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	Ramiro Daniel Crego
Project title	Predatory impacts and variables determining the spatiotemporal occupancy of the invasive American mink (*Neovison vison*) on a pristine island in Southern Chile
RSG reference	14986-1
Reporting period	January 2014 - April 2015
Amount of grant	£3412
Your email address	ramirocrego84@gmail.com
Date of this report	24/4/2015

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
Goal A. To estimate occupancy and detection probabilities of the invasive American mink on Navarino Island, Chile, during three seasons: summer, winter, and spring.			✓	I set 98 camera stations on Navarino Island to estimate occupancy and detection probabilities of the American mink, completing a year cycle, starting in summer 2014 and concluding in summer 2015, having three seasons assessed (summer, winter, and spring). Given extreme weather conditions and access limitations to the most remote places, I was able to set cameras in just 49 stations during winter 2014. However, this limitation did not interfere with overall results.
Goal B. To model associations of habitat factors and prey abundances with American mink occupancy and detection probabilities during the three seasons.		✓		I successfully modelled habitat factors with occupancy and detection probabilities of the American mink. Initially, I planned to estimate prey abundance to use the information as covariates for the models. In my proposal I included rodents, birds, and insects. After discussing the project with my committee, they recommended that I only focus on birds and rodents, but also including muskrats. These species account for 70% of the mink diet on Navarino Island, and so the effort involved in estimating insects would not be worthwhile in comparison. However, the low density of rodents found and the difficulties while estimating avian abundance given bad climatic conditions during counting sessions, made this variable difficult to estimate without including large variation.
Goal C. To study spatial and temporal (seasonal) relationships between American mink diet and prey		✓		I collected a total of 174 scats to study American mink diet. I initially planned to use stomach contents. However, most of mink stomachs I analysed were empty and government agents did not trap mink intensively during

abundance.				2014. Therefore, I decided to collect scats to assess mink's diet to increase the sample size. Also, given that I could not be sure how long a scat has been on the ground or in a latrine, I decided to analyse data annually and not seasonally.
Goal D. To investigate rodent prey naivety to American mink predation.			✓	I conducted two natural experiments to investigate if a native rodent species (*Abrothrix xhanthirinus*) perceived mink odour as predation risk.
Goal E. To propose a management plan to control or eradicate American mink from Navarino Island.			✓	Using all information gathered from the study, I proposed a trapping strategy to control mink population in Navarino Island. The control programme based on this management plan is planned to start next spring 2015, directed by the Chilean Agriculture and Livestock Bureau (SAG).

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

During the course of the project I experienced some unforeseen difficulties. The first difficulty arose during the winter season, when I realised it was too dangerous to assess some of my remote field locations given the accumulated ice and snow on roads. Therefore, during the winter I was able to access just half of the camera locations. However, I still was able to get good information about mink occupancy during that part of the year, and the problem did not compromise general results.

The second unforeseen problem happened during the spring, when the vehicle provided by my advisor had severe mechanical problems. Repairing the vehicle involved taking it out from the island to the nearest city, Punta Arenas, on a ferry. This took over a month and, as a consequence, I could not use the vehicle during November. The problem was overcome thanks to the good relationship I built with local people in the island. Several people let me use their personal vehicles to continue my work.

Finally, after being in the island conducting a pilot study during the summer of 2013, I arranged with the agents of the Chilean Agriculture and Livestock Bureau (SAG) to get all mink trapped during 2014 to analyse stomach contents. However, SAG agents did not trap mink intensively during 2014. As soon as I realised I was not going to have an optimal sample size for my analysis, I decided to collect mink scats instead. I collected a total of 174 scats to study American mink diet and solved the problem.

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

First, my study showed that American mink on Navarino Island present high occupancy during the summer, occupying forested areas away from the shoreline or even streams. Occupancy dropped during the winter, with animals concentrating more closely to the shoreline during the spring. These data suggest that currently, given that most of the trapping activities occur during the summer, when mink are more active with juveniles dispersing, most of the animals that are being removed likely will not survive winter famine. In order to have a substantial effect on the population, reproductive adults should be removed. Therefore, trapping during the summer will not be effective in controlling the population if several animals remain inland and would subsequently recolonise the empty territories, at the time that adults are not removed. Therefore, allocating trapping efforts at the end of the winter and beginning of the spring when mink are occupying mostly shrub coastal areas, and reproductive adults are more likely to be eliminated from the population, would likely be more effective. In this way, SAG would have a better impact controlling mink population, and should avoid spending resources on trapping animals that likely will not survive the winter. I am currently working with SAG agents to develop an intensive trapping control during September and October of 2015.

