP, SC
1.4. Continue satellite, aerial, ground monitoring	Survey reports Analyses conducted		DCFAP, ZSL, SCBI, SC
1.5. Consolidate community engagement	Community reporting system maintained Community workshops held Agreements signed in areas of Scimitar-horned Oryx expansion		DCFAP, SC
1.6. Avoid construction of new water wells in key zones	Key zones mapped No new wells constructed Unauthorised wells destroyed		DCFAP, SC, local authorities
Objective 2. Consolidate the reintroduced populations in Tunisia and Senegal			
2.1. Tunisia			
2.1.1. Develop metapopulation management programme	Increase in numbers at each site		DGF, Marwell
2.1.2. Conduct regular monitoring	Results available (numbers, reproduction, habitat use)		DGF, Marwell
2.1.3. Establish corridors between sites	Corridors mapped		DGF, Marwell
2.1.4. Release oryx into the wider landscape	Oryx released		DGF, Marwell
2.1.5. Secure community engagement	Community workshops MoUs agreed		DGF, Marwell, community leaders
2.1.6. Strengthen capacity of DGF	Capacity needs assessment conducted Training workshops held		DGF, Marwell
2.2. Senegal			
2.2.1. Develop the Katane population	Increase in numbers		DGF, partners

Objective / Action	Indicator	Urgency	Implementation
2.2.2. Conduct regular monitoring	Results available (numbers, reproduction, habitat use)		DGF, partners
2.2.3. Expand the Katane enclosure	Expanded enclosure constructed		DGF, partners
2.2.4. Restore habitat in Ferlo Reserve	Key areas restored		DGF, partners
2.3.5. Release oryx into the wider landscape	Oryx released		DGF, partners
	Community agreements signed		
2.2.6. Strengthen capacity of DGF	Capacity needs assessment conducted		DGF, partners
	Training workshops held		
Objective 3. Scimitar-horned Oryx are successfully reintroduced to new sites			
3.1. Morocco			
3.1.1. Implement the scheduled release programme	Oryx released		BEF, partners
3.1.2. Develop a monitoring programme	Programme developed		BEF, community leaders, WAC
3.1.3. Secure community engagement	Community workshops MoUs agreed		BEF, community leaders
3.2. Niger			
3.2.1. Implement the proposed release in Gadabedji BR	Oryx released		DCFAP, partners
3.1.2. Develop a monitoring programme	Programme developed		DCFAP, partners
3.2.3. Secure community engagement	Community workshops MoUs agreed		DCFAP, partners
3.3. Conduct feasibility studies on other reintroductions	- Studies completed - Potential release sites identified		All
Objective 4. Genetic diversity of Scimitar-horned Oryx is maximised			
4.1. Continue genetic and genomic research	Analyses conducted		RZSS, SCBI, partners
4.2. Develop a global plan to ensure maximal retention of genetic diversity	Plan completed		RZSS, SCBI, partners
4.3. Prioritise biobanking, cell line generation, reproductive technologies, and movement of germ cells	Strategies developed		RZSS, SCBI, partners
Objective 5. Management of the <i>ex-situ</i> populations is optimised to support <i>in situ</i> conservation			
5.1. Maintain and expand coordinated breeding programmes	- Increased number of participating institutions		AZA, EAZA, SPA,

Objective / Action	Indicator	Urgency	Implementation
5.2. Integrated <i>in situ</i> and <i>ex situ</i> management under a 'One Plan Approach'	- Increased number of Scimitar-horned Oryx included in programmes Integrated plan produced		All
5.3. Maintain the Souss-Massa National Park population as a regional source for reintroductions	Breeding continues		BEF
5.4. Improve integration of molecular genetic data into population viability modelling and management strategies	Results incorporated		RZSS, SCBI, Ex situ managers
Objective 6. Roadmap objectives are implemented effectively			
6.1. Establish a roadmap coordination mechanism			
6.2. Review progress at regular intervals	Progress reviews conducted at 2.5, 5, 7.5 years		CMS, Government agencies, IUCN, NGOs, NGOs, All
6.3. Provide adequate resources and capacity to implement the roadmap	- Resources and capacity provided - Training sessions held - Projects operate effectively		CMS focal points, IUCN/SSC ASG, NGOs
6.4. Maintain communication between all stakeholders	- Information exchange mechanism established Regular reports circulated		CMS focal points, IUCN/SSC ASG, NGOs

DAMA GAZELLE - *NANGER DAMA* (PALLAS, 1766)

COMMON NAMES

Arabic: Mhor, Adam,

English: Dama Gazelle, Addra Gazelle, Mhorr Gazelle

French: Gazelle Dama

Spanish: Gacela Dama, Mohor

TAXONOMY

Several Dama Gazelle subspecies have been described, based on variations in pelage patterns observed in specimens obtained from different parts of the range. Specimens in the east have a larger amount of white on the hindquarters and only a reduced or absent brown haunch stripe which is mainly horizontal; the amount of chestnut-brown tends to increase towards the west and the stripe on the haunches becomes larger and more prominent. Cano Perez (1984) proposed three subspecies *N. d. mhorr* (in the west, east to about 7°E); *N. d. dama* (between about 7° and 14°E) and *N. d. ruficollis* (east of 14°E). Groves and Grubb (2011) also proposed three subspecies, said that all specimens from Senegal resembled *N. d. dama*, not *N. d. mhorr*, and placed the boundary between these two forms approximately along the Senegal river. *N. d. mhorr* is extinct in the wild and all surviving animals in captivity are descended from four founders, captured in 1958 (Cano and Abaigar 2018).

Analysis of mitochondrial DNA sequences revealed no genetic support for the traditional 3-subspecies arrangement (Senn et al. 2014, 2016). It is not known if the variation in colour has any adaptive variation or if it represents an east-west cline and there are extensive geographical gaps in sampling. A lack of clear natural barriers to limit movements of individuals, and therefore gene flow between different parts of the range, and the very small number of mhorr founders, are among other factors to consider (Senn et al. 2014). Wild herds may show variation in appearance, especially in the centre of the range (RZSS and IUCN SSC Antelope Specialist Group (2014). Two animals showing *ruficollis*-pattern were observed in Mali, to the west of 7°E (Lamarque et al. 2007b) and some Dama Gazelles photographed or portrayed in rock art in southern and western Algeria are also relatively pale. A thorough review of historical descriptions, colour patterns, taxonomic arrangements, rock art and other evidence is provided by Kitchener (2018). The variation in coat colour indicates some underlying genetic variation which may or may not be adaptive, but there may be other forms of variation. Constraining breeding by coat colour alone may in fact eliminate other important variation.

Genetic analysis of Dama Gazelles has assessed the diversity and relatedness of populations both in the wild and in captivity. In total 252 samples have been analysed (Senn et al. 2014, Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland (2019). Genetic analysis of the captive population has relied on mtDNA. Further investigation of genetic structure with nuclear markers to clarify the taxonomic status of mhorr is currently underway. The 252 Dama Gazelle samples have shown 37 control region haplotypes, 29 in the wild population and eight in the global captive population. No haplotypes are shared between the captive and wild samples.

The genetic structure within this dataset does not match any underlying geographical pattern. That is, closely related haplotypes are distributed among geographically separated populations and do not cluster by locality. Therefore, application of the traditional subspecies divisions would result in a polyphyletic phylogenetic arrangement in the mtDNA data, suggesting that these divisions are not valid. These analyses therefore revealed no genetic support at mitochondrial gene regions for the historical classification of subspecies (Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland 2019).

Among the wild populations. Manga (Chad) has the greatest gene diversity (14 haplotypes identified). DNA from the Air Mountains (Niger) contains four unique haplotypes not found elsewhere in the 11 samples, which highlights the general trend in wild Dama Gazelles for high levels of mitochondrial DNA diversity. The USA population contains the greatest gene diversity of the captive populations even though the samples in this dataset originated from only seven institutions which is a small fraction of the North American captive populations. It seems likely that at least four female lineages are represented in the North American dataset.

The level of gene diversity in the US population is comparable to that found in the wild population in Termit, and the nucleotide diversity is higher than that in Termit. This is a marginally positive sign for the US captive population which clearly shows higher genetic diversity than its counterpart in Europe, but it may signal a more depressing situation for the Termit population. Despite the relatively high number of Dama Gazelle in Termit, it could be that the population has undergone a bottleneck, i.e. it is derived from a small number of founders. The current population (30-50 individuals) is located in a marginal habitat for the species and has managed to survive, while those in the original habitat have been killed because of hunting or drought (Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland 2019).

GENOMICS

Modern techniques and new technology have vastly increased the capacity of genetic analysis, allowing the whole genome (the entirety of the genetic information on an individual) to be sequenced, not just short lengths of DNA, as has been done previously. The results of genomic sequencing are potentially much more informative but produce a huge amount of information (billions of base pairs) that requires careful and sophisticated analysis. The Smithsonian Conservation Biology Institute (SCBI) has sequenced one reference genome (addra) and re-sequenced four individuals (2 addra, 2 mhor) all from captive animals, to examine genome-wide variation. Genomic diversity (observed heterozygosity) in the mhor was found to be significantly lower than addra, reflecting the small number of original founders and subsequent inbreeding. In contrast, the two addra gazelle genomes showed high levels of heterozygosity across the genome and no evidence of inbreeding. Despite these differences, overall variation for the species was high, relative to other ungulate species.

DESCRIPTION

Dama Gazelle is the tallest of the gazelles, with long legs and a long neck. Its distinctive pelage is in general a rich brown on the neck and back and white on the head, underparts, and legs. There is variation east to west. Eastern forms show the most white, especially on the hind quarters, with a faint or absent brown stripe on the hind leg. Western forms are browner, the colour becoming darker brown in the far west, and the leg stripe increases in size. The horns are short and stout, lyrate in form and swept backwards (Scholte 2013).

BIOLOGY AND ECOLOGY

The original habitat, as described by early visitors to the region, consisted of lightly wooded savanna, dense woodlands, and wadis with sparse trees, rarely in open desert, though occasionally seen in dunes (Dragesco-Joffe 1993, Beudels et al. 2005; Scholte 2013). Some current populations inhabit rocky hills and open desert plains, both of which may be suboptimal refuge habitat (Scholte 2012, 2013). For more details of biology, ecology, conservation of Dama Gazelle see Mungall 2018).

Dama Gazelle is primarily a browser on trees and woody shrubs but also feeds on grasses such as *Panicum turgidum* and other species in the wet season, and on herb-rich ephemeral pastures (Scholte 2013).

Groups consist of harems (a male with several females and young), family groups, bachelor groups, and individuals (Grettenberger and Newby 1986). Groups are generally small but larger aggregations of up to 500-600 have been observed in the past (Scholte 2013).

MIGRATIONS

Dama Gazelles are thought to be nomadic to some extent, making some seasonal movements between wet and dry seasons to obtain good forage. The contemporary population fragments all seem restricted to small areas. Several original populations were likely to be transboundary.

CURRENT DISTRIBUTION AND STATUS

The former range of the species was estimated to cover 3,616,260 km² but less than 1% is still occupied (Durant et al. 2014). There are currently three known wild populations of Dama Gazelle (Ouadi Rime-Ouadi Achim Faunal Reserve, Chad; Termit Tin Toumma and Air and Ténéré National Nature Reserves, Niger) and three possible populations (Manga and Ati in Chad, and Tamesna in Mali). All are small and fragmented. There is also a small population released into an enclosure within Ferlo Nord Reserve in Senegal.

POPULATION

Numbers in the three main wild populations (Air & Ténéré, Termit-Tin Toumma, OROA) total 90-140. No estimates are available for Alifa and Manga (Chad), or Tamesna (Mali), but if any Dama Gazelles remain at these sites, numbers are probably low. The *ex situ* population numbers 2772 (170 within the region, 807 in zoos outside the region, 285 in the Middle East and 1510 on private ranches; Table 6).

STATUS BY COUNTRY (EXCEPT EXTANT POPULATIONS)

Algeria

Dama Gazelles occurred on the Tindouf du Drâa in the southwest in the 1940s and 1950s and until the end of the 1970s–1980s in Ahaggar and Tassili N'Ajjer in the south (Kowalski et Rzebik-Kowalska 1991). The species also features in many rock paintings in Ahaggar, Tassili N'Ajjer and sites such as Taghit in the Saharan Atlas. There are some local reports from the south (including Tassili de Tin Gherghor) but no confirmed recent records. No Dama Gazelles are kept in captivity in the country. Dama Gazelle is protected by law (Ordonnance 06-05 du 15 juillet 2006).

Burkina Faso

Formerly very small numbers occurred in the Sahel zone of the north, but it is now extinct there (Heringa et al. 1990; Beudels et al. 2005).

Chad

Dama Gazelle was formerly widespread but has disappeared from most of its range. Dama Gazelles still occur in in the Ouadi Rime-Ouadi Achim Faunal Reserve and possibly in Manga and Ati.

The largest population occurs in the Ouadi Rime-Ouadi Achim Faunal Reserve (OROA; 77,950 km²). The main group occupies an area in the south-east, with a smaller group in the north of the reserve near Wadi Hawach. The estimated population in the reserve is around 50 individuals. This population is subject to regular ground and aerial monitoring. A group of 47 gazelles was observed in late 2022 by the reserve monitoring team.

Manga is an unprotected area of vegetated dunes covering 6000-7000 km² situated north of Lake Chad. Sightings are too few to allow a population estimate, but the population is believed to be very small (Wacher et al. 2015). These Dama Gazelles are known to be genetically

diverse, and three females were captured in 2019 to form the nucleus of a captive breeding population.

The species was formerly reported at Alifa, south of Ati, where one poached animal was reported in 2014. The present status of this population is unknown.

Libya

The former status of Dama Gazelle in the country is unclear. There are a few verbal reports from the far south, but no confirmed evidence. In 2014 captive Dama Gazelles were photographed in Libya (RZSS & ASG 2014), perhaps brought from Niger or Chad. There has been no subsequent news since then.

Mali

Dama Gazelle formerly occurred across the Sahel zone and southern fringe of the Sahara in Mali but was already reduced to small, scattered populations by the end of the 1980s (Heringa 1990). It occurred in the Gourma area and around Menaka in the early 1970s, the Gourma and Ansongo areas in 1979, and south-east of Arouane and on the Mauritania border in 1980 (Heringa 1990). Since that time, the only reports are from the Tamesna plains in eastern Mali which lie south-east of the Adrar des Ifoghas massif.

The only recent reports have come from the Tamesna region which lies south-east of the Adrar des Ifoghas massif. Three surveys of Tamesna were conducted in 2002-2005. A ground survey was conducted in February 2002 and local reports indicated their presence in three areas (Lamarque and Stahl 2002). A second ground mission in February 2005 made systematic surveys of two blocks identified on the basis of local reports and covering 1775 km². Seven Dama Gazelles were seen and field signs of 18 more found in the western block, indicating a density of 0.047/km² (Lamarque et al. 2007a). An aerial survey in November 2005 surveyed the same two blocks and a third block identified from local reports. Three gazelles were observed in the western block in the same place as a concentration of tracks in February, in the Tassamaka dunes west of Amasaouas (Lamarque et al. 2007b). No Dama Gazelles were seen in the eastern zone on the border with Niger. In February, numbers were estimated at 170 (130 in the east and 38 in the west) but too few were seen in November to make a population estimate (Lamarque et al. 2007a, 2007b). The last confirmed record of Dama Gazelle in Mali was therefore in November 2005, though some local reports from western Niger were received in 2010 and may have referred to animals from the Tamesna population. The security situation prevents field missions at the present time.

Niger

Dama Gazelles are currently present at two sites: Aïr and Ténéré National Nature Reserve (ATNNR; 77,360 km²) and Termit Tin Toumma NNR (97,000 km²). In both sites they are confined to rocky areas, Mont Takoukougatt in ATNNR and the Termit massif in TTNNR, which likely represent refuge habitat (Razack et al. 2021). Although the two reserves are contiguous, the two Dama Gazelle populations are isolated from each other. The population in ATNNR may number c. 30 and in TTNNR, 50-70, based on observations and field signs since 2012, though 30-50 individuals may be more realistic (Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland 2019).

Management of TTNNR was devolved to a French NGO, Noé Conservation, in 2018. No cases of poaching have been reported in TTNNR in recent years. In ATNNR 13 camera traps have been deployed since January 2017 to monitor the Dama Gazelles and a guide employed to work with the reserve management team; the data are collected every 6 months. The latest field mission in 2021 also saw several groups (Razzack et al. 2021).

Mauritania

Formerly widespread and may have survived longest in the Akle Aouana region on the border with Mali, but eliminated by uncontrolled hunting and habitat degradation (Sournia and Verschuren 1990). Dama Gazelle was assessed as extinct in the country on the national Red List (Brito et al. 2022).

Morocco

There are 43 georeferenced records of Dama Gazelle in the Saharan region, south of the Anti-Atlas (Cuzin et al. 2003). The last observation was in the Drâa valley, south of Iriqui, in 1993 (Aulagnier et al. 2015). A captive breeding group is maintained at R'Mila Royal Conservation Reserve. Dama Gazelles have been transferred from there to acclimatization centres including to the M'Cissi reserve. There are currently 120 Dama Gazelles at R'Mila and 23 at M'Cissi. In addition, there are breeding groups at Rabat Zoo (7) and the privately-owned Al Maha Farm near Rabat (c. 40). Twenty-one Dama Gazelles from three German zoos were introduced to the Rokkein enclosure (2000 ha) in Souss-Massa National Park in 1994 and 1998, but later died out, unlike Addax (*Addax nasomaculatus*) and Dorcas Gazelles (*Gazella dorcas*) that were released in the same enclosure.

Nigeria

Occurred rarely in the Sahel zone but likely only a vagrant by the end of the 1980s (Anadu and Green 1990).

Senegal

Probably a seasonal visitor in the dry season to the far north but extirpated by the end of the 1980s (Sournia and Dupuy 1990). In June 1984, seven individuals from the Almeria breeding centre were introduced to the Guembeul Faunal Reserve (Reserve Spécial de Faune de Guembeul; RSFG) from the Estación Experimental de Zonas Áridas (Arid Zones Experimental Station EEZA-CSIC) at Almeria in Spain. In 2003 five Dama Gazelles were transferred from Guembeul Reserve to the Katane enclosure (12 km²) in Ferlo Nord Wildlife Reserve (Réserve de Faune de Ferlo Nord) in northern Senegal. The reserve has an area of 4870 km², with a core area of 847 km². In 2018 a population of 15 was estimated but the size and vegetation cover in Katane makes a precise estimate difficult. There are plans to expand the enclosure to 50 km² (Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland 2019).

Sudan

Dama Gazelles occurred across the Sahel zone of the country in Darfur and Kordofan provinces, east to the river Nile (Hillman and Fryxell 1988). Aerial surveys in 1975-1977 found that 'gazelles' were widely distributed across Northern and Southern Darfur and Northern and Southern Kordofan Provinces and estimated c.25,000 gazelles of all species (possibly including some Dama Gazelles) in areas west of the Nile (Hillman and Fryxell 1988). There were still a few Dama Gazelles in North Darfur according to Wilson (1990) and local reports from North Darfur and North Kordofan in the 1990s (East 1999) but there has been no confirmed evidence of Dama Gazelle presence since then.

Tunisia

Dama Gazelle is long extinct. Five animals were transferred from zoos in Germany to Bou Hedma National Park (168 km²) followed later by three more, and 14 in 1994. The population failed to establish and only one male now remains. Poaching and predation by African wolves (*Canis lupaster*) are believed to have contributed to the decline (Jebali and Zahzah 2013).

Outside the SSMF region

The historic distribution extended into northern Cameroon in the Lake Chad Basin (Schreiber 2021).

THREATS

The main causes of the Dama Gazelle's decline are uncontrolled hunting and habitat degradation. The Dama Gazelles in Ouadi Rimé and Termit Tin Toumma reserves are relatively well managed and protected. Air & Ténéré Reserve is in a less secure area and is subject to wide scale illegal artisanal gold mining. The three possible sites are unprotected.

In certain areas, poaching and feral dogs are significant threats to Dama Gazelles (L. Sikli, pers. Comm.) (ANEF 2019).

The remaining wild subpopulations of Dama Gazelle are situated a long way apart from one another. These zones are subject to varying levels of livestock grazing and development and they lack protection from disturbance or poaching. The possibility of regular movement of Dama Gazelles between them is considered to be extremely low or non-existent (Al Ain Zoo, IUCN SSC Antelope Specialist Group and Royal Zoological Society Scotland 2019;).

