## 2021 Annual Report

# Chad Oryx Reintroduction Project

**A joint initiative of the Government of Chad and the Environment Agency Abu Dhabi, implemented in Chad by SaharaConservation**

Edited by SaharaConservation

SAHARA CONSERVATION

ZSL LET'S WORK FOR WILDLIFE

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Environment Agency - ABU DHABI

SMITHSONIAN'S NATIONAL ZOO & CONSERVATION BIOLOGY INSTITUTE

FOSSIL RIM WILDLIFE CENTER

# Document information

**Report prepared for use by:** all the partners and stakeholders involved in the scimitar-horned oryx reintroduction project
**Prepared by:** SaharaConservation
**Citation:** SaharaConservation. 2022. Chad Oryx Reintroduction Project 2021 Annual Report. SaharaConservation.
Publication date: September 2022

## Executive summary

This report provides an overview of activities and results through 2021 of the Scimitar-Horned Oryx Reintroduction Project taking place in the Ouadi Rimé-Ouadi Achim Game Reserve, Chad. A joint-initiative of the Environment Agency Abu Dhabi (EAD) and the Government of Chad, this unique and highly ambitious program is implemented in-country by SaharaConservation.
The report integrates data, information and observations collected by the project team, including valuable data on the behavior, social structure, calving performance and survival of the oryx reintroduced. It uses data inputs from all project partners, including EAD, the Direction de la Faune et des Aires Protégées (DFAP), SaharaConservation, the Smithsonian's National Zoo & Conservation Biology Institute (SNZCBI) and the Zoological Society of London (ZSL).

**Cover photo**: Reintroduced scimitar-horned oryx with calf in Chad - © Taboye Abdelkerim Ben / SaharaConservation

# Acknowledgements

This project would never have happened without the vision, the resources, the animals and the skills of the Environment Agency - Abu Dhabi and its leaders. The partnership between EAD, the Government of Chad and SaharaConservation has insured the project's success to date in many ways both technical and administrative. The initiative is not only one of the most ambitious wildlife reintroductions ever undertaken but a glowing example of what can be done to save Africa's imperiled wildlife if we all pull together.

# Abbreviations and acronyms

| | |
|---|---|
| DFAP | Direction de la Faune et des Aires Protégées |
| EAD | Environment Agency - Abu Dhabi |
| FRWC | Fossil Rim Wildlife Center |
| GFF | Garde forestière et faunique |
| GPS | Global Positioning System |
| IRED | Institut de Recherche en Élevage pour le Développement au Tchad |
| Iridium | Iridium Satellite Communications |
| MEPDD | Ministère de l'Environnement, la Pêche et du Développement Durable |
| OROAGR | Ouadi Rimé-Ouadi Achim Game Reserve |
| Oryx Project | Chad Oryx Reintroduction Project |
| POROA | Ouadi Rimé-Ouadi Achim Project (project to support the development of the Reserve de Faune de Ouadi Rimé Ouadi Achim) |
| RZSS | Royal Zoological Society of Scotland |
| SNZCBI | Smithsonian's National Zoo & Conservation Biology Institute |
| UAE | United Arab Emirates |
| Vectronic | VECTRONIC Aerospace GmbH |
| VHF | Very High Frequency |
| WFC | Wings for Conservation |
| ZSL | Zoological Society of London |

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# INTRODUCTION

The Ouadi Rimé-Ouadi Achim Game Reserve, located in Central Chad, was created by decree No. 135/PR/EFP/PNR of 10 May 1969 to protect Sahelo-Saharan antelopes, cheetahs and ostriches. It covers a surface area of 7,795,000 hectares.
It straddles five Provinces: Batha, Borkou, Bahr el Gazel, Wadi Fira and Ennedi-Ouest.
Unfortunately, the years of conflict and drought that the country has experienced have had negative consequences on these species. The scimitar-horned (*Oryx dammah*) became extinct in the wild in the eighties, but the reserve is still brimming with a great many wild dorcas gazelles, bustards and dama gazelles (*Nanger dama*).
On 4 September 2014, the Chadian Ministry of Environment and the Environment Agency – Abu Dhabi (EAD) signed an agreement to reintroduce the scimitar-horned oryx into OROAGR. In this agreement, it is stipulated that the NGO SaharaConservation is responsible for the oryx project in Chad. This agreement was renewed in October 2019, which has allowed addax (*Addax nasomaculatus*) to be reintroduced as well as scimitar-horned oryx.
The Ministry of Environment, Fisheries and Sustainable Development through the Directorate of Wildlife and Protected Areas (DFAP) plays the following roles:

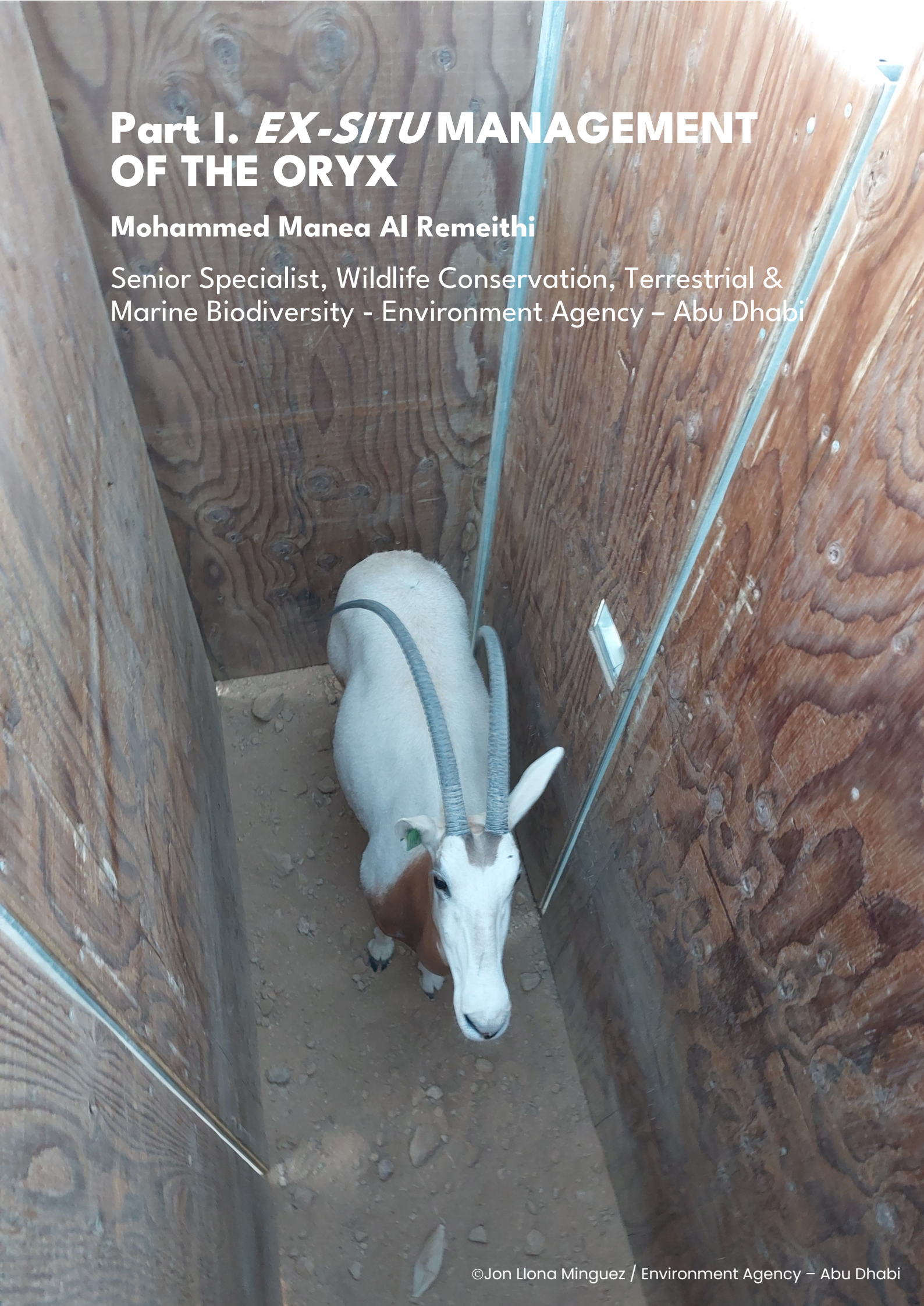
- Ensure the protection of scimitar-horned oryx, addax and their habitat by implementing appropriate management of the reserve and maintaining strong cooperation between the various local players;
- Provide all the permits required for the arrival of the animals and the project's activities (CITES, veterinary, aircraft landing permits, planning permission, etc.);
- Provide and help to obtain any official permits for staff and operators working on behalf of EAD and SaharaConservation (visas, residence permits, travel permits, etc.);
- Guarantee and protect the pre-release site chosen by the project team.

Through its technical departments, the Ministry of the Environment has carried out the different activities concerning these roles.

# Part I. *EX-SITU* MANAGEMENT OF THE ORYX

**Mohammed Manea Al Remeithi**

Senior Specialist, Wildlife Conservation, Terrestrial & Marine Biodiversity - Environment Agency – Abu Dhabi



# 1. Environment Agency Abu Dhabi

The Environment Agency – Abu Dhabi (EAD) is the program sponsor in this major initiative to reintroduce the scimitar-horned oryx to its historical range in Chad. Inspired by the UAE's founder, the late Sheikh Zayed and his efforts to protect endangered species and sustain them in their natural habitat, the Scimitar-horned oryx Reintroduction Program was initiated on behalf of the UAE Government in close collaboration with the Government of Chad.

EAD has established new MOU's with its partners which incorporate the additional species into the conservation program and is taking the lead in managing the initiative. EAD is curating the "World Herd" of scimitar-horned oryx, and breeding addax and dama gazelles in Abu Dhabi (to ensure a genetically diverse source population is used for reintroduction or reinforcement) and providing additional technical expertise in wildlife management and veterinary services as well as arranging the cargo flights to translocate the animals and supplies.

EAD is communicating the project locally and internationally in a variety of conferences and workshops and the journey is being shared via the inspiring documentary film, "Back to the Wild" and captured in a 120-page book published in Arabic, English and French.

# 2. *Ex-situ* management of scimitar-horned oryx, addax, and dama gazelles

Throughout the year, the EAD team has positioned itself to build on all the previous efforts, knowledge and experience put forth by the reintroduction partners, including the Republic of Chad (Ministry of the environment, water and fisheries and the Directorate of Wildlife and Protected Areas) and SaharaConservation.

The project partners had developed ambitious plans for the year (2021) with two translocations of scimitar-horned oryx and addax, along with the mission to capture wild scimitar-horned oryx and collar them for monitoring.

A great deal of preparation and effort was put forth to ensure the 2021 translocations would be a success. As well as the team worked very closely with all the project partners to make this year a great success with many accomplishments, including darting and collaring oryx in the wild in between the two translocations in November. 25 scimitar-horned oryx and 25 addax were translocated this year (2021).

The achieved milestones of this year are continuing toward the goal of reaching sustainable populations of endangered species in the wild and this innovative, iconic conservation program is beginning to have a real impact on the long-term sustainability of several endangered species and their native habitat.

The EAD is honored to be part of such an important wildlife conservation program and excited to continue to see the successful expansion of the project, which is now becoming an inspiring species conservation model. All project partners were honored to have received accolades on our conservation work with the scimitar-horned oryx in Chad in the Journal of the Society for Conservation Biology in the article "*How many bird and mammal extinctions has recent conservation action prevented*?" (Bolam et al. 2020).

**This study determined that the combined conservation effort has significantly decreased the likelihood of extinction of the scimitar-horned oryx.**

There are a number of reasons this project is becoming a model for conservation reintroductions, including the adoption of world-class wildlife management and husbandry techniques at Deleika Wildlife Conservation Center, in Abu Dhabi. The completion of phase I of the master-planned, state of the art wildlife conservation facility has made immense benefits in our ability to safely manage our collection. Included in the expansion are five purpose-built breeding complexes with built-in corridors leading to sorting alleyways which lead to a Tamer ungulate restraint device.

These facilities have greatly increased the ability to manage, selectively breed and efficiently prepare the animals for translocation to Chad. Phase II is currently under construction and will bring a comprehensive and fully functional veterinary facility, enabling the team to undertake research and practical day-to-day veterinary procedures in an efficient and professional manner.

The second phase of the construction, including a veterinary clinic, staff accommodations, and an administration center, made significant progress throughout the year and is nearing completion (Figure 1).

Fig 1. Phase II construction of the Deleika Wildlife Conservation Center

# 3. Ensuring genetic diversity in the reintroduced population

In our efforts to maintain and increase the resiliency of our endangered species, and with the expansion of the reintroduction efforts to addax and eventually the dama gazelle, we have increased the diversity and sustainability of these species by incorporating new

animals into the breeding groups that will serve as source populations for reintroduction. The focus continues to be on building genetically diverse and resilient founder populations of all the species in the program for reintroduction in the wild.

The scimitar-horned oryx that were translocated from the US and Europe over the years have been a paramount milestone in building a diverse and resilient founder population, and continue to reproduce at a sustainable rate. These imported individuals continue to breed with the original Abu Dhabi animals and are ensuring that a genetically diverse, healthy population of scimitar-horned oryx is utilized for the reintroduction, that represents the great majority of the diversity available in the world.

To better understand the genetic makeup of the oryx, addax and dama gazelle population, we have continued the genetic analysis project with the Royal Zoological Society of Scotland. Their expertise and utilization of advanced genetic analysis techniques has helped to make informed breeding decisions and allows the selection of the most appropriate individuals for reintroduction.
Additionally, the project with the University of Edinburgh to understand more about the functional diversity in the scimitar-horned oryx, through study of the complete genome, continues to progress. All animals that are sent for reintroduction are analyzed and the results show that the mitochondrial genetic diversity in the reintroduced population has increased by 2.2x (Figure 2). The genetic samples of most animals that have been translocated to Chad have been analyzed or are under analysis and the results show that there is a great deal of the world's available diversity represented in the reintroduced population and the mixture between original EAD animals and those imported is increasing the allelic richness significantly.

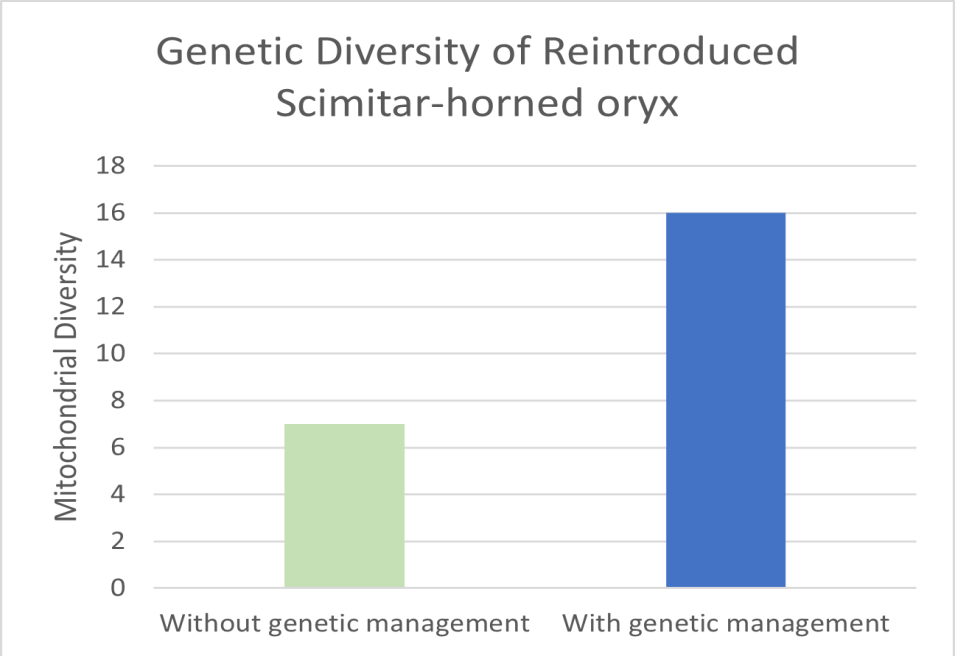



Fig 2. The mitochondrial diversity and the allelic richness of the reintroduced population have increased with the genetic management program in place

# 4. Preparation of animals for reintroduction

While we continued to focus on increasing the genetic diversity of the world herd of scimitar-horned oryx in Abu Dhabi, there was a focus on selecting appropriate individuals that would make up the next reintroduction groups. The plan was to translocate a group of 25 oryx and 25 addax in November.

The EAD team worked very closely with project partners and experts in the field to ensure that the animals slated for reintroduction were prepared in every way for reintroduction as in the previous years. The vaccination protocol that was re-evaluated last year was kept the same for this year. All animals that are considered for the reintroduction are first given a thorough physical examination and screened for any pathogens including the following: Tb Test-Intradermal comparative test (Avian/Bovine), Brucellosis Test (RBT and Skin), Blue Tongue Virus, BVD, QFever, prior to being considered for translocation.
In order for an animal to be chosen for shipment they first have to pass a physical examination where their body condition, hoof condition, teeth, legs and joints are evaluated. Once the animal is chosen for reintroduction it is then given the following vaccinations: PPR using a live attenuated vaccine for Peste des Petits Ruminants; sheep and goat pox virus using a live attenuated vaccine for Goat pox; FMD using inactivated vaccine, multiple strains including "O", "A" and "SAT1"; Bar-Vac 10: (*Pasteurella m*ultocida, *Mannheimia haemolytica* and *Clostridium*), Rift Valley fever (OBP, S. Africa), Anthrax, *Pasteurella m*. (Farcha Lab, Chad), CCPP (Cirad Lab-Montpellier) and given an anti-parasitic treatment.

After performing the screening and vaccinations, the animals are housed in the pre-shipment pens where all the final preparations for translocation take place. Each animal is individually identified with an ear tag and an intradermal microchip. At least two vials of blood are banked for each animal that is sent for reintroduction. All details concerning the animals' identification (ear tag, microchip, sex, age, origin) are recorded in a database and transferred to the team in Chad.

# 5. Translocation of oryx from Abu Dhabi to Chad

After the animals are prepared, a key component to the success of the project is always ensuring that all translocation logistics are carefully planned, which ensures a smooth transfer to Chad. This step is never taken lightly, and every effort is taken to adhere to best practice standards. The timing of translocations from the UAE to Chad, and the subsequent release of animals into the wild are timed to match the environmental conditions (temperature, seasonal ecology), to minimize stress and maximize survival. All transportation crates were replaced this year with redesigned, heartier crates, as the previous ones were deteriorating. These specially designed crates have no sharp edges on the inside, plenty of ventilation, water provisions, access doors for observation/manipulation and a steel frame that will endure the tough journey. The oryx and addax are selected, crated, and transported during the cooler months in the UAE (i.e., November-February), which also aligns with the cool, dry season in Chad. Animals are flown from Abu Dhabi to Abéché, Chad and then transported approximately 200 km by truck to the release site.

As per the previous shipments, the cargo plane and all ground and air logistics are coordinated well in advance of the shipment date. All documents required to send the animals from the UAE to Chad: health certificate, a CITES import permit from Chad, and a CITES export permit from the UAE, were obtained prior to travelling.

With each shipment of animals, the extra space was filled with as much food and supplies as could fit on the plane. On each of the two planes were three pallets of grass hay and pellet concentrate (a total of 6 pallets of 600 kg each) which was meant to serve as a transition diet for the animals, as they started to eat the native grasses and locally available peanut leaves and cut grass. A transition diet plan was provided to the team at the pre-release pens to use as a guideline. In addition to the animal food material, there were also some needed animal capture supplies and general site supplies.

For each of the shipments, the process started as soon as the sun came up at the Deleika wildlife conservation center. After certifying that the oryx and addax were fit to travel on the morning of the flight, the animals were individually loaded into specially designed crates (Fig. 3) and transported on trucks to the Al Ain Airport, about an hour away. After the customs and security clearance at the Airport, they were loaded onto a chartered Ilyushin 76 cargo plane, along with animal food and supplies.

Figure 3. Addax in the process of loading into crate during translocation

The flight from Abu Dhabi to the airport in Abéché, Chad is about 7 hours, and the animals were checked often and given water. Upon arrival in Abéché, the oryx and addax were unloaded from the plane and loaded onto trucks with the help of members of the French military stationed in Chad.

After an eleven to twelve-hour drive through the night, the oryx convoy arrived at the pre-release facility. Prior to release from the crates, the animals were vaccinated for Anthrax by pole syringe. When released, all animals in both groups were in good shape and had no ill effects from the journey. The first group of addax traveled very well and began grazing in

the acclimation pens soon after release. The door-to-door time ranged from 28 to 30 hours per trip.

This is an exciting time in the project as phase II of the project is further implemented. We are planning to send another 20 scimitar-horned oryx, 25 addax and 5 dama gazelle in March 2022, with additional translocations in November if everything is going well. This phase of the project will increase the number of oryx in the wild, working toward a sustainable population.

# 6. Communication, outreach and awareness

The documentary 'Back to the Wild', depicting the Scimitar-horned oryx Reintroduction Project, which tells the story of this ambitious reintroduction program, has continued to air on the factual entertainment channel, Quest Arabiya, Etihad and Emirates Airways. Additionally, a variety of press releases have appeared in newspapers, and the project has been highlighted in a variety of social media channels. The project team has developed a data portal to share information on the released animals monitoring program and movement data. This portal will include interactive maps showing the movement data, as well as an app to visualize and download any field monitoring data. There have been multiple peer-reviewed, scientific publications, including papers on the genetic management and the genome assembly of the scimitar-horned oryx, published in Biological Conservation and Molecular Ecological Resources.

**

## Published paper

Paper published in the journal Biological Conservation:
Ogden, R., Chuven, J., Gilbert, T., Hosking, C., Gharbi, K., Craig, M., Al Dhaheri, S., Senn, H. (2020). Benefits and pitfalls of captive conservation genetic management: Evaluating diversity in scimitar-horned oryx to support reintroduction planning. Biological Conservation, 241, 108244. doi: 10.1016/j.biocon.2019.108244

# Annex 1

## Update on genetic diversity in antelope populations reintroduced to Chad

Kara Dicks[1], Emily Humble[2], Justin Chuven[3], Alex Ball[1], Rob Ogden[2] and Helen Senn[1]
[1] Royal Zoological Society of Scotland, UK
[2] University of Edinburgh, UK
[3] Environment Agency Abu Dhabi, UAE

Genetic diversity is essential for long-term survival of populations, providing them with the raw material to enable adaptation to changing environments. As the reintroductions of arid land antelope to Chad progress, it is essential to ensure that as much diversity as possible is incorporated within the founders of these populations. To capture what diversity exists, antelope from several captive populations around the world were included within the reintroduction, by bringing them together and forming a breeding program in the UAE, prior to selecting diverse groups of animals for release in Chad. Once a genetically diverse group of founders has been released, it is important to monitor the genetic diversity as the population becomes established, as not all founders will breed successfully and contribute to future generations. This information will enable targeted reinforcement of the population.

We have previously reported on the ongoing work by the Royal Zoological Society of Scotland, University of Edinburgh, and EAD to monitor the levels of genetic diversity within the founders of the reintroduced populations. Here, we provide an update on genetic diversity in the founders of the scimitar-horned oryx (*Oryx dammah*) reintroductions, provide an overview of ongoing genetic research on the addax (*Addax nasomaculatus*) and dama gazelles (*Nanger dama*) in Chad, and outline future avenues of work to incorporate monitoring of the populations as they become established.

**Scimitar-horned oryx founders**

Genetic samples have been analyzed from 166 out of 181 (92%) samples of the oryx which were translocated to Chad between March 2016 and February 2020. We identified 19 maternal lineages (mitochondrial DNA) carried by these oryx, which is 40% of the total number of lineages identified globally and all of the lineages known to exist within the World Herd in the UAE. A few lineages are more prevalent than others, which can be seen in Figure 1, while others are represented by just a single individual.

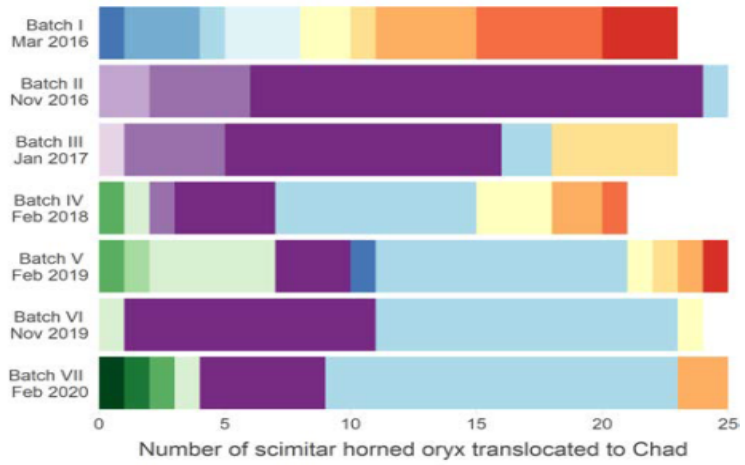



Fig 1. Mitochondrial DNA lineages carried by scimitar-horned oryx that were translocated to Chad in Batches I – VII. Each color indicates a different mitochondrial lineage. Note that oryx from Batch IV which died shortly after release are not included here, and the 11 surviving oryx have not yet been analysed

From a genome-wide perspective, the founders of the Ouadi Rimé-Ouadi Achim Game Reserve (OROAGR)population are now representative of the vast majority of the global captive populations (data not shown). Allelic richness, a measure of the amount of genetic diversity within a population has increased throughout the course of the reintroduction, as shown in Figure 2. In the first group of oryx translocated to Chad in 2016, allelic richness was 1.64 (± 0.021). With each subsequent group of founders, the cumulative allelic richness increased, up to a total of 1.90 (± 0.015) (note animals released in Batch IV (2018) have not yet been analyzed). As additional founders are released, we no longer see a substantial increase in the total amount of genetic variation.

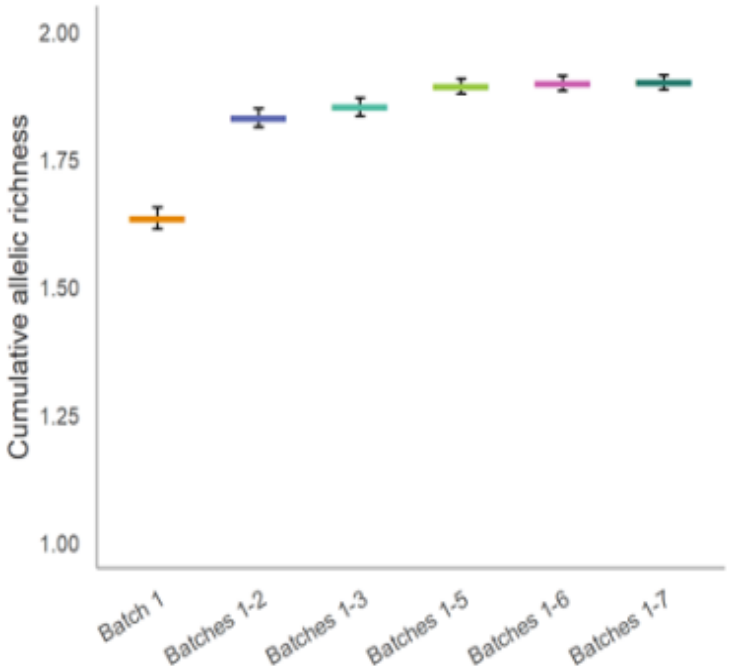



Fig 2. Cumulative allelic richness estimates over time for the scimitar-horned oryx population in Chad shown by colored bars with 95% confidence intervals (black bars). Dashed horizontal lines show the minimum (1.00) and maximum (2.00) possible values for allelic richness

These genetic data indicate that the Chad oryx population incorporates a substantial amount of the genetic diversity available in the global population. From a genetic perspective, a focus can now be placed on boosting numbers of individuals carrying rare genetic variants to maximize the chances of all genetic variants persisting as the population grows.