The second most important outcome does not come from one of my specific objectives on the original proposal. Difficulties with estimating prey abundance and time in the field made me think about a different question. While assessing abundance of the muskrat (*Ondatra zibethicus*) I realised there was a close relationship between the muskrat, an important mink prey item, and the beaver (*Castor canadensis*), another invasive mammal in this ecosystem. I found that beavers create suitable habitat for muskrats, which at the time, represent almost 50% of the diet of mink that live inland. Ultimately, beavers may be playing a key role in the invasive system. Moreover, the idea of invasion meltdown arises in invasion ecology in the 2000s. Even though a lot of research has been done to support this hypothesis; most studies come from two species interactions, with only a few including mammal species. My results are showing a three-level interaction among three mammal species: American beaver, muskrat and American mink; something that is novel to the field. After discussing the idea with my advisor, I decided to put more effort into this question, and it will be a future chapter of my thesis. I am also presenting a talk on this subject at the Annual Meeting of the Ecological Society of America in August 2015.

The third most important outcome is related with education. Before starting my graduate studies in the USA, I worked for almost 3 years in a project in Argentina with Dr. Emiliano Donadio. That project was partially supported by the Rufford Foundation. I learned most of my field skills from that experience. During the course of my project, I was able to support four undergraduate and graduate students that received intensive training in field and lab techniques, as well as, quantitative techniques that today drive the field of ecology and conservation. The first of these students conducted his university practice, required for graduation in the Bachelor of Biology at the Pontificia Universidad Católica de Chile, and is now starting a magister programme at the same university. Another student was accepted at the master programme at the University of Florida, USA, planning to continue working with American mink ecology in Chile. The other two technicians were encouraged to continue working in conservation programmes in their own regions. I feel that with this project I was able to transmit some of the knowledge and conservation spirit I got several years ago when I was a technician. I believe that cultivating and continuing the initiative to conserve biodiversity was one of the most important outcomes of my project.

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

Having the grant and with it the opportunity to live in Puerto Williams, Navarino, while conducting my research, gave me the chance to get involved with the local community through different activities. I presented several talks in the local school and other local places organised by the Sub-Antarctic Biocultural Conservation Program. Furthermore, together with other biologists from the Sub-Antarctic Biocultural Conservation Program, we took children to the field where they had a "face to face" experience with nature, learning to appreciate local biodiversity and the threat that invasive species represent to it.

In addition, during February and March 2015, with my assistant Gabriel Nicolas Gomez, we presented two workshops for the local community of Puerto Williams, combining invasive species and photography topics. They were free and open to all of the people from the town. The goal of the workshops was to educate people about the problem of invasive species and, at the same, allow them an opportunity to learn more about photography. The activity was called "Through the eyes of the tree". The idea behind this metaphor was to make people "see" and "feel" as a tree through the lenses of a camera (such as the trap cameras attached to a tree) how new exotic animals affect local biodiversity that historically cohabitated with the forests. Many trees are more than 200 years old and have been alive before beavers, mink, dogs, and cows arrived to Navarino Island. Finally, and with support from the Sub-Antarctic Biocultural Conservation Program (SBCP), Puerto Williams Municipality, the Chilean Agriculture and Livestock Bureau (SAG), and local electricity company EDELMAG, we organised a photograph contest with the topic, exotic species. The municipality, EDELMAG and SBCP provided the awards, and SAG educational material about exotic species. People benefited from this activity as they could perceive those new inhabitants and be aware of the threat they represent to the ecosystem. At the same time, the activity encourages people to go into the forest to take photographs and have recreation activities outside the town.

5. Are there any plans to continue this work?

This project is part of my PhD dissertation. The objectives covered during the course of this project, represent 75% of my dissertation. I am planning to work further during next austral spring to investigate how mink affect forest bird reproduction.

I also plan to work further on the analysis and preparation of predictor variables to run the occupancy models. For instance, the geographic information data I have now present some spatial error that needs to be corrected. This will occur when I return to the University of North Texas, Denton, TX, USA, to write my doctoral dissertation. Also, I am planning to fully investigate vegetation data collected during sampling to include as covariates in the models, distinguishing analyses at micro-habitat level, from macro-habitat level. Finally, it is also likely that beaver (*Castor canadensis*) dams play an important role in explaining mink population dynamics, as I have observed that muskrats are highly associated with these modified habitats. Unfortunately, I do not have good geographic information to include this variable in the models. However, it is my goal to map beaver dams and include this variable in the analysis.