CONSERVATION MEASURES

International designations

CMS: Listed on Appendix I

CITES: Listed on Appendix I

IUCN Red List: Critically Endangered

Planning

A workshop was held in Edinburgh December 2013 to develop a conservation review, including a long-term vision and a set of objectives and actions, and published in English and French versions (RZSS and ASG 2014). In March 2017 a workshop took place in N'Djamena, Chad to recommend conservation measures for the remaining wild populations of Addax and Dama Gazelle in Niger and Chad (DCFAP et DFCPR 2017). A second global planning workshop took place in December 2018 at Al Ain Zoo in Abu Dhabi. The aim of the workshop was to review and update the objectives and actions to identify and agree concrete actions to reduce the extinction risk of the Dama Gazelle and a revised strategy produced ((Al Ain Zoo, IUCN SSC Antelope Specialist Group and Royal Zoological Society Scotland 2019). A 2.5 year review of this strategy was conducted online in mid-2021 and revisions made to some actions and time targets (Al Ain Zoo, IUCN SSC Antelope Specialist Group and Royal Zoological Society Scotland 2021).

There are national strategies to restore the species in Tunisia (DGF 2001) and Morocco (Cuzin et al. 2007).

Ex situ

Dama Gazelles are maintained in captive and semicaptive conditions in public and private facilities in the region, North America, Europe, and the Arabian Peninsula. Ex-situ Dama Gazelles are mainly managed as two populations: mhorr (*N. d. mhorr* or the western type) and addra (*N. d. ruficollis* or the eastern type). There are no *N. d. dama* in captivity. As far as is known, all the eastern Dama Gazelles in captivity derive from 35 animals caught in OROA in 1967 (van den Brink 2018).

The *ex situ* population numbers 2772 in total (170 within the region, 807 in zoos outside the region, 285 in the Middle East and 1510 on private ranches; Table 6). The European

Association of Zoos and Aquariums (EAZA) has 377 mhorrr (148.229) in 19 EU and 7 (non-EU) facilities. The population trend is increasing. These are managed in a European Endangered Species Programme (EEP), currently coordinated by the Estación Experimental de Zonas Áridas, Almeria, Spain. A studbook and husbandry guidelines are available [here](#).

At the R'mila Royal Reserve in Morocco, the Dama Gazelle population was founded with six (3.3) individuals, it increased to 120, then declined. The current population has recovered to 120. Furthermore, Dama Gazelles have also been relocated to a acclimatisation centre in the Safia reserves that currently counts 12 individuals.

In North America, the Association of Zoos and Aquariums (AZA) manages a population of Addra Gazelles (*Nanger dama ruficollis*) through a Species Survival Plan (SSP) currently coordinated by San Diego Zoo Global Safari Park. There are 183 (83.100) animals in 21 institutions. There were only 13 founders, but the gene diversity is 84.8%. Among the challenges that adversely affect the program are a lack of space, especially for males and a need to identify unrelated animals (Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland 2019).

The Exotic Wildlife Association's latest survey (January 2015) showed 1,510 Dama Gazelles mainly on Texas ranches (Mungall 2018). The Source Population Alliance (SPA) was formed in 2014 to collaborate among the private and public sectors under the umbrella of the Conservation Centers for Species Survival (C2S2). There are 214 Dama Gazelles (60.124.30), in 14 facilities, including some overlap since five of those 14 facilities are also in AZA. Between 2014 and 2018 there has been an increase of 82% in participants (17 to 31) and 140% in animals (475 to 1196; all species).

In the Arabian Peninsula there are 285 Dama Gazelles in 10 facilities. These consist of 99 addra (28.56.15), 65 mhorrr (24.41.0) and 24 mixed (8.9.7). Al Ain Zoo holds all of the mixed animals as part of an addra x mhorrr breeding experiment, as well as separate breeding populations of 63 addra and 70 mhorrr.

Manga capture

The Dama Gazelles in the Manga region contain unique genetic diversity and a capture operation, coordinated by Sahara Conservation Fund, was carried out by a multinational team from Chad's Directorate for Wildlife Conservation and Protected Areas (DCFAP), Environment Agency - Abu Dhabi, Zoological Society of London, Fossil Rim Wildlife Center, Smithsonian Conservation Biology Institute, Gulf Breeze Zoo and Noé Conservation. Preliminary field surveys were undertaken in May and early November 2019 to locate the gazelles and a capture mission was organized in January 2020. Three females were successfully immobilised and transported by air to the Ouadi Rimé-Ouadi Achim Faunal Reserve (OROA) in central Chad, 350 km away. A male Dama Gazelle was caught in OROA to form the first breeding group. Two of the females died later in 2020. The male and remaining female produced a young female in August 2020 and another female in March 2021. In December 2020 three wild females were seen close to the enclosure on several occasions and in March 2021, one was encouraged to enter and join the breeding group (Al Ain Zoo, IUCN SSC Antelope Specialist Group and Royal Zoological Society Scotland (2021). The last Manga female has also died. In January 2023, the breeding group consisted of 17 animals.

Reintroduction

In the Safia region a group of 24 Dama Gazelles were released in the wild from a acclimatisation centre on 22 May 2015. Seven were shortly killed by feral dogs and 11 were recaptured and placed in an enclosure while six dispersed in the wild. Meanwhile 39 feral dogs were removed and the recaptured gazelles were rereleased in the wild on 27 July 2015, at which point they dispersed towards the north and south-east (Abáigar 2018).

In Morocco, in the Rokkein enclosure (1500 ha) in Souss-Massa National Park, no reintroduced Dama Gazelle survived, and in Tunisia in the Bou Hedma National Park only one male remains. In the Katane enclosure in Senegal in the Ferlo Nord Faunal Reserve, the released population also increased but is now slowly decreasing. The causes of the declines have not been clearly identified.

LOGICAL FRAMEWORK

Updated objectives and actions for Dama Gazelle (*Nanger dama*) conservation (2021-2028). (From the 2.5 year review, 2021)⁶

Vision: Sustainable and free-living populations of dama gazelle in indigenous range, supported by well-managed populations elsewhere.

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
WILD						
Objective 1: Monitor wild populations effectively						
1.1. Chad: Wadi Rimé-Wadi Achim Faunal Reserve (OROA)	Ongoing	Survey results	DCFAP, SCF		<ul style="list-style-type: none"> Systematic population monitoring hampered by restrictions on travel due to Covid Local opportunistic record keeping ongoing Numbers are stable Aerial survey is on track for Nov 2021 	SCF / DCFAP (VB, JN, MHH)
1.2. Chad: Manga	2019-2020	Survey results	Noé, DCFAP, SCF	Achieved over the period 2019 – 2020. No more funding from 2021.	Noé research effort in the Manga: <ul style="list-style-type: none"> 13 research missions in the border area (2018 - 2020) 4 community agents in place, 220 person/days of patrols between 2019 and 2020 Worked on capture and translocation of 3 dama gazelles from Manga to OROA with partners 2 groups of dama gazelles present on the basis of local reports, without real estimate of the size of the groups Groups may be connected to each other? Other groups may be present? Estimate 10 to 20 individuals? 30 maximum? 	Noé (SP)
1.3. Chad: Alifa-Ati	L	Survey results	DCFAP, SCF		<ul style="list-style-type: none"> No news since 2017 because of local insecurity linked to illegal gold mining Area cannot be accessed 	SCF / DCFAP (VB, JN, MHH)
1.4. Niger: Aïr and Ténéré National Nature Reserve (ATNNR)	H	Survey results	DFCPR, SCF	Ongoing	<ul style="list-style-type: none"> Regular field monitoring ongoing (two missions per year) 2 eco-guards on site for monitoring, awareness raising Use of camera traps finalized in 2020; data analysis/image processing ongoing 	SCF (VB, JN, AR)

Achieved/Partially Achieved	Ongoing/In progress	New	Amended	Dropped
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⁶ The *Updated objectives and actions for Dama Gazelle (Nanger dama) conservation (2021-2028)* developed from the 2.5 year review in 2021 was not developed through a CMS process. The CMS Secretariat as a UN entity follows the rules and guidelines as set by the United Nations and any designations employed and the presentation do not imply the expression of any opinion whatsoever on the part of the CMS Secretariat or contributory organisations concerning the legal status of any country, territory, city or area in its authority, or concerning the delimitation of its frontiers or boundaries.

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
					<ul style="list-style-type: none"> Observed intensification of human activities on the massif (small-scale gold mining); increased signs of motorbikes Poaching occurs in the area (direct evidence of poaching of a Dorcas gazelle collected in 2020 by field team) A PhD research project (University of Prague) is being carried out on the Dama in Air Recommendations on conservation and management are being made to the Governmental authorities Need to reinstall the camera traps for an additional year Dama gazelles are confined to sub-optimal mountain habitats 12 dama gazelles, including 4 very young individuals, were observed on Mount Takolokouzet in late May / early June 2021 as reported to AR (SCF) by a community guard on site 	
1.5. Niger: Termit and Tin-Toumma National Nature Reserve (TTNRR)	H	Survey results	Noé Conservation, DFCPR	Ongoing	<ul style="list-style-type: none"> Permanent, regular monitoring of the population of the Termit massif Population census planned for Q2 2021 Increasing observations of dama gazelles in the valleys and not on the foothills of the Termit massif -> sign of the recolonisation of habitats near the Termit massif? Population census planned for Q2 2021 Census scheduled every 2 years Regular observations with up to more than 20 distinct individuals recorded during these missions No poaching activity recorded in the Termit massif (2019/2020) Population to be re-estimated (awaiting results of the planned census Q2 2021) 	Noé (SP)

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
1.6. Niger, Western: Tamesna plains						
1.6.1. Establish local contacts	L-M	Contacts established Local reporting system	DFCPR		<ul style="list-style-type: none"> Region too insecure 	
1.7. Mali: Tamesna						
1.7.1. Establish local contacts	M	Contacts established Local reporting system	Government agency, NGO		<ul style="list-style-type: none"> Region too insecure 	
1.8. Algeria: follow-up local reports	L-M	Results available	ANN, DGF			
1.9. Sudan: follow-up local reports and survey former range when feasible	L	Results available	SWS, ASG, Government agency			
1.10. Provide training in survey and monitoring methods for all range states	M	Training courses conducted	Government agencies, NGOs	Ongoing (Morocco)		DEF (LS)
1.11. Produce ID-card for local use	L	ID-card produced and distributed	ASG	Dropped	<ul style="list-style-type: none"> No longer a priority 	ASG (DM)
Objective 2: Secure and expand key wild populations						
2.1. Niger, Air and Ténéré NNR: follow recommendations in DCFAP et DFCPR (2017)	H	Recommendations implemented	DFCPR		<ul style="list-style-type: none"> Surveillance needs to be increased for dama gazelles to return to their more optimal habitat in the wadis 	SCF (AR)
2.2. Niger, Termit and Tin-Toumma NNR: follow recommendations in DCFAP et DFCPR (2017)	H	Recommendations implemented	Noé Conservation, DFCPR	Ongoing	<ul style="list-style-type: none"> Termit massif is fully protected 1200 person/days of anti-poaching patrols in the TTNNR 2500 person/days of community patrols in the RNNTT No poaching observed on dama gazelles (2019/2020) nor traces of vehicles / motorcycles in the eastern part of the Termit massif (in 2020) Permanent establishment of management resources in the Termit massif (camp, permanent patrol system, camera trap grid, aerial surveillance) 	Noé (SP)

Achieved/Partially Achieved	Ongoing/In progress	New	Amended	Dropped
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Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
					<ul style="list-style-type: none"> system from Q2 Boundaries of RNNTT were changed in July 2019 and amended in January 2021 to reincorporate the entire Termit massif 	
2.3. Chad, OROA: follow recommendations in DCFAP et DFCPR (2017)	H	Recommendations implemented	DCFAP, EAD, SCF	Ongoing	<ul style="list-style-type: none"> The species is incorporated into the signed, funded and ongoing project on the conservation of endangered species 	SCF (VB, JN)
2.4. Incorporate dama gazelle conservation in all site management plans (MPs)	M	MPs produced	Government agencies			
2.5. Monitor route of the Great Green Wall and potential impact on movements of dama gazelle	L	Recommendations on changes to route made to governments, as appropriate		New	<ul style="list-style-type: none"> See Naja M. et al (2021) for possible impacts of the GGW on the dama gazelle 	
3. Reintroduce to new sites						
3.1. Niger, Gadabedji BR: conduct feasibility study	M	Study produced	DFCPR, SCF		<ul style="list-style-type: none"> Cartography and habitat data was collected in 2018 by SCF Analysis is required 	SCF (VB, JN)
3.2. Niger, Ennedi NCR: conduct feasibility study	M	Study produced	DCFAP, APN		<ul style="list-style-type: none"> An ethnozoological study of 110 interviews has been carried out focused on absence/presence of species and those extinct No reports of dama currently being present A map is being developed based on reports of former presence 	AP (AH)
3.3. Errachidia: conduct feasibility study	M	Study produced	DEF	Dropped	<ul style="list-style-type: none"> No longer relevant 	DEF (LS)
3.4. Boujdour-Safia ABC: conduct feasibility study	M	Study produced	DEF	Dropped	<ul style="list-style-type: none"> No longer relevant 	DEF (LS)
3.5. Morocco, M'hamid Elghizlane (Iriqui National Parc): conduct feasibility study	H	Study produced	DEF	New	<ul style="list-style-type: none"> Establishment of habitat map of Iriqui National Parc by November 2022 Analysis of the evolution of the carrying capacity of the habitat by September 2022 Translocation of the first group in Oct/Nov 2022 	DEF (LS)

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
4. Reinforce wild populations						
4.1. Chad, OROA: conduct feasibility study	H	Study produced	DCFAP, EAD, SCF		<ul style="list-style-type: none"> Plans are underway to reinforce the captive group sourced from OROA/Manga with animals from EAD/Abu Dhabi in late 2021 See new action 7.5 below 	SCF / EAD (VB, JN, JC)
SEMICAPTIVE						
5. Secure and expand semi-captive populations						
5.1. Senegal: Katane						
5.1.1. Extend area to 5000 ha	H	Extension created and fenced	DPN	Achieved	<ul style="list-style-type: none"> Extension completed but lack of development for feed and water supply A comparative study report between the interior and the exterior of the completed enclosure 	DPN (SF, BY)
5.1.2. Conduct drone survey	M	Survey report	ABZC, DPN		<ul style="list-style-type: none"> Exchange with ABZC with the facilitation of David Mallon on a Memorandum of Cooperation Document not finalized by ABZC 	DPN (SF, BY)
5.1.3. Conduct training programme	H	Programme completed	ABZC, DPN		<ul style="list-style-type: none"> Relevant training needed for DPN Requested finalization of memorandum with ABZC 	DPN (SF, BY)
5.1.4. Conduct feasibility study on obtaining new animals	M	Study produced	DPN	In progress	<ul style="list-style-type: none"> Study already carried out with the participation of National universities, NGOs, and DPN curators (report available) with strong recommendations on obtaining new animals 	DPN (SF, BY)
5.1.5. Conduct research on movement patterns population dynamics and diet	M	Results produced	DPN, partners	In progress	<ul style="list-style-type: none"> Permanent Sahelo-Saharan antelope monitoring in the Katane enclosure A memorandum was signed with the Spanish cooperation This will be strengthened by a research study in partnership with the university 	DPN (SF, BY)
5.2. Senegal, Guembeul: Evaluate role in dama conservation and need for new stock	M	Study produced	DPN	Achieved	<ul style="list-style-type: none"> Guembeul is a key site in the context of increasing dama numbers The DPN strategy provides for the reinforcement of the Guembeul population with a reproductive nucleus 	DPN (SF, BY)

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
5.3. Morocco, Safia & M'Cissi: Continue government programme	M	Breeding continues	DEF	Ongoing	<ul style="list-style-type: none"> A special population management plan was produced to ensure the optimum development of the population As of March 2021, there were 24 damas in M'cissi and 12 in Safia Numbers are increasing There's a plan to create a separate enclosure for addax to give the damas more space to breed Reintroduction is the long-term plan 	DEF / EEZA (LS, TA, ZA)
5.4. Morocco, Assa: Continue government programme	M	Enclosure created	DEF	Achieved	<ul style="list-style-type: none"> Translocation of the first group to the enclosure will be carried out by the end of 2021 (October-November) 	DEF (LS)
5.5. Morocco, R'Mila: Continue breeding programme	H	Breeding continues	DEF	Ongoing	<ul style="list-style-type: none"> Work is being carried out to establish a breeding centre in R'Mila to manage genetic diversity in the controlled breeding program A mission was carried out in March 2021 which showed that more than 100 damas are currently present Numbers are increasing To provide more space for dama gazelle breeding, the dorcas gazelles are being removed and transferred to another site in the South Reintroduction is the long-term plan 	DEF / EEZA (LS, TA, ZA)
5.6. Algeria: Conduct feasibility study into possible reintroduction	L-M	Study produced	ANN, DGF	Ongoing	<ul style="list-style-type: none"> A qualitative, interview-based investigation exploring local perceptions of a future project to reintroduce extinct ungulates in Ahaggar, including dama gazelle and addax, has been carried out in the Protected Area 	UB (FB, KDS)
5.7. Tunisia: Conduct feasibility study on establishment of a breeding group at Haddej NP	H	Study produced	DGF, MW	Ongoing but delayed due to COVID travel restrictions	<ul style="list-style-type: none"> Will need to be coordinated with the management of the existing breeding group of addax in Haddej NP 	MW (MP)

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
CAPTIVE AND SEMICAPTIVE OUTSIDE RANGE						
6. Maximise the effectiveness of captive populations						
6.1. Minimise loss of genetic diversity of captive populations	H	Genetic diversity managed in all populations	SSP and EEP coordinators, SPA, SAF, EWA, others	Ongoing in AZA and EEZA	<ul style="list-style-type: none"> Three animals were transferred from ABZC to EAD EAD population now more than 40 animals SAF and EWA – ranches in USA (mainly Texas) continue to buy and sell dama gazelles among each other. Increasing genetic diversity is sometimes a definite objective 	EAD (JC) SAF / EWA (EM)
6.1.1. Exchange animals between AAZ and EAD	H	Exchanges completed	AAZ, EAD		<ul style="list-style-type: none"> The process has been initiated Awaiting results of genetic analysis of EAD animals to inform exchanges 	EAD / AAZ (JC, MQ)
6.1.2. Transfer mhorh gazelles from EAZA to AAZ	H	Transfers completed	AAZ, EAZA, Studbook keeper	Amended / Ongoing EEP coordinator	<ul style="list-style-type: none"> Action changed from "exchange" to "transfer" More information about the affiliation of the AAZ population is necessary 	EEZA (TA, SD)
6.1.3. Exchange animals between Morocco and EAZA	H	Exchanges completed	DEF, EEZA	Ongoing EEZA	<ul style="list-style-type: none"> In collaboration with the CSIC, we are working on establishing an exchange plan with the Arid Zones Experimental Station of Almería (2023) 	EEZA (TA, SD, LS)
6.1.4. Transfer addra from US to AAZ/EAD	H	Exchanges agreed and completed	AZA, SPA, SAF, AAZ, EAD	Amended and ongoing	<ul style="list-style-type: none"> Action changed from "AAZ" to "AAZ/EAD" EAD is also planning to transfer some animals in the future 	EAD (JC)
6.1.5. Develop a metapopulation management plan for animals in the UAE	M	Plan developed	All regional holders	Amended	<ul style="list-style-type: none"> Action changed from "Arabian Peninsula" to "UAE" 	
6.1.6. Evaluate role of mixed animals in reintroduction and reinforcement operations	H	Evaluation conducted	AAZ, Key stakeholders	Ongoing	<ul style="list-style-type: none"> Need to take into account social and genetic needs Need to consider who, how and when the decision is made whether or not to treat all dama gazelle as one population for conservation purposes 	EEZA (TA) UO (MSP)
6.1.7. Identify collections in Texas with rare haplotypes and recommend appropriate animal	H	Animals identified Transfers agreed and arranged	RZSS, SCBI Studbook keepers	Amended	<ul style="list-style-type: none"> Amended to include approval of the owners SAF and EWA members are supportive of 	

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
transfers or exchanges subject to approval of the owners					conservation initiatives	SAF / EWA (EM)
6.2. Continue to develop the C2S2 consortium	Ongoing	Increased number of holders Increased number of animals	C2S2, SPA, SAF, EWA	Ongoing	<ul style="list-style-type: none"> SAF and EWA members are supportive of conservation initiatives 	SAF / EWA (EM)
6.3. Continue the breeding experiment at Al Ain Zoo	M-H	Results available	AAZ	Ongoing	<ul style="list-style-type: none"> Mixed groups of males and females have been separated for now Plans to develop mixed breeding herds are being discussed 	AAZ (MF)
6.4. Increase range state capacity for dama husbandry and management	M	Trained teams in each facility	Government agencies	Ongoing (Morocco)		DEF (LS)
6.4.1. Establish a training programme	2019-2020	Training courses provided	DEF, EAD, EEZA	Ongoing	<ul style="list-style-type: none"> Delayed by covid Training cycle is implemented for the local managers of the natural reserves (Morocco) 	EEZA / DEF (TA, SD, LS)
6.4.2. Circulate husbandry guidelines	M	Guidelines circulated	EEZA	Ongoing		EEZA (TA, SD)
6.4.3. Translate guidelines into French	M	Translation available	EEZA, NGOs			
6.5. Carry out PVA and metapopulation management planning to evaluate different strategies of management and produce enough animals for release operations	L-M	PVA conducted	SPA, SAF, EWA, Studbook keepers, others	Amended	<ul style="list-style-type: none"> Clarification: Evaluate mhor, addra and mixed animals separately and consider joint evaluations Management strategies used in Texas and how withdrawal of animals will affect owners' livelihood need to be considered 	ASG / AAZ / RZSS (DM, LB, HS) SAF / EWA (EM)
6.6. Produce a long-term plan for producing enough animals for release operations				Dropped	<ul style="list-style-type: none"> Merged with 6.5 	
6.7. Review development of wider metapopulation models				Dropped	<ul style="list-style-type: none"> Covered under 6.5 	