**Other species**

**Addax** - In November 2019 and March 2020, 40 addax were translocated to the OROAGR. Samples from all founder individuals are currently being analyzed to establish baseline levels of genetic diversity. Recent work has surveyed genetic diversity throughout the global captive populations (scientific manuscript in preparation), and this information is already being used to identify individuals for translocation to maximize genetic diversity within the source populations providing founders to Chad.

**Dama gazelles** - In January 2020, three female dama gazelles were captured in Manga, Chad and a captive breeding group was initiated with a male captured in OROAGR. Blood samples collected from these wild caught dama gazelles represent the first opportunity to analyze high quality DNA samples from any wild population. These genetic analyses will inform decision making for a captive breeding strategy for this group, as well as contributing to the global picture of genetic diversity across the in situ and ex situ populations.

**Upcoming avenues of research**

- **Post-release monitoring of established population**: Determine how levels of genetic diversity and inbreeding are changing through time in the released population, using samples collected from calf ear tags and faecal matter. This will provide valuable insights into population dynamics and inform the selection of future founders.
- **Functional genomics of arid land antelopes**: Integration of whole genome sequencing data with annotation information to investigate functional genomic differences among antelopes and enhance capacity for population and reintroduction management.
- **Microbiome and metabarcoding analysis of future release batches**: Exploratory analysis of oryx faecal samples to assess the microbiome (microbial composition) as an indicator of gastrointestinal health within the World Herd and reintroduction project, and to examine diet composition in reintroduced animals.

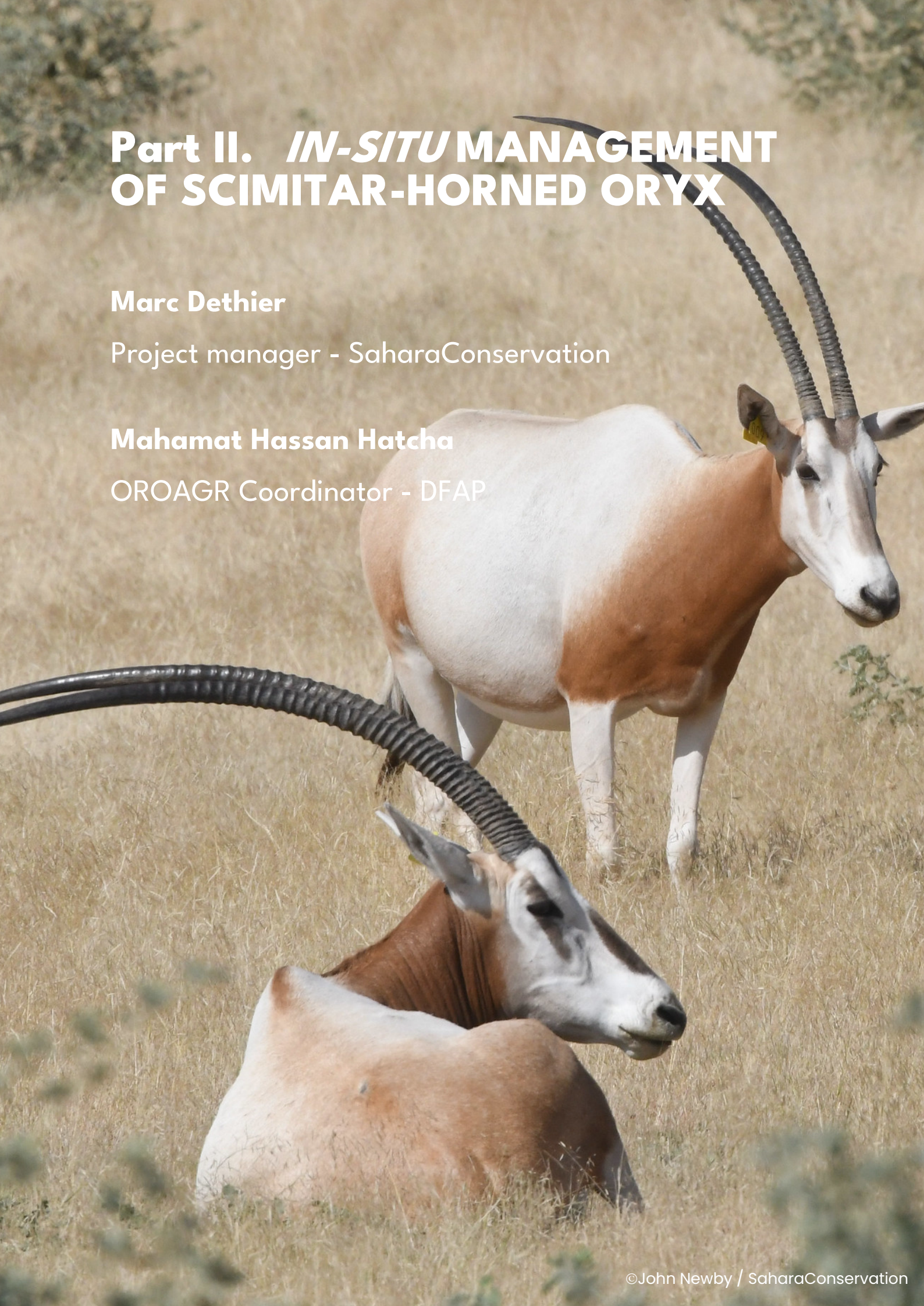
# Part II. *IN-SITU* MANAGEMENT OF SCIMITAR-HORNED ORYX

**Marc Dethier**

Project manager - SaharaConservation

**Mahamat Hassan Hatcha**

OROAGR Coordinator - DFAP



# 1. Human resources

## 1.1 Staff

The Oryx Project has entered its second phase (2019-2024). The activities have increased and diversified, leading to a greater demand for staff. Accordingly, 22 people currently work full-time for the project: 16 people on the reintroduction site and six people in N'Djamena.

These permanent staff members also regularly receive support from SaharaConservation's administrative and logistics cell based in N'Djamena.

**Fig. 1. Permanent staff on the 2021 project**: Marc Dethier (Project Manager), Firmin Dingamtebeye (Infrastructure maintenance manager), Honoré Todjibaye Midjigue (Chef), Dieudonné Kephas Doldiguim (Chef), Evariste Djibkebeng (Mechanic), François Madjitigal (Tractor driver/Driver), Yacoub Hassaballah Hagry (Driver), Abdoulrassoul Mahamat (Tractor driver/Driver), Djiddi Aklabach Ali (Tractor driver), Oumar Annadif (Head keeper of animals in the enclosure/ecological monitoring of ostriches), Kalle Dakou (Enclosure animal keeper), Loutfallah Ali (Enclosure animal keeper), Caleb Ngaba Waye Taroum (Ecological monitoring manager), Habib Ali Hamit (Ecological monitoring officer), Taboye Abdelkerim (Ecological monitoring officer), Hissein Abdarahim (Escort guard), Ahmat Anour (Driver), Nathalie Kabria (Housekeeper N'Djamena), Dana (N'Djamena Villa guard), Debi Ali (N'Djamena Villa guard), Nanga Yanga (N'Djamena Villa guard).

## 1.2 Staff activities

Marc Dethier, project manager, carries out his functions primarily on the oryx base to support all the management activities associated with the base and the animals in the enclosures or animal monitoring. He is assisted by the entire administrative and logistics team in N'Djamena.

Firmin Dingamtebeye ensures that the base runs smoothly by keeping the different infrastructures maintained and monitoring the equipment and consumables. He carries out various tasks: electricity, carpentry, welding, stock management, waste management, etc. He is also responsible for the logistics of staff travel and purchasing supplies at Biltine or Arada market. He lends a hand to the different teams, whether feeding the animals in the enclosure or carrying out ecological monitoring of the wild species.

The animal keepers set off around 5 o'clock in the morning to the enclosure. They will close the drinking troughs there, which are only open overnight, because during the day the water attracts different species of birds as well as jackals. The keeper team also gives adequate food depending on the species to be fed: oryx, addax, dama gazelles and red-necked ostriches. In the afternoon, from 3 p.m., they return to the enclosure to open the drinking troughs, while remaining in attendance to chase away birds and distribute food. These members of staff also perform small tasks on the base camp (cleaning, etc.).

Honoré Todjibaye Midjigue and Dieudonné Kephas Doldiguim are the chefs on the oryx base. They are also responsible for managing the food store by organizing the purchase of provisions in the town. They prepare the staff's three daily meals. The chefs also prepare all the meals when large teams are present on the base camp, such as when staff from EAD and other partners are present, when animals from Delaika arrive.

The mechanics (Evariste Djibkibeng Malbe for small vehicles and François Madjitigal for tractors) maintain and repair the rolling stock. They have all the equipment (tools, lubricants, etc.) required to maintain the vehicles. The vehicles are taken to N'Djamena for a major service.

Ahmat Anour is the driver in N'Djamena, Yacoub Hassaballah Hagry (hired in September 2021) is the light vehicle driver, Abdoulrassoul Mahamat drives light vehicles and tractors, while Djiddi Aklabach Ali (hired in September 2021) is a tractor driver.

Oumar Mahamat Annadif (hired in November 2021) monitors the diet of the animals in the enclosure and is also responsible for monitoring ostriches in the wild.

Lout Fallah Ali and Kallé Dakou provide the animals in the enclosure with food and water on a daily basis. Djidi helps them from time to time.

Caleb Ngaba Waye Taroum, Habib Ali Hamit, Taboye Abdelkerim (hired in July 2021) carry out ecological monitoring of animals in the wild. They are in constant contact with ZSL and NZSCBI. They go into the field every day to observe the behavior of the oryx and addax. In

general, two outings a day are planned: one in the morning for the distant groups and the other in the afternoon for the closer groups.

In N'Djamena, under the supervision of Hiti Ngaryanouba, SaharaConservation's administrative and financial manager, Adam Tchang Yakouma is the administrative officer. Four people have been hired to guard and look after the SaharaConservation villa/office: Ali Debi, Takadji Nanga Yanga, Dana Mahamat as guards and Nathalie Kabria Aguidi as housekeeper.

The people present on the base camp on the oryx reintroduction site are housed and fed. The base camp has electricity, running water, an internet connection and television.
The staff also take part in other activities, such as:

- extinguishing bush fires,
- the logistics of transferring oryx and addax between Abéché and the reintroduction site, in November 2021 and March 2022.

## 1.3 The Directorate of Wildlife and Protected Area escort guard

For all journeys between N'Djamena and the reintroduction site, the guard Hissein Abderahim Gadaye, assigned to the project by the Ministry of Environment, Water and Fisheries (Memorandum No. 004/PR/PM/MEP/SG/DPELCB/2017), escorts the vehicles.

## 1.4 Temporary staff

Several people have come to support the project for short stays, such as Hissein Abdoulaye as driver or Krazidi Abeye, ecologist.

In October and November 2021, four-day laborers came to create the firebreaks. They also played an active role in fighting the many fires set off by nomads, sometimes even inside the areas protected by firebreak strips.

| **Temporary staff supporting the project (2021)** | | |
|---|---|---|
| Krazidi Abeye | Ecologist | 3 months |
| Hissein Abdoulaye | Driver | 4 months |
| Mahamat Zen | Creation of firebreaks; fire fighting | 46 days |
| Mahamat Hamdan | Creation of firebreaks; fire fighting | 46 days |
| Mahamat Moumine | Creation of firebreaks; fire fighting | 46 days |
| Haroun | Creation of firebreaks; fire fighting | 46 days |

## 1.5 Welcoming interns

Bertrand Djikoloum came for a three-month work placement (June – August 2021) to collect the ticks and biting insects found in OROAGR. His report is entitled "Collection and sampling of ticks, mosquitoes and Culicidae, vectors of disease in antelope".

From 15 June to 7 September 2021, Oumar Mahamat Annadif carried out his final-year internship on the "Problem of reintroducing and adapting certain wildlife species in Ouadi Rimé – Ouadi Achim Game Reserve (OROAGR)" to obtain a bachelor's degree in farming techniques and sciences - specialization: livestock production. (cf. Dama in the enclosure chapter).

Kher Issakha Kher, a geography graduate specializing in mapping, followed career development training from September to November 2021.

Izzadine Abdel-Hakim came for an end-of-training internship to obtain the Water and Forestry Technical Assistant qualification. This internship took place from 1 September to 1 November 2021. The subject was "Contribution to restoring and protecting oryx declared extinct in the wild – Case of Ouadi Rimé - Ouadi Achim".

## 1.6 Arada and Ati sectors

The guards remain in position to ensure the safety of the project's facilities, staff and the area around the base camp. At present, two guards from the Northern sector (Arada) and two guards from the Southern sector (Ati) keep watch over the area on a ten-day rotation. Their role is also to prevent animals from coming within a circle of radius three kilometers formed by the circular firebreak, with the base camp forming the center point.

## 1.7 Oryx project staff training

### Formation IMET

From 20 to 23 November 2021, the monitoring team took part in IMET training given by M. Babakar Matar Breme in POROA's offices in Arada.

# 2. Infrastructure management and maintenance


**Fig. 2. Aerial view of the reintroduction site's facilities.** The base camp (on the left), the guards' camp (bottom right) and the pre-release enclosures (back). The closest town is Arada, 70 km to the east of the base camp.

## 2.1 Base camp management

**Fig. 3. Oryx project base camp** (photo taken by plane by APN)

### 2.1.1 Water management

Two collapsible tanks totaling 500 m3 have been installed inside the base camp. The water that they contain is intended for the needs of humans and the animals in the enclosure. The water is also used to water the alfalfa that we have sown to feed the ostrich chicks.

In 2021, a 24 $m^3$ tank truck reprovisioned the oryx base three times, totaling 36 journeys (150-km round trip) between Arada and the base camp.
Accordingly:

- In March 2021, 384 $m^3$ was delivered
- In May 2021, 120 $m^3$ was delivered
- In October 2021, 360 $m^3$ was delivered

Monitoring water consumption on the base camp shows that one person consumes on average 67 liters of water per day to cover all their needs (food, hygiene, laundry, etc.). The greatest amounts were consumed:

- in July, up to 18 people on the base camp, due to the presence of a team from N'Djamena come to modify and adapt the addax enclosure to raising dama gazelles,
- in October, up to 21 people on the base camp, due to the presence of temporary workers who were helping us to create the firebreak network,
- in November, up to 50 people on the base camp, due to the presence of teams accompanying the arrival of the oryx and addax, teams who had come to attach collars to animals in the wild, and tourists.

| Monthly water consumption monitoring (human and enclosure needs) for 2021 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water (liters) | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
| TOTAL | 49 700 | 65 750 | 74 900 | 76 400 | 62 000 | 36 400 | 41 010 | 29 320 | 25 250 | 33 220 | 49 560 | 29 540 |
| Human needs | 16 700 | 16 850 | 15 100 | 20 000 | 21 000 | 19 000 | 31 710 | 23 820 | 21 250 | 30 820 | 40 860 | 25 540 |
| Animal and alfalfa needs | 33 000 | 48 900 | 59 800 | 56 400 | 41 000 | 17 400 | 9 300 | 5 500 | 4 000 | 2 400 | 5 600 | 4 000 |
| Needs liter /person/ | 78 | 78 | 52 | 70 | 67 | 69 | 75 | 65 | 66 | 64 | 46 | 73 |

From January to May 2021, the watering of the alfalfa, sown in part of the capture area for the ostrich chicks that arrived in early March, significantly increased the water consumption. The 80 $m^2$ of alfalfa required 1,500 liters of water/day. In mid-June, the 13 two-month-old ostrich chicks had eaten all this alfalfa, allowing us to stop watering it.

During 2021, the enclosures were permanently occupied by dama gazelles and ostriches. Their number has increased due to births and captures.
The number of dama gazelles thus rose from three to ten individuals between January and December 2021.

Until March 2021, 11 one-year-old ostriches occupied the enclosures. In March 2021, with the arrival of new ostrich chicks, their number rose to 24 individuals.
In November 2021, the EAD team brought 25 oryx and 25 addax into the enclosures. These animals were released in December 2021.

| Number of the different species and time spent in the enclosures | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan.** | **Feb.** | **March** | **Apr.** | **May** | **June** | **July** | **Aug.** | **Sept.** | **Oct.** | **Nov.** | **Dec.** |
| Ostriches | 11 | 11 | 24 (11 adults and 13 ostrich chicks) | | | | | 15 (2 adults and 13 ostrich chicks) | | | 14 (2 adults and 12 ostrich chicks) | |
| Dama | 3 | 3 | 5 (1 birth + 1 capture ♀) | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 (2 births) | 10 (3 captures – 1♂+ 2♀) |
| Oryx | | | | | | | | | | | 25 | 25 |
| Addax | | | | | | | | | | | 25 | 25 |
| Alfalfa | X | X | X | X | X | | | | | | | |

As an intern, Oumar Annadif monitored the water consumption of the ostriches and dama gazelles in the enclosure. His observations from 14 June to 31 August 2021 cover the end of the dry season and a large part of the rainy season:

- In June, the ostriches consumed between 9 and 11 liters of water/ostrich/day. At the end of August, they consumed half of this: 5 liters/ostrich/day.
- In June, the seven dama gazelles perhaps consumed 2.5 liters of water/gazelle/day. At the end of August, they perhaps consumed 0.400 l/gazelle/day (it is difficult to measure the amount of water actually drunk by the gazelles). Other animals, probably major consumers looking for water, visited the basins filled with water and even bathed in them.


Fig. 4. Water in the dama gazelles' basins attracts different species.

Given the abundance of birds, especially crows and vultures, the animals in the enclosure only have access to water at night. As soon as the sun sets, the drinking troughs are opened.

### 2.1.2 Electricity management

As soon as the base camp was built (between January and April 2016), one of the operating aims was to use green energy for electricity needs, even though we initially purchased an 18-kva generator.

In November 2016, the Spanish company Bornay studied the base camp's electricity needs and sold us the equipment.

Following their studies, considering the power of the different equipment (light bulbs, refrigerators, small appliances, VSAT, computers, air conditioners, etc.) and their number of hours' use per day, the daily amount of electric power for the base was estimated at 57,046 Wh/day.

Given the sunshine and wind speed in our area of activity, we installed a wind turbine (3,000 W), 27 solar panels (27x250 kW) and batteries that power the base camp with electricity 24/7. At night, the wind turbine complements the batteries to cover the on-going needs, such as the refrigerator, internet, computers, and the fans to cool the machines (such as the modem, for example).

With the arrival of the first ostrich chicks in March 2020, then in March 2021, an electricity supply was required in the enclosures to run an infrared radiator. This radiator operated at night to prevent the ostrich chicks from getting cold. The radiator's thermostat was programmed so that the temperature did not drop below 23°C.
To meet this electricity need, we ran a long cable (1,000 m) from the oryx base to the enclosures.

Since November 2016, we have been constantly using these facilities. We run the generator for rare and vary occasional needs, such as using welding equipment or an electric angle grinder that have a very high electric power. During Ramadan, which currently falls in the warm month of April, the project staff asked to have access to air conditioners between 10 a.m. and 3 p.m. This additional request requires the generator to be used.

### 2.1.3 Internet connection management

VSAT is important for the project to run smoothly. It allows us to locate the oryx wearing satellite collars. It is also the only means of communication with the outside world (although we have two satellite telephones). It is impossible to work correctly without it.

For communication needs: sending reports, photos or other heavy files, we have chosen a bandwidth of 1024 kbps/512kbps ratio 4:1 on the Africasat 1a satellite. The N'Djamena-based company Globaltech provides technical support.

### 2.1.4 Vehicles management

#### Small vehicles

The oryx reintroduction project has:

- 4 Toyota crew cab vehicles,
- 2 Toyota single cab vehicles,
- 1 Toyota V8 vehicle.

All these vehicles are in good working order and insured.


**Fig. 5.** Oryx project motor vehicle fleet

The Toyota crew cab vehicle 18C4107TT was purchased in August 2015. It is currently made available to the ecological monitoring team. This vehicle covers +/- 40,000 km per year, primarily for watching oryx and addax.

The single cab pickup 18C4213TT, purchased in January 2016, is used for logistics on the base camp, to carry out return trips to the enclosure. This vehicle is involved a great deal in fighting bush fires (creating firebreaks and interventions in the event of fire). Depending on the year, it travels between 22,000 km and 31,000 km.

The Toyota crew cab vehicle 18C4328TT was purchased in August 2016. In 2019, we increased the number of plane journeys, with flights by UNHAS and the company Tchadia, thus reducing the frequency of N'Djamena/Base camp/N'Djamena journeys and the corresponding mileage. In December 2020, this vehicle was damaged in an accident and out of action for all of December in Abéché for repairs.

The Toyota Land Cruiser V8 vehicle 18C4484TT was donated by EAD in July 2017. After having long been off the road due to mechanical problems not solved by the mechanics in N'Djamena, it was finally repaired by the project's mechanic. It once again makes journeys between N'Djamena and the oryx base (1,200 km). In December 2021, it had accrued 60,000 km. It is used by EAD staff on mission in Chad.

| Mileage tracking of the oryx project's vehicles since their acquisition date | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Toyota vehicles** | **Allocation** | **Acquisition month** | **Mileage June 2017** | **Mileage June 2018** | **Mileage June 2019** | **Mileage Dec. 2020** | **Mileage Dec. 2021** |
| Crew cab Land Cruiser 18C4107TT | Ecological monitoring | August 2015 | 85,000 km | 125,000 km | 167,000 km | 218,301 km | 243,267 km |
| Single cab Land Cruiser 18C4213TT | Logistics, short journeys Enclosure | January 2016 | 40,000km | 62,000 km | 93,000 km | 128,223 km | 145,290 km |
| Crew cab Land Cruiser 18C4328TT | Ostrich monitoring | August 2016 | 55,000 km | 115,000 km | 166,000 km | 226,970 km | 246,068 km |
| Land Cruiser V8 18C4484 TT | EAD N'Djamena - Oryx base | July 2017 | | | | 25,000 km | 60,000 km |
| Crew cab Land Cruiser 18C5206TT | Logistics, long journeys Arada, Biltine, Abéché, N'Djamena | May 2021 | | | | | 33,046 km |
| Crew cab Land Cruiser 18C5207TT | Ecological monitoring | May 2021 | | | | | 23,283 km |
| Single cab Land Cruiser 18C5208TT | Logistics, infrastructure maintenance | May 2021 | | | | | 19,905 km |

As the activities are continuing to expand, we acquired three new vehicles in May 2021. One "single cab" and two "crew cabs" were purchased at CFAO in N'Djamena. The single cab vehicle 18C5208TT and the crew cab 18C5206TT provide logistical support but are also involved in the ecological monitoring of ostriches. The crew cab vehicle 18C5207TT is used by the monitoring team to monitor the oryx and addax.

The Kawasaki mule came from Abu Dhabi in January 2017. It is used by the oryx keeper staff. It only carries out journeys between the base camp and the enclosure. At the end of June 2017, its counter indicated 2,050 km, at the end of June 2018: 5,300 km, at the end of June 2019: 8,000 km and at the end of December 2019: 10,106 km. This vehicle had therefore driven 2,950 km in one year and then 2,700 km. The mule has been out of action since 2020. We are still looking for the parts to repair the injection pump or even replace the engine.

These vehicles are also regularly reinforced by SaharaConservation's vehicle, which is a Toyota crew cab based in N'Djamena.

Since the beginning of October 2021, each vehicle has been equipped with GPS/Inreach, which allows us to track their movements. The chosen subscription gives us a location every 10 minutes. It is a good safety system for drivers. It also allows us to send and receive SMSs using the messaging system. The monitoring teams in the field can thus receive the latest coordinates of the animals wearing collars (oryx, addax, ostriches) more easily. It is also easy to communicate with drivers who are travelling in towns.

## Tractors

Since January 2022, the project has had six tractors and ploughs for carrying out firebreak work and fighting bush fires. None of these was purchased by the oryx project. However, we cover all the operational costs: fuel, maintenance, repair, etc.

- New Holland 75CV and tractor Mahindra 6500

In 2019, through the intervention of the Minister of Environment, Water and Fisheries, the Ministry of Agriculture gave Ouadi Rimé - Ouadi Achim Game Reserve two second-hand tractors and two-disc ploughs. We received a New Holland 75CV tractor and a Mahindra 6500 tractor with a power of 65 CV.

- John Deere 6100D

In the third quarter of 2019, the POROA project donated a new John Deere 6100 D tractor and a rotary cutter to OROAGR.

- John Deere 6100D

In September 2021, the PREPAS project provided a John Deere 6100 D tractor with a 2x12 disc plough.

- John Deere 5503

Finally, at the end of December 2021, the Forest and Wildlife Guard (GFF) gave two John Deere 5503 tractors equipped with a mouldboard plough to OROAGR.


Fig. 6. The fleet of tractors to fight bush fires

Since the end of August 2021, i.e. after the heavy rains, and until early January 2022, these tractors were used to create firebreaks. They are also involved in fighting bush fires. Finally, they are used to level out the tracks most used by vehicles.

To improve the firebreak creation work, three Erdvark G40B graders were ordered in July 2021 in South Africa. The blade width of these G40 graders is 3.1 meters and it weighs 1,500 kg. They will be towed by tractors and are extremely suitable for firebreak creation and maintenance. They are currently being delivered.

### 2.1.5 Food management

We mainly buy food in Biltine and Abéché, and from time to time in N'Djamena, and fresh produce (fruit and vegetables) and meat (sheep, chicken) from the weekly markets in Arada (Thursday) and Biltine (Monday) or from nomads. This food is stored in the refrigerators and freezer installed in the kitchen.

On average, 12 people are present on the base camp.

### 2.1.6 Enclosure management

**Oryx enclosure**

The wide mesh of the fence for the "oryx" enclosure does not prevent jackals from entering it. Jackals manage to slip in by jumping through the highest mesh.

While jackals are not dangerous for adult oryx, they can be predators for the newborns or ostrich chicks also found in the enclosure. In August 2021, 3,000 meters of fencing (reference 2096/3) was purchased from the South Africa-based company Bonnox. The fencing was delivered in April 2022.

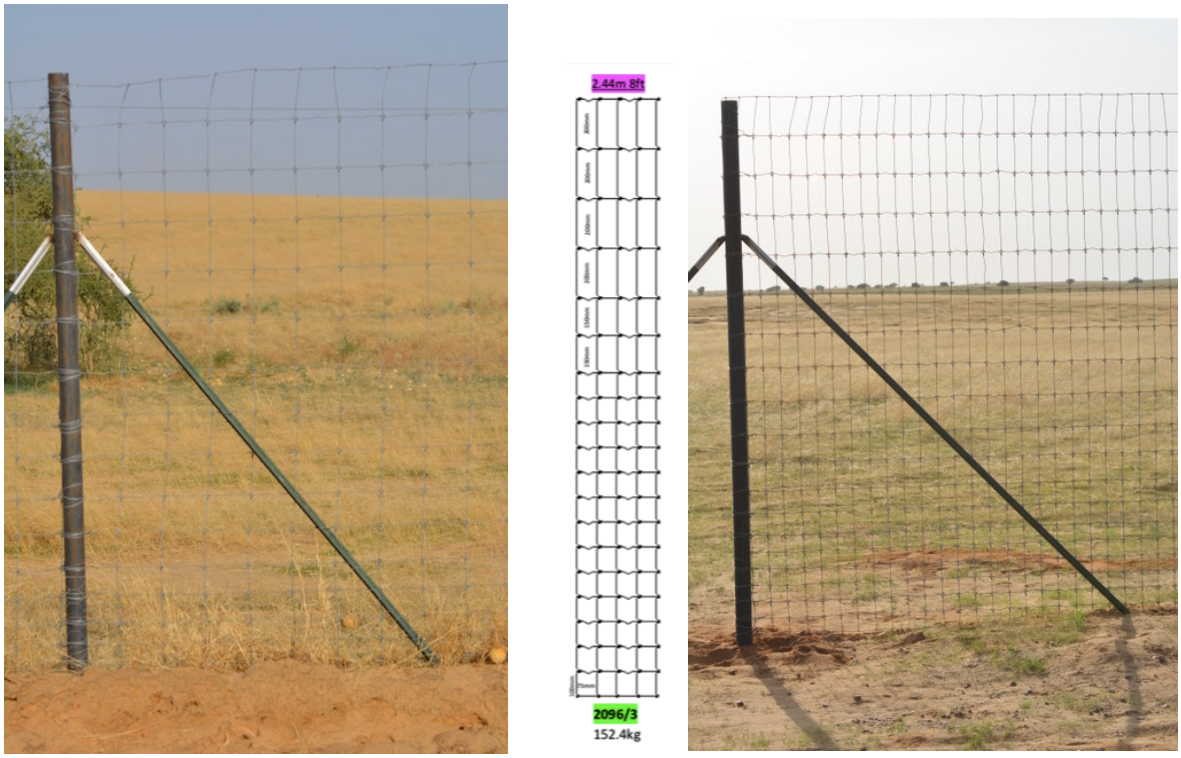



Fig. 7. Fencing to prevent jackals from slipping into the enclosures

## Addax / Dama enclosure

To boost the existing dama gazelle population in OROAGR (2019-2022 conservation strategy), estimated at 40-50 individuals, a breeding project for this species began within the project.

