Chad Oryx Reintroduction Project

A joint initiative of the Government of Chad and the Environment Agency Abu Dhabi, implemented in Chad by the Sahara Conservation Fund

2020 ANNUAL REPORT

Edited by the Sahara Conservation Fund

هـيـئـة الـبـيـئـة - أبـوظـبـي
Environment Agency - ABU DHABI

SAHARA CONSERVATION FUND

ZSL LET'S WORK FOR WILDLIFE

Smithsonian Conservation Biology Institute

FOSSIL RIM WILDLIFE CENTER

Acknowledgements

This project would never have happened without the vision and leadership, 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 the Sahara Conservation Fund 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 imperilled wildlife if we all pull together.

Document Information:

Report prepared for use by: all the partners and stakeholders involved in the scimitar- horned oryx reintroduction project
Prepared by: Sahara Conservation Fund
Citation: Sahara Conservation Fund. 2021. *Chad Oryx Reintroduction Project 2020 Annual Report*. Sahara Conservation Fund.
Date issued: August 2021

Executive Summary:

This report provides an overview of activities and results through 2019 and early 2020 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 the Sahara Conservation Fund (SCF).

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 Conservation de la Faune et des Aires Protégées* (DCFAP), SCF, the Smithsonian Conservation Biology Institute (SCBI) and the Zoological Society of London (ZSL).

Cover photo: reintroduced scimitar-horned oryx in Chad © John Newby/Sahara Conservation Fund

Abbreviations and acronyms

Addax	Addax (*Addax nasomaculatus*)
DCFAP	Direction de la Conservation de la Faune et des Aires Protégées
EAD	Environment Agency Abu Dhabi
FRWC	Fossil Rim Wildlife Center
GPS	Global Positioning System
Iridium	Iridium Satellite Communications
MEEP	Ministère de l'Environnement, de l'Eau et de la Pêche
OROAGR	Ouadi Rimé-Ouadi Achim Game Reserve
Oryx	Scimitar-horned oryx
Oryx Project	Chad Oryx Reintroduction Project
Release 1	Oryx released in August 2016
Release 2	Oryx released in January 2017
Release 3	Oryx released in August 2017
RFOROA	Réserve de Faune de Ouadi Rimé-Ouadi Achim
SCBI	Smithsonian Conservation Biology Institute
SCF	Sahara Conservation Fund
Vectronic	VECTRONIC Aerospace GmbH
VHF	Very High Frequency
UAE	United Arab Emirates
ZSL	Zoological Society of London

TABLE OF CONTENTS

Introduction

The Ouadi Rimé-Ouadi Achim Game Reserve, located in the north-central part of Chad, was created by Decree No. 135/PR/EFP/PNR of May 10, 1969, for the protection of the area's Sahelo-Saharan antelopes, cheetah and ostrich. It covers an area of 7,975,000 ha and straddles five regions, namely Batha, Borkou, Barh Al Ghazal, Wadi Fira and Ennedi-Ouest.

Unfortunately, the years of conflict and drought in the country have had a negative impact on the population of these species. The scimitar-horned oryx (*Oryx dammah*) went extinct in the wild in the 1980s, but the reserve still has the largest number of dorcas gazelles (*Gazella dorcas*), bustards and an important population of dama gazelles (*Nanger dama*).

On September 4, 2014, the Ministry in charge of the Environment, and the Environment Agency of Abu Dhabi signed an agreement for the reintroduction of the scimitar-horned oryx in the reserve; it is stipulated in this agreement that the NGO Sahara Conservation Fund (SCF) be responsible for the implementation of the oryx project in Chad.

This agreement was renewed in October 2019 which allowed the reintroduction of the addax (*Addax nasomaculatus*) in addition to the oryx.

The Ministry of the Environment, Water and Fisheries, through its Directorate of Conservation of Wildlife and Protected Areas (DCFAP, French acronym) will play the following roles:

- Ensure the protection of the oryx and its habitat through the implementation of appropriate management of the reserve, as well as the maintenance of strong cooperation between the various local actors;
- Provide all necessary permits for animal arrival and project activities (CITES, veterinarian, aircraft landing permits, building permits, etc.);
- Provide assistance in obtaining official documents for staff and operators working on behalf of EAD and SCF (visas, residence permits, traffic permits, etc.);
- Ensure and protect the pre-release site selected by the project team.

The Ministry in charge of the Environment through its technical services carried out the various activities mentioned in the agreement.

Part I.

1. Environment Agency Abu Dhabi (EAD)

The Environment Agency – Abu Dhabi (EAD) is the programme 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 Programme 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 (Fig. 1) which incorporate the additional species into the conservation programme 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.

Figure 1. Project partners

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

Throughout the year the Environment Agency Abu Dhabi (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 Conservation and Protected Areas) and the Sahara Conservation Fund.

The project partners had developed ambitious plans for the year with two translocations of scimitar-horned oryx and addax along with the mission to capture the wild dama gazelles in the Manga in order to preserve their unique genetic material.
With Phase II of the project in full swing, the first, pilot group of addax would be translocated from base camp to a satellite release pen for the inaugural Addax release into the wild.

A great deal of preparation and effort was put forth to ensure the 2020 translocations would be a success but unfortunately the covid-19 pandemic forced a cancellation of all plans after March and all translocations would not be possible. Nevertheless, 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 March. This was a year of significant challenges but the fact that 25 oryx and 25 addax were translocated in a year such as this is something to be take pride in (Fig. 2).

Figure 2. The beginning of the year was full of project activity both in Abu Dhabi and in Chad

The beginning of the year proved to be full of action and included an importation of 34 addax from Morocco in an effort to increase the ex-situ population of addax in Abu Dhabi and the genetic diversity in the source population for reintroduction.

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 Environment Agency Abu Dhabi 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 honoured 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 species has recent conservation action prevented?”

They determined that the combined conservation effort has significantly decreased the likelihood of extinction of the scimitar-horned oryx (Fig. 3).

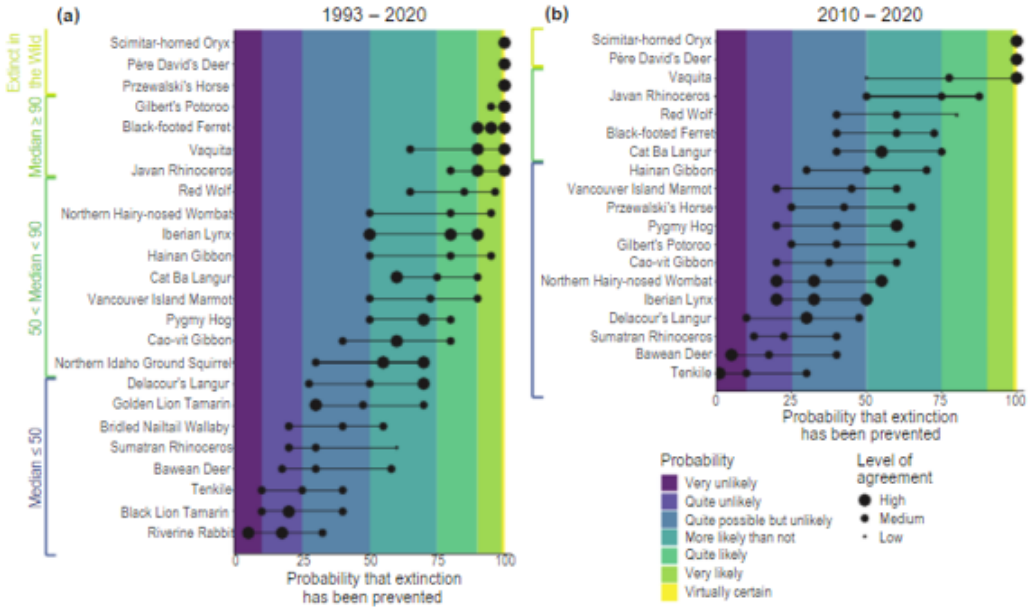


Figure 3. Probability that extinction of mammal species would have occurred in the absence of conservation action during (a) 1993-2020 (N – 24 species) and (b) 2010-2020 (N – 19 species). Values represent medians calculated from estimates by 26 evaluators, except for species that are extinct int the wild, wich were set at 100%. For a description of the probability categories see Table SI, based on Keith et al. (2017). Przewalski's Horse was assessed as extinct in the wild in 1996, but was reintroduced and assessed as critically endangered by 2008. We thefore set its probability to 100% for 1993-2020, but asked evaluators to assess its probability for 2010-2020.

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 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 administration centre made significant progress throughout the year and is nearing completion (Fig. 4 a/b).


Figure 4 a/b. 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. A large importation of 34 Addax arrived from Morocco in January plus three Addax from a private collection in Dubai which were incorporated into the breeding program in an effort to increase diversity. The focus continues to be on building genetically diverse/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 analysed and the results show that the mitochondrial genetic diversity in the reintroduced population has increased by 2.2x (Fig. 5). The genetic samples of most animals that have been translocated to Chad have been analysed 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 (Fig. 6) and the mixture between original EAD animals and those imported is increasing the allelic richness significantly (Please see full details and updates in Annex I).

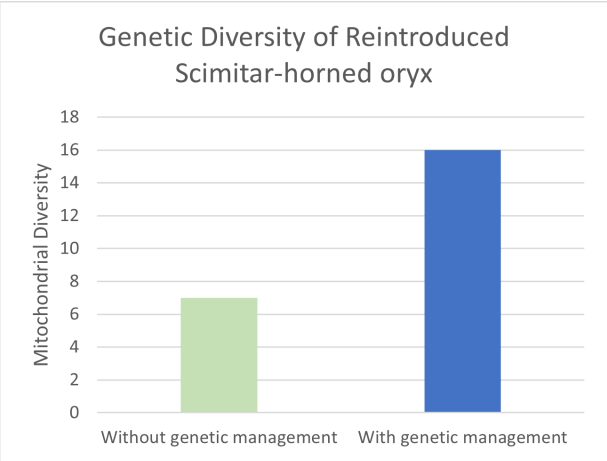


Figure 5. The mitochondrial diversity and the allelic richness of the reintroduced population have increased with the genetic management program in place (Full details in Annex 1)

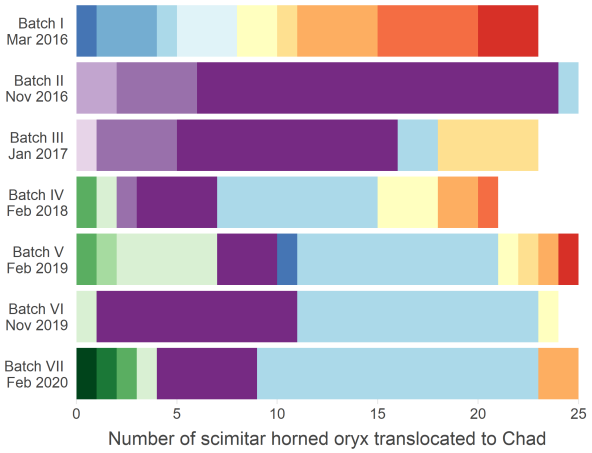


Figure 6. The genetic diversity of the reintroduced oryx includes a large majority of the available diversity within the global population. Each color represents a different mitochondrial lineage.

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 original plan was to translocate a group of 25 oryx and 25 addax in March and in November. We were luckily able to send the March groups just before travel became very difficult. The oryx were sent on the cargo plane as normal on the 3rd of March 2020 but by the 6th when the addax were slated to go, the international travel options were becoming very restrictive and there was a fear that the EAD crew on the first plane would not be able to return to the UAE. With this rapidly changing situation the decision was made to send the addax on the plane without the accompanying EAD team so that the team in Chad could return on the empty cargo plane after dropping the addax with the SCF team in Abeche. This was far from ideal but the team was with the animals in the plane until it left Abu Dhabi and we had the good fortune to have all the animals arrive in Chad without any complications. The SCF team transferred the addax to the pre-release pens at basecamp without any issues and the translocation was a success.

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 previous years. The vaccination protocol that was re-evaluated last year was kept the same for this year. All animals that were considered for the reintroduction were 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, Q-Fever) prior to being considered for translocation. In order for an animal to be chosen for shipment they first had to pass a physical examination where their body condition, hoof condition, teeth, legs and joints are evaluated (Fig. 7.5). Once the animal was chosen for reintroduction it was then given the following vaccinations: PPR using a live attenuated vaccine for Peste de Petites Ruminantes; 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 multocida, 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 were housed in the pre-shipment pens (Fig. 7.6) where all the final preparations for translocation took place. Each animal was individually identified with an ear tag and an intradermal microchip (Fig. 8). At least two vials of blood were banked for each animal that was sent for reintroduction. All details concerning the animals' identification (ear tag, microchip, sex, age, origin) was recorded in a database and transferred to the team in Chad.

Figure 7.5 Addax receiving a hoof trim prior to shipment

The scimitar-horned oryx and addax translocated in March were sent without any satellite tracking collars because we planned to fit them at base camp in the pre-release pens in September, just prior to the release in order to preserve battery life. Unfortunately, international travel was still impossible in September and therefore there was no choice but to release the animals without collars. They did all have ear tags as identification but unfortunately that was all. The team was able to dart and collar three scimitar-horned oryx in the field while on the ground in between the two cargo planes. This exercise was a practice run for possible extended efforts in the future. The immobilizations and procedures went well and there were no complications. It is planned to utilize this method to collar some wild-born animals as well as re-collar some founder animals in the future.

Figure 7.6 Addax in alleyway of the pre-shipment pens at Deleika Wildlife Conservation Center

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 was timed to match the environmental conditions (temperature, seasonal ecology) to minimize stress and maximize survival. All transportation crates were replaced with redesigned, heartier crates this year 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 were 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 were 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 were 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 there were three pallets of grass hay and pellet concentrate (a total of 6 pallets (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.

Figure 7. Addax in the process of loading into crate during translocation

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. 7) 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.

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.

Fig. 8 An addax receives its ear tag prior to translocation

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 (see Fig. 5.1). When released, all animals in both groups were in good shape and had no ill effects from the journey (see Fig. 5.2). 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, and we look forward to having a very productive 2020 as phase II of the project is further implemented. We are planning to send another 25 oryx and 25 addax in February 2020 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. Satellite boma release strategy of pilot group of addax

The first pilot group of Addax (15) was translocated to Chad in November 2019 and they were released into the wild in January 2020. Due to the fact that addax historically inhabited areas North of the base camp and pre-release pens, it was decided to release them via a “satellite-pen” release strategy which would put them in prime addax habitat for the season. This strategy could also encourage dispersal away from base camp which would be beneficial and possibly create some separation between the addax and oryx. Since this was a dry season release and conditions could be a difficult this time of year, it was decided to transfer the animals only 40 km to the North of base camp to ensure that there was ample vegetation and shade available for the newly released animals.

The EAD team had previously sent to Chad all materials needed to construct a mobile/modular boma therefore, everything needed was available to allow the simple construction of the satellite boma. The team chose a suitable location with shade available that could be easily accessed by the animal transport trucks. The round boma was about 40m in diameter and constructed from modular panels 3m x 2.4m which can fit together in any configuration. The entire boma was covered with shade cloth to provide a visual barrier for the animals helping them to acclimate and feel secure. Once the boma was complete, the Addax were captured, collared and translocated

to the temporary boma where they were again released in order to have time to recover the capture and transfer (Fig. 9).
This strategy would allow them to acclimate to the satellite boma and be in a calmer state when they were eventually released into the wild (Fig. 10). The capture and transfer was completed without any injury or complication and considered a complete success.

Figure 9. The addax satellite release boma, capture and collaring procedure

Figure 10. The release of the pilot group of 15 addax into the wild from the satellite boma

7. Communication, outreach and awareness

The documentary 'Back to the Wild', depicting the Scimitar-horned Oryx Reintroduction Programme, which tells the story of this ambitious reintroduction programme 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 (*see Bibliography).

Published papers

- Paper Published in the journal *Biological Conservation*
  "Benefits and pitfalls of captive conservation genetic management: Evaluating diversity in scimitar-horned oryx to support reintroduction planning"
  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
- Paper Published in the journal *Molecular Ecological Recources*
  "Chromosomal-level genome assembly of the scimitar-horned oryx: insights into diversity and demography of a species extinct in the wild Molecular Ecology Resources (Fig. 3)
  Humble E., Dobrynin P., Senn H., Chuven J., Scott A.F., Mohr D.W., Dudchenko O., Omer A.D., Colaric Z., Lieberman Aiden E., Al Dhaheri S.S., Wildt D., Oliaji S., Tamazia G., Pukazhenthi B., Ogden R., Koepfli KP. Chromosomal-level genome assembly of the scimitar-horned oryx: Insights into diversity and demography of a species extinct in the wild. Mol Ecol Resour. 2020;00:1–15. https:// doi.org/10.1111/1755-0998.13181

Annexe 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 programme 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 Environment Agency – Abu Dhabi 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 (SHO; *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 analysed from 166 out of 181 (92%) samples of the SHO which were translocated to Chad between March 2016 and February 2020. We identified 19 maternal lineages (mitochondrial DNA) carried by these SHO, 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.

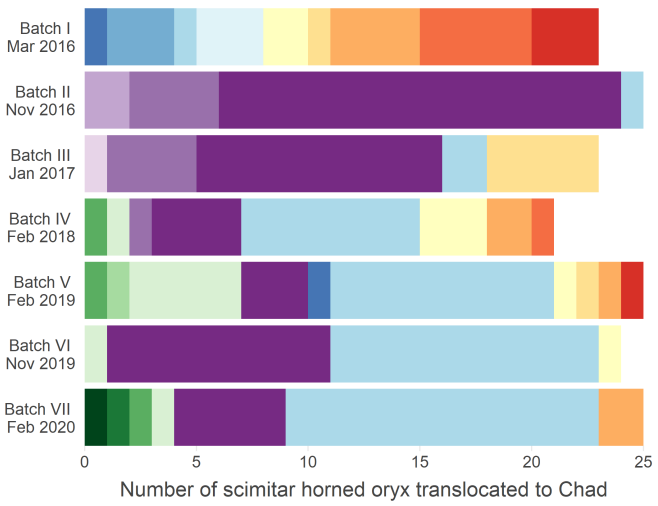


Figure 1. Mitochondrial DNA lineages carried by scimitar horned oryx that were translocated to Chad in Batches I – VII. Each colour indicates a different mitochondrial lineage. Note that SHO from Batch IV which died shortly after release are not included here, and the 11 surviving SHO have not yet been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

From a genome-wide perspective, the founders of the OROA 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 SHO 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 analysed). As additional founders are released, we no longer see a substantial increase in the total amount of genetic variation.