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
7. Obtain new founders						
7.1. Obtain privately held animals in range countries				Amended	<ul style="list-style-type: none"> Action amended by adding 'in range countries' for clarity 	
7.1.1. Monitor possible captive animals in Chad and Niger	L-M	Captive animals obtained	DCFAP, DFCPR			
7.1.2. Develop a protocol and holding facilities	L-M	Protocol developed	DCFAP, DFCPR, NGOs			
7.2. Chad: Capture wild animals from Manga	2019-2020	New founders obtained	DFCPR, SCF, others	Achieved	<ul style="list-style-type: none"> 3 Manga females successfully captured and relocated to holding facilities in OROA Female group supplemented with 1 male captured in OROA Subsequent loss of 2 females due to nutrition issues Remaining female and male have produced 2 calves Group supplemented by 1 female self-caught in holding facilities Total group in June 2021 includes: 1 adult male, 2 adult females, 2 young females Need to decide what to do with the remaining wild animals in Manga as the site is unprotected A decision tree developed for this scenario is available in the strategy (page 44) See also section 2.3 	SCF / Noé / DFCPR (VB, JN, SP, MHH)
7.2.1. Conduct scoping survey	2019-2020	Survey results	DFCPR, SCF	Achieved		SCF (VB, JN)
7.2.2. Feasibility study on capture methods	Done 2019	Study published	SPA, EAD, SCF	Achieved		SCF (VB, JN)
7.2.3. Plan capture operation	Done 2019	Plan developed	DFCPR, SCF, others	Achieved		Noé / SCF (SP, VB, JN)
7.2.4. Ensure suitable holding facility available in OROA	Done 2019	Facility available	DFCPR, SCF, EAD	Achieved		SCF (VB, JN)

Achieved/Partially Achieved	Ongoing/In progress	New	Amended	Dropped
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Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
7.3. Collate all capture and veterinary information in US	L-M	Summary available	SPA, AZA			
7.4. Train range state personnel in gazelle handling and management (see 6.4.1)	L-M	Training courses provided	DEF, EAD, EEZA		<ul style="list-style-type: none"> Delayed by covid Needs to be reviewed and rescheduled 	EEZA / DEF (TA, SD, LS)
7.5. Chad: Assess feasibility of capturing additional wild founders from Manga	H	Decision taken	DFCPR, SCF, Noé, others	New		
7.6. Chad: Develop a plan for ex-situ population at OROA	H	Plan developed	EAD, SCF, RZSS, ASG, Noé, others	New	<ul style="list-style-type: none"> Ensure optimal use of new founder genetic diversity and minimise inbreeding Mid to long-term plan for breeding and release 	
OTHER						
8. Continue genetic research						
8.1. Record morphological data and take genetic samples from all museum specimens with locality data	Ongoing	Data available	NMS, RZSS	Ongoing	<ul style="list-style-type: none"> Hybrid capture array developed for use on museum and wild faecal samples 	RZSS (HS, KD)
8.2. Continue genome sequencing	Ongoing	Results available	SCBI, RZSS, partners	Ongoing	<ul style="list-style-type: none"> Hybrid capture array developed for use on museum and wild faecal samples ddRAD analysis conducted on AAZ mixed animals and whole genome sequencing to be explored Whole genome & ddRAD analysis of US captive addra and mhorh samples completed with two publications pending Less than 1% difference found between the genomes of addra and mhorh gazelle, five times less than the difference between dama gazelle and grant's gazelle Mhorh gazelles have a greater number of deleterious mutations Three different chromosome numbers (38, 39 & 40) have been found but these do not correlate to specific subspecies 	RZSS, SCBI (HS, KD, KK)

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
8.3. Assess the role of cryobanking	L	Study published	SCBI, RZSS			
8.4. Include option of gamete preservation in any wild capture operations	L-M	Protocol developed	SCBI, RZSS			
8.5. Obtain and analyse new samples	Ongoing	Samples analysed	RZSS	Ongoing	<ul style="list-style-type: none"> Samples from newly captured animals are under analysis Continuing genetic analysis of animals in EAD and Chad (Manga and OROA) and a private collection in Morocco 	RZSS / EAD (HS, KD, JC)
8.6. Continue genetic and morphological research into intraspecific structure, using nuclear markers	Ongoing	Analyses published	RZSS	Ongoing	<ul style="list-style-type: none"> Hybrid capture array developed for use on museum samples and wild faecal samples 	RZSS (HS, KD)
8.7. Morocco: Carry out genetic analysis on any untested captive populations	M	Analyses conducted	RZSS, DEF		<ul style="list-style-type: none"> Looking for potential partnership and funding 	DEF (LS)
8.8. Continue breeding experiment and carry out genetic analysis, semen analysis, and karyotyping on offspring	Ongoing	Results available	AAZ, RZSS	Partially achieved	<ul style="list-style-type: none"> Genetic analysis on mixed animals is complete Semen analysis and karyotyping delayed due to lack of a local collaborator and covid-related travel restrictions A potential collaboration for semen analysis is being investigated Potential for genomics investigation on the mixed animals to be explored 	AAZ (LB)
9. Conduct research on biology and conservation of dama gazelle						
9.1. Compile lists of in-situ and ex-situ research needs	L-M	Lists available	Done at Al Ain workshop	Achieved	<ul style="list-style-type: none"> Available in the strategy document The following are added: studies related to the behaviour, morphology, health, survival and reproduction of mixed mhorr x addra animals 	
9.2. Continue research in Texas on movements and population dynamics	Ongoing	Some results available, some in progress	SAF, EWA	Ongoing	<ul style="list-style-type: none"> Biological research is continuing, study into skull set for tooth replacement and wear almost complete (to complement visual criteria already published) 	SAF / EWA (EM)

Achieved/Partially Achieved	Ongoing/In progress	New	Amended	Dropped
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Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
					<ul style="list-style-type: none"> Paper on habitat selection under Texas conditions has been published (Mungall & Cooper, 2020) Paper on home range size aspects under Texas conditions has been published (Mungall & Cooper, 2021) Paper on movement data is under development With the help of management interventions, winter losses among dama gazelles in Central Texas were fortunately quite light despite the unusually cold period with ice and snow lasting about a week 	
9.3. Analyse radio-collaring data from the Safia release	Ongoing	Analysis available	EEZA, DEF	Achieved in 2020	<ul style="list-style-type: none"> Results and data published in: <ul style="list-style-type: none"> Abáigar et al (2019): e00680 Abáigar et al (2020): e01389 	EEZA / DEF (TA)
9.4. Conduct research into interspecific interactions and competition at OROA and other sites	L-M	Research results available	DCFPR, SCF			
9.5. Review release operations to date and reasons for success and failure	M	Review published	EEZA, Government agencies	Ongoing	<ul style="list-style-type: none"> Assessment of the first release operation in Safia has been completed Planning the next release operation in Assa taking into consideration all the results of the previous release Article on 50 years of mhorr conservation has been submitted to the forthcoming Gnusletter 38 (1) (Abáigar, 2021) 	EEZA / DEF (TA, SD, LS)
10. Implement the strategy effectively						
10.1. Continue and expand Dama network	Ongoing	Key stakeholders participate Regular updates produced	RZSS, ASG	Ongoing		RZSS (HS)
10.2. Maintain 'Dama-library' (Google Groups etc)	Ongoing	Library up-to-date	RZSS, ASG	Ongoing	<ul style="list-style-type: none"> Accessible here 	RZSS (HS)
10.3. Hold a review meeting in Texas	2024	Meeting to be held	SAF, EWA	Amended	<ul style="list-style-type: none"> Covid travel problems have meant postponement of the 2022 Texas dama gazelle update workshop until 2024 (5-year review in Kerrville, Texas) 	SAF / EWA (EM)

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

Action	Timeline / Urgency	Indicator	Responsibility	Update	Notes / Comments	Updated by: Institution (Individual)
					<ul style="list-style-type: none"> Overseas participants need to be present to see ranch conditions, and US owners need to hear the discussion on how their animals can contribute to species sustainability – especially for addra 	
10.4. Publish and distribute the 2019-2028 strategy	H	Strategy published in EN and FR	AAZ, ASG, RZSS	Achieved in 2019	<ul style="list-style-type: none"> 150 English and 150 French hard copies of the conservation strategy were distributed to reviewers and delegates of the 2018 Al Ain workshop Some hard copies are available upon request PDF versions are available for download from AAZ website 	AAZ, ASG, RZSS (LB, DM, HS)
10.5. Initiate an education and awareness programme on dama gazelle and ecosystem in range countries (schools, media, public)	L-M	Programmes established	Government agencies, NGOs	Ongoing (Morocco)		DEF (LS)
10.6. Develop and implement Monitoring & Evaluation Plan for the strategy	M	M&E Plan available	AAZ, ASG, RZSS	Ongoing	<ul style="list-style-type: none"> Added "and implement" Plan developed (see section 3.0) 	ASG / AAZ / RZSS (DM, LB, HS)
10.7. Obtain adequate resources for each component	2019-2028	Resources obtained Actions implemented	All	Partially achieved	<ul style="list-style-type: none"> Funding has been obtained for some activities 	

AH - Annabelle Honorez (AP)
 AE - Adam Eyers (FRM)
 AR - Abdoul Razack Moussa Zabeirou (SCF)
 BY - Babacar Youm (DPN)
 DM - David Mallon (IUCN ASG)

EM - Elizabeth Mungall (SAF & EWA)
 FB - Farid Belbachir (UB)
 HS - Helen Senn (RZSS)
 JC - Justin Chuyen (EAD)
 JN - John Newby (SCF)
 KD - Kara Dicks (RZSS)

KDS - Koen de Smet
 KK - Klaus Koepfli (SCBI)
 LB - Lisa Banfield (AAZ)
 LS - Latifa Sikli (DEF)
 MF - Mohammed Al Faqeer (AAZ)

MHH - Mahamat Hassan Hatcha (DCFAP)
 MQ - Myyas Al Qarqas (AAZ)
 MSP - Mark Stanley Price (UO)
 SD - Sonia Dominguez (EEZA-CSIC)
 SF - Serigne Fall (DPN)

SP - Sébastien Pinchon (Noé)
 TA - Teresa Abáigar (EEZA-CSIC)
 VB - Violeta Barrios (SCF)
 ZA - Zouhair Amhaouch (DEF)

Achieved/Partially Achieved
Ongoing/In progress
New
Amended
Dropped

SLENDER-HORNED GAZELLE - *GAZELLA LEPTOCEROS* (F. CUVIER, 1842)

COMMON NAMES

Arabic Reem (Algeria, Tunisia), Ghazal abiad (Egypt, Libya, Tunisia)

English: Slender-horned gazelle, Reem, Rhim, Loder's 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

Tamasheq/Tamahaq: Adam

TAXONOMY

The type specimen was obtained in Lower Egypt (Flower 1932). Specimens from northern Algeria were described as a separate species *G. loderi* (Thomas 1894) then reclassified as a subspecies of *G. leptoceros*. 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. Beudels & Devillers 2013). However, the geographical limits 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. marica* from the Arabian Peninsula which also prefers sand dune habitat and has the same Arabic name 'reem'. Hammond *et al.* (2001) also 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; Wachter *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).

Despite their lack of genetic differentiation, *G. leptoceros* and *G. cuvieri* show 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, 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). Only functional genomics would clarify the relationships between *G. leptoceros* and *G. cuvieri* (Silva *et al.* 2017). They are certainly distinct ecotypes and are provisionally treated separately (Silva *et al.* 2017). Establishing the taxonomic relationships within this group of species (*G. leptoceros*, *G. cuvieri*, *G. marica*) is a high priority to inform conservation priorities.

HABITAT AND ECOLOGY

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).

MIGRATIONS

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 graze in the pre-Saharan steppe. 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.

CURRENT STATUS

G. leptoceros is distributed in the Sahara, from about longitude 40°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. The original range has declined by an estimated 86% (Durant et al 2014). Presence is confirmed in Algeria, Tunisia, Libya, and Egypt. On the southern side of the Sahara the presence of *G. leptoceros* is reported from around the Air massif in northern Niger and north of Tibesti in Chad, but there are no confirmed specimens or photos. In Tanoust (1930) considered that the species did not occur in French West Africa or French Equatorial Africa. The possibility of confusion with very pale individuals of Dorcas Gazelle cannot be excluded.

Numbers have been reduced by excessive, uncontrolled hunting and the species has disappeared from several areas, including most of the eastern part of the range. In the last 20 years, *G. leptoceros* 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.

POPULATION

Large numbers were reported by several authors at the end of the 19th and beginning of the 20th centuries, at least in the Great Ergs of Algeria and Tunisia (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”. 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 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 alone there are probably more than 250 (A. Fellous, *in litt.*) which may indicate a higher population overall.

STATUS BY COUNTRY

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 & Rzebik-Kowalska 1991). Heim de Balsac (1936) said that in years of drought gazelles from the Great Western Erg may move north as far as the Saharan Atlas. In 2004, some individuals were observed in the El Khala depression south of Taghit during a mission to classify the Taghit-Guir protected area. 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, identified a small breeding population (IUCN SSC Antelope Specialist Group and RZSS 2020).

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 and 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. On a survey between Oued Es Segguer and Oued Zeghoun no animals 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. 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.

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 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 recorded 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 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).

Chad

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

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 Faiyoun 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).

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 2011-2016 (O. Attum, pers. comm.). There are also a few records in 1997-2005 from the area around Farfara Oasis. Recent fieldwork in Siwa, Shiyata, and Gerba found no sign of presence and local rangers suggest that the more southerly oases in the Western Desert have more potential (H. Elalqamy *in litt.* December 2019).

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, 1954) listed a few localities in Fezzan and said it was very rare in Edri, Wadi Sciati, Wadi Bergiug and in the desert of Murzuq 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.

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.*).

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 (Khatabi & 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.

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).

Niger

Described as very rare and seen occasionally in the desert around the Aïr Massif (Grettenberger & Newby 1990). There are no recent sightings from the country (T. Rabeil pers. comm. 2019) and there is no confirmed evidence of former presence.

Sudan

There are no confirmed records. 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 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.

Tunisia

Slender-horned Gazelle formerly occurred across the desert zone south of the Chott el Jerid (Schomber and Kock 1961; Smith *et al.* 2001). It is 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 National Park 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). 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 quad bikes, motorbikes, and all-terrain vehicles, especially in the desert around Douz (A. Jebali, in litt. 2019).

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 National Park (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 National Park (2,804 km²) was established in 2010 and lies at the southern end of the Erg. Jbil National Park 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 National Park 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). In October 2019, no gazelles were observed during three days of aerial monitoring in the far south of Tunisia, though tracks of ungulates were seen at two sites and information collected on the ground confirmed the presence of individuals or a small group of gazelles. Locals report a strong decrease in numbers over the previous eight years. Observations are now very rare. 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 National Park and including Jbil National Park. Recent air and ground surveys have been conducted in the Great Eastern Erg (Meliane et al. 2023).

THREATS

The primary cause of the decline is excessive, uncontrolled illegal hunting (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 (IUCN/SSC Antelope Specialist Group 2020) and such sites are still active. These photos feature up to 20 dead gazelles displayed on a single vehicle on several occasions). 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, videos were posted online showing hunting, including a group of six individuals. A widespread issue is weak enforcement 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.

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. The risk from poaching to these animals which tolerate the presence of people has not yet been assessed.

The remaining populations of *G. leptoceros* are small and isolated. The 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 also inherently more vulnerable to stochastic risks.

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.

CONSERVATION MEASURES

International designations

CMS: Listed on Appendix I

CITES: Listed on Appendix I

IUCN Red List: Endangered

Legal status

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

Protected areas

There are several protected areas within the former and current range in Algeria, Egypt, and Tunisia. Slender-horned Gazelle currently occurs in Jbil National Park, which was designated especially for the conservation of the species and Senghar-Jabbes National Park in Tunisia. In Algeria, the species may also occur in Taghit-Guir National Park, Touat-Gourara Tidikelt Cultural Park and possibly Tindouf Cultural Park, especially the ergs in its northern and eastern parts (presence to be confirmed) and in Egypt in Qattara Depression reserve.

Planning

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 conservation strategy 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. The covid pandemic prevented a physical workshop, so the planning process was finalised through online and email discussions with a government and other stakeholders (IUCN/SSC Antelope Specialist Group 2020).

Ex situ

The global *ex situ* population is very small, especially in comparison to other Sahelo-Saharan antelopes, currently totalling 124 animals (59 inside the region and 65 outside).

In Algeria, the Brezina Gazelle Breeding Centre near El Bayadh was built in 2000 and now covers 120 ha. There were 37 (10.27) Slender-horned Gazelles in 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).

In Tunisia, a captive group is maintained at Sidi Toui National Park in south-east Tunisia. It was established in 1993 and covers 6135 ha. The captive Slender-horned Gazelle population is descended from a single wild male (found as a calf in 1997 and confiscated). Two captive born females donated by Planckedael Zoo were transported to Sidi Toui National Park to establish a breeding group in spring 1999 (Direction Générale des Forêts 2001; Molcanova *et al.* 2001). Numbers increased to 22 in April 2020, including 8 young born in spring (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 took place in Tlemcen, Algeria, organized by the Direction General of Forests, Algeria (DGF) and the IUCN Centre for Mediterranean Cooperation, (IUCN, DGF Algeria, EEZA-CSIC, Barcelona Zoo, & Marwell Wildlife 2018). The aim of the workshop was to transfer scientific and technical knowledge on captive management of threatened gazelles in North Africa. 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.

LOGICAL FRAMEWORK

Slender-horned Gazelle *Gazella leptoceros* Planning Logframe 2020-2029

Objective	Action	Indicator	Implementation
1. Current status in the wild is established	11. Conduct feasibility study on aerial surveys of Great Western Erg and Great Eastern Erg (Algeria)	Study reports completed	DGF (agency responsible), ANN
	12. Conduct ground surveys in the Great Western Erg and Great Eastern Erg (Algeria)	Survey reports completed	DGF (agency responsible), ANN
	13. Carry out interview surveys with local communities in Erg Erraoui, Erg Cherch, Erg Iguidi, Region of Tadmait, Erg Issaouene (Algeria)	Surveys completed	DGF (agency responsible), ANN
	14. Conduct aerial survey of Great Eastern Erg (Tunisia)	Survey reports completed	DGF, Marwell Wildlife
	15. Conduct ground surveys in the Great Eastern Erg (Tunisia)	Surveys completed	DGF, Marwell Wildlife
	16. Conduct questionnaire and field surveys in Egypt	Surveys completed	Government agency, Nature Conservation Egypt (NGO)
	17. Collate reports of SHG in Libya and conduct questionnaire and field surveys where feasible	Information available Survey results available	Government agency, Alhaya organisation
	18. Collate historic reports of SHG in Sudan	Information available	Government agency, NGOs
	19. Collate reports of SHG in countries south of the Sahara	Information available	Government agencies, NGOs
	110. Monitor poaching reports on social media with the support of anonymous volunteers	Monitoring in place with regular reports coordinated with the roadmap	
	111. Carry out a study to characterise poaching through enquiries on the ground and administration archives	Report available	Proposed by TWCS to the DGF (Tunisia)
	112. Develop standardized survey and monitoring methods	Methods developed and in use	All
	113. Develop an identification card (SHG and dorcas gazelle) Arabic/ French/English	ID card produced and available online	ASG, IUCN-Mediterranean
	114. Maintain an updated status summary	Running update maintained	ASG, Living Desert
	115. Establish a central database and national databases to store records	Databases set up	Government agencies
	116. 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

CUVIER'S GAZELLE - *GAZELLA CUVIERI* (OGILBY, 1841)

COMMON NAMES

Arabic and Amazigh: Edmi, Ledm ou Edem; Dama (eastern Morocco), Harmouch; Ed Ddami, (Rguibat), Aharmouch (Amazirh, south-west Morocco) Amlal or Asguin (south-east Morocco), Harmush (Atlantic Sahara)

English: Cuvier's Gazelle, Edmi Gazelle, Edmi, Atlas Gazelle.

French: Corinne, Kevel, Gazelle de Cuvier, Gazelle de l'Atlas, Gazelle de Montagne.