To this end, a suitable conservation site had to be established in OROAGR.

In July 2021, following the plan sent by the EAD team, the 20-hectare enclosure was subdivided into four parts. Shady areas were also provided.

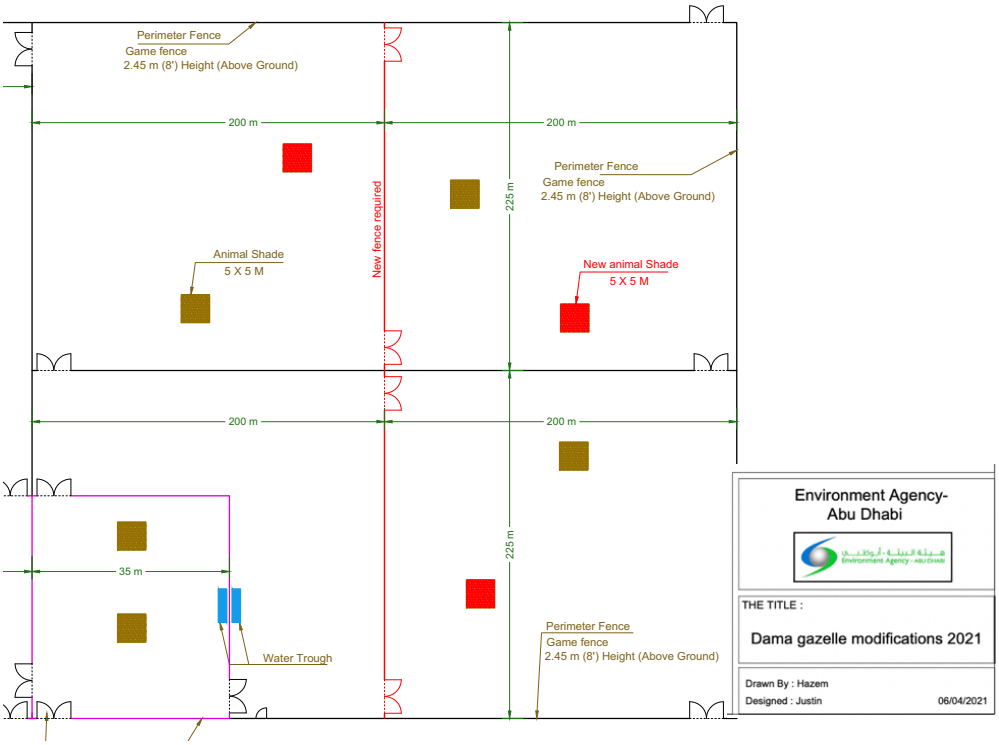



Fig. 8. Organisation of the addax enclosure for dama gazelle management Organisation of the addax enclosure for dama gazelle management

In February 2022, to facilitate the work of the keepers, who had to cross the whole enclosure to bring food and water to the dama gazelles already divided up into different small enclosures, Evariste, the mechanic, created an exterior gate that was placed at the northern part of the enclosure.

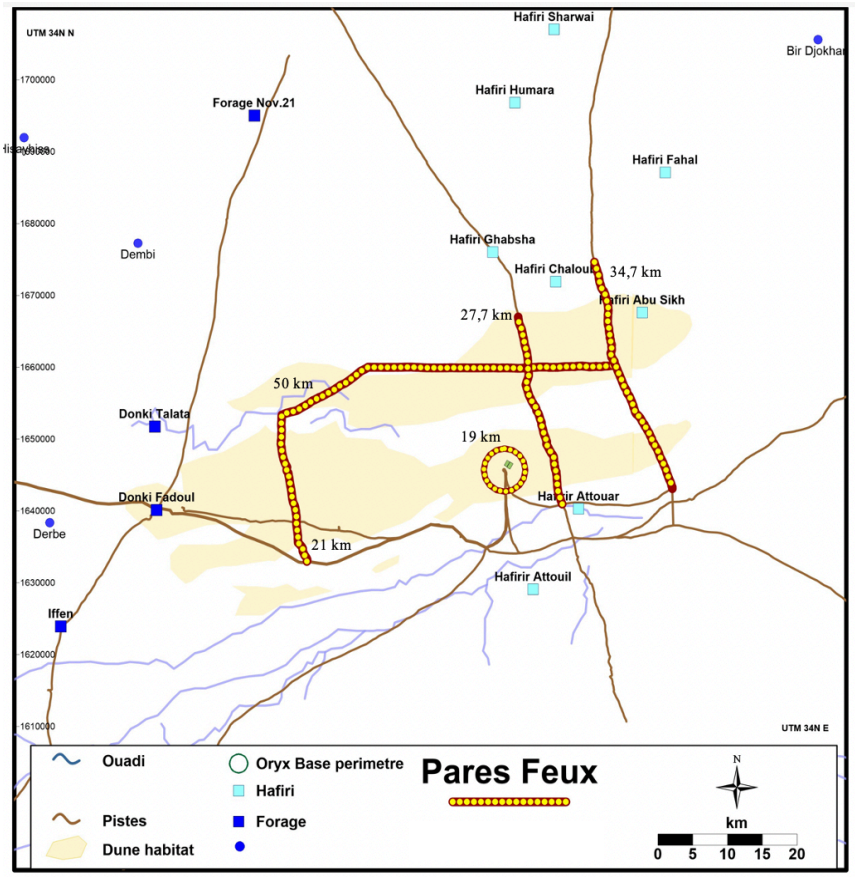
Fig. 9. Gate manufacture and installation

## 2.2 The firebreak network

To protect the project's facilities, along with the reintroduced animals and their pastureland, we have opened a network of firebreaks.

In September and October 2021, four tractors were used to create 153 km of firebreaks, divided into:

- A circular firebreak centered on the base camp and the enclosures (19 km),
- A firebreak along the first fraudsters' road (34.7 km),
- A firebreak along the second fraudsters' road (27.7 km),
- A firebreak in the West-East direction (50 km),
- A firebreak along the western fraudsters' road (21 km).



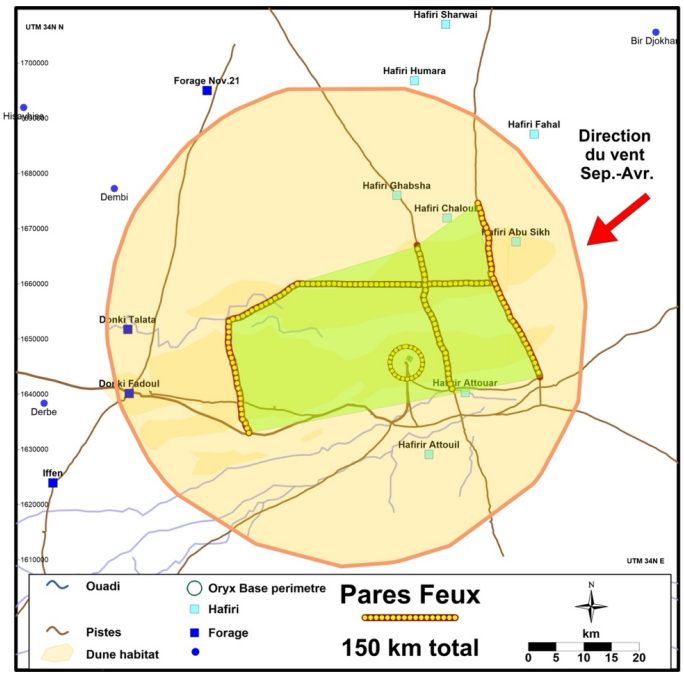

For these, we used the technique of preventive fires. This involves burning a broad strip of grass between two strips of land ploughed by tractors. When it is done well, this technique makes it possible to create very broad firebreaks (50 meters). As well as tractors, at least six people are required to correctly control the lighting of the fire and the fire itself. This team worked for 45 days.

Fig. 11. Setting up firebreaks

To carry out this work, the tractors consumed 3,073 liters of diesel. To weed it properly, a tractor has to pass over the same strip at least three times. The oldest tractors' mileage counters (New Holland and Mahindra) do not work. To create the 153 km of firebreaks, the tractors covered at least 407 km.

| | SEPTEMBER | | OCTOBER | |
|---|---|---|---|---|
| | Liters | Km | Liters | Km |
| **JOHN DEERE / POROA** | 565 | 88 | 735 | 77 |
| **JOHN DEERE / PREPAS** | 428 | 58 | 705 | 74 |
| **MAHINDRA** | 150 | 55 | 55 | |
| **NEW HOLLAND** | 215 | 55 | 220 | |
| **Total** | 1 358 | 256 | 1 715 | 151 |

At present, we estimate the surface area protected by the firebreaks to be 1,330 km2. Considering that 95% of the oryx occupy a 6,533-km2 area, this represents 20% of the surface area.



## 2.3 Creation of a landing strip

A landing strip has been created in OROAGR, 8 km to the south of the base camp. This does not require too much work because the chosen site is on lowland. We simply scrape the strip twice a season to remove grassy shoots and level out the hoofprints left by domestic livestock.

However, the strip cannot be used during the rainy season, unless there are at least two days between consecutive rain showers, which gives the strip time to dry.

The strip is 1,200 meters long. Aircraft such as Cessna 172 (Wings for Conservation), Cessna 182 (APN, MAF) and Caravan (MAF, AVMAX) land there.

The Ennedi Natural and Cultural Reserve's (RNCE) Cessna used this strip several times in March 2021 to transfer the 29 ostrich chicks from Zakouma National Park.

Fig. 12. Arrival of the baby ostriches by plane

Fig. 13. Arrival of the dama gazelles by plane

On several occasions, other APN aero planes landed on this strip to refuel. APN asked us if they could store fuel on the oryx base for their supply needs. We thus provide this logistical service as a "filling station".

VIP visitors (American Embassy, VIP tourists) arrived via AVMAX Caravan aircraft.

MAF's Cessna 182 came to carry out the aerial survey in November 2021.

Finally, we signed a six-month contract with Wings for Conservation for 20 hours of flying per month with the Cessna 172, piloted by Jaime Dias. WFC is also involved in spotting oryx and addax during the fitting of the collars on wild animals (November 2021).

## 2.4 The transit house in Arada

The transit house in Arada is still rented, although it is very seldom used.

## 2.5 The N'Djamena office

The project rents the SaharaConservation villa, which serves both as an office and a transit house.

# 3. The different species in the enclosure

During the course of 2021/2022, we received oryx, addax and dama gazelles several times from Abu Dhabi, along with ostriches born in Zakouma National Park.

## 3.1 Oryx

On 8 November 2021, the tenth group of 25 oryx from Abu Dhabi arrived in Abéché and was transferred during the night to the pre-release enclosure. These animals were fitted with GPS collars. They were released on 5 December 2021.

Fig. 14. Tenth oryx release in OROAGR

As a reminder:

| Date | Number of animals | Release date |
|---|---|---|
| 16 March 2016 | 21 | 14 August 2016 |
| 14 November 2016 | 14 | 21 January 2017 |
| 18 January 2017 | 37 | 3 August 2017 |
| 11 February 2018 | 24 | 6 August 2018 |
| 15 February 2018 | 25 | 6 August 2018 |
| 18 February 2018 | 24 | 6 August 2018 |
| 25 February 2019 | 23 | 17 September 2019 |
| 11 November 2019 | 25 | 17 December 2019 |
| 3 March 2020 | 25 | 22 September 2020 |
| 8 November 2021 | 25 | 5 December 2021 |

## 3.2 Addax

On 15 November 2021, the third group of 25 addax fitted with GPS collars arrived at Abéché airport. After staying in the enclosure for 25 days, they were released on 10 December. However, a male and a female did not follow the group and went out the next day.

| Date of arrival in Abéché | Number of founders | Date of arrival in Abéché |
|---|---|---|
| 13 November 2019 | 15 | January 2020 |
| 6 March 2020 | 25 | 7 September 2020 |
| 15 November 2021 | 25 | 12 December 2021 |

## 3.3 Dama gazelles

***Increase in the number of gazelles through births and the passive capture of wild animals***

In January 2021, three dama gazelles were present in the enclosure: the **male Moussa**, the **female Becki** and their **daughter Sherka**. The three gazelles easily went through the gates to move from the capture zone to the large enclosure and vice versa. They were regularly observed resting under the shed in the capture area.
It is in this area that they received food (alfalfa pellets, wild melon) and water during the night. During the day, the water is moved because it attracts many birds.

In February 2021, two wild dama gazelles approached the enclosure, attracted by the gazelles in captivity. After discussion, we decided to try to capture them: we opened the gate of the enclosure adjacent to the one with the three dama gazelles, hoping that one or both wild gazelles would enter it. As suggested by John Newby, we attracted them with slightly damp hay attached to the fence and also placed on the ground.
However, during this transhumance period, many nomads passed by not far from the enclosures and the wild gazelles kept their distance.

Finally, on 4 March 2021, a (female) wild dama gazelle entered the enclosure next to the one with the captive gazelles. Frightened on the first day, it struck the enclosure fence several times, damaging one of its horns. This gazelle was christened **Habiba**.

On 22 March, the female Becki, captured in Salal, gave birth to its second calf, a young female that we called **Hiti**.

As the hot season had arrived, we increased the number of bitter apples (water-rich wild melon) that we gave the gazelles. This juicy fruit was particularly popular with Habiba, captured at the beginning of the month. This gazelle did not drink the water that we provided during the night. The two other gazelles only drank very little. We monitored them with camera traps placed in the capture area. Today, all the dama gazelles are still monitored using camera traps placed in their feeding area.

As soapberry trees (*Balanites aegyptiaca*) were in fruit, we harvested the ripe fruit to give them to the gazelles, which loved them. In nature, this fruit is eaten in abundance by dorcas gazelles, which we regularly see at the foot of the trees.

In March 2021, there were therefore five dama gazelles in the enclosure.

In April 2021, the gazelles spent a lot of time in the feeding area at night. During the day, they were constantly in the soapberry grove.

Given the hierarchy in the group, we added a second feed trough in the capture area to be sure that each gazelle had access to it, especially Habiba. Becki, the female captured in Salal, was often the first to enter the capture area as soon as food or water was distributed.

In order to turn their large 16-hectare enclosure into four 4-hectare enclosures, we had to move the five gazelles. We began by gradually moving the feed troughs towards the gate giving access to the addax enclosure, which was empty at this time, in order to transfer the gazelles to this enclosure soon after.

### Dama gazelle diet

We offer the following amount of food to the five gazelles (3 adults and 2 young) every day:

- 2.8 kg pellets from the white bag,
- 1.4 kg pellets from the brown bag,
- 2 portions of soapberry fruit (they eat it like sweets),
- hay from Abu Dhabi (but very little is eaten and it accumulates in the feed troughs),
- bitter apple leaves and fruit in the evening (very much appreciated).

In May 2021, we saw that the male was extremely active in its attempts to mount the females, especially its daughter, the young female Shaika born on 24 August 2020 (8.5 months). It became increasingly important to partition the existing enclosure to separate the family.

On 13 May, we opened the gate leading to the “addax capture” area and placed a feed trough just behind this gate. The gazelles came to eat there without any problem.
The other feed trough remained in the dama capture area. The gazelles thus circulated between the food troughs placed in the two capture areas.

On 3 June 2021, we placed the two food troughs and water basins in the addax capture area, without opening the gates leading to the large addax enclosure. The gazelles therefore still grazed in their original enclosure.

We opened the gate of the addax enclosure on 11 June in the evening. In the morning of 12 June, four dama gazelles were in this enclosure. Only Habiba (passively captured) did not go through the gate. She subsequently crossed through it in the morning. The gazelles remained in this part of the enclosure until 20 October 2021.

Oumar Annadif (intern with a view to obtaining a bachelor's degree in farming techniques and sciences) monitored the dama gazelles' diet from 13 June to 13 July 2021, i.e. from the end of the dry season to the beginning of the rainy season. On average, per day, one gazelle ate:

- 450 g of alfalfa,
- 710 g of bitter apples,
- 260 g of soapberry fruit.

**Fig. 15.** Wild melon, alfalfa pellets and soapberry fruit

From 7 to 21 July 2021, work was carried out in the dama enclosure to divide it into four enclosures measuring 200 x 200 meters. The work was finished at the end of August.

On 19 October 2021, the gates of the capture area were therefore opened to allow the gazelles to move into the part of the enclosure reserved for them. On 20 October, the gazelles had moved and the team searched the enclosure to see if there had been a birth, given the strange behavior of the female Habiba and the male. They discovered a young gazelle that was estimated to be 4 or 5 days old.

This female, called **Leilika**, was born in the enclosure around 15 October. The mother, Habiba, is the female that was passively captured in OROAGR in March 2021. The father is the male Moussa.

On 9 November 2021, the third calf of Becki, the female captured in Salal, was observed in the enclosure. It is a male called **Kallé**, probably born on 8 November 2021.

On 16 December 2021, we saw another newborn in the enclosure. It was the son of Moussa and its daughter Shaika. The team placed a tag on this young **male 001**. Unfortunately, in the morning of 24 March 2022, we found it dead alongside the fence with a broken neck.

On 22 December 2021, Firmin Dingamtebeye managed to pen three wild dama gazelles (2 females and 1 male) in the enclosure.

By opening and closing the gates, we achieved the following distribution in the different parts of the enclosure:

- A single male (one individual): **Firmin** (4 ha)
- A group formed by the old male **Moussa** and two new females (3 individuals) (4 ha)
- A group formed by a new male **Andréa**, the old females and their offspring (8 individuals) (8 ha)

On 31 December 2021, 11 dama gazelles were present in the enclosure.

**Fig. 16**. Group of eight dama gazelles at the feed troughs

## 3.4 The ostriches in the enclosure

The ostrich reintroduction activity is carried out in partnership with APN. We share the logistics, expertise and lessons learnt from raising ostrich chicks and their reintroduction into RNCE or OROAGR.

From March to August 2021, one-year-old ostriches lived alongside 15-day-old ostrich chicks.

Fig. 17. One-year-old ostriches and 15-day-old ostrich chicks

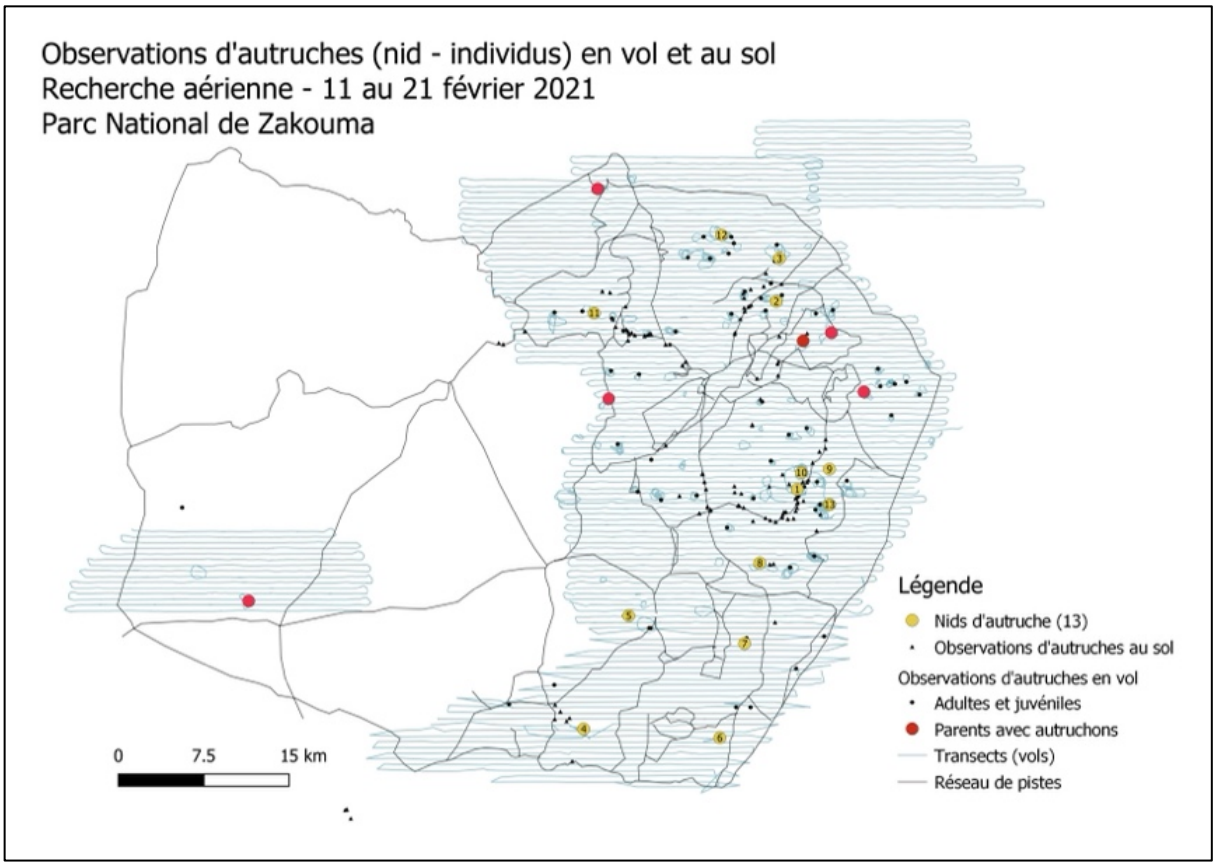
### 3.4.1 Capturing and raising the second batch of ostriches

**Study phase in Zakouma**

To support the removal of the second batch of 30 ostrich chicks from Zakouma National Park (PNZ) and have an idea of the impact of removing 30 ostrich chicks on PNZ's total ostrich population, the RNCE team, with whom we have joined forces, set up an ostrich nesting study in the park.

As the COVID pandemic prevented the South African expert from coming to lead the study, Krazidi Abeye, who had initially been chosen as assistant, supervised the work on the ground between 16 January and 26 March 2021, the date of the last hatching of the monitored eggs.

RNCE's aero plane made an aerial survey in the eastern part of PNZ to find the location of as many nests as possible.
For each nest found, a camera trap was placed to observe the incubation period, hatching and predation.




19 eggs were counted, 79% of which were incubated and could hatch. But 11% then broke and 42% were eaten by predators. Olive baboons and spotted hyenas were the most destructive. Honey badgers and Egyptian vultures were unable to break the shell. Giraffes and a leopard simply passed by to look. Seven of the twelve nests monitored produced 76 ostrich chicks, eight of which were immediately devoured. The fate of the others, which scattered, remains unknown.

Fig. 18. Female ostrich sitting on its eggs (drone photo)

Fig. 19. Male ostrich ready to incubate the eggs (aerial view))

## Capturing the second batch of ostrich chicks

29 ostrich chicks were captured in Zakouma in March 2021

- 11 arrived on 5 March, 5 were transferred to Fada (8 March 2021),
- 8 arrived on 6 March, 4 were transferred to Fada (8 March 2021),
- 10 arrived on 8 March, 5 were transferred to Fada (9 March 2021)

15 ostrich chicks remained in OROAGR. On their arrival, all the ostrich chicks received their first dose of the Multivax clostridium vaccine.

## Vaccination program

As soon as they arrived, the ostrich chicks followed a vaccination program for clostridium (Multivax and Covexin) and Newcastle's disease (Multivax and Struvac). They first received a dose of Multivax. They were then vaccinated with Covexin and Struvac.

| Date | Vaccine and quantity | Disease |
|---|---|---|
| From 5 to 8/03/2021 | Multivax (0,5ml) | Clostridium+ Newcastle |
| 3/04/2021 | Covexin (0,5ml) | Clostridium |
| 17/04/2021 | Struvac (1ml) | Newcastle |
| 7/05/2021 | Covexin (1ml) | Clostridium |

As a precaution, the ostrich chicks were also treated with Zentel. In 2020, during the first transfer, some of them had tapeworms, which also caused the death of two ostrich chicks in RNCE.

## The ostriches' diet

Dr Fanus Cilliers, a nutritional scientist (Camelus Grondstowwe cc), in contact with RNCE/APN, calculated the food rations for ostrich chicks from 15 days to 10 months old. He based his calculations on the information provided on the availability of the different ingredients in Chad.

| DÉMARRAGE<br>Éclosion à 3 mois (pèse environ 40kg à 3 mois) | | |
|---|---|---|
| **Ingrédients** | **OPTION 1 Inclusion Rate kg/ton mix** | **OPTION 2 Inclusion Rate kg/ton mix** |
| Maïs finement moulu | 436 | 286 |
| Maïs stover straw finement moulu | 0 | 0 |
| Sorgho (blanc) | 0 | 200 |
| Son de maïs | 120 | 120 |
| Fanes d'arachide | 67 | 15 |
| Tourteaux d'arachide | 200 | 200 |
| Haricots blancs / lupin doux finement moulu | 120 | 120 |
| Méthionine | 2,2 | 2 |
| Lysine | 4,8 | 4,9 |
| DCP 18%P | 16 | 16 |
| Carbonate de Calcium | 25 | 26 |
| Sel | 5 | 5 |
| Toxin Binder | 3 | 3 |
| Camelus Ostrich **STARTER** premix | 4,5 | 4,5 |
| Camelus Ostrich **BREEDER** premix | 0 | 0 |
| | | |
| | | |
| | | |
| Total | 1003,5 | 1002,4 |
| | | |
| Normal Feed intake per 3 month period - MIN | 50 | 50 |
| Normal Feed intake per 3 month period - MAX | 60 | 60 |

| CROISSANCE<br>3 à 6 mois (de 40 à 75 kg) | | |
|---|---|---|
| **Ingrédients** | **OPTION 1 Inclusion Rate kg/ton mix** | **OPTION 2 Inclusion Rate kg/ton mix** |
| Maïs finement moulu | 121 | 145 |
| Maïs stover straw finement moulu | 0 | 0 |
| Sorgho (blanc) | 250 | 250 |
| Son de maïs | 93 | 0 |
| Fanes d'arachide | 200 | 274 |
| Tourteaux d'arachide | 131 | 128 |
| Haricots blancs / lupin doux finement moulu | 150 | 150 |
| Méthionine | 1,5 | 1,6 |
| Lysine | 2,9 | 3 |
| DCP 18%P | 16 | 18 |
| Carbonate de Calcium | 26 | 21 |
| Sel | 4 | 5 |
| Toxin Binder | 3 | 3 |
| Camelus Ostrich **STARTER** premix | 4,5 | 4,5 |
| Camelus Ostrich **BREEDER** premix | 0 | 0 |
| | | |
| | | |
| | | |
| Total | 1002,9 | 1003,1 |
| | | |
| Normal Feed intake per 3 month period - MIN | 100 | 100 |
| Normal Feed intake per 3 month period - MAX | 135 | 135 |

| FIN DE CROISSANCE<br>6 à 10 mois (de 75 à 100 kg) | | |
|---|---|---|
| **Ingrédients** | **OPTION 1 Inclusion Rate kg/ton mix** | |
| Maïs finement moulu | 0 | |
| Maïs stover straw finement moulu | 0 | |
| Sorgho (blanc) | 262 | |
| Son de maïs | 0 | |
| Fanes d'arachide | 534 | |
| Tourteaux d'arachide | 109 | |
| Haricots blancs / lupin doux finement moulu | 50 | |
| Méthionine | 1,1 | |
| Lysine | 1,6 | |
| DCP 18%P | 30 | |
| Carbonate de Calcium | 3,3 | |
| Sel | 5 | |
| Toxin Binder | 3 | |
| Camelus Ostrich **STARTER** premix | 4,5 | |
| Camelus Ostrich **BREEDER** premix | 0 | |
| | | |
| | | |
| | | |
| Total | 1003,5 | |
| | | |
| Normal Feed intake per 3 month period - MIN | 275 | |
| Normal Feed intake per 3 month period - MAX | 320 | |

Some of these nutrients (Methionine, Lysine, Diphosphate) were purchased in Farcha from the “Complexe Nutritionnel Animal Alta-Aoun” cooperative, which supplies feed to chicken farmers in Chad. The rest was bought from traders in Abéché. We imported the Camelus Starter premix via different containers (POROA, APN, etc.) from South Africa.

