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	Andrea Loayza
Project title	Ecology and recruitment dynamics of *Myrcianthes coquimbensis*: A threatened endemic of the Atacama coastal desert
RSG reference	9531-2
Reporting period	01/27/2011-03/31/2012 (14 months)
Amount of grant	£5912
Your email address	loayza.andrea@gmail.com
Date of this report	04/04/2012

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
Establish the breeding system of *M. coquimbesis*			✓	See results detailed in question 3
Establish sources of seed loss of *M. coquimbesis*			✓	See results detailed in question 3
Establish the seedling emergence thresholds of *M. coquimbesis*			✓	See results detailed in question 3
Create a demographic model for *M. coquimbesis*			✓	See results detailed in question 3
Design a conservation strategy for *M. coquimbesis*		✓		See results detailed in question 3

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

Among the unforeseen difficulties were that the first breeding system experiment in the field did not work because most of the plants lost their entire flower crop due to drought. We thus repeated these experiments this year. Additionally, some of our marked plants in the field were cut down, presumably for fuel (i.e., fire). There was no way we could control this since most of our populations are isolated, but only a few individuals suffered this fate.

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

1. INFORMATION ON THE BASIC ECOLOGY OF *M. coquimbensis*

Seed loss rates. We established an experiment in the middle of the fruiting season in 2011 to establish the percentage of seed loss due to post-dispersal seed predation in the southern- and northernmost populations of *M. coquimbensis* (Totoralillo and Barrancones, respectively).

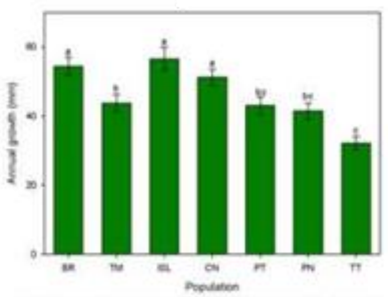

Figure 2. Mean length of new shoots produced by plants at each of seven populations (arranged from the Northern to the Southern edge of the distribution): BR, Barrancones; TM, Temblador; ISL, Isla; CN, Conchillas; PT, Punta Teatinos; PN, El Panul; TT, Totoralillo. Error bars show 1 SE.

Approximately the same percentage of seeds in Barrancones and Totoralillo (70% and 60%, respectively; no significant statistical difference) are lost to seed predators, which are mainly rodents and lagomorphs. Most of the predation occurs within the first two weeks after the seed has been dispersed. The remaining seeds usually desiccate, and are not consumed by seed predators. Desiccated seeds die and cannot establish. In terms of the temporal pattern of seed mortality, this does not differ statistically between both populations. **Together these results suggest that 1) the seed predation intensity is similar along the distribution range of *M. coquimbensis*, and 2) the majority of seeds are lost to seed predators (and desiccation), which severely limits the potential for this species to naturally recruit.**

Plant growth. We collected 20 new shoots from each population at the end of the growing season in 2011 to estimate the amount plants had grown. This is an important measure first, because it provides an insight as to whether plants were stressed during the growing season; that is, we expected plants that were drought-stressed to show little to no new growth. Second, determining whether plants grow each season is important because flowers (and consequently fruits) are produced within the new shoots, thus if there is no annual growth the plant will not produce flowers.

Plants in all of the seven populations sampled presented annual growth (Fig. 2). Generally, southern populations grew less than northern ones. In two to three months time, when ripe fruits become available, we will be able to determine if there is a relationship between the length of annual growth and the mean number of fruits produced per plant at each population.

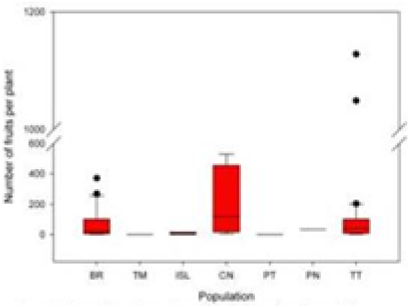

Figure 3. Boxplots of number of fruits produced per *M. coquimbensis* plant at each population

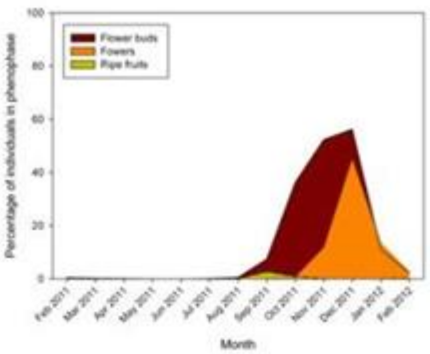

Figure 4. Percentage of *M. coquimbensis* individuals with flower buds, flowers and ripe fruits between February 2011 and 2012 across the whole distribution range.