Spanish: Gacela de Cuvier

TAXONOMY

The genus *Gazella* includes some close phylogenetic relationships. *Gazella cuvieri* and *G. leptoceros* share morphological and physiological characters, but the first species is darker and is found in mountain areas, while the second is lighter in colour and is associated with sand dunes. Phylogenetic analyses based on mitochondrial and nuclear genes show that the two taxa form a single monophyletic group. The absence of genetic differentiation found between these taxa indicates that they should be grouped in *G. cuvieri*, while the ecological and morphological differences suggest that the latter correspond to distinct ecotypes. Conservation planning for *G. cuvieri* should consider the preservation of mountain and wetland ecotypes to maintain the overall adaptive potential of both forms (Silva et al. 2016).

HABITAT AND ECOLOGY

Cuvier's Gazelle inhabits open semi-arid Mediterranean forests with *Pinus halepensis* and *Juniperus phoenicea*, *Quercus ilex* and *Q. suber*, maquis, and grassy steppes. In the north-west Saharan ranges of Morocco and Algeria the species also occurs in arid mountains and desert hamada (Beudels et al. 2013). The species has been recorded up to 3,300 m (Beudels et al. 2013) but it avoids areas with heavy snow. In the Tiaret region of Algeria, Cuvier's Gazelles graze in cereal fields (Bounaceur et al. 2015).

MIGRATIONS

The populations on the Morocco-Algeria and Algeria-Tunisia border areas are transboundary.

CURRENT DISTRIBUTION AND STATUS

Endemic to mountains and hills of the Atlas and adjacent ranges of north-west Africa from Morocco to Tunisia (Figure 6). Overhunting and habitat degradation have reduced the former range and led to fragmented populations. Up to 66% of the original range has been lost (Durant et al. 20014). Beudels-Jamar et al. (2005) mapped 48 sites occupied by the species.

POPULATION

Figures reported at the strategy workshop in Agadir, October 2015, suggested a total population of 2,360-4,560, made up of: Morocco - 1,600-3,800 including possibly 1,000-2,200 in the western Anti-Atlas; Algeria - 560 (based on De Smet 1991); Tunisia <100 (IUCN 2015). Updated population estimates from Algeria are urgently needed. Total numbers *ex situ* are 170. The wild population in Morocco is now estimated at around 4000 (Amhaouch 2020). In 'IAydar, in the north-east of Smara, there are estimates of 935 (597-1,607) individuals (Gil-Sánchez et al. 2017).

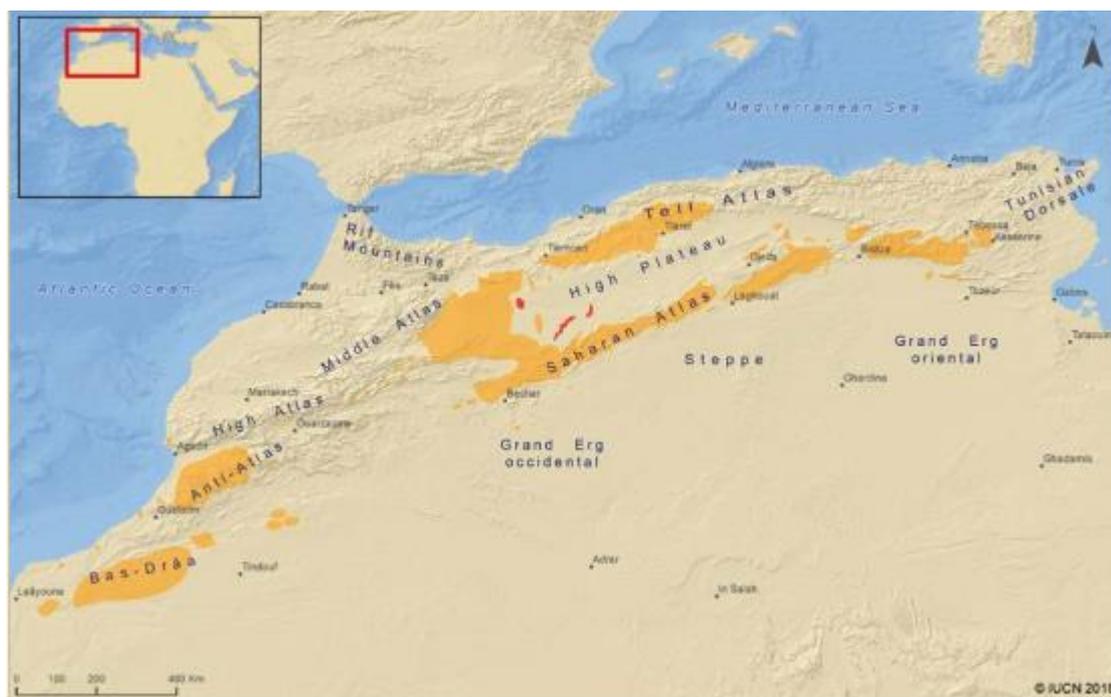


Figure 6. *Gazella cuvieri*, current distribution. (Map: IUCN 2018).

STATUS BY COUNTRY

Algeria

The distribution is limited to the northern part of the country. It is no longer found either north of the Tell Atlas or to the south of the Saharan Atlas (De Smet and Smith 2001). The populations of the western Tell Atlas, Batna-Biskra, and the Aurès mountains are no longer contiguous, and some groups in the Saharan Atlas were recently extirpated. The most recent information indicates that some of these populations are growing. The most easterly populations are found in the Aurès, the Némentcha mountains, and the hills near the Tunisian border (Beudels-Jamar *et al.* 2006).

Morocco

Populations are highly fragmented, but recent reports indicate relatively substantial populations in the western Anti-Atlas, south to the Tindouf Hamada and Aydar (Beudels-Jamar *et al.* 2005, Herrera-Sanchez *et al.* 2015; Amhaouch 2020).

Tunisia

Numbers and distribution declined steeply due to overhunting by the 1970s, but the population then began to increase as a consequence of effective conservation measures in and around Chambi National Park (Kacem *et al.* 1994). However, insecurity and forest fires since 2013 have severely affected this site (IUCN 2015). Cuvier's Gazelle was reintroduced to Jebel Serj National Park in 2016 (Moreno *et al.* 2016, 2020).

THREATS

The major threats to the species are overhunting and habitat degradation, mainly due to the transformation of forests into cropland and pastures for livestock, and wood cutting for charcoal (Cuzin 2003, Beudels-Jamar *et al.* 2005). Predation by dogs on young gazelles at least is also a threat, and dogs foiled an attempt to reintroduce Cuvier's Gazelle into Souss-Massa National Park in Morocco (Loggers *et al.* 1992).

CONSERVATION MEASURES

International designations

CMS: Listed on Appendix I

CITES: Listed on Appendix I

IUCN Red List: Vulnerable

Planning

A conservation workshop was held in Tunis in 2016 and a strategy developed for 2017-2026 (IUCN 2018). There are national strategies to restore the species in Tunisia (DGF 2001) and Morocco (Cuzin et al. 2007).

Protected areas

Important protected areas across the range include Saharan Atlas National Park, Belezma National Park and Mergueb N.R. (Algeria), and Djebel Chambi National Park (Tunisia). Djebel Chambi is of key importance for the recolonisation of the Dorsale range.

Ex situ

A captive population, originating from animals in Morocco, is maintained in Almeria, Spain (Abáigar and Cano 2005).

Reintroduction

A project to reintroduce Cuvier's Gazelle to Jebel Serj National Park, Tunisia, began in October 2016. Numbers had grown to 80 by the end of 2019 (Moreno et al. 2020).

In Morocco a reintroduction programme is underway in the Central Plateau and the Ifrane National Park.

LOGICAL FRAMEWORK

Cuvier's Gazelle *Gazella cuvieri* Objectives and actions (from IUCN 2017)

Regional Objectives

Intervention strategy: International cooperation

Objective R1: Coordinate the Action Plan

R.1.1. Establish a mailing list of all stakeholders	List established	Government agencies, NGO, IUCN-Med, CMS
R.1.2. Create a database on Cuvier's gazelle	Database created and available	
R.1.3. Identify a focal point in each range country	3 focal points identified	Government agencies
R.1.4. Assess at regular intervals (2-3 years) if the indicators have been achieved	Report produced	CMS, others
R.1.5. Distribute the results of actions taken to all stakeholders	List established and implemented (R1.1)	All
R.1.6. Standardise monitoring methods	Pilot actions, training courses	Government agencies

Intervention strategy: Reinforce capacity

Objective R2 Reinforce capacity

R.2.1. Organise courses on census and monitoring methods (« distance sampling », camera traps, tracks, genetic ID)	Courses organised Monitoring teams trained in each country Standardised monitoring methodology put into effect	Governments, SC, NGO, universities
R.2.2. Organise courses on habitat management	Regional training organised	

Intervention strategy: Management in captivity

Objectif : R3 Develop a coordinated captive breeding programme

R3.1. Develop guidelines on captive breeding	Guidelines developed and published	EAZA-CSIC
R3.2. Translate guidelines into French	French translation circulated	IUCN Med
R3.3. Strengthen capacity in captive management (husbandry, handling, demography, genetics)	Training courses organised Team trained in each site with Cuvier's Gazelle	EAZA-CSIC, Government agencies

R3.4. Complete the genetic analysis of Cuvier's Gazelle	Study completed, results published	Research institutes Spanish National Research Council (CSIC) Government agencies, NGO
R3.5. Ensure that reinforcement and reintroduction projects follow the IUCN guidelines	Projects planned according to IUCN (2013)	
R3.6 Investigate the possibility of exchange of animals to Almeria through EAZA	Feasibility report published	EAZA-CSIC, Government agencies

Objectives and Actions: Morocco

Intervention strategy: Protection and restoration of populations

Objective 1: Anti-poaching

Actions	Indicators	Implementation	Urgency
1.1. Reinforce the system of surveillance (humans and material resources).	Cadre trained and equipped in each key site	ANEF	
1.2. Put in place surveillance systems dedicated to wild fauna	Structures in place Monitoring programme	ANEF	
1.3. Consolidate coordination between different authorities to control and prevent.	Liaison committee established	ANEF, government agencies	

Objective 2: Control stray dogs

2.1. Organise programmes to shoot stray dogs (regularly)	Decrease in number of stray dogs in key sites		
2.2. Prevent rubbish disposal in key sites	Decrease in rubbish Decrease in stray dogs at key sites		

Intervention strategy: Protection and management of habitats

Objective 3: Protect and restore Cuvier's Gazelle habitat

3.1. Integrate key sites into the Protected Area system	Gaps in the PA network analysed Potential reserves identified	ANEF	
3.2. Restore degraded habitats to favour Cuvier's Gazelle	Improved habitats in key sites	ANEF, Ministère de l'Agriculture	

Intervention strategy: Awareness

Objective 4: Reinforce awareness programmes

4.1. Develop materials to support awareness	Materials developed	
4.2. Organise meetings with hunters	Meetings organised Dialogue established	ANEF Hunting federation
4.3. Organise meetings with local actors	Meetings organised Local organisations involved in conservation	ANEF Local organisations NGO,
4.4. Organise regional and national media campaigns	Articles published or broadcast (press, TV, radio)	

Intervention strategy: Research and monitoring

Objective 5: Conduct research and monitoring activities

5.1. Study space use and movements.	Study conducted Results published	Universities, researchers
5.2. Study the diet of Cuvier's Gazelle in the Anti-Atlas	Study conducted Results published	Universities, researchers
5.3. Implement a data collection system	Database developed Monitoring system established	Universities, researchers
5.4. Implement a population monitoring system	Monitoring methodology adopted Teams trained	Universities, researchers, ANEF

Objectives and Actions: Algeria

Intervention strategy: Protection and restoration of populations

Objective 1 : Reduce direct mortality

1.1. Train staff	Teams trained in all key sites Direct mortality reduced
1.2. Ensure rigorous application of the law	Poachers prosecuted Direct mortality reduced
1.3. Implement an anti-poaching strategy	Strategy in place Direct mortality reduced
1.4. Involve hunting federations in anti-poaching	Meetings organised Dialogue established Direct mortality reduced
1.5. Involve civil society in anti-poaching	Awareness programme Co-management committee

1.6. Put in place a strategy to control stray dogs
 Direct mortality reduced
 Decrease in stray dogs in key sites

Intervention strategy: Protection and management of habitats

Objective 2 : Protect and manage the habitat

2.1. Establish protected areas in key sites Gaps in the PA network analysed
 Potential reserves identified

2.2. Create ecological corridors Corridors identified and mapped
 Management measures developed

2.3. Conduct rigorous impact assessments Impact assessments conducted according to international standards

Intervention strategy: Awareness

Objective 3 : Reinforce awareness programmes

3.1. Launch awareness campaigns (media, local communities) Articles published or broadcast (press, TV, radio)
 Meetings organised
 Local organisations involved in conservation

3.2. Develop a programme of environmental education Meetings organised
 Local organisations involved in conservation

3.3. Organise awareness days on wild fauna Meetings organised
 Local organisations involved in conservation

Intervention strategy: Research and monitoring

Objective 4: Conduct a programme of research and monitoring

4.1. Basic research: population dynamics Study conducted
 Results published

4.2. Applied research: carrying capacity Study conducted
 Results published

Objectives and Actions: Tunisia

Intervention strategy: Protection and restoration of populations

Objectif 1. Reduce direct mortality

1.1. Reduce poaching to a minimum	Increase in the Cuvier's Gazelle population Decrease in signs of poaching Direct mortality reduced	DGF and <i>Commissariat Régional au Développement Agricole</i> (Regional Commission for Agricultural Development – CRDA) ONG
1.2. Rigorous application of the law	Prosecutions conducted Decrease in number of cases	Garde Nationale, courts, Local and national authorities

Objectif 2 : Launch a reintroduction programme

2.1. Develop a captive breeding programme	Programme developed et implemented Increase in the captive population	DGF, CSIC (Almeria)	MoU signed April 2015
2.2. Identifier the optimal sites for reintroduction	Sites assessed	DGF	
	Gazelles transferred	DGF, CSIC	Transfer from Almeria to Serj National Park, October 2016
	Gazelles released in national parks	DGF, CSIC	

Intervention strategy: Protection and management of habitats

Objective 3: Protect and restore the habitat

3.1. Improve and strengthen wardening	Teams trained in all key sites Direct mortality reduced	DGF and CRDA ONG, national authorities
3.2. Coordinate habitat management and planning	Improvement in habitats in key sites	
3.3. Monitor forest fires and wood cutting	Increase in area of forest	
3.4. Protect and restore the alfa steppe	Increase in area of alfa steppe	

Objectif 4 : Ensure habitat connectivity

4.1. Conduct studies on potential corridors	Corridors identified and mapped	
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Intervention strategy: Awareness

Objectif 5 : Strengthen awareness raising programmes

5.1. Launch awareness campaigns among: schools, media, local communities, journalists	Public are more supportive of nature Increase in volunteering Articles published or broadcast (press, TV, radio)
5.2. Launch awareness campaigns among: Police, Army, hunters, administrative authorities	Meetings organised Leaders trained
5.3. Develop brochures, conferences, information days, postcards, social networks, films	Materials developed

Intervention strategy: Research and monitoring

Objectif 6 : Conduct a programme of research and monitoring

6.1. Determine the current status of the relict population of Cuvier's gazelle	Programme of study developed Population estimates	
6.2. Assess the response of the habitat to the needs of the reintroduced populations	Studies conducted Management plans adapted	
6.3. Monitor the adaptation of the reintroduced populations (diet, diseases, behaviour)	Studies conducted Management adapted	DGF, NGO, Universities
6.4. Organise courses for managers, researchers, wardens, eco-guards	Programme de training courses organised	IUCN, national and international specialists
6.5. Reinforce human capacity: increase numbers of personnel	Numbers increased in key sites	DGF
6.6. Reinforce equipment and methods of monitoring	Adequate equipment in key sites	DGF, NGO
6.7. Put in place a monitoring and evaluation programme	System in place Regular monitoring implemented	

DORCAS GAZELLE - *GAZELLA DORCAS* (LINNAEUS, 1758)

TAXONOMY

Six subspecies have been described:

Gazella dorcas dorcas (North Africa and parts of the Sahara)

Gazella dorcas isabella (includes *G. d. littoralis*) (East of the River Nile, Israel, and Jordan)

Gazella dorcas massaesyala (NW Africa)

Gazella dorcas osiris (includes *G. d. neglecta*) (Sahel and parts of the Sahara)

Gazella dorcas pelzelni (Horn of Africa)

These forms are based on morphological differences only, none of these named subspecies seems isolated, and the geographical boundaries between several forms are very unclear. A genetic analysis using mitochondrial DNA found no clear-cut geographic pattern or genetic structure and raises doubt about the validity of the proposed subspecies (Lerp *et al.* 2011). IUCN does not currently recognize any subspecies due to the uncertainty over their validity.

COMMON NAMES

Arabic: Ghazel, Rhazal, Afri, Al Hamra

English: Dorcas Gazelle

French: Gazelle dorcas

HABITAT AND ECOLOGY

Dorcas Gazelle is an adaptable species, inhabiting a wide range of arid and semi-arid habitats, but avoiding extensive areas of dunes and hyperarid areas (Lafontaine *et al.* 2005; Scholte and Hashim 2013). In Tunisia it prefers sparsely vegetated rocky plains (Cooke *et al.* 2018).

MIGRATIONS

In some places the species makes seasonal movements to exploit localised areas with high-quality forage (Dragesco-Joffé 1993, East 1999). Many populations are transboundary.

CURRENT DISTRIBUTION AND STATUS

Dorcas Gazelle formerly occurred over the entire Sahelo-Saharan region from the Atlantic coast in the west across to the Red Sea. Its range extends to the south-east into the Horn of Africa (Ethiopia, Eritrea, Djibouti, north coast of Somalia in the south-east) and north-east into southern Israel and Jordan (Beudels-Jamar *et al.* 2005; Scholte and Hashim 2013; Durant *et al.* 2014). It is estimated to have lost an estimated 86% of its range (Durant *et al.* 2014). Remaining populations are scattered across the Sahara-Sahel but sometimes in good numbers such as in Chad, Niger and Morocco. Scattered populations are widely present, including on and around the Adrar Souttoug (Cuzin 1996, 2003; Aulagnier *et al.* 2001). This species seems to have withstood the threats and pressures better than the other SSMF species.

POPULATION

East 1999 estimated 35-40,000 in sub-Saharan Africa and 'tens of thousands' globally. Lafontaine *et al.* (2005) reported recent declines in almost all range states and said it had disappeared from many regions and is seriously reduced in numbers where it survives. A population of 1,000-2,000 was in rapid decline in Egypt, and mostly outside protected areas (Saleh 2001). There are no recent estimates for Algeria, Tunisia, or Libya, although the population in each country is unlikely to exceed 1,000 individuals (Scholte and Hashim 2013). In Morocco, the wild population was estimated at 800-2,000 individuals (Cuzin *et al.* 2007). The largest current populations are in Chad (especially in the Ouadi Rimé-Ouadi Achim Faunal Reserve), Niger (Air-Ténéré National Nature Reserve and the Termit Massif-Tin Toumma), and in the Horn of Africa (Scholte and Hashim 2013, and references therein). The population estimate for Ouadi Rimé-Ouadi Achim Faunal Reserve in September 2022 was ca. 20,000 (Wacher *et al.* 2022). Therefore, the total population may be at least 50,000.

STATUS BY COUNTRY

Algeria

Occurs across most of the Algerian Sahara, north to the Saharan Atlas, with a small number possibly present on the Hauts Plateaux (Kowalski and Rzebik-Kowalska 1991; De Smet and Smith 2001). There are no estimates of population size.

Burkina Faso

Formerly occurred in the small area of the north, and a small number may still occur in the Seno-Manga Biosphere Reserve (Heringa et al. 1990, Scholte and Hashim 2013). There are no estimates of population size.

Chad

Widely distributed across the northern half of the country except for rocky massifs and some localities where it has been extirpated by hunting (Thomassey and Newby 1990). It is still present in many localities and remains relatively numerous in Ouadi Rimé-Ouadi Achim Faunal Reserve where ca. 20,000 were estimated in September 2022 (Wacher et al. 2022).

Egypt

The range is now highly fragmented. Scattered populations are found in the Western Desert (Qattara Depression, Siwa, around Lake Nassir), Gilf el Kebir Plateau, and the southern part of the Eastern Desert (Saleh, 2001; Elalqamy and Baha El Din 2006). Saleh (2001) estimated 1000-2000, mainly outside protected areas and rapidly declining.

Ethiopia

Restricted to the desert and semidesert areas of the Awash Valley and Afar region of the north-east (Yalden et al. 1984; Bekele and Yalden 2013). There are no estimates of population size.

Eritrea

Quite widely distributed, in the north and northwest and along the Danakil south to the border with Djibouti (Yalden et al. 1984; Bekele and Yalden 2013). There are no estimates of population size.

Libya

Presumed to have been formerly widespread across the country but now greatly reduced in range in numbers (Khattabi and Mallon 2001; Scholte and Hashim 2013). There is very little recent information.