Once a week, we gave them pebbles no bigger than the size of their toe claw.

## Ostrich chick identification

On 3 April 2021, Dr Willem Burger, a wildlife veterinarian and ostrich specialist, a consultant on the red-necked ostrich reintroduction project in Ennedi, came to fit a microchip. On this occasion, a sample of blood and feathers for sexing was taken.


Fig. 20. Fitting the ostrich chicks with microchips

## Sexing

The UNISTEL laboratory analyzed the feather samples sent to them for sexing the ostrich chicks. We had the same number of males and females.

| Microchip number | Nest | Sex | Comments |
|---|---|---|---|
| 14265 | 1 | M | Ostrich chick from the same nest |
| 14266 | 1 | M | Ostrich chick from the same nest |
| 14268 | 1 | F | Ostrich chick from the same nest |
| 14260 | 1 | F | Ostrich chick from the same nest |
| *14262* | *1* | *M* | Died on 16 November 2021 |
| *14272* | *1* | *F* | *Handicapped following the microchip fitting* |
| 14275 | 2 and 3 | M | Ostrich chicks from two nests |
| 14278 | 2 and 3 | F | Ostrich chicks from two nests |
| 14274 | 2 and 3 | F | Ostrich chicks from two nests |
| 14277 | 2 and 3 | M | Ostrich chicks from two nests |
| 14276 | 2 and 3 | M | Ostrich chicks from two nests |
| 14279 | 2 and 3 | M | Ostrich chicks from two nests |
| 14263 | 2 and 3 | F | Ostrich chicks from two nests |
| 14264 | 2 and 3 | F | Ostrich chicks from two nests |

#### Mortality in the enclosure

- On 14 March, one of the ostrich chicks from the third group that had been displaying spasms from the beginning,
- In May, an ostrich chick that showed a dislocation of one leg probably due to poor handling or a shock during capture for fitting of the microchip,
- On 16 November, mortality due to a neuromotor problem.

Out of the 15 ostrich chicks received in early March 2021, there were 12 remaining in the enclosure in December 2021.

### 3.4.2 Release of the first ostrich group

#### Choosing and fitting the tags on the ostriches

There was no GPS tag on the market that could be attached to ostriches in the wild.
The South African/RNCE team worked together to develop a new system.
Dr Willem Burger worked in collaboration with Intricode to develop a lightweight product (about 60 g, equipped with solar panels, with an attachment system that allows it to be positioned at the base of the animal's neck above the back, fixed to the skin.)

The prototype was tested on two ostriches in a farm in Oudtshoorn in South Africa. The two devices transmitted 100% of the expected GPS points, without any indication suggesting any technical problems. The minimum lifespan of the tag is two years and may reach five years.

Dr Elsa Bussière took over the reins and we chose nine tags with a subscription that takes points every 30 minutes during the day and every hour at night, i.e. 32 positions per 24 hours.

The tags are configured to send the points at 5 a.m., 9 a.m., 10 a.m. and 7 p.m. The ostriches are monitored on the “MOVEBANK” site.

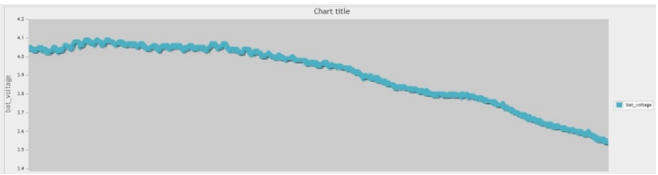

Fig. 21. Fitting the ostriches with GPS tags

## Releasing the ostriches

On 2 September 2021, nine ostriches (5 males and 4 females) aged 18 months were released in OROAGR. Two ostriches (a female and a male) were kept in the enclosures for reproduction in captivity.

## Functioning of the tags

| Number of points recorded/day | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male In a couple with 9 | Female tag fitted the wrong way round | Male Tag hanging (April 2022) | Male with tag N 5 Tag hanging | Male poached 15 Nov 2021 Tag removed | Female feather covering tag | Female Tag hanging | Male Tag hanging | Female In a couple with 1 |
| Ostrich number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **2021** | | | | | | | | | |
| September | 32 | 32 | 32 | 32 | 32 | 30 | 32 | 31 | 32 |
| October | 32 | 32 | 32 | 32 | 32 | 32 | 33 | 32 | 32 |
| November | 32 | 8 | 32 | 32 | 17 | 27 | 32 | 32 | 32 |
| December | 32 | 0 | 32 | 32 | 0 | 21 | 32 | 20 | 32 |
| **2022** | | | | | | | | | |
| January | 32 | 0 | 32 | 32 | 0 | 32 | 32 | 8 | 32 |
| February | 32 | 0 | 32 | 31 | 0 | 32 | 28 | 2 | 32 |
| March | 32 | 0 | 29 | 14 | 0 | 32 | 23 | 0 | 29 |
| | Good | Bad | Good | | Out | Irregular data sending | | | Good |




The feathers on the neck of ostrich No. 6 grew back, covering the solar panels of the battery, which no longer recharged. We have once again removed these feathers.

**Fig. 22.** New feathers covering the GPS tag

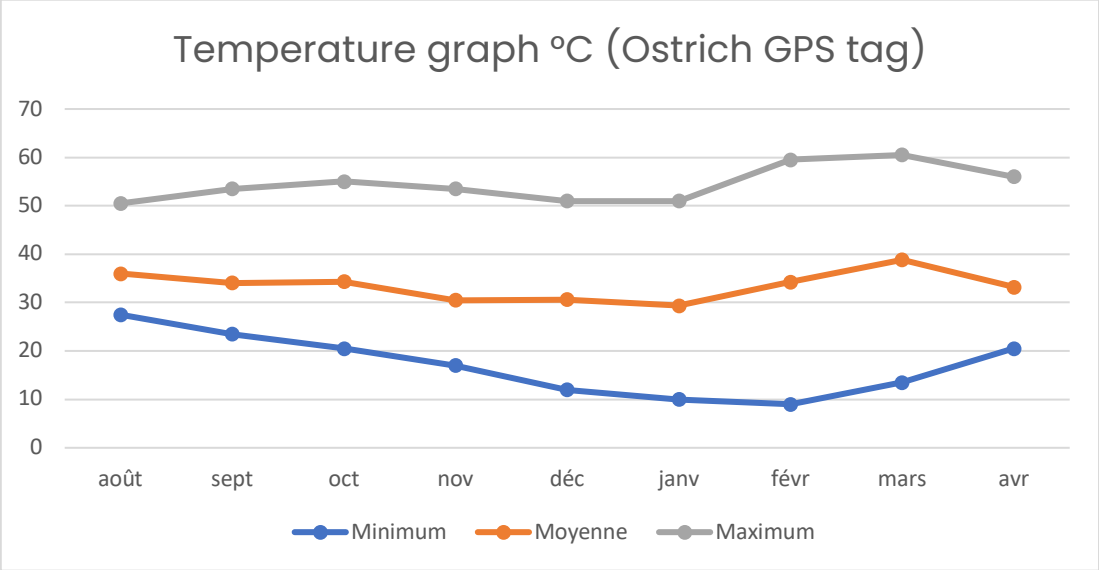
Fig. 23. Dysfunctional GPS tags

Tags No. 3, 5, 7 and 8 broke at different times (the manufacturer acknowledged that the material was faulty). It was supposed to be more robust and flexible than the material used to manufacture the first batch sold to RNCE, which did not have this problem.
Intricode will alter the construction method so that this does not happen again in future for the ostriches that will be released in August 2022.

A positioning error occurred when attaching the tag to ostrich no. 2. It was placed the wrong way round, with the small solar panels turned downwards. The tag stopped working on 27 November 2021.

## Temperatures

The GPS tags placed at the base of the ostriches' neck have a temperature sensor. The following graph shows the minimum, maximum and mean temperatures recorded for the group of eight ostriches from August 2021 to the beginning of April 2022.




## Ostrich monitoring

The four females (N1, N2, N6, N7) and the five males (N3, N4, N5, N8, N9) are monitored on the Movebank and Spoortrack sites. Google Earth also makes it possible to observe their movements.

During their release, many nomads were camping near the perimeter of the circular firebreak located 3 km from the base camp.

The ostriches were afraid of the sheep and dromedaries and did not move away. Three weeks after their release, the ostriches separated into two groups: another group of three ostriches that set off a dozen kilometers to the west of the base and a group of six ostriches that remained within the perimeter of the base camp.

All the ostriches subsequently dispersed, each with their own behavior.

After moving away towards the west, **male No. 5** returned within the 3-km perimeter and has not left it since. It was still present in April 2022.

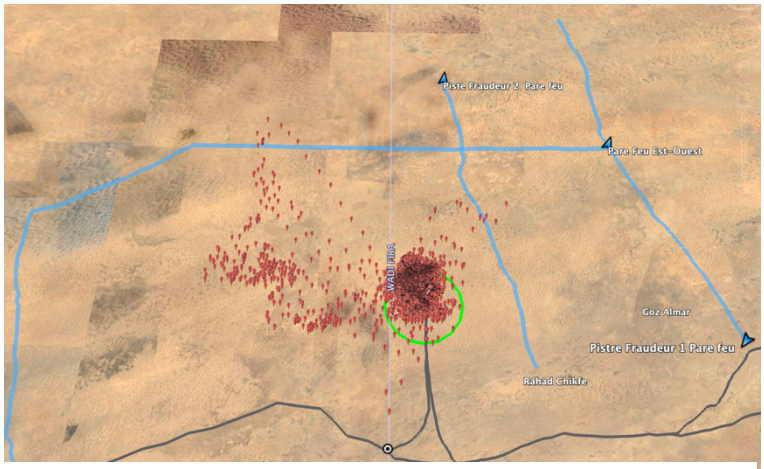



Fig. 24. Distribution range of male No. 5

**Males No. 3 and 8** stayed together to the west of the base camp.

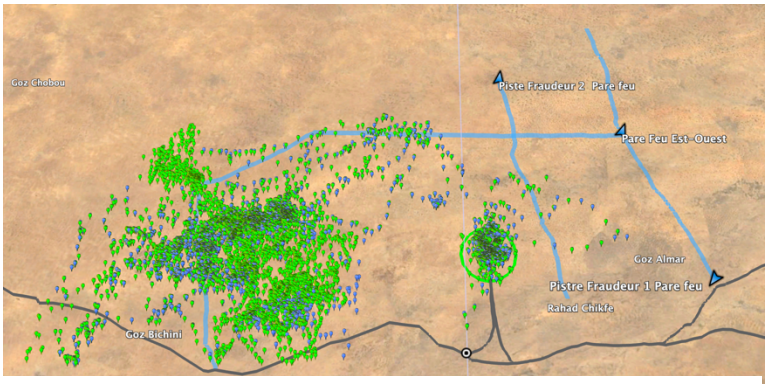



**Fig. 25.** Distribution range of males No. 3 and No. 8

Two **females**, **No. 2 and 7**, remained in the same area, without couples forming. **Male No. 8** performed a display with the two females. These females laid eggs.

**Female No. 7** (blue dots) and **female No. 2** (pink dots) laid eggs.

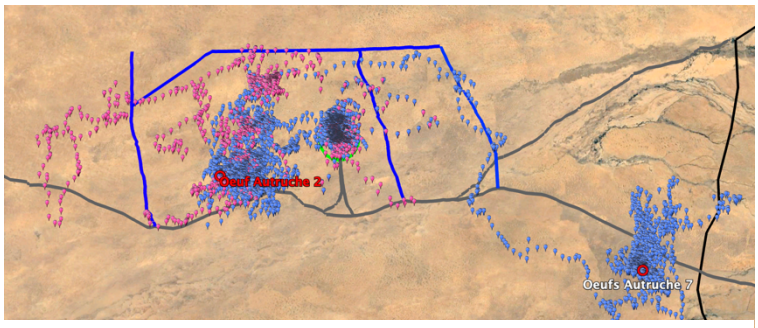



Fig. 26 Distribution ranges of females No. 2 and No. 7

Female **No. 7** left the area where the two males (**No. 3 and 8**) were present on 3 February 2022 to travel 60 km from the base camp to the west side. It laid three eggs (red circle on the map), which were discovered on 23 February 2022. The eggs were small, one was recovered, as the other two were broken. On 28 February, a single egg was found on another site, 20 km to the west of the base camp, where female No. 2 lives. The egg was normal-sized.


**Male No. 6** moved away from the base camp on 9 November 2021 and headed to the East side. It left the reserve on the morning of 16 November and the collar no longer sent coordinates. This beautiful male was found poached (red arrow), killed by a bullet in the millet fields 60 km from the base camp.

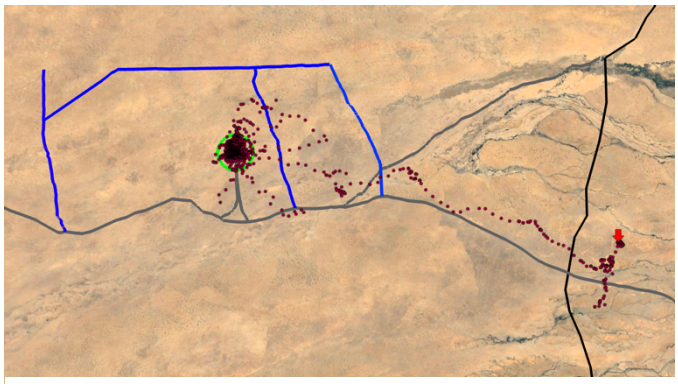


Fig. 27. Distribution range of male No. 6

**Female No. 6** is a great explorer. It has travelled 220 km from North to South!

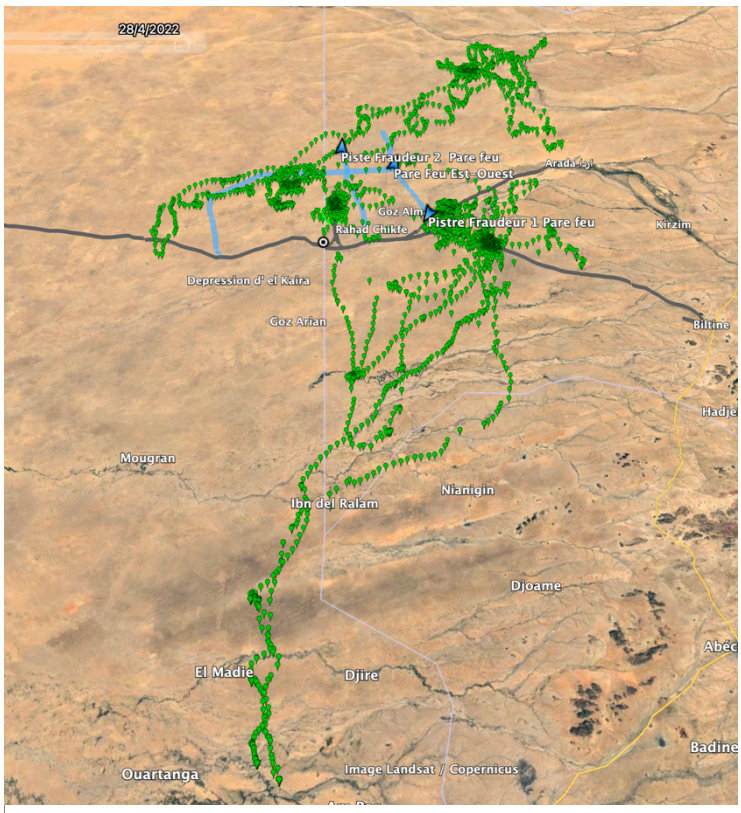



Fig. 28. Movement of female ostrich No. 6

Found to the south of Ouadi Kharma, seeming lost 80 km from the oryx base, we brought it back to the base on 2 December 2021 in 24 hours. It followed a motorbike.

Two days later, it moved off towards the south, reaching the village of Am Sack (Ougla wadi) located 140 km from the oryx base.

It then moved up towards the millet fields located 60 km from the oryx base, eating the unharvested ears. In this area, on 1 February 2022, the team observed that the ostrich was hampered. The next day, we were able to intervene to remove the cord.

**Female No. 1 and male No. 9** formed a couple as of December 2021. The ostrich monitoring team saw them mating on 27 December 2021.

However, the female did not lay an egg. The two ostriches remained for a long time in an area burnt by fire. Male **No. 9** was stabbed on 16 February 2022.

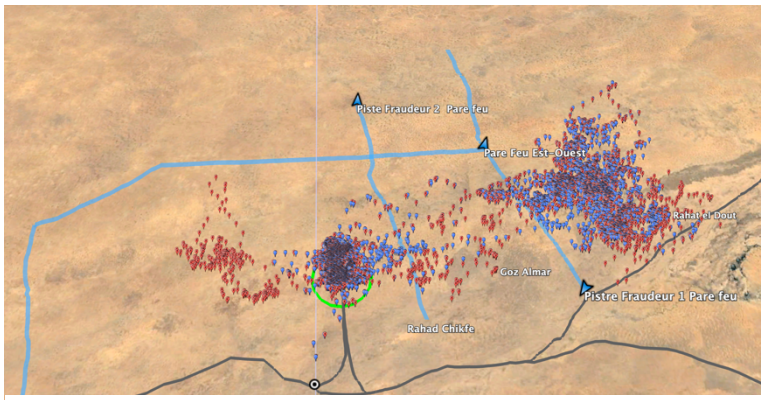


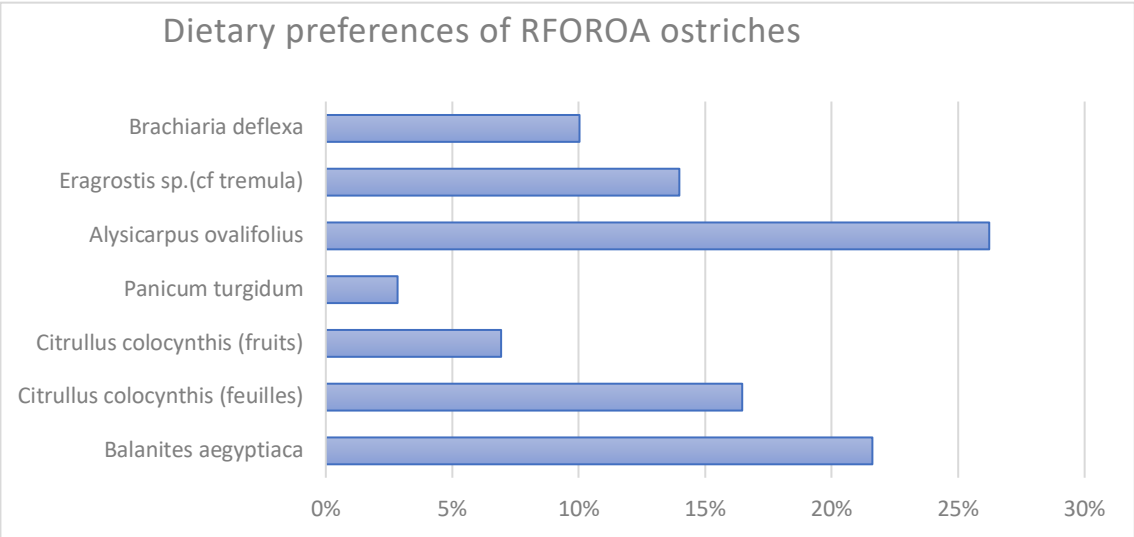

Fig. 29. Distribution range of female No. 1 and male No. 9

These two ostriches still form a couple. They remain some thirty kilometers to the east of the base camp.

## Diet monitoring

Kher Issakha Kher and Izzadine Abdel-Hakim, who came on an internship from September to November 2021, monitored the ostriches in the wild to note the different types of plants ingested. They monitored five ostriches (No. 1, No. 4, No. 5, No. 7 and No. 9) for a total number of 195 hours of observation. These ostriches were found less than 3 km from the oryx base.

The most popular plant is *Alysicarpus ovalifolius* (Fabaceae). The ostriches also eat abundant amounts of leaves from the Soapberry tree.




Plants that grow abundantly in the ostriches' path were not eaten, such as *Aristida mutabilis* and the two species of *Indigofera,* whereas these two plants are very popular with oryx and addax.

Fig. 30. Monitoring the ostriches' diet

## Different interrelations (by Oumar Annadif and Kher Issakha)

- **Relations between ostriches and the population**
  We remarked that during our monitoring days, relations between the ostriches and the populations went well. The female ostriches did not hesitate to follow the movements of the populations. Unfortunately, some farmers are still afraid of this approach. When females are in heat, males avoid getting close to farmers. They are extremely aggressive towards the latter.
- **Relations between the ostriches and sheep**
  We found certain ostriches (females No. 6 and 2) with sheep farmers, they sometimes stay with them for the whole day.
- **Relations between the ostriches and dromedaries**
  According to accounts by several farmers questioned by the monitoring team, dromedaries do not tolerate cohabiting with ostriches. They see the ostriches as a danger to them. Whenever they spot an ostrich, the dromedaries flee in different directions.
- **Relations between the ostriches, oryx and addax**

The ostriches cohabit well with the oryx. However, during the reproduction period, male ostriches become aggressive and can sometimes run and chase the oryx and addax away from their territory.

Fig. 31. Female No. 2 with a group of oryx (Photo: Oumar Annadif)

## Support for RNCE

- From 29 March to 3 April 2021, the project manager went to Fada and Aloba to help to fit the GPS tags on the ostriches and to Am Djaras to help with the DNA sampling on the Field Marshal of Chad's ostriches.
- At APN/RNCE's request, from 6 to 9 June 2021, we transported 80 fencing units that had come from Abu Dhabi and built a temporary enclosure in Aloba. This enclosure allowed the APN/Ennedi team to keep their adult ostriches there and free up the other enclosure to welcome the new ostrich chicks. The release of the adult ostriches is scheduled for mid-July.
- The operation to translocate 11 ostriches between Fada and Aloba was successfully completed between 16 and 22 June.

## Other

At the request of Maren Frerking, EEP coordinator for North African ostriches, we sent several photos to create an awareness-raising brochure for Hanover Zoo.


AUCH STRAUSSE KÖNNEN FLIEGEN

WIEDERANSIEDELUNGS-PROGRAMM IM ZENTRALEN TSCHAD

JAMBO! INFO


RÉPUBLIQUE DU TCHAD
Unité - Travail - Progrès

Ministère de l'Environnement, de la Pêche et du Développement Durable
Direction de la Faune et des Aires Protégées

Stratégie nationale de conservation de l'autruche (*Struthio camelus camelus*) au Tchad

Avril 2021

Financé par L'Union européenne

In preparation for the workshop on validating the national ostrich conservation strategy in Chad, we assisted Dr Elsa Bussière in creating her PowerPoint presentation.
Issacka Gooney, Deputy Director of RNCE, Arrachid Ahmat Ibrahim, Deputy Director of POROA, and Krazidi Abeye, responsible for analyzing the data from the camera traps on the ostrich nests, jointly gave the presentation.

## 4. The oryx and addax population in Chad in December 2021

At the end of December, the oryx population in Chad was estimated at 467 animals and the addax population 97 individuals.
All these animals roam free in Ouadi Rimé - Ouadi Achim Game Reserve.

## 5. The threat to grasslands

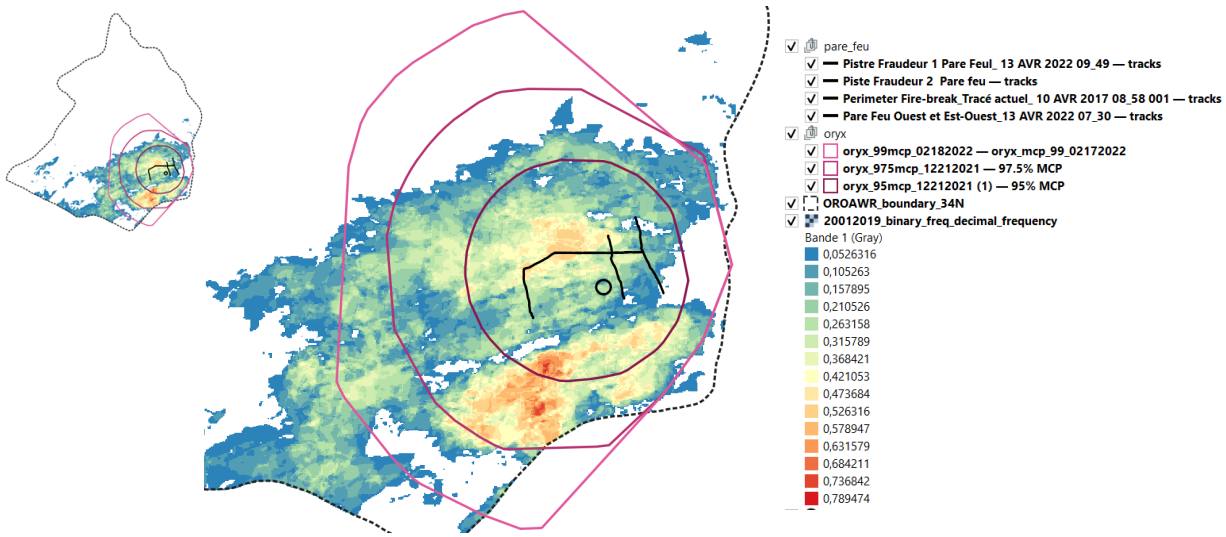
The greatest threat to the success of the project, which is looking to reintroduce a viable population of 500 adult oryx, along with addax and other species in the future, is the risk of a lack of grassland for these animals and diseases that can be transmitted from domestic to wild animals. The two factors that are causing a major loss of grassland are bush fires and overgrazing of domestic animals.

## 5.1 The problem of bush fires

Bush fires represent a recurrent threat that has been difficult to treat to date by the competent local authorities and administrations. These fires are responsible for the loss of considerable areas of pastureland, both for wildlife and livestock. They destroy perennial plants, microfauna and the nests of birds that nest on the ground – such as bustards – thus impoverishing OROAGR's plant biodiversity.

The fires are almost all started due to carelessness (cigarette butts, fire pits not extinguished properly, etc.) by "fraudsters", who are gold diggers or traders trafficking between the north (Libya, Sudan, etc.) and Chad towns further south. In order to avoid road checks on the national roads, they travel through the bush, including the wildlife reserve, from north to south and south to north.

The nomads passing through OROAGR also unintentionally cause fires. As there are no official regulations, certain nomads move into pastureland protected by firebreaks, sometimes starting a fire in these theoretically protected areas. This map shows the boundaries of OROAGR, the frequency of fires from 2001 to 2019, the oryx distribution area, the network of firebreaks to protect the project's infrastructure and the pastureland areas closest to the base camp.



We have asked the GFF for new tractors. They gave us 2.

