Conservation of the Sahelo-Saharan fauna & their arid steppe habitat in Tunisia: report on 2021 conservation action and impact

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Cover photograph: female scimitar-horned oryx in front of the Dghoumes National Park eco-museum, Tunisia. Photograph by Marie Petretto, Marwell Wildlife, with camera trap STEALTH CAM STC-DS4K.

Acknowledgements

We would like to thank Dublin Zoo, Safari Parc Monde Sauvage, Parco Faunistico Le Cornelle, Wrocław Zoo Foundation DODO, and Branféré Parc Animalier et Botanique for their ongoing and generous support. As always, we appreciate the unwavering collaboration and hospitality of our friends and colleagues at the Direction Générale des Forêts (Ministry of Agriculture, Fisheries and Water Resources, Tunisia), and the Commissariats Régionaux au Développement Agricole (CDRA) of Tozeur, Kebili, Medenine, Tataouine, Sidi Bouzid and Gafsa. We are especially grateful to our team in Tunisia: Amira Saidi, Mohamed Khalil Meliane and the late Abdelkader Chetoui.

Contents

Tribute

We, along with our Director of Conservation, Dr Tim Woodfine, and colleagues at Marwell Wildlife, pay tribute to our dear friend and colleague Abdelkader Chetoui who passed away after contracting COVID-19 in Tunisia.

Remembering Abdelkader Chetoui (1949 – 2021)

Abdelkader was best known as the Conservator of Dghoumes National Park until 2011, playing a pivotal role in the creation of this important protected area and building the infrastructure to make it work. He developed a team of park Guardians drawn from the local community, training them to restore, monitor, and manage the local ecosystem.

Dghoumes National Park was designed to protect and restore the remnants of an arid-steppe ecosystem within a wider degraded landscape. It was against this background that Abdelkader's love of nature and creative mind came to the fore. He drew on his considerable engineering skills to introduce innovative approaches to restoring vegetation communities. This included building impressive dams in the foothills of the mountain range to the north and providing a gravity driven supply of water to help restore vegetation communities. He established a plant nursery in his hometown of Tozeur to cultivate indigenous trees and shrubs, supplying the park and helping to combat desertification elsewhere in the area. The impressive stands of *Acacia tortilis* in the eastern side of Dghoumes National Park, probably not seen in the area for many decades before, are an enduring testament to Abdelkader's vision.

The restoration of the arid-steppe vegetation rejuvenated the ecosystem and Abdelkader delighted in the improved fortunes of mammals, the multitude of resident and migratory birds including houbara bustard, and the abundance of reptiles. With this food chain restored, sightings of wolves, foxes, wild cats and raptors became more common. Abdelkader and his team catalogued all of this over the years providing a wealth of information about the biodiversity of Dghoumes National Park and its surroundings.

This, however, was just the beginning and Abdelkader reintroduced dorcas gazelles, watching their numbers grow steadily over the years. He then worked with Marwell and the international conservation community to bring back the scimitar-horned oryx and North African ostrich; species that had disappeared from the wild in Tunisia around a century before. Abdelkader's understanding of animal biology and husbandry proved invaluable throughout these processes, and when challenged by new subjects or situations, his lifelong passion for learning and openness to new ideas were ideal traits.

Following his statutory retirement, Abdelkader continued working with the Marwell Tunisia team. He continued to monitor the vegetation communities, oryx, ostriches and other wildlife in Dghoumes National Park while bringing his expertise to projects elsewhere in the country. It was clear how greatly he was admired and respected throughout Tunisia and his work to reintroduce oryx and ostriches to Dghoumes National Park and restore that ecosystem gained international recognition.

Abdelkader left the natural environment in a far better state than he found it, and the legacy of his lifetime's work will endure long into the future. He was a great naturalist and communicator, always generous with his time and hospitality, openly sharing his knowledge and experiences and keen to support new generations of conservationists. For those who knew him, Abdelkader will be remembered for his friendship, kindness and wisdom, and a man who always had a smile!

Ecomuseum Abdelkader Chetoui, Dghoumes NP and Marwell Wildlife are seeking funds for an exhibition in Dghoumes NP Ecomuseum in memory of Abdelkader Chetoui. We plan to create and install an exhibition that will reflect the important role the park plays for the Sahelo-Saharan conservation locally and globally.

Introduction

Marwell Wildlife started working on aridland conservation in the 1980s, when the Tunisian government revised its Forest Code, signed the Convention on Migratory Species and the Convention of Biological Diversity, and created a network of protected areas. Today, nearly 485,000 hectares in the Sahelo-Saharan ecoregion are protected within eight National Parks (NP) and Reserves (NR). The protected areas are dedicated to the reintroduction of emblematic species, such as addax *Addax nasomaculatus*, scimitar-horned oryx *Oryx dammah*, and North African ostrich *Struthio camelus camelus* that are locally or globally extinct.

Marwell Wildlife's initial focus in the country was the reintroduction of scimitar-horned oryx, but in the following 30+ years we have worked closely with our Tunisian partners, the Direction Générale des Forêts (DGF), in the restoration and conservation of several key species and their arid-land ecosystem. In 2020, Marwell Wildlife and the DGF renewed the Memorandum of Understanding (MoU) that formalises our partnership and provides the framework for our continuing activities to conserve Tunisian biodiversity.

Our work includes the conservation of key species and their habitats, particularly scimitar-horned oryx, addax, North African ostrich and slender-horned gazelles *Gazella leptoceros*, and we work in close collaboration with our Tunisian colleagues in Jbil NP (Djebil), Senghar-Jabbes NP, Dghoumes NP, Bou Hedma NP and the Haddej reserve within it, Sidi Toui NP and Oued Dekouk NR. We also work with Tunisian colleagues on the *ex situ* breeding centre for slender-horned gazelle in El Gonna NR. Over the years, we have built considerable knowledge of aridland antelope and ostrich and their habitats to better understand the factors that impact long-term reintroduction success.

Our commitments

Restoration of populations to the wild and the conservation of their habitats is challenging and requires the long-term commitment that Marwell Wildlife is making. We focus our work around three core themes: restoring nature, catalysing change, and sustainable living. Having a team on the ground in Tunisia enables on-going and adaptive monitoring so we can remain alert to problems and learn from successes. Conducting research and embedding robust monitoring protocols with local teams means that we can understand and respond to the underlying drivers of large herbivore survival and the use of their habitats. This work is linked to efforts to restore these ecosystems and reverse land degradation, providing benefits for local communities that will lead to sustainable co-existence with wildlife. In over three decades of wildlife conservation in Tunisia, we have gained considerable expertise in reintroduction, monitoring and management techniques for the species and their habitat, and we continue to share expertise and knowledge with both our national and international colleagues, as well as the teams within the parks and reserves.

In 2020/2021, thanks to the generous support of EAZA members and other partners, we made progress against our project objectives, despite the continuing disruption caused by Covid-19. Members of our Tunisia team were able to conduct fieldwork, although some activities were curtailed. Covid-19 is likely to impact on our activities in the near future, but we will continue with our conservation efforts within the limits of government restrictions.

We focus on activities from 2020-2021 in this report; however, as previous reports predominantly presented conservation work for scimitar-horned oryx, we have included some information on previous years' activities to provide context for ongoing work with addax, North African ostrich, and slender-horned gazelle.

Find out more about our annual review of charitable activities and impacts at **https://www.marwell.org.uk/conservation/achievements/our-achievements**: in our annual impact report, we share highlights of our work to restore nature, promote sustainable living, and help catalyse changes needed to improve the fortunes of people, wildlife, and the wider environment.