Mali

Locally common and probably still widespread across the north of the country, and present in small numbers in Ansongo-Menaka Reserve and the Elephant Reserve (Heringa 1990). Its range in Mali is subject to high levels of insecurity and there is no recent information. The population was estimated at 2500-3000 by East (1999).

Mauritania

The species has been largely extirpated except for some remote areas (Sounia and Verschuren 1990). Small populations are found in Banc d'Arguin National Park and on Tidra island (Lamarque 2006).

Dorcas Gazelle was assessed as Vulnerable on the national Red List (Brito et al. 2022).

Morocco

There is only one remaining population north-west of the Atlas mountains, in M'Sabih Talaa Reserve and which is assigned to *G. d. massaesyla* (Cuzin 1996). Scattered populations occur

widely to the east and south of the Atlas including along the Oued Draa valley (Cuzin 1996, 2003; Aulagnier et al. 2001). The estimated population was 800-2000 (Cuzin et al. 2007). About 4725 animals are kept in 16 enclosures (Amhaouch 2020) Around 100 Dorcas Gazelles have been released in Mhamid El Ghizlaine in the south-east.

Niger

Still widespread in the drier northern part of the country, and locally common in a few places such as Termit National Nature Reserve and Air and Ténéré National Nature Reserve (estimated population size 4800-6400) (Grettenberger and Newby 1990). A survey of the Termit Massif estimated the population of Dorcas Gazelles at 3,000 (Wacher et al. 2008).

Nigeria

Formerly occurred in the Lake Chad Basin in the north-east (Anadu and Green 1990) but is now probably extinct (Scholte and Hashim 2013).

Senegal

Recorded as an occasional visitor to the north in the dry season but became extinct (Sournia and Dupuy 1990; East 1999). In 1974, 15 Dorcas Gazelles from Mauritania were reintroduced to Djoudj National Park Their numbers increased to about 60 then declined as water levels rose following construction of the Diama dam reduced the area of habitat (Sournia and Dupuy 1990). Dorcas Gazelle has also been released in enclosures in Guembeul Reserve and Ferlo Nord Reserve (Abaigar et al. 2008). The current population size is unknown.

Sudan

Dorcas Gazelles occur in the northern deserts and the Red Sea Hills but the distribution is not known in detail (Hillman and Fryxell 1988). No recent field surveys in this area have been reported.

Tunisia

Dorcas Gazelles had mostly disappeared from northern Tunisia by the 1960s and are now restricted to the southern half of the country (Smith et al. 2001; Scholte and Hashim 2013).

Outside the SSMF region

Dorcas Gazelles occur widely in Djibouti (Laurent and Laurent 1990), the north coast of Somalia (Scholte and Hashim 2013), and southern Israel (Clark and Frankenberg 2001).

THREATS

Motorized hunting has had a major impact on Dorcas Gazelle populations aggravated by drought, as well as habitat loss and degradation due to expanding agriculture, and overgrazing by sheep and goats (East 1999, Mallon and Kingswood 2001, Lafontaine et al. 2006; Scholte and Hashim 2013).

CONSERVATION MEASURES

International designations

CMS: Listed on Appendix I

CITES: Appendix III (Algeria, Tunisia)

IUCN Red List: Vulnerable

Planning

There are national strategies to restore the species in Tunisia (DGF 2001) and Morocco (Cuzin et al. 2007).

Protected areas

Dorcas Gazelle occurs in many protected areas throughout their range, including: M'Sabih Talâa Reserve (Morocco); Tassili and Ahaggar National Parks (Algeria); Bou-Hedma, Sidi Toui, Dghoumes, Oued Dekouk and Djebil National Parks (Tunisia); Elba National Park and Saint Catherine Protectorate (Egypt); Banc d'Arguin National Park (Mauritania); Ouadi Rimé-Ouadi Achim Reserve (Chad); Termit Tin Toumma National Nature Reserve (Niger) (Scholte and Hashim 2013). The species occurs several smaller protected areas in Morocco, but the populations in (M'Sabih Talâa Reserve and El Kheng Reserve) may be particularly valuable as they are known to be of local origin.

Ex situ

Dorcas Gazelle are held in several privately owned, captive collections in the Middle East, Mostly originating from Egypt, the Horn of Africa, and Sudan (Scholte and Hashim 2013). There are about 550 in zoos outside the region and 4725 in breeding enclosures in Morocco (Amhaouch 2020).

LOGICAL FRAMEWORK

Objective / Action	Indicator	Urgency	Implementation
Objective 1. Known populations are protected effectively			
1.1. Enhance anti-poaching	Patrol schedules agreed and funded Reduction in poaching incidents		
1.1.1. Strengthen capacity of government agencies	Training sessions for rangers Sufficient vehicles and motorcycles available		All
1.2. Identify key sites and corridors	Map of key sites and corridors produced		All
1.3. Develop or update management plans for all key sites	Management plans produced/updated		Government agencies
Objective 2. Status in the wild is established			
2.1. Conduct air and ground surveys	Surveys completed		
2.2. Enhance regional capacity for survey and monitoring	Capacity needs assessment conducted Training workshops held Trained teams present in all range countries		
Objective 3. Dorcas Gazelles reintroduced into parts of former range			
3.1. Implement the reintroduction programme in Morocco			
3.1.2. Minimise effects of tourist disturbance on Dorcas Gazelle	Dune-driving exclusion zones designated Tourism operators engaged Awareness programmes developed		BEF, Tourism operators
3.2. Conduct feasibility studies on other reintroductions	- Studies completed - Potential release sites identified	L	All
Objective 4. Genetic diversity is assessed			
4.1. Continue genetic and genomic research	Analyses conducted Genetic diversity assessed		University of Porto, RZSS, SCBI, partners
4.1.1. Confirm status of <i>G. d. massaelya</i>	Analysis completed		DGF (Morocco), RZSS, University of Porto, SCBI, partners
4.1.2. Assess phylogenetic structure	Conservation units identified		University of Porto, RZSS, SCBI, partners

Objective / Action	Indicator	Urgency	Implementation
Objective 5. Management of <i>Ex situ</i> Dorcas Gazelle populations is optimised to support <i>in situ</i> conservation			
5.1. Maintain and expand coordinated breeding programmes	- Increased number of participating institutions		AZA, EAZA, EEZA,
5.2. Integrated <i>in situ</i> and <i>ex situ</i> management under a 'One Plan Approach'	Integrated plan produced		All
5.3. Maintain the <i>ex situ</i> populations in Morocco as a regional source for reintroductions	Breeding continues		BEF
5.4. Improve integration of molecular genetic data into population viability modelling and management strategies	Results incorporated		RZSS, SCBI, Ex situ managers
Objective 6. The Roadmap objectives are implemented effectively			
6.1. Establish a roadmap coordination mechanism			
6.2. Review progress at regular intervals	Progress reviews conducted regularly (2.5, 5, 7.5 years)		CMS, Government agencies, IUCN, NGOs, all
6.3. Provide adequate resources and capacity to implement the roadmap	- Resources and capacity provided Training sessions held - Projects operate effectively		All
6.4. Maintain communication between all stakeholders	- Information exchange mechanism established Regular reports circulated		CMS focal points, IUCN/SSC ASG, NGOs

RED-FRONTED GAZELLE - *EUDORCAS RUFIFRONS* (GRAY, 1846)**TAXONOMY**

Red Fronted-Gazelle *E. rufifrons* has been subject to several different taxonomic arrangements. It is sometimes treated as conspecific with Thomson's Gazelle (*Eudorcas thomsonii*) and Mongalla Gazelle (*E. albonotata*) and *E. tilonura* is either considered a subspecies of *E. rufifrons* or as a full species (Gentry 1972, Kingdon 1997, East 1999). Grubb (2005) recognised one species from the Atlantic to the Red Sea: (*E. rufifrons* including subspecies *rufifrons*, *albonotata*, and *tilonura*). This arrangement has been adopted by CMS. In the *Mammals of Africa*, Groves (2013) provisionally recognized these subspecies as three species: Red-fronted Gazelle (*E. rufifrons*) (from Senegal to Sudan, west of the White Nile), Mongalla Gazelle (*E. albonotata*) (South Sudan), and Heuglin's Gazelle (*E. tilonura*) (east of the Blue Nile). IUCN follows Groves (2013) and assesses the three taxa separately on the Red List. Clarification of the relationships among all taxa in the genus *Eudorcas* through genetic research is urgently needed.

COMMON NAMES

English: Red-fronted gazelle

French: Gazelle à front roux

German: Rotstirngazelle

HABITAT AND ECOLOGY

Formerly this species was widespread in Sahelian grassland, light woodland, and shrubland. It is known to occupy fallow agricultural land if sufficient cover is available (Scholte and Hashim 2013). *E. r. tilonura* inhabits dry grassland, and thorn bushland up to 1,400 m (Yalden et al. 1996). *E.r. albonotata* prefers open floodplain and savanna grasslands where it follows an annual migratory cycle over the eastern Sudd floodplains (Hillman and Fryxell 1988, East 1999; Hashim and Kingdon 2013).

MIGRATIONS

E. r. rufifrons may make some seasonal movements north in the wet season and south in the dry in Chad and Sudan but these are increasingly limited by human settlement (Scholte and Hashim 2013). *E. r. albonotata* undertakes seasonal movements in the Sudd floodplains following the separate migrations of Tiang (*Damaliscus lunatus tiang*) or White-eared Kob (*Kobus kob leucotis*) and it may depend on these two species to reduce the cover of coarse vegetation (Hashim and Kingdon 2013).

E. r. tilonura has not been reported to undertake regular migrations. Several populations are transboundary.

CURRENT DISTRIBUTION AND STATUS

Formerly occurred throughout dry Sahelian grasslands and bushlands from southern Mauritania and northern Senegal to the Nile (*E. r. rufifrons*), on eastern side of the Blue Nile (*E. r. tilonura*) and south into the Sudd floodplains (*E. r. albonotata*). It has now been reduced to scattered, localised patches, except for *E. r. albonotata* which retains a large migratory population in South Sudan (East 1999, Hashim, 2013; Hashim and Kingdon 2013; Scholte and Hashim 2013). Very few field studies have been conducted on this species. *E. r. tilonura* ranges east of the Nile between the southern part of the Red Sea Hills in Sudan and the southern foothills of the Ethiopian massif in western Eritrea and north-western Ethiopia (East 1999, Hashim 2013). Currently it is believed to remain present in much of its historical range but in localized patches (Hashim 2013).

POPULATION

E. r. rufifrons: Estimates of population size are based mainly on informed guesses. East (1999) produced an estimated total population of about 21,000, including ca. 4000 in Niger and ca. 3000 in Mali, but numbers in both these countries are now considered to be far lower. Numbers in Sudan have been greatly depleted (I.M. Hashim, in litt. To ASG 2016) and population trends throughout the range are almost universally downwards. The total population is estimated to number approximately 12,000 (IUCN SSC Antelope SG 2017).

E. r. albonotata: An aerial survey in 2007 carried out by the Wildlife Conservation Society produced a population estimate for part of South Sudan of 278,000 (Fay et al. 2007). Ongoing conflict may have reduced the numbers, perhaps significantly, but no censuses have been carried out since 2007.

E. r. tilonura: East (1999) produced a rough estimate of 3500-4000 Heuglin's Gazelles, with a declining trend in Eritrea, stable or declining in Ethiopia, and unknown trend in Sudan. Since then, the species has been reduced to small, fragmented populations throughout its range and it is declining in Sudan (Hashim 2013). According to East (1999) it was present in 'fair numbers' in parts of Eritrea such as Gash-Setit, but its numbers in the country have been greatly depleted and it may number no more than the low hundreds (H. Yohannes, Eritrean Forestry and Wildlife Authority, pers. comm.). Given these reported declines in most of its range since 1999, it is likely that numbers now are no more than 2500-3500 at best. Density in Dinder National Park was estimated at 1/km² (Hashim 1998).

STATUS BY COUNTRY

Burkina Faso

E. r. rufifrons Formerly widespread but reduced to small remnant populations, e.g. in W National Park in the southeast (East 1999). There are no estimates of current population size.

Chad

E. r. rufifrons Formerly widespread and survives in several places (East 1999). It occurs in Zakouma National Park, north of Lake Chad, and in central Chad. There are no estimates of population size.

Eritrea

E. r. tilonura formerly occurred across northern and western Eritrea (Bekele and Yalden 2013) but there have been very few recent records. Populations have been severely depleted, with a few still present in the Kerkebet area and possibly also Gash-Setit in the south-west (H. Yohannes, Eritrean Forestry and Wildlife Authority, pers. comm., 2013, Mallon 2014). A preliminary survey conducted by staff of the Eritrean Forestry and Wildlife Authority in Dige Sub-Region of Gash Barka Region in July 2019 observed five groups of Eritrean Gazelle (Heuglin's gazelle) (Hagos 2019) and the species has been recorded at some additional localities in NW Eritrea (F. Hagos in litt. to ASG, 2022). There is no estimate of population size.

Ethiopia

E. r. tilonura formerly occurred across the north-west corner of Ethiopia species (Bekele and Yalden 2013). It is still present in Kafta Sheraro National Park in the north-west (Siege and Pohlstrand 2017). It was not recorded on recent surveys in Alatish National Park which lies further south and is contiguous with Dinder National Park in Sudan (Bauer et al. 2018; H. Pohlstrand, pers. comm. 2019). There is no estimate of population size.

E. r. albonotata has been recorded from the Omo region in south-west Ethiopia, but there is no recent information on its occurrence there (Hashim and Kingdon 2013).

Mali

E. r. rufifrons was formerly widespread but now scattered populations only; strongholds include the Mopti-Timbuktu-Gao region and the Ansongo-Menaka and Elephant reserves (East 1999). Little recent information. Some recent records from the Elephant reserve (S. Canney pers. comm.). There is no estimate of current population size.

Mauritania

E. r. rufifrons formerly occurred across the south of the country but has been extirpated from many localities (East 1999). The species was assessed as Endangered on the national Red List (Brito et al. 2022).

Niger

E. r. rufifrons Formerly widespread in the southern third of the country but much reduced; by 1998 it was reportedly quite common in W National Park but uncommon elsewhere (East 1999).

Nigeria

E. r. rufifrons has disappeared from most of its range in the far north (East 1999). There is no recent information on occurrence.

Senegal

E. r. rufifrons was formerly widespread in the northern Sahel zone but only small, scattered populations remain (East 1999).

South Sudan

E. r. albonotata Mongalla Gazelle inhabits the flood plains and flat savannah grasslands in South Sudan, east of the Nile. Mongalla Gazelle is present in Boma National Park, although seasonal movements cause very large fluctuations in numbers, but the large population surviving in the Jonglei region remains unprotected (Hashim and Kingdon 2013).

Sudan

E. r. rufifrons formerly occurred in a band of savanna grassland and light bush across the centre of the country east to the River Nile (Fryxell and Hillman 1988) but has been reduced to scattered remnants (East 1999). There is no recent published information on its status.

E. r. tilonura occurs in the south-east of the country, east of the Blue Nile along the border with Ethiopia (Hillman and Fryxell 1988). The only recent published report concerns a small number of animals seen and photographed in Dinder National Park (Bauer et al. 2018). Trophy hunts for the species are advertised by 1-2 companies and a YouTube video of a successful hunt in an unspecified locality was posted online in 2022.

OUTSIDE THE SSMF REGION**Cameroon**

E. r. rufifrons was formerly widespread in north and Far North provinces, but it is increasingly confined to protected areas (East 1999; Scholte and Hashim 2013). There is a small population in Waza National Park in the far north (Tumenta et al. 2022).

Ghana

E. r. rufifrons once occurred in the northern savannas but is likely to be extinct (Scholte and Hashim 2013).

Togo

E. r. rufifrons was formerly a visitor to the north in the dry season (East 1999).

Uganda

E. r. albonotata is an irregular visitor in small numbers to Kidepo Valley National Park in the north of the country, where it was photographed in 2020 (Muramura and Byaruhanga 2021).

Threats

Hunting and habitat degradation due to overgrazing, clearance of scrub, cutting of shade trees, drought, agricultural encroachment, and insecurity are the main threats (Hashim, 2013; Hashim and Kingdon 2013; Scholte and Hashim 2013). The species is targeted by poachers for their meat, skins and as pets (Scholte and Hashim 2013). An indication of former abundance is that a group of hunters with dogs and nets collected more than 1,600 skins during 3.5 months in north Cameroon (Jeannin 1936). In the Sudd ecosystem, *E. r. albonotata* is potentially vulnerable to changes to the hydrological regime from dams and water diversion projects as well as development of commercial agriculture.

CONSERVATION MEASURES

International designations

CMS: Appendix II (as *E. rufifrons*)

CITES: Not listed

IUCN Red List: Assessed as three species:

E. r. rufifrons: Vulnerable

E. r. albonotata: Least Concern

E. r. tilonura: Endangered

Protected areas

Approximately 15% of the range of this species occurred in protected areas (East 1999) The extension of effective protection and management to additional populations is urgently needed.

E. r. rufifrons occurs in W National Park, Niger; Zakouma National Park in Chad, Ferlo Nord Faunal Reserve (Senegal), and Waza National Park (Cameroon).

E. r. albonotata occurs seasonally in Boma National Park (South Sudan)

E. r. tilonura occurs in Kafta Sheraro National Park in Ethiopia, which is likely to be a stronghold, and Dinder National Park (Sudan).

Ex situ

A limited number of Red-fronted Gazelles (ca. 40) are maintained in captivity, but without formal breeding programmes. There may be hundreds of gazelles kept privately in cities such as N'Djamena that have generally been taken as young from the wild (Scholte and Hashim 2013).

LOGICAL FRAMEWORK

Red-fronted Gazelle (*Eudorcas rufifrons*) Logical framework

Objective / Action	Indicator	Urgency	Implementation
Objective 1. Known populations are effectively protected			
1.1. Enhance anti-poaching measures	Patrol schedules agreed and funded Reduction in poaching incidents		All
1.1.1. Strengthen capacity of government agencies	Training sessions for rangers Sufficient vehicles and motorcycles available		All
1.2. Identify key sites and corridors	Map of key sites and corridors produced		All
1.3. Develop or update management plans for all key sites	Management plans produced/updated		Government agencies
Objective 2. Status in the wild is established			
2.1. Conduct air, ground, and questionnaire surveys throughout the range			
2.1.1. <i>G. r. rufifrons</i>	Surveys completed Distribution maps produced Population estimates produced		Government agencies (Senegal, Mali, Mauritania, Burkina Faso, Niger, Chad, Sudan) WAC, AP,
2.1.2. <i>G. r. tilonura</i>	Surveys completed Distribution maps produced Population estimates produced		Government agencies (Eritrea, Ethiopia, Sudan)
2.1.3. <i>G. r. albonotata</i>	Aerial survey completed Distribution maps produced Population estimates produced		Government agencies (South Sudan) African Parks
2.2. Enhance regional capacity for survey and monitoring	Capacity needs assessment conducted Training workshops held Trained teams in all range countries		
2.3. Identify key sites and corridors	Map of key sites and corridors produced		All
Objective 3. Taxonomy of <i>Eudorcas</i> is clarified			
4.5. Conduct rangewide phylogenetic analyses units	Conservation units identified		RZSS? SCBI? Univ Porto? partners
4.6. Develop a global plan to ensure maximal retention of genetic diversity	Plan completed		RZSS, SCBI, partners

Objective / Action	Indicator	Urgency	Implementation
4.7. Investigate role of biobanking, cell line generation, reproductive technologies, and movement of germ cells	Strategies developed		RZSS, SCBI, partners
Objective 4. Needs for ex situ management assessed			
4.1. Review feasibility of establishing coordinated breeding programmes	Review completed		AZA, EAZA,
Objective 5. Role of reintroduction assessed			
5.1. Review the importance of reintroductions	Review completed		
Objective 6. Roadmap objectives are implemented effectively			
6.1. Establish a roadmap coordination mechanism			
6.2. Review Roadmap progress at regular intervals	Progress reviews conducted (2.5, 5, 7.5 years)		CMS, Government agencies, IUCN, NGOs, all
6.3. Provide adequate resources and capacity to implement the roadmap	- Resources and capacity provided - Training sessions held - Projects operate effectively		All
6.4. Maintain communication between all stakeholders	- Information exchange mechanism established -Regular reports circulated		CMS focal points, IUCN/SSC ASG, NGOs

BARBARY SHEEP - *AMMOTRAGUS LERVIA* (PALLAS, 1777)

TAXONOMY

Six subspecies have been described (Ansell 1972; Cassinello 1998, 2013).
Ammotragus lervia lervia (Atlas Mountains from Morocco to northern Tunisia).
Ammotragus lervia fassini (southern Tunisia and Libya)
Ammotragus lervia sahariensis (Sahara)
Ammotragus lervia ornata (Egypt)
Ammotragus lervia blainei (Sudan)
Ammotragus lervia angusi (Niger)

These subspecies were based on morphological differences that are not always well defined, there are several possible zones of hybridization, and some populations have not been assigned with certainty to one form or another. A comprehensive genetic analysis of individuals from across the range is needed to identify conservation units and inform conservation action (Cassinello 2015, 2022; Cassinello et al. 2020).

