Conservation of Sahelo-Saharan fauna & their arid steppe habitats in Tunisia: report on 2022 conservation action and impact

Marie Petretto, Conservation Biologist, Marwell Wildlife
Tania Gilbert, Head of Conservation Science, Marwell Wildlife

THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE

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Cover photographs: female scimitar-horned oryx in the arid steppe of Oued Dekouk National Reserve, Tunisia. Photograph by Marie Petretto, Marwell Wildlife,

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We are especially grateful to our team in Tunisia: Amira Saidi, Mohamed Khalil Meliane and the late Abdelkader Chetoui.

Supporting Nature's Recovery: A Conservation Health Approach

Marwell Wildlife's Conservation Strategy 2023 – 2028

Marwell Wildlife's five-year conservation strategy addresses the critical issues of climate change, ecosystem degradation, and biodiversity loss caused by the disconnection between people and nature. The unsustainable use of natural resources exacerbates this disparity and puts future generations at a disadvantage. Conservation Health is a unifying approach that recognises the interdependency between the health of people, animals, and ecosystems and applies conservation action to assist nature's recovery. We aim to connect people with nature and demonstrate nature-based solutions and sustainable living based on equity, diversity, and inclusion to solve complex problems and support the recovery of global biodiversity.

Contents

Introduction

Marwell Wildlife began working on aridland conservation in Tunisia in the 1980s, as the government revised its Forest Code, signed international agreements for migratory species and biodiversity, and established a network of protected areas. Today, over 485,000 hectares in the Sahelo-Saharan region are protected through eight National Parks and Reserves. These protected areas aim to restore emblematic species like addax, scimitar-horned oryx, and North African ostrich that are locally or globally extinct.

Marwell Wildlife's initial focus was the reintroduction of scimitar-horned oryx, but over the past 30+ years, we have worked closely with our Tunisian partner, the Direction Générale des Forêts (DGF) on restoring and conserving a number of priority species and their aridland ecosystems. In 2020, Marwell Wildlife and the DGF renewed their Memorandum of Understanding, solidifying their partnership and the framework for future conservation efforts.

These conservation efforts focus on scimitar-horned oryx, addax, North African ostrich, and slender-horned gazelle and are based on close collaboration with Tunisian partners at Jbil National Park (NP), Senghar-Jabbes NP, Dghoumes NP, Bou Hedma NP, the Haddej reserve, Sidi Toui NP, and Oued Dekouk National Reserve (NR). We also work to enhance the skills and expertise of local partners to ensure the long-term sustainability of conservation efforts, particularly for *ex situ* breeding centres for slender-horned gazelle, addax, and North African ostrich.

Over the years, Marwell Wildlife has gained extensive knowledge of aridland fauna and their environments, allowing us to better understand what influences conservation success.

V
BELOW
Group of reintroduced scimitar-horned oryx in Bou Hedma NP

Our commitments

The restoration of wildlife populations to their natural habitats, and the conservation of those habitats, remains a challenge, but one that Marwell is committed to. Our work in Tunisia applies the concept of conservation health to our projects emphasising the key role of partnerships and collaboration around the themes of health, connection, and knowledge exchange and innovation. By having a Tunisia-based team, we are able to respond quickly to new issues and capitalise on our successes. Our research and the implementation of robust monitoring protocols in collaboration with local teams enables us to gain a better understanding of the factors affecting aridland wildlife and their habitats. This work is connected to the provision of benefits for local communities and promoting sustainable coexistence with wildlife. Over the past three decades, Marwell has worked to conserve wildlife in Tunisia, developed a Conservation Health approach, and gained extensive expertise in reintroduction, monitoring, and management techniques for aridland species and their habitats. We continue to share our knowledge and expertise with our national and international partners, as well as with the teams within the parks and reserves. By leveraging Marwell's unique skills, networks, and interests, we will continue our work to find solutions for some of the greatest challenges facing Tunisia's aridlands.

We are delighted to share the progress made on our projects in 2022, thanks to the generous support of our partners including EAZA members.

Since 2020, we have not only been reporting on conservation efforts for scimitar-horned oryx, but also for addax, North African ostriches, and slender-horned gazelles. In this report, we will be focusing on the activities of 2022. For additional information on ongoing work, please refer to our previous report.

Find out more about our charitable activities and conservation impact 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 change for people, animals, and ecosystems.

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RIGHT
A Tunisian shepherd near Bou Hedma NP

Background and current context

35+

years

since the first scimitar-horned oryx and addax were released in Tunisia

Tunisian strategy for Sahelo-Saharan conservation

Tunisia's conservation strategy incorporates partially-fenced protected areas that maintain metapopulations[1] of scimitar-horned oryx, addax, and North African ostriches in conditions similar to their free-ranging ancestors. Slender-horned gazelles *Gazella leptoceros* still exist in the wider landscape outside the fenced areas in the Grand Erg Oriental and may use unfenced parts of the national park network. A small number are managed *ex situ* to secure the species with the ambition to potentially repopulate depleted areas in the future.

Like many countries, Tunisia is challenged by habitat fragmentation that impacts the ability of the protected area network to support self-sustaining populations of aridland herbivores. Existing protected areas are not large enough to restore or conserve viable populations of these emblematic animals in Tunisia, so we need to address the threats that prevent their release into the wider landscape. Connecting the landscapes between populations is the most practical option for their long-term future in the country, but substantial challenges need to be overcome first.

The current metapopulation management approach in Tunisia is an intermediary step towards fully free-ranging herds.

Our long-term goal is to have sustainable populations of scimitar-horned oryx, addax, North African ostriches, and slender-horned gazelles roaming freely across large areas of contiguous habitat. As we assess the feasibility of releasing wildlife populations outside of fences in Tunisia, Marwell and the DGF are working to recreate natural species assemblages through management interventions across the protected area network. This work is already informing similar projects in other areas.