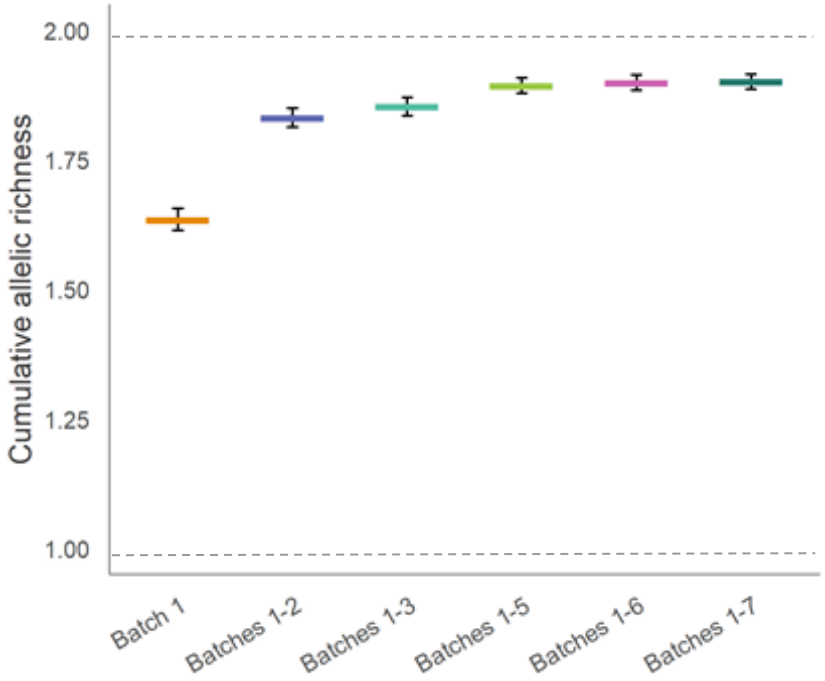


Figure 2. Cumulative allelic richness estimates over time for the scimitar-horned oryx population in Chad shown by coloured bars with 95% confidence intervals (black bars). Dashed horizontal lines show the minimum (1.00) and maximum (2.00) possible values for allelic richness

These genetic data indicate that the Chad SHO 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 maximise 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 OROA, Chad. Samples from all founder individuals are currently being analysed 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 maximise 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 OROA. Blood samples collected from these wild caught dama gazelles represent the first opportunity to analyse 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 SHO 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 THE ORYX

Marc Dethier
Project Leader
Sahara Conservation Fund

Mahamat Hassan Hatcha
Coordinator of the OROAGR
DCFAP

1. Human resources

1.1. The oryx project staff

Moussa Katirfache, who worked with us since the beginning of the project, sadly passed away on May 3, 2020, from cerebral malaria. He was the project manager's right-hand person and a very important support to the project from its beginnings. We will miss him, both as a colleague and as a person.

There are 16 people who are on staff, working to ensure the smooth operation of the project and the reintroduction of oryx in the Ouadi Rimé-Ouadi Achim Game Reserve (OROAGR).

Figure 1. The project's permanent staff in 2020: Marc Dethier (project leader), Moussa Katirfache (administrative officer, passed away in March 2020), Firmin Dingamtebeye (infrastructure maintenance officer), Krazidi Abeye (ecological monitoring leader, left the project in November 2020), Habib Ali Hamit (ecological monitoring officer), Honoré Todjibaye Midjigue (cook) , Kalle Dakou (oryx caretaker), Loutfallah Ali (oryx caretaker), François Madjitigal (tractor operator / driver), Ahmat Anour (driver) Dieudonné Kephas Doldiguim (cook), Khalid Rahama (assistant to the ecological monitoring leader), Nathalie (housekeeper),Dana (guard villa Ndjamena), Debi Ali (guard villa Ndjamena), Nanga Yanga (guard villa Ndjamena), Caleb Ngaba Waye Taroum (ecological monitoring leader), Evariste Djibkebeng (mechanic)

Krazidi Abeye left the project in November 2020 to attend graduate school and obtain a master's degree. He completed a three-month handover to mentor Caleb Ngaba, his replacement.

Four new people joined the project and are present at the oryx base:

- On May 1, 2020, Doldiguim Dieudonné Kephas joined the team as a cook. Kephas had previously provided support at the base camp when visitors were present.
- On May 25, 2020, Khalid Rahama Abderaman, holder of a bachelor's degree in Land Use Planning from the University of Science and Technology of Ati (USTA), was hired as an assistant for ecological and addax monitoring.

- On August 1, 2020, Caleb Ngaba Waye, holder of a Master II in Environmental Sanitation and Restoration, from the University of Yaoundé 1, joined the team as an ecological monitoring officer.
- On September 7, 2020, Evariste Djibkibeng Malve was hired on as a mechanic. Malve has several years of experience in the Geyser company.

In N'djamena, on July 1, 2020, four people were hired to guard and maintain the SCF villa/office. These new team members are guards Ali Debi, Takadji Nanga Yanga, and Dana Mahamat, and housekeeper Nathalie Kabria Aguidi, as housekeeper.

The staff is contracted and the contracts have been formalized by the Office national de promotion de l'emploi (National Employment Promotion Office) (ONAPE). The staff is registered with the national social security fund.

The staff at the oryx reintroduction site are provided with food and lodging. The base camp has electricity, running water, an internet connection, and television.

Permanent staff members (December 2020)		
Marc Dethier	Project leader	5 years and 3 months
Firmin Dingamtebeye	Infrastructure maintenance officer	3 years and 1 month
Caleb Ngaba Waye Taroum	Ecological monitoring leader	4 months
Khalid Rahama Abderaman	Ecological monitoring officer	11 months
Habib Ali Hamit	Ecological monitoring officer	4 years and 9 months
Honoré Todjibaye Midjigue	Cook	3 years and 11 months
Doldiguim Dieudonné Kephas	Cook	6 months
Kalle Dakou	Oryx caretaker	4 years and 10 months
Loutfallah Ali	Oryx caretaker	4 years and 10 months
Ahmat Anour	Driver	1 year and 11 months
François Madjitigal	Tractor and vehicle diver	1 year and 8 months
Evariste Djibkibeng Malbe	Mechanic	4 months
Nathalie Kabria Aguidi	Housekeeper / Villa SCF Ndjamena	4 months
Dana Mahamat	Guard SCF villa Ndjamena	5 months
Debi Ali	Guard SCF villa Ndjamena	6 months
Takadji Nanga Yanga	Guard SCF villa Ndjamena	6 months
Support staff		
Hiti Ngarya Nouba	Administrative and financial manager	1 year and 11 months
Hissein Gadeye	Permanent escort guard DCFAP	4 years
Ouchar	Logistics officer	1 year and 11 months
Mahamat Moussa Katirfache	Administrative assistant	6 months

Figure 2. List of project staff

1.2. Staff duties

Hiti Ngaryanouba, the administrative and financial manager of OROAGR helps us with all necessary tasks in N'djamena. She is in charge of accounting and tracking expenses and is in contact with the different national institutions. She also assists the team in logistical activities when necessary.

The person in charge of infrastructure maintenance ensures the proper functioning of the base camp. They carry out various small jobs: electricity, carpentry, welding, stock management, waste management, etc. They also ensure the staff's travel logistics, and they purchase food at the Biltine or Arada markets.

The animal caretakers leave at sunrise to the pen to water and feed the animals (oryx, addax, dama gazelles, and ostriches). They return around 7 am. During the day, they are also in charge of scaring away the many crows that are attracted by the water. These staff members also perform small tasks at the base camp, such as ensuring cleanliness.

Every day the ecological monitoring leader and the ecological monitoring officer go out into the field to observe oryx and addax behaviour. Generally, two field trips are scheduled per day. One in the morning for the groups that are further away and the other in the afternoon for the closer groups.

The two cooks prepare three staff meals daily: breakfast, lunch, and dinner. The presence of a second cook should facilitate the work of the ecological monitoring team by allowing them to stay in the field for several days without having to continually return to the base camp for food.
This should therefore aid in the observation and monitoring of animals (oryx and addax) that are far from the base camp.

The mechanic works out of the base camp. He has the necessary equipment (tools, lubricants, etc.) to maintain the vehicles. If vehicles need major repairs, they are sent to N'djamena.

The drivers are responsible for all transportation, whether between N'djamena and the base camp or for transport related to the project's logistics.

When OROAGR received two tractors, a tractor operator was hired to maintain and drive them.

Other activities in which all staff participate include the following:

- Extinguishing bushfires.
- Organising logistics for the transfer of oryx and addax from Abeche to the reintroduction site on March 3 and 6, 2020.
- Capturing sick oryx or addax for veterinary care.

1.3. System of rest

Because the staff reside a substantial distance from their homes, a mode of operation has been implemented to allow them to see their families on their days off. Therefore, as stipulated in the labour code, every Sunday that is worked can be taken off at a later date.

Usually, after four weeks on site, staff from Arada or Biltine take one week off, which excludes the two travel days.

The staff from N'Djamena leave the base camp after three months on the site. This allows them to spend three weeks at their home.

1.4. The guard of the Direction de la Conservation de la Faune et des Aires Protégées (Directorate of Wildlife Conservation and Protected Areas)

For any travel between N'djamena and the reintroduction site, guard Hissein Abderahim Gadaye—assigned to the project by the Ministry of Environment, Water and Fisheries (Memorandum N°004/PR/PM/MEP/SG/DPELCB/2017)—escorts the vehicles.

1.5. Temporary staff

In February 2020, the project welcomed two students (Belgian/Chad), Sophie Lox and Lamane Adoum Izzick, who arrived at OROAGR for an internship and were supervised by the SCF team (OROAGR and oryx). Both interns are supervised by Dr. Al-Hadj Hamid Zagalo, Secretary General of the University of Science and Technology of Ati and Professor Cédric Vermeulen of the Gembloux Agro-BioTech faculty of the University of Liege.

Several people came to support the project temporarily.

- Abdelrassoul Mahamat, tractor operator
- Yacoub Mahamat and Mamai SokoÏ, drivers
- Before Evariste was hired full-time by the project, two mechanics from N'djamena were temporarily hired: Hissein Abdoulaye and Ahmat Hit Ahmat.

In October, day labourers were recruited to create fire breaks. First three, then six-day labourers were hired to help fight bushfires. The season's abundance of rain favoured the growth of grasses. And the bush fires started very early in the reserve and were wide in scope.

Temporary staff hired as support (2020)		
Mahamat Abdourassoul	Tractor operator	3 months
Mahamat Sokoï	Driver	3 months
Hissein Abdoulaye	Mechanic	45 days
Ahmat Hit Ahmat	Mechanic	45 days
Yacoub Mahamat	Driver	15 days
Moussa Adoum	addax pen construction; fire break creation; fire fighting	28 days + 24 days
Issa Younous	addax pen construction; fire break creation; fire fighting	28 days+ 24 days
Souleyman	addax pen construction + logistical support Salal (dama)	28 days
Amdan Brahim	Creation of fire breaks; firefighting	24 days
Mahamat Zen	Creation of fire breaks; firefighting	24 days
Mahamat Moumine	Creation of fire breaks; firefighting	24 days
Ahmat Issa	Creation of fire breaks; firefighting	24 days

Figure 3. List of temporary staff

1.6. Arada and Ati

The guards maintain their position to ensure the security of the project's facilities.Their role is also to prohibit the passage of animals into the 3 km radius circle, which is formed by the circular fire break. The base camp is at the centre of this circle.

1.7. Training of the oryx project staff

Imet Training

From March 10 to 20, the monitoring team participated in IMET training given by Mr. Babakar Matar Breme in the Arada's OROAGR office.

Smart training

From May 25 to June 5, 2020, Krazidi Abeye and Eric Abba participated in the SMART initiation workshop organised by Oliver Fankem (ZSL Cameroon). This training was conducted online and at the offices at the oryx base camp.

Office automation training

In December 2020, OROAGR 's two-sector managers, the ecological monitoring assistant Habib Ali Hamit, and cook Honoré Dingamtebeye, received a 20-day training in Word and Excel from Ir Mahamat Ali Ahmat.

2. Infrastructure management and maintenance

2.1. Base camp management

Figure 4. Aerial view of the oryx project's base camp

2.1.1. Water management

Two flexible water tanks totalling 500 m3 were installed within the base camp. Their water is intended for humans as well as for the animals living in the pen. Breeding ostriches means that we must sow and grow alfalfa, which requires daily watering that consumes a lot of water.

In February 2020, two water trucks supplied the flexible tanks with 480 m3 of water, requiring 20 trips between Arada, the supply site, and the base camp.

There was an increase in water consumption due to the number of animals in the pen and the water requirements for the alfalfa production planted for the ostriches. Therefore, we added a second supply of water of 120 m3 in June 2020.

A third supply was added in November 2020. A tanker containing 24 m3 made 16 trips between Arada and the base camp to fill the water tanks.

Therefore, in 2020, the total water supply was 624 m3.

Monitoring the water consumption at the base camp indicates that, on average, an individual consumes 58 litres of water per day to cover all their needs (food, hygiene, laundry, etc.).

2.1.2. Electricity management

One of the operational objectives of the base camp is to use green energy for its electricity needs. The installation of the wind turbine and the solar panels allows us to permanently have electricity. This is ideal for day-to-day needs such as refrigeration, internet, computers, or fans to cool machines such as the modem.

We observed that the project uses a substantial amount of energy during the day and that we could benefit from a greater number of storage batteries. This way, electricity needs would be better met from 4 pm to 6 am, when the sun is absent.

2.1.3. Managing the internet connection

The Vsat is important for the smooth operation of the project. It allows us to locate the oryx that wear satellite collars. It is also the only means of communication with the outside world (although we have two satellite phones).

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

2.1.4 Vehicle management

Small vehicles

The oryx reintroduction project has the following vehicles at its disposal:

- Two Toyota double cab
- One Toyota simple cab
- One Kawasaki Mule
- One Toyota V8

Toyota double cab vehicle 18C4107TT arrived at the project in August 2015. It is currently being used by the ecological monitoring team. This vehicle travels +/- 40,000 km each year, mainly for oryx, and now addax, observation.

The single-cab pickup 18C4213TT, purchased in January 2016, is used at the base camp for logistics-related transportation. The vehicle travels to and from the base camp and Arada and the base camp and Biltine during staff rest days and to purchase food in these cities. This vehicle is used a lot during bush firefighting—for the creation of firewalls and to travel to the location of the fires. Depending on the year, it drives between 22,000 km and 31,000 km.

The Toyota double cab vehicle 18C4328TT was purchased in August 2016. This vehicle is used by the project leader and also provides most of the travel between Ndjamena and the base camp (1,100 km). In 2019, we increased air travel, with UNHAS flights and Tchadia, thus decreasing the frequency of trips to and from the base camp and Ndjamena. In December 2020, this vehicle had an accident. For the entire month of December, it was out of service in Abéché for repairs.

Vehicles Toyota	Acquisition	Mileage June 2017	Mileage June 2018	Mileage June 2019	Mileage December 2020
double cab 18C4107TT	August 2015	85,000 km	125,000 km	167,000 km	218,301 km
simple cab 18C4213TT	January 2016	40,000 km	62,000 km	93,000 km	128,223 km
double cab 18C4328TT	August 2016	55,000 km	115, 000 km	166,000 km	226,970 km

Figure 5. Vehicle mileage tracking table

The Kawasaki mule arrived from Abu Dhabi in January 2017. This vehicle is used by the oryx caregiving staff and only travels between the base camp and the oryx pen. At the end of June 2017, its meter indicated 2050 km; at the end of June 2018, 5300 km; at the end of June 2019, 8000 km; and at the end of December 2019, 10,106 km. This vehicle travelled 2950 km in one year, then 2700 km. It ceased operations during the year 2020. We are still looking for parts to repair the injection pump.

The Toyota land cruiser V8 vehicle was donated by the EDA in July 2017. Its meter currently indicates 25,000 km. It is parked in Ndjamena.

In addition to these vehicles, the Toyota double cab based in Ndjamena regularly supports the vehicles of the Sahara Conservation Fund.

All these vehicles are insured and in good working order.

In 2019, thanks to the intervention of the Minister of Environment, Water and Fisheries, the OROAGR was allocated two tractors and two disc ploughs. These machines help the reserve's managers fight bushfires. The oryx project maintains and operates these two tractors.

A tractor operator was hired to maintain and operate these machines. The operator has also trained the project staff to drive them.

We also use the OROAGR project's John Deere tractor.

Figure 6. Gifts from the government to the OROAGR

From the end of August 2020 (after the major rains) until the beginning of January 2021, these tractors will be used to create fire breaks. They will also be used to fight bush fires. Finally, they are used to level the tracks most frequented by vehicles

2.1.5 Food management

We primarily purchase food in Ndjamena. We purchase fresh products (vegetables and fruits) and meat (sheep, chicken) at the weekly markets in Arada (Thursday) and Biltine (Monday) or from nomads. This food is refrigerated in the refrigerators installed in the kitchen.

On average, seven people are present at the base camp.

2.2. The fire break network

Over the past three years, to protect the project facilities, the reintroduced animals, and their pasture, we have opened a network of fire breaks. Every year, we try to improve this protection system.

In 2020, the rains were abundant, and vegetation grew throughout the OROAGR, so that areas that were previously quite bare were covered with grass. This vegetation growth had consequences for the spread of fire: the fires advanced rapidly and spread easily.

While we began creating fire breaks in late August, unfortunately the earliness of the fires and their frequency beat us to the punch. Furthermore, the locations where we were creating fire breaks were burned before we acted. On November 15, 2020, we stopped creating fire breaks.

This year, two types of fire breaks were positioned:

- The circular fire break centred around the base camp and with a radius of 3 km.
- Fire breaks located on both sides of the smugglers' tracks (yellow line).

The Fire Break at 3 km from the Base Camp

This fire break is intended to protect the facilities of the base camp and the pre-release pen. In theory, it also provides a barrier between breeding animals and the outside world to limit the transmission of disease. But this barrier is not respected by the breeders.

Figure 7. The circular fire break focused on the project facilities.

Open firewalls along fraudster tracks

For these, we used the technique of preventive fires. This technique involves burning a wide strip of grass between two strips of land ploughed by a tractor. This technique, when well mastered, creates very wide fire breaks. A minimum of six people are needed to carry out this work.

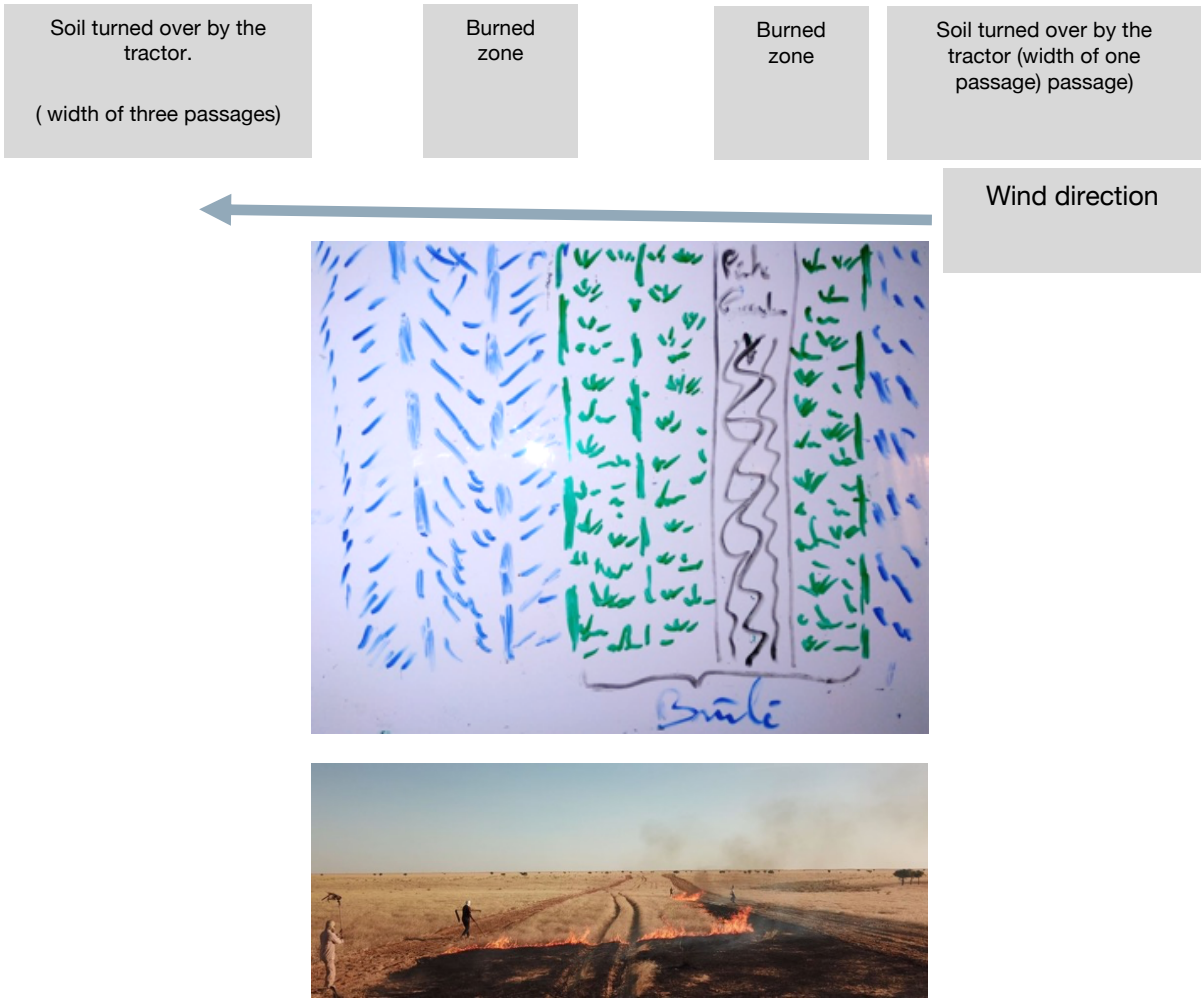


Figure 8. Fire break along a fraudster track

2.3. Development of a runway

OROAGR is increasingly feeling the necessity of having an airplane for the smooth management of the project.