COMMON NAMES

Arabic: Kebsh el Gebel, Lerwi, Orwiyya, Wadden
 Berber: Arrouy, Naddan, Naded, Oudad, Outhath
 English: Aoudad, Barbary Sheep, Uaddan
 French: Mouflon à manchettes
 Spanish: Arruí, Carnero de Berbería, Muflón del Atlas

HABITAT AND ECOLOGY

Barbary Sheep can be found in various habitats, from open forest to various types of montane steppes. It tends to occupy rocky and often precipitous areas, from near sea level up to snow-free areas at about 4167 m in the Moroccan Atlas, using sparse tree cover for shade (Cassinello 2013; Cassinello et al. 2020). Barbary Sheep is a generalist herbivore combining grazing with browsing, although recent analyses of its feeding habits in Tunisia, Algeria, and Morocco show a significantly greater consumption of grasses and forbs. Barbary Sheep probably make small migratory movements in response to food availability.

MIGRATIONS

Some seasonal movements between wet and dry seasons have been described, other populations are sedentary, but these movements are not well understood. Transboundary populations occur in several places: Atlas chain of North Africa, southern Tunisia-Libya, Adrar des Ifoghas (Algeria-Mali), Tibesti (Libya-Chad), Ennedi (Chad-Sudan), Gebel Uweinat (Egypt-Libya-Sudan).

CURRENT DISTRIBUTION AND STATUS

The Barbary Sheep has a widespread range in all the mountains and rugged terrain across the Sahara and Sahel. Its range has declined by an estimated 77% (Durant et al. 2014). In its southwesternmost range, from northern Mauritania to southern Morocco, the Barbary sheep is present in the regions of Zemmur, Oum Dreyga, Negjyr, Adrar Souttouff and Bass Draa-Seguia Alhamra (Cuzin et al. 2017, Gil-Sánchez and Herrera-Sánchez 2020). A recent presence has been confirmed in Adrar Souttouff (Qninba et al. 2016). It is probably extinct in the Aousserd Mountains (Aulagnier et al. 2017). The species has been recorded in 15 localities in the Bass Draa-Seguia Alhamra region, with an estimated population of less than 250 individuals, and in the Negjyr-Aousserd Mountains, with less than 50 individuals (Gil-Sánchez and Herrera-Sánchez 2020).

Introduced populations have been established in South-West USA, Spain, and Croatia.

POPULATION

There are very few robust population estimates at site level. The IUCN Red List estimates the global population size at 5,000–10,000 and a projected decline of more than 10% over the next 15 years (Cassinello et al. 2008, 2020). In Morocco there are an estimated 800-2000 (Amhaouch 2020). Across most of the distribution there are strong indications that the population has declined (Cassinello et al. 2020). There are an estimated 3762 in ex situ facilities, including 917 in captive breeding facilities in Morocco.

STATUS BY COUNTRY

Algeria

The original distribution covered a large part of the country, including the Tell Atlas, Saharan Atlas, Aures mountains and the Hauts Plateaux in the north; all the mountains and rocky areas of the Sahara (Hoggar, Tassili the Tinhert hammada and Tanezrouft; and wadis far from mountains (Kowalski and RzebiK-Kowalska 1991). By the end of the 1980s it was apparently limited to the Saharan Atlas from the border with Morocco to the Mesaad mountains, and some regions around Aures, Tassili n'Ajjers, Hoggar and the Algerian side of the Adrar des Ifoghas (Kowalski and RzebiK-Kowalska 1991). Only a few individuals have been observed in the Algerian Atlas since 2010, so it is possible that only small populations remain in the area. In 2020 populations were located near Bechar, in south-west Algeria (Cassinello et al. 2020). In central and southern Algeria, numbers are probably declining due to poaching and habitat degradation, but a few thousand are estimated to be still present in the main mountain ranges such as Hoggar and Adrar des Ifoghas (Cassinello et al. 2020). Small numbers are present in breeding enclosures in Djelfa Hunting Reserve in the Hauts Plateaux (Bounaceur et al. 2016a).

Chad

Barbary Sheep probably once occurred widely from the Tibesti mountains on the north-western border to the Jef-Jef Plateau and Ennedi mountains, and as far as Kaapka and Maroone (Mekonlaou and Daboulaye 1997). Continued presence in Tibesti has been confirmed recently by aerial and ground sightings but no information is available on population size (Cassinello et al. 2020). In the Ennedi Massif, aerial surveys showed the presence of 1,000 individuals in July 2016 (wet season) and 400 individuals in winter in December 2019 (dry season) with the difference possibly due to seasonal movements (Wacher 2016, 2019). A GPS collaring operation has been carried out in Ennedi (Bussière 2020).

Egypt

Ammotragus lervia formerly occurred in most of the hills in the Eastern Desert, some rugged parts of the Western Desert, and the Gebel Elba area of the south-east, but was considered possibly extinct in Egypt (Amer 1997). Wacher et al. (2002) found evidence of presence in the Elba Protected Area (SE) and the Western Desert between 1997 and 2000. There are recent reports from Gebel Uweinat, probably reaching the Djebel Kissu in Sudan, and possible occurrence in parts of Gilf el Kebir and Gebel Nazar (Cassinello et al. 2020). Once regarded as extinct, Barbary Sheep seem to be locally numerous in the Eastern and Western Deserts of Egypt (Cassinello 2013).

Libya

Occurs in the Hamada al Hamra, parts of the Fezzan, Gebel Uweinat (on the border between Libya, Egypt and Sudan) and northern Tibesti (Hufnagl 1972; Shackleton and De Smet 1997). Currently the species occurs in mountains in the west, close to the Tassili Mountains in Algeria, on Gebel Uweinat, possibly also on Djebel Arkenu and Djebel Bahari (Cassinello et al. 2020). Heavy hunting pressure was already causing declines 40-50 years ago (Hufnagl 1972; Essghaier 1980). And many posts on social media by hunters show dead animals since last

10 years. Shackleton and De Smet (1997) said it appeared to have always been rare. There is no current population estimate.

Morocco

Barbary Sheep occurs along the whole High Atlas, mainly in Toubkal National Park and the Eastern High Atlas National Park and its surroundings (Cassinello et al. 2020). Observations are much rarer outside these two protected areas, except for High Dades, 2019. In Eastern Morocco, small populations live in the Eastern Middle Atlas, Saharan Atlas, Djebel Grouz and Djebel Maïz, near the Algerian border. In the Anti Atlas the species is quite rare, but it seems more abundant in the central Anti Atlas and Western Anti Atlas, with more than 100 individuals (Cuzin 2019), and in the Assif n'Oumarhouz gorges (Cassinello et al. 2020). The total population in Morocco was estimated to be between 800 and 2,000 animals (Cuzin et al. 2007). Currently there are only estimations for the Toubkal National Park (several hundred, with an increasing trend), the High Dades area (about 50) and Djebel Lekst (more than 100) (Cuzin 2019). About 917 animals are held in five breeding enclosures. A release in the wild of the Barbary sheep has been realized from the SIBEs Beni snassen and Jbel Bounacer in eastern Morocco in March 2019 and the National Park of Ifrane in 2022 (Amhaouch 2022). An official program of hunting valorization of trophies has been launched at 2 pilot sites.

Mali

The Barbary Sheep only occurs in the Adrar des Ifoghas massif (Lamarche 1997b). There are no population estimates but it is assumed that only low numbers survive (Cassinello et al. 2020).

Mauritania

Occurs on the Adrar Massif, from Chinguetti to Ouadane, possibly from Guelb er Richat to El Ghallouya, although it is not clear if any population remains in the area, and according to local reports in November 2019, the area south of Atar (Cassinello et al. 2020). Numbers are assumed to be low (Cassinello et al. 2020). The species was assessed as Endangered on the national Red List (Brito et al. 2022).

Niger

It inhabits the Aïr Massif in the north of Niger, the Termit massif in the centre, and probably the Djado Plateau of the north-east (Magin and Newby 1997). In Niger, the Barbary Sheep population inhabiting the Réserve Naturelle Nationale de Termit et Tin-Toumma is estimated at between 100–150 individuals (Rabeil and Turmine 2016); whereas for the Réserve Naturelle Nationale de l'Aïr et Ténéré there is no updated information, although field observations carried out by the Sahara Conservation Fund indicate a strong decrease from the 3,500 individuals estimated in the 2008 Red List assessment (Razack and Zabeirou 2020).

Sudan

Barbary Sheep formerly occurred in the hills of Kordofan and North Darfur in the west, and the Red Sea Hills in the east, but was probably restricted to the Red Sea hills and the only reliable reports came from Jebel Egrim (Nimir 1997). No recent surveys have been conducted and no population estimate is available. Some trophy hunting companies still advertise hunts for this species on the internet.

Tunisia

In Tunisia *A. lervia* occupies the Tunisian Dorsale range and some small mountain ranges in the centre of the country (Ben Mimoun and Noura, 2013). *Ammotragus lervia fassini* is found in extreme southern Tunisia in the low mountain range rising to 400–600 m from Matmata to the Libyan border but its presence in Jenein and Senghar in the extreme south is uncertain (Ben Mimoun et al. 2016). The Tunisian population is estimated at 700–800 individuals, in severely fragmented populations, mainly in protected areas (Ben Mimoun et al. 2016). The species has been released into Oued Dekouk Nature Reserve.

Outside the SSMF region

Free-ranging, introduced Barbary Sheep populations can be found in the United States of America, Mexico, Spain, and Croatia (Cassinello et al. 2020).

THREATS

Most of the range area of Barbary Sheep is located in areas with low levels of law enforcement, partly affected by civil unrest and irregular armed groups, and a generally high incidence of poaching. Furthermore, increasing human population and associated growing livestock numbers contribute to loss of available habitat. Habitat destruction, mainly from livestock grazing, fuelwood collection, and drought and desertification are further factors. The decline of the Egyptian Barbary Sheep was accelerated by competition with livestock and feral camels. The availability and distribution of gueltas (waterholes) that may fluctuate from year to year, is likely to be a major factor during summer, when water requirements are higher (Cassinello et al. 2020).

CONSERVATION MEASURES

International designations

CMS: Listed on Appendix I

CITES: Listed on Appendix II

IUCN Red List: Vulnerable

Planning

There are national strategies to restore the species in Tunisia (DGF 2001) and Morocco (Cuzin et al. 2007).

Protected Areas

Barbary Sheep occurs in Tassili n'Ajjer National Park (Algeria), Gebel Elba Conservation Area (Egypt), Toubkal National Park and the Eastern High Atlas National Park (Morocco), Termit Tin Toumma National Nature Reserve and Aïr & Ténéré National Nature Reserve (Niger), Djebel Chambi National Park, Dghoumes National Park and Oued Dekouk National Reserve (Tunisia).

LOGICAL FRAMEWORK

Barbary Sheep (*Ammotragus lervia*) Logical framework

Objective / Action	Indicator	Urgency	Implementation
Objective 1. Known populations are protected effectively			
1.1. Enhance anti-poaching	Patrol schedules agreed and funded Reduction in poaching incidents		
1.1.1. Strengthen capacity of government agencies	Training sessions for rangers Sufficient vehicles and motorcycles available		All
1.2. Identify key sites and corridors	Map of key sites and corridors produced		All
1.3. Management plans for all sites produced or updated	Plans produced/updated		
Objective 2. Status in the wild is established			
2.1. Conduct air and ground surveys	Surveys completed Individual population status established		
2.2. Enhance regional capacity for survey and monitoring	Capacity needs assessment conducted Training workshops held Trained teams in all range countries		DCFAP, Sahara Conservation
Objective 3. Reintroduced into appropriate parts of former range			
3.1. Consolidate reintroduction in Morocco			
3.1.1. Continue the scheduled release programme	Population growth and expansion		BEF, WAC
3.1.2. Maintain the monitoring programme	Analysis of results (reproduction, movements, habitat use)		BEF, WAC, SCBI
3.1.3. Consolidate community engagement	MoUs renewed		BEF, community leaders, WAC
3.5. Conduct feasibility studies on other reintroductions	- Studies completed - Potential release sites identified	L	All
Objective 4. Genetic diversity is assessed			
4.1. Conduct genetic and genomic analyses	Genetic diversity assessed Conservation units identified		Research laboratories, IUCN SSC Caprinae Specialist Group, Government agencies
4.1.2. Assess phylogenetic structure	Analysis completed		

Objective / Action	Indicator	Urgency	Implementation
4.2. Identify conservation units			
4.3. Research biobanking, cell line generation, reproductive technologies, and movement of germ cells	Strategies developed		
Objective 5. Management of <i>ex situ</i> populations is optimised to support <i>in situ</i> conservation			
5.1. Maintain and expand coordinated breeding programmes	- Increased number of participating institutions - Increased number of animals included in programmes		AZA, EAZA
5.2. Integrated <i>in situ</i> and <i>ex situ</i> management under a 'One Plan Approach'	Integrated plan produced		All
5.3. Improve integration of molecular genetic data into population viability modelling and management strategies	Results incorporated		RZSS, SCBI, Ex situ managers
Objective 6. The Roadmap objectives are implemented effectively			
6.1. Establish a roadmap coordination mechanism			
6.2. Review Roadmap progress at regular intervals	Progress reviews conducted regularly (2.5, 5, 7.5 years)		CMS, Government agencies, IUCN, NGOs, all
6.3. Provide adequate resources and capacity to implement the roadmap	- Resources and capacity provided Training sessions held - Projects operate effectively		All
6.4. Maintain communication between all stakeholders	- Information exchange mechanism established Regular reports circulated		CMS focal points, IUCN/SSC ASG, NGOs

8. References

- Abáigar, T. 2018. Rescuing the mhorh gazelle: the path to Almeria. Pp. 181-184 in: Mungall, E.C., ed. *The dama gazelles. Last members of a critically endangered species*. College Station: Texas A&M University Press
- Abáigar, T. 2021. Celebrating 50 years of “Operacion Mohor”: avoiding the complete extinction of the mhorh gazelle (*Nanger dama mhorh*). *Gnusletter* 38(1-2): 33-39.
- Abáigar, T. and Cano, M. 2005. Management and conservation of Cuvier’s Gazelle (*Gazella cuvieri* Ogilby, 1841) in captivity. *International Studbook*. Instituto de Estudios Almerienses.
- Abáigar, T., Ellouze, G., Zahzah, K., García-González, R. and Nouira, S. 2004. Détermination du statut de la gazelle de montagne (*Gazella cuvieri*, Ogilby 1840) en Tunisie. Rapport dans le cadre du Programme de Coopération Inter-universités espagnoles-tunisiennes, Ref: 2003TN003, Agence Espagnole de Coopération Internationale.
- Abáigar, T., et al. 2005a. Evaluation of habitat use of a semi-captive population of Cuvier’s gazelles *Gazella cuvieri* following release in Boukornine National Park, Tunisia. *Acta Theriologica* 50: 405-415.
- Abáigar, T., Belbachir-Bazi, A. & Cano, M. 2009a. Inventario 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.
- Abáigar, T., Rodriguez-Caballero, E., Martinez, C., Amaouch, Z., Samlali, M.L., Aparicio, F., El Balla, T., Essalhi, A., Fernández, J., García, F., Haya, M., M’Bareck, A., M’Bareck, H., González, L.M. & Fernández de Larrínoa, P. 2019. The first reintroduction project for mhorh gazelle (*Nanger dama mhorh*) into the wild: knowledge and experience gained to support future conservation actions. *Global Ecology and Conservation* 19: e00680.
- Abáigar, T., Martínez, C., Amaouch, Z., Alifald, M., Lemdimigh, A., El Makkid, S.A., El Mokhtard, M., Samlali, M.L., Fernandez de Larrínoa, P. & Rodriguez-Caballero Almería, E. 2020. Habitat requirements of the Mhorh gazelle: What does this species need to survive in the wild? *Global Ecology and Conservation* 24: e01389.
- Al Ain Zoo, IUCN Antelope Specialist Group and Royal Zoological Society of Scotland. 2019. *Dama Gazelle Conservation Strategy 2019-2028*. Al Ain Zoo, United Arab Emirates.
- Al Ain Zoo, IUCN SSC Antelope Specialist Group and Royal Zoological Society Scotland. 2021. *Dama gazelle (Nanger dama) Conservation Strategy 2019-2028: 2.5-Year Review and Update*. Al Ain Zoo, Abu Dhabi, United Arab Emirates.
- Alados, C.L. and Escós, J. (1991). “Phenotypic and genetic characteristics affecting lifetime reproductive success in female’s Cuvier’s, dama and dorcas gazelles (*Gazella cuvieri*, *G. dama* and *G. dorcas*).” *Journal of Zoology London* **223**: 307-321.
- Alados, C.L., Escós, J. and Vericad, J.R. (1988). Captive populations of Northwest African antilopinae and caprinae at the Estación Experimental de Zonas Áridas. *Conservation and biology of desert antelopes*, 199, 211.
- Amhaouch, Z. 2020. The Conservation Strategy for Sahelo-Saharan antelopes in Morocco. Presentation at CMS COP13, Gandhinagar, India, 15-22 February 2020.

- Amhaouch, Z. & Sikli, L. 2019. Addax reintroduced into the wild in Morocco. *Gnusletter* 36(2): 29-30.
- Amer, M. 1997. Egypt. In: D.M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 21-26. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- Ansell, W.F.H. 1972. Part 2, 15 Family Artiodactyla. In: J. Meester and H.W. Setzer (eds), *The Mammals of Africa: An Identification Manual*, pp. 1-84. Smithsonian Institution Press, Washington, DC, USA.
- Audas, R.S. 1951. Game in northern Darfur. *Sudan Wildlife and Sport* 2: 11-145.
- Aulagnier, S. and Thevenot, M. 1997. Morocco. In: D. M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 34-38. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- Aulagnier, S., Cuzin, F., Thevenot, M. and Loggers, C. 2001. Morocco. 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. 13-21. IUCN, Gland, Switzerland.
- Aulagnier, S., Bayed, A., Cuzin, F. & Thévenot, M. 2015. Mammifères du Maroc : extinctions et régressions au cours du XXème siècle. *Travaux de Institut Scientifique, Série Générale* 8, 53-67.
- Barrios, V. 2022. Sahara Conservation. Presentation. SSIG meeting May 2022.
- Bassett, T.H. 1975. Oryx and Addax in Chad. *Oryx* 13: 50-51.
- Bauer, H., Mohammed, A.A., El Faki, A., Hiwyalla, K.O., Bedin, E., Rskay, G., Sitotaw, E. and Sillero-Zubiri, C. 2018. Antelopes of the Dinder-Alatash Transboundary Protected Area, Sudan and Ethiopia. *Gnusletter* 35(1): 26-30.
- Bekele, A. and Yalden, D.W. 2013. *The Mammals of Ethiopia and Eritrea*. Addis Ababa University Press, Ethiopia.
- Ben Mimoun, J. and Nouira, S. 2017. Le mouflon à manchettes (*Ammotragus lervia*) en Tunisie. Presses Académiques Francophones.
- Ben Mimoun, J., Cassinello, J. and Nouira, S. 2016. Update of the distribution and status of the aoudad *Ammotragus lervia* (Bovidae, Caprini) in Tunisia. *Mammalia* 81: 181-187.
- 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.
- Beudels-Jamar, R.C., Devillers, P., Lafontaine, R.-M., Devillers-Terschuren, J. and Beudels, M-O. (eds.) 2005. Les Antilopes Sahélo-Sahariennes. Statut et Perspectives. Rapport sur l'état de conservation des six Antilopes Sahélo-Sahariennes. Action Concertée CMS ASS. 2^e édition. CMS Technical Series Publication N° 11. UNEP/CMS Secretariat, Bonn, Allemagne.
- Beudels-Jamar, R., Devillers, P., Lafontaine, R.-M. and Newby, J. 2005. *Addax nasomaculatus*. Sahelo-Saharan Antelopes. Status and perspectives. Report on the conservation status of the six Sahelo-Saharan antelopes (eds. R.C. Beudels, P. Devillers, R-M. Lafontaine, J. Devillers-Terschuren & M-O. Beudels). CMS SSA Concerted Action. 2nd Edn. CMS Technical Series Publication No 10, 2006. UNEP/CMS Secretariat, Bonn, Germany.
- Boualem, A. 2017. Distribution spatiale, structure des populations, écoéthologie et conservation de *Gazella cuvieri* (Mammalia, Bovidae) dans la région de Tiaret. Thèse de Doctorat en Sciences, Université de Tiaret.