Our priorities include increasing in-country expertise in wildlife and habitat management in collaboration with established Tunisian institutions. Our Tunisia-based staff also participate in national conferences, meetings, and scientific committees to raise awareness about 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.

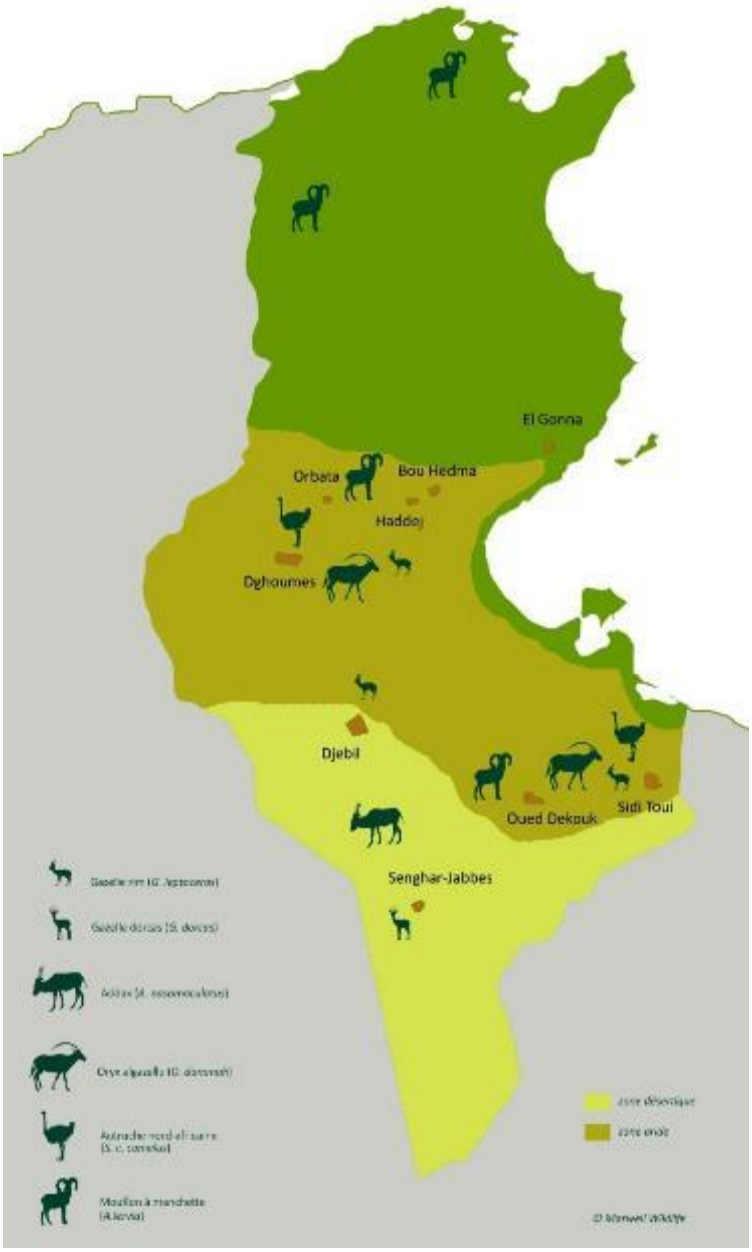
5

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). Scimitar-horned oryx remain 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 are dedicated to the reintroduction of locally or globally extinct priority species within the Sahelo-Saharan ecoregion.

In 2023, the Third Regional Seminar on Sahelo-Saharan Megafauna by the CMS Secretariat, will bring together range states and the IUCN Species Survival Commission's Antelope Specialist Group to review the previous action plan for eight Sahelo-Saharan ungulates species. In 2022, Marwell and the Tunisian DGF delivered a report on past and current activities for the review.



Monitoring the reintroduced populations of scimitar-horned oryx, addax, gazelles 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, 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.

40

years

of conservation efforts in Tunisia

Reintroductions history

The reintroduction of scimitar-horned oryx and addax began in the 1980s when European and North American zoos donated animals to Bou Hedma NP in Tunisia. Since then, scimitar-horned oryx have been returned to four protected areas, and addax to three National Parks in Tunisia.

In 2008, North African ostrich were imported from Morocco where they had previously been reintroduced from Chad. 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.

Marwell has been involved in these Tunisian conservation programmes since their inception and has had an in-country team since 2012. We support reintroduction planning and management, aiming to reintroduce priority Sahelo-Saharan species to their natural habitats. On the following pages, we present our 2022 activities, and we invite you to read our published scientific papers or contact us for more information.

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RIGHT
Scimitar-horned oryx reintroduction in Dghoumes NP (2007)

Conservation action in Tunisia

8

protected areas

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

Monitoring priority animal species

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.

Our Tunisia team also conducted surveys and provided management advice to the parks, reserves and *ex situ* centres that hold addax, slender-horned gazelles, and North African ostrich, to facilitate the management of these priority species.

Marie Petretto, our Tunisia Conservation Biologist, has been working in close collaboration with the Tunisian staff in each protected area since 2011 and has been assisted by two Tunisian ecologists, Mohamed Khalil Meliane and Amira Saidi, for the last four years. Over the last decade, and thanks to the generous support of Marwell's partners, Marwell and the DGF ensured that monitoring protocols for the Sahelo-Saharan species were enacted and data on species and ecosystem health consistently recorded. This includes not only the collection of demographic data (births and deaths) as well basic surveys on social structure and habitat use, but also the monitoring of the wider biodiversity through remote cameras to record aridland wildlife within Dghoumes, Sidi Toui and Jbil and Senghar-Jabbes NPs.