Fruit production. We estimated fruit production from the 2010 flowering season, by counting all fruits in the fruiting plants within the plots at each population. Additionally, at each population we randomly selected fruiting individuals that were not within our plots. The overall mean number of fruits produced per *M. coquimbensis* plant across its distribution range is 62. This varied, however, largely among populations and individual plants (Fig. 3)

Plant phenology. To determine phenological patterns of *M. coquimbensis*, we established four permanent 25*25m plots at each of seven populations across its distribution range. Within plots, we individually tagged all plants, and followed their phenology once a month for 12 months. *M. coquimbensis* has flower buds from August to February. Flowers are open from October until February, with the peak of the flowering season in December. Ripe fruits, from the previous flowering season are available from August through mid October. During the 2010-11 season, only 13% (SD= 14%) of the individuals flowered, and less than 4% produced fruit. In contrast, in the 2011-2012 season almost 50% of the population flowered (Fig. 4). By September 2012, we will know what percentage of individuals fruited.

Emergence thresholds. To determine the minimum amount of rainfall necessary to trigger emergence of *M. coquimbensis*, we conducted a greenhouse experiment where seeds were irrigated with different amounts of water and at different frequencies. Specifically, we simulated four precipitation regimes (50 [R1], 80 [R2], 150 [R3] and 200 [r4] mm), each of which was distributed in one [F1], two [F2] and three [F3] pulses.

Table 1. Rainfall required to trigger seedling emergence of M. coquimbensis.

Rainfall amount (mm)	No emergence	Emergence	%	Total seeds
50	44	1	2,2	45
80	39	6	13,3	45
150	32	13	28,9	45
200	22	23	51,1	45
Total	137	43		180

Only the 43 of the 300 seeds (23,8%) emerged at the end of the experiment. Emergence increased with higher amounts of simulated rainfall (Table 1). Contrary to what we expected, however, emergence decreased with more "rain" pulses (Fig. 5). Our results suggests that *M. coquimbensis* requires approximately 150mm of annual rainfall to emerge, and that one or two pulses of rain per year are enough to ensure seedling emergence.

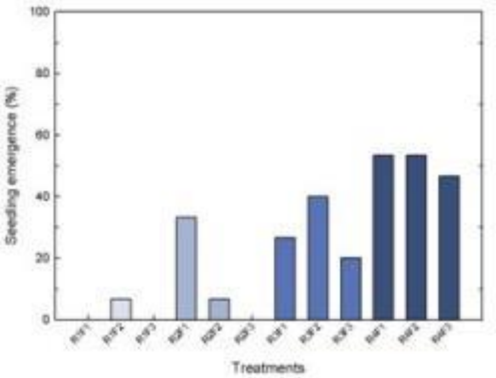

Fig. 5. Seedling emergence percentage observed as a result of applying a combination of different rainfall amounts at different frequencies. Rx denotes the rainfall amount and Fx denotes the frequency at which it was applied

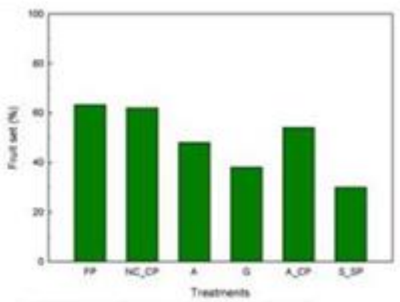

Fig. 6. Fruit set (%) observed for each pollination treatment. FP: Free pollination (Control); NC_CP: Natural condition self-pollination; A: Agamospermy; G: Geitonogamy; CP: Cross-Pollination and S_SP: Spontaneous Self-Pollination.

Breeding system. To determine the breeding system of *M. coquimbensis*, we performed controlled pollination experiments at the Totoralillo population. These consisted of six different pollination treatments for each plant. The treatments were a) Free pollination (FP), unbagged and untreated flowers; b) Natural conditions Cross-Pollination (NC-CP), the flowers were emasculated and unbagged; c) Agamospermy (A), the flowers were emasculated and bagged; d) Geitonogamy (G), the flowers were emasculated, hand pollinated with pollen from a flower of the same plant and bagged; e) Artificial Cross-Pollination (A-CP), the flowers were emasculated, hand pollinated with pollen from a flower of a different plant and bagged (S-SP); f) Spontaneous Self-Pollination, the flowers were left untreated and bagged. We marked 50 plants for a total of 300 flower replicates. Our results suggest that *M. coquimbensis* can produce fruit even in absence of pollination (note, however, that we did not evaluate whether seeds produced by such means are viable). However, the highest percent of seed set was when flowers are pollinated, which emphasizes the important role of natural pollination for fruit production in this plant.

2. DEMOGRAPHY OF *M. coquimbensis*

We created a demographic model (Fig. 7) using plant data from the established plots as well as additional plants outside the plots. Some of the transitions in the model were not observed during this year because of the long life cycle of the plant. We estimated these transitions based on our knowledge of the natural history of *M. coquimbensis*.

With the 2011-2012 transitions, the model revealed that over its distribution range the population of *M. coquimbensis* is stable (λ= 1.0056); in other words the population is not growing or shrinking. We caution over interpretation of these results, however, as 2011 was a year with above average rainfall (*approx.* 150 mm), and thus many of the transitions we observed were probably inflated in response to this precipitation. To have an accurate estimate of the true population dynamics, we need at least two more years of demographic data.

Elasticity analysis, using this one-year of data, suggests that reproductive adults contribute most to population growth. Consequently, it becomes particularly important to protect large reproductive adults in the field.