- Bounaceur, F., Benamor, N., Bissad, F.Z., Aoued B., Aulagnier, S. 2016. Statut actuel et distribution spatiale de *Gazella cuvieri* (Ogilby, 1841) en Algérie. *Biocenoses, Bulletin d'écologie terrestre. Numéro spécial : Séminaire international « Biodiversité et Changement Global », Djelfa, 23-25, novembre 2015* : 49-55.
- Bounaceur, F., Benamor, N., Bissaad, F. Z., Abdi, A. and Aulagnier, S. 2016a. Is there a future for the last populations of Aoudad (*Ammotragus lervia*) in northern Algeria? *Pakistan Journal of Zoology* 48: 1727-1731.
- Bounaceur, F., Benamor, N., Bissaad, F. Z., Douba, F., Benmammar-Hasnaoui, H. and Guellil, L. 2016b. État des populations et régime alimentaire du mouflon à manchette *Ammotragus lervia* (Pallas, 1777) au niveau de la réserve de chasse de Moutas à Tlemcen. *Revue Écologie-Environnement* 12: 42-52.
- Brashares, J.S., Abrahms, B., Fiorella, K.J., Golden, C.D., Hojnowski, C.E., Marsh, R.A., ... Withey, L. (2014). Wildlife decline and social conflict. *Science* 345: 376–378.
- Brito, J. C., Godinho, R., Martínez-Freiría, F., Pleguezuelos, J. M., Rebelo, H., Santos, X., ... Carranza, S. 2014. Unravelling biodiversity, evolution and threats to conservation in the Sahara-Sahel. *Biological Reviews* 89: 215–231.
- Brito, J.C., Tarroso, P., Vale, C.G., Martínez-Freiría, F., Boratyński, Z., Campos, J.C., Ferreira, S., Godinho, R., Gonçalves, D.V. Leite, J.V., Lima, V.O., Pereira, P., Santos, X., Ferreira da Silva, M.J., Silva, T.L., Velo-Antón, G., Veríssimo, J., Crochet, P.A., Pleguezuelos, J.M. Carvalho <https://onlinelibrary.wiley.com/doi/full/10.1111/ddi.12416>, S.B. 2016. Conservation biogeography of the Sahara-Sahel: additional protected areas are needed to secure unique biodiversity. *Diversity and Distributions* 22: 371-384.
- Brito, J.C., Sow, A.S., Vale, C.G., Pizzigalli, C., Hamidou, D., Goncalves, D.V., et al. 2022. Diversity, distribution and conservation of land mammals in Mauritania, north-west Africa. *PLoS ONE* 17: e0269870.
- Brocklehurst, H.C. 1931. *Game animals of the Sudan. Their habits and distribution*. London, Gurney and Jackson.
- Burgess, N., Hales, J.A., Underwood, E., Dinerstein, E., Olson, D., Itoua, I., Schipper, J., Ricketts, T. and Newman, K. 2004. *Terrestrial ecoregions of Africa and Madagascar: a conservation assessment*. Island Press.
- Bussièrre, E. 2020. Collaring operation of aoudads and dorcas gazelles in Ennedi Natural and Cultural Reserve – February 2020. Unpub. report. African Parks and Réserve Naturelle et Culturelle de L'Ennedi Tchad.
- 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.
- Cano, M. 1984. Revision der Systematik von *Gazella* (Nanger) dama. *Zeitschrift des Koelner Zoo* 27: 103-107.
- Carvalho, S.B. 2018. Armed conflicts and wildlife decline: challenges and recommendations for effective conservation policy in the Sahara-Sahel. *Conservation Letters* 11: e12446.
- Cassinello, J. 1998. *Ammotragus lervia*: a review on systematics, biology, ecology and distribution. *Annales Zoologici Fennici* 35: 149-162.
- Cassinello, J. 2013. *Ammotragus lervia*. In: J. S. Kingdon and M. Hoffmann (eds), *The Mammals of Africa. Volume VI. Pigs, Deer, Giraffe, Bovids, and Hippos*, pp. 595-599. Bloomsbury Publishing, London, UK.

- Chardonnet, P. and Nare, R.N.B. (2022). A long-running story: the enduring search for health security common to humans, livestock, and wildlife. *Sandscript* 30: 6-8.
- Clark, B. and Frankenberg, E. 2001. Chapter 19. Israel. In: D.P. Mallon, S.C. Kingswood (eds.). *Antelopes. Part 4: North Africa, the Middle East, and Asia. Global Survey and Regional Action Plans*. pp. 107-111. IUCN, Gland, Switzerland.
- Cooke, R.S.C., Woodfine, T., Petretto, M. and Ezard, T.H.G. 2016. Resource partitioning between ungulate populations in arid environments. *Ecology and Evolution* 6: 6354-6365.
- 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.
- Cuzin, F. 2003. Les grands mammifères du Maroc méridional (Haut Atlas, Anti Atlas et Sahara): Distribution, Ecologie et Conservation. Ph.D. Thesis, Laboratoire de Biogéographie et Ecologie des Vertébrés, Ecole Pratique des Hautes Etudes, Université Montpellier II.
- Cuzin, F. 2008. Etude sur le mouflon à manchettes (*Ammotragus lervia*) dans le Parc National du Toubkal. Recherche de groupes reproducteurs hors Réserve Zoologique du Takherkhort en période de rut et évaluation de l'occupation de l'ensemble du territoire du PNT par l'espèce en période printanière. DREF Haut Atlas Marrakech, PN du Toubkal, Marrakech.
- Cuzin, F. 2015. Plan de gestion pour les populations sauvages de Gazelle de Cuvier (*Gazella cuvieri*). Direction Régionale des Eaux et Forêts et de la Lutte contre la Désertification du Sud-Ouest/Agadir, GIZ.
- Cuzin, F. 2019. Diagnostic de la Biodiversité du SIBE du Jbel Lekst. Haut Commissariat aux Eaux et Forêts et à la Lutte contre la Désertification. Direction Régionale du Sud-Ouest Agadir.
- Cuzin, F., Sehhar, E.A. and Wachter, T. 2007. Etude pour l'élaboration de lignes directrices et d'un plan d'action stratégique pour la conservation des ongulés au Maroc. Haut Commissariat aux Eaux et Forêts et à la Lutte Contre le Désertification (HEFLCD), Projet de Gestion des Aires Protégées (PGAP) et Banque Mondiale, Global Environment Facility (GEF).
- DCFAP et DFCPR. 2017. *Plan d'action régional pour l'addax et la gazelle dama 2018-2022*. DFCPR / DCFAP / Noé, Paris.
- De Smet, K. 1989. The distribution and habitat choice of larger mammals in Algeria, with special reference to nature protection. Ph.D. Thesis, Rijksuniversiteit Gent.
- De Smet, K. (1991). Cuvier's Gazelle in Algeria. *Oryx* 25 : 99-104.
- De Smet, K. 1997a. Algeria. In: D. M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 17-19. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- De Smet, K. 1997b. Tunisia. In: D.M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 45-47. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- De Smet, K. and Smith, T.R. 2001. Algeria. 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. 22-29. IUCN/SSC Antelope Specialist Group, Gland, Switzerland.
- De Smet, K., Maziz, S.B., Fellous, A., Belbachir, F., Belbachir-Bazi, A., Commizoli, P. & Wachter, 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. and Devillers-Terschuren, J. 2005. *Oryx dammah*. In: R. C. Beudels, P. Devillers, R.M. Lafontaine, J. Devillers-Terschuren and 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, 2005. UNEP/CMS Secretariat, Bonn, Germany.*
- 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.*
- DGF. 2001. *Stratégie Nationale Tunisienne pour la conservation et la Restauration des Antilopes Sahélo-Sahariennes et de leurs habitats. Ministère de l'Agriculture Direction Générale des Forêts Direction de la Conservation des Forêts.*
- DGF and IUCN. 2017. *Stratégie et plan d'action pour la conservation du mouflon à manchettes (Ammotragus lervia) en Tunisie 2018-2027.* IUCN/DGF, Malaga, Spain.
- Dicks, K. L., Ball, A. D., Banfield, L., Barrios, V., Boufaroua, M., Chetoui, A., Chuven, J., Craig, M., Faqeer, M. Y. A., Garba, H. H. M., Guedara, H., Harouna, A., Ivy, J., Najjar, C., Petretto, M., Pusey, R., Rabeil, T., Riordan, P., Senn, H. V., Gilbert, T. 2023. Genetic diversity in global populations of the critically endangered addax (*Addax nasomaculatus*) and its implications for conservation. *Evolutionary Applications*, 16, 111– 125.
- Dinerstein E, Olson D, Joshi A, Vynne C, Burgess ND, Wik-ramanayake E, Hahn N, Palminteri S, Hedao P, Noss R, Hansen M, Locke H, Ellis EC, Jones B, Barber CV, Hayes R, Kormos C, Martin V, Crist E, Sechrest, W., Price L, Baillie JEM, Weeden D, Suckling K, Davis C, Sizer N, Moore R, Thau D, Birch T, Potapov P, Turubanova S, Tyukavina A, de Souza N, Pinteá L, Brito JC, Llewellyn OA, Miller AG, Patzelt A, Ghazanfar SA, Timberlake J, Klöser H, Shennan-Farpon Y, Kindt R, Lillesø J-PB, van Breugel P, Graudal L, Voge M, Al-Shammari KF, Saleem M. 2017. An ecoregion-based approach to protecting half the terrestrial realm. *BioScience* 67(6): 534-545
- Dragesco-Joffé, A. 1993. *La Vie sauvage au Sahara*. Lausanne, Delachaux et Niestlé,.
- Duncan, C., Kretz, D., Wegmann, M., Rabeil, T. and Pettorelli, N. 2014. Oil in the Sahara: mapping anthropogenic threats to Saharan biodiversity from space. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 369: 20130191.
- 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.
- Durant, S.M., Pettorelli, N., Bashir, S. *et al.* (2012) Forgotten biodiversity in desert ecosystems. *Science* 336: 1379–1380.
- Durant, S.M., Wachter, T., Bashir, S., Woodroffe, R., De Ornellas, P., Ransom, C., Newby, J., Abáigar, T., Abdelgadir, M., El Alqamy, H., Baillie, J., Beddiah, M., Belbachir, F., Belbachir-Bazi, A., Berbash, A.A., Bemadjim, N.E., Beudels-Jamar, R., Boitani, L., Breitenmoser, C., Cano, M., Chardonnet, P., Collen, B., Cornforth, W.A., Cuzin, F., Gerngross, P., Haddane, B., Hadjeloum, M., Jacobson, A., Jebali, A., Lamarque, F., Mallon, D., Minkowski, K., Monfort, S., Ndoassal, B., Niagate, B., Purchase, G., Samaïla, S., Samna, A.K., Sillero-Zubiri, C., Soutan, A.E., Stanley Price, M.R. and Pettorelli, N. 2013. Fiddling in biodiversity hotspots while deserts burn? Collapse of the Sahara's megafauna. *Diversity and Distributions* 20: 114-122.
- East, R. (compiler). 1999. *African Antelope Database 1998*. IUCN, Gland, Switzerland and Cambridge, UK.

- 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.
- Essghaier, M.F.A. 1980. A plea for Libya's gazelles. *Oryx* 15 : 384-385.
- Fay, M., Elkan, P., Marjan, M. and Grossman, F. 2007. Aerial Surveys of Wildlife, Livestock, and Human Activity in and around Existing and Proposed Protected Areas of Southern Sudan, Dry Season 2007. WCS – Southern Sudan Technical Report.
- 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-Français Alger: 5-6 Juin 2012.
- Fellous, A. & Siga, A. 2007. Mission d'investigation sur la faune saharienne menacée en particulier les ongulés sauvages. Ghardaia–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.
- Fremantle, T. P., Wachter, T., Newby, J. and Petorelli, N. 2013. Earth observation: overlooked potential for support to species re-introduction programmes. *African Journal of Ecology* 51: 482-492.
- Funaioli, U. and Simonetta, A.M. 1966. The mammalian fauna of the Somalia Republic: Status and conservation problems. *Monitore Zoologico Italiano, Supplemento*: 285-347.
- Gentry, A.W. 1972. Genus *Gazella*. In: J. Meester & H.W. Setzer (eds). *The Mammals of Africa: An Identification Manual*, pp. 85-93. Smithsonian Institution Press, Washington, D.C, USA.
- Gil-Sánchez, J.M., Herrera-Sánchez, F.J., Álvarez, B., Arredondo, A., Bautista, J., Cancio, I., Castillo, S., Díaz-Portero, M.A., de Lucas, J., McCain, E., Pérez, J., Rodríguez-Siles, J., Sáez, J.M., Martínez-Valderrama, J., Valenzuela, G., Qinba, A., Virgós, E. (2016). Evaluating methods for surveying the Endangered Cuvier's gazelle *Gazella cuvieri* in arid landscapes. *Oryx* 51: 648-655.
- Gil-Sánchez, J.M. and Herrera-Sánchez, F.J. 2020. Status of the Barbary sheep in the Atlantic Sahara: updating for the IUCN Red List (April 2020). Harmusch, Association for Wildlife Research and Conservation.
- Gilbert, T. 2015. International studbook for the scimitar-horned oryx *Oryx dammah*. Tenth edition. Current to 31 December 2014. Marwell Wildlife, Winchester, UK.
- Gilbert, T. 2022. International studbook for the scimitar-horned oryx *Oryx dammah*. Seventeenth edition. Marwell Wildlife, Winchester, UK.
- Gillet, H. 1965. L'Oryx algazelle et l'Addax au Tchad. *La Terre et la Vie* 1965(3): 257-272.
- Gillet, H. 1969. L'oryx algazelle et l'addax au Tchad, Distribution géographique. Chances de survie. *Comptes Rendues de la Société de Biogéographie* 405: 177-189.
- Gilpin, M.E. & Soulé, M.E. 1986. Minimum viable populations: Processes of species extinction". In M.E. Soulé (ed.). *Conservation Biology: The Science of Scarcity and Diversity*. Sinauer, Sunderland, Mass.
- Godinho R, Abáigar T, Lopes S, et al (2012) Conservation genetics of the endangered Dorcas gazelle (*Gazella dorcas* spp.) in Northwestern Africa. *Conservation Genetics* 13 13:1003–1015.

- Gray, G.G. 1985. Status and distribution of *Ammotragus lervia*: a worldwide review. In: M. Hoefs (ed.), *WildSheep: distribution, abundance, management and conservation of the sheep of the world and closely related mountain ungulates*, pp. 95-133. Northern Wild Sheep & Goat Council, Whitehorse, Yukon, Canada.
- Gray, G.G. and Simpson, C.D. 1980. *Ammotragus lervia*. *Mammalian Species* 144: 1-7.
- Grettenberger, J.F. and Newby, J.E. 1990. Niger. In: East, R. (ed.). *Antelopes. Global survey and regional action plans. Part 3. West and Central Africa*, pp. 14-22. IUCN, Gland, Switzerland.
- Groves, C.P. 2013. Genus *Eudorcas* Ring-horned gazelles. In: J. Kingdon and M. Hoffmann (eds), *Mammals of Africa. VI. Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer, and Bovids*, pp. 356-357. Bloomsbury Publishing, London, UK.
- Grubb, P. 2005. Artiodactyla. In: D.E. Wilson & D.M. Reeder (ed.), *Mammal Species of the World. A Taxonomic and Geographic Reference. 3rd edition*, pp. 637-722. Baltimore, USA, Johns Hopkins University Press.
- Hagos, F. 2019. Rediscovery of the Eritrean Gazelle in Eritrea. *Gnusletter* 36(2): 25-28.
- 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
- Harmusch. 2015. *Expediciones zoológicas al Sáhara Atlántico. Harmusch, Asociación de Estudio & Conservación de Fauna*. Ed. Rodeno, Valencia, Spain.
- Hashim, I.M. 1998. Status, abundance, and distribution of four endangered wildlife species in Eastern Sudan. *Gnusletter* 17(2): 12-16.
- Hashim, I. 2013. *Eudorcas tilonura* Heuglin's Gazelle. In: J. Kingdon and M. Hoffmann (eds), *The Mammals of Africa. VI*. pp. 359-361. Bloomsbury Publishing, London, UK.
- Hashim, I. M. and Kingdon, J. 2013. *Eudorcas albonotata* Mongalla Gazelle. In: J. Kingdon and M. Hoffman (eds), *Mammals of Africa. VI. Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer, and Bovids*, pp. 369-372. Bloomsbury Publishing, London, UK.
- 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.
- Hempel, E., Westbury, M.V., Grau, J.H., Trinks, A., Pajmans, J.L.A., Kliver, S., Barlow, A., Mayer, F., Müller, J., Chen, L., et al. 2021. Diversity and paleodemography of the Addax (*Addax nasomaculatus*), a Saharan Antelope on the verge of extinction. *Genes* 12: 1236.
- 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 and Cambridge: IUCN. Gland, Switzerland: IUCN Species Survival Commission.
- Herrera-Sánchez, F.J., de Lucas, J., Castillo, S., Rincón-García, A., Llaneza, L., Mellone, U., Mallo-Leira, M., Rodríguez-Siles, J. and Gil-Sánchez, J. M. 2016. Expedición zoológica y sondeo del arruí sahariano (*Ammotragus lervia sahariensis*) en el Djebel Ouarkiz y Montes Aydar. *Go-South Bulletin* 13: 224- 240.
- Hillman, J.C. and Fryxell, J.M. 1988. Chapter 3: Sudan. In: R. East (ed.). *Antelopes. Global Survey and Regional Action Plans. Part 1. East and North Africa*, pp. 5-16. IUCN, Gland, Switzerland.
- Hufnagl, E. 1972. *Libyan Mammals*. The Oleander Press, New York, USA.

Ibáñez, B., Moreno, E., Barbosa, A. (2013). Parity, but not inbreeding, affects juvenile mortality in two captive endangered gazelles. *Animal Conservation* 16 : 108–117.

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

IPCC. 2021. Sixth assessment report. Working Group I. The physical science basis.
<https://www.ipcc.ch/report/ar6/wg1/>

Irzagh, A., Bounaceur, F., Antar, D., Benrima, A. and Aulagnier, S. 2020. Contribution à l'actualisation des connaissances sur les mammifères du Tassili algérien. *Revue Agrobiologia* 10 : 2010 -2020.

IUCN. 2018. *Conservation strategy and action plan for Cuvier's gazelle (Gazella cuvieri) in North Africa 2017-2026*. IUCN Gland, Switzerland and Malaga, Spain.

IUCN SSC. 2012. IUCN SSC Guiding principles on trophy hunting as a tool for creating conservation incentives. Ver. 1.0. IUCN, Gland.

IUCN – SSC Species Conservation Planning Sub-Committee. 2017. *Guidelines for Species Conservation Planning*. Version 1.0. Gland, Switzerland: IUCN.

IUCN SSC Antelope Specialist Group. 2016a. Addax nasomaculatus. The IUCN Red List of Threatened Species 2016: e.T512A50180603. <https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T512A50180603.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 2016c. *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 2016d. *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. 2016e. Eudorcas albonotata. The IUCN Red List of Threatened Species 2016: e.T8992A50188208.

IUCN SSC Antelope Specialist Group. 2017a. *Gazella dorcas*. *The IUCN Red List of Threatened Species* 2017: e.T8969A50186334. <https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T8969A50186334.en>

IUCN/SSC Antelope Specialist Group. 2017b. *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

IUCN SSC Antelope Specialist Group. 2017c. *Eudorcas rufifrons*. *The IUCN Red List of Threatened Species* 2017: e.T8973A501870

IUCN SSC Antelope Specialist Group. 2017d. *Eudorcas tilonura*. *The IUCN Red List of Threatened Species* 2017: e.T8991A50188182.

IUCN SSC Antelope Specialist Group. 2020. IUCN mission to Niger for the conservation of the last wild addax and dama gazelles and the Termit and Tin Toumma National Nature Reserve: Report and Recommendations. IUCN, Gland, Switzerland.