In 2022, Marwell's Tunisia team continued to monitor priority wildlife species across eight Tunisian protected areas in close collaboration with the DGF and Commissariat Régional au Développement Agricole (CRDA) of Medenine, Tatatouine, Tozeur, Sidi Bouzid, Kebili, Gafsa and Sfax. Local participation is critical to long-term success, and we endeavour to involve as many people as possible in our activities. To build capacity in Tunisia, we facilitated peer-to-peer training to enhance skills and share expertise between the park staff that monitor and manage the wildlife in four of the protected areas.

Population monitoring

Scimitar-horned oryx

Approximately

210

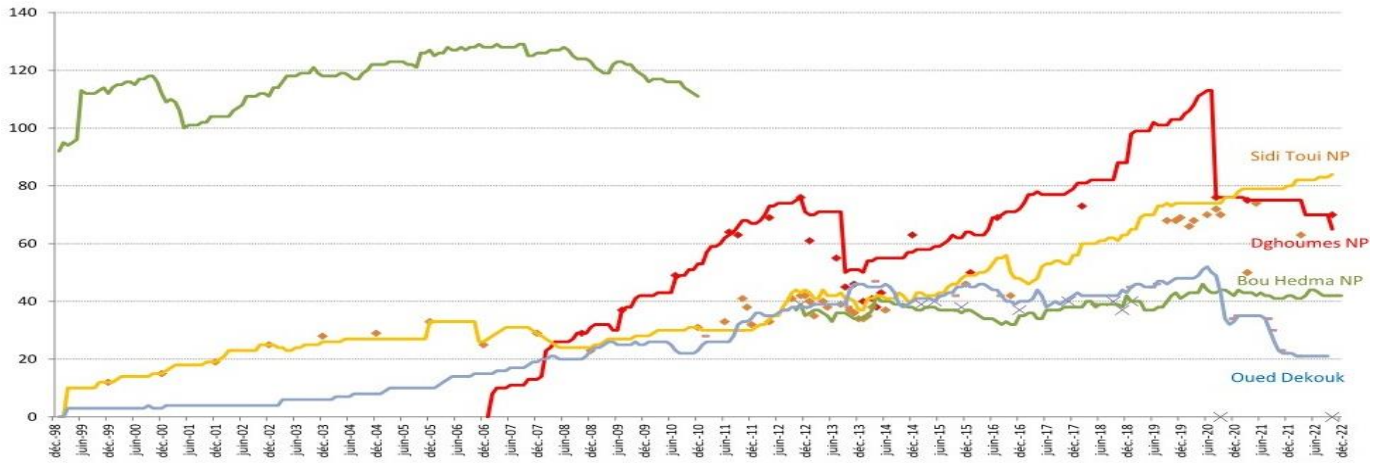
scimitar-horned oryx

across four national parks

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 2022, our team visited each protected area several times throughout the year to conduct transect surveys to assess population sizes and body condition, collate and analyse data collected by park staff, and manage the remote camera grids established to monitor wider biodiversity.

The last two years have been challenging due to a combination of environmental, climate and pathogen pressures, but the small decline in the numbers we reported by the end of 2021 has not continued in 2022. The metapopulation remains at nearly 210 scimitar-horned oryx but some populations have been impacted by environmental factors. In Tataouine, drought has had a significant effect on the population in Oued Dekouk NR, resulting in a population decline of nearly 60% over the last two years, whilst the population in Dghoumes NP has declined by less than 10%. In Sidi Toui NP and Bou Hedma NP, where the lack of rainfall has had a lesser impact due to permanent sources of water, the populations have remained approximately constant.

As anticipated, the growth of the scimitar-horned oryx population started to slow as population density approached the carrying capacity in each protected area. 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. These mechanisms are further accentuated when resources become scarcer under challenging environmental conditions, such as drought.



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ABOVE Demographic trends of Scimitar-horned oryx populations between 1998-2022 in four Tunisian protected areas (Sidi Toui, Dghoumes, Bou Hedma and Oued Dekouk)

Population monitoring

Addax

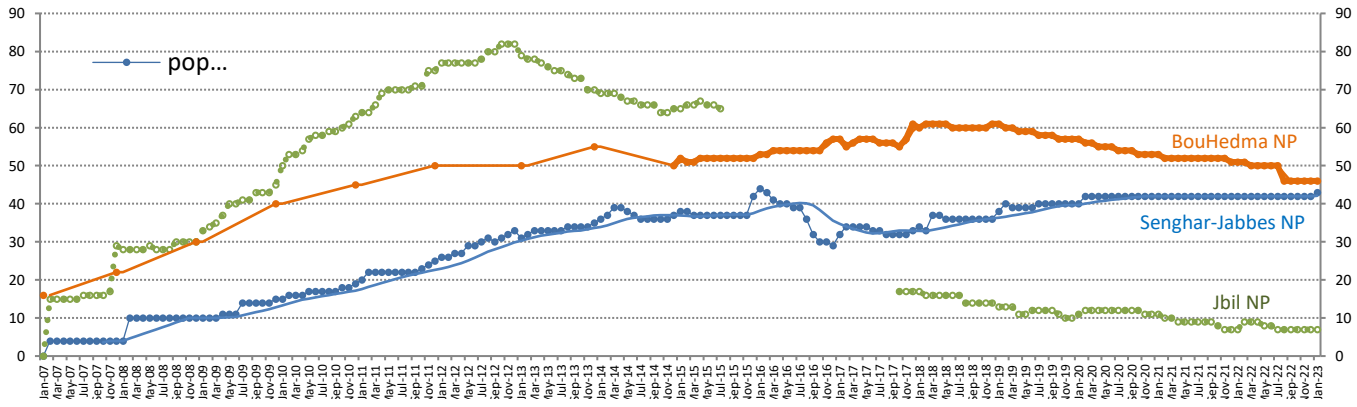
3
protected areas support addax populations in Tunisia

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.