The very good relationship with African Parks has led us to set up an airstrip located in a low-lying area 8 km from the oryx base.

The APN plane has landed (and taken off) several times on this runway.

Figure 9. Ndjamena-Fada route of the APN aircraft with a stop at the oryx base

The plane that transports the ostriches from Zakouma to OROAGR and to the RNCE lands arrives and departs on this runway.

2.5. Offices

The Sahara Conservation Fund has rented a building with African Parks Network in N'djamena since March 2017. The project therefore has an office, a storage room, and easy internet access.

Our conversations with APN colleagues as well as with the MEEP members present in this building have been enriching. The rental of this office was suspended in December 2019.

The project continues to rent the SCF villa, which serves as both an office and a transit hut.
The stopover hut in Arada is always rented out, even if it is infrequently used.

2.6. Oryx in the pen

In January 2020, a single male oryx with a collar occupied the pen. This animal was limping when the animals were released in December 2019. He remained alone in the northern part of the pen.

On March 3, 2020, 25 oryx arrived from Abu Dhabi, including 18 females and seven males. Some of the females were pregnant and gave birth inside the pen. Four young oryx were born. Unfortunately, one of them died quite quickly.

To install the oryx collars, a joint mission between EAD and the Smithsonian Conservation Biology Institute teams was planned for July and August 2020. However, the COVID-19 pandemic prevented the experts from travelling.

It was agreed during a Zoom conference in early September 2020 to release the animals without wearing radio collars.

We opened the gates of the pen on September 22 to release the 29 oryx (15 days after the addax).

- On September 22, 2020, 10 oryx exited at 12 pm. At 4 pm, we closed the gate.
- On September 23, 2020, at 9 am, the 18 other oryx exited the pen.
- On September 24, 2020, at 7 am, the "isolated" male exited the pen, without a collar because it had fallen off inside the pen.

On September 25, 2020, there were no more oryx inside the pen.

3. The addax in the pen

3.1 The addax in the first group

The first 15 addax (11 females and four males) arrived on November 13, 2019, in Chad. They were kept in the pre-release pens until January 16, 2020.

Originally, the addax area was in northern OROAGR. Having patrolled OROAGR, the expert team found an area 40 km from the pens with vegetation typical of good addax habitat. In mid-January, a temporary pen was constructed at this location to hold 15 addaxes for two days before releasing them into OROAGR. These operations took place from 15 to 17 January 2020.

Figure 10. Group of 15 addax in the temporary pen located 40 km from the base camp

3.2. The addax in the second group

A second group of addax arrived in Chad on March 6, 2020, comprising 25 addax that were transported to the 20 ha pre-release pen.

Two addax were injured during their stay in the pen.

The first addax, a female, lost one of her horns, probably as a result of a fight.

The second addax, also a female, injured her left hind leg. The reason behind this injury is unknown. The addax limped heavily. We did not intervene because when we approached her, she walked and accelerated showing signs of vitality. She recovered after several days, and when she was released, she followed the group.

At the beginning of the rainy season, to prevent the addax from being continually disturbed by biting insects, we installed insecticide-impregnated cloth strips at the entrance door to the capture area. This was the only door that allowed the addax to get to the feeders and watering hole. As the addax passed through this door, their bodies touched the insecticide strips, coating them with the product.

Figure 11. Addax moving through the insecticide strips

The 25 addax (17 ... r 7, 2020.
There are no more addax in the pen.

3.3. The dama gazelles in the pen

In mid-January, the oryx project team moved the mobile elements to construct a temporary pen in Manga (Salal town) to house any captured dama gazelles. Men from the town of Biltine were hired as labourers, and a dump truck was rented in that town. After loading the necessary equipment, the truck left the oryx base for the eight-hour drive through the OROAGR between the oryx base and Salal.

The Tropicair Kenya helicopter that arrived in Chad for the tourist operator SVS was available for rent, when not in use for tourist travel.

A window of availability was open from January 22 to early February 2020. During this time, the helicopter was used first to capture the dama gazelles and then to collar bighorn sheep and dorcas gazelles in the RNCE.

On January 26, 2020, three dama gazelles captured in the Manga travelled by air. Two by helicopter and one by plane (MAF), also rented for the operation.

These three female damas were placed in the capture area of the addax pen on the north side. Beforehand, this area had been equipped with an opaque tarpaulin attached to the fence around its perimeter. Two feeders containing hay from Abu Dhabi and two small troughs were placed.

On January 27, 2020, one male dama gazelle was captured in the OROAGR and locked in the small pen with the females.

In addition to the hay in the feeders, the gazelles were fed daily with wild foods: acacia branches, balanite branches, Indigofora colutea, and coloquint leaves and coloquint fruits. They preferred this vegetation.

Three camera traps were placed to ensure that the gazelles sufficiently ate and drank.

On February 3, 2020, one week after his capture, the male jumped the fence (2.4 m high), arriving at the large pen. He limped the first few days, but the pain quickly subsided.

One month later, the doors separating the capture area from the large pen were opened and on the night of March 8–9, 2020, the three females went through the door, joining the male.

The gazelles were very discreet in the pen. We could see them grazing from a distance. At the end of March, we drove into the pen and observed the gazelles at the edge of the balanite grove.

On April 8, 2020, we entered the pen by car and found the youngest female dead in the grove. This foray into the pen also showed us that all the gazelles were thin.

One of them was captured in an advanced state of weakness. She was put in the capture area and veterinary care was provided to her. But on April 11, 2020, she also died.

On April 11, 2020, we only had one female dama captured in the Manga and one male captured in the OROAGR.

We set up a system to better control the gazelles. We created four feeding and watering stations, and we can now regularly observe the gazelles either grazing or resting. We installed camera

traps. We were able to follow the evolution of these two gazelles by driving into the pen in the morning and evening. After the first week, we limited the water supply to the period between sunset and sunrise. During the day, the watering hole attracted the many crows present in the area.

Each morning we brought in branches of leptadenia and coloquint, which allowed the gazelles to eat hydrated food during the day.

In the evening we brought large branches of balanites and acacia when these were still leafy. The acacias lose their leaves at the end of the dry season.

We added alfalfa pellets (a white bag because the gazelles were not eating the pellets from the brown bag), a few handfuls of dry alfalfa and hay. A licking stone was also placed in one of the feeding areas.

The two gazelles quickly gained weight. And they even reproduced inside the enclosure.

On August 24, the female gave birth to a young female. She was four months old at the end of December 2020.

In order not to continuously enter the pen with the car, each day we moved the feeder and the water basin from the balanite grove to the capture area by 4 to 5 metres. Since October 17, 2020, the three gazelles (two females and one male) come to eat and drink in the capture area.

The decision chart for the fate of the dama gazelles in the pen.

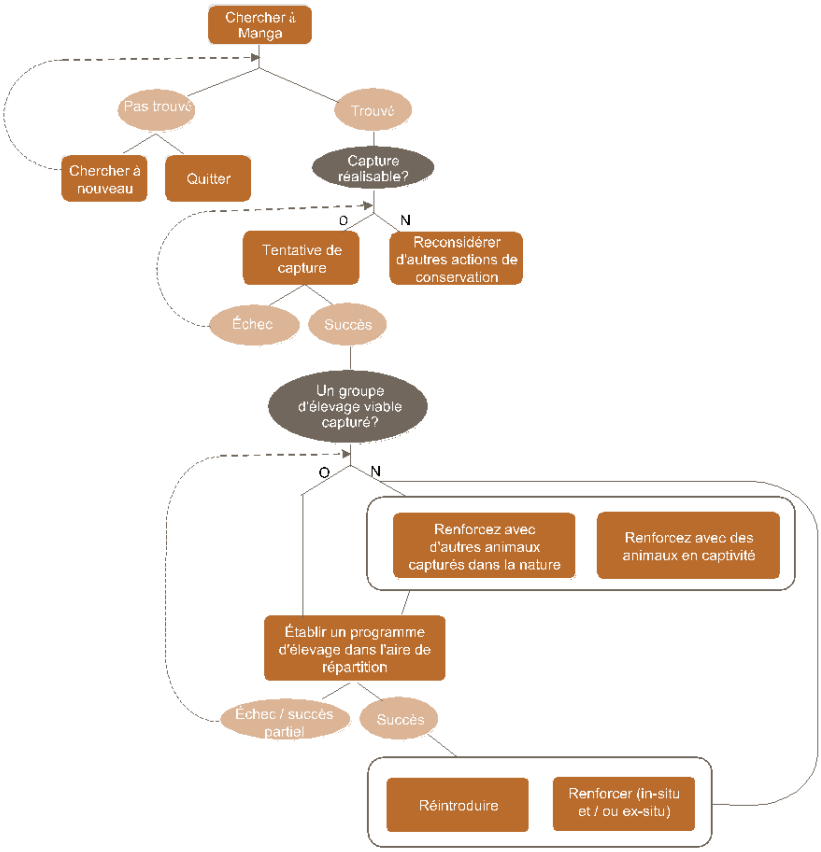


Figure 13. Arbre de décision lié à la capture potentielle de toute gazelle dama restante de la région de Manga.

4. The ostriches in the pen

The ostrich reintroduction activity is conducted in partnership with APN/RNCE. We share the logistics, expertise, and lessons learned from breeding the ostriches.

Thirty-four ostriches aged about 15 days were captured five times in Zakouma NP and transferred by the RNCE plane to OROAGR on the following dates

- eight ostriches 20.02.20
- four ostriches 26.02.20
- four ostriches 9.03.20

- two + 16 ostriches 11.03.20

After a brief stay in the oryx project pens, varying from one night to three nights due to weather conditions stabilizing the aircraft on the ground, half of the ostriches were sent to the RNCE's Sougounow ("ostrich" in the Goran language) farm.

One of the ostriches that arrived on February 20, 2020, exhibited signs of neurological problems. It died on February 23, 2020.

The ostriches that arrived on February 26, 2020, and March 9, 2020, showed no physical abnormalities.

The 18 ostriches moved on March 11, 2020, were from two different families. The Zakouma team had captured two ostriches that were locked in a cage. It was while picking up these two birds that, upon landing, the Zakouma team reported the presence of other ostriches not far from their base. We then captured the 16 other ostriches.

There was a difference in size between ostriches from each group. The two larger ostriches were placed in a cardboard box to separate them from the other 16 that occupied the entire back of the plane. Unfortunately, one of the two ostriches of the first family died during the flight from Zakouma to OROAGR. After landing, we discovered that it had a broken neck. We assume that the other ostrich stepped on its neck during the flight. The second ostrich died shortly afterwards in the pen.

In total, 17 ostriches were sent to Sougounow and 14 remained in OROAGR .

Vaccination and Veterinary Follow-Up

As soon as they arrived, the ostriches were vaccinated against clostrodium (Covexion) and Newcastle disease (Etanew). They were all vaccinated twice with Covexion with a 10-day period between each vaccine. Then they were vaccinated against Newcastle disease.

The ostriches were treated with Zentel because some of them had taenia. This was the cause of death for two ostriches, which had become infected in the RNCE.

The Ring Fitting

The ostriches received a numbered ring which was implanted on their wing. This allowed us to match the feather samples taken during the DNA analysis with each ostrich. However, these rings proved to be unsuitable in the long run because with the growth of the ostrich, the ring entered the flesh of the wing, and we had to remove them.

The Follow-Up of the Ostriches During the First Three Months

Of the 14 ostriches, one died of disease despite the veterinary care provided. For this case, we were remotely advised by the veterinarian Dr. Willem Burger. The autopsy pictures that were sent to him did not reveal anything special, except the abundance of citrullus in the stomach.
Two other ostriches had injured a leg. One of them came out of a watering hole where it used to bathe; the other one was discovered one morning with a badly positioned leg, probably after having been struck or pushed by the other ostriches.

There are now 11 ostriches in the project's pens.

DNA Analysis

A few feathers were taken from each ostrich and sent to Unistel Medical Laboratories in Tygervalley (South Africa) for analysis and sexing.

At the beginning of April 2020, we received the results:

- From the 1st batch that arrived on February 20, 2020, we kept one female and one male.
- From the 2nd and 3rd group, we have two females and two males.
- From the March 11 group, four females and three males remained in OROAGR. We believe that a male and a female from this group have leg problems. There are three females and two males left from this group.

There are currently six females and fice males in the pen.

Ostrich Feeding

Dr. Fanus Cilliers, a scientific nutritionist (Camelus Grondstowwe cc), in contact with RNCE/APN, calculated the food rations for ostriches ages 15 days to 10 months. Dr. Gillers based his calculations on information provided about the availability of various ingredients in Chad.

DÉMARRAGE 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 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 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	

Figure 12. Nutritional monitoring table for baby ostriches

Some of the feed (methionine, lysine, diphosphate) was purchased in Farcha from the ALTA_AOUN animal nutrition complex cooperative, which supplies feed to chicken farmers in Chad. The rest was purchased from traders in Abeche. Back from the training trip to Ousdthoorn, we brought the Camelus starter premix.

Getting Used to the Presence of Oryx and Increasing the Available Space

Given the growth of the ostriches and the space available, the ostriches were placed in the capture area. In the event of sharing the large pen with the oryx, several specialists (EAD, San Diego Zoo, Disney Zoo, St. Louis Zoo, Fossil Rime Center, Smithsonian, and Marwell Wildlife) advised us on how to strategically place the two species together so that they would gradually accept one another. This advice concerned the position of the feeders and the drinking troughs in each pen as well as the size of the ostriches when they entered the pen with the oryx.

The ostriches were still too young and too small to share the same pen with the oryx, but too large to remain in the space reserved for them. On May 16, 2020, we built a small corridor that gave them access to the long corridor that separates the north and south capture areas.

Figure 13. Accustomisation of oryx and ostriches

In June 2020, under our supervision, we let the oryx living in the pen to drink in the capture area occupied by the ostriches. On June 14, 2020, at the age of four months, the ostriches were placed in the pen in which a male was located.

Figure 14. Oryx, ostriches, and tortoise

At the end of December 2020, the 11 ostriches are still in the pen.

5. Tortoises

On March 4, 2020, we visited the pen where six tortoises live. The Barkhane force in Abéché were taking care of them.

These six tortoises joined the tortoise that was already in the pen.

Figure 15. Release of tortoises into the pen

6. The oryx and addax population in Chad in December 2020

At the end of December, there were 348 oryx and 50 addax in Chad.

All of these animals are free-ranging in the OROAGR.

7. The threat to grazing

The greatest threat to the success of the project, which aims to reintroduce a viable population of 500 oryx and, in the future, addax and ostriches, is their potential lack of grazing vegetation. The two factors that cause significant loss of grazing are bushfires and overgrazing by domestic animals.

7.1. The problem of bushfires

Bush fires are a recurring threat that local administrations and departments have struggled to manage. These fires are responsible for the loss of considerable areas of grazing land, both for wildlife and for livestock. They destroy perennial plants, microfauna, and nests of ground-nesting birds, such as bustards, for example, and thus impoverish OROAGR's plant biodiversity.

The fires are almost exclusively due to the carelessness (cigarette butts, fire pits that are not properly extinguished, etc.) of fraudsters, who are gold seekers or traders dealing between the north (Libya, Sudan, etc.) and the Chadian cities further south. To avoid road controls on the national roads, they cross the bush, including the reserve, from north to south and from south to north.

The project has put in place a strategy to combat bush fires. This strategy needs to be built upon and improved.

Prevention strategy

- Awareness-raising messages to nomads.

- The creation of a network of preventive fire breaks 40 km to 60 km long, spaced about 10 km apart and oriented perpendicular to the direction of the prevailing winds.
- The installation of firewalls to block the tracks of fraudsters

At the intervention level

- The use of harrows towed by pickup trucks to create a fire break located a few metres from the fire line. In this way, fires can be more easily extinguished or, at least, its intensity reduced.
- The use of tractors and disc ploughs. These machines, driving next to the fire line, throw sand while executing a proximity firewall. This process is very effective
- The use of professional equipment, such as fire bats made of fireproof material.

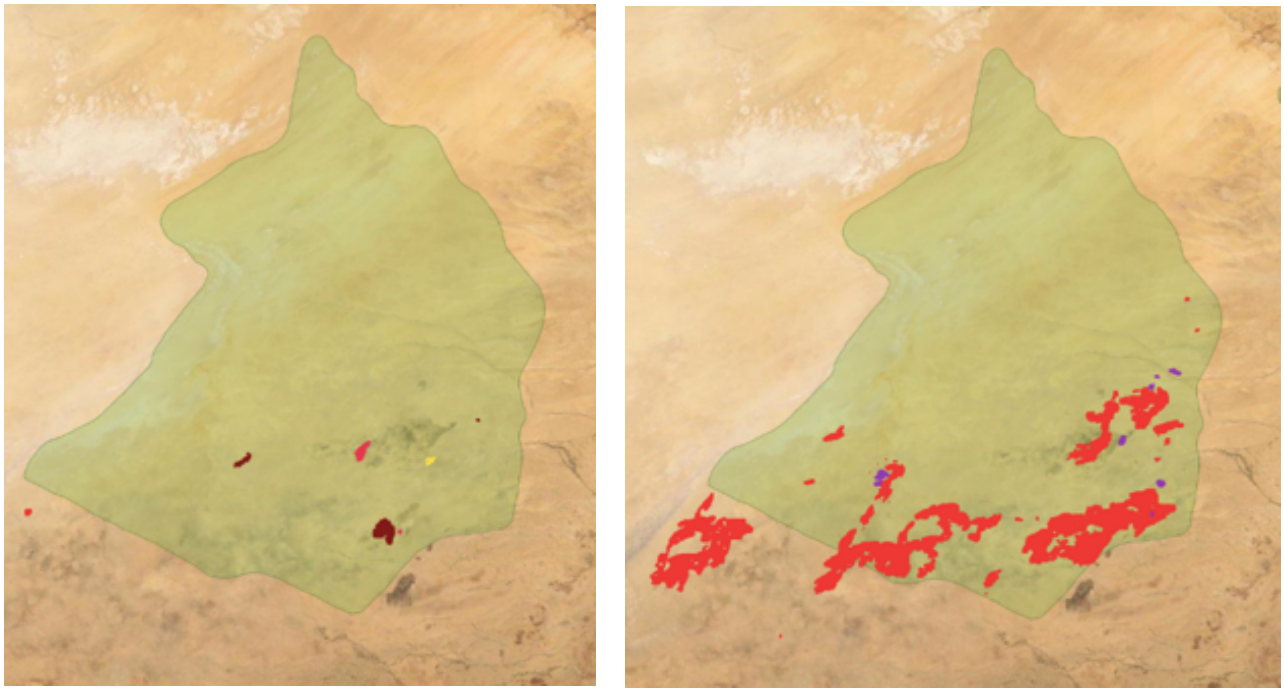


Figure 17. Bush fires from January to May 2020

The map of burned areas was compiled based on information provided by NASA Firm. It shows the bush fires at the beginning of the year (orange area), and those after the rainy season (red).