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

At the academic avenue I already published a manuscript based on the data of this project:

Crego, R.D., Jiménez, J.E., Soto, C., Barroso, O., &Rozzi, R. 2014. Tendencias poblacionales del visón norteamericano invasor (*Neovison vison*) y sus principales presas nativas desde su arribo a isla Navarino, Chile. *Boletín de la Red Latinoamericana para el Estudio de Especies Invasoras,* 4: 4-18.

I plan to publish at least three more papers that will result from my doctoral dissertation.
I will present one chapter of my dissertation in the 2015 Ecological Society of America (ESA) Annual Meeting, entitled: *The synergic trio of exotic mammals at the southern end of the Americas: Evidence of an invasional meltdown among beavers, muskrats, and mink on Navarino Island (55°S), Chile.*

At the technical avenue, I already presented a brief report of the main outcomes of this project to the Chilean Agriculture and Livestock Bureau (SAG). The information is being used to plan an intensive American mink population control plan that will start next spring 2015. It is common in the academy that all information is published in English. However, this results in a language barrier that prevents local agents to access much of the information. Therefore, I also plan to write a full report in Spanish to publish with the aim to make the information available to the regional SAG as well as to other managers in Chile and Argentina, where wild populations of American mink occur.

In terms of society and media, my project and activities related with the Sub-Antarctic Biocultural Conservation Program appeared on different Chilean news, showing the public the importance of managing the invasive American mink population on Navarino and other areas and the threat it poses to local biodiversity (see detailed report for a list of news). I have also participated in a Chilean TV documentary that shows biodiversity of Cape Horn, explaining the problems that invasive species represent in pristine ecosystems. This documentary will be shown in Chilean TV next year.

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

I started this project on January 2014 with funding from other sources. I finished this project in April 2015. The RSG was used to cover project expenses during the last 7 months of the project.

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
Travel expenses for technicians	£426	£444	- £ 18	Funds were spent as planned. The £ 18 were covered from the total surplus.
Housing - At Field Station in Puerto Williams	£730	£713	£17	Funds were spent as planned.
Food	£1466	£1466	£0	Funds were spent as planned
Gasoline for vehicle	£365	£395	-£30	I spent £30 more than planned. The £ 30 were covered from the total surplus.
Vehicle maintenance	£304	£85	£219	I covered regular vehicle maintenance with funds from RFG. When the truck presented severe engine damage, it was taken out from the island and the Sub-

				Antarctic Biocultural Conservation Program took responsibility for covering the costs.
Field supplies	£121	£123	-£2	Funds were spent as planned. The £ 2 were covered from the total surplus.
TOTAL	**£3412**	**£3226**	**£186**	

Given Chilean pesos suffered inflation, I calculated the exchange using the exchange rate at the beginning of each month: October 2014: 1GBP = 960CLP; November2014: 1GBP = 923CLP; December 2014: 1GBP = 962CLP; January 2015: 1GBP = 941CLP; February 2015: 1GBP = 957CLP; March 2015: 1GBP = 948CLP; April 2015: 1GBP = 918CLP

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

The ultimate goal of this project is to conserve biodiversity and natural ecological processes on Navarino Island. Fortunately, the regional government trough the Chilean Agriculture and Livestock Bureau (SAG) are going to provide financial support to conduct a control programme on mink population in the north coast of Navarino Island. Therefore, the most important next step will be to cooperate to management actions that SAG are planning to implement. On April 17th 2015, I met the regional director of SAG, Nicolas Soto, and the regional coordinator of exotic species of SAG, Rodrigo Molina. I explained the main outcomes of my project to them and presented a general report. They are using the information for planning the control programme. Furthermore, I will help SAG officer at Puerto Williams, Cristian Soto, during the spring with field activities. I recommended using camera traps to monitor the effects of the control programme on mink population. If cameras are provided, I will teach SAG agents how to use and set trap cameras, as well as, help with the monitoring design. Finally, I will help with the data analysis.

Another important step is to continue with the data analysis toward my PhD dissertation, and to publish these results and make them available to the academy. The American mink has been introduced in many other regions of the world; thus, results from this study can contribute with management actions in those regions. Also, I think that some of my results can contribute with general theories in invasion biology. Finally, many other questions arise from my results. Therefore, publications from this study will be the base for future research in the region.

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?

The logo was used when advertising the workshops and photograph contest "Through the eyes of the tree". Also, it was used, and it is going to be used in any academic or conference presentation related to this project. RSGF was mentioned and is going to be mentioned in every public talk, academic seminar I presented, or I will present.

11. Any other comments?

Together with this report, I attach a detailed report with the results from the field work and data analysis.