The re-established populations in both Jbil and Senghar-Jabbes NPs have encountered difficulties and the current addax population stands at 34 in Senghar-Jabbes NP and only seven in Jbil NP. Both groups are still breeding but are now kept in the acclimatisation enclosures because sand repeatedly piles up against the fences compromising the security of the parks. This needs regular removal, but Jbil NP does not currently have the resources to manage this. In Haddej, the addax population remained constant until an acute mortality event occurred leading to the death of approximately 10 adults. The cause of the death wasn't clearly established but a high level of parasitism was noted during the post-mortems carried out in the field by local vets. This outbreak could be partially attributable to the drought that impacted all the wildlife in 2021-2022.

In 2022, Marwell continued working with the rangers and management team in Jbil NP to address some key management issues affecting the addax, including nutrition. We also extended this evaluation to Senghar-Jabbes NP. To see the return of the addax to its natural habitat, there is an urgent need for equipment, maintenance, and repairs to improve management capacity. 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 is now being assessed.

In 2022, we were very pleased to share the results of the 'addax genetic project' 2017-2022 that we described in our previous report. Please read our article: 'Genetic diversity in global populations of the critically endangered addax and its implications for conservation' (https://doi.org/10.1111/eva.13515)



ABOVE Demographic trends of addax populations between 2007-2022 in three Tunisian national parks (Senghar-Jabbes, Jbil and Haddej-Bou Hedma)

Population monitoring

North African ostrich

101

North-African ostriches managed in three protected areas 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 in 1887.

There are now approximately 80 adult North African ostriches in three fenced, protected areas in Tunisia; Dghoumes NP, Bou Hedma NP, and Sidi Toui NP. In 2022, despite the drought, chick survival was very promising. The young birds reintroduced in Bou Hedma NP reached sexual maturity and there are to-date nine young ostriches free-ranging with their parents within the park boundaries. In Sidi Toui NP, nine chicks have survived so far as well.

In the *ex situ* facilities within Orbata NR, 11 chicks were produced in 2022 despite concerns that the adult sex-ratio was unbalanced and the pasture has become impoverished through over-grazing and drought. The chicks were bought into an enclosure to protect them against adult aggression and ensure they have access to an appropriate diet. Bringing chicks into enclosures has not been the standard practice to date, and it is considered a last resort for unavoidable threats to the ostrich chicks' survival. However, our experience has shown negative impacts of this approach on reintroduced populations, making it unsuitable for routine rewilding. These chicks will likely be translocated to their natural habitat in Dghoumes and Bou Hedma NPs in 2023.

In 2022, Marwell continued providing ad-hoc support for ostrich post-release monitoring. We identified priorities in animal care for the *ex situ* ostriches as well as other priority species and we will discuss these with the DGF.

>

RIGHT
North African ostrich and scimitar-horned oryx captured by remote cameras in Dghoumes NP

Population monitoring

Slender-horned gazelle

28

slender-horned gazelles in two *ex situ* facilities

Slender-horned gazelle *Gazella leptoceros* are suffering a worrying population decline in the wild due to poaching and disturbance. The species 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. This 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, the great Eastern sand sea of the Sahara Desert covering a transboundary area of some 600 km wide by 200 km north to south stretching across Algeria and Tunisia.

Since 2019, Marwell has focused efforts on assessing the size and distribution of the wild slender-horned gazelle population in Tunisia and identifying threats to its survival. Our aerial and ground surveys were reported in our 2021 report and indicated that a small remnant wild population remained in Tunisia.

In 2022, Marwell published survey results in the Journal of Arid Environments (https://doi.org/10.1016/j.jaridenv.2022.104874). The two surveys confirm the presence of a remnant wild population of slender-horned gazelles in the Tunisian Grand Erg Oriental and stressed the need of a wider, multi-disciplinary biodiversity assessment to start and implement targeted conservation actions as part of the Grand Erg restoration and addax and slender-horned gazelle conservation.

There are two *ex situ* slender-horned populations in Tunisia in enclosures in Sidi Toui NP and El Gonna NR. These two groups are managed as one connected population with individuals translocated between the enclosures within the two protected areas, when required.

The larger group in Sidi Toui NP was founded by three animals from the wild in Tunisia and Zoo Planckendael, Belgium in 1999. **In 2022, the group was supplemented by two adult females confiscated by the anti-poaching police. This *ex situ* group consists of 10 male and 14 female (24) gazelles including five calves**.

In November 2020, four slender-horned gazelles (one mature male, two mature females, and one young male) were translocated to El Gonna NR to increase the capacity for *ex situ* management of the species in Tunisia. One calf was born in 2022, but unfortunately, the founder male died. Overall, the *ex situ* population of slender-horned gazelles in Tunisia is growing, albeit slowly. However, the DGF and the park managers are facing some substantial management challenges, that need addressing. Marwell is working with the DGF to improve facilities and management practices for the species, and this is one of key areas of work in 2023.

Up to 97% less rainfall
compared to references values in the Tunisian aridlands

Supporting wildlife when faced with natural challenges

The last couple of years have been characterised by an extreme drought in Tunisia, and particularly in the southern parts of the country. According to the Tunisia's National Institute of Meteorology (www.meteo.tn), there was a significant deficit of rainfall last winter (December 2021- March 2022), varying between 46% less rainfall in Sfax (El Gonna NP) and 96% less in Matmata (Jbil NP and Senghar NP). While it eventually rained in the Jbil NP area in September 2022, most of the protected areas that support priority Sahelo-Saharan species still suffer from a lack of water, particularly Oued Dekouk NR where there has been 97% less rain than usual and Senghar-Jabbes NP where there has been no rain.