Background

Tunisian strategy for Sahelo-Saharan conservation

30+

years

since the first scimitar-horned oryx and addax were released into their natural habitat in Tunisia

The Tunisian conservation strategy relies on a number of partially fenced protected areas that maintain a metapopulation[1] of scimitar-horned oryx, addax and North African ostriches in similar conditions to their free-ranging ancestors. Slender-horned gazelle *Gazella leptoceros* still exist in the wider habitat outside of fenced areas in the Grand Erg Oriental but may utilise unfenced parts of the national park network.

In common with many countries, Tunisia faces the challenge of providing sufficiently sized areas of continuous habitat to support self-sustainable populations of aridland herbivores. Evaluations of the status indicate that the existing protected areas alone will not be large enough to achieve the goal of restoring or conserving viable populations of these emblematic animals in Tunisia. Consequently, we must address the anthropogenic threats that prevent their release from protected areas into the wider landscape. A metapopulation strategy that connects the landscapes between populations is the most pragmatic option available for the long-term future of these species in the country. However, substantial challenges must be overcome before this can be realised.

The current approach to large-bodied herbivore management in Tunisia is an intermediate step before fully free-ranging herds can be re-established.
The long-term vision we are working towards with stakeholders is to have self-sustaining populations of scimitar-horned oryx, addax, North African ostrich and slender-horned gazelle moving freely across large areas of contiguous habitat. While assessing the suitability of possible unfenced release sites in Tunisia, Marwell Wildlife and the DGF are working together to recreate natural species assemblages through management interventions across the network of protected areas. The result of this work is already informing similar projects in other areas.

Our priorities include efforts to increase in-country expertise in wildlife and habitat management in collaboration with established Tunisian academic and research institutions. Our Tunisia-based staff are also participating in national conferences, meetings, and scientific committees to raise awareness on the wider aspects of Sahelo-Saharan conservation.

[1] A metapopulation is a group of populations of the same species that are spatially separated but linked to varying degrees allowing movement of individuals between them. Whilst occurring naturally under conditions of habitat discontinuity, they are relevant to conservation efforts where populations are separated for reasons of human intervention, such as protected areas and *ex situ* management. The resilience of metapopulations, and the long-term survival of those species, is reliant on the movement of individuals and genetic exchange.

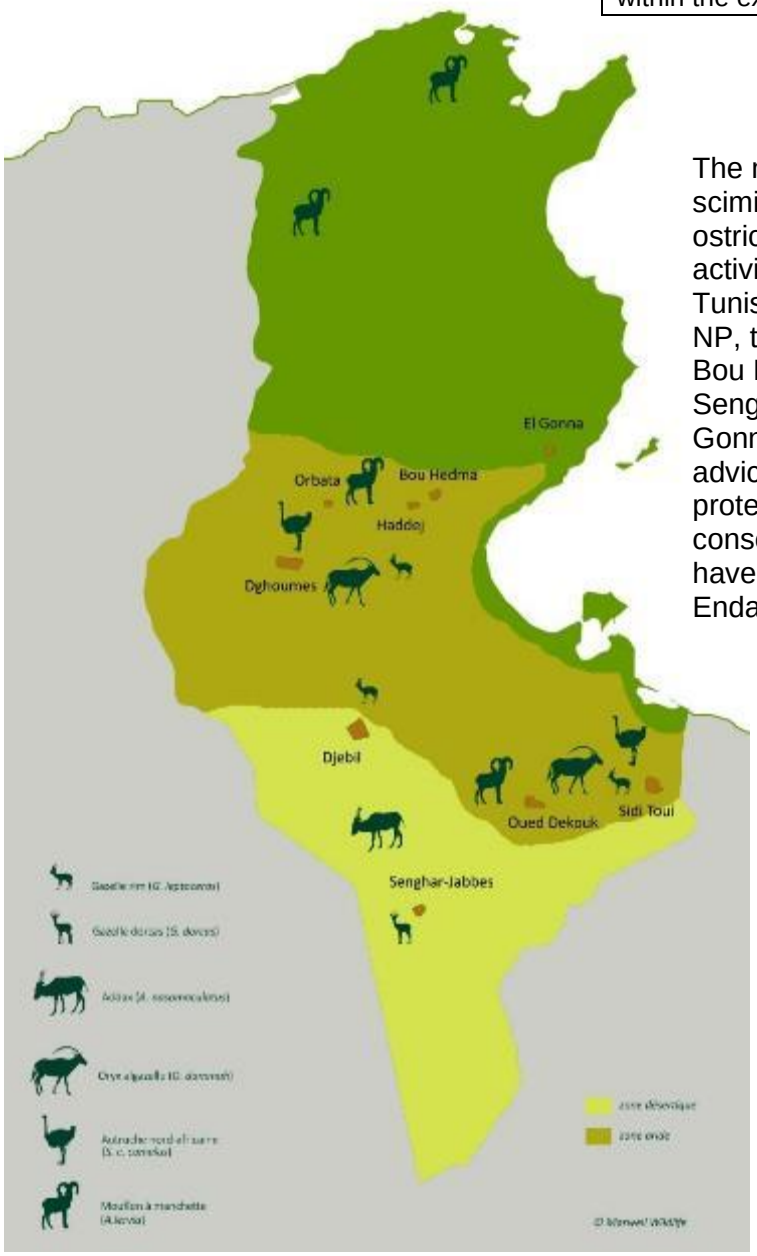
5

emblematic species

of the Sahara are benefitting from herbivore reintroductions in Tunisia

Tunisia is committed to biodiversity and wildlife conservation and is a signatory to the Convention on Migratory Species (CMS) and the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). The scimitar-horned oryx remains a priority species along with other aridland antelopes and gazelles: addax, dama gazelle *Nanger dama*, Cuvier's gazelle *Gazella cuvieri*, slender-horned gazelle and dorcas gazelle *Gazella dorcas*. Today, nearly 485,000 hectares of protected natural landscapes dedicated to the reintroduction of locally or globally extinct emblematic species are included within the Sahelo-Saharan ecoregion.

In 2021, Marwell Wildlife and the DGF of Tunisia's Ministry of Agriculture, Fisheries and Water Resources focused on the urgent question of addax recovery, as the species is on the edge of extinction in the wild. Particular efforts have been deployed in Jbil NP to resolve some key management issues. However, we continued monitoring the progress of scimitar-horned oryx and North African ostrich and their natural habitat within the existing protected area network.



The monitoring of the reintroduced populations of scimitar-horned oryx, addax and North African ostrich and their aridland habitat remains our core activity and we work in close collaboration with our Tunisian colleagues in Dghoumes NP, Bou Hedma NP, the Haddej conservation area within the wider Bou Hedma NP, Sidi Toui NP, Oued Dekouk NR, Senghar-Jabbes NP, Jbil NP, Orbata NR and El Gonna NR. We provide technical support and advice to the DGF and the local teams in the protected areas and carry out research to inform conservation management decisions. Recently, we have expanded activities to include the Endangered slender-horned gazelle.

Conservation actions in Tunisia

Implementing standardised monitoring protocols

9

protected areas

dedicated to the reintroduction and conservation of aridland herbivores in their natural habitat

Re-established populations of aridland herbivores in Tunisia now consist only of animals born and raised within their natural habitat. Data are systematically collected across species and protected areas and used to evaluate and implement appropriate conservation management.

A standardised approach to monitoring and data collection on biodiversity and herbivore populations offers the opportunity to compare the impact of various management approaches on population performance and contributes to a better understanding of the species' needs.