7.2 Overgrazing

In five years, we have seen new ways of exploiting grassy areas that were previously partially grazed. These areas, far from water points, were almost inaccessible to OROAGR's animals, leaving large feeding areas for wildlife.

Recently, owners of large livestock have been providing water for their herds by installing water tanks or tarps. These are supplied by tanker trucks that travel several dozen kilometres to ensure the supply. In this way, cattle that must regularly drink (bovine, ovine, caprine) can remain for a long time in these grazing areas.

Figure 18. Tarpaulin and water tank for watering domestic livestock

The presence of these permanent camps disturbs the environment and the tranquility of the wildlife.

It is common to see dorcas gazelles near herds of domestic animals and to therefore assume that dorcas gazelles tolerate the presence of these animals. However, an analysis of inventory data from a large area indicates that the dorcas gazelles are much more numerous in areas in which the livestock are absent.

The increase in domestic livestock and the duration of their stay in OROAGR is becoming a major health problem. Many diseases are transmitted from these animals to wild animals. This becomes a serious risk factor for the success of the reintroduction project (see other section of this report).

8. Event management or participation

January 2020 Team EAD, USA, EU
Collaring of oryx and addax.
Capture of dama gazelles in Salal.

Visit of a World Bank delegation (January 2020)
During an identification mission for the PDLA project (flora and ecosystems), Dr. Souleymane Adam and Ing. Brahim Oumar, briefly stayed at the oryx base.

Visit of the S.G of the University of Science and Technology of Ati (February 2020)
Reception of Dr. Al-Hadj Hamid Zagalo, Secretary General of the University of Science and Technology of Ati, who visited the SCF team (OROAGR and oryx);

9th arrival of a group of 25 oryx and 2nd arrival of a group of 25 addax. (March 2020)
9th arrival of a group of 25 oryx from Abu Dhabi (3 March 2020). The previous arrivals were in March 2016 (25), November 2016 (25), January 2017 (25), February 2018 (75), February 2019 (25), and November 2019 (25).
A total number of 225 oryx were imported from Abu Dhabi.

A second group of addax arrived in Chad on March 6, 2020. 25 individuals were transported to the pre-release pen.

Visit of the Head of Section of the Delegation of the European Union (April 2020)
Mr. Didier CARTON, Head of Section - Rural Development and Food Security visited us at the D. He accompanied Pierre-Armand Roulet (APN).

Transport of ostriches from the RNCE (July 2020)
A SCF team supported the APN/RNC for the translocation of ostriches between Fada and Aloba (146 km). Twelve ostriches were transported during two trips on the night of July 1–2 and the night of July 3–4, 2020.

Ostrich and pen visit by the Marshal of Chad (August 2020)
On August 23, the project leader went to Fada and then, at the request of the presidency, accompanied the APN/RNCE team to Am Djarass to identify the ostriches belonging to the Marshal of Chad. They met with the Director of the Office of the Presidency to debrief on the observation of the ostriches and the pen. Return to the oryx base camp on August 30.

Zoom conference call on the management of animals in the pen (September 2020)
On September 7, 2020, a call between Abu Dhabi Environment Agency, Fossil Rim Wildlife Center, Sahara Conservation Fund, and Smithsonian Conservation Biology Institute (update on field conditions (animals, rain, etc.), infrastructure needs and their development at Oryx Chad, human resources, and material needs.

Wings for Conservation air support (September 2020)
From September 28 to October 1, Jaime Dias of Wings for Conservation flew four times to observe the oryx and addax that were far from the base camp and had not been seen for several weeks by the monitoring team.

Visit of a delegation from APN (December 2020)
On December 2 and 3, we received a visit from an APN team (Angela Gaylars and Charles Wells, accompanied by Pierre-Armand Roulet) who were passing between Fada and Ndjamena. We discussed the ostrich study to be conducted in Zakouma NP.

9. Bushfire management

The fires usually start towards late September and sometimes keep going until as late as March, if there is biomass available. But the peak is usually recorded from September to November. From September 17 to November 6, 2020, twenty-seven active hotspots were identified in the Reserve thanks to the alerts the crews receive from NASA FIRMS (Fire Information for Resource Management System). In addition, three cases of bushfires that went undetected by NASA FIRMS were also located. NASA FIRMS is unable to detect fires when there is too much cloud cover, or if the fire is too small to generate sufficient heat to trigger the satellite to send an alert.

9.1. Bushfire causes

Bushfires are usually started by human activity, but rare cases of fires started by lightning strikes have been recorded in RFOROA:

- When gasoline-powered vehicles' hot exhaust pipes come into contact with dry grasses, the grass is automatically set on fire. In several cases, the car has been burnt to a husk,

although in some lucky cases, the occupants managed to put out the car fire and get away, leaving the fire to spread in all directions.

Figure 19. Fraudsters' burned vehicles

These vehicles belong to unregulated gold miners – known locally as fraudsters – who travel from northern Chad to Batha, Ouadai and Wadi-fira provinces. Wanting to avoid main roads because of roadblocks, they cut through the reserve instead.
They have created several known trails through the reserve, but the phenomenon is on the rise.
This past year, certain brands of vehicles (like Colora and Honda) that didn't used to get through, were spotted coming from the north on those trails. Those vehicles started even more fires, because, being lower to the ground, they are more likely to make contact with grass.

Figure 20. Fraudsters' vehicles stopped by the guards

- Herders don't always put their cooking fires out completely when they pass through or camp in grassy areas. It can only take a moment's inattention for a cooking fire to spread out of control. Children sent to fetch burning firewood from neighbors are another cause, because when burning twigs fall, they can start fires too.

- Lightning strikes can also start fires late in the rainy season, but those cases are rare. Lightning started a brushfire on September 29, 2020, but luckily, the rain that followed the lightning put the fire out.

9.2. Tools for fighting bushfires

- Branches from thorny trees, especially acacias, as well as fire beaters, are used as tools to fight fires. Larger branches can also be dragged by vehicles to create firebreaks. Still, the height of the grass and the speed of the wind make it very difficult to put fires out with those tools.
- Tractors are efficient for fighting fire; three tractors from the reserve were used by the Oryx Project against fires in the oryx zone.

Figure 21. Guards putting out a fire with fire beaters

To prevent and put out fires, a general mobilization on the part of local administrations, traditional chiefdoms, and decentralized rural development services is necessary. Currently, bushfires are seen as solely the Water and Forest Officers' problem, even though pastureland benefits everyone. Article N° 59 of Law N°14/PR/2008, stipulates that "populations living on the periphery of the forests are obliged to collaborate in forest-fire-fighting operations."

Approximately 27 cases of bushfires were identified; guards from the reserve and staff from the Oryx Project intervened to put out approximately 19 of them. It took four days and four nights to conquer the largest of the fires.

Nine bushfires were started by fraudsters' vehicles; 3 vehicles were found entirely burnt, and 13 fraudsters were arrested and handed over to the authorities in Arada. An observation: most of the fires in the Batha section are caused by herders, while in the Wadi-Fira section, most fires are started by vehicles.

10. Preventing poaching and monitoring the reserve

Not a single case of poaching of reintroduced species was recorded in 2020. But there were several recorded cases of dorcas gazelles being poached during a gap in surveillance at the Reserve, when the guards had to go to N'djamena for their physicals.

On April 19, 2020, two poachers killed 7 dorcas gazelles in the Ouadi Rimé-Ouadi Achim Faunal Reserve. Caught in the act by a surveillance mission, the criminals wounded the Reserve Coordinator in the shins. They were arrested and handed over to the Prefect of Albiher and the Governor de Wadi-Fira respectively, along with the evidence, which included 7 gazelles, an AKM (N°5486) assault rifle, and a motorcycle.

Figure 22. The poachers arrested with the gazelles

At the hearing on June 25, 2020, the Court dismissed the case against Mr. Moussa Mahamat, and sentenced Youssouf Souleymane to five years in prison. On June 27, just 48 hours after the verdict, the convicted man escaped from the cell where he had been held in chains. He has not been spotted since. As regards other illegal activities, the reserve's guards managed to prevent two wells from being drilled in the northern and eastern parts of the reserve respectively. All together, 24 guards monitor the reserve using two TOYOTA vehicles that were acquired in 2016 as part of the Oryx Project.

11. Project staff's safety

An outpost of four guards has been set up on the road to the oryx project base camp. Its role is to ensure the safety of project's staff and infrastructure, and to escort any project vehicle in and out of the reserve.

The Northern section vehicle was mobilized, along with several guards, to escort the environmental-impact vehicle when it was traveling through the northern section of the Reserve, since a few oryx remained in the northwestern section of the Reserve.

12. Issuance of documents

In accordance with the oryx project agreement, several documents pertaining to the project were issued during the past year, namely:
- Invitation letters

- CITES import permits
- Authorisation of aircraft overflight and landing
- Authorisation to use drones
- Authorisation to export samples of ticks and flies

13. Other activities

Over the past year, fauna management staff and reserve administrators participated in several activities, including reintroducing addax and oryx; locating, capturing and trans-locating dama gazelles from manga to the Reserve. They also participate actively in choosing guards to staff the reserve within the framework of the PORQA.

Figure 23: Meeting with the DCFAP to raise awareness and select reserve guards

Part III.

1. Introduction

The Phase 2 plans to use routine ground sample surveys , coordinated with a least one aerial survey, as the prime means of assessing oryx population size was prevented because of international travel restrictions during 2020-21. For the same reason the planned reduction in intensity of satellite tracking was accelerated, when it became necessary to release 25 oryx and 25 addax marked only by ear tags, because support teams were unable to travel to Chad to fit collars to animals in pre-release. Security and staffing considerations in 2021 also meant that field work has been less intensive than previously. Despite this, the ground monitoring team has continued to generate valuable information on post-release progress of both species. Very encouraging results on wild born calf survival have been obtained, and a remarkable long-term record of known individuals is reaching the stage when interesting comparisons between release groups and species can be made. This report summarises the information collected on births and survival of scimitar-horned oryx and addax, provides a brief review of the dama gazelle records and summarises other outputs of the monitoring team during the period 2020-June 2021.

Staff changes

A complete change of ground monitoring personnel took place in 2020-21. Krazidi Abeye conducted a 4-week handover in October 2020 before leaving the project to pursue further study opportunities. Krazidi made an excellent contribution and his work is greatly appreciated. More recently Mr. Habib Ali also departed after providing solid support to the team from the outset. They have been replaced by Messrs. Caleb Ngaba and Khalid Rahama, who joined in September 2020 and recently the team has been enlarged with the addition of Mr. Abdelkerim Toboye.

2. Oryx

Satellite collars: The major change in oryx monitoring has been the anticipated, though in the event, accelerated, reduction in proportion of functional satellite collars on individual oryx. On 1st January 2020, 64 animals were being tracked with the help of satellite collar locations. By 30th June 2020 this dropped to 39 collars, and then to 12 collared individuals by 30th June 2021. This has inevitably reduced search efficiency and information on general oryx dispersion. As a result, although useful and accurate until mid-2019, it is now no longer reasonable to assess population size based on balance of sightings, births and deaths. The fact that the project has reached this stage and sample-based estimates are now the most practical way to follow progress, is an important indication of positive progress.

Oryx Calf detections: A total of 94 oryx births were recorded in 2020, with an additional 31 in the first six months of 2021, spread across all months, Fig.1. This brings the total births detected to 275 since the first in September 2016. Thirty-six of the 275 are known to have died (includes records of peri-natal mortalities). These raw data take no account of undetected births and deaths that must also be happening. But see section on calf tagging program below for summary of very positive results on calf survival.

Oryx Mortalities: A total of 25 oryx deaths have been recorded by the monitoring team between 1st Jan. 2020 and 30th June 2021, Fig. 1. Four of these involved new-born calves with jackal presence noted (but role not established) in two cases. A 7-month calf (therefore potentially independent) was found dead close to its dead mother, B01F (considered dead 4 days with signs of profuse bleeding from the nose), after both had moved to an untypical location 90km from base camp.

Adult female mortality: Among the 20 adults found dead 17 were adult females, all from the release groups 5 & 6, (released in September and December 2019 respectively) and all less than 8 years of age at death, indicating premature deaths.

Among 52 founder females of Groups 1-4 known to be alive in January 2020 all except one, B36F, were confirmed still alive at the end of the year (with circumstantial evidence obtained in June 2021 suggesting possibility that B36F may also be still alive).

Causes of death in adult females during 2020-21 were not definitively established; association with possible birth events was suspected in three cases; bleeding from the nose or anus was noted twice; including B01F who was also one of three found at ranges of 74 – 90km from base camp having moved to 'untypical' locations. Presence of plastic in the alimentary track was noted once; cases of failure to thrive post-release, deteriorating to very poor body condition despite additional food and water support were specifically noted four times.

Adult male mortality: Two adult males from Group 4 found dead in February (R01M) and June 2020 (R85M) were both in good body condition, with strong indications of involvement in a recent fight in the first case and circumstantial indications of recent fighting reported in the second. Cause of death at the estimated age of c. 9 years in Group 3 adult male R08M is unknown. The carcass was reported desiccated and quite old when found in March 2021, eight months after last observation alive in July 2020.
The pattern of detected mortalities in 2020 points primarily to difficulties encountered but the newly released females of Groups 5 & 6, particularly in the 2020 dry season.

Calf tagging program : In 2017 14 oryx calves born in pre-release pens were ear tagged before release with their dams at 1-4 months of age in August 2017. All of them were confirmed alive at three years of age by resighting at or after August 2020 and all seven females in this cohort have produced at least one calf.
A further 6 oryx born in pre-release and released in August 2018 were all confirmed alive at two years of age by re-sightings at or after August 2020.

In order to follow natural recruitment in the newly established wild oryx population, a program to catch and ear tag wild-born oryx calves by hand as opportunity allowed was introduced following preliminary training in September 2019. By June 2021, 55 wild-born oryx calves have been caught, ear-tagged and released. An elapsed time of 12 months since tagging is available for the first 30. The resighting histories of these 30 shows that one year survivorship in this cohort must lie between 87%-97%, Fig. 1.

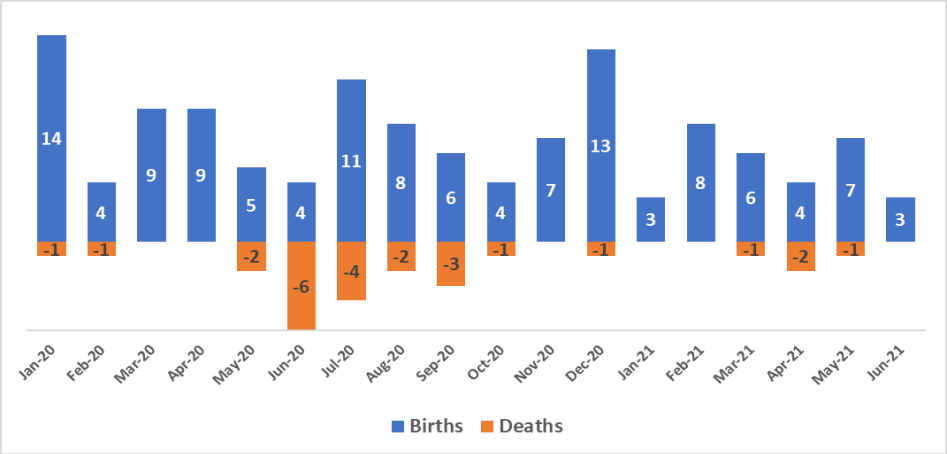


Figure 1. Summary of all detected oryx births (125) and oryx deaths (25) by month, Jan-2020 to Jun 2021. Note raw data only; takes no account of undetected births and deaths, nor of reducing efficiency of survey coverage caused by reduction in satellite collars and increase in proportion of unrecognised individuals over time. Ouadi Rimé-Ouadi Achim Game Reserve

Oryx calf Identity	Sex	2019				2020												2021					
		S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
G1371F_R06-03	F	B	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	0	0	0
G1372F_B09-04	F		B	1	1	0	1	1	1	1	1	1	1	0	1	1	0	0	0	0	1	0	0
G1373F_R47-02	F		B	1	1	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	1	0	0
G1374M_B73-02	M		B	1	1	1	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0
G1375M_R51-03	M		B	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
G1377M_R89-02	M			B	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1
G1376M_B57B10-04	M		B	1	1	0	1	1	1	1	1	1	0	0	1	0	1	1	1	1	1	0	0
G1378M_B13-04	M			B	1	0	1	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1
G1341M_R49-02	M			B	1	0	1	1	1	1	0	1	0	1	0	0	1	1	1	0	0	0	1
G1342F_R88-02	F			B	1	0	1	1	1	0	1	0	1	0	1	1	0	0	0	1	0	0	0
G1343M_R71-01	M				B	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1
G1344F_R76-02	F				B	D																	
G1345M_B05-01	M				B	0	1	1	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0
G1346F_B74-01	F				B	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0
G1347M_Y005-01	M					B	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0
G1348F_G1323-01	F					B	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0
G1349M_R15-04	M					B	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0
G1350M_R11-01	M					B	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	1	0
G1351M_B84-02	M					B	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1
G1352M_B55-01	M					B	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G1353F_B20-04	F					B	1	1	1	1	0	1	1	0	0	0	0	0	0	1	0	1	1
G1354F_B83-01	F						B	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
G1355M_R36-03	M						B	1	0	1	0	1	1	0	1	1	1	1	1	1	0	0	1
G1356_B46-03	M							B	0	1	1	0	1	0	1	1	1	0	0	0	0	1	1
G1357_F99-01	F							B	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1
G1358M_B56-03	M							B	1	1	0	0	1	0	1	1	0	0	0	0	1	0	0
G1359?_B07-04	?								B	1	1	1	1	0	0	1	0	0	0	0	1	0	1
G1360F_R20-03	F								B	1	1	1	1	0	0	1	1	0	0	1	1	0	0
G1361M_R03-03	M										B	0	1	1	1	1	1	1	1	1	0	1	1
G1362_R47-03M	M										B	1	1	1	0	1	0	0	0	0	0	1	1

Legend					
	B	Birth month	1	Observed alive
	D	Found dead	0	No record

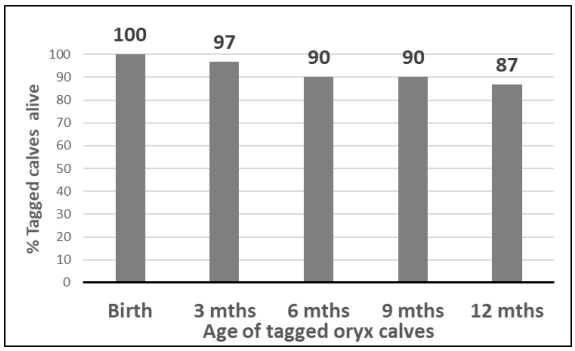


Figure 2. Monthly re-sighting histories of the first 30 oryx calves caught by hand and tagged (left) and minimum survivorship at 3-monthly intervals to one year of age (right), based on raw re-sighting data only, (no modeling of detectability). Ouadi Rimé-Ouadi Achim Game Reserve

3. Addax

Addax Group 1

After a four-month acclimatisation at base camp the first 15 addax (4.11) were moved 36 km north-west to a temporary boma for release in February 2020. All were fitted with satellite/VHF collars.

By the end of January 2021, 12 months after release, thirteen (4.9) of this group were confirmed alive.

Two females died in the first year. On 4th April AB15F was found 57km WNW of base camp with heavy discharge of blood from nose and anus. On veterinary advice the carcass was burnt *in situ*.