The winter rains play a crucial role in arid ecosystem resilience, as they refill groundwater and allow the vegetation to regenerate. Drought conditions mean that wildlife disperses more widely in search of food, water, and cover bringing them into more developed areas and often increasing interactions with humans. The ungulates that are kept in semi-fenced protected areas cannot migrate in search of resources, therefore the managers provide emergency food and water without interfering with the rewilding process.

In 2022, supportive measures were implemented to avoid a drastic decline in population size of priority species e.g. supplementary feeding, artificial water points, protection of ostrich chicks, due to drought. Marwell acts as an adviser for the park managers, and we provided food resources when no other solution could be found. Our continuing monitoring is crucial to identify risks as soon as possible to mitigate sudden population declines.

> RIGHT
Two North African ostriches attracted to a leaking water pipe in Dghoumes NP

Disease risk at the human-wildlife interface

Disease transmission across the human-wildlife interface is a key concern, particularly in southern Tunisia where livestock management is an important economic resource. Potential cross-contamination between livestock and wildlife via the wider environment, arthropod vectors, and carnivores pose a threat to wildlife, livestock, and human health. It is crucial to consider risks in both directions because the spread of infections from antelope to livestock could impact the often impoverished and marginalised communities accessing the protected areas, many of whom rely on income from livestock and have limited access to healthcare.

Recognising this interdependence of wildlife, people, and the wider ecosystem in this shared landscape, we support investigations into infectious diseases in both antelope and livestock, which also provide information relevant to human health.

In Tunisia, we are monitoring the health of the endangered ungulates and working toward identifying and mitigating the risks associated with pathogen transmission and together with our partners from the IRVT (Institut de la Recherche Vétérinaire de Tunis), the CNVZ (Centre National de Veille Zoosanitaire) and the DGF. In parallel, we entered the fourth 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.

RIGHT
Stephanie BRIEN, performing opportunistic health surveillance on reintroduced oryx in Chad (photo credit: Tim Wacher, ZSL)

Stephanie is using samples collected from scimitar-horned oryx during procedures in Tunisia and Chad to perform serological monitoring on a range of diseases of public health and economic importance. This project provides an opportunity to increase our understanding of infectious diseases in a region that is currently under-studied and help inform future reintroductions.

In 2022, despite substantial challenges posed by Covid-19 for her research on the immunogenetics of scimitar-horned oryx *Oryx dammah*, Stephanie has collected a unique set of samples and is awaiting results from laboratory analyses. Towards the end of 2022, Stephanie entered her final academic year for her PhD; research that she is conducting in collaboration with Marwell Wildlife and the Pirbright Institute.

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 15 years ago, and the populations are now 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, particularly in Dghoumes NP, Sidi Toui NP, Jbil NP and in 2022, we expanded monitoring to Senghar-Jabbes 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.

Systematic camera-trap surveys

In June 2022, we set up 20 automatic cameras in Senghar-Jabbes NP, a protected area located in the Tunisian Grand Erg Oriental, targeted to detect fauna over 1kg. After the first few months, fennec foxes *Vulpes zerda*, African golden wolves *Canis anthus*, hares *Lepus capensis* and addax *Addax nasomaculatus* were detected, and we hope to soon observe the most cryptic species such as the sand cat *Felis margarita* or slender-horned gazelle *Gazella leptoceros*.

This is the fourth Tunisian site in which Marwell and the DGF are running this study on Sahelo-Saharan biodiversity, and 64 devices are deployed in grids across 4 protected areas. Our approach using remote cameras is yielding some unexpected and interesting data on species presence, distribution, and animal behaviour.

The thousands of photos taken each month have already allowed us to confirm the presence of the Rüppell's fox *Vulpes rueppellii* in the Tunisian Great Erg, the Barbary sheep *Ammotragus lervia* in the Atlas Mountains, the Houbara bustard *Chlamydotis undulata* in Sidi Toui NP close to the Libyan border, striped hyenas *Hyaena hyaena* settling in the Chott Ejjerid plain in Dghoumes NP, and crested porcupines *Hystrix cristata* in semi-arid habitats in Sidi Toui NP. This is the first time that such a level of consistent wildlife monitoring has been implemented in North Africa. By working with our local partners, we have had the pleasure of seeing skills develop within local communities, an increased number of guards trained at each site in the use of the camera traps, and a huge increase in the collection of data.

In 2022, the journal 'Oryx' published our news article on the change in striped hyaena behaviour in Dghoumes NP, with data derived from remote camera studies. Citation: Meliane *et al.* (2022) Sedentarization of the striped hyaena *Hyaena hyaena* in Dghoumes National Park, Tunisia. Oryx 56(5): 649-650. https://doi.org/10.1017/S0030605322000837

Consistent and long-term monitoring has enabled us to answer fundamental questions about the spatial and temporal distribution of wildlife. For example, our remote camera grid in Jbil NP has captured photographs of dorcas and slender-horned gazelles with notable variations in the coat colours of Dorcas gazelles. This variation in pelage pattern has resulted in historical misidentification between dorcas and slender-horned gazelle potentially resulting in inaccurate estimates of population sizes. Our new information helps us to refine

observations of the two species in the areas where both are found together. More generally, comparisons between NPs provides a better understanding of species ecology and helps to inform conservation project planning.