3. CONSERVATION STRATEGY OF *M. coquimbensis*

With the results obtained from this study, we are currently designing a conservation strategy for this endangered plant. The following are key points that will be included in this strategy:

- Seed loss to post-dispersal predation is high (>60%) in natural environments. Additionally, the few surviving seeds usually die because of desiccation. Therefore, to promote recruitment, a conservation plan for this species should consider establishing a tree nursery.
- Seedling emergence rates are extremely low. Only a third of the seeds emerge when simulated rainfall levels are 150mm, which is double the current average annual rainfall in the region. This result reinforces the need for a tree nursery to promote recruitment.
- Pollination services appear to be key to promote fruit set in this species. Thus, it is important to maintain this ecosystem service by protecting large areas of natural habitat where pollinators are abundant.
- The demographic data reveals that the population appears to be stable, although this result must be interpreted with caution. Additionally, the elasticity analysis shows that in situ conservation actions should focus on protecting reproductive shrubs, as this is the stage that contributes more to population growth rate.
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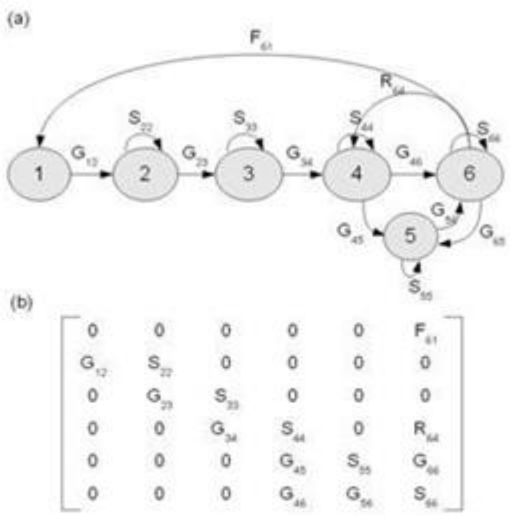

Fig. 7. (a) Life cycle graph for *Myrcianthes coquimbensis*. Circles correspond to plant stages (1: seedling; 2: sapling; 3: juvenile; 4: vegetative adult; 5: vegetative clone; 6: flowering adult). Arrows indicate potential transitions between stage classes. Matrix entries are subdivided in fertility (F), growth (G), stasis (S), and retrogression (R). (b) Population projection matrix corresponding to the life cycle graph in panel (a).

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

N/A

5. Are there any plans to continue this work?

Yes, we will continue monitoring the phenology another year and we will also study the population dynamics for at least two more years, so as to be able to create a more realistic stochastic population demography model. Additionally, we are planning on doing some seed dispersal studies with this species. Furthermore, we want to explore whether natural pollination rates are lower near urban areas than in isolated areas. This will allow us to examine whether populations near urban areas are even more threatened than previously perceived.

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

We are preparing a manuscript to be submitted to Biological Conservation. Results from this study will also be presented in scientific meetings. Finally, we are preparing a management plan to be handed to CONAF, the National Forestry Cooperation.

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

The funds for the project were used during 14 months; this is two more months that was initially anticipated. This is because we needed to wait for the appropriate phenological stages of *M. coquimbensis* to start certain experiments.

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.
Exchange rate used 1CHP=0.00129 £ sterling (this is the average exchange rate for 2011)

Item	Budgeted Amount	Actual Amount	Difference	Comments
Fuel	1395	1287.64	107.36	We obtained extra funds for fuel expenses and thus were able to reduce the original amount.
Food expenses for fieldwork	1935	1327.82	607.18	We were able to reduce the original amount estimated by buying food in bulk quantities. The amount we saved was used to cover field assistant stipends.
Field equipment (e.g. entomological kits, flagging tape, field books, tags, etc.)	972	967.47	4.53	
Computer/printer	1310	1305.43	4.57	
Shipping and handling fees	300	64.5	235.5	One of our team members travelled to the United States of America at the beginning of 2011 and was able to bring all the equipment. Thus we did not pay the original amount we estimated for shipping and handling. We

				used these funds to cover some of the stipends for field assistants.
Field assistant stipends	0	903	903	We did not originally consider a stipend for field assistants, however these needed to be included in the budget for two reasons: First, two of the original team members left the country, thus we were understaffed to conduct some of the experiments. Second, given that we had to monitor 7 populations and follow the fate of more than 1200 individual plants on a monthly basis, throughout the year, we needed field assistant to help with the data collection in the timeline required. This amount corresponds to a stipend of 10000 CHP/day/assistant (12.9 £ sterling/day) for a total of 70 days.
TOTAL	**5912**	**5855.86**	56.14	**To date we have 56.14 £ sterling left, which we will use for fuel for one more fieldtrip.**

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

Gather more information to obtain more accurate population dynamics. Obtain detailed information of the seedling emergence probabilities in the field, and determine how indirect effects of urbanization can further limit recruitment of this species.

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?

We will use the RSGF logo in every talk when we present our results. We will also use it in the management plan we are developing for CONAF. Finally, we will thank the Rufford Small Grant Foundation in the Acknowledgments section of scientific publications related to the project.