The second mortality involved AB01F. Seen limping very heavily in February '20, deteriorated in body condition through April (though no longer limping), was offered supplementary food and water in April and May (see below) , including on 12th May before her carcass was found in very deep cover of a dry *Balanites* on 16th May, 13km WSW of base camp. The field notes also recorded: 'we found a tangled plastic rope'. Although in poor condition and being supported, the exact cause of death, and how the carcass finished up so deep under *Balanites* branches and the role of the tangled rope is not clear.

Support to Addax Group 1 in 2020

Loss of body condition affected many addax through the 2020 dry season, Fig. 3. Project management initiated a program of post-release support through April to June 2020 involving provision of food and/or water in situ on at least 60 occasions, Fig. 4.

Addax Group 2

A second release of 25 addax (8.17) took place direct from the basecamp pre-release pens in September 2020. Plans to fit Satellite/VHF collars to this group had to be abandoned due to travel restrictions, so the second group are identified by ear-tags only.
In the month following release several deteriorated sharply in condition and the weakest were captured by net and provided with a complex of veterinary treatments, Fig. 4. The carcass of female AG238F, treated in this way on 5th October (one month after release), was found near the pens on 13th October.
Three months after release 22 of the 25 were confirmed alive and at 6 months at least 20 were confirmed alive. Of the four 'missing' Group 2 addax (which do not have satellite collars), one is male. One of them, female AY449F, has not been seen since the second month of release.

Addax calf detections:

Twenty-five addax births have been reported to June 2021. Five of these are believed to have died, of which three were recorded as peri-natal mortalities, one died very soon after capture and tagging and one disappeared within one month after tagging.
All opportunities to catch wild born addax by hand have been taken since the outset, resulting in eighteen addax calves tagged to date, of which two are known to have died. Four untagged surviving calves are young and potentially recognisable by association with the dam.
Group 1 calving: All nine surviving females of Group 1 gave birth between June and August 2020, although the first three births were all lost at or very close to birth. The three calves were all.

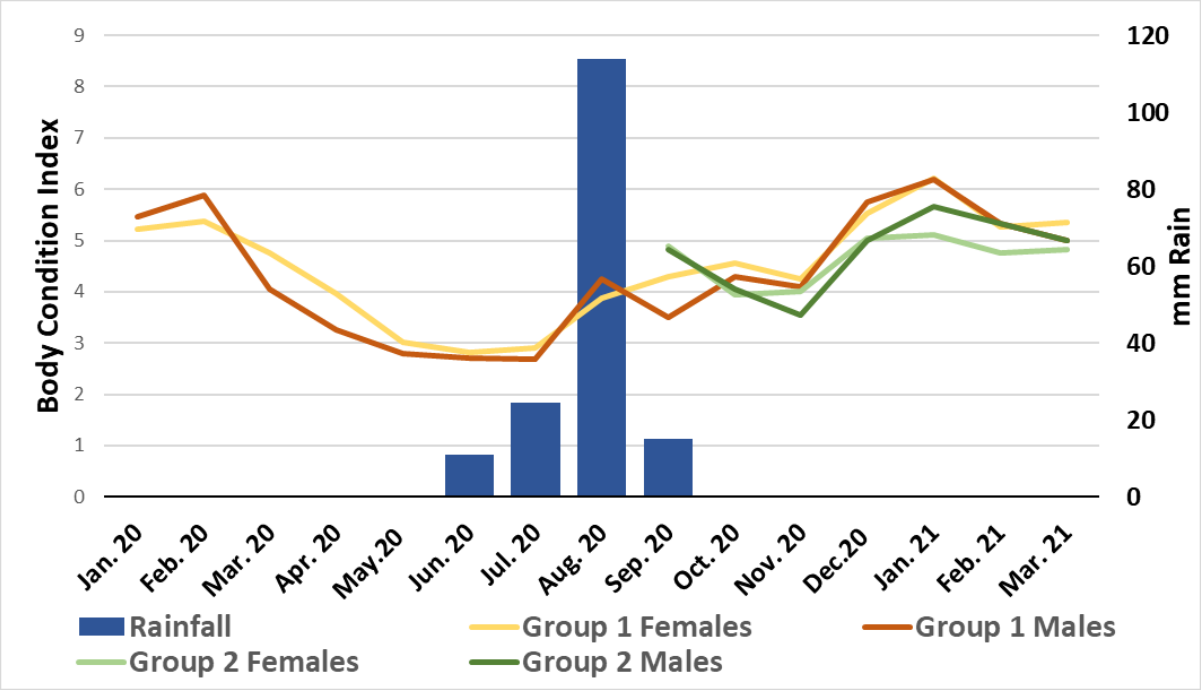


Figure 3. General trend in addax body condition index (field team assessment on 9-point scale, Fossil Rim system) averaged by release group and sex, in relation to rainfall, Jan. 2020 to March 2021. Ouadi-Rimé-Ouadi Achim addax reintroduction project

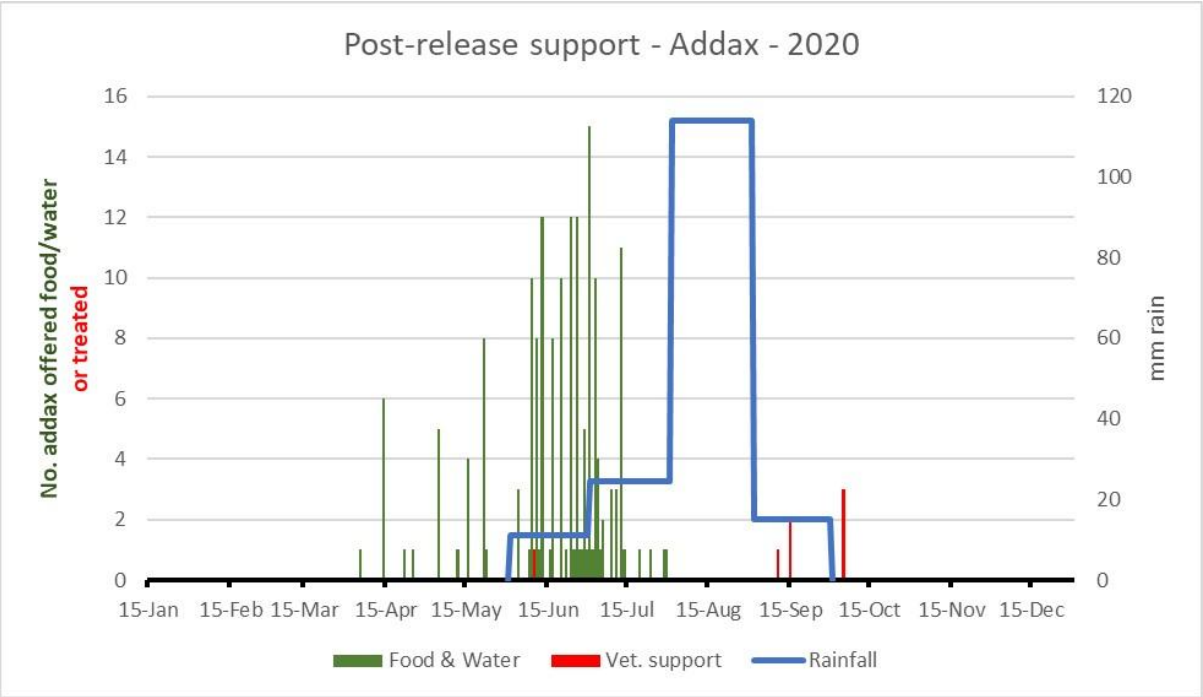


Figure 4. Time line for interventions to supply supplementary food and water (green) or veterinary treatments (red), as reported by field teams in relation to monthly rainfall, Jan. 2020 to Dec. 2020. Ouadi-Rimé-Ouadi Achim addax reintroduction project

Considered very small and weak, associated with the poor condition of the dams, being supported at the end of their first dry season. Three Group 1 females gave birth to a second calf in April 2021.

By January 2021, twelve months after release, Group 1 has grown from 15 individuals to 19, an increase of 26%.

Group 2 calving: By June 2021 thirteen of the fourteen regularly seen Group 2 females had produced calves in the period November 2020 to February 2021. Among them one case of peri-natal mortality was recorded in February 2021, and one calf, tagged O211 disappeared after 2 months.

Association of addax groups 1 and 2

Following release at a temporary site 36km from the pre-release pens, the group did not stay together, but most moved back south to the sand dune systems west of base camp, while others have stayed further out. Addax of Group 2 began to encounter addax from Group 1 almost immediately, and by January 2021 addax herds contained members of both release groups in more than 50% of encounters. Fig. 5.

Addax population growth

After the release of 15 addax in January 2020 and 25 addax in September 2020, the population has grown to at least 53 and possibly 57 individuals in the wild by June 2021. Fig.6.

4. Oryx and addax associations

Since July 2020 the standard field recording menus were modified to ensure that at every recorded encounter with oryx or addax, the presence or absence of the other species is always indicated. The objective is to monitor the frequency of association, and identify individuals involved to facilitate understanding of inter-specific relationships.

From March 2021 the menus were further modified to distinguish occasions when animals were in spatially mixed groups as opposed to sightings of the species at 10-100m from each other, or in sight but at >100m from each other.
A preliminary analysis of all records from July 2020 to June 2021 showed that associations have been observed persistently, affecting 5% of oryx observations and 12% of addax observations, Fig.7. Two occasions when male oryx-female addax 'pairs' were encountered have been logged. Comparison with known calving dates of the female addax involved indicates no cause for concern in these cases.

5. Dama gazelles

Routine recording of all dama encounters while monitoring oryx and addax has been conducted since 2016. Key observations are that the limited area of extent (c. 2200km^2) known to be used by dama in the years prior to the reintroduction project commencement (2011-2015) has not significantly changed despite the addition of more than 500 dama observations by the project 2016-2021,. Nor have any other indices of population status (encounters /day in the field and group size) shown any notable change. It remains clear that the wild dama within the Ouadi Rimé-Ouadi Achim Game Reserve are few in number, remain highly vulnerable and urgently require the conservation support that has been initiated by SCF in 2020.

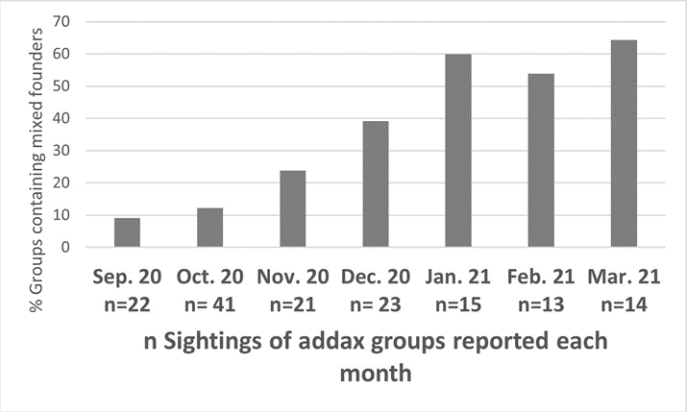


Figure 5. Proportion of addax herds containing members of both release groups, September 2020 – March 2021. Ouadi Rimé-Ouadi Achim addax reintroduction project

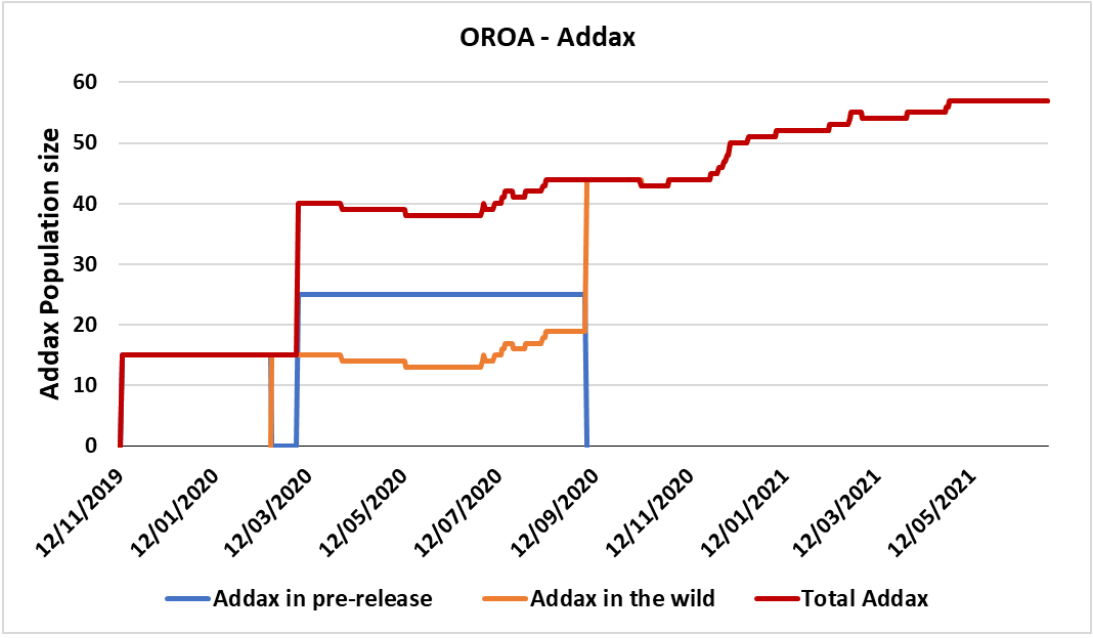


Figure 6. Development of addax herd from February 2020 to June 2021, Ouadi Rimé-Ouadi Achim addax reintroduction project

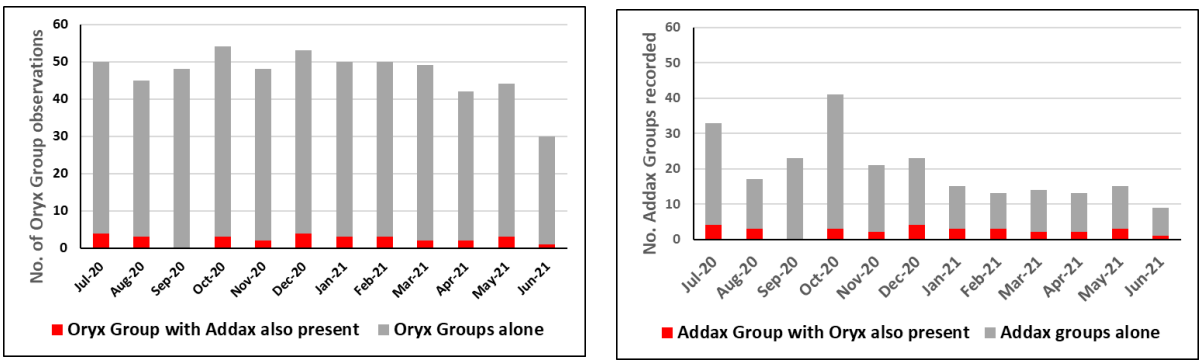


Figure 7. Frequency of association between reintroduced scimitar-horned oryx and reintroduced addax, July 2020 to June 2021, Ouadi Rimé-Ouadi Achim reintroduction project

6. Monitoring team reporting and other documents

- Bilingual monthly summary reports of monitoring records have been circulated to all project partners throughout the reporting period, January 2020 to June 2021.
- Supplementary reports on 1) results of a photographic exercise to focus attention of new members of the monitoring team on recognition of the first founder oryx who mostly now lack collars etc.,.2) preliminary results of data collected on addax-oryx contacts.
- A series of PowerPoint training materials on aspects of data collection, data management and camera trapping data management were delivered to the monitoring team. The data collection menus were also transitioned fully into French at the departure of Krazidi Abeye.
- Three-monthly renewals of the data collection database files have been supplied to manage file size, including necessary updates to the individual identity code menus.
- Several updates to charts predicting expected / possible calving months for tagged female oryx and addax were prepared and supplied to the monitoring team.
- A multi-author manuscript reviewing results of eight wildlife and livestock line transect surveys conducted from 2011-2019 has been prepared and submitted to the journal Oryx.
- A detailed review of biodiversity history, current status and requirements in the Ouadi Rimé-Ouadi Achim Game reserve was submitted as part of the World Bank 'Projet de developpement local et adaptation aux changements climatiques'
- A contribution to the chapter on wildlife for the EU Project Ouadi Rimé-Ouadi Achim reserve management plan was made in June 2021.
- A planning document detailing exact time and distance budget requirements to complete a large-scale aerial survey of the oryx, addax and dama zones was prepared and sent to SCF in April 2020, with daily navigation routes from the base camp airstrip compiled and ready for upload to GPS. Fig. 8.

7. Recommendations

Oryx:

- Establishment at earliest opportunity of systematic ground-based sample surveys of the core oryx area to obtain updated information on distribution and population estimates for wildlife and livestock. Note that Chadian staff familiar with ground-based line transect protocols and capable of leading a survey (Mahamat Hatcha, Coordonateur of the reserve) and Krazidi Abeye (now departed but similarly experienced) are available, as are established GPS transect routes.
- Ensure that in the event of an aerial sample survey becoming possible, a coordinated ground-based line transect survey is conducted simultaneously, or as near simultaneously as possible.

- The calf -tagging program has proved successful and productive and should be continued, noting that while results to date are very encouraging, they represent a short time span relative to expected annual variability in conditions. Routine opportunistic tagging should be maintained for scientific and protective reasons, while collection of resighting data should continue throughout the 5-year span of the second phase of the project.
- When conditions allow the Phase 2 plan to fit satellite collars to a selection of original founder oryx (to study long term calf production) and wild born oryx (to compare survival, movement and production with founder oryx) should be implemented as soon as possible.

Addax and dama:

- Continue to assess feasibility of releasing a new group, fitted with satellite collars, at the western end of the Ouadi Achim.
- Maintain calf tagging program for addax.
- Develop pen design capacity to manage dama breeding groups; develop a captive breeding plan for captive dama at the oryx base and augment the number of captives.

General:

- Training and capacity building in sample survey work should be conducted jointly for the oryx project and POROA ranger teams.
- Ground-based sample survey work should be conducted in collaboration between the oryx project teams and the Arada-based ranger team of the POROA project.
- Complete resighting history sequences for all tagged oryx and addax in the project (close to completion) to begin modelling analysis (Software MARK or other) to investigate effects e.g. of sex, age group at release, release group, tag type, and origin (wild born, pen born founder) on survivorship and detectability.