Overall, the use of remote camera grids benefits a wide range of people, from local managers to researchers, students, local communities, and policy makers. It highlights previously unnoticed wildlife and behaviour that enables the implementation of more targeted conservation actions. It is also an effective tool for engaging park staff in priority species monitoring and biodiversity surveys, creating greater local capacity for wildlife conservation. The deployment of this tool is only possible through the commitment of our local partners, particularly the park staff.

In 2022, 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.

Vegetation surveys

In 2022, we continued monitoring vegetation coverage and habitat condition in Jbil NP and initiated a comparable study in Senghar-Jabbes NP. These surveys have provided us with valuable baseline data that informs park management decisions.

> **RIGHT**
> Monitoring vegetation coverage and habitat condition in Jbil NP

Seasonal surveys

We are building a long-term dataset on mammal species records and vegetation data across the four seasons. Data on surface-active invertebrates are also collected as they are a crucial component of the fragile arid ecosystem and useful indicator species on ecosystem health. After collecting the data in Jbil NP, in 2022, we expanded our surveys into Senghar-Jabbes NP providing a more complete assessment of the ecosystems in the Grand Erg Oriental.

We are now developing further assessments and information about how the invertebrate communities can inform the management of the protected areas and the wider landscape.

^ **ABOVE** A scimitar-horned oryx in an area being re-wetted by the creation of tabia (bunds) in Dghoumes NP

Landscape management

evaluating the ecological management within the small fenced protected areas

Rewilding depleted habitats: re-wetting in Dghoumes NP

The protected area managers implemented a number of techniques to help and restore natural habitat and local biodiversity. In particular, “rewetting” overgrazed areas within national parks is achieved through the construction of tabia (bunds) that slow water flow and retain rain water for longer periods of time, allowing vegetation to naturally recolonise and form lasting vegetation communities. Bunds also help accumulate organic matter and reduce erosion and the loss of organic material thereby deriving long-term benefits for carbon accumulation.

The construction of bunds was first used by protected area managers to increase natural pasture and subsequently the carrying capacity of the areas where ungulates populations have been re-established. However, there are additional ecosystem benefits that appear over time, for example, target vegetation restoration / colonisation, organic matter accumulation, preventing erosion and soil loss, or supporting long term climate resilience by capturing carbon. Together with our Tunisian colleagues we started exploring some of these aspects in Dghoumes NP by placing remote cameras at bunds to evaluate the fauna using re-wetted areas.

Practical habitat management in Jbil NP

Jbil NP is experiencing substantial management issues that is impacting their ability to manage addax and other priority species in the larger fenced section of the park. Our Tunisian team has been providing practical assistance and support to the management team in Jbil NP in an attempt to resolve some of the immediate issues, such as sand piling up against fences, and find some longer-term solutions.

V BELOW

Khalil Meliane (Marwell) helping the staff of Jbil NP to move the sand dunes that cover the fences

Sharing experiences, networking and supporting our Tunisian colleagues

3

Peer-to-peer training sessions

Organised to bring together the guards from different parks

v

NEXT PAGE

Top photo: Boudhief, Amara and Saad, trained guards from Dghoumes and Sidi Toui NPs. Bottom photo: Amara (Sidi Toui NP), Mohamed (Senghar-Jabbes NP), Ibrahim (Oued Dekouk NR) and Khalil (Marwell) during a peer-to-peer training session in Sidi Toui NP.

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 institutes;
- contributing to students' training;
- representing our Tunisian projects in various national and international conferences and workshops.

Creating interactions to foster strong connections

This strategy requires the continuous training of guards, who are members of the local community without specific conservation or ecological backgrounds. Following a skills assessment carried out at the end of 2021/beginning of 2022, we identified that working in isolation could potentially compromise staff motivation and efficiency. We have therefore started a peer-to-peer training programme consisting of an exchange between parks to allow the guards to discover the work of their colleagues and share their experiences with each other. In 2022, three courses of 15 people were organised on the theme of camera-trapping and resulted in visible changes in working approaches, supporting the development of further conservation activities. We will continue taking the guards from one protected area to another for them to learn new monitoring and management techniques with us and their colleagues as we know that conservation success relies on local communities.

In 2022, we did three "peer-to-peer" training sessions for the park staff of the protected areas we are working in. The sessions consisted of bringing guards from one protected area to another so that they met their counterparts and exchanged experiences. We appreciated a significant increase in motivation and a skill dissemination.

Conservation health is about people *and* nature

Supporting personal development

RIGHT
Some Master students from the University of Tunis on placement with Marwell's team in Tunisia

Our operations in Tunisia offer opportunities for personal development and increased capacity as our team train students and volunteers from Tunisia and overseas. Those who join us as part of their academic career undertake an applied project from our portfolio of conservation work in Tunisia to help them build skills, expertise, and confidence in applied conservation and research.

Marwell's practising conservationists provide opportunities for students to experience real-world challenges, inspire debate and craft a solution-focussed mindset. We offer an exceptional degree of interaction with our team and partner organisations and use results from research projects to guide conservation decision-making.

ABOVE
Amira Saidi, Tunisian ecologist and PhD student in aridland entomology

In 2022, within the framework of his PhD, Med Khalil MELIANE analysed remote camera data and has written eight peer-review publications! This fantastic output helps understand and inform the status and trends of Tunisia's biodiversity and provides critical information for conservation management. Amira SAIDI also made some significant progresses with her PhD work, collecting more seasonal data on the invertebrate populations in Jbil and Senghar-Jabbes NPs completed by further lab-work on climatic influences on beetle mobility.

