The Rufford Small Grants Foundation

Final Report

Congratulations on the completion of your project that was supported by The Rufford Small Grants Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Teresa Luísa Silva
Project title	Combining ecological niche-based modelling and landscape genetics for conservation planning of endangered North African gazelles
RSG reference	15399-1
Reporting period	1 year
Amount of grant	£6000
Your email address	teresaluisafs@gmail.com
Date of this report	30-06-2015

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To address conservation planning of endangered North African antelopes (*Gazella dorcas* and *G. cuvieri*).		Yes		These objectives are part of the PhD project and by now the papers are under preparation to be submitted. Conservation planning is the major objective of the thesis so it will be addressed at the very end. The PhD thesis is expected to be completed in December 2015.
To develop spatially explicit models of species occurrence and of genetic variation in fragmented gazelle populations for assisting local conservation plans		Yes		A paper about "Evolution, ecology and systematics of *Gazella cuvieri* and *Gazella leptoceros*" is currently under preparation to be submitted. Particularly in this section the Algerian samples were fundamental to complete the sampling gap between Morocco and Tunisia
Gaining insights into the genetic structure of gazelle populations and the availability of suitable areas for their occurrence and potential reintroduction		Yes		The insights into the genetic structure of gazelle populations were partially achieved. Although preliminary data were presented in congresses (section 9 of the report), it is expected by the end of the thesis to be able to determine suitable areas for occurrence and reintroduction
To provide conservation managers with framework data for conservation planning of populations		Yes		The results of this study are being contemplated in the regional strategy for the conservation of Curvier's gazelle in the Maghreb region, presently under preparation by IUCN. Project results should be taken into account when designing conservation options for this endangered species.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

The unforeseen difficulties were mainly related to the difficulties of getting a visa to go to Algeria. The complexity of bureaucratic procedures did not allow me to do the field work. However, Teresa Abáigar (one of my PhD supervisors) had an invitation from Tiaret University to go to Algeria. Fortunately, she was able to take the opportunity and it was possible to do the necessary field work.

3. Briefly describe the three most important outcomes of your project.

3.1. Scientific results.

Evolutionary relationships of the genus *Gazella* have been extensively studied. However, phylogenetic studies based solely on mitochondrial data express difficulties in separating clearly some gazelle species. For instance, some species classified as distinct that display different life histories and habitat selection patterns, are phylogenetic very close. This is the case of *Gazella cuvieri* and *Gazella leptoceros*: they exhibit different distribution areas and ecological characteristics but are not distinguishable with mitochondrial markers. In this work, a mitochondrial fragment of the cytb gene and sequences of five nuclear genes from a total of five species (*Gazella dorcas, G. cuvieri*, *G. leptoceros, Eudorcas rufifrons* and *Nanger dama*) were used to investigate the phylogeny of genus in their North African range. Analyses using maximum parsimony, maximum likelihood, and Bayesian approaches provided a unique and well supported scenario of phylogenetic relationships. Results show that none of the markers clearly separates *G. cuvieri* and *G. leptoceros*, and they always represent a monophyletic lineage within the clade. These findings led to hypothesise that these species are ecologically distinct entities that have been evolutionarily adapted to living in different habitats with unique local adaptations. Nevertheless, samples from Egypt (type locality of *G. leptoceros*) are needed to fully understand the phylogenetic relationships between these two species and to resolve the systematics of the group. In the future, these hypotheses should be taken into account when designing conservation options for the two endangered species.

Thanks to the Rufford Small Grant Foundation (RGSF), it was possible to complete a previous sampling gap in Morocco, Algeria and Tunisia, which allowed completing the work. Presently, a paper is under preparation to be submitted. The preliminary title is "Evolution, ecology and systematics of Gazella cuvieri *and* Gazella leptoceros*".*

Together with other North African ungulates, wild Cuvier's gazelle (*Gazella cuvieri*) have suffered considerable population reduction and habitat fragmentation and, as consequence, increased genetic isolation and structure are expected for the extant populations. This work aims to determine the genetic diversity and population structure in wild *G. cuvieri* in Morocco, an area where the species was historically abundant, and its distribution area was almost continuous along the Atlas Mountains. Invasive and non-invasive molecular methods were used to genotype 80 samples with a set of 15 microsatellites from two wild populations: Jebel Ouarkziz region (N=30) in the extreme south-west of the Moroccan range and the Moulouya river valley (N=30) in the extreme north-east. Additionally, a captive population in Almeria (Spain) established with founders from the western populations was analysed (N=20). Overall, population structure analyses revealed medium-low heterozygosity levels (ranging from 0.49 to 0 .54) and gene flow levels between subpopulations (low FST values), but populations from north-east exhibited signs of inbreeding (positive values of FIS) and/or geographic isolation. Although genetic drift estimates suggested spatial connectivity among analysed populations, detailed understanding on the role of landscape features in structuring genetic diversity in mostly unknown. Many sampling gaps, especially in the central portion of the Moroccan range, need to be completed to fully understand population connectivity patterns. This study is particularly relevant for the conservation of *G. cuvieri*, given that Morocco still keeps one of the largest populations of this species (compared with Tunisia and Algeria) on the westernmost part of the range.