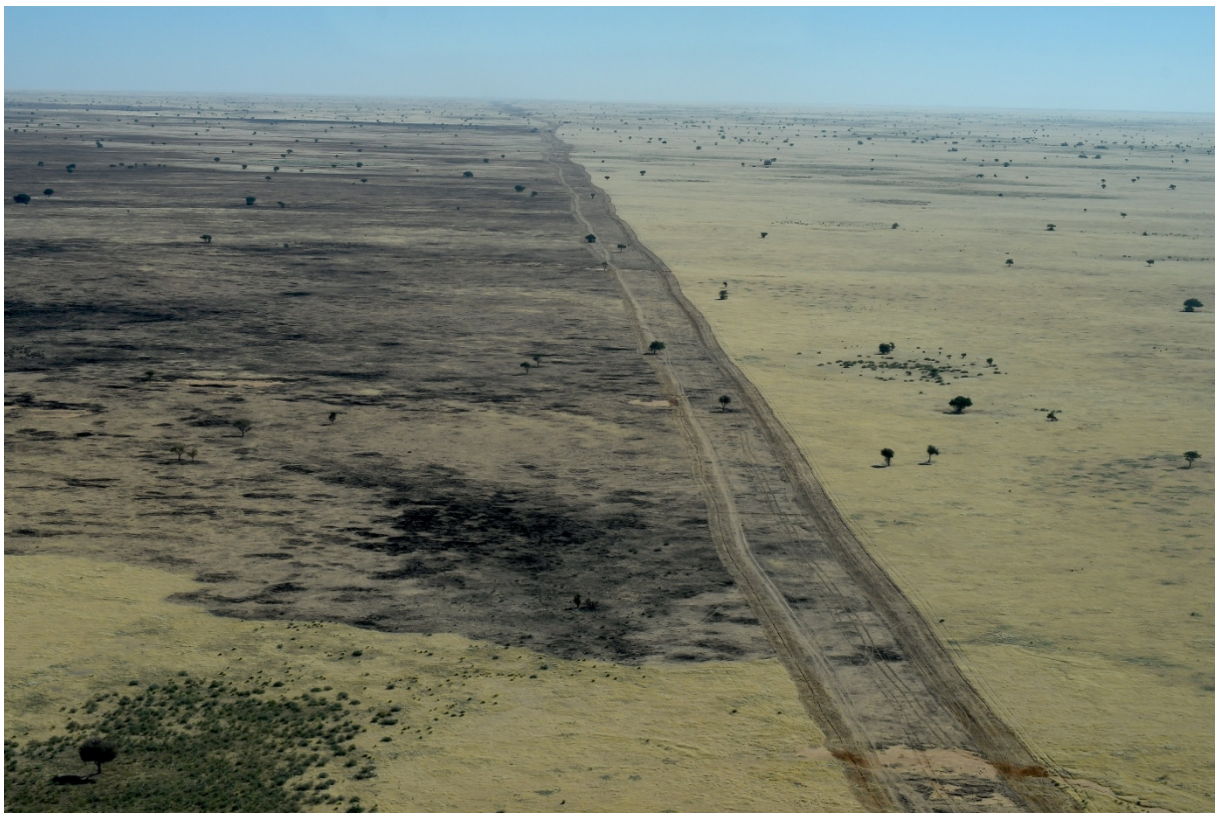


Fig. 32. Bush fire stopped by a firebreak

## 5.2 Overgrazing

Within six years, we have seen new ways of exploiting grassy areas that were previously not used much for grazing. Far away from a watering place (the closest being Donki Fadoul 55 km from the oryx base), these areas were virtually inaccessible for ruminants, thus leaving broad feeding grounds for wildlife.

Recently, major livestock owners have been providing their herds and flocks with water by setting up water tanks. These water tanks are of all kinds and different capacities. They are regularly replenished by tankers that come from Biltine (120 km) or Arada (80 km).

Moreover, a business transporting water in cans by motorbikes has been set up from these water tanks, supplying the most distant farmers.


**Fig. 33.** Proliferation of water tanks in OROAGR

This system of setting up water tanks replenished by tankers allows commercial farmers to remain in place on good pastureland with livestock that under normal circumstances should not be found there. Cattle, for example, have to drink every two days.

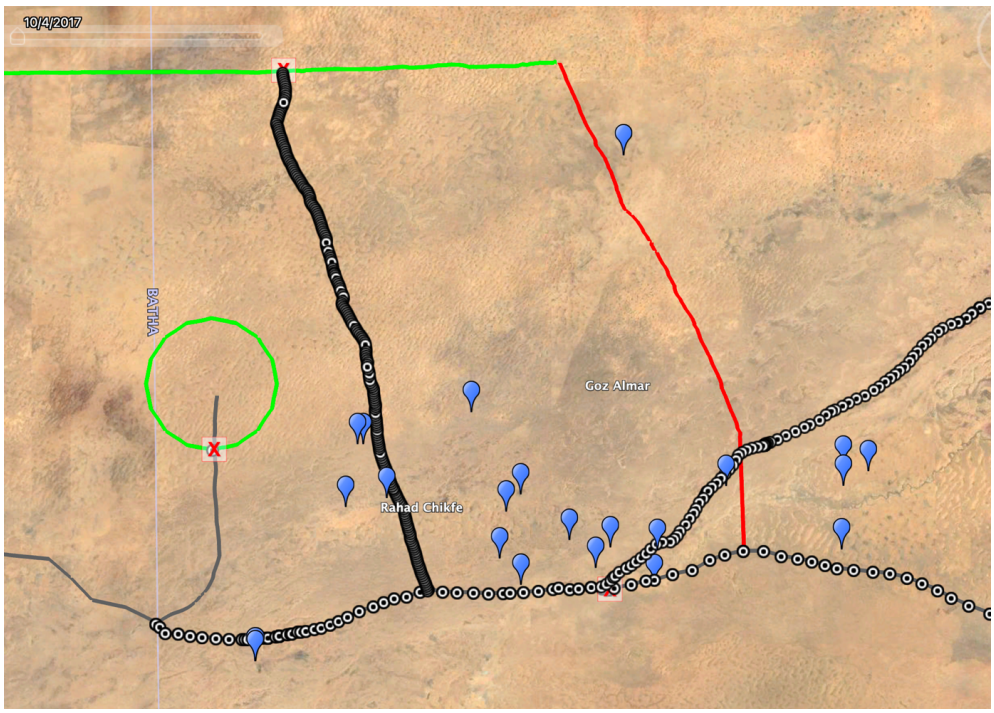



Fig. 34. Position of the 23 water tanks less than 20 km from the oryx base

In February 2022, during a flight with the NGO Wings for Conservation, we observed a proliferation of water tanks next to the oryx base.

On 23 and 24 February 2022, OROAGR's team of guards removed 23 water tanks installed less than 20 km from the base camp. Taking advantage of the firebreak network, the livestock owners enjoy pastureland protected against bush fires.

The solution negotiated was to move these tanks more than 30 km away from the oryx base. Paradoxically, we now see motorbikes coming to stock up with water from these tanks to provide water for the livestock that has remained in the area less than 30 km away.

The presence of these permanent camps disrupts the environment and tranquility of the wildlife. While, from time to time, it is common to see dorcas gazelles not far from herds of domestic animals and therefore to think that they tolerate their presence, analysis of the data from the survey carried out over a large area shows that they are much more numerous in areas where there is no livestock.

The increase in domestic livestock and the time that they spend in OROAGR is becoming a real health problem. Many diseases are transmitted from these animals to the wild animals, thus becoming a major risk factor in the reintroduction project (cf. other section of this report).

## 5.3 The presence of farmers near the pens

In the conclusions to his expert assessment on the mass mortality of oryx in 2018, Dr Philippe Chardonnet explained that the oryx that were in the worst general condition were affected by at least four diseases, which can be divided into different categories, according to their mode of transmission:

- 2 diseases transmitted by arthropods: babesiosis & Rift Valley fever (RVF),
- 1 disease promoted by arthropods: dermatophilosis,
- 1 opportunistic disease depending on the climate and the poor general condition of the animals: pasteurellosis,
- possibly, 1 disease transmitted by domestic livestock: PPR.

All these pathological problems encountered by the oryx are native to Chad and not the United Arab Emirates.

One of the recommendations was to safeguard the adaptation pen by protecting it from being approached by people, livestock and wildlife.

Currently, awareness-raising efforts are ineffective and the lack of enforcement of the law means that farmers continue to cross OROAGR, passing next to the enclosures. They even knowingly let their livestock enter the 3 km-radius circular area at night where the pastureland protected from bush fires is of good quality.

**Fig. 35.** Nomads and their dromedaries passing next to the enclosures

## 5.4 Interactions between wild animals and the animals in the enclosure

First of all, the wild animals released, whether oryx, addax or ostriches, return from time to time next to the enclosures and have contact with the enclosed animals. The oryx and addax males fight against their enclosed and newly arrived counterparts.

Fig. 36. Interactions between the wild animals and the animals in the enclosure

The presence of dama gazelles in the enclosures also attracts wild dama gazelles (which, on three occasions, has made it possible to passively capture the gazelles that approached them. Five gazelles have been captured in this way.)
From January to April 2022, two wild dama gazelles, one female and one male, were seen on a daily basis next to the enclosure. The male displayed territorial marking behavior and fought against the enclosed males through the fence.

Finally, the peaceful atmosphere that reigns around the base camp and enclosures gives dorcas gazelles and jackals the opportunity to flourish. They regularly pass by along the enclosures.

Fig. 37. A male dama in the wild confronts a male dama in captivity

# 6. Management or participation in events

## 6.1 February 2021

**Signature of the project agreement entitled** "Coordination, implementation, supervision and management of a project to reintroduce oryx and other endangered species in the Republic of Chad. Phase II" between the Government of the Republic of Chad, represented by the Minister of the Economy, Development Planning and International Cooperation and the NGO SaharaConservation. The aim of this project agreement is to facilitate the implementation of activities in the country.

## 6.2 March 2021

**Mission of the Directorate for monitoring the activities of non-governmental organisations and community organisations (MEPDCI) (From 1 to 7 March 2021)**
In the first week of March 2021, a multidisciplinary team made up of a member of the Directorate for monitoring the activities of non-governmental organisations and community organisations (SPONGAH/Ministry of the Economy, Development Planning and

International Cooperation) and two people from MEP came for a mission entitled: "Report on the activities carried out by the NGO known as SaharaConservation within the framework of the oryx project during the period 2014-2021". This 12-day mission, including N'Djamena / oryx base round trips, allowed the team to observe and record the progress of the project's activities and discuss with all the team members. In addition to the work related to the mission, the evaluation team witnessed the passive capture of a dama gazelle and the arrival of the first ostrich chicks from Zakouma National Park.

**Celebration of International Women's Day**
On 7 March 2021, to celebrate International Women's Day, the project welcomed a group of women from the town of Arada, supervised by POROA. These women were able to see ostriches, oryx and addax in the wild. They left the base camp after the lunchtime meal.

Fig. 38. Group of women from Arada visiting the oryx base

## 6.3 April 2021

**Visit by OROAGR guard trainers**
On 3 April, two guard trainers (POROA) visited the oryx base.

**Death of Field Marshal Idriss Déby Itno, President of the Republic of Chad**
20 April 2021

## 6.4 May 2021

**20th annual meeting of the Sahelo-Saharan Interest Group (SSIG)**
From 18 to 20 May, the employees from the oryx project and POROA were able to participate in and watch the different presentations by the SSIG projected onto the office wall using an overhead projector. Ngaba Caleb and Khalid Rahama presented the report on the Oryx and Addax Reintroduction Project.

On 27 May, the project provided schools in Arada with two vehicles so that the six best pupils from years 5 and 6, accompanied by the school's seven teachers, i.e. **13 people could visit the oryx base.**


Fig. 39. Pupils from years 5 and 6 visiting the oryx base

## 6.5 July 2021

On 1 July, RFROA's canton chiefs were invited to take part in an information and awareness-raising session on releasing ostriches into the wild. The data collected to draw up the development plan (PAG) was reviewed on this occasion.



Fig. 40. 27 canton chiefs meeting at the oryx base

## 6.6 November 2021

November was marked by several visits to the oryx base:

- The envoy from the American Embassy, along with several people working at the embassy, arrived with a caravan plane by the company Avmax to visit the project's activities during the day (4 November 2021),
- The company SVS visited the oryx base with a group of five tourists, who came with the Avmax caravan plane (18 and 19/11),
- The director of the Ecobank agency in Abéché, accompanied by the manager and cashier, came to spend the weekend at the oryx base (20 and 21/11/2021),
- A group of 11 teachers from Arada came on an excursion to the oryx base (21/11/2021).
-

### 6.7 December 2021

On 4 December 2021, the provincial coordination of Wadi Fira of the Chad national youth council came to visit OROAGR to learn about our activities and see the support that it could receive from SaharaConservation to carry out awareness-raising activities in the surrounding villages with a view to environmental protection.


Fig. 41. Visit by young people from Wadi Fira to the oryx base

## 7. Security and project management

### 7.1 Project staff security

To ensure the safety of the project staff and other personnel involved from time to time within this framework, a guard outpost was built beside the project's base camp. Four guards are permanently on the premises; they ensure the security of the base, escort the project's vehicles for all travel and also control the animals wandering into the perimeter.

### 7.2 Law enforcement

The surveillance missions on the reserve are carried out jointly by the two sectors of the reserve, one of which is based in Arada and the other in Ati. These missions were strengthened by the arrival of the 40 new guards trained by the Ouadi Rimé-Ouadi Achim

project (POROA). Each team now spends ten days on the ground. The patrols are concentrated in the sensitive areas of the reserve, in other words the distribution area of the species reintroduced, dama gazelles and areas at risk of poaching. A team is always present on the ground.
Over the past year, no incidences of poaching of the antelopes reintroduced were recorded, but there were a few cases concerning dorcas gazelles. Another animal released in 2021 was found dead in a millet field outside the reserve between Biltine and Arada. After investigation, the animal had been killed with a weapon and no organs had been removed. The fields' owners were arrested and brought to justice but they were released due to a lack of incriminating evidence.

## 7.3 Bush fires

The number of bush fires in the reserve also increased this year; several ignition sites were noted by Nasa Firm. The constant presence of the guards on the ground and the use of Inreach as a means of communication with the control room have reduced the guards' response time and the perpetrators were questioned in most cases. The oryx project staff has played an important role both in the fight against bush fires and the creation of preventive firebreaks. This year, over 80% of the fires were caused by farmers' children. A request for new tractors was made to the Forest and Wildlife Guard (GFF) and two new tractors were provided for the reserve by GFF.

## 7.4 Raising farmers awareness

Awareness-raising among farmers and other residents of the reserve is a daily activity for the guards on their different travels. Raising awareness particularly concerns bush fires, poaching, the reintroduced species and the concept of the reserve.

# Part III. FIELD-BASED POSTRELEASE MONITORING OF ORYX & ADDAX

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Ecological Monitoring Officer – SaharaConservation

**Taboye Abdelkerim Ben**

Ecological Monitoring Officer – SaharaConservation

# Introduction

Routine post-release monitoring of reintroduced oryx and addax populations was maintained in the field by the monitoring team throughout 2021. External support to the team on data management, particularly supervision of breeding records and reporting, was maintained remotely from the Zoological Society of London (ZSL) through regular email contacts. Towards the end of the year, ZSL staff joined the team in November and December, when planned aerial and ground-based sample surveys, much delayed by international travel restrictions, were completed.

# The team

The field monitoring team comprised four SaharaConservation members through most of the year:

- Caleb Ngaba Waye Taroum
- Habib Ali Hamit
- Khalid Rahama Abderaman
- Taboye Abdelkerim Ben

# 1. Oryx

## 1.1 Satellite collars

The proportion of oryx carrying functional satellite collars was, for most of the year, the lowest it's been since the start of the project: 19 oryx at the start of the year falling to 12 by mid-year, in a population likely to be well more than 400 individuals (see below). International travel restrictions meant that the seventh release group of 25 oryx had to be released in September 2020 without collars, while existing collars dropped off as programmed.
When the EAD team was able to return to Chad in November 2021, 25 new oryx all carrying collars were delivered and then released after a 26-days pre-release period in December 2021. Additionally, and in fulfilment of monitoring plans established by EAD in December 2019, 18 wild-living oryx were darted and fitted with new collars in November 2021. Six of these were young adults born in Chad and collared for the first time to provide comparative data between wild-born and founder animals. Ten individuals were founder animals who had lived wild in Chad between 3-5 years, collared for a second time to provide longer term measures of survivorship and reproductive performance. Two individuals from the September 2020 release were captured and collared as none of this group were carrying collars at release.

At the end of 2021 the number of fully functioning satellite collars on oryx rose to 44, approaching the long-term monitoring target of 50, calculated by SCBI.

## 1.2 Oryx population size

Assessing oryx population size is currently in a technically difficult phase. Routine field work suggests the population could be in the vicinity of 450 at the end of the year. But the quality and value of this assessment is diminishing and an exact population size is not possible to estimate. The proportion of marked animals varied widely through 2021. The number of completely lost tags (collar drop-off and ear tag loss combined) is not accurately known, but examples are becoming increasingly evident. The numbers of undetected births, deaths and losses to emigration are also unknown and must also be increasingly significant. Two sample surveys of different designs carried out consecutively at the end of 2021 were both strongly affected by the wide dispersion and low density of the oryx, exacerbated by the highly variable group sizes, sometimes very large, that were encountered.

Example of an and adult female oryx showing evidence of tagging in the left ear, which has not been matched to photo library images of any founder female oryx. Photo: Khalid Rahama - SaharaConservation.

## 1.3 Aerial strip count November 2021

An extensive aerial strip count in November 2021 (see below for details) provided an unrealistically high (808) and very low precision (c.v. 126%) technical estimate for oryx. The very low precision indicates that this estimate is not reliable and the presence of a single herd of 63 animals found within the sample strip helps explain why. If this single group of oryx had been 100m to one side as the plane passed, the technical estimate would have dropped to around 300 oryx.

## 1.4 Vehicle-based line transect survey December 2021

The results of a repeat of the standard line transect survey design conducted by a combined Oryx project and DFAP team since 2011 produced an estimate of 400 oryx in December 2021. Although the precision of this survey (c.v. 41%) was much improved compared to the aerial survey and the estimate accords better with general expectation from ground surveys, the 95% statistical confidence limits are still excessive, implying the estimate should lie somewhere between 178 to 885 oryx.

In both surveys the key issue affecting precision is failure to obtain a high enough encounter rate with oryx, which are widely dispersed at low density over a very large area in groups of widely varying sizes. This situation implies unrealistically high survey effort to achieve improved precision.

## 1.5 Oryx calf detection – 2021

The births of 86 oryx calves were registered by the monitoring team through 2021, bring the total births recorded in Chad to 331 by end of the year.

## 1.6 Oryx calf tagging

Thirty-six of the 86 calves were caught and tagged, bringing the total Chad-born calves' ear-tagged and recorded by the monitoring team to exactly 100. The overall sex ratio among the 100 tagged oryx born in Chad at the end of 2021 is 56 males to 44 females, which does not differ from 50:50 ($\chi$2 1.44, p=0.23). But among the 36 calves caught and tagged in 2021, 24 were classified as males and 12 females. The male bias in this sub-sample differs from 50:50 ($\chi$2=4, p=0.045). This might be a real but trivial effect in a small sample that will correct in due course; but it may reflect problems with sexing new-born calves in the hand or even signal that males are more easily caught, though this is less likely.

## 1.7 Oryx mortalities

Only five deaths amongst oryx were reported in 2021. The backgrounds of all the individuals involved are given in Table.1 and specific details of the circumstances in Table 2.

Table 1. Background record of all oryx found to have died during 2021.

| Code No. | Sex | Estimated DOB* | Arrival at Oryx camp Pre-release | Release date | Release group | Age at release (yrs.) | Date death detected | Age when death detected (yrs.) | Survival post release (yrs) |
|---|---|---|---|---|---|---|---|---|---|
| **R08MD** | M | 04/03/2012 | 19/01/2017 | 23/01/2018 | 3.5 | 5.9 | 02/03/2021 | 9.0 | 3.1 |
| **B95FD** | F | 17/06/2018 | 12/11/2019 | 16/12/2019 | 6 | 1.5 | 06/04/2021 | 2.8 | 1.3 |
| **N24MD** | M | 17/01/2017 | 12/11/2019 | 16/12/2019 | 6 | 2.9 | 16/11/2021 | 4.8 | 1.9 |
| **DG351D** | F | 01/09/2016 | 04/03/2020 | 21/09/2020 | 7 | 4.1 | 29/05/2021 | 4.7 | 0.7 |
| **DY1019-02** | ? | 07/09/2021 | Wild born | n/a | Wild born | n/a | 09/09/2021 | | 2 days |

Table 2. Field reports of circumstances associated with each wild oryx mortality.

| Identity | Sex | Notes on circumstances and cause of death |
|---|---|---|
| **R08MD** | M | Found by Habib; Report KR email; Carcasse dry and quite old; ear tag W186 found although ears missing; horns missing; cause of death unknown; buried |
| **B95FD** | F | Mortality alert 7 Apr.. 2021 à 18:56, Mertes, Katherine <MertesK@si.edu> a écrit : 'has not moved for 36 hours' Death date entered as 06/04/2021; recorded in Cybertracker 08/04/2021. Bonjour à tous,Nous avons reçu une alerte de mortalité du collier 95_BLU. La dernière position connue de B95F est: 14.92659, 20.19685. Il semble qu'elle se soit déplacée de moins de 20m au cours des 36 dernières heures. 8 Avr. Caleb email@ . Suite à l'alerte de mortalité envoyée hier, nous nous sommes rendus sur les lieux aujourd'hui. Helas! c'est avec regret que nous vous annonçons que l'oryx B95 F est bien morte. La carcasse retrouvée était endommagée et complètement vidée de l'appareil digestif.Veuillez trouver en attaché: - Le rapport de mortalité (version word)- 02 Photos |
| **N24MD** | M | Found freshly dead on the base camp fire brake perimeter during visit of EAD team. Full necropsy demonstration by Elena ; perforated small intestine found. |
| **DG351D** | F | Last observation 15/05/2021 being courted intensively by R21M, but very thin and exhausted. After mounting she 'fell' and stayed lying for a while before standing again. |
| **DY1019-02** | ? | Intact carcasse found ; no sign of predator, possible lick marks. Cause not clear. |

The c. nine-year-old adult male R08 from release group 3, who lived successfully in the wild for almost 3 years, had been dead for some while before his dried remains were found by chance (satellite collar long since dropped off). Hence it is not possible to deduce why the horns were missing or any confident insight into the cause of death.

Of the two young to mid-age oryx from Group 6 who died, one was fortuitously found very fresh and close to base camp during the transfer of oryx and addax to Chad in November 2021. The opportunity to provide a demonstration of field post-mortem was taken by Dr. Elena Pesci, from EAD staff.

Of the five detected deaths, likely 'causes' were established for three (Table 2). One case of very early mortality in a neo-nate calf; one perforated gut in an otherwise healthy adult male, and one adult female who was known to be doing very poorly (failing to adapt or suffering from an undiagnosed health issue) only 8 months after release.

## 1.8 Founder oryx missing

It is noted that among 143 founder oryx from release groups 1-7, possibly alive at the end of 2021, 12 (8.4%) were not reported at all during 2021. It is not known how many of these are dead, how many are examples of individuals being seen but not recognized because both collar and ear tags have fallen, or are still alive but not encountered for reasons of chance or emigration.

## 1.9 Oryx survival rates preliminary analysis

Monthly resighting histories have been maintained for all tagged oryx since the beginning of the project. Each resighting history comprises a string of one's (1) or zeroes (0), where 'one' indicates that the individual was seen during a particular month and 'zero' indicates that it was not seen. For individuals known to have died, the month of the mortality is scored as minus one (-1), creating a 'live-encounter, dead-recovery' model. The array of individual resighting histories is aligned chronologically by month, running from August 2016 to December 2021 (and ongoing). One row for each individual. Covariates attributed to each re-sighting history indicate the sex, release group number or wild-born status of the oryx as appropriate. Other covariates (management history, time in pre-release etc.) are also envisaged for further analysis.

This format provides the basic input for estimation of post-release survival, which is key information for a population viability analysis (PVA) based on actual outcomes in the wild. There are assumptions in survivorship analysis; marks are not lost, identities are recorded correctly and there must be no temporary emigration (if animals leave the study area, they are assumed not to return). Survey effort should also be 'consistent' for each monthly interval. Apparent survival means alive and still in the study area, so the study area must not change. Inevitably these assumptions are not perfectly met, especially with respect to loss of identity marks, which is known to have occurred and will cause a negative bias, reducing survival rate estimates.

With the technical assistance of colleague Rajan Amin (ZSL), we are exploring a Bayesian Cormack-Jolly-Seber (CJS) model implemented in the program JAGS (Just Another Gibbs Sampler) accessed through the program 'R', version 4.0.4, using the package RJAGS. At this preliminary stage, model convergence indices are favorable and will be described in full in the final manuscript.

## 1.10 Provisional survivorship results to end of 2021 – Founder oryx

Combining all founder oryx from the seven releases that took place prior to 2021, the annual survival probability has been 0.78 (95% c.i. 0.74-0.83) for females and lower for males at 0.75 (95% c.i. 0.69-0.81) (Fig. 1). This includes the impact of the exceptional bout of mortalities which incurred in September-October 2018 (Fig. 2). The events of September 2018, which disproportionately affected the 75 oryx of Release group 4, represents a situation that is modelled in a PVA as a 'catastrophe'. Further investigation of survivorship in 75 oryx of release group 4 compared to all other groups confirms that after the first-year mortality rates among the survivors of group 4 returned to normal levels in year 2 and subsequently. It is also evident that for combined survivorship among all groups other than group 4 (groups 1,2,3,5,6 & 7) the relationship between male and female survivorship is reversed: 0.80 (95% c.i. 0.75-0.85) for females, 0.88 (95% c.i. 0.83-0.94) for males. Male survivorship in Group 4 was particularly poor at 0.39 (95% c.i. 0.26-0.51), significantly lower compared to females from the same group (0.71, 95% c.i. 0.6-0.81). This indicates that the events of 2018 are responsible for bringing male survivorship below female survivorship in the overall result. As group 4 was three times larger than any other release group, this result poses interesting questions about the possible role of social stress among males in pre-release.

Variation in overall survivorship (male and female combined) by release group shows annual survivorship of 0.8 or greater for the first three release groups (Fig. 3). The analysis also suggests that Group 5, has shown no better overall survivorship than Group 4. This fact has been less appreciated as the mortalities did not occur as an obvious epidemic and merits closer investigation on causes and timing of losses in Group 5.

## 1.11 Provisional survivorship results to end of 2021 – Wild born oryx

The same analysis methods have been applied to the cohort of 69 wild-born oryx calves tagged in Chad to the end of 2021. This returns a female survivorship of 0.77 (95% c.i. 0.61-0.92) and a high male survivorship of 0.93 (95% c.i. 0.84-0.99). There is also a counter intuitive provisional indication that calf survivorship is highest for calves born in the late dry season (March to June) compared to wet season and early dry season.