Marie Petretto, our Tunisia Programme Manager, has been working in close collaboration with the Tunisian staff in each of the nine protected areas for a decade together with the late Abdelkader Chetoui and two Tunisian ecologists, Mohamed Khalil Meliane and Amira Saidi. The monitoring protocols that Marwell and the DGF initially tested in Dghoumes NP have been replicated in the other parks and reserves. Consequently, in addition to the demographic data (births and deaths) routinely recorded by the park managers and their staff, basic surveys on social structure and habitat use are also performed, enabling us to gain wider knowledge on scimitar-horned oryx, addax and North African ostriches, and their environment over different seasons. Since 2018, thanks to the generous support of Marwell's partners, we have been able to deploy enough camera traps to establish a monitoring grid to continuously record aridland wildlife within Dghoumes and Sidi Toui NP, and further south in the pre-Saharan steppe of Jbil NP. This monitoring tool enables us to collect unprecedented data on aridland biodiversity in North Africa and helps us to better understand the interspecific relationships that underpin restoration efforts.

In 2021, whilst the pandemic reduced fieldwork opportunities for Marwell's Tunisian-based team, we continued monitoring activities across the protected areas and collected and analysed data on behaviour, predation, and competition for resources for our focal species. Reduced capacity meant that we relied extensively on the skills and experience of the park staff who have been working with us, leaving our team to dedicate more of their time to activities on addax in Jbil NP that required considerable support to build local capacity.

v
NEXT PAGE
Top photo; camera trap photo of a scimitar-horned oryx herd in a wadi of Dghoumes NP. Bottom photo; Marwell, Sidi Toui and Dghoumes staff in Sidi Toui NP on a camera trap training mission

From left to right: Marie Petretto (MW), Hamid Bessaoud (ST), the late Abdelkader Chetoui (MW), Saad Rejili (ST), Amara Derbel (ST), Mabrouk Ben Othman (ST), Med Khalil Meliane (MW), Med Ali Tradi (DNP), Boudhief Yahyaoui (DNP), Amira Saidi (MW) and Fathi Derbel (ST). (MW = Marwell Wildlife; ST = Sidi Toui National Park; DNP = Dghoumes National Park)

Monitoring reintroduced populations and their habitat

Nearly

210

scimitar-horned oryx

across four national parks

The scimitar-horned oryx

Scimitar-horned oryx populations have been re-established in Bou Hedma NP, Sidi Toui NP, Dghoumes NP, and Oued Dekouk NR, with a further group in Haddej, a fenced conservation area within the larger Bou Hedma NP.

In 2021, we observed a small decline in the numbers due to a combination of environmental, climate and pathogen pressures, but the protected areas still support a metapopulation of nearly 210 scimitar-horned oryx. Each park and reserve have a population approaching the estimated carrying capacity with a minimum of 60 individuals in each of Dghoumes and Sidi Toui NPs, 30 in Oued Dekouk NR, and 42 in Bou Hedma NP. There is still a group of 22 scimitar-horned oryx in Haddej, a separate fenced area of Bou Hedma NP dedicated to addax conservation. We had hoped to translocate these oryx prior to the pandemic but practical constraints mean that these animals will remain in Haddej for the moment.

Each reintroduction sourced animals from different *ex situ* populations and each protected area is geographically isolated from the others with no existing natural migration routes between them. All the populations are too small to be sustainable over the long-term, and this necessitates wider metapopulation management to ensure long-term persistence of scimitar-horned oryx in Tunisia.

As anticipated, the growth of the scimitar-horned oryx population has started to slow down as population density approaches the carrying capacity in each park. The population growth rate is partially determined by the availability of ecological resources such as food, shade, and habitat that reduces the chances of predation. Disturbance and competition can have a detrimental impact on reproductive success as individuals display heightened vigilance in response to disturbance and compete for resources, expending more energy on these activities than on reproduction.

Birth and death rates remain one of the best indicators of population sustainability and habitat quality for the species and these data are collected by the park rangers with support from our Tunisia team. However, the population sizes in each protected area are now such that it is increasingly unlikely that we can successfully count all scimitar-horned oryx in each census. Some animals hide in mountains, wadis or pockets of thick vegetation, and our focus is now on tracking the number of calves, juveniles and sub-adults observed from one year to the next to maintain consistency. We also use remote-triggered cameras (camera traps) in established grids to

provide data on scimitar-horned oryx distribution, social structure, health, and activity levels in their natural habitat. Long-term monitoring will help us to understand the population dynamics through the different seasons and across years.

In addition to the routine monitoring of antelope herds, our Tunisian colleagues from the protected areas maintain a high level of anti-poaching vigilance.

In 2021, we analysed data from the camera traps in Dghoumes NP to evaluate activity levels and temporal niche partitioning between scimitar-horned oryx, dorcas gazelle, North African ostrich and two top-order predators of the region, African wolf *Canis lupaster* and red-fox *Vulpes vulpes*. We found seasonal differences in activity levels across the focal species with the herbivores utilising hotter times of the day in summer to avoid predators. These results help improve our understanding of reintroduced populations and enable us to refine monitoring approaches for reintroduced species.

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RIGHT
African wolves (top), scimitar-horned oryx (bottom left), and red fox (bottom right) captured by camera traps in Dghoumes NP

The addax

3
protected areas support addax populations in Tunisia

The addax, *Addax nasomaculatus*, is a Critically Endangered (IUCN SSC Antelope Specialist Group, 2016) desert antelope that was formerly widespread and abundant in the dunes and gravel plains of the Sahara. The species suffered catastrophic declines due to unsustainable hunting, habitat degradation and competition with domestic livestock, disturbance and persecution through oil exploration in prime addax habitat, and political and civil unrest. As a result, the addax is on the brink of extinction in the wild and became extinct in Tunisia in 1932.

A series of historical conservation translocations has re-established three populations of addax in Tunisian national parks. The first project started in 1985 with addax released from European zoos into the fenced Total Protection Zone 1 within Bou Hedma NP. In 1988, these were augmented with additional addax from North America. This herd was later transferred in its entirety from Total Protection Zone 1 to another fenced area, Haddej, within the wider Bou Hedma NP. Haddej currently supports a population of approximately 56 addax. Whilst Haddej is outside the species' indigenous range, it provides a protected location with good habitat for addax within a range-country and has acted as a source population for translocations to other national parks in the south of Tunisia.

In 2007, addax were translocated from Bou Hedma NP to Senghar-Jabbes NP and Jbil NP in Southern Tunisia. The population in Jbil was augmented later that year with addax from European and North American zoos. The populations in both national parks have encountered difficulties and the current addax population stands at approximately 33 in Senghar-Jabbes NP and only seven in Jbil NP. However, some of the Jbil females are pregnant and calves are expected in 2022.

Concerns over calf predation and sand piling up against fences in the wider Jbil NP led to the herd being moved into an acclimatisation enclosure. However, feeding practices were not meeting the addax's nutritional requirements leading to poor health.

A comparable situation exists in Senghar-Jabbes NP, where the addax herd is held in an enclosure to protect them from predation and prevent them from leaving the safety of the park where sand has compromised the fences. A field mission in December 2021 to assess the status of addax within the three protected areas identified key changes in management needed to improve the status and condition of addax. The DGF and park management are now considering their options.

In 2021, Marwell worked closely with the rangers and management team in Jbil NP to address some key management issues impacting the addax, including nutrition. Marwell's team also helped evaluate the needs of Jbil NP in terms of equipment, maintenance, and repairs to improve capacity. The management team are now working towards releasing the addax back into the wider fenced area within the national park. It is unlikely that the population will be able to recover without translocating additional animals to augment the remaining addax, and the feasibility of this will be assessed once the management concerns have been fully resolved.