Presently, and thanks to RGSF, there was an increase in the availability of distribution data about the species in Morocco, Algeria and Tunisia. These data are currently under analysis to be submitted to a

scientific journal. Moreover, the study will include two more species: "The role of landscape features in gene flow patterns of Gazella dorcas*,* G. cuvieri *and* G. leptoceros *in the Western Sahara".*

Wild populations face extinction risks caused by deterministic factors, such as habitat loss, and by stochastic events of demographic, genetic, or environmental nature. Populations experiencing range and demographic reductions due to poaching are particular sensible to population fragmentation, genetic drift and inbreeding. For such species, captive programs are important to maintain genetic diversity for potentially supplementing wild populations. North African gazelles are excellent models to understand factors determining genetic structure in wide-range vertebrates that have undergone strong population declines. This is the case of *Gazella dorcas*, a Vulnerable antelope threatened by population reduction and habitat loss. We aim to quantify genetic diversity/structure in differently managed populations of Dorcas gazelle and to estimate gene flow levels between wild populations across the north-western range of the species, an area subjected to intense poaching. Invasive and non-invasive molecular methods were used to sequence five fragments of mitochondrial and nuclear DNA and genotype 222 individuals from the differently managed populations with 15 microsatellite loci. Genetic diversity in all markers showed that wild populations exhibited higher levels of genetic diversity in comparison to captive/semi-captive populations. Gene flow levels were high between wild populations resulting in shallow genetic structure and weak spatial isolation. The isolated population from Tidra Island (Banc d'Arguin National Park, Mauritania) exhibited unique genetic characteristics that should be effectively preserved. High-dispersal ability is probably associated to high gene flow levels detected along the Atlantic Sahara and the Sahel. Integrative conservation strategies, combining ecological niche modelling and landscape genetics, are needed to fundament conservation action plans for wild populations. The protection of dispersal corridors allowing gene flow is paramount.

With the help of RSG, there are more data about the species distribution, and consequently more genetic data. So, the analysis are ongoing and a manuscript is being prepared: "Phylogeography and conservation of Gazella dorcas*."*

3.2. Collaboration and network.
Beyond the scientific results, the most important outcome of my project on this North African flagship species is the extent to which conservation action can be achieved and the involvement of different stakeholders.

With the support of RSG I was able to establish work contacts with national and international experts in wildlife conservation. In the future the network will be consolidated and expanded, namely with collaborative publications.

3.3. Thesis.
The integration of genetic and ecological data in a spatial context will allow understanding the relative roles of different processes (e.g. landscape features, isolation by habitat fragmentation, range regression, niche parameters, social structure and behaviour) in the documented degrees of population structure. Together with the identification of suitable areas for potential reintroductions, these data will be used for the definition of management and/or evolutionary significant units for conservation of wild populations and used to improve current captive breeding and restocking programs for both gazelle species.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

Young students and scientists were involved in the field work of this project. They are motivated to start their own conservation studies on the ecological aspects of this emblematic species and its habitat

5. Are there any plans to continue this work?

My work with North African gazelles started 4 years ago and it was integrated in two research units:

i) the BIOSEDSERTS research group hosted by CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos da Universidade do Porto, Portugal. The group comprises 36 researchers, including post-doctoral researchers, PhD, MSc and internship students, research technicians, and collaborators. BIODESERTS is focused on assessing biodiversity patterns and processes in deserts and arid regions. Since 2000, 28 research scientific expeditions were developed in Africa, totalling more than 800 workdays and nearly 200,000 km of overland travel.

ii) the group of research on Conservation of Endangered Species from Estación Experimental de Zonas Áridas (EEZA/Spanish National Research Council) in Almeria, Spain. This programme is leading projects on the conservation of North African gazelles through programs of reintroduction and population reinforcement in several North African countries.