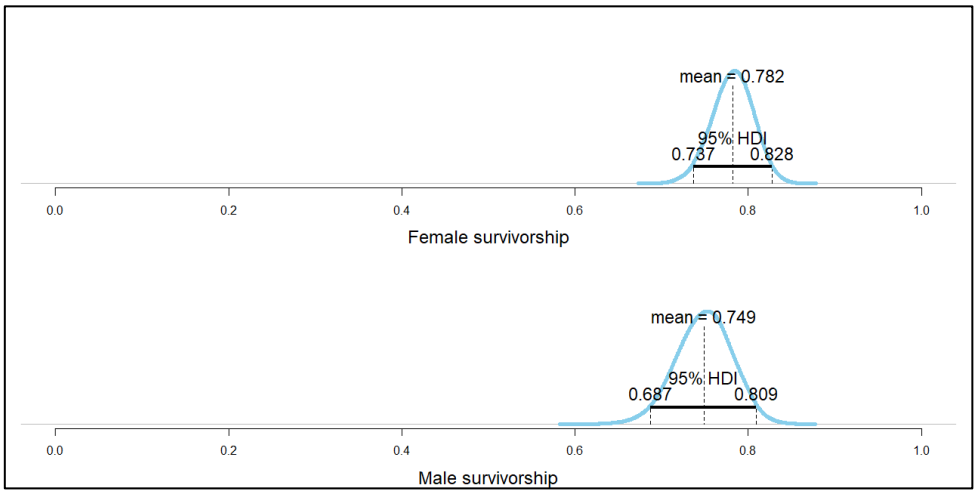


Fig. 1 Overall founder oryx survivorship, comparing females and males

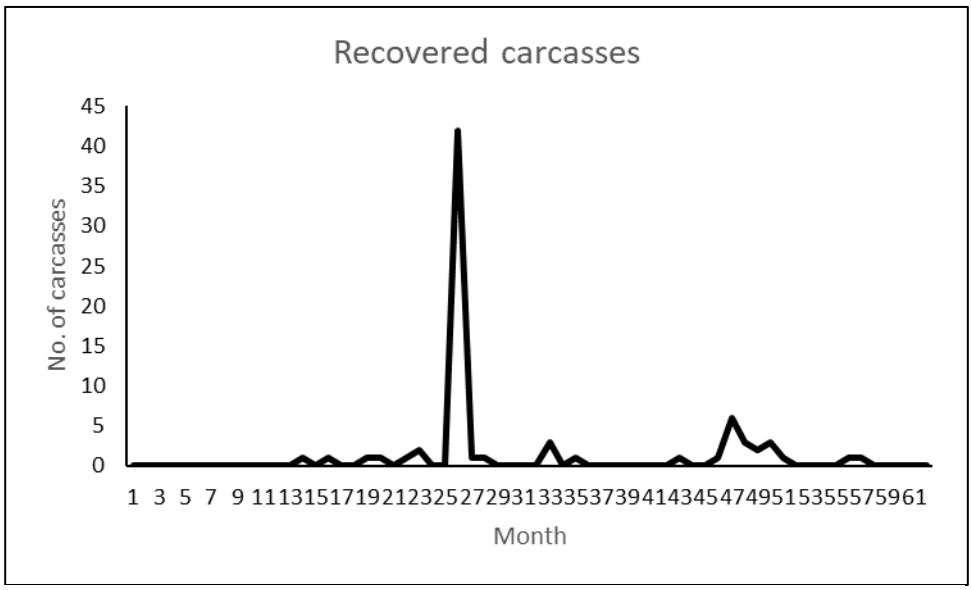


Fig. 2 Chronology of detected oryx mortalities, August 2016 to December 2021

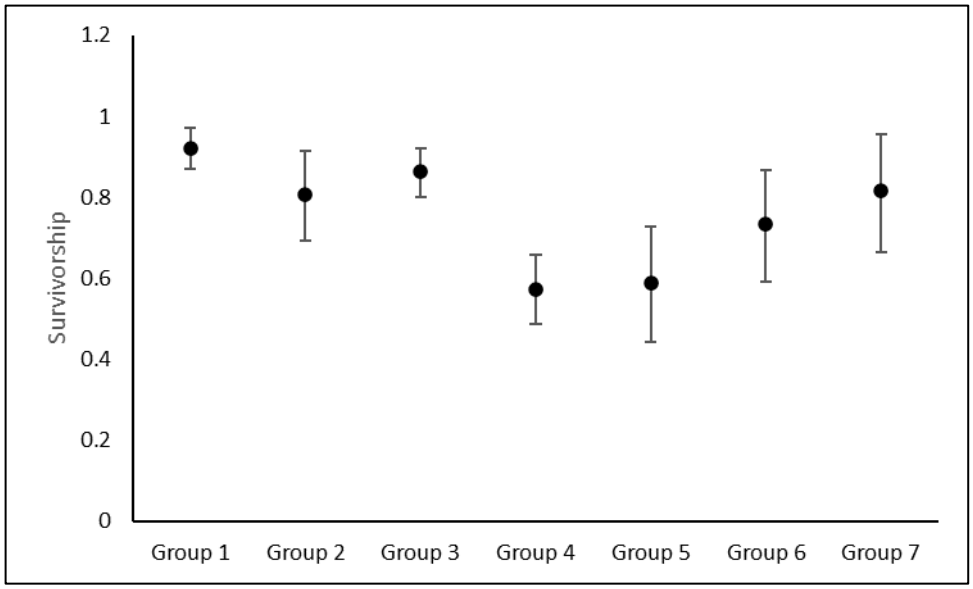


Fig. 3 Founder oryx survivorship by release group, August 2016 to December2021

# 2. Addax

## 2.1 Satellite collars and tags

Through 2021, the proportion of functioning satellite collars fell from 12/51 animals at the beginning of the year to a low point of 2/66 animals in November, following planned drop-offs without replacement. All 25 second release addax had been released in September 2020 marked only by ear-tags after a 185-day pre-release period. A third release of 25 collared addax on 10th December 2021, after a 24-day prelease period, brought collared addax up to 27 of approximately 91 animals.

## 2.2 Addax calf detection

Seventeen addax births were recorded during 2021 of which one was known to result in peri-natal mortality. This brings the total births recorded in Chad 34, of which five resulted in peri-natal or very early losses. Six calves have not been sexed. The sex ratio among the remaining 28 addax births in Chad is 18:10 males: females. This sample does not yet differ from 50:50 ($\chi 2$ 2.28, p=0.13, d.f =1), but as for oryx, indicates that attention to the sex ratio should be maintained in 2022. Addax calf-tagging has been successful: of the 29 surviving calves to date, 24 have been ear-tagged, all with standard numbered orange tags.

## 2.3 Addax mortalities

Eight addax mortalities detected since the start of the addax reintroduction involve three founders and five Chad born calves (Table 3). Information on the circumstances and causes of death are summarized in Table 4.

Three of the forty addax released in the first 2 groups did poorly from the outset and died early. But two others from release Group 2 who were also sufficiently weak post-release to be captured for support with a mix of veterinary medicines (Table 4), did recover and were confirmed present and in good condition at the end of 2021.

All thirteen addax from Group 1 who survived the initial post-release period (two died early) were confirmed alive and well at the end of 2021, two years after arrival in Chad. Five of the 24 surviving Group 2 addax released in September 2020 had not been seen for 6 months at the end of 2021, and one of these was not seen at all during the year. No problems with the 25 addax released on 10th December 2021 had been encountered by the end of the year.

## 2.4 Addax population growth

The addax population has maintained positive increase (Fig. 4). At the end of 2021 the population is possibly up to 91, after the release of 65 individuals since the beginning of 2020. If it is conservatively assumed that the 5 founders from Group 2 (ear tagged only) not seen for six months at the end of the year are all dead, then the minimum population size is 86.

**Table 3.** Background records of all addax known to have died, 2020 & 2021

| Identity | Sex | Estimated DOB* | Arrival at Oryx camp Pre-release | Release date | Release group | Age at release | Date of death | Age when death detected | Survival post release |
|---|---|---|---|---|---|---|---|---|---|
| AB01F | F | 25/02/2017 | 14/11/2019 | 18/01/2020 | 1 | 2.9 | 14/05/2020 | 3.2 yrs | 117 days |
| AB15F | F | 14/11/2016 | 14/11/2019 | 18/01/2020 | 1 | 3.2 | 03/04/2020 | 3.4 yrs | 76 days |
| AG238F | F | 23/12/2017 | 06/03/2020 | 07/09/2020 | 2 | 2.7 | 12/10/2020 | 2.8 yrs | 35 days |
| AB04-01 | ? | 23/06/2020 | | | Chad born | | 23/06/2020 | 0 | |
| O200F_AB12-01 | F | 02/07/2020 | | | Chad born | | 22/07/2020 | 20 days | |
| AB09-01M | M | 03/07/2020 | | | Chad born | | 04/07/2020 | 1 day | |
| O211_AY457-01 | F | 08/12/2020 | | | Chad born | | 14/02/2021 | 68 days | |
| AG231-01 | ? | 01/02/2021 | | | Chad born | | 01/02/2021 | 0 | |

**Table 4.** Field reports of circumstances associated with each addax mortality, 2020 & 2021

| Identity | Sex | Cause of death |
|---|---|---|
| AB01F | F | Sa tête est bloquée dans le bosquet de balanites. Nous Avons trouvé une corde enroulée au plastique. Elle est enterrée. Photo on Cyber |
| AB15F | F | Found with bloody discharge at anus and mouth: carcasse burnt without p.m. Elena : 'from the picture, she doesn't seems skinny, therefore, it seems an acute process.<br>Blood from mouth and anus make me think of Anthrax or Clostridium ( but without a Postmortem, is very hard to say). All animals were vaccinated in UAE for Clostridium ( 2 times) at the arrivals for Anthrax and Pasteurella, but we have no idea of the capability of this vaccine to create an immunity in this specie. |
| AG238F | F | One of three addax in very poor condition shortly after release and captured manually (nets from vehicle) on 05/10/2020 for administation of Oxytetracycline IM 12ml, , Betamox LA 12ml, Nyxyvet IM 4ml, 5ml each of Vit B and VitE + Selenium, 13ml of Bayticol dispersed over back to suppress ticks and biting flies. |
| AB04-01 | ? | Premature birth / late abortion reported by Khaled. |
| O200F_AB12-01 | F | Condition '3 - thin' on 15/07/2020' according to KA; not seen again. |
| AB09-01M | M | Not known but very feeble small new-born calf. When found AB09F was located 3km away, but AB12F, (who had also given birth in previous 24 hrs to AB12-01_O200F) was still nearby, initially causing uncertainty as to identity. But AB09F photographed licking carcasse of untagged male calf on 4/07/2020. Corpse buried because female waiting near it. |
| O211_AY457-01 | F | Disappeared. 3 sightings of Dam AY457F in March and 2 in april without calf present. |
| AG231-01 | ? | Assumed peri-natal mortality based on observation of Dam in January and especially 02/02/2021 |

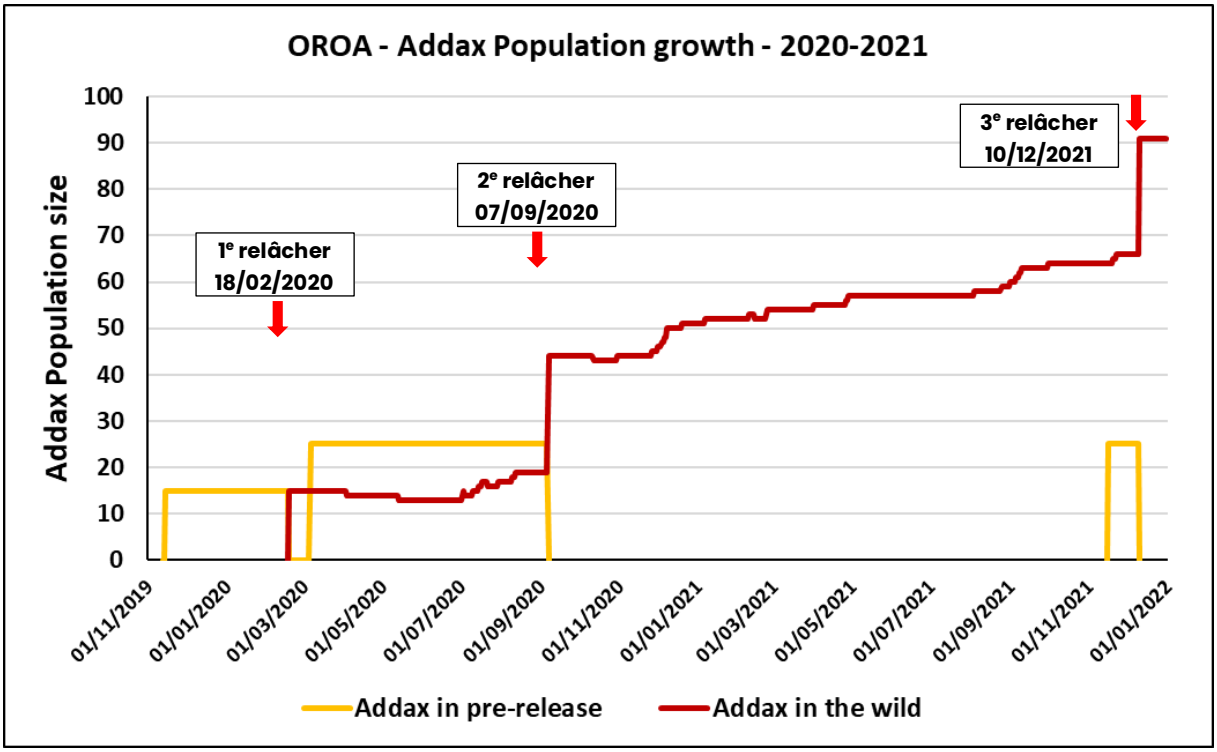


**Fig.4**. Addax numbers following start of reintroduction to the Ouadi Rimé-Ouadi Achim Game Reserve, based on assumption that all births and deaths have been detected, 2020 & 2021

# 3. Dama gazelles

Routine recording of all wild dama encounters during monitoring work was maintained throughout the year. Intensified aerial survey effort directed to wild dama locations known from ground survey records was introduced in November and December 2021. Detailed recording of the captive dama group was maintained at ZSL and distributed regularly to all partners.

## 3.1 Dama captive breeding group

The captive dama population held at the oryx base enclosures rose from 1.2 individuals in January to 4.8 by early January 2022 (Fig.5). Most individuals are untagged but a photo library of all the dama is being maintained to assist with identification and future management. The increase in numbers arose from two sources: births and passive captures.

- *Births*: Four births included a second female calf born to the Manga sourced female, Becki (OYF) in March 2021. This was followed by her third calf, a male, born 232 days later in November. All four calves were sired by the OROA-sourced male Moussa (YYM).
- *Passive capture*: The presence of dama inside the pens began to attract wild dama to the enclosure almost immediately. The base camp staff utilized the pen structures to encourage wild dama to enter an empty pen voluntarily, and in this way one adult female was captured to join the group in March 2021 and two more females and a male were added the same way in late December 2021. A third adult male was caught in early January. By 11 January 2022, the team had successfully reorganized the groupings so that Moussa was removed from his original herd (and son & daughters) to join with two newly caught OROA females in pen 6. A new OROA male replaced him in the large breeding group in pens 3 & 4, while the third male was isolated in pen 5 (destined to be joined by five females from EAD in March 2022) (Fig. 6).

## 3.2 Aerial surveys for wild dama

The formal aerial strip count survey conducted under the POROA project in November 2021 produced sightings of 24 dama gazelles of which 4 fell within the 12% strip sample fraction. Two subsequent flights by Wings for Conservation, targeted to visit areas known to be important to dama from the ground monitoring work, produced sightings of 18 in November and 38 in December. The latter included a herd of 30 individuals and represents the biggest single day count of dama since systematic field work began in 2011. Monthly targeted survey flights are scheduled to continue in 2022.

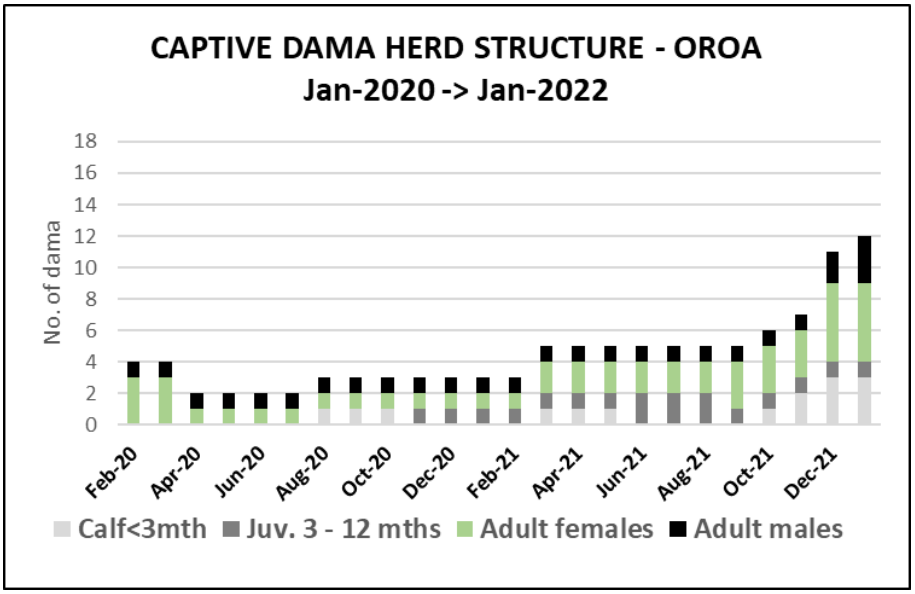


Fig. 5. Combined size and composition of captive dama herd; OROAGR, February 2020 to January 2022

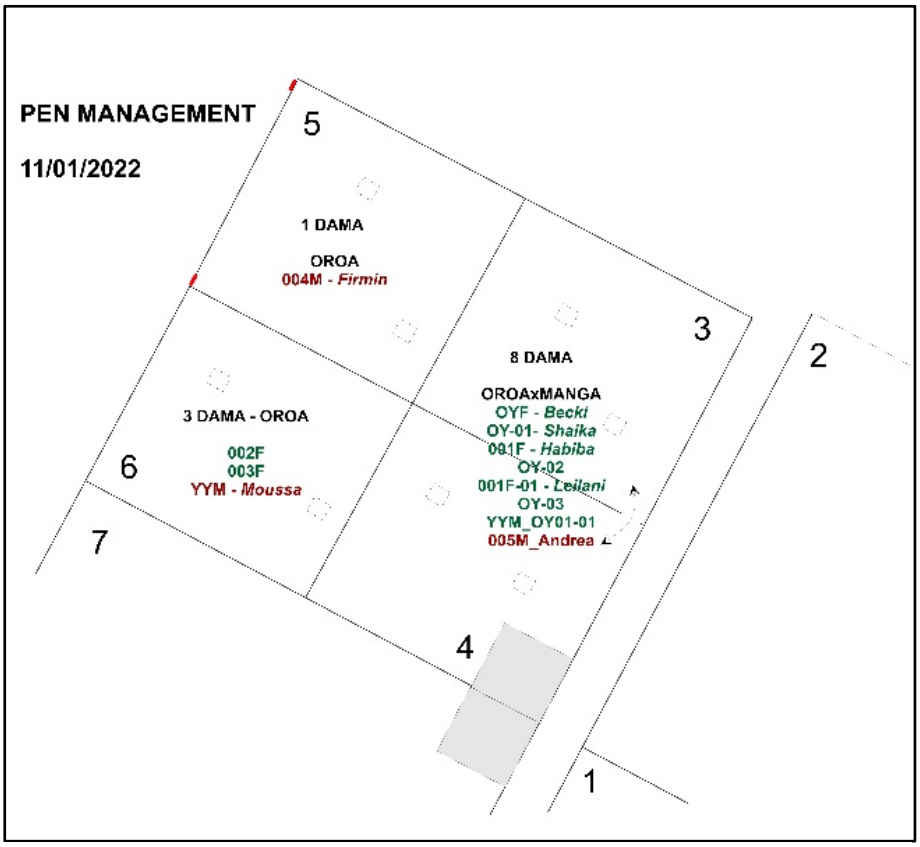


Fig. 6. Captive dama group management within the enclosures; January 2022.

# 4. Sample surveys

## 4.1 Aerial survey

A formal aerial strip survey was conducted by oryx project staff in November 2021, searching a 3.200km$^2$ core zone used by the oryx at 12% sample fraction and a 7.200km$^2$ surrounding zone at 6% sample fraction. The objective was to count and map large wildlife and livestock in relation to distribution of other ecological impacts such as bush fire and human activities. The results for oryx (201 seen, 98 within the sample strips) did not produce sufficient precision to be very useful (see discussion above), but indicated they share the grasslands with a population of c. 44.000 dorcas gazelles and some 300.000 livestock of all species. No addax was seen. The aerial survey clearly illustrated the impact of bush fires in influencing the distribution of all ungulate species; oryx distribution is shown in Fig. 7. *Full report: Wacher, Dethier and Habib 2021. Aerial sample count: Projet Ouadi Rimé-Ouadi Achim, 18$^{th}$-25$^{th}$ November 2021.*

## 4.2 Line transect survey

Oryx project staff collaborated with DFAP staff and POROA guards in December 2021 to complete a repetition of the standard vehicle-based line transect survey covering a 3.200km$^2$ core block around the oryx base. This produced sightings of 96 oryx in 19 groups and 23 addax in 5 groups (Fig. 8). Results using a global detection function in software Distance 6.0 (©1998-2022 Research Unit for Wildlife Population Assessment, University of St. Andrews) combining observations from the four line transect surveys repeated since oryx were released are shown in Fig. 9. The survey provided an estimate of 33.000 dorcas gazelles with good precision (c.v. 11.3 *%). Full report: Tim Wacher, Mahamat Hatcha, Caleb Ngaba, Taboye Abdelkerim. Re-introduction of Scimitar-horned oryx. Line transect survey, 1-4 December 2021.*

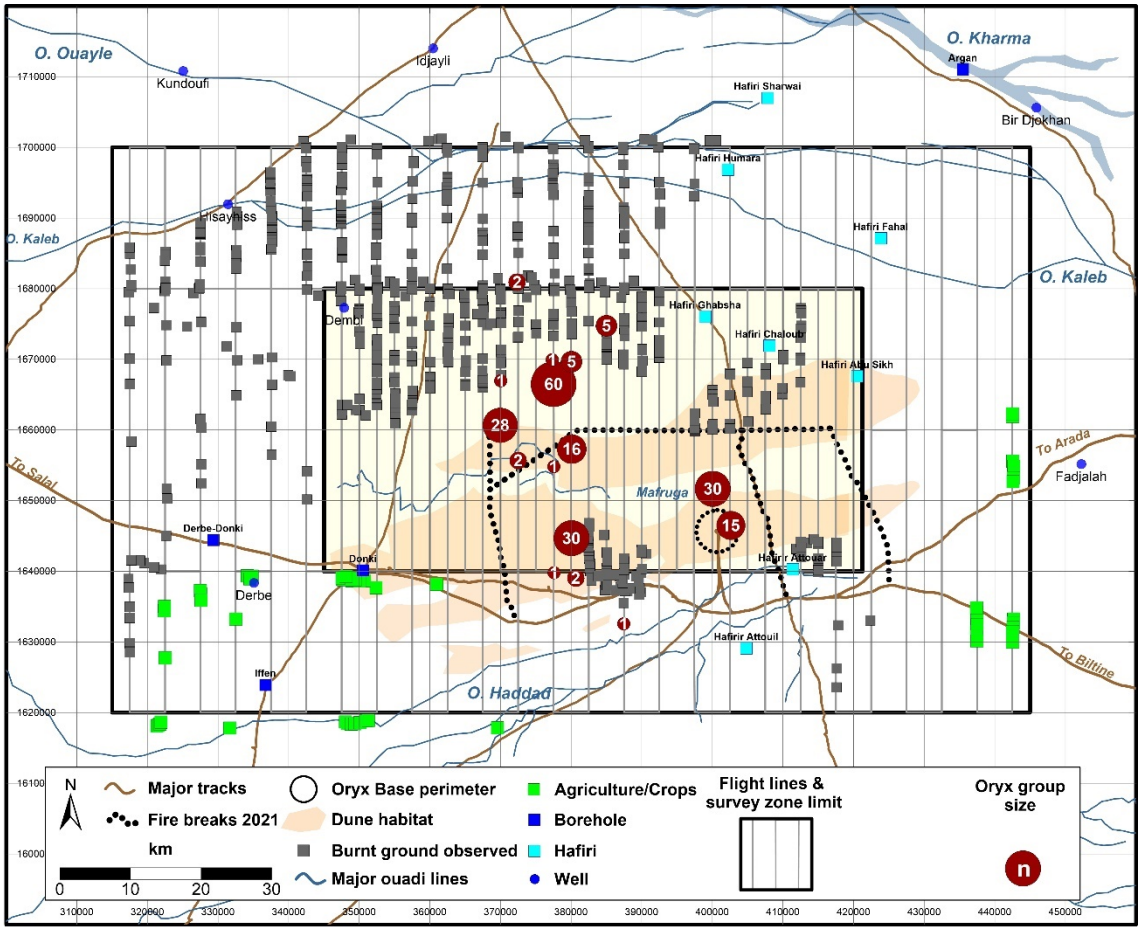


Fig. 7. Distribution of all oryx groups observed in relation to burnt zones and major habitat features - aerial survey of the central OROAGR, Nov. 2021.

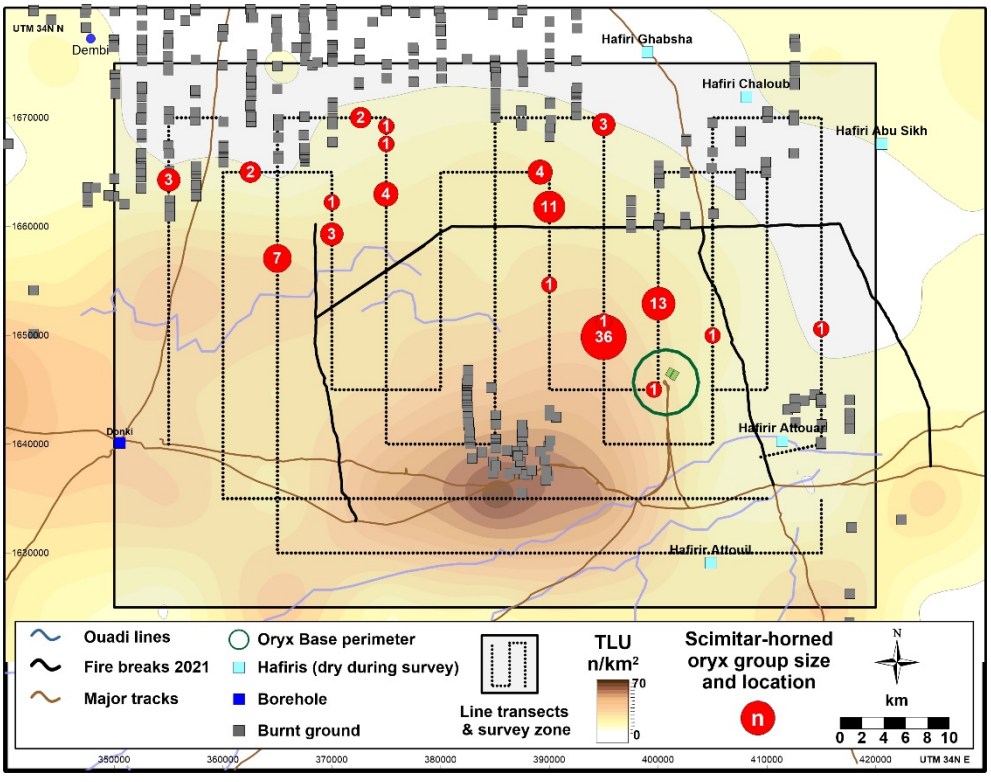


Fig. 8. Distribution of all oryx groups observed in relation to burnt zones and livestock distribution - ground survey in the OROAGR, Dec. 2021.