The North African ostrich

127

year absence from Tunisia

The giant flightless birds are back in their natural habitat in Tunisia

The ostrich, *Struthio camelus*, is assessed as Least Concern with a declining population by the IUCN Red List (Birdlife International, 2018). However, there is no specific assessment of the distinct, red-necked, North African ostrich, *S.c.camelus*, despite disappearing from most of its former range. Extant wild populations of the sub-species are restricted to just a few fragmented populations in Cameroon, Chad, Central African Republic, and Senegal.

North African ostriches were once abundant in the South of Tunisia, but following exploitation were extirpated from the country at the end of the Nineteenth Century, with the species last recorded in Tunisia in1887.

In 2008, North African ostrich were imported from Souss Massa National Park in Morocco, where they had previously been reintroduced from Chad, to an *ex situ* facility in Orbata Faunal Reserve, Tunisia. The ostriches bred in a 10ha enclosure and four ostriches (one male and three females) were translocated to an enclosure within Dghoumes NP; this group started breeding in early 2011.

In 2012, the Saudi Wildlife Authority's National Wildlife Research Centre in Taif donated unrelated chicks of Sudanese origin to the breeding and reintroduction programme in Tunisia, to enhance genetic diversity.

In October 2014, nine ostriches (five males and four females) were released from their enclosure into the wider Dghoumes NP marking the first stage of a reintroduction project that saw the return of the species after a 127-year absence from the Tunisian landscape. In 2015, three (one male and two females) of the Saudi ostriches were translocated to an acclimatisation enclosure in Sidi Toui NP prior to release later that year. This was followed by the reintroduction of two adults and six juveniles to Bou Hedma NP in October 2019.

There are now approximately 80 North African ostriches in three fenced, protected areas in Tunisia; Dghoumes NP, Bou Hedma NP, and Sidi Toui NP.

Preparations are underway to release of some of the ostrich males that are currently housed in Friguia Zoo into Oued Dekouk NR next winter.

There have been some unanticipated benefits to reintroducing ostrich to Tunisian protected areas. We previously shared concerns over the high predation pressure on scimitar-horned oryx calves observed in Bou Hedma NP. Whilst some juvenile mortality is expected in a fully functioning ecosystem, poor calf survival slows the progress of restoring a species to the wild. Since the reintroduced ostriches started grazing alongside the scimitar- horned oryx herd, survival of

scimitar-horned oryx calves has improved and the density of African wolves in close proximity to the oryx has reduced. Our wider biodiversity monitoring has indicated that the number of African wolves in Bou Hedma NP has not decreased, but we hypothesise that the additional presence of ostrich makes oryx calves harder to target due to increased vigilance in the oryx – ostrich group, and the wolves may have diversified their prey base as a consequence.

The reintroduction of ostrich has presented a number of questions on interactions between megafauna and wider impact on the biodiversity of the protected areas. We have some ongoing studies that will help us to understand more about the behaviour of these reintroduced birds.

As expected in a natural breeding system, population growth is slow. The precocial chicks of these flightless birds are particularly vulnerable and juvenile mortality from predation and environmental events is high. However, it is encouraging to see the reintroduced animals nesting, eggs hatching, and some offspring raised to adulthood every year.

RIGHT
A camera trap photo of a female ostrich turning the eggs in the nest

RIGHT
A flock of ostrich in Bou Hedma NP

Population management and genetic diversity monitoring

2 species

comprehensively genetically assessed (Comprehensive Genetic Species Assessments – CGSA) in Tunisia

A low genetic diversity within a population impedes recovery due to risks associated with inbreeding and the inability of populations to adapt to changing environmental conditions, such as climate change. Genetic diversity is needed to ensure a sustainable population, and the 2007 reintroductions of scimitar-horned oryx and addax to Tunisia maximised genetic diversity within the release cohort, within the practical constraints of the project.

We collected tissue samples through biopsy darting from the reintroduced scimitar-horned oryx and addax populations in 2012 and 2017, respectively, to evaluate levels of genetic diversity in the reintroduced populations. Samples were also provided by EAZA (European Association of Zoos and Aquaria) and AZA (Association of Zoos and Aquariums) members and zoological institutions in the Arabian Peninsula. The scimitar-horned oryx project was carried out in partnership with the DGF and the WildGenes Laboratory at the Royal Zoological Society of Scotland (RZSS), and the addax project with the DGF, RZSS, Al Ain Zoo, and San Diego Zoo Wildlife Alliance.

The results for both species indicate that the Tunisian metapopulations have unique genetic diversity that differs between reintroduced populations in the different protected areas, and that additional genetic diversity remains in *ex situ* populations. These data have been incorporated into population viability analysis models and are helping to guide population management decision-making.

We plan to repeat these Comprehensive Genetic Species Assessments (CGSA) at suitable generational intervals to evaluate how genetic diversity changes within naturally breeding reintroduced populations and obtain up-to-date genetic data to use in ongoing management planning.

The value of assessing genetic diversity in the wild and *ex situ* populations for slender-horned gazelle in Tunisia is a priority, but low numbers and logistical challenges currently restrict sample collection. However, we are collecting samples as the opportunity arises.

In 2021, we held a workshop in Tunis to deliver the results of the addax genetics project and its implications to the DGF. This was followed by a field mission to the addax protected areas; Jbil NP, Senghar-Jabbes NP and Haddej within the wider Bou Hedma NP, to discuss the results with local teams and collate information that impacts the management of addax in those parks. This information will inform the development of a National Action Plan for the Conservation of Addax in Tunisia planned for 2022/2023. We have previously held workshops in Tunisia to discuss the results and implications of the scimitar-horned oryx genetic analyses.