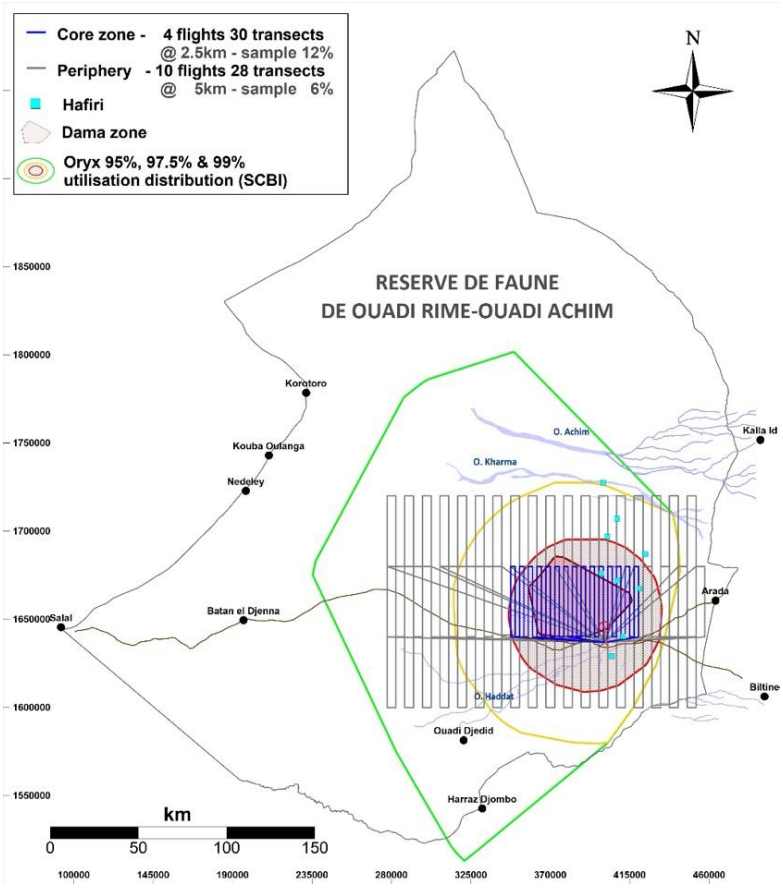
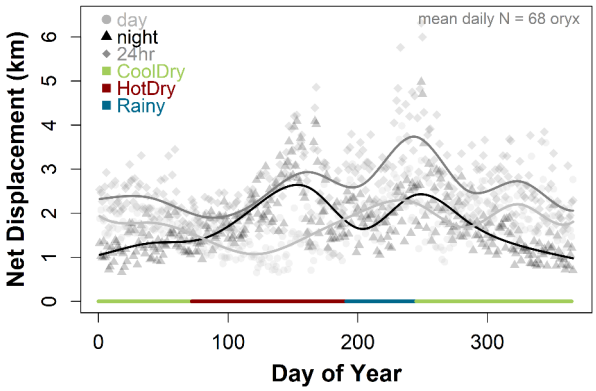


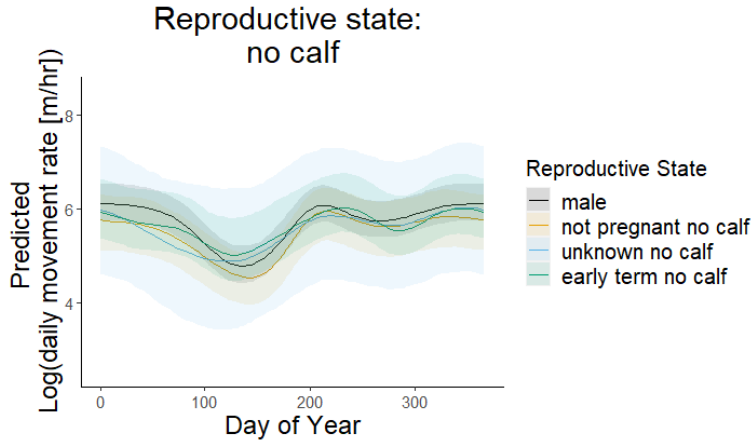
Figure 8. Flight plan for a stratified strip sample count in relation to oryx utilisation distribution contours (thanks to Katherine Mertes, SCBI) from satellite tracking data to 2019. Requires 42 hours of flight time over 12 days to complete. ZSL, April 2020

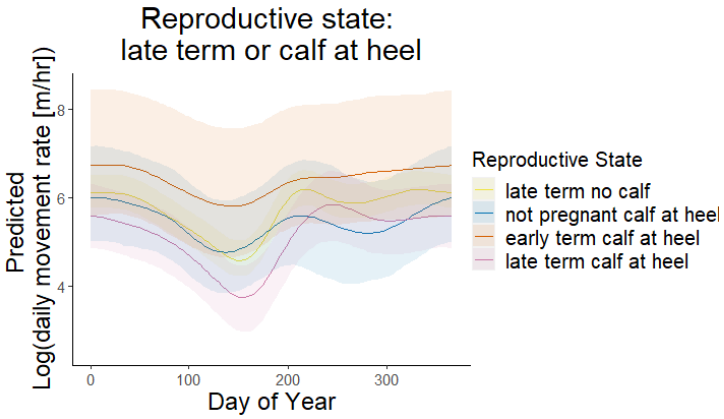
Part IV. REMOTE MONITORING OF ORYX & ADDAX

Katherine Mertes
Postdoctoral Research Fellow
Smithsonian Conservation Biology Institute

Reintroduced oryx move differently throughout the year. During the rainy season, oryx generally travel further each day than at other times of year. During the hot / dry season, oryx move somewhat less, and mostly at night – likely to conserve energy and escape the intense daytime heat.





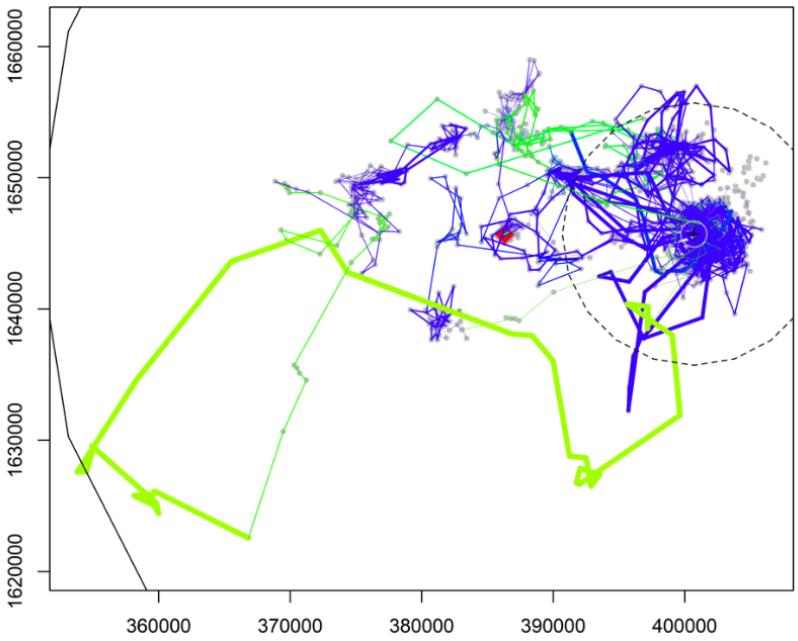


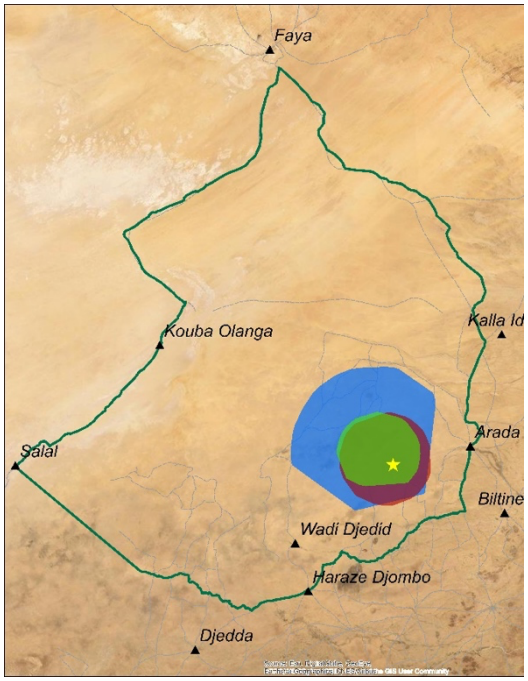
Reproductive state strongly affects how oryx change their movement behavior from season to season.

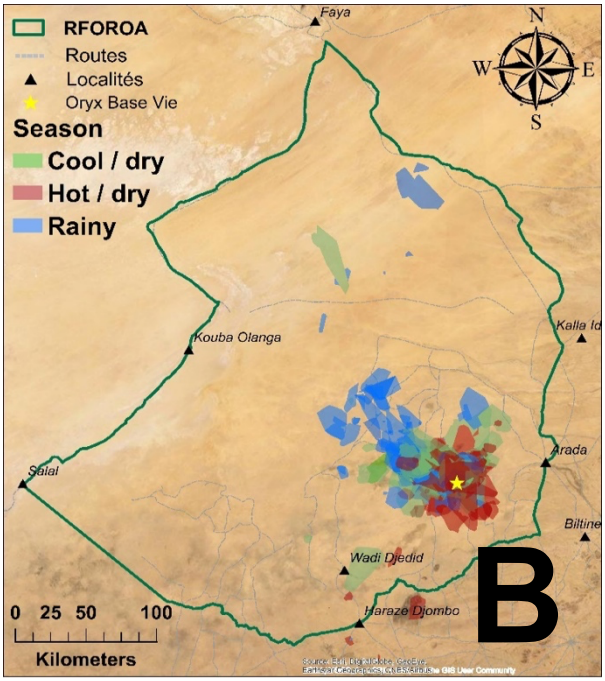
Males and females without calves change their movements the least across seasons.

Females in the late stages of pregnancy, and those with young calves, change their movements the most across seasons.
Late-term females with young calves move the slowest overall, and also move the shortest distances overall (*not shown*). They also change movement patterns from the hot / dry season to the rainy season much later than other oryx.

Oryx perform different behaviors at different times and places. *Blue lines* show the parts of R25M's movement path where this oryx was using the landscape (e.g., foraging or resting), and *green lines* show where this oryx was traveling longer distances. Comparing use areas and travel routes across oryx may reveal important resources and corridors in the RFOROA.







During the rainy season, reintroduced oryx travel North and West of the release site. Drawing an envelope around all oryx locations during this season (A) suggests the reintroduced population also uses more space (ca. 10,400 km^2) during the rainy season than at other times (ca. 4000km^2). However, extracting movements that likely represent "use" of the landscape (e.g., foraging) and delineating these short-term use areas across seasons (B), indicates smaller seasonal differences in space requirements. The distribution of short-term use areas among seasons indicates that oryx space use shifts to the North and West, but is only somewhat higher during the rainy season than at other times.

Key findings

- Oryx exhibit three distinct movement strategies during a typical year, which correspond to “Rainy”, “Cool / dry” and “Hot / dry” regional environmental conditions.
- During the rainy season, reintroduced oryx travel relatively far each day, move both day and night, use slightly more space, and expand their distribution Northwest of the release site, than in other seasons.
- Reintroduced oryx also prioritize resource gain during the rainy season, selecting sites with both high short-term vegetation greenness (i.e., growing grasses and forbs) and high long-term greenness (i.e., trees and shrubs). Oryx also select sites with low elevation and complex topography, consistent with interdunal depressions and other areas that may hold moisture and support growing vegetation.
- Post-release experience influences oryx movement decisions. As oryx spend more time in the RFOROA, they select sites with higher daytime temperatures in the hot / dry season. This apparent increase in heat tolerance occurs because experienced oryx move mostly at night during this season.
- During the dry seasons, oryx select sites with long-term vegetation greenness (i.e., trees and shrubs are present), but not high short-term greenness (i.e., growing grasses and forbs). Moreover, experienced oryx do not prefer particular elevations or topography. These results indicate that, during these seasons, oryx prioritize shade and conserving energy over seeking (increasingly rare) forage.

Management Applications

- Analyses of oryx movement inform the spatial and temporal deployment of monitoring personnel and resources. For example, short-term use areas during the hot / dry season were used to select transect routes for SCF intern Bertrand Djikoloum.
- During the rainy season, reintroduced oryx use somewhat more space, and shift their distribution to the Northwest – into areas heavily used by transhumant families and their livestock. This co-occurrence may increase competition between humans and oryx for limited grazing resources during this period.
- Larger groups of reintroduced oryx moved more slowly, tolerated higher temperatures, and had stronger preferences for low elevation and complex terrain. These relationships indicate that large groups employ a patch exploitation strategy during the rainy season – possibly due to their greater energy requirements, more effective searching, or information pooling within a group. These findings indicate that a pre-release management strategy to form large groups of oryx with established social relationships may improve post-release outcomes. Alternatively, releasing oryx under conditions that increase opportunities for integration with existing free-roaming groups – for example, releasing oryx when free-roaming groups are nearby, or satellite releases to occupied sites – may have similar effects.

Products

- SCBI personnel harmonized observations of oryx from 2017 to 2019 across ODK and CyberTracker platforms. The harmonized data set contains ca. 2400 records of oryx groups through June 2019, and is available from https://www.oryxreintroduction.org.
- On May 20, 2021, SCBI personnel presented “What is a season to an oryx? Movement strategies identify three seasons for scimitar-horned oryx reintroduced into Chad” to the 20th meeting of the Sahelo-Saharan Interest Group. This study is being prepared for publication in a scientific journal, and will be shared with SCF before submission.
- SCBI personnel have provided short reports – on short-term space requirements, seasonal habitat preferences, seasonal distribution changes, and potential movement corridors for

reintroduced oryx – to the POROA Director. This information will support upcoming workshops on zonation in the RFOROA, and the reserve management plan.

- In November 2020, SCBI personnel began working with Majaliwa Masolele to investigate the movement tendencies and habitat preferences of reintroduced oryx. This analysis is being prepared for publication in a scientific journal, and will be shared with SCF before submission. Majaliwa previously studied common eland in the Serengeti region of his native Tanzania. During his SCBI internship, Majaliwa was awarded a scholarship to support his PhD at the University of Glasgow. This collaborative project and educational outcome illustrate the project's commitment to capacity-building through training, mentorship, and increased access to resources.
- From April-June 2020, SCBI personnel and Caleb Ngaba collaboratively developed a work plan for SCF intern Bertrand Djikoloum. SCBI personnel provided protocols for the sampling and processing of insect vectors of disease (including ticks, mosquitos, and biting midges), materials to support insect identification, and remote instruction in insect collection, specimen preservation, and data management.

1. Statuts of the reintroduced oryx population

As of June 2021, the mean survival rate for oryx released into the RFOROA is 0.7. Both the oldest and most recent release groups (1 and 7) exhibit the highest founder survival (0.81 and 0.96, respectively). Release 3 has produced the most surviving calves: 66, with a calf survival rate of 63%, and a mean recruitment rate of 0.77 calves per surviving founder female per year (Table 1). The next most productive cohort is Release 4, which has produced 55 calves with a 72% survival rate, and a mean annual per capita recruitment rate of 0.8. However, detecting mortalities of oryx without GPS collars is extremely difficult – especially for unmarked animals born in Chad. For current population estimates (Table 1 and Figure 2), we consider any marked oryx dead if they have not been sighted by the SCF field monitoring team for one year.

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

	Years since release	Released founders (m.f)	Surviving founders (m.f)	Founder survival rate	Surviving calves	Calf survival rate	Mean annual recruitment (per capita)
Release 1	4.8	8.13	8.9	0.81	37	0.38	0.34
Release 2	4.4	6.8	4.5	0.64	22	0.42	0.50
Release 3	3.9	14.23	12.15	0.73	66	0.63	0.77
Release 4	2.9	38.35	11.19	0.41	55	0.72	0.80
Release 5	1.8	3.20	3.12	0.65	15	0.94	0.71
Release 6	1.5	7.17	7.9	0.67	11	1.0	0.79
Release 7	0.8	8.18	8.16	0.96	14	0.93	1.10

Releases 1 and 2 produced relatively few calves during the first year after their release (Figure 1). This initial reduction in calf production was not observed in subsequent release groups. Indeed, Release 3 exhibited a 30% decline in calf production – and Release 5 a 50% decline in calf production – in later years, compared to their first year after release. Together, these outcomes indicate that reintroduced oryx do not experience a characteristic "post-release period" of reduced recruitment. In other species, elevated adult and calf mortality soon after release has been attributed to the stresses of the release itself, or initial encounters with an unfamiliar environment.

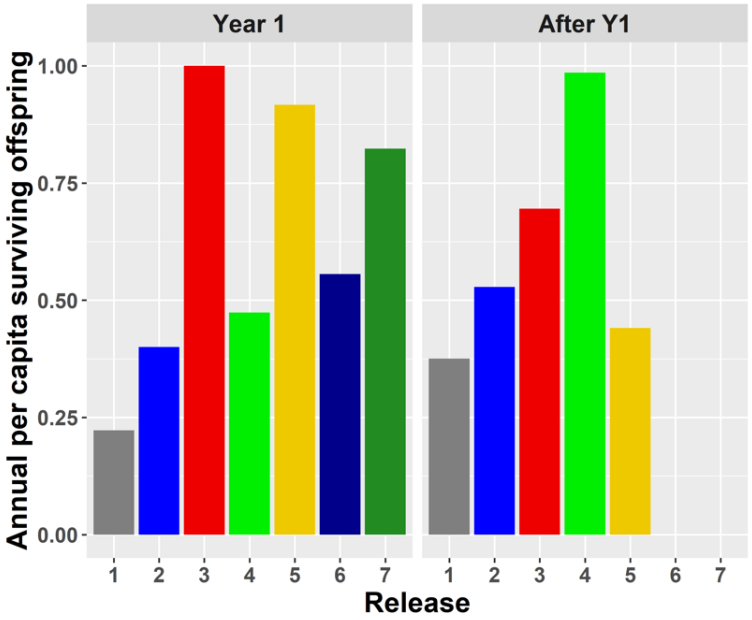


Figure 1. Calf production during the first year after release, versus subsequent years

The growth of the reintroduced population continues the positive, promising trends observed in earlier years. In 2020, the estimated number of surviving Chad-born oryx exceeded the estimated number of surviving founder oryx for the first time. The impressive calf ear-tagging program implemented in 2019 is beginning to yield information on survival rates for young age classes. In the near future, this program will enable the estimation of survival and mortality rates for age classes from neonate (<30 days) to sub-adult (3 years), and thus facilitate more accurate estimates of the unmarked portion of the oryx population.

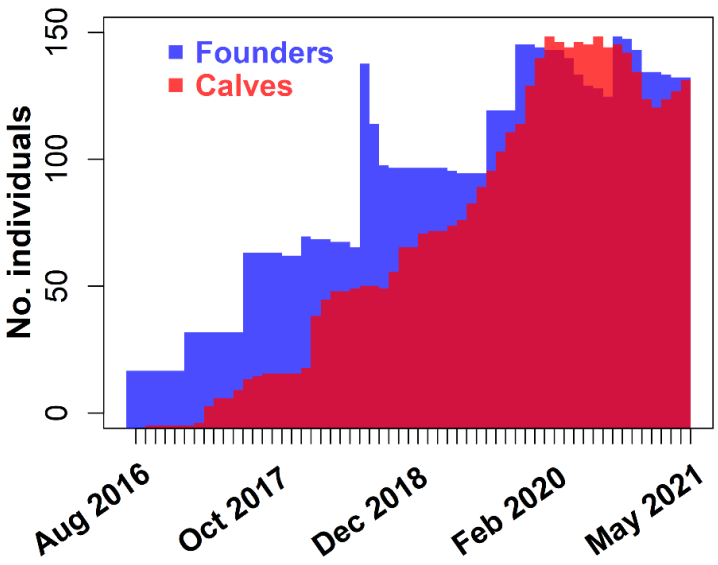


Figure 2. Estimated size of the reintroduced oryx population from August 2016 to present

2. What is a season to an oryx?

Sahelian landscapes exhibit extreme variation in rainfall and vegetation productivity over a calendar year. We analyzed the times at which oryx respond to this variation, estimating (1) seasons from the point of view of the oryx and (2) typical dates of transitions between seasons. Using movement data integrates across the many factors – e.g., temperature, precipitation, and forage availability – that collectively affect oryx, capturing the species' responses to its dynamic environment.

We calculated mean daytime movement rates for 68 oryx (26 m, 42 f) who retained at least one year of collar data after a 25-week post-release period was removed. The resulting data set contained ca. 25,000 daily movement rates from 2017 to 2021 (Fig. 3). We used generalized additive mixed models

(GAMMs) implemented in a Bayesian framework to fit complex nonlinear functions to these annual response curves.