21st

annual meeting for Sahel and Sahara Conservation

10 – 12 May 2022
Online due to the Covid-19 pandemic

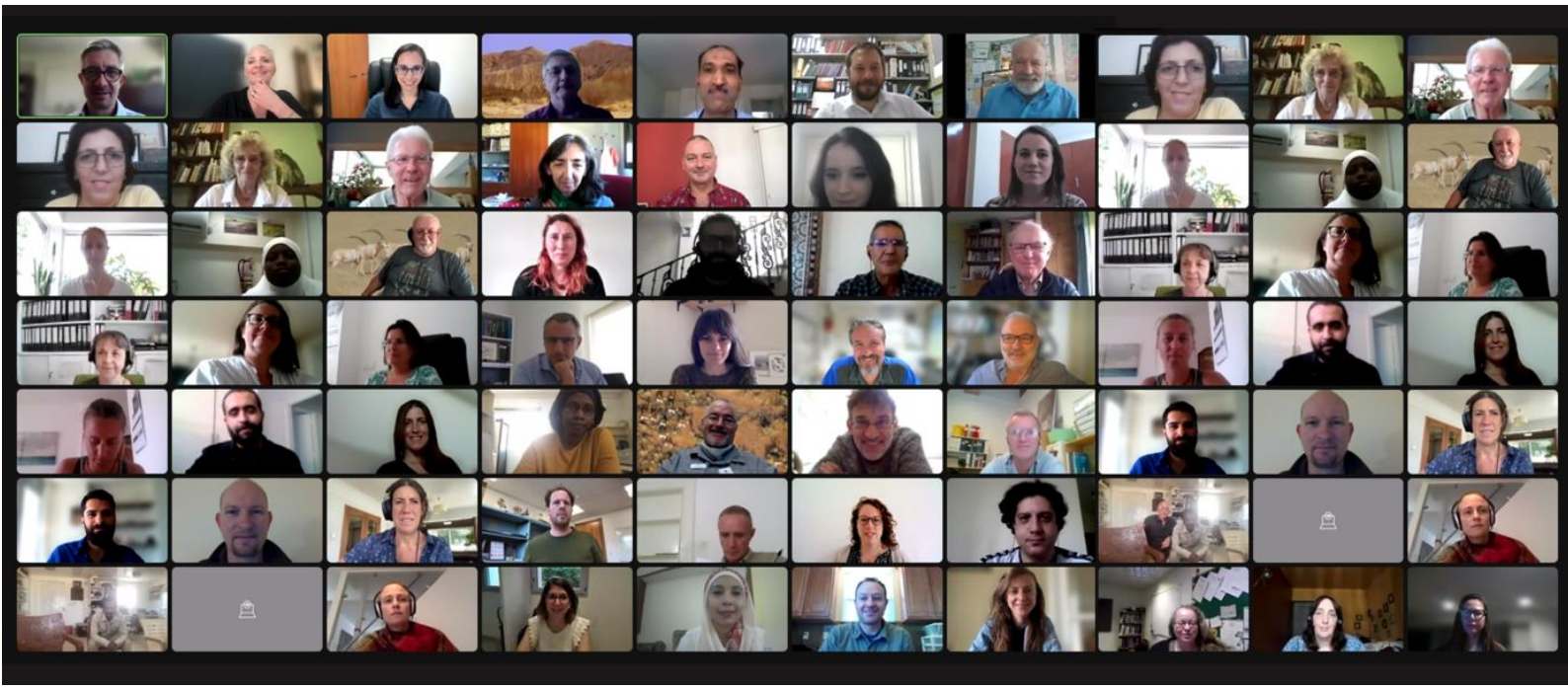
International meeting on Sahelo-Saharan Conservation

The Sahelo-Saharan Interest Group (SSIG) meeting is an annual forum for those working in wildlife conservation within the arid areas of North Africa and Western Asia. Facilitated by Sahara Conservation and hosted by various 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 2022, 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, Stephanie Brien reported on her PhD work on disease transference across a wildlife-livestock interface, and our project partner, Dr Kara Dicks from the Royal Zoological Society of Scotland, reported on the results of the global addax genetics project.

The SSIG provides an excellent opportunity to exchange knowledge and experiences with an exceptional group of conservationists dedicated to the Sahelo-Saharan region. This annual gathering is a critical phase in our efforts to assess and realign our priorities to meet the current regional requirements.

V
BELOW
Some of the participants of the online 2022 SSIG meeting



Connecting with local initiatives

3

Tunisian NGOs

dedicated to the protection of Tunisia's natural heritage

As sustainable conservation actions rely on a deep local awareness of the value of nature, we would like to take this opportunity to introduce some of the young Tunisian associations that we've seen develop in the last few years. In particular, we would like to feature three of them that developed under the umbrella of the scimitar-horned oryx reintroduction in Tunisia.

In 2022, we were delighted to have reinforced our relationship with non-governmental organisation by sharing and collaborating with the local actors. Marwell is very proud to be now part of a local network of Conservation NGOs!

ATVS, the Association Tunisienne de la Vie Sauvage (https://atvs.org.tn/), is a young and dynamic group of experts committed to safeguarding Tunisia's biological heritage. Marwell has trained and employed some ATVS members in the past. They have successfully completed over 10 funded projects, including biodiversity surveying and environmental monitoring network development.

ABOVE
ATVS's field team after a biodiversity survey in Southern Tunisia (photo credit: Marc Gansuana)

Bouhedma National Park Conservation Community (BHNP CC) is working on small projects focused on public awareness, environmental education, and community development. They have opened a tourist cottage and visitor centre in Bou Hedma NP to help the local community benefit from the park and generate income. This initiative could serve as a model for other communities in the future.

ABOVE Hayfe Chamki and Souhaiel Laafrif (BHNP CC), with local community and Hungarian tourists within the framework of the Project 'BouHedma Ghodwa' (photo credit: BH Ghodwa).