Disease risk and the One Health concept

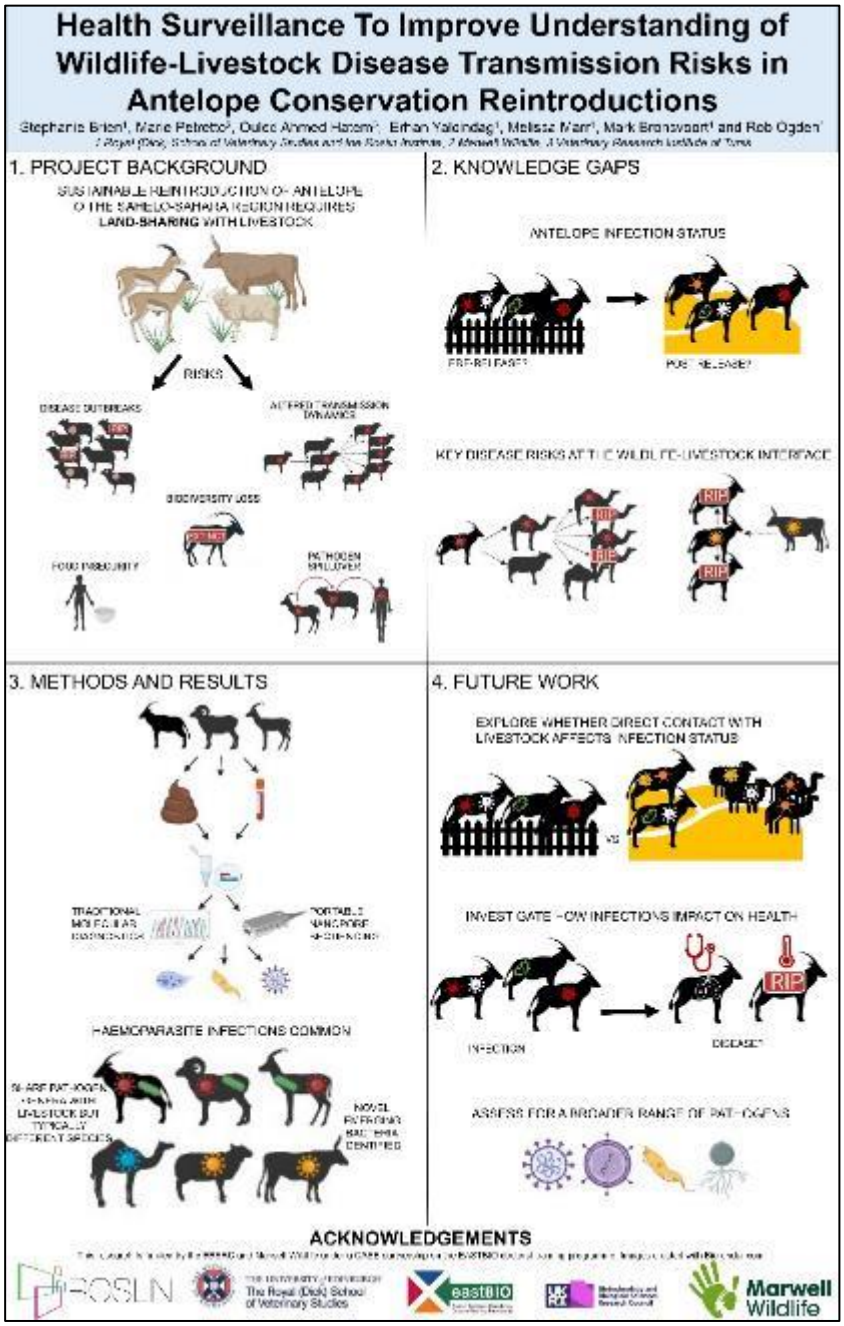
RIGHT
Stephanie BRIEN, PhD student at the Roslin Institute and the Royal (Dick) School of Veterinary Studies (University of Edinburgh, Scotland) processing samples collected during management procedures in Chad to investigate infectious disease transmission between scimitar-horned oryx and livestock

Regular health monitoring is an important but challenging activity to implement for semi-wild or free-ranging populations. We have trained rangers in all the protected areas to identify abnormal conditions in wildlife, and we developed a network of partner institutions within Tunisia to increase the availability of veterinary and laboratory support services to protected area managers. In particular, we are working with our local partners at the IRVT (Institut de la Recherche Vétérinaire de Tunis) and the CNVZ (Centre National de Veille Zoosanitaire) to assess disease risks and find the best way to screen antelope and other wildlife populations.

Ungulate reintroductions potentially exacerbate infectious disease transmission risks between newly reintroduced populations, livestock, and people, that could have consequences for health, conservation, and food security. In Tunisia, we are monitoring the health of scimitar-horned oryx and working toward identifying and mitigating the risks associated with pathogen transmission. Very little is known about wildlife susceptibility to most widespread diseases, therefore our work is an opportunity to better understand how pathogens and diseases can circulate between wild and domestic ungulates and consequential risk to human health. Livestock management is a key economic resource in southern Tunisia, and this potentially presents a risk of cross contamination between livestock and wildlife via the wider environment, arthropod vectors, and carnivores. In 2021, we entered the third year of a collaboration with PhD student Stephanie Brien of the Roslin Institute and the Royal (Dick) School of Veterinary Studies (University of Edinburgh, Scotland) who is investigating how molecular and genomic diagnostic techniques can be used to identify infectious diseases in scimitar-horned oryx using blood, tissue or faecal samples. Looking at the scimitar-horned oryx genome, she will

explore adaptive diversity as a measure of population-level disease resistance.

The result of Stephanie's work will be instrumental in developing a systematic disease risk analysis for scimitar-horned oryx with region-specific hazards. Information on disease risk will be combined with immunogenetic data to predict the potential outcome of wider reintroductions in Tunisia and to identify risk mitigation strategies to increase the chances of establishing self-sustaining wild populations of scimitar-horned oryx and other antelopes.



RIGHT
Poster summarising Stephanie Brien's research, adapted from a presentation to the 69th Wildlife Disease Association (WDA) congress (CUENCA 2021 Virtual)

BELOW
Marie Petretto and Dr Mohamed Ghorbel performing emergency care on an injured slender-horned gazelle in the *ex situ* centre in El Gonna NR (Sfax)

In 2021, we continued our health monitoring programme together with trained national park personnel as in-country travel was limited. All stakeholders are engaged in detecting problems in a timely manner, but logistical challenges are limiting data collection in some places. We therefore started to create a network of local vet practitioners able to visit when necessary, thus improving early response time.

Biodiversity surveys

10

consecutive years of biodiversity surveys

evaluating changes over long timescales to understand biodiversity trends within the small fenced protected areas

The last release of scimitar-horned oryx and addax from European and North American zoos took place nearly 15 years ago, and the populations are now well established in their natural habitat. A key part of our work includes evaluating the changing biodiversity in the aridland ecosystems in the protected areas that support these populations.

For the tenth consecutive year, we surveyed the biodiversity in Dghoumes NP and expanded monitoring to Jbil NP and Sidi Toui NP. Our aim is to evaluate how these habitats are changing and the role of protected areas in restoring arid steppe botanical communities and its associated wildlife.

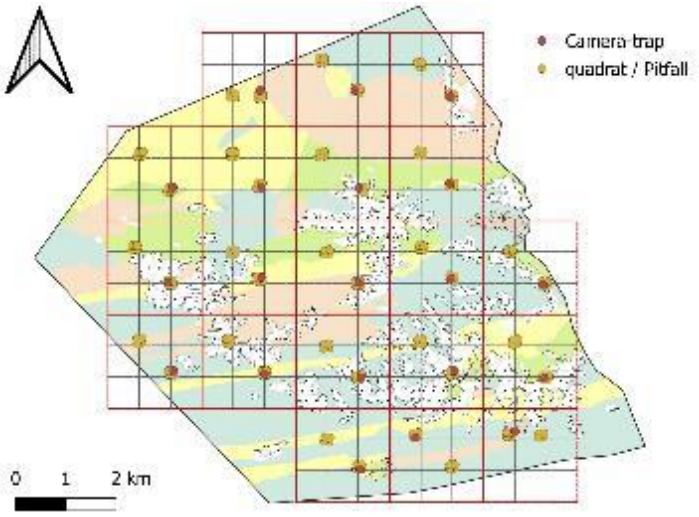
Vegetation and habitat monitoring

Our annual vegetation surveys in Dghoumes NP are contributing to an existing dataset that will help to develop a locally appropriate monitoring approach to assess changes in biodiversity.

In 2021, we continued camera trap monitoring in Dghoumes NP, Sidi Toui NP, and Jbil NP with local rangers taking on the responsibility of managing and maintaining the camera traps and downloading the photos, with oversight from our team in Tunisia. This is a great opportunity to empower and engage people from local communities as they can directly see the results from conservation activities.

Mammal surveys

We are building a long-term dataset on the density, location, and behaviour of key mammal species. Data are collected through spoor transects and camera trap surveys; they document species richness and abundance, habitat use, and social structure of key species. As a result of the development of vegetation in the protected areas, direct observations of animals are becoming increasingly difficult, particularly the cryptic species that have critical ecological functions and are indicators of habitat quality. Established camera trap grids enable us to detect and monitor these cryptic species. Long-term monitoring will help us to understand the population dynamics through the different seasons and across years.