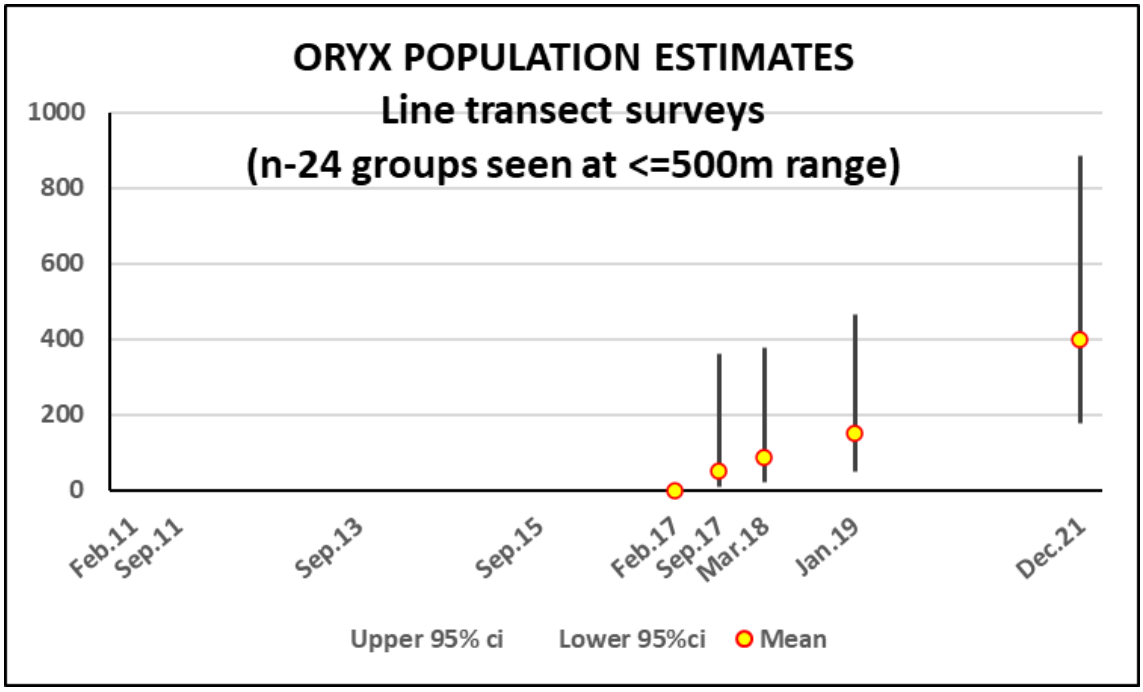


Fig. 9. Provisional scimitar-horned oryx population estimates from five line transect surveys conducted since oryx release in August 2016; OROAGR, Chad. An estimate of zero in Feb. 17 results from zero encounters when 24 oryx were present.

# 5. Data analysis and publications

With field work restricted, ZSL staff focused on developing two publications in support of the oryx project.

**a.** An analysis of wildlife and livestock spatial interactions, in relation to distribution of artificial water points from the series of line transect surveys conducted at the oryx release site, from 2011 to 2019 (and resumed in December 2021) was completed and accepted for publication in the conservation journal Oryx:
*Tim Wacher, Rajan Amin, John Newby, Mahamat Hatcha, Krazidi Abeye, Habib Ali, Sadock Zeubobe Bourtchiakbé, Felix Banlongar.* ***Gazelle–livestock interactions and impact of water resource development in the Ouadi Rimé–Ouadi Achim Game Reserve, Chad*** *(read here)*

**b.** At the end of 2021, work was initiated using the monthly resighting record of all tagged oryx (founders and wild born calves), to analyze formal estimates of post-release survival rates. Provisional results are discussed above. Final analysis for publication will include data to the end of 2022. The results provide 'real outcome' information of this reintroduction, for an updated Population Viability Analysis.

**c.** Analysis of reproduction performance of reintroduced oryx and addax is also planned for 2022, also for publication.

# 6. Recommendations

**1.** Improved methods to register the presence of unidentified founders, usually recognized only by chance observation of an ear tag hole in one ear, were needed in 2021. This was introduced in early 2022 and should permit improved modelling-based approaches to population size estimation from existing monitoring data.

**2.** Because newborn calf tagging only became routine from September 2019, the oryx calf survivorship results are based on animals that are mostly less than 2 years old. It is proposed to finalize oryx survivorship analysis at the end of 2022, when with calves born within the pens in Chad included, the cohort of all tagged oryx born in Chad and potentially reaching at least 3 years of age will be 34 individuals.

**3.** The calf tagging protocol, focused on calves that are in hiding mode and using the vehicle for cover and protection from the adults must be adhered to. Calves that run are not followed or chased.

4. Opportunities to provide refresher training to full time monitoring staff in proper use of tag applicators for all species should be taken.

5. Because signs of male bias in both birth ratios and founder survivorship (except for the epidemic situation in oryx Group 4 in 2018), were detected in 2021, attention should be given in 2022 to the overall sex ratios in the reintroduced populations.

6. Captive dama: close attention to individual identification of untagged members of the captive founder population must be maintained through 2022. Regularly updated photographs of all individuals, especially untagged adults and calves should be taken and added to appropriate folders of the existing photo library. Whenever possible newborn captive dama should be ear-tagged in first 48 hours following birth, using color coded small ear tag combinations (and see Recommendation 4 above).

7. Wild dama: targeted flights to search areas heavily used by dama gazelles should be maintained, and systematic photography of the herds encountered used to derive population age and sex structure information.

8. General monitoring: for general management of the reserve, it is strongly recommended that both intermittent aerial surveys and more regular vehicle-based line transect surveys, (with updated transect designs to increase encounter rate and take account of changes in distribution) are maintained. Ongoing training and support to local staff to manage these exercises should also continue. These surveys provide a wealth of information valuable for management feed-back on a range of key species and other activities that can affect the oryx and other conservation goals of the reserve. They still provide a systematic framework to track the progress of the rarest species over time and if e.g. oryx, addax and dama increase as desired, this will become evident and allow improved confidence in population size estimation by local reserve management.

9. The protocols for ostrich reintroduction should be reviewed, with particular attention to minimizing imprinting of young birds on people during pre-release.

10. Recording methods and nest records are in place to develop systematic monitoring of the nesting vulture populations found in the reserve. It is recommended that monitoring time is scheduled in Nov-Dec. late 2022 to implement a systematic survey of nest activity at known and new sites, with a view to assessing nesting outcomes and success rates with a similar exercise in March-April 2023.

# Partie IV. REMOTE MONITORING OF ORYX

**Katherine Mertes**

Postdoctoral Research Fellow - Smithsonian Conservation Biology Institute

## 1. Key findings

- Oryx traveled further between short-term use areas during the rainy season than any other season. This finding supports a previous analysis, which found that oryx prefer environmental conditions likely to support forage patches during the wettest months of the year. Together, these analyses suggest that oryx employ seasonal movement and resource tracking strategies, including exploiting high-quality resource patches during the rainy season, and moving long distances to reach such patches.
- Addax showed similar habitat preferences during the wet six months of the year. However, during the dry period, addax selected sites with intermediate short-term vegetation productivity and avoided sites with elevated long-term vegetation productivity, indicating the two species may employ different seasonal strategies.
- When founder oryx not seen alive during the last year are considered potential mortalities, 149 of 243 founders likely survive to date. Most release groups exhibit mean annual survival > 0.9, with slightly lower annual survival in the first year.
- Based on births detected in the field, most releases produce 0.5 – 0.9 calves per surviving female each year, at least 70% of which likely survive to reproductive maturity.

## 2. Management applications

Reintroduced oryx have begun moving from the Southeast section of the OROAGR to the Northwest during the rainy season. In contrast, during the dry seasons reintroduced oryx exhibit more constrained movements largely within the Southeast section of the reserve. Reserve management policies should protect both of these seasonally preferred habitats and the ability for reintroduced antelope to move between them.

## 3. Products

- SCBI personnel maintained an EarthRanger site to provide real-time tracking data from reintroduced oryx, addax, and ostrich on a secure online platform. This site supports monitoring activities and facilitates multiple types of alerts for reintroduced animals. A second Earthranger site for the Niger addax project was also created and maintained.

- Twenty-three oryx were sampled and fit with GPS collars in the field during November 2021 and March 2022. Along with three oryx sampled and collared in March 2020, these animals comprise a representative sample of the reintroduced oryx population on which future monitoring effort will focus, along with ear-tagged animals born in Chad.
- SCBI personnel produced a harmonized field monitoring data set for oryx groups. Observations collected in ODK and CyberTracker from 2016 to 2021 were compared and merged where appropriate; common issues were identified and corrected, including updating animal identity codes; and all records were integrated into a joint format. This process yielded a harmonized set of ca. 4400 harmonized field monitoring observations.
- On October 18, 2021, SCBI personnel presented "Movement rates identify seasons and transition dates for a reintroduced ungulate" to the 7th Bio-Logging Symposium.
- SCBI personnel shared information on land cover in the OROAGR, and space use and seasonal movements by reintroduced oryx, with the POROA to develop proposed conservation zones and a reserve management plan.
- A draft manuscript on oryx seasonal habitat selection was shared with SaharaConservation and other partners in November 2021. After revision and opportunity for review, this manuscript was submitted to the journal *Movement Ecology*.
- SCBI personnel contributed two short reports summarizing data flow, communications systems, and security of location data communicated by GPS/satellite collars to SaharaConservation and CMS.

# 4. Field capture, sampling, and collaring operations

In 2019, the project adopted a revised monitoring strategy centered on long-term monitoring of a representative sample of ca. 50 oryx within the reintroduced population. The sample size of 50 was based on a power analysis in which at least 50 marked oryx were required to achieve 80% power to detect the actual difference in survival rate among release groups 1 - 4 with $\alpha = 0.1$. This sample size was also deemed a reasonable number of animals for a team of 2 - 4 to regularly observe, based on experiences during Phase I of the project. Data produced through the long-term monitoring of these 50 oryx will be used to estimate demographic and population parameters, and evaluate and refine management protocols.

Shortly after the project adopted this revised monitoring strategy, in March 2020, a joint team of EAD, SaharaConservation, and SCBI personnel captured 3 oryx originally released in 2016 - 2017. These activities demonstrated that reintroduced oryx respond well to sedation and reversal in the field and perform well in the wild after intervention. Due to the global COVID-19 pandemic, the field work necessary to add more animals to the long-term monitoring group was not feasible for ca. 18 months. However, in November 2021 and March 2022, a joint team was able to return to the field.


Fig. 1. Approaching and immobilizing a sedated scimitar-horned oryx in the field, November 2021.

During November 9 – 18, 2021, a joint team of EAD, SaharaConservation, ZSL, U Edinburgh, IRED, and SCBI personnel captured, sampled, and collared 18 oryx in the field. SCBI and ZSL personnel ranked previously released and marked oryx based on release group, birth type (founder or Chad-born), calving history, sociality (to maximize the potential to monitor other oryx), and other factors. Groups of oryx were located in the field based on suggestions from SaharaConservation ecological monitoring team members Habib Ali and Caleb Ngaba,

recent field monitoring data, and aerial observations by Jaime Dias of WFC. Once a group was located, members of the SaharaConservation ecological monitoring team approached the group to identify priority animals. Once the identities of priority oryx were confirmed, EAD personnel maneuvered a vehicle typically used for field monitoring (such that most reintroduced oryx are acclimated to its presence) close enough for EAD veterinarian Jon Llona Minguez to dart the selected oryx.

Once an oryx was sedated, EAD personnel approached on foot and restrained the animal using horn covers and pressure on body sections. Once the animal was immobilized, additional team members approached to conduct a brief health check and biological sampling. The following samples were collected from each oryx:

- 2-3 x 9 mL tubes of serum
- 2-3 x 9 mL tubes of whole blood preserved in EDTA
- 2 x nasal swabs preserved in RNALater
- 2 x oral swabs preserved in RNALater
- 2 x ocular swabs preserved in RNALater
- 1 x fecal sample collected per rectum
- Attached parasites (e.g., ticks) preserved in RNALater

Finally, each recaptured oryx was fit with a GPS / VHF / satellite collar programmed to take a GPS location every 4 hours, broadcast a VHF signal for 12 hours daily, and operate for at least 3 years. The immobilized oryx was then reversed, manually steadied as it regained mobility, released, and monitored for 15-60 minutes, depending on animal condition. Animals captured were visited several times over subsequent days; no animals exhibited negative impacts from capture and handling.

**Table 1.** Oryx immobilized, sampled, and collared in the field 9 - 18 November 2021

| Animal | Release group | Sex | Date of birth | Birth Type | Release date | Calves to date | Date collared | Expected dropoff |
|---|---|---|---|---|---|---|---|---|
| R11R86_G1312F | 4 | F | 16/12/2016 | founder | 8/6/2018 | 3 | 11/9/2021 | 7/30/2024 |
| N23B28_Y66F | 1 | F | 21/10/2014 | founder | 8/13/2016 | 4 | 11/12/2021 | 8/2/2024 |
| N07R15_B491F | 3 | F | 04/03/2012 | founder | 8/3/2017 | 6 | 11/13/2021 | 8/3/2024 |
| N16_Y007F | 3 | F | 02/04/2017 | pen-born | 8/3/2017 | 3 | 11/13/2021 | 8/3/2024 |
| N22R40_B492F | 3 | F | 24/04/2013 | founder | 8/3/2017 | 5 | 11/13/2021 | 8/3/2024 |
| B88B17_B493F | 3 | F | 12/12/2014 | founder | 8/3/2017 | 4 | 11/14/2021 | 8/4/2024 |
| R52R29_B494F | 1 | F | 21/09/2014 | founder | 8/13/2016 | 5 | 11/14/2021 | NA |
| R78B19_B495F | 3 | F | 02/07/2015 | founder | 8/3/2017 | 0 | 11/14/2021 | 8/4/2024 |
| N14_Y009F | 3 | F | 08/04/2017 | pen-born | 8/3/2017 | 3 | 11/16/2021 | 8/6/2024 |
| N15_Y1104F | 7 | F | 01/09/2016 | founder | 9/23/2020 | 2 | 11/16/2021 | 8/6/2024 |
| B03R47_B499F | 4 | F | 23/01/2017 | founder | 8/6/2018 | 4 | 11/17/2021 | 8/7/2024 |
| N18_Y013F | 3 | F | 11/07/2017 | pen-born | 8/3/2017 | 2 | 11/17/2021 | 8/7/2024 |
| N20_B496F | 4 | F | 23/04/2018 | pen-born | 8/6/2018 | 1 | 11/17/2021 | 8/7/2024 |
| R53R10_B498M | 3 | M | 19/09/2014 | founder | 8/3/2017 | NA | 11/17/2021 | 8/7/2024 |
| B91_B497F | NA | F | 21/03/2018 | wild-born | NA | 1 | 11/18/2021 | 8/8/2024 |
| R04B53_G17F | 4 | F | 01/07/2016 | founder | 8/6/2018 | 2 | 11/18/2021 | 8/8/2024 |
| R06_Y003M | 3 | M | 19/04/2017 | pen-born | 8/3/2017 | NA | 11/18/2021 | 8/8/2024 |
| R75_Y1042F | 7 | F | 01/08/2018 | founder | 9/23/2020 | 1 | 11/18/2021 | 8/8/2024 |

In addition, the joint team conducted a 3-day trip to the remote Northwest section of the OROAGR. While no oryx were directly encountered during this trip, SCBI, U of Edinburgh, and EAD personnel collected 10 non-invasive DNA samples from fresh oryx fecal material. Using a protocol developed by RZSS personnel, fresh oryx fecal deposits were swabbed. These samples will be analyzed by RZSS personnel to:

- attempt to identify the oryx inhabiting this section of the reserve,
- assess the potential utility of non-invasive approaches for future monitoring of the reintroduced oryx population.

Fig. 2. Collecting non-invasive DNA samples from fecal deposits

On November 8, 2021, 25 oryx were transported from Abu Dhabi to the OROAGR. SCBI and U of Edinburgh personnel collected one fecal sample from each crate in which oryx were transported. These samples will provide benchmark information on gut microbiome, which may be compared with future samples from the same individuals to assess changes in gut microbiota after release. These oryx were released into the reserve on December 5, 2021. Similarly, 25 addax were transported from Abu Dhabi to Chad on November 15, 2021, and released on December 9, 2021.

Following the field mission, SaharaConservation, SCBI, ZSL, and U of Edinburgh personnel met with DFAP, the Direction des Services Vétérinaires, and the Division Santé Animale in N'Djamena. One aliquot of each sample type from each oryx captured in the field was deposited with IRED. The remaining aliquots were transported to the University of Edinburgh for preservation and analysis.

During March 7 – 19, 2022, a joint team of EAD, SaharaConservation, ZSL, U Edinburgh, and IRED personnel captured, sampled, and collared 6 oryx in the field. For this mission, SCBI and ZSL personnel prioritized groups of at least 8 oryx containing ≤ 1 collared animal to increase monitoring capacity. Groups of oryx were located in the field based on recent field monitoring data and aerial observations by Jaime Dias of WFC. Once a target group was located, suitable animals were identified within the group and EAD personnel maneuvered a vehicle for veterinarian Jon Llona Minguez to dart selected oryx. Once an oryx was sedated, the same health assessment, sampling, collaring, and post-handling monitoring protocols followed in November 2021.

**Table 2.** Oryx immobilized, sampled, and collared in the field 7 - 19 March, 2021

| Animal | Release group | Sex | Date of birth | Birth Type | Release date | Calves to date | Date collared | Expected dropoff |
|---|---|---|---|---|---|---|---|---|
| B17_G38F | NA | F | unknown | wild-born | NA | unknown | 3/15/2022 | 12/31/2024 |
| B87_G44F | NA | F | 4/2/2018 | pen-born | 8/6/2018 | 2 | 3/17/2022 | 6/19/2025 |
| R07_G40M | NA | M | unknown | wild-born | NA | unknown | 3/16/2022 | 1/8/2025 |
| R27_G1358M | NA | M | 3/28/2020 | wild-born | NA | unknown | 3/16/2022 | 1/1/2025 |
| R28_G39F | NA | F | unknown | wild-born | NA | unknown | 3/16/2022 | 1/1/2025 |
| R34N12_G45F | 6 | F | 6/1/2016 | founder | 12/12/2019 | 1 | 11/5/2019 | 1/2/2025 |

In addition, University of Edinburgh personnel demonstrated the use of a buccal swab to collect a DNA sample from a newborn calf captured for ear-tagging. This sample will be analyzed by RZSS personnel to assess the potential utility of similar sampling on wild-born calves captured for ear-tagging. U of Edinburgh personnel also collected another 15 fecal samples from the crates of the newly arrived oryx, as a microbiome benchmark.

In collaboration with Dr. Richard Ngandolo and Dr. Fayiz Abakar of the Division Santé Animale, heat treatment and DNA extraction were performed on samples at IRED laboratories in N'Djamena. As in November 2021, one aliquot of each type of sample

collected from oryx captured in the field in March 2022 was deposited with IRED. Remaining aliquots were transported to the University of Edinburgh.

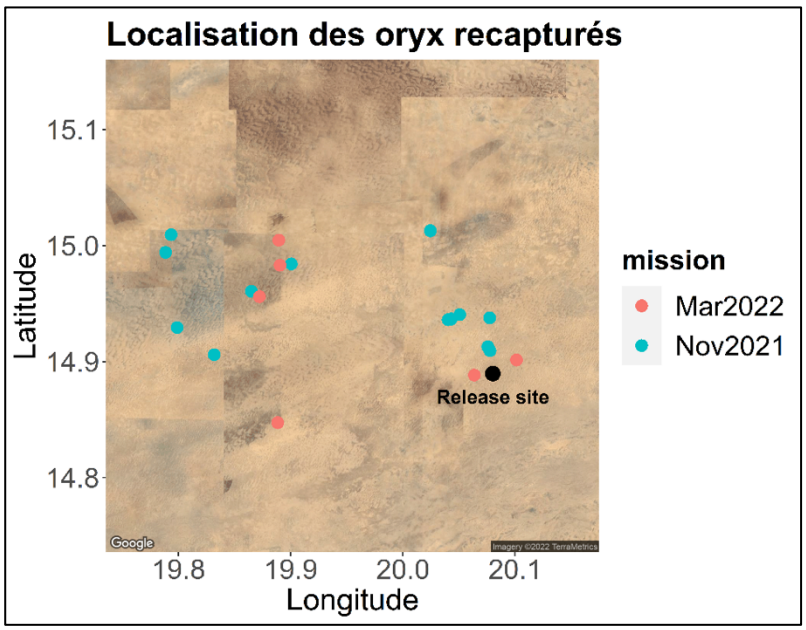


Fig. 3. Locations where scimitar-horned oryx were immobilized, sampled, and collared in the field from November 9, 2021, through March 19, 2022.

## 5. Status of the reintroduced oryx population

Of 243 founder oryx released into the OROAGR, 149 founders have been observed alive in the past year. (For this report, any founder not seen alive over the last year is considered a potential mortality.) Under this approach, most oryx releases exhibit a mean annual survival rate > 0.9, with a slightly lower annual survival rate in the first year after release (Table 3; paired t-test p = 0.1). Release 4, which was affected by a Rift Valley Fever outbreak in 2018, experienced the lowest year one founder survival rate (0.45).

**Table 3.** Founder and calf survival for oryx releases 1-7

| Release | Time since release (yrs) | Released founders (m.f) | Known living founders (m.f) | Y1 annual founder survival | >Y1 annual founder survival | Known living calves | Mean annual calf survival | Mean annual per capita production |
|---|---|---|---|---|---|---|---|---|
| 1 | 5.7 | 8.13 | 6.10 | 1 | 0.96 | 8 | 0.68 | 0.67 |
| 2 | 5.3 | 6.8 | 4.6 | 1 | 0.93 | 5 | 0.78 | 0.79 |
| 3 | 4.7 | 14.23 | 10.16 | 0.92 | 0.95 | 36 | 0.85 | 0.79 |
| 4 | 3.7 | 38.35 | 9.19 | 0.45 | 0.97 | 27 | 0.94 | 0.82 |
| 5 | 2.6 | 3.20 | 2.11 | 0.78 | 0.89 | 16 | 0.97 | 0.47 |
| 6 | 2.4 | 7.17 | 7.8 | 0.71 | 0.94 | 11 | 1.0 | 0.90 |
| 7 | 1.6 | 8.18 | 8.16 | 0.96 | NA | 22 | 0.89 | 0.94 |

All founder oryx are marked before release, allowing their identification for up to three years via GPS collar, and many more years via ear tag (though some founder oryx have lost ear tags after release). However, Chad-born calves are extremely difficult to identify after they wean from marked dams. Thus, the counts of living calves and calf survival rates in Table 3 are likely under-estimates. In 2019, the reintroduction project initiated an ear-tagging program that has marked 106 Chad-born calves to date. Marked calves are considered high-priority targets for field monitoring, yielding a rapidly expanding data set that can be used to estimate calf survival rates more precisely in the future. Based on births detected in the field, most releases produce 0.5 – 0.9 calves per surviving female each year, at least 70% of which survive (Table 3). This ample production has led to a rapidly growing population of reintroduced oryx relatively evenly divided among captive- and Chad-born individuals (Fig. 4).

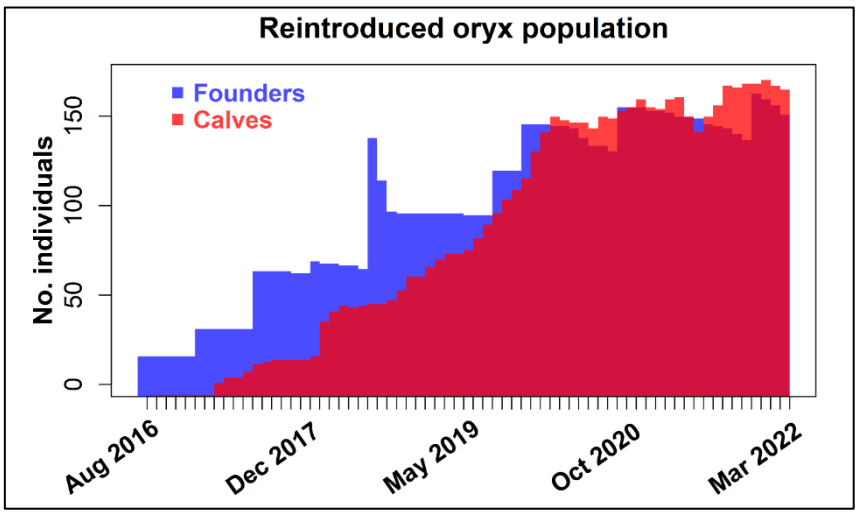


Fig. 4. Estimated founder and Chad-born oryx in the reintroduced population from August 2016 to present. Estimates are based on the number of oryx observed alive during the previous year.

Releases 1 and 2 produced relatively few calves during their first year in the OROAGR (Figure 5). Lower calf production during the first year after release has since been observed in most releases (paired t.test $p < 0.05$), although this depression in calf production is typically more minor than the extreme decrease observed in Release 1. In other species, elevated adult and juvenile mortality soon after release has been attributed to the stress of the release itself – or inefficiencies in movements, foraging strategies, or energy expenditures due to unfamiliarity with the novel environment.

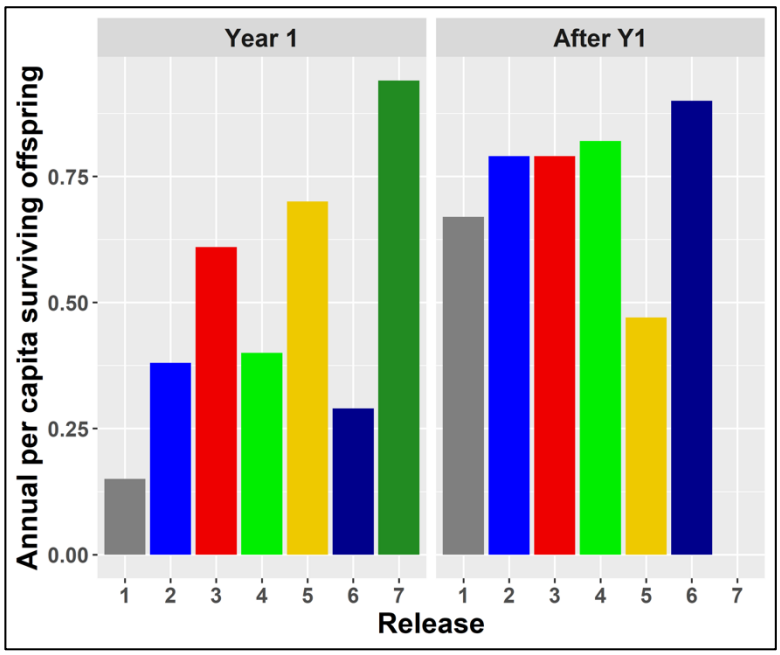


Fig. 5. Per capita calf production during the first year after release versus subsequent years.

# 6. Emerging seasonal movements by reintroduced oryx

SCBI personnel performed behavioral change point analysis on GPS collar data from oryx tracked for at least 60 days (n=140). This analysis classified sections of oryx movement paths as "use" (movements of shorter distances, lower speeds, and variable turning angles) or "travel" (movements of longer distances, higher speeds, and homogeneous turning angles). Mapping movements classified as "travel" performed during the rainy season shows a clear directional trend (Figure 6).

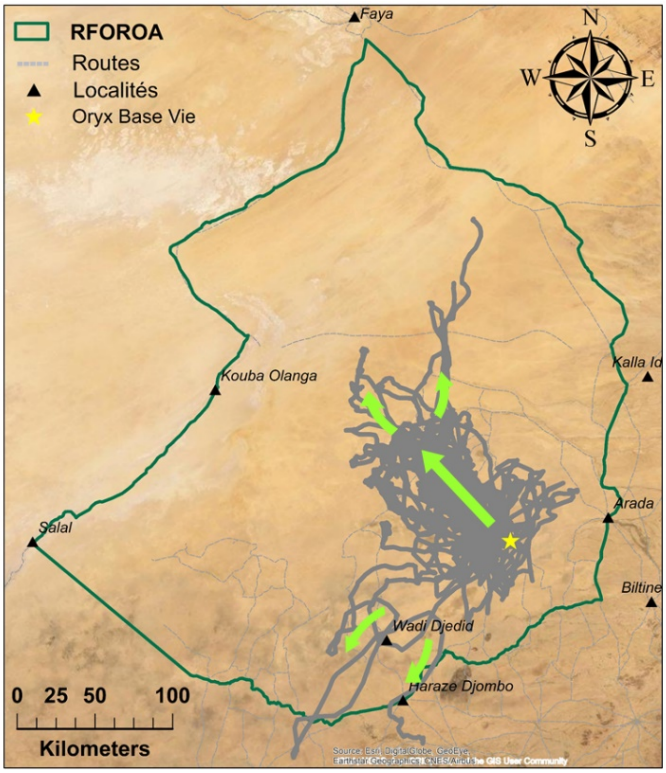


**Fig. 6. Travel routes of reintroduced oryx during the rainy season.** Gray lines show sections of individual oryx movement paths classified as "travel," buffered by 1km. Green arrows highlight general trends in location and direction of oryx movements classified as travel.