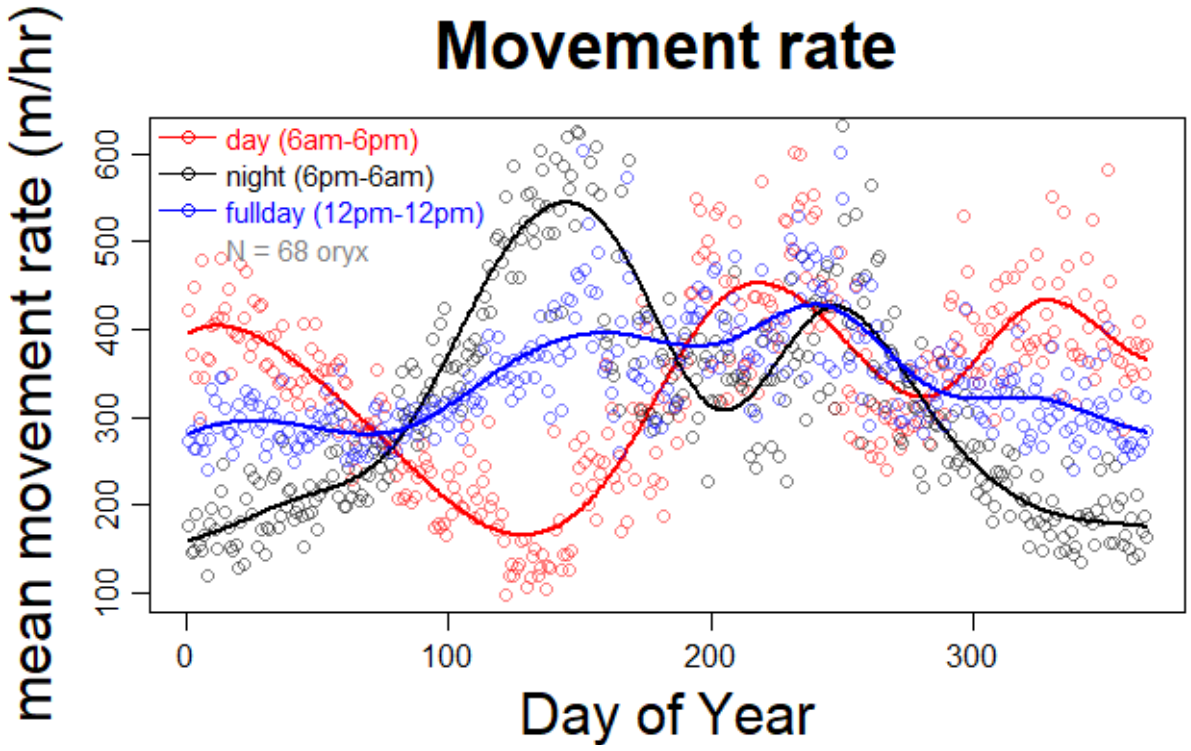


Figure 3. ***Mean hourly movement rates across a typical year.*** *Reintroduced oryx show substantial variation in movement rates and timing (day, night, or full 24-hour period) across the calendar year*

The best model, including age, release group, and reproductive state, explained substantial variation in oryx movement rates across the year. While release group and age modestly affected oryx movement rates across seasons reproductive state had the strongest influence on movement rates and transition between seasonally distinct movement strategies (Figure 4).

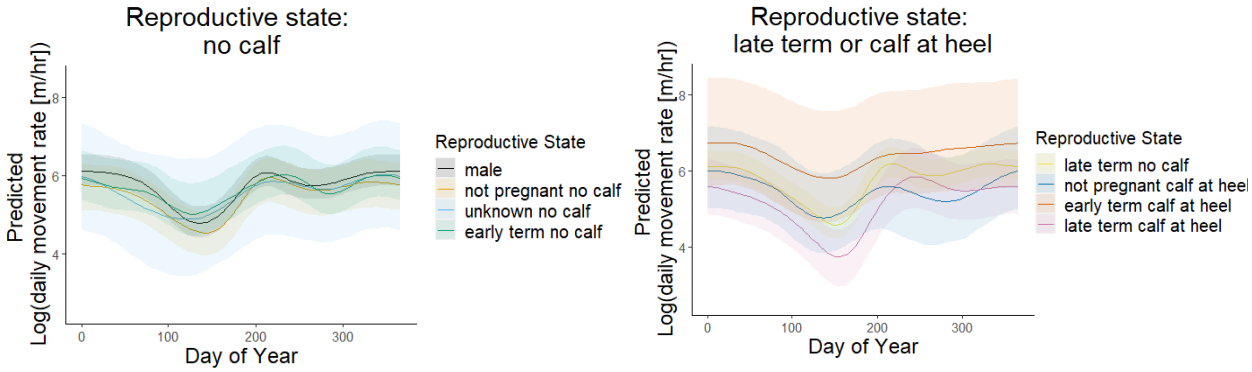


Figure 4. ***Reproductive state influences oryx movement rates and seasonal transition dates.*** *Upper panel shows model-predicted movement rates by males and females without calves, which show the smallest changes across a typical year. Lower panel shows females (of any pregnancy state) with calves, and late-term females with no calf, which show the greatest change in movement rates across a calendar year*

Of all reproductive states, males and females without calves exhibited limited variation in hourly movement rates across a typical year (Figure 4). In contrast, females in late-term pregnancy – with or without a young calf – exhibited the lowest movement rates overall, and dramatically decreased their movement rates during the hottest time of the year (Figure 4). These two reproductive states also increased and decreased their movement rates much more slowly than other states.

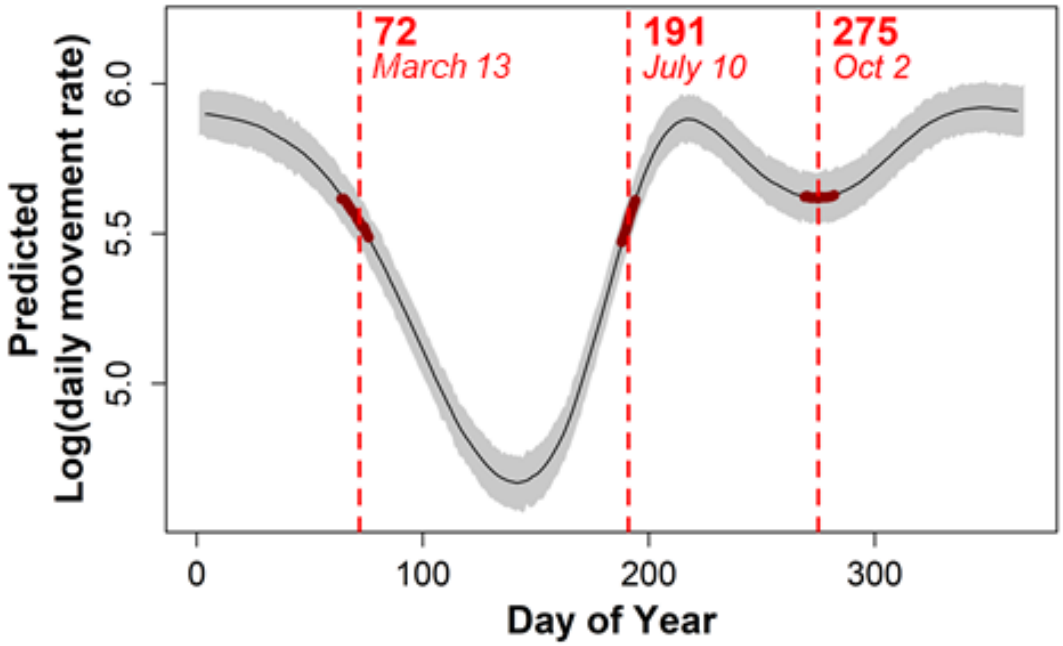


Figure 5. Three seasons of ecological importance to reintroduced oryx

We then calculated the global mean of all daytime movement rates predicted by the final model, and identified the dates when the population-level predicted movement rate passed through this value (Figure 5). We considered these dates to represent transitions between different movement strategies. This approach identified three seasons that are ecologically relevant to oryx – and which also align well with typical annual environmental variation.

The "Cool / dry" season stretches from October 2 to March 12, and roughly aligns with the period after the typical annual rains in July and August, when temperatures are relatively cool. The "Hot / dry season" reaches from March 13 to July 9, and aligns with peak conditions of the annual dry period, when no rain has fallen since the previous year and daytime temperatures may reach 110°F. Finally, the "Rainy season" lasts from July 10 to October 1, and corresponds to the period when the most rain falls each year.

These seasons may be used to partition data collected on reintroduced oryx into ecologically relevant time periods for more nuanced analysis. For example, seasonally divided accelerometer data and behavioral observations may be used to create and compare seasonal activity budgets.

3. Seasonal space use by reintroduced oryx

Identifying ecologically relevant seasons for reintroduced oryx facilitates further evaluation of how oryx movements change across a typical year. Once seasonal transition dates are identified, oryx movement data can be partitioned into time periods of established ecological relevance.

We performed behavioral change point analysis on GPS collar data from oryx that were tracked for at least 60 days (n=140; Figure 6). Two movement behaviors were plainly evident: shorter-distance movements at low speeds, termed “use” (e.g., foraging), and longer-distance movements at higher speeds, termed “travel” (e.g., dispersal).

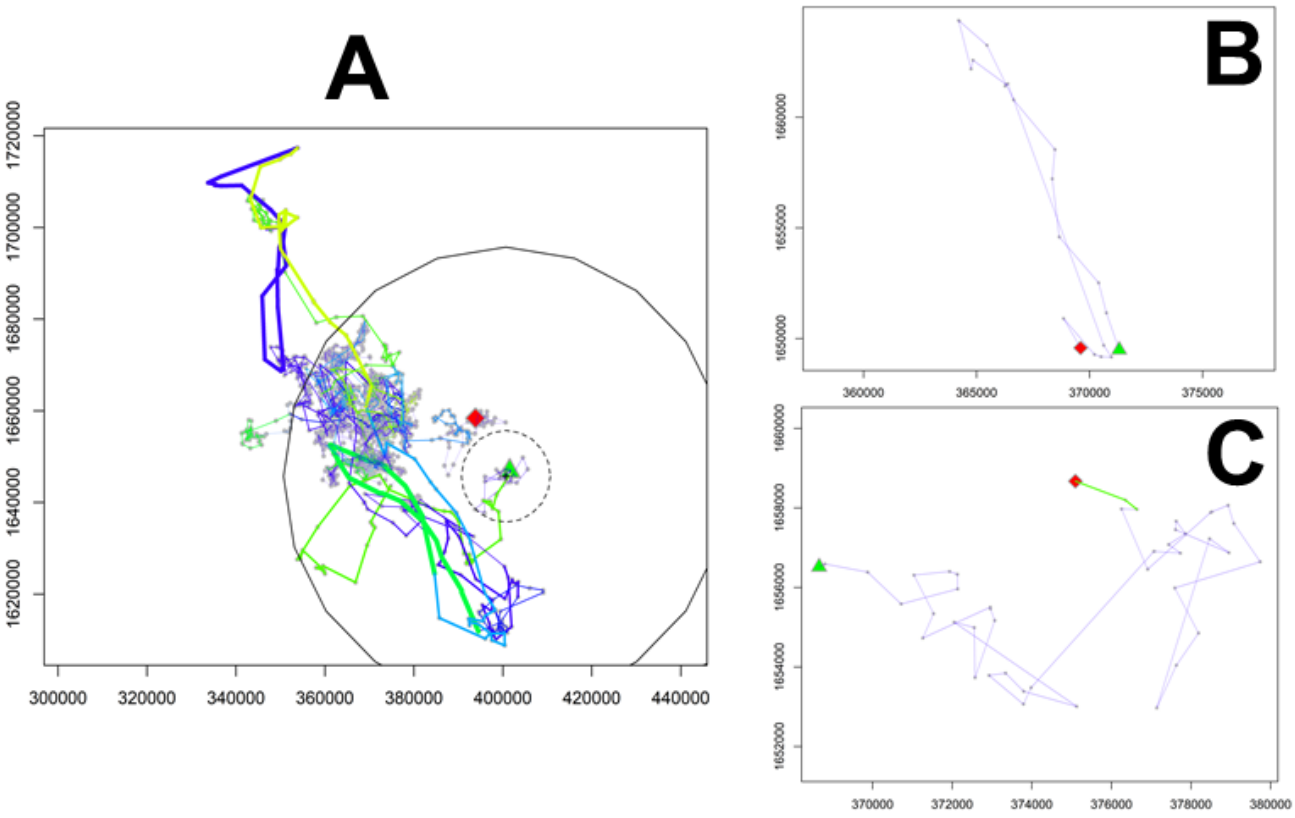


*Figure 6. **Example movement path and basic movement behaviors.** The full movement trajectory of R82M (A) contains smaller segments that arise from specific movement behaviors, including “travel” (B) and “use” (C)*

For each section of the movement path classified as “use,” we used a 95% minimum convex polygon around that section to estimate the area used. Dividing these short-term use areas among the three seasons that are ecologically relevant to oryx (Figure 7) reveals that oryx short-term use areas are generally smaller in the cool / dry season, compared to the hot /dry and rainy seasons.

The seasonal cycle of increased short-term space use during the rainy season, and decreased short-term space use during the cool / dry season, is also apparent in a timeline of mean monthly space use across the reintroduced population (Figure 8).

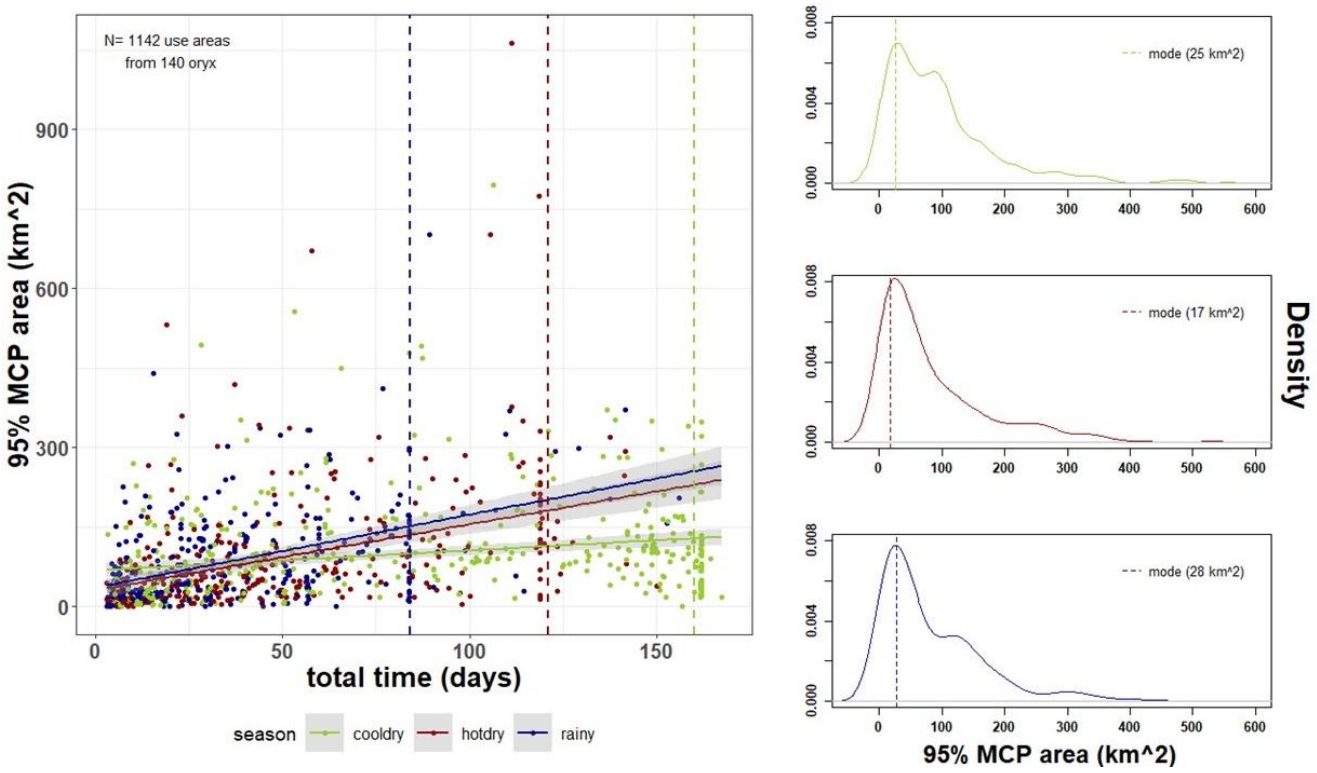


Figure 7. ***Size of short-term use areas occupied by oryx in different seasons.*** *Reintroduced oryx perform two general types of movements, "use" and "travel." We calculated the length of time and size of short-term areas (right panels) associated with each bout of "use" behavior (left panel), in each season*

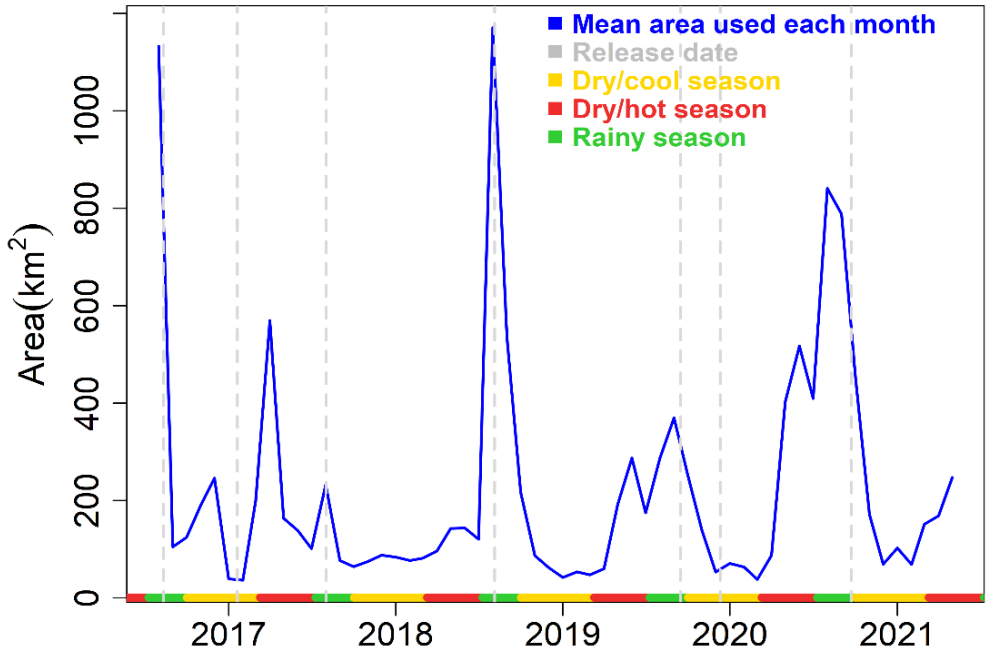


Figure 8. ***Area used by an individual oryx in a month.*** *Blue lines show mean area used by a "typical" oryx each month (estimated using 95% minimum convex polygons). Gray dashed lines indicate when oryx were released. The colored x-axis indicates different seasons*

In addition to increased space use, reintroduced oryx shift their spatial distribution to the Northwest of the release site during the rainy season (Figure 9).