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An example of the grid for camera trap studies in Jbil NP

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A specimen of a small desert beetle, *Erodius nanus*, in Jbil NP

We are currently compiling different monitoring datasets to better understand the relationships between animal and plant species and their environment.

In 2021, we were able to confirm, for the first time, the occurrence of the Libyan striped weasel *Ictonyx libycus* in Dghoumes NP. The presence of the species has occasionally been reported by locals in the vicinity of Dghoumes, but this had not been verified before the camera trap photo. The Libyan striped weasel has suffered a population decline since the end of the last century due to a belief that it can provide medicinal benefits. Dghoumes NP also appears to provide a refuge for the persecuted striped hyaena *Hyaena hyaena*. Camera trap detections of the species in the park are becoming more frequent suggesting the formation of a sedentary population.

Ground beetles

Surface-active invertebrates are vital to the functioning of these fragile arid ecosystems. Since 2020, we have been surveying the beetle assemblages in several protected areas of Southern Tunisia. We have identified most of the beetle families and evaluated their seasonal activities in relation to the habitat features and climatic conditions. This unprecedented study provides baseline data on this crucial component of the ecosystem. There was encouraging evidence of species fulfilling a range of ecological functions from the recycling activities of dung beetles (*Scarabaeidae*) to the pollination services of flower chafers (*Cetoniidae*). We are now developing further assessments and information about how the conservation invertebrate communities can inform the management of the protected areas and the wider landscape.

In 2022 the protocol will be replicated further south in Senghar-Jabbes NP providing a more complete assessment of the ecosystems in the Grand Erg Oriental.

Conserving the endemic slender-horned gazelle population

12,000

km²

of the wider arid landscape are being monitored in conjunction with the DGF, where we aim to enhance biodiversity management and connect fragmented populations by increasing available habitat for slender-horned gazelle, aridland antelope and other wildlife, ultimately expanding into the desert wilderness of the Grand Erg Oriental.

The slender-horned gazelle

The slender-horned gazelle *Gazella leptoceros* is a small ungulate that has suffered a worrying population decline due to poaching and disturbance. It is listed as Endangered by the IUCN SSC Red List of Threatened Species and has a global declining wild population of only 300-600 mature individuals.

These gazelles are well-adapted to the dunes (ergs) and interdunal depressions (regs) of the Sahara, and they range widely in response to the ever-changing desert landscape. They exist by feeding on sparse vegetation, and are important for dispersing seeds across the landscape, creating vegetation patches that support islands of unique biodiversity that also act to stabilise dunes.

Their wild population is highly fragmented with patchy records from Algeria to the Nile, but in the last 10 years they have only been seen in the Grand Erg Oriental stretching across Algeria and Tunisia. Recent observations suggest that they persist in the 5,600,000 ha of the Tunisian Eastern Grand Erg. Slender-horned gazelles are known to occur in Jbil and Senghar-Jabbes NP in Tunisia and in the neighbouring parts of Algeria, with last confirmed sightings in 2021.

The Grand Erg ecosystem is under continuing threat of extensive degradation from human activities. Despite being listed on Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals and protected by national law, slender-horned gazelles continue to face high levels of poaching and disturbance. However, accurate assessments of the wild population are hampered by their inaccessible desert habitat. Despite this, the Tunisian slender-horned gazelle population needs assessing to target conservation action where it will be the most effective.

The global *ex situ* population is mostly located in North America, but as of April 2022 totals only 68 individuals across 13 institutions. A small *ex situ* population has been maintained in an enclosure in Sidi Toui NP for over 20 years. When considering both their wild and *ex situ* status, it is clear that slender-horned gazelles are facing a high risk of extinction.

Given its precarious situation both in the wild and *ex situ*, Marwell Wildlife and the DGF have developed a conservation project that encompasses both the wild population in the Grand Erg Oriental and *ex situ* centres in Tunisia.

The Grand Erg Oriental surveys

The Grand Erg Oriental (English: 'Great Eastern Sand Sea') is a large field of sand dunes in the Sahara Desert situated in Tunisia and Algeria. It covers a transboundary area of some 600 km wide by 200 km north to south and 150,000 ha and 287,000 ha within this area are dedicated Tunisian national parks (Jbil and Senghar-Jabbes NPs, respectively).

The Tunisian erg can be divided in two areas: the Northern part (mainly within Kebili Governorate) is mostly utilised for tourism, and is delimited by the oases of Nefta, Tozeur, and Douz at its north-eastern edge and includes Jbil NP. The Southern part (Tataouine Governorate) is controlled by the military and begins below the latitude of Senghar-Jabbes NP; it comprises the areas utilised for military, and gas and oil exploration and extraction.

Aerial survey

Since 2019, we have focused efforts on assessing the size and distribution of the wild slender-horned gazelle population in Tunisia, and the threats to its survival. We carried out an aerial survey of the Sahara Desert within Tunisia over three days in Winter 2019 to gather preliminary data on the status of the wild population and their habitat, and evaluate the feasibility of monitoring desert habitat and fauna using an ultralight aircraft in Tunisia.

The survey comprised 440 km of systematic transects with additional 925 km of active searching where the route was determined by habitat features. No gazelles were directly observed during the preliminary survey. Although we could not confirm if they were slender-horned or dorcas gazelle tracks, gazelle tracks were recorded in areas of confirmed presence by locals. Sampling effort was limited by practical constraints and therefore it was not possible to estimate the size of the wild population from this survey. Anecdotal reports from members of the local community suggested that slender-horned gazelles might engage in a seasonal migration between the study area and Algeria, and this could partially explain the absence of evidence of the gazelles' presence during the survey period.

The mission did achieve its secondary objective of evaluating the feasibility of aerial surveys to monitor desert fauna in Southern Tunisia, and we established protocols that can be used for future surveys.

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Aerial survey over the Grand Erg Oriental in Tunisia

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Fresh slender-horned gazelle tracks spotted during the ground survey in the Grand Erg Oriental in Tunisia

Ground survey

A follow-up ground survey took place in October 2020 covering a total of 350 km of wild habitat of the Grand Erg Oriental. Using one car and two all-terrain vehicles (ATVs), four experienced trackers and three ecologists surveyed for the presence of wild slender-horned gazelles. Spoor transects, insect traps and camera traps were also deployed for three nights near camps to collect some baseline knowledge on the wild fauna of the area.

We recorded the presence of tracks and fresh latrines indicating the presence of at least nine slender-horned gazelles with group sizes ranging between two and four, but possibly more. Only one pair was directly observed and they took flight at the sound of the approaching vehicles. Wild mammals detected by camera traps were restricted to the fennec fox *Vulpes zerda* and the jerboa *Jaculus jaculus*.

This survey did confirm the presence of a remnant wild population of slender-horned gazelles in the Tunisian Grand Erg Oriental.

Despite the terrain being extremely difficult to navigate, the area is frequented by poachers, local campers, and tourists. There is now an urgent need to better assess the size of the remnant wild population and protect it from exploitation and disturbance.

In 2021, Marwell Wildlife and the University of Southampton's unmanned aerial vehicle (UAV) team (Soton UAV) started exploring the possibilities of using aerial platforms for innovative application to wildlife conservation and surveying in remote areas. In the future we hope to evaluate the application of this technology in aridlands. Find out more at: https://www.southampton.ac.uk/iris/marwell-wildlife.page

The *ex situ* breeding centres

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ABOVE
Outer edge of the new *ex situ* breeding facilities in El Gonna National Reserve

Creation of a new *ex situ* breeding group in El Gonna NR

El Gonna Nature Reserve (NR) was established in 2010 and is a 4,700 ha reserve near the town of Agareb, a short distance from Sfax. An *ex situ* facility has recently been built within the reserve to manage a herd of slender-horned gazelles to increase the capacity for *ex situ* management of the species in Tunisia. An *ex situ* group of slender-horned gazelle originating from the wild in Tunisia and Zoo Planckendael, Belgium, have been held in Sidi Toui NP since 1999. However, the national park is remote making it difficult to manage the *ex situ* population.