However, sections of oryx movement paths classified as "travel" in other seasons show much less directional similarity and spatial overlap. These patterns suggest the emergence of a distinct Southeast-to-Northwest movement during the rainy season – but also that oryx moving long distances have not developed common routes or "corridors" to date. Through continued field monitoring and movement analyses, we will assess the stability of this emerging seasonal movement across years and environmental conditions, and detect potential movement corridors.

# 7. Experienced oryx use space differently

To capture short-term space use across seasons, SCBI personnel calculated a 95% minimum convex polygon around each section of an oryx movement path classified as "use." Because the integrated step selection analysis conducted in 2021 (and described in the manuscript submitted to Movement Ecology) revealed that oryx habitat preferences change over the time since release, we removed data within one year of release. We then calculated the total area over which "experienced" oryx (animals that have spent >1 year roaming the OROAGR) performed "use" behaviors in each season.

Experienced oryx used between 50 – 350 km2 in a single season. Median space use was 153 km2 during the Cool / dry season, 132 km2 during the Hot / dry season, and 162 km2 during the Rainy season (Figure 7). A 3-way ANOVA showed that experience significantly affected total space use by an individual within a season ($p = 0.037$), though this relationship was weaker than the effect of season ($p = 0.027$) or individual year ($p < 0.001$).

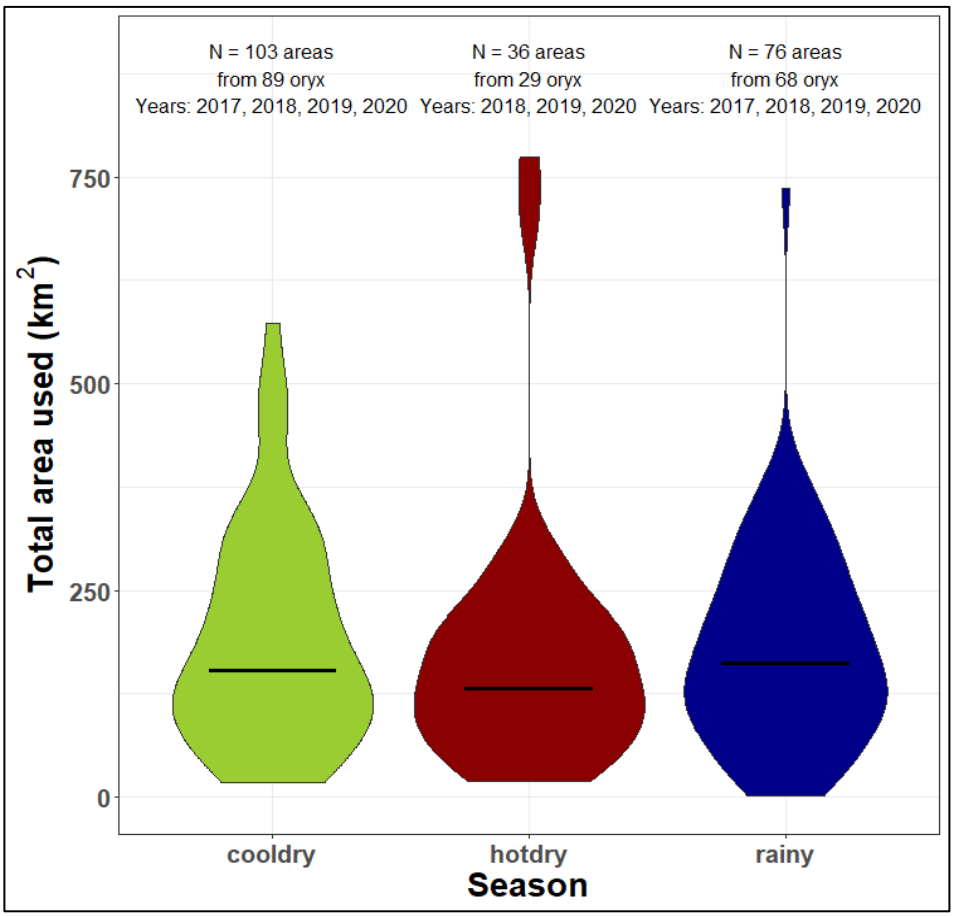


Fig. 7. Area used by "experienced" oryx in each season.

*Violin plots* show the total area over which individual oryx perform "use" behaviors in a season. *Violin width* represents the proportion of experienced oryx that used each estimated area. *Upper text* shows sample size. Only oryx with ≥1 year of experience were included.

We also calculated distances between successive short-term use areas within the same season. Distances between use areas ranged from 0.2 km - 90 km (Figure 8). Oryx traveled further between short-term use areas during the rainy season (median = 23 km) than in any other season (Figure 8). A 3-way ANOVA also indicated that season had a strong, significant effect ($p << 0.001$) on the distances oryx traveled between use areas.

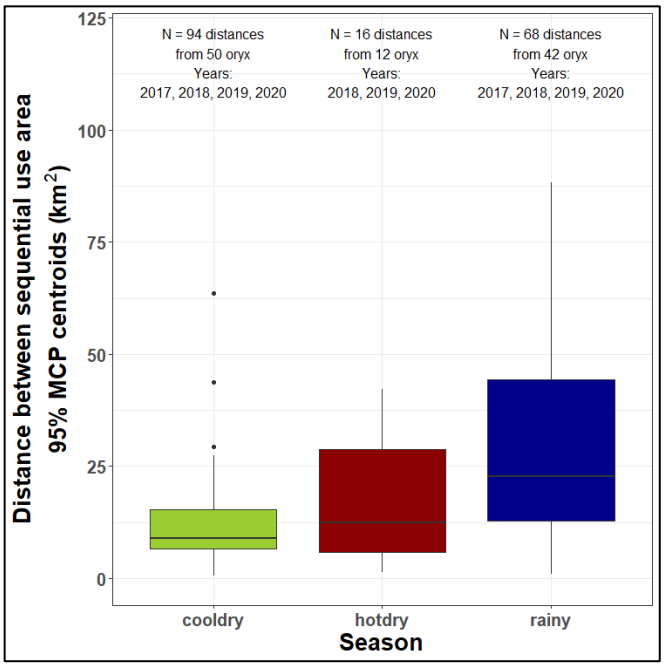


Fig. 8. Distances between short-term use areas

*Colored boxes* show distances between successive short-term use areas in the same season. *Black horizontal lines* indicate the seasonal medians: 9 km in the Cool / dry season; 13 km in the Hot / dry season; and 23 km in the Rainy season. Only oryx with > 1 year of experience in the OROAGR were included.

Oryx also moved farther between use areas during the rainy season as they gained additional years of experience (Figure 9). In a 3-way ANOVA, experience significantly affected the distances oryx traveled between use areas ($p = 0.019$), though this relationship was weaker than the effect of individual year ($p << 0.001$).

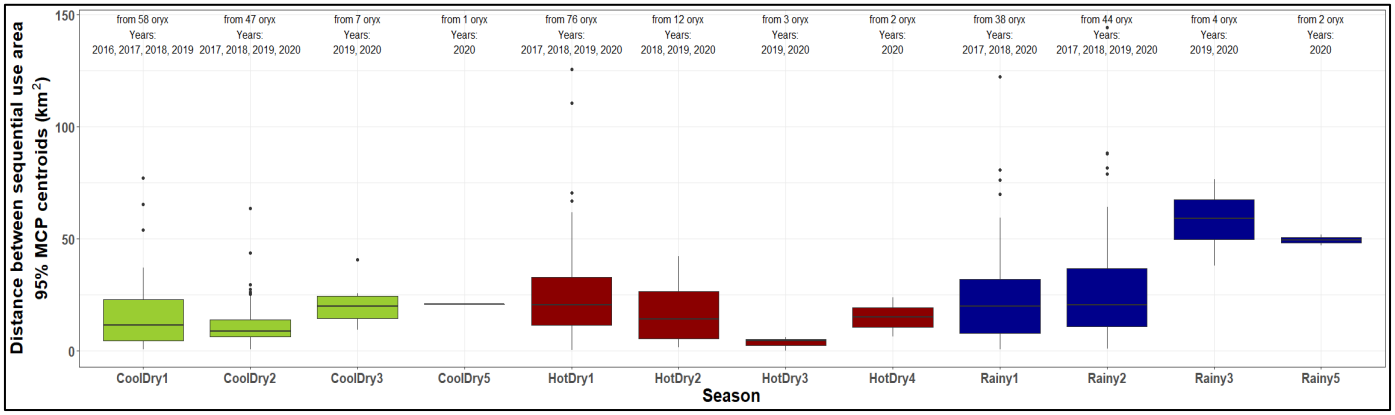


Fig. 9. Post-release experience affects the distance oryx travel between use areas.

*Colored boxes* show distances traveled between short-term use areas by reintroduced oryx in a given season and year after release. *Upper text* indicates sample size for each season. Median travel distances ranged from ca. 5 – 60 km, and varied with post-release experience in all seasons.

These results align with our analysis submitted to *Movement Ecology*, which found that, during the wettest period of the year, oryx selected sites with both high short-term vegetation greenness (i.e., growing grasses and forbs) and high long-term greenness (i.e., trees and shrubs), low elevation, and complex topography. These conditions are consistent with interdunal depressions and other sites that support dense patches of herbaceous vegetation. Together, these analyses indicate that oryx employ a patch exploitation strategy during the rainy season – and that, as oryx gain experience in the OROAGR, they use larger patches and move longer distances to reach those patches. Thus, as more reintroduced oryx gain experience, seasonal variation in movement strategy (patch exploitation vs. energy conservation), distances traveled, and size of short-term use areas, may all increase across the population.

## 8. Status of the reintroduced addax population

Of 65 founder addax released into the OROAGR to date, 61 individuals have been observed in the past year. (For this report, any founder addax not seen alive during the last year is considered a likely mortality.) Under this approach, two of three releases exhibit mean annual survival > 0.9, with slightly lower annual survival during the first year (Table 4). However, because the Release 2 addax were not fit with GPS collars due to the COVID-19 pandemic, monitoring this release group is particularly difficult, and the counts and estimated survival rates in Table 6 are likely underestimates.

**Table 4.** Founder and calf survival for addax releases 1-3.

| Release | Time since release (yrs) | Released founders (m.f) | Known living founders (m.f) | Y1 annual founder survival | >Y1 annual founder survival | Known living calves | Mean annual calf survival | Mean annual per capita production |
|---|---|---|---|---|---|---|---|---|
| **1** | 2.3 | 4.11 | 4.9 | 0.87 | 1 | 9 | 1.0 | 0.55 |
| **2** | 1.6 | 8.17 | 8.16 | 0.96 | 1 | 15 | 1.0 | 0.18 |
| **3** | 0.4 | 8.17 | 7.16 | 0.96 | NA | NA | NA | NA |

The high founder survival observed across all addax releases to date is promising. However, estimates of per capita annual calf production are much lower than for oryx. The difficulties with monitoring addax in Release 2 may explain part of this variation. In addition, a substantial number of addax in Release 1 exhibited extreme declines in body condition during their first dry season, potentially leading to aborted or abandoned calves. The total number of founder addax is also still quite small, potentially limiting mating opportunities. Additional monitoring over the next year, especially of Release 2 addax, will be necessary to obtain more precise estimates of calf production.

# 9. Habitat selection by reintroduced oryx and addax

In 2021, SCBI personnel developed an integrated step selection function to investigate movement decisions and habitat selection by reintroduced antelope. For each movement step by oryx in Releases 1 and 2, we generated nine "available" (but unused) steps based on each individual's movement data. This approach yielded 972,709 steps for 32 oryx from 2016-2019. We competed four candidate models with different covariates (see Table 5). We then performed this analysis for addax released in January 2020. For both species, and in both seasonal periods, the best-performing model included covariates that captured local environmental conditions, post-release experience, and social factors (see Table 5), indicating that all three influence oryx and addax movement decisions.

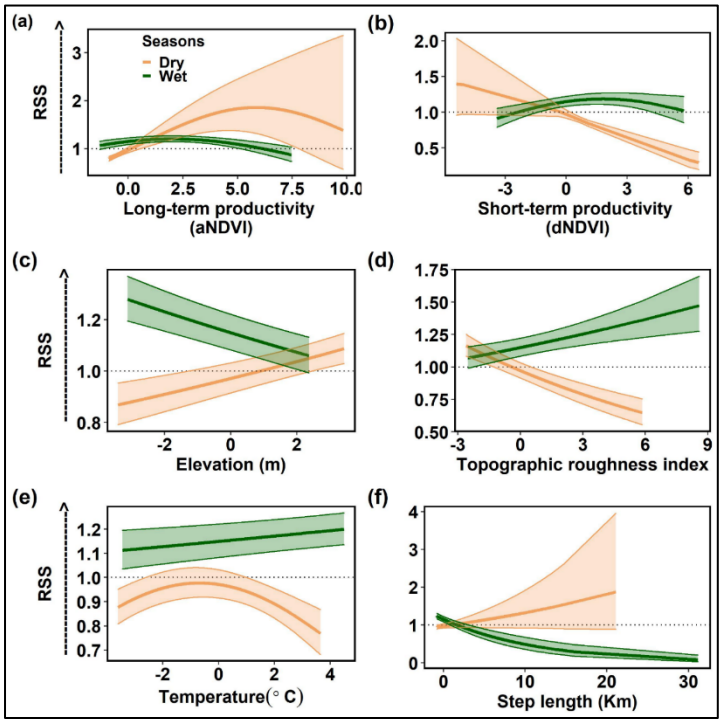


Fig. 10. Oryx relative selection strength for environmental conditions during dry (*brown*) and wet (*green*) periods. Shading indicates 95% confidence intervals. Detailed descriptions of model covariates may be found in Table 5

During the dry period (January – June), oryx selected sites with relatively high long-term vegetation productivity (aNDVI) and responded negatively to short-term vegetation productivity (dNDVI; Figure 10). Together, these findings indicate that when resources are limited, oryx select sites with trees and shrubs, rather than seeking out green herbaceous vegetation (i.e., forage). Oryx also generally selected sites with relatively high elevation and low topographic complexity, thus avoiding moving through complex terrain. We interpret this suite of responses – as well their negative response to higher temperatures – as an energy conservation strategy during the dry period of the year.

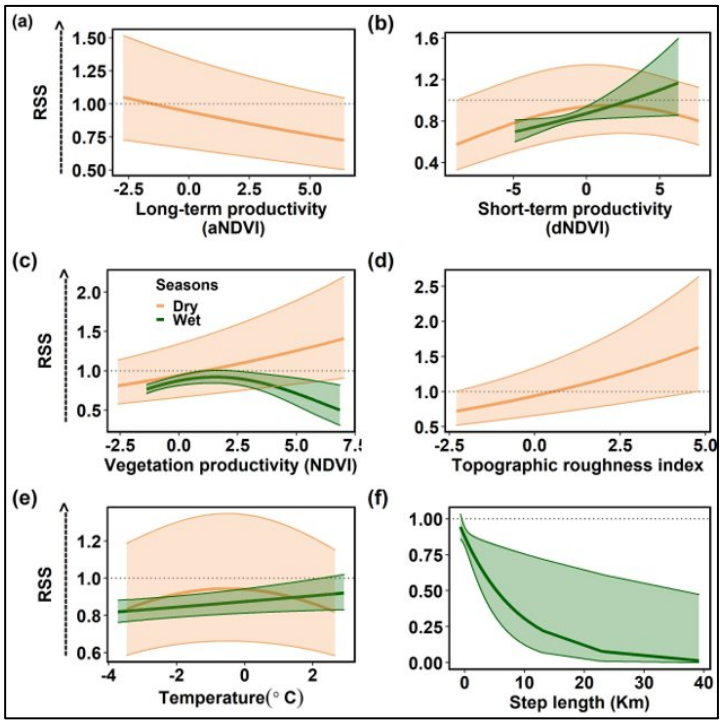


Fig. 11. Addax relative selection strength (RSS) for environmental conditions during dry (*brown*) and wet (*green*) periods. Shading indicates 95% confidence intervals. Detailed descriptions of environmental variables may be found in Table 5

In contrast, addax exhibited both a negative relationship with long-term vegetation productivity (aNDVI) and selection for intermediate short-term vegetation productivity (dNDVI) during the same seasonal period (Figure 12). Thus, it appears that oryx and addax may employ contrasting resource selection strategies during dry periods. However, the movement data underlying the addax model includes the only first dry season experienced by a single release of addax. Future analyses incorporating data from more experienced addax, and additional releases of addax, are necessary to fully assess these relationships.

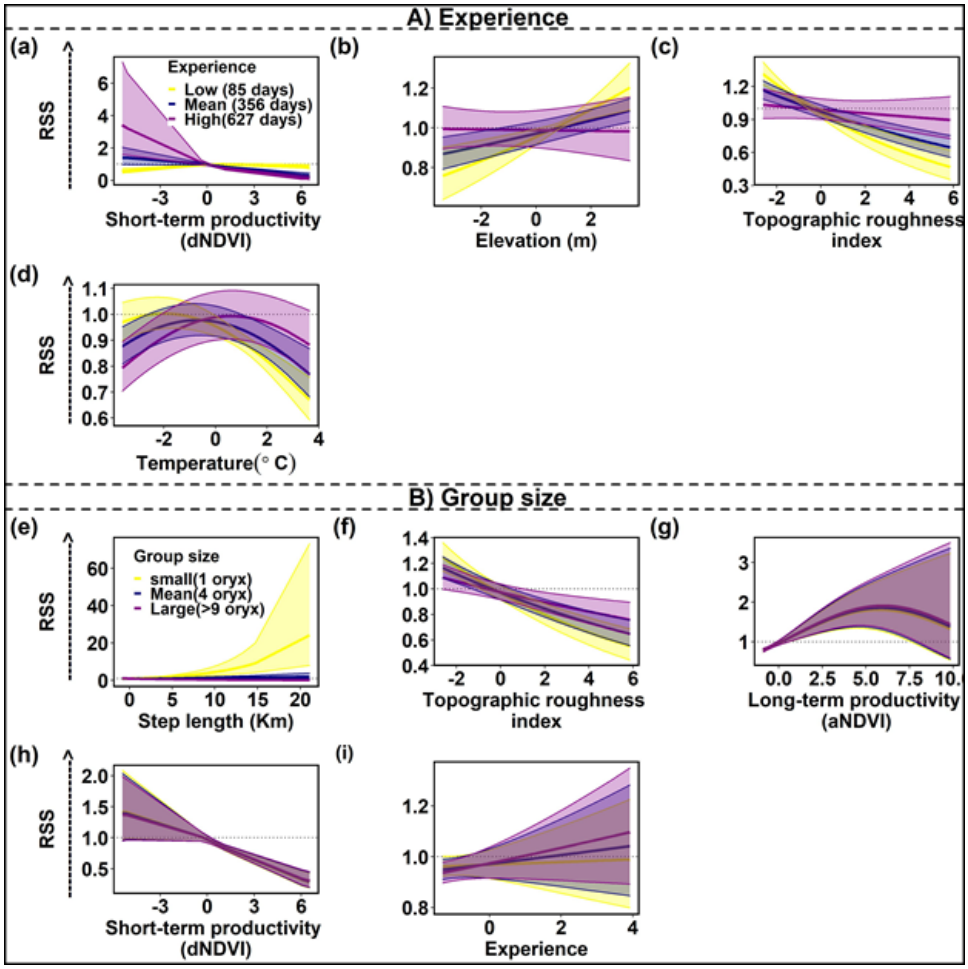


Fig. 12. Interactions between experience, group size, and environmental conditions in the final dry period model for addax. Shading indicates 95% confidence intervals. Detailed descriptions of environmental covariates may be found in Table 5.

During the wet period, oryx preferred sites with intermediate short-term vegetation productivity (dNDVI), low elevation, and high TRI (Figure 10 b, c, d), consistent with inter-dunal depressions that often support patches of herbaceous vegetation. Similarly, addax selected sites with higher short-term productivity (dNDVI) and intermediate mean productivity (NDVI; Figure 11 b, c). Both species also exhibited generally shorter steps. In sum, oryx and addax habitat selection (for green herbaceous vegetation) and movement characteristics (relatively short, relatively slow steps characteristic of foraging behavior) were most similar during the wet period.

For oryx, estimated coefficients for interaction terms between environmental factors and experience were both larger, and more likely to be statistically significant, than those for group size, across both seasonal periods. Oryx with more experience significantly preferred longer steps in the wet period (Figure 14a), indicating that experienced oryx may move further steps when resources are comparatively abundant. Oryx with less experience (animals that spent ca. 3 months to 1 year roaming the OROAGR) showed a relatively flat response to short-term vegetation productivity (Figure 12A), while more experienced oryx (≥18 months in the OROAGR) showed a much stronger negative response. And while oryx generally selected sites with higher elevation and lower topographic complexity (TRI; see Table 5) during the dry period, more experienced oryx showed a nearly flat response to both topographic

variables, indicating that sensitivity to topography decreases rapidly as oryx gain experience. Collectively, these results indicate that, in reintroduced oryx, post-release experience affects movement decisions more strongly than social factors.

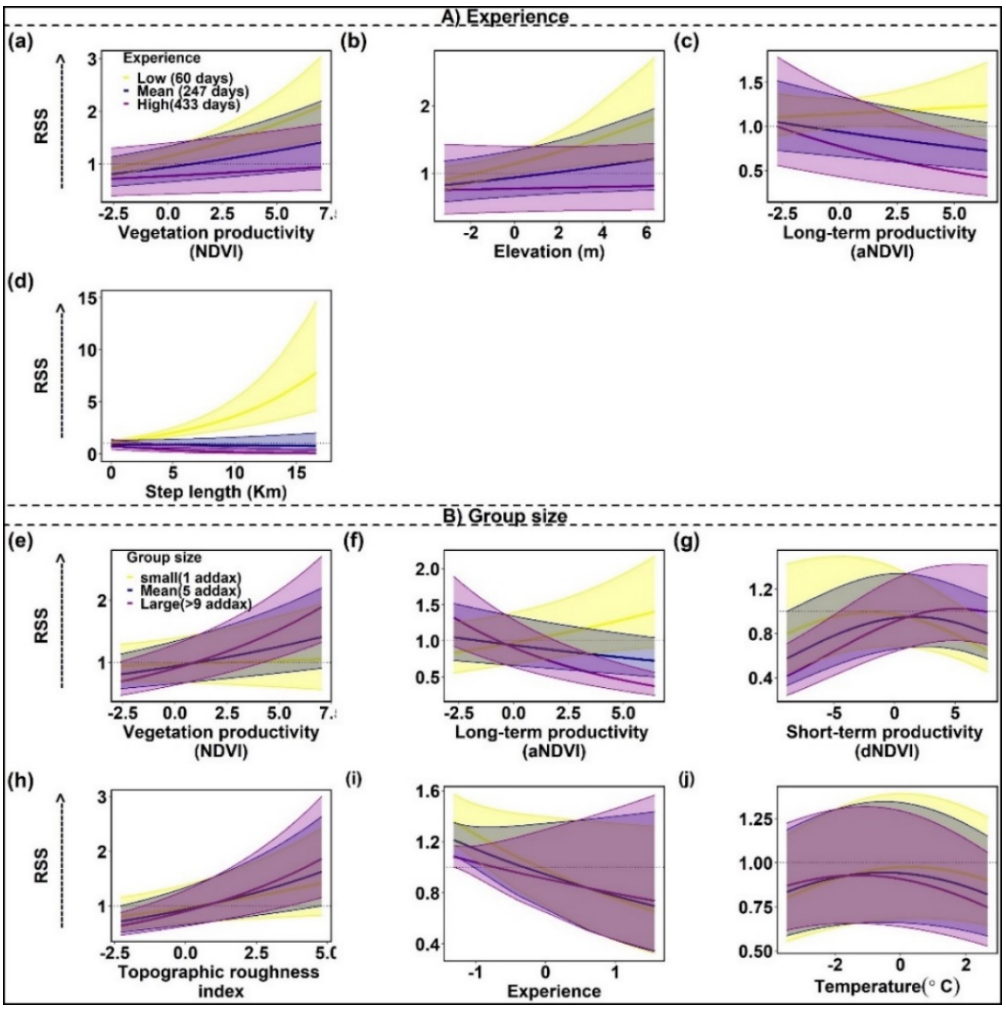


Fig. 13. Interactions between experience, group size, and environmental conditions in the final dry period model for oryx. Covariates may be found in Table 5.

# 10. Conclusions and recommendations

## 10.1 Protect emerging seasonal habitats and movements

Reintroduced oryx have begun moving from the Southeast section of the OROAGR to the Northwest during the rainy season. In contrast, during the dry seasons reintroduced oryx exhibit more constrained movements largely within the Southeast section of the reserve. Reserve management policies should protect both of these seasonally preferred habitats and the ability for reintroduced antelope to move between them.

## 10.2 Continue toward a « long-term monitoring group" of 50 oryx

Based on a power analysis conducted in 2020, 50 animals represent the minimum sample size to detect actual differences in survival across oryx Releases 1-4. In three field missions from March 2020 – 2022, joint teams efficiently captured, sampled, and collared 27 founder oryx. Reaching the target of a long-term monitoring cohort of 50 oryx will both standardize monitoring effort and strengthen the project's ability to detect population and demographic trends.

## 10.3 Dedicate one monitoring team to each species

The reintroduced addax population now likely contains more than 80 animals, and the oryx population more than 350 animals – the majority of which do not carry GPS collars. Monitoring each reintroduced population has grown in complexity over time, and now requires detailed planning, strategic decision-making, and intensive data management. Structuring monitoring field work as two teams of two observers each, with teams operating independently in separate vehicles, is the most practical way to achieve full monitoring coverage for both species.

## 10.4 Focus monitoring effort on marked oryx

Because the reintroduced oryx population is growing so rapidly, and because unmarked juvenile and sub-adult oryx typically cannot be individually identified, observations of unmarked oryx provide relatively limited information. In contrast, every observation of a marked Chad-born or founder oryx contributes to a timeline of survival probability, space use, and social dynamics. Thus, focusing monitoring effort on groups of oryx that contain marked animals will be a more efficient strategy, and yield more monitoring data of greater utility, over the long term.

## 10.5 Collect DNA samples from wild-born calves via buccal swab

The primary opportunity to collect biological samples from wild-born oryx and addax is soon after birth, when calves may be captured and ear-tagged by field monitoring personnel. In March 2022, personnel from U Edinburgh demonstrated a protocol developed by RZSS, using a buccal swab to rapidly collect a DNA sample from an ear-tagged calf. DNA samples from calves may provide insights on parentage, population genetics, and disease exposure. These analyses may also pave the way for future monitoring of the reintroduced populations using non-invasive DNA samples (also trialed in 2021-2022 and currently under analysis at RZSS).

## 10.6 Deploy camera collars on a subset of reintroduced oryx and addax

A previous collaboration among SaharaConservation, FRWC, and SCBI showed that the additional weight of camera attached to a GPS / satellite collar (ca. 600g) does not negatively affect oryx health. In addition, mean activity budgets captured by camera collars were equivalent to those estimated by a human observer (overall Wilcoxon signed-rank test, $p=0.24$). Camera collars thus represent a cost-effective tool to assess animal behavior after release, evaluate spatial overlap with livestock and wildlife – and thereby potential human-wildlife conflict – and identify gregarious individuals that may act as vectors for infectious diseases. Camera collar data may also be used to develop an accelerometry-based oryx behavior model. Moreover, the images and videos recorded by camera collars are extremely useful for outreach, communication, and other public-facing materials. We recommend that select oryx and addax in good body condition be fit with camera collars in 2022.