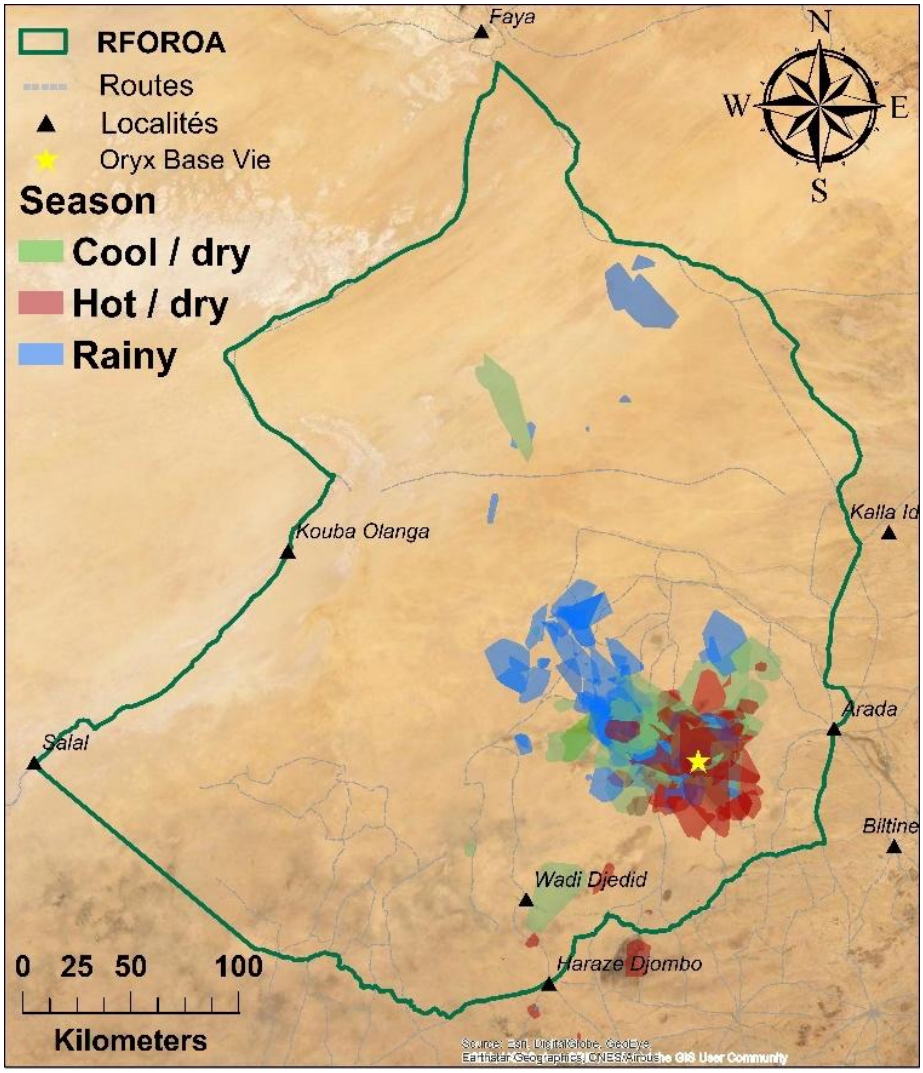


Figure 9. ***Areas where reintroduced oryx perform "use" behaviors across the year.*** *During the Rainy season (blue areas), reintroduced oryx perform use behaviors further to the Northwest of the release site. During the cool / dry season (green areas), oryx perform use behaviors nearer to, and to the West and North of, the release site. During the hot / dry season (red areas), oryx use areas very close to, and sometimes South and East of, the release site.*

Brouin (1950) suggested that, before their extinction in the wild, oryx used the Southern portion of their range during the hot season (ca. March-June), moved several hundred kilometers North during the rainy season (ca. July-November), and were irregularly dispersed across their range at other times. Later, Gilet (1965, 1969) proposed that two disjunct populations occupied the region. One population may have been largely sedentary, moving according to local precipitation and forage availability, while the second may have performed seasonal migrations. Observations by Newby in the mid-1970s supported this proposition (Newby 1974), recording recurring movements by oryx into the Koola region west of the Tefi Basal after the first rains of the year (Newby, *unpubl. data*). To date, the spatial distribution of the reintroduced oryx population does not correspond well with these historical occurrence data – except perhaps for generally Southeast-to-Northwest movements during the rainy season (Figure 10).

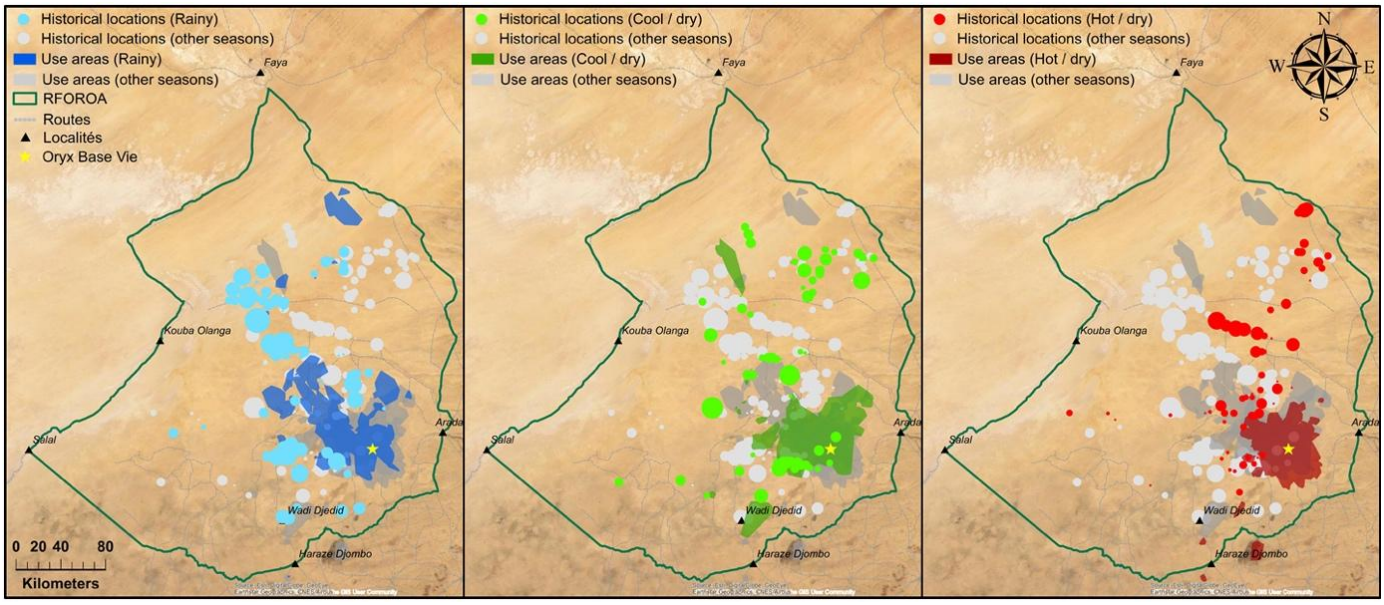


Figure 10. ***Comparing past and present oryx locations.*** *From 1972-1977, John Newby recorded locations and herd sizes of scimitar-horned oryx in the RFOROA. In general, these sites (colored and gray circles; larger circles indicate larger herds) do not strongly correspond with areas where reintroduced oryx have performed use behaviors (colored and gray polygons).*

4. Seasonal habitat preference of reintroduced oryx

We developed integrated step selection functions (iSSFs) to investigate oryx habitat selection in different seasons. For each movement step "used" by oryx in Releases 1 and 2, we drew nine "available" (but unused) steps from statistical distributions fitted to each individual's movement data. This workflow produced 972,709 used and available steps for 32 oryx from 2016-2019. We competed candidate models containing all possible combinations and interactions of environmental, experience, and social variables. The final model included the following remotely sensed environmental variables:

- Anomaly NDVI: the difference between a given measurement of NDVI (a well-known proxy for vegetation greenness and productivity) and long-term mean NDVI (2016-2020). This variable is approximately equivalent to long-term vegetation productivity.
- dNDVI: the difference between a given NDVI measurement and NDVI measured 16 days earlier. This variable represents short-term vegetation productivity.
- Elevation: measured by void-filled data from the Shuttle Radar Topography Mission.
- Topographic roughness index (TRI): an index of variation in elevation values around a focal location that captures topographic complexity.
- Temperature

To explore the potential effects of experience on habitat and resource selection, we included the time each oryx had spent in the RFOROA. We also included group size as a covariate, to investigate whether information transferred via social relationships (or some other aspect of sociality) influenced oryx habitat selection.

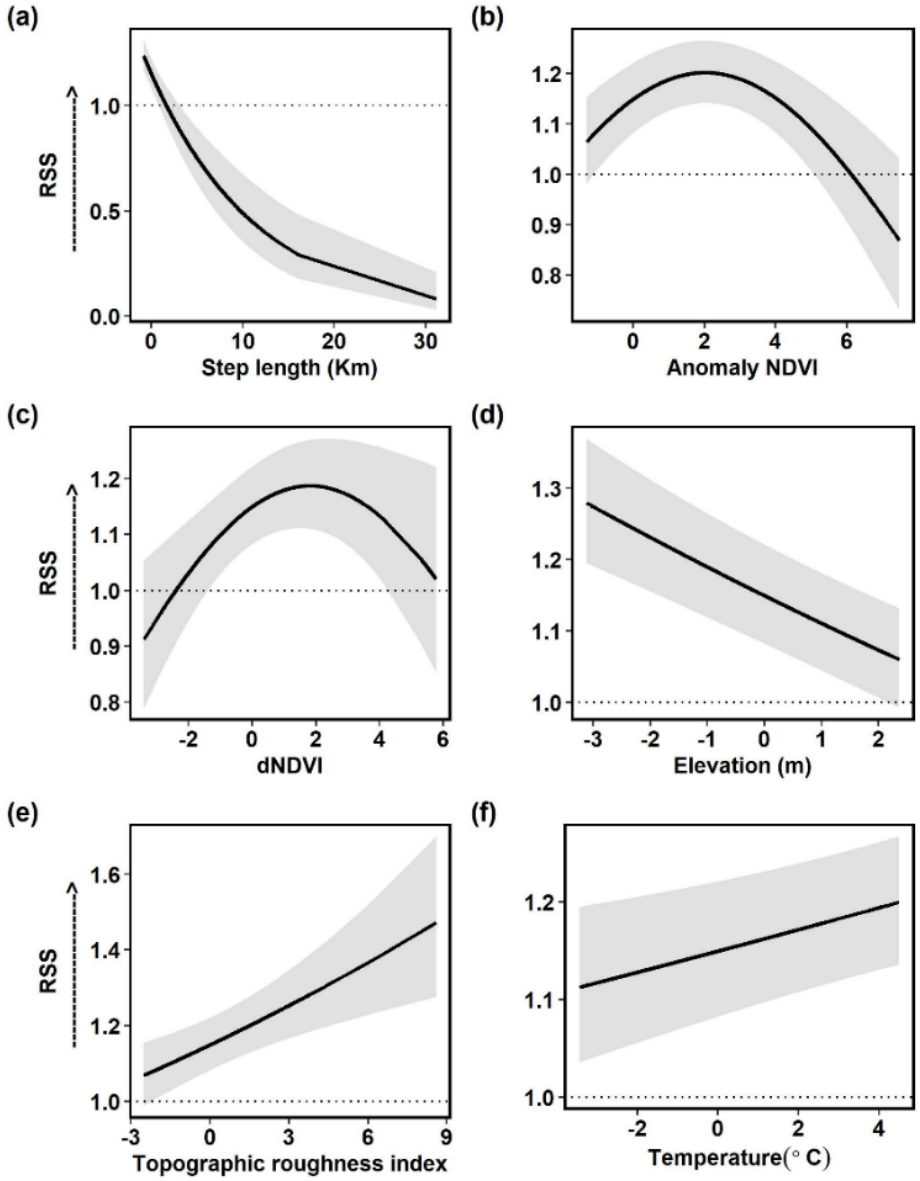


Figure 11. ***Oryx relative selection strengths (RSS) for environmental conditions during the rainy season.*** *Shading indicates 95% confidence intervals*

During the rainy season, reintroduced oryx select sites with both high short-term vegetation greenness (dNDVI; i.e., growing grasses and forbs) and high long-term vegetation greenness (Anomaly NDVI; i.e., trees and shrubs; Figure 11). Oryx also select sites with low elevation and complex topography, consistent with interdunal depressions and other sites that may hold moisture and support growing vegetation. Together, these relationships indicate that reintroduced oryx strongly prioritize resource gain during the rainy season.

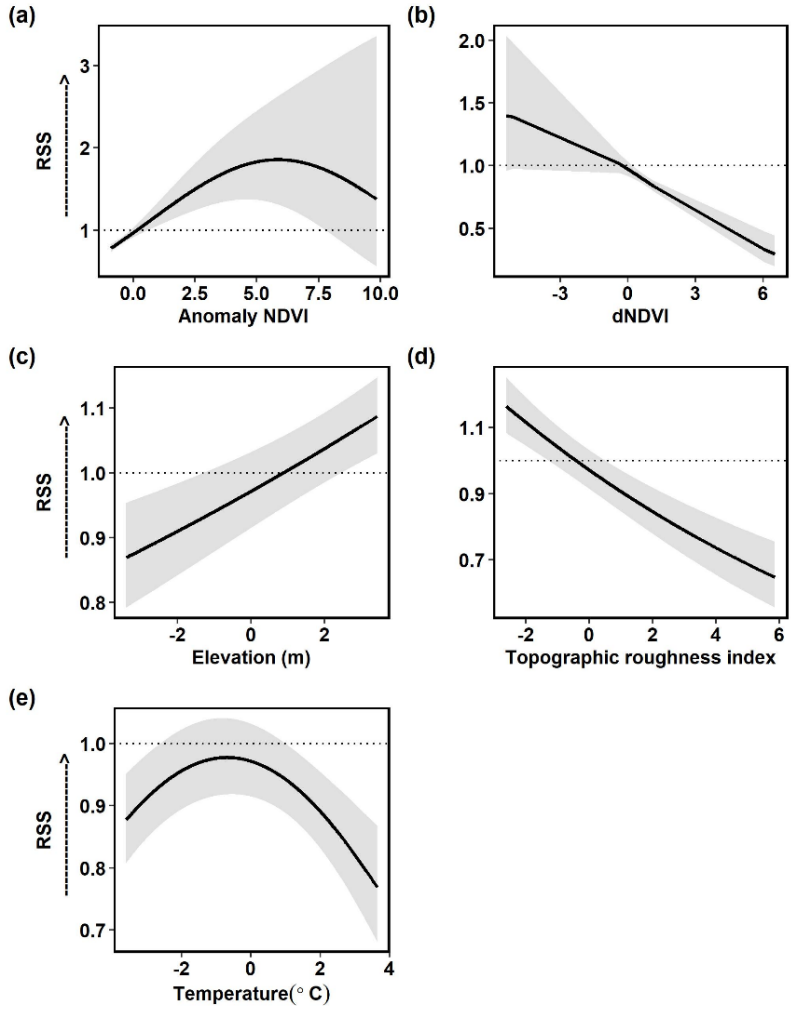


Figure 12. ***Oryx relative selection strengths (RSS) for environmental conditions during the dry season.*** *Shading indicates 95% confidence intervals*

In contrast, during the dry seasons, oryx select areas with low short-term vegetation greenness (dNDVI; i.e., growing grasses and forbs) but elevated long term greenness (Anomaly NDVI; i.e., trees and shrubs; Figure 12), and high elevation but low topographic variation. After oryx spend at least one year in the RFOROA, they select sites with higher daytime temperatures (Figure 13, *right*) and abandon any earlier preferences for topographical conditions (Figure 13, *left* and *center*). This apparent increase in heat tolerance occurs because experienced oryx shift movements to nighttime hours (Figure 3). Together, these results indicate that oryx strongly prefer shaded sites during the dry seasons, and prioritize conserving energy over seeking (increasingly rare) forage.

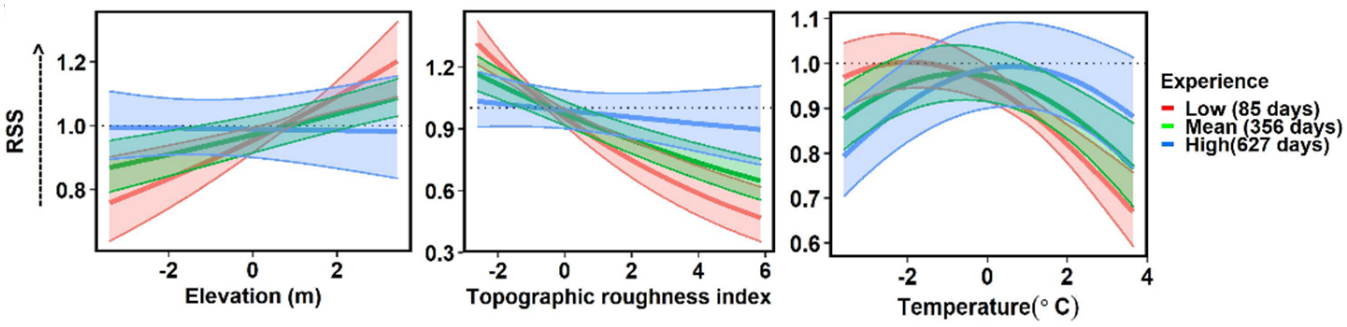


Figure 13. ***Select interactions between experience and environmental covariates.*** *Each interaction was extracted from the final dry season iSSF (see Figure 12)*

5. Conclusion and recommendations

1. Track 25 founder and 25 wild-born oryx as soon as feasible.

In March 2020, a team of project partners quickly and efficiently captured, sampled, and collared three founder oryx. These actions demonstrated the viability of long-term monitoring on a sample of the reintroduced population. Tracking data from these recollared oryx indicate that space use by reintroduced oryx may be highly variable over the long term. Focusing monitoring on a subset of the reintroduced population will reveal the extent to which founder oryx change their movements with accumulated memory and experience, as well as potential differences in the movements and home ranges of founder oryx versus Chad-born oryx.

2. Develop a sustainable protocol for estimating population size

The ultimate goal of the Chad reintroduction project is to establish viable populations of wild oryx and addax. Estimating the sizes of the reintroduced populations is thus of critical importance. Previous surveys by ZSL and DCFAP suggest that the relatively small numbers of oryx and addax, and their clustered distribution in space, may lead to low population estimates characterized by high uncertainty. Thus, an appropriate – and sustainable – set of methods to estimate population size must be identified. Multi-method surveys – for example, aerial counts alongside with ground-based distance sampling – followed by a detailed analysis are critical to identify the best approach for regularly estimating population sizes.

3. Establish standard practices for animal mortalities

Without a thorough understanding of the threats facing different life stages of reintroduced antelope, opportunities to maximize and stabilize population growth may be missed. We recommend developing standard sampling protocols, sample transport times and routes, and laboratory analyses when animal mortalities are encountered in the field. SCF personnel received field necropsy training in 2018-2019. An inventory of necropsy supplies and a refresher course would identify needed materials and maintain these skills. Identifying a regional laboratory, developing a working relationship with this institution, and establishing transport procedures for samples collected during a necropsy, will increase capacity to rapidly obtain actionable information after a mortality is discovered.

4. Collect DNA samples from wild-born calves

Over the long term, most oryx and addax will roam the reserve without any human intervention. The primary opportunity to sample wild-born individuals is immediately after birth, when calves are often caught and ear-tagged by SCF field monitoring personnel. The tissue removed when an ear tag is attached offers an ideal DNA sample that, when preserved and analyzed, will provide insights on parentage, population genetics, and disease exposure.

5. Record video observations of collared oryx

Project monitoring protocols include collecting basic behavior information when a group of oryx or addax is encountered in the field. However, more detailed behavior information is required to address questions important to the overall success of the reintroduction; for example, assessing an animal's progress from "recently released" to "entirely self-sufficient." Detailed behavioral data will also enable the calibration of accelerometer data collected by GPS / satellite collars under field conditions and validation of an existing accelerometer-based machine learning model. We recommend that at least one 10-minute video observation (the same protocol used in previous studies at SCBI and Fossil Rim Wildlife Center) be recorded per month for each founder and Chad-born oryx selected for intensive monitoring.

6. Deploy camera collars on a subset of reintroduced oryx and addax.

A previous collaboration among SCF, 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

captured 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 validate an accelerometer-based model of oryx behavior, instead of manually collected behavioral observations. Moreover, the images and videos recorded by camera collars are extremely useful materials for outreach, communication, and other public-facing activities. We recommend that select oryx and addax in good body condition be fit with camera collars in 2021.