In November 2020, four slender-horned gazelles (one mature male, two mature females, and one young male) were successfully translocated from the *ex situ* facility within Sidi Toui NP to El Gonna NR. Both facilities will be managed as one connected population, with individuals translocated between them when required.

In 2021, the Sidi Toui population was managed in two groups. One group consisted of one adult male, one sub-adult male, and four adult females. All four females gave birth, with three calves surviving totalling nine gazelle (2 males; 4 females; 3 calves). The second group of gazelles produced eight calves in March 2021 ending the year as a group of 17 (2 males; 7 females; 8 calves), Overall, the *ex situ* population of slender-horned gazelles in Tunisia is growing.

In 2021, signs of breeding were apparent, but the *ex situ* facility in El Gonna NP did not see successful births. The facilities require some modification to improve the husbandry conditions and breeding performance, and we are working with the team in El Gonna NP. In 2022/2023, we are seeking financial support to build additional pens and a hand-capture area and deliver additional training to park staff.

Sharing experiences, networking and supporting our Tunisian colleagues

Park staff training, teamwork and networking

We believe that our long-term collaboration with the DGF and our other Tunisian and International partners is essential for sustainable conservation. We have a philosophy of continually sharing experiences and working closely with our Tunisian colleagues. We also facilitate opportunities for our Tunisian partners to communicate on a national and international stage, by:

- facilitating communication between the park managers and local NGOs, universities and research instituts;
- contributing to students' training;
- representing our Tunisian projects in various national and international conferences and workshops.

In 2021, we continued capacity building in Sidi Toui NP. The newly trained guards have been applying their new skills to managing the camera trap grid and creating organised photo databases. They are sharing key photos to help the park managers report on biodiversity in each protected area. We plan to expand this training to Jbil NP as well.

Higher education

10

Master's students

encouraged to explore the diversity of opportunities available to professionals

Our scientists supervise and facilitate undergraduate and postgraduate research projects, and teach university students contributing to academic qualifications in the UK and internationally.

As part of our work in Tunisia, we accept a small number of students each year, embedded in our Conservation Biology Team, exposed to real-world challenges, and undertaking projects contributing to our programme of work.

Over the last few years, we have supervised five students completing their Master of Research (MRes) Wildlife Conservation degrees, run in collaboration between the University of Southampton and Marwell Wildlife, and five Master's degree students in Ecology, from the University of Tunis El Manar. We also commit ourselves to increasing in-country expertise in Wildlife and Conservation Medicine in collaboration with the University of Tunis El Manar, the Institute of Aridlands of Medenine and the National Veterinary School of Sidi Thabet.

In 2021, we were unable to deploy international research students in the field in Tunisia because of global travel restrictions and risk assessment protocols relating to the global Covid-19 pandemic. However, we are very pleased to continue to support two of the next generation of Tunisian ecologists, Amira Saidi and Mohamed Khalil Meliane, in their PhDs. To know more about those young conservationists, do watch this space in next year report!

International meeting on Sahelo-Saharan Conservation

20th

annual meeting for Sahel and Sahara Conservation

18 – 20 May 2021
Online due to the Covid-19 pandemic

The Sahelo-Saharan Interest Group (SSIG) meeting is an annual forum for all those working in wildlife conservation within the arid areas of North Africa and the Middle East. Facilitated by the Sahara Conservation Fund (SCF) and hosted by different countries, the meeting provides an opportunity to bring people together to exchange ideas and continue a strong tradition of collaboration on behalf of Sahelo-Saharan wildlife and its people.

In 2021, the event was held online due to the Covid-related travel restrictions. Marwell was, however, very proud to share the results of some of our activities. In particular,

"Evaluating biodiversity of a degraded desert ecosystem to inform protected area management" that described our close collaboration with the managers of Jbil NP for the reintroduction of the addax in a restored desert ecosystem (Meliane, M.K, Saidi, A., Petretto, M. & Gilbert, T.)

"A global perspective on genetic diversity within wild, semi-wild and captive addax" presented by our partner from WildGenes Laboratory of the Royal Zoological Society of Scotland (Dicks, K., Petretto, M., Ivy, J., Ball, A., Senn, H., Craig, M., Banfield, L., Guedara, H., Taghouti, E., Boufaroua, M., Chuven, J., Riordan, P. & Gilbert, T.)

"Using molecular tools to assess the infection status of endangered antelope populations to support conservation reintroduction" that introduced our collaboration with Dr Stephanie Brien on pathogen transmission at the interface between scimitar-horned oryx and domestic ungulates (Brien, S., Petretto, M., Ahmed Hatem, O., Yalcindag, E., Marr, M., Bronsvoort, M. & Ogden, R.)

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ABOVE
Tim Woodfine, Director of Conservation (Marwell Wildlife)

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Some of the participants of the online 2021 SSIG meeting

Proposed activities for 2022

£200

buys a camera trap

£650/month

covers the cost of a post-graduate field assistant

£22,000

purchases and imports a tamer into Tunisia

We will continue to monitor the populations of the key reintroduced populations of scimitar-horned oryx, addax, and North African ostrich across the protected area network. Collected data will be analysed and used to develop appropriate management strategies with the Tunisian government. This necessitates regular visits to the protected areas by the field team, training of rangers within the parks and reserves, and collection of population data. **We will deploy teams of Tunisian post-graduate ecologists to carry out surveys and collect population data.**

We are planning on continuing and expanding the monitoring of species assemblages in the protected areas, primarily through camera trap surveys. We will continue our work in Dghoumes, Jbil and Sidi Toui NPs, but we would also like to expand these surveys to Oued Dekouk NR and Senghar-Jabbes NP as well as replicate short-term surveys in Bou Hedma NP. This will enable us to simultaneously survey the protected areas and facilitate site comparisons to fully understand the underlying ecological processes. These important data will improve our understanding of how the scimitar-horned oryx, addax and other key species use their habitat, allow us to assess the carrying capacity of the area and develop appropriate management strategies with the Tunisian government. Most of the devices from Dghoumes and Jbil NPs need replacing due to wear and damage from being used continuously for over 2 years in an arid environment. **We need to deploy at least 25 cameras per park; therefore we will seek to purchase 50-80 additional devices.**

Whilst we don't have any evidence of circulating diseases within the scimitar-horned groups, it has been demonstrated in the past how important health surveillance is. Exposure to infectious diseases is a limiting factor for translocations and we need to evaluate and mitigate risk before moving animals between sites as part of the metapopulation management plan as well as preventing any disease events impacting antelope and gazelle populations in the protected areas. **There is a need to increase health screening** for scimitar-horned oryx and other ungulates within those protected areas to better understand the cause of unexplained mortalities that have occurred in the past and may happen again.

Slender-horned gazelles are threatened with extinction in the wild, and the global *ex situ* population is vulnerable due to its small size. The Tunisian *ex* situ population is an important part of *ex situ* conservation efforts, but it requires some attention. **There is a need to extend the facilities in El Gonna NP to improve group management, create a hand-capture facility, vaccinate the group, and train park staff in capture and handling techniques.**

As a consequence of the metapopulation management planning, we have identified a need to translocate scimitar-horned oryx between protected areas. To achieve this, we will need to **purchase and import safe capture materials into Tunisia**. These materials are not available locally and are vital for enacting conservation translocations and disease monitoring. It is challenging to import mass capture materials into Tunisia so we would like to start with a portable boma, runways and a tamer to safely hold the animals, and we are therefore looking for funds to begin the purchase process and to cover the associated veterinary expenses.