- 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.
- Iyengar, A., Gilbert, T., Woodfine, T., Knowles, M., Dinz, F.M., Breneman, R.A., Louis Jr E.E. and Maclean, M. 1997. Remnants of ancient genetic diversity preserved within captive groups of scimitar-horned oryx (*Oryx dammah*). *Molecular Ecology* 16: 2436-2449.
- Jeannin, A. 1936. *Les Mammifères sauvages du Cameroun*. Paul Lechevalier, Paris.
- 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.
- Jebali, A., Zahzah, K. (2013). Causes et trajectoires de la mortalité chez deux gazelles réintroduites en Tunisie : la gazelle Mohor au PNBH et la gazelle de l'Atlas dans le PNBK. Rapport pour la DGF, 28 pp.
- Joleaud, L. (1929). Étude de géographie zoologique sur la Berbérie, les ruminants. V. Les gazelles. *Bull. Soc. Zool. 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.
- Kowalski, K. & Rzebik-Kowalska, B. 1991. *Mammals of Algeria*. Wroclaw, Polish Academy of Sciences.
- 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.
- Krause, F. 2015. European studbook for the addax *Addax nasomaculatus*. Zoo Hannover GmbH.
- Krausman, P.R. and Casey, A.L. 2017. *Addax nasomaculatus. Mammalian Species* 807: 1-4.
- Lamarque, B. 1987. Note sur le statut et la répartition de l'addax *Addax nasomaculatus* (Blainville) dans le Majabat al Houbra (Mali, Mauritanie). Pp. 48-49 in: P.P. Vincke, G. Sournia, and E. Wangari (eds.). *Actes du Séminaire de Nouackchott. Environnement Africain : Séries Etudes et Recherches*. MAB/ENDU/UICN.
- Lamarque, B. 1997a. Mali. In: D. M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 32-33. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- Lamarque, B. 1997b. Mauritania. In: D. M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 33-34. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- Lamarque, F. and Stahl, P. 2002. Rapport de Mission en République du Mali "Inventaire de la faune dans le Tamesna" (28 janvier – 09 février 2002). Paris: Office National de la Chasse et de la Faune Sauvage.
- Lamarque, F., Sid'Ahmed, A.A., Bouhu, S., Coulibaly, G. and Maïga, D. 2007a. Confirmation of the survival of the Critically Endangered dama gazelle (*Gazella dama*) in south Tamesna, Mali. *Oryx* 41: 109-112.
- Lamarque, F., Sid'Ahmed, A.A., Bouhu, S., Coulibaly, G. and Maïga, D. 2007b. Confirmation de la présence de la gazelle dama au Sud Tamesna (Mali). *Faune sauvage* 276: 15-22.

- Lamarque F., Saley H. and Chardonnet, P. 2009. Réintroduction de l'Oryx algazelle au Niger: Etude de faisabilité et proposition de projet. Fondation IGF, Direction Générale des Eaux et Forêts, Abu Dhabi Environmental Agency. Niamey, Niger and Abu Dhabi, UAE.
- Lamprey, H.F. 1975. Report on the desert encroachment reconnaissance in northern Sudan, 21-10 November, 1975. Nairobi : UNEP.
- Laurent, A. and Laurent, D. 2002. *Djibouti: Les mammifères d'hier à aujourd'hui pour demain*. Editions Beira, Toulouse.
- Lavauden, L. 1920. *La chasse et la faune cynégétique en Tunisie*. Direction générale de l'agriculture, du commerce et de la colonisation. Tunis.
- Lavauden L. 1924. Mammifères. In: *La Chasse et la faune cynégétique en Tunisie*, pp. 9-13. Guénard & Franchi, Tunis.
- Lavauden, L. 1926. Les gazelles du Sahara central. *Bulletin de la Société d'histoire naturelle de l'Afrique du nord* 17: 11-27.
- Le Houerou, H.N. 1990. Outline of the biological history of the Sahara. *Journal of Arid Environment* 22: 3-30.
- Lerp H., Wronski T., Pfenninger M. and Plath M. 2011. A phylogeographic framework for the conservation of Saharan and Arabian dorcas gazelles. *Organisms Diversity & Evolution* 11: 317–329.
- Lhote, H. 1946. Observations sur la repartition actuelle et le mœurs de quelques grands mammifères du pays Touareg. *Mammalia* 10: 26-56.
- Loarie, S.R., Duffy, P.B., Hamilton, H., Asner, G.P., Field, C.B. & Ackerly, D.D. (2009) The velocity of climate change. *Nature*, 462, 1052– 1055.
- Loche, V. (1867). *Histoire naturelle des mammifères de l'Algérie : exploration scientifique de l'Algérie pendant les années 1840, 1841, 1842*. Paris : A. Bertrand.
- Loder, E.G. 1894. On the "Reem" antelope of Algeria. *Proceedings of the Zoological Society of London* 1894: 473-476.
- Liu, Y. and Xue, Y. 2020. Expansion of the Sahara Desert and shrinking of frozen land of the Arctic. *Scientific Reports* 10: 4109.
- Loggers, C., Thévenot, M. & Aulagnier, S. 1992. Status and distribution of Moroccan wild ungulates. *Biological Conservation* 59: 9-18.
- Magin C. D. 1990. The status of wildlife populations in the Air and Tenere National Nature Reserve, 1988-90. Serie des Rapports Techniques. IUCN / WWF, Niamey, Niger.
- Magin, C.D. and Newby, J. 1997. Niger. In: D. M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 38-40. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland.
- Malbrant, R. 1952. *Faune du centre Africain français*. Encyclopédie Biologique XV. Paris : P. Lechevalier.
- Mallon, D. 2014. Eritrea Reconnaissance 2013: Trip report. IUCN/SSC Antelope Specialist Group and Zoo Landau in der Pfalz.
- Mallon, D.P. and Kingswood, S.C. 2001. *Antelopes. Part 4: North Africa, the Middle East, and Asia. Global Survey and Regional Action Plans*. IUCN, Gland, Switzerland.

- Manlius, N., Menardi-Noguera, A. and Zboray, A. 2003. Decline of the Barbary sheep (*Ammotragus lervia*) in Egypt during the 20th century: literature review and recent observations. *Journal of Zoology* 259: 403-409.
- Mekonlaou, M. and Daboulaye, B-Y. 1997. Chad. In: D. M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 19-21. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- Misonne, X. 1977. Mammifères du Jebel Uweinat, desert de Libye. Musée Royal de l'Afrique Centrale, Tervueren. *Série 8° Sciences Zoologiques* 217: 5-33.
- Molcanova, R. and Wachter, T. 2010. scimitar-horned oryx population management (PN Sidi Toui) and addax monitoring (PN Djebil and Senghar) Tunisia, October 2010. Direction Générale des Forêts, Tunis.
- Molcanova, R. and Wachter, T. 2011. Scimitar-horned oryx population management (PN Sidi Toui, RN Oued Dekouk; PN Bou Hedma) and addax monitoring (PN Djebil) April 2011. Direction Générale des Forêts, Tunis.
- Monfort, S.L., Newby, J., Wachter, T., Tubiana, J. and Moksia, D. 2004. Sahelo-Sharan Interest group Wildlife Surveys. Part 1 : Central and western Chad (September-October 2001),. ZSL Conservation Report No. 1. Zoological Society of London.
- Monod, T. 1990. *Memoirs d'un voyageur naturaliste*. Marseille, Editions AGEF.
- Morrow, C., Molcanova, R. and Wachter, T. 2013. Oryx dammah Scimitar-horned Oryx. In: J. Kingdon and M. Hoffmann (eds), *The Mammals of Africa. VI: Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer, and Bovids*, pp. 586-592. Bloomsbury Publishing, London, UK.
- Mungall, E.C., ed. 2018a. The dama gazelles. Last members of a critically endangered species. College Station: Texas A&M University Press.
- Mungall, E.C. 2018. Species numbers throughout the years. *Exotic Wildlife* 6: 61–62.
- Muramura, M. and Byaruhanga, H. 2021. Recent sightings of antelopes in Kidepo Valley National Park, Uganda. *Gnusletter* 38(1-2) : 31-32.
- Naia, M. and Brito, J.C. 2021. Ecoregions of the Sahara-Sahel: characteristics and conservation status. CIBIO/InBIO. Biodeserts Report EN-03.
- Naia, M., Tarroso, P., Sow, A.S., Liz, A.V., Gonçalves, D.V., Martínez-Freiría, F., Santarém, F., Yusefi, G.H., Velo-Antón, G., Avella, I., Hanson, J.O., Khalatbari, L., Ferreira da Silva, M.J., Camacho-Sanchez, M., Boratyński, Z., Carvalho, S.N., Brito, S.B. 2021. Potential negative effects of the Green Wall on Sahel's biodiversity. *Conservation Biology* 35: 1966-1968.
- Newby, J.E. 1974. The ecological resources of the Oudi rime-Ouadi Achim Faunal Reserve, Chad. FAO/UNDP.
- Newby, J.E. 1981. Desert antelopes in retreat. *World Wildlife News* 1981 (summer):14-18.
- Newby, J.E. 1984. Larger mammals of the Sahara. In: J.L. Cloudsley-Thompson (ed). *Sahara Desert*. Oxford, Pergamon Press.
- Newby, J.E. 1988. Aridland wildlife in decline: the case of the scimitar-horned oryx. In: A. Dixon and D.M. Jones (eds), *Conservation and biology of desert antelopes*, pp. 146-166. Christopher Helm, London, UK.
- Newby, J. 2013. *Addax nasomaculatus* Addax. In: J. Kingdon and M. Hoffmann (eds), *The Mammals of Africa. VI. Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer, and Bovids*, pp. 566-571. Bloomsbury Publishing, London, UK.

- Newby, J.E. 2021. Chad update from SCF. *Gnusletter* 38(1-2): 9-15.
- Newby, J.E. and Grettenberger, J. 1986. The human dimension in natural resource conservation: a Sahelian example from Niger. *Environmental Conservation* 13: 29-256.
- Newby, J., Wachter, T., Durant, S.M., et al. 2016. Desert antelopes on the brink: How resilient is the Sahelo-Saharan ecosystem? In: J. Bro-Jørgensen and D.P. Mallon (eds). *Antelope Conservation: From Diagnosis to Action*. John Wiley & Sons Ltd, Chichester, UK, pp 253–279.
- Nimir, M. B. 1997. Sudan. In: D. M. Shackleton (ed.), *Wild Sheep and Goats and their Relatives: Status Survey and Conservation Action Plan for Caprinae*, pp. 40-45. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland.
- OECD-SWAC (2014). An Atlas of the Sahara-Sahel. Geography, Economics and Security. OECD Publishing. <https://doi.org/10.1787/9789264222359-en>
- Ogden R, Chuven J, Gilbert T, et al. 2020. Benefits and pitfalls of captive conservation genetic management: Evaluating diversity in scimitar-horned oryx to support reintroduction planning. *Biological Conservation* 241:108244
- Olmedo, G., Escós, J. and Gomendio, M. (1985). Reproduction de *Gazella cuvieri* en captivité. *Mammalia* 49: 501-507.
- Olson DM, Dinerstein E, Wikramanayake ED, Burgess ND, Powell GVN, Underwood EC, D'Amico JA, Itoua I, Strand HE, Morrison JC, Loucks CJ, Allnutt TF, Ricketts TH, Kura Y, Lamoreux JF, Wettengel WW, Hedao P, Kassem KR. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. *BioScience* 51, 933–938.
- Osborn, D.J. and Helmy, I. 1980. *The contemporary land mammals of Egypt (including Sinai)*. Field Museum of Natural History, Bethesda, Maryland.
- Panouse, J. B. 1957. Les Mammifères du Maroc. *Travaux de l'Institut Scientifique Cherifien, Série Zoologique* 5: 1-206.
- Pease, A.E. 1896. On the antelopes of the Aures and Eastern Algerian Sahara. *Proceedings of the Zoological Society of London* 1896: 809-814.
- Pesci, M.E. 2022. Vaccinating antelopes before their reintroduction: a necessity? *Sandscript* 30: 9-10.
- Pfeffer, P. 1995. Convention sur la conservation des espèces migratrices appartenant à la faune sauvage. Nouvelles données sur quelques mammifères de l'Ennedi (nord-est de Tchad). CMS/ScC.6/Doc. 7.1. Bonn, Secrétariat de la Convention.
- Petretto, M., Gilbert, T. & Riordan, P. 2022. Conservation of the Sahelo-Saharan fauna & their arid steppe habitat in Tunisia: report on 2021 conservation action and impact. Marwell Wildlife, UK.
- Poilecot, P. 1991. La faune de la Réserve Naturelle Nationale de l'Aïr et du Ténéré. In: F. Giazzi, F. (ed.), *La Réserve Naturelle Nationale de l'Aïr et du Ténéré (Niger)*, pp. 181- 259. MHE/WWF/IUCN, Gland, Switzerland.
- Quinba, A., El Balla, T., Khayya, M.L., Semlali, M.E.A., Samlali, M.L., Maarouf, S., El Jaffali, B., El Brini, H., Benhoussa, A. and Ibn Tattou, M. 2016. 2016. Koudiat Laghnam, probablement le dernier refuge pour le mouflon à manchettes *Ammotragus lervia* dans l'Adrar Soutouff (Province d'Aouerd- Sud Marocain). *Go-South Bulletin* 13: 55-60.
- Rabeil, T. 2016. Addax survey in Niger. *Sandscript* 19: 6.
- Rabeil, T. 2016. Rapport succinct des recensements terrestre et aérien dans la réserve naturelle nationale de Termit et Tin Toumma et sa périphérie, Niger. Sahara Conservation Fund.

- Rabeil, T. and Turmine, V. 2016. Atlas de la Réserve Naturelle Nationale de Termit et Tin-Toumma. Projet Antilopes Sahélo-Sahariennes Niger. Sahara Conservation Fund, Niamey, Niger.
- Rabeil, T., Hacha, M.H., & Moustapha, A.D. 2016. Rapport de mission dans le Manga-Eguey (Tchad) Décembre 2016. Sahara Conservation Fund, DCFAP Projet d'appui à la gestion durable d'aires protégées Sahélo-Sahariennes, Paris.
- Randle, B. 2016. *Slender-horned Gazelle Gazella leptoceros International Studbook*. Palm Desert, CA: The Living Desert.
- Razack, A. and Zabeirou, M. 2020. Le Mouflon à manchettes (*Ammotragus lervia*) au Niger. Sahara Conservation Fund contribution to the species Red List reassessment. SCF Project Officer Niger.
- Shackleton, D.M. 1997. *Wild Sheep and Goats and Their Relatives: Status Survey and Conservation Action Plan for Caprinae*. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- Razack, A., Zabeirou, M. and Pourchier, C. 2021. Hope for dama gazelle (*Nanger dama*) in the Air mountains of Niger. *Gnusletter* 38(1-2): 21-24.
- Rebholz, W. & Harley, E. 1999. Phylogenetic relationships in the Bovid Subfamily Antilopinae based on mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution* 12: 87-94.
- RZSS & IUCN Antelope Specialist Group. 2014. *Conservation review of the dama gazelle (Nanger dama)*. Royal Zoological Society of Scotland, Edinburgh, UK.
- 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 and S.C. Kingswood (eds), *Global survey and regional action plans: Antelopes. Part 4: North Africa, the Middle East, and Asia*, pp. 48-54. IUCN, Gland, Switzerland.
- Sayer, J.A. 1977. Conservation of large mammals in the Republic of Mali. *Biological Conservation* 12: 245-263.
- Scholte, P. 2013. Nanger dama Dama Gazelle. Pp. 382-387 in: J. Kingdon & M. Hoffmann, eds. *Mammals of Africa: Volume VI: Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer and Bovids*. London: Bloomsbury Publishing.
- Scholte, P. and Hashim, I. 2013b. *Gazella dorcas*. In: J. S. Kingdon and M. Hoffmann (eds), *The Mammals of Africa. VI. Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer, and Bovids*, Bloomsbury Publishing, London, UK.
- Scholte, P. and Hashim, I. 2013b. *Eudorcas rufifrons Red-fronted Gazelle*. In: J. Kingdon and M. Hoffmann (eds). *The Mammals of Africa. VI. Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer, and Bovids*, pp. 357-359. Bloomsbury Publishing, London, UK.
- Schomber, H.W. & Kock, D. 1961. Wildlife protection and hunting in Tunisia. *African Wild Life* 15: 137-150.
- Schreiber, A. 2021. Cameroon as a historical range country of the dama gazelle (Mammalia, Bovidae). *Annali del Museo Civico di Storia Naturale "G. Doria"* 114: 329-347.
- Senn, H., Banfield, J.L., Wachter, T., et al. 2014. Splitting or lumping? A conservation dilemma exemplified by the critically endangered dama gazelle (*Nanger dama*). *PLoS One* 9: 98693.
- Senn, H., Wachter, T., Newby, J., et al. 2016. Update: Genetic relatedness of Critically Endangered dama gazelle populations in the wild and captivity. *Gnusletter* 33: 5–8

- Shackleton, D.M. and De Smet, K. 1997. Libya. In: D. M. Shackleton (ed.), Wild sheep and goats and their relatives. Status survey and conservation action plan for Caprinae, pp. 30-32. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK.
- Shaw, W.B.K. 1936. An expedition in the south Libyan desert. *Geographical Journal* 87: 193-221.
- Sidiyene, E.A. & Tranier, M. 1990. Données récentes sur les mammifères de l'Adrar des Iforas (Mali). *Mammalia* 54: 472-477.
- Siege, L. and Pohlstrand, H. 2017. Report on the occurrence of the Red-fronted gazelle and the Nile lechwe in Ethiopia. *Gnusletter* 34(1): 8-10.
- 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.
- Silva, T.L., Godinho, R., Castro, D., Abáigar, T., Brito, J.C. and Alves, P.C. (2015). Genetic identification of endangered North African ungulates using noninvasive sampling. *Molecular Ecology Resources* 15: 652–661.
- Silva, T.L. 2018. Biodiversity, evolution and conservation of threatened desert ungulates. PhD Thesis. Universidade do Porto.
- 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. and Dupuy, A.R. 1990. Chapter 7. Senegal. Pp. 33-35 in: R. East, ed. *Antelopes. Global survey and regional action plans. Part 3. West and Central Africa*. Gland and Cambridge: IUCN.
- Sournia, G. and Vershuren, J. 1990. Mauritania. Pp. 6-8 in: *Antelopes. Global survey and regional action plans. Part 3. West and Central Africa*. East R, (compiler) Gland and Cambridge, IUCN, pp. 6-8.
- 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.
- Thomas, O. 1894. On some gazelles brought by Sir E. Loder from Algeria. *Proceedings of the Zoological Society of London* 1894 : 467-472.
- Thomassey, J.-P. and Newby, J.E. 1990. Chad. In: R. East (ed.). *Antelopes: Global Survey and Regional Action Plans. Part 3: West and Central Africa*, pp. 22-28. IUCN/SSC Antelope Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.
- 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.
- Tumenta, P., Croes, B., Bertola, L., Adam, S., Kagalang, D., Kamgang, S., Loth, P., Chardonnet, P. & de longh, H. (2021). Assessment of antelope populations, the prey base of lions, and human encroachment in Waza National Park, Cameroon, April-July 2021. *Gnusletter* 39(2): 13-21.

- Vale, C.G. & Brito, J.C. (2015) Desert-adapted species are vulnerable to climate change: insights from the warmest region on earth. *Global Ecology and Conservation* 4: 369–379.
- Vernet, R. (2008). *Addax nasomaculatus*. [cited 2009 January 12]. Available from: http://www.geres-asso.org/Nouvelles_observations.html#MAMMIFERES
- WAC. 2022. Wild Africa Conservation. Progress Report August 2022 to National Geographic Society. www.wildafricaconservation.org
- Wacher, T.J. 1997. Field Survey to Qattara Depression, Siwa & Wadi El Rayan. Cairo: Egyptian Environmental Affairs Agency. (Unpublished report).
- Wacher, T. 2019. Aerial survey of the Ennedi Massif - December 2019. African Parks and Zoological Society of London.
- Wacher, T., Baha El Din, S., Mikhail, G. and Baha El Din, M. 2002. The current status of Barbary sheep in Egypt. *Oryx* 36: 301-304.
- Wacher, T., Newby, J., Houston, W., Spevak E., Barmou, M. and Issa, A. 2004. Sahelo–Saharan Interest Group Wildlife Surveys. Tin Toumma & Termit (February–March 2004). ZSL Conservation Report No. 5. The Zoological Society of London, London, UK.
- Wacher, T.J., Rabeil, T. & Newby, J.E. 2008. Aerial survey of the Termit & Tin Toumma regions of Niger – November 2007. Sahelo-Saharan Antelope Project (Niger). Sahara Conservation Fund.
- Wacher, T., Potgieter, D., Hassan, M., Dogringar, S. and Rabeil, T. 2015. Dama gazelle survey. The Manga region, Western Chad, February 2015. Zoological Society of London, African Parks Network and Sahara Conservation Fund.
- Wacher, T., Hacha, M.H., Taroum, C.N.W., Ali, H., Ben, A.T., Saad Hassane, S., Mbangoguina, C., Annadif Djele, A.A. 2022. Réserve de Faune de Ouadi Rimé-Ouadi Achim. Re-introduction of scimitar-horned oryx. Line transect survey, 26-30 September 2022. Direction de la Faune et des Aires Protégées, Sahara Conservation, Zoological Society of London, Réserve de Faune de Ouadi Rimé-Ouadi Achim.
- Whitaker, J. 1906. Sport and Camp-life in Tunisia. In: *Carthage and Tunis*, edited by D. Sladen. Hutchinson, London.
- Wildt, D.; Miller, P.; Koepfli, K.-P.; Pukazhenti, B.; Palfrey, K.; Livingston, G., Beetem, D., Shurter, S., Gregory, J., Takács, M., et al. 2019. Breeding centers, private ranches, and genomics for creating sustainable wildlife populations. *BioScience* 69: 928–943.
- 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.
- Yalden, D.W., Largen, M.J. and Kock, D. 1984. Catalogue of the Mammals of Ethiopia 5. Artiodactyla. *Italian Journal of Zoology* n.s. 19, 67-221.