Les Amis du PN Sidi Toui (https://www.facebook.com/profile.php?id=100076242280088) is a newly established non-profit organization in Ben Guerdane, near Sidi Toui NP. Led by its president, Mr. HELALI, a retired park manager, and members with backgrounds in agronomics, ecology, teaching, conservation, and Tunisian administration, the organisation aims to support park management and develop activities related to public perception, ecomuseum management, and infrastructure maintenance based on their extensive local knowledge.

ABOVE Board and some members of the Association "les Amis de Sidi-Toui" (photo credit: APNST).

Proposed activities for 2023

£500

covers the cost of 4-fieldwork days with the Tunisian Association's (ATVS) team to survey scimitar-horned oryx and build capacity in Dghoumes NP

£405/month

required to ensure the camera trap grids continue to function and the survey data are managed

£100

Pays for a veterinary visit and analyses in a remote protected area

We will continue to monitor the populations of the re-established 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. **Continuing our commitment to support local initiatives and promote local capabilities, in 2023 we also plan to develop formal working partnerships with some Tunisian conservation organisations.** Though our field team will continue to regularly visit to the protected areas, they will work with new Tunisian partners to collect data, train park staff, and build skills, capacity and engagement within Tunisia.

The camera-trap surveys we initiated five years ago are still ongoing, thanks to the generous support of our EAZA supporters. These surveys not only provide us with the opportunity to help our partners develop new skills, but they also serve as a valuable management tool to support decision-making back by robust peer-reviewed publications. Our future plans involve both continuing and expanding the monitoring of species assemblages in protected areas such as Dghoumes, Jbil, Sidi Toui, and Senghar-Jabbes NPs. Additionally, we aim to expand these surveys to include Oued Dekouk NR and replicate short-term surveys in Bou Hedma NP. This comprehensive approach will enable us to simultaneously survey the protected areas and facilitate meaningful comparisons to fully understand the underlying ecological processes. We replaced many worn-out devices and deployed a new camera trap grid in Senghar-Jabbes NP in 2022, but further devices need replacing due to wear and damage from being used continuously in an arid environment. **We are looking to purchase an addition 15 devices to replace those that are worn-out, provide the batteries and data storage units, and deliver additional peer-peer training session for park staff to increase Tunisia's capacity to manage the remote camera grids.** We also have plans to develop a database that will make the collected data more accessible and reach a broader audience of conservationists.

Whilst we don't have any evidence of circulating diseases within priority species, we know 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. **In 2023, we will actively seek to involve more local veterinarians, empowering them to provide *ad-hoc* support to park managers.** Our aim is to establish a comprehensive database that enhances management practices and enables effective implementation of wildlife disease surveillance.

£2,300

to build one enclosure for a slender-horned gazelle breeding group

£450

to support the expenses to train one Tunisian ecology student

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 conservation efforts, but it requires some attention. **We are planning to improve and extend the facilities in Sidi Toui NP in 2023 and have developed plans to improve the facilities in El Gonna NP to enhance group management, create a hand-capture facility, vaccinate the group, and train park staff in capture and handling techniques.** It is critically important to divide the existing group into smaller breeding groups, but to achieve this we will need to construct 15 new enclosures to accommodate the current population.

We see the immense value in building skills for young Tunisian veterinary and ecology graduates and for them to gain experience of working in the field 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. **In 2023, we will offer a training to two Tunisian Master's degree students.**

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.

V BELOW
Captive slender-horned gazelles in Tunisia.

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 EAZA and other 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 emphasise the contribution of the partners of our work.

Cost item	Cost basis	£
Slender-horned gazelle *ex situ* centre in Sidi Toui NP and El Gonna NR		
Build sub-units for small breeding groups in El Gonna NP (extend and improve the *ex situ* facility)	£6,000 per 60x160m pen,	6,000
Build sub-units for small breeding groups in Sidi Toui NP (comprising fence, hand-capture area, anti-predator electric wire)	£2,300 per 15x20m enclosure, 12 needed + 1 double enclosure for calves (i.e. equivalent to 14 units)	32,200
Battery and solar panel for electric wire (anti-predator)	£4200 material £1250 labour costs	5,450
Veterinary prevention and emergency care	£79 per month x 12 months: vaccines, consumables, and vet fees	948
Pedigree management & Animal handling training for staff	External experts' flights and accommodation	3,000
TOTAL		**47,598**
Standardised oryx, addax, North African ostrich and habitat monitoring		
Tunisian field assistants (Marwell-employed ecologists)	2 x 12 month @ £1000 per month (salary & expenses)	24,000
partnering with local NGOs	£700 per month (staff fees & expenses), 12 months	8,400
Monitoring protected areas by Marwell team	Mileage: 2,000km/mo @ 0.36p per km	8,640
Training and skill development for protected area staff	Up to 4 training events, totalling 20 days @ £600/event	2,400
Camera traps & consumables	15 x camera traps @ £200 per unit	3,000
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		**48,320**
Integrated wildlife & livestock health monitoring		
Emergency care, diagnosis and management of antelope and ostrich	Estimated: 5 oryx, 5 addax, 2 ostrich per year, @ £60 per animal (drugs, consumables)	720
Sampling and analyses	parasitology, histology, serology etc.+ storage and shipping @ £50/animal, estimated 20 individuals per year	1,000
TOTAL		**1,720**
Research on the restoration of the arid steppe ecosystem		
Wages for short-term contracts of Tunisian personnel	@1,500 TND (£450) month/person Estimated 3 persons or month to complete specific projects	1,350
Transport and food cost	3 months @ £ 450/mo	1,350
TOTAL		**2,700**
Overall Total		**£ 100,338**

Marwell Wildlife

THE QUEEN'S AWARDS FOR ENTERPRISE: SUSTAINABLE DEVELOPMENT 2022

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

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