We see the immense value in capacity building and skills development for young Tunisian veterinary and ecology graduates to gain experience of working in the field, developing skills, and collecting crucial data to facilitate management decisions. As the next generation of conservationists in Tunisia, it is important that students have support to travel to and work in these remote field sites.

Together, these activities will collect fundamental ecological and population data that, once analysed, will inform and help enact management strategies for the conservation of the focal species and their habitats in Tunisia.

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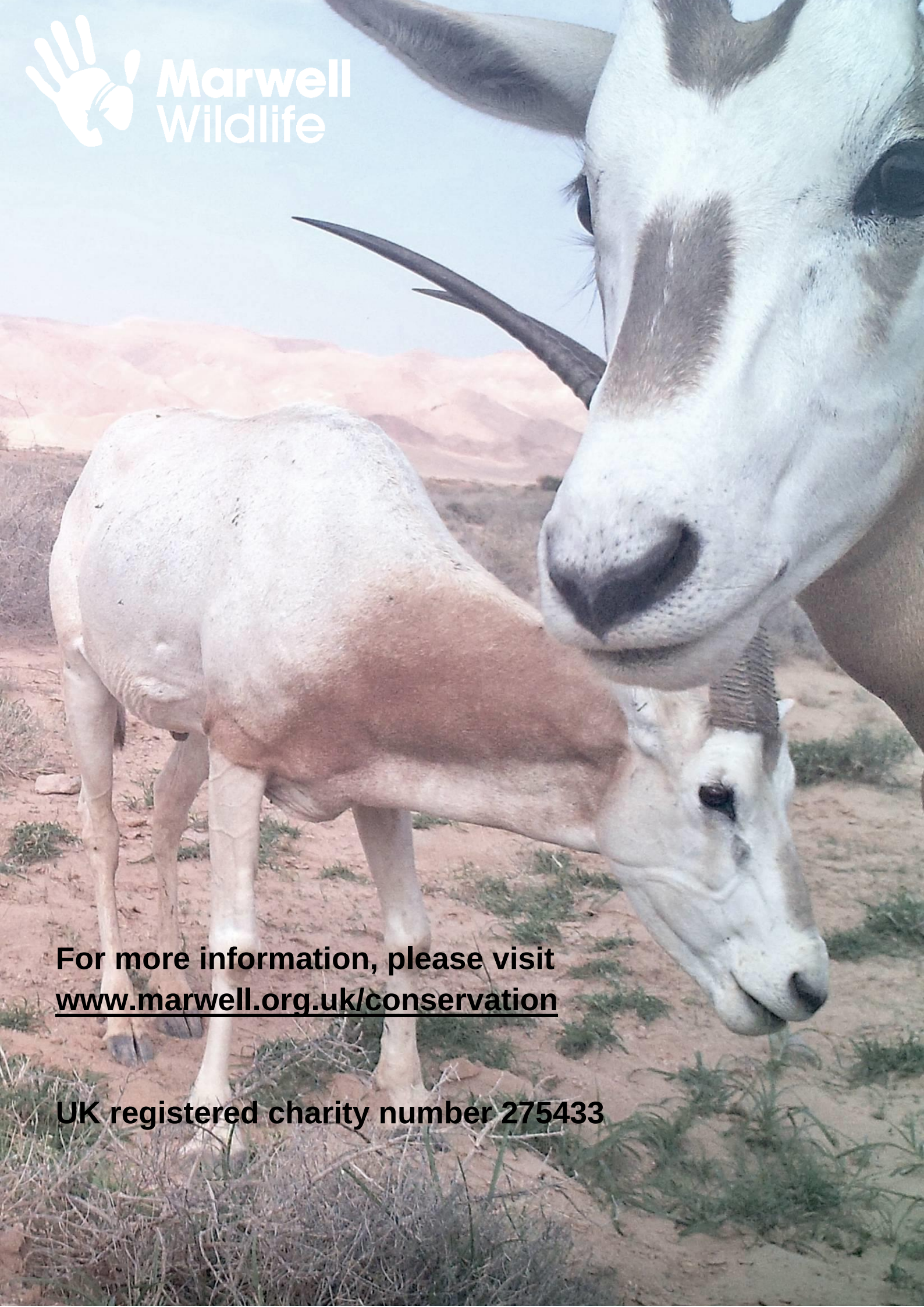
Slender-horned gazelle in the *ex situ* facility in El Gonna NP

Costs & Funding Proposal

The annual costs of operations in Tunisia are underwritten by Marwell Wildlife, maintaining our presence in-country, and ensuring the continuity of work that is essential for long-term success. We have the opportunity and ability to expand our work and enhance conservation impact and are seeking funding for delivery of specific projects. Hence, we would very much welcome the support of EEP partners who share our goals of achieving sustainable populations of slender-horned gazelle, scimitar-horned oryx, addax, and North African ostrich, and the restoration of their habitat and local biodiversity. By supporting local development and promoting the motivation and the skills of the next generation of Tunisian ecologists, our programme could provide great and inspiring stories to emphasize the contribution of the partners of our work.

Cost item	Cost basis	£
Implementation of oryx meta-population plan		
Purchase mass capture material	Plastic boma incl. all components @ £ 8,800 importation costs @ £2,500	11,300
Purchase tamer & portable alley system	Tamer incl. all components @ £11,000 + importation costs @ £7,000	18,000
TOTAL		**29,300**
Slender-horned gazelle *ex situ* centre in El Gonna NP		
Extend and improve the *ex situ* facility	£13.20 per metre of fence x 950m @ £12,540 £1,052 doors and canvas	13,592
Add a hand-capture area to the facility	£500 mobile gate and corridor	500
Veterinary prevention and emergency care	£79 per month x 12 months: vaccines, consumables, and vet fees	948
Animal handling training for staff	External experts' flights and accommodation	3,000
TOTAL		**18,040**
Standardised oryx, addax, North African ostrich and habitat monitoring		
Tunisian field assistants (2 teams of 2 graduated Tunisians)	4 x 12 month @ £650 per month (salary & expenses)	31,200
Monitoring 4 protected areas by Marwell team	Mileage: 2,000km/m @ 0.36p per km	8,640
Training and skill development for protected area staff	4 training events, totalling 20 days	3,000
Camera traps & consumables	2 x 25 x camera traps @ £200 per unit	10,000
Laptop and external hard drive	1 per park, 2 parks @ £ 240 (used laptop) +£60 (hard drive)	600
Batteries	8 batteries/camera, 4 times a year, 80 cameras @ £0.5/batt	1,280
TOTAL		**54,720**
Integrated wildlife & livestock health monitoring		
Emergency care, diagnosis and management of antelope and ostrich	5 oryx, 5 addax, 2 ostrich @ £60 per animal (drugs, consumables)	720
Sampling and analyses	parasitology, histology, serology etc.+ storage and shipping @ £50/animal, 20 individuals	1,000
TOTAL		**1,720**
Research on the restoration of the arid steppe ecosystem		
Stipend for Tunisian trainees and local trackers	2 pers., 3 months (60 days) @1,500 TND (£393) mo/pers	2,358
Transport and food cost	3 months @ £ 500/mo	1,500
TOTAL		**3,858**
Overall Total		**£ 107,638**



For more information, please visit
www.marwell.org.uk/conservation

UK registered charity number 275433