The scientific work will be continued and enhanced with the collaboration of international experts in ungulates management. My plan is to finish the thesis and continue working on this issue, in direct contact with international authorities and NGOs.

6. How do you plan to share the results of your work with others?

Regularly, I send preliminary reports of my results to local entities, including Morocco, Algeria and Tunisia national authorities, Sahara Conservation Found and Emirates Centre of Wildlife Protection Project results are presented since 2011 (Almeria) at the annual Sahelo- Sahara Interest Group meeting (Barcelona, 2016 will be the next one), where I have the opportunity to share results and develop collaborations. Additionally, results will be shared in international congresses that I intend to participate (Next ICCB-ECCB, August 2nd-6th 2015, Montpellier). Apart from the Rufford Small Grant Foundation website I also intend to submit three manuscripts to international journals and RSG will be acknowledged.

7. Timescale: Over what period was the RSG used? How does this compare to the anticipated or actual length of the project?

The Rufford Small Grant was used over the period of 12 months. Overall, all objectives were attained without significant delays. Still, the collection of scats was very difficult because of the size of the distribution area, the concise field team, and the bureaucratic difficulties associated to North African countries. The laboratory work to process the collected samples has presently finished but the analyses are not fully completed yet. They will be finished this year and the results will be published thereafter.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Flight Oporto-Algeria and Return	£410	£0	+£410	All expenses about travel to Algeria were not spent because the mission was done by my supervisor Teresa Abáigar
Rent a car for 10 days in Algeria	£902	£0	+£902	Same comment as above
Visa	£73	£0	+£73	Same comment as the first row
Fuel	£150	£0	+£150	Same comment as the first row
Field guide	£247	£0	+£247	Same comment as the first row
Hotels (Argel, Tiaret, Bousaada)	£450	£0	+£450	Same comment as the first row
Food	£328	£0	+£328	Same comment as the first row
Taxis and other communications transport	£167	£0	+£167	Same comment as the first row
MRW expenses	£0	£28.72	-£28.72	
Lab work from field work in Algeria (N=44)	£3280	£2893	+£387	
Lab work from field work in Morocco (N=29)	£0	£1906.75	-£1906.75	
Lab work from field work in Tunisia (N=8)	£0	£1183.5	-£1183.5	
TOTAL	£6007	£6011.97	-£4.97	Local exchange rate: 1 EUR = 0.821885 GBP

The costs for genotyping 15 microsatellites add about 80€ per sample.
The Moroccan field samples were collected from Emirates Center for Wildlife Protection collaborators. Tunisian samples were sent from Mar Cano, Abdelkader Jebali and Koenraad De Smet (of their own field missions).

9. Looking ahead, what do you feel are the important next steps?

The publication of project results in scientific journals and completing the PhD thesis are the natural following steps. Afterwards, the important next step is to find a postdoctoral scholarship that will allow me to keep on doing research in North African gazelles. Given the preliminary results found so far, there are some questions that I would like to investigate in the future, namely: is there any genetic adaptation to local environments?; is there hybridization between sympatric species?; which human pressures affect conservation strategies of priority corridors?

10. Did you use the RSGF logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

RSGF logo was used in the following presentations:
Silva TL, Abáigar T, Godinho R, Alves PC, Brito JC (2014). Phylogeny of North African gazelles: a mitochondrial and nuclear approach; Modern Phylogenetic Comparative Methods, Seville (Spain), November 11-15, 2014 (poster presentation).

Silva TL, Abáigar T, Godinho R, Gil-Sánchez JM, Leveque G, Hingrat Y Alves PC, Brito JC (2015)**.** First data on the genetic diversity of wild populations of Cuvier´s gazelle (*Gazella cuvieri*) in Morocco; 15th Annual Sahelo-Saharan Interest Group Meeting, Abu Dhabi, United Arab Emirates; April 29 – May 1, 2015 (oral communication).

RSGF logo will be used in the following presentation:
Silva TL, Abáigar T, Godinho R, Alves PC, Brito JC (2015). Wild populations and protection of dispersal corridors are vital for the conservation of genetic diversity and gene flow in North African Dorcas gazelle; ICCB ECCB, August 2 to 6, 2015, Montpellier, France (oral communication).

Also, the RSG foundation logo is to be used on the final reports to NGOs and other collaborators. RSGF will be acknowledge in my thesis and on papers published in international journals.

11. Any other comments?

RSGF provided a unique opportunity to pursuit my PhD project and is a pleasure to say that is very easy to contact the Foundation, particularly with the Trust Administrator, Jane Raymond, which is always available to help and support.