

Final Evaluation Report

Your Details	
Full Name	Marcelo Rodolfo Castro
Project Title	<i>Araucaria araucana</i> ecosystems at risk: climate and land use changes increase vulnerability
Application ID	36755-1
Date of this Report	12/06/2024

1. 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
Conduct a forest inventory to quantify the survival of seed trees and natural regeneration in sites that burned with different severity.				We carried out the forest inventory in 117 plots distributed in two fires that occurred in 2013-14. We measure more than 10 variables of forest structure and regeneration.
Conduct an <i>A. araucana</i> seed sowing experiment to evaluate the influence of the environmental characteristics of the microsites generated by fallen trunk on seed establishment processes.				We carried out the experiment. We sowed 2400 seeds of <i>A. araucana</i> (in the southern autumn and spring) near and far from fallen trunks in 60 plots distributed in different severity burned areas.
Conduct an <i>A. araucana</i> planting experiment (of nursery-grown plants) to evaluate the influence of environmental characteristics of post-fire microsites on plant survival and growth.				We planted 606 plants in total. Of this total, 288 plants (4 years old) were planted near and far from fallen trunks in 48 plots distributed in burned areas of different severity. The remaining 318 plants (of which half were 6 and 36 months old) were planted in groups in a 0.5 ha area burned at high severity.
Monitor the seeding experiment.				During the spring-summer of 2022-23 and 2023-24 we measured predation, emergence and survival of seed seedlings every 2 months.

Monitor the planting experiment.				At the end of each summer of 2023 and 2024 we measured the survival, and growth in height and neck diameter of each plant.
Monitor reforestations carried out by the Lanín National Park within the framework of the "Pewen Program"				At the end of each summer of 2022, 2023 and 2024 we monitored more than 1000 <i>A. araucana</i> plants. We recorded the survival and height growth of each plant.
Communicate the results of this project to the main actors and the scientific community.				We gave six talks to members of the Mapuche Ñorquinco community, Lanín National Park (PNL) technicians and Asociación Amigos de la Patagonia (AAP) volunteers. We presented the results obtained at the VIII <i>Congreso Forestal Latinoamericano</i> (CONFLAT) y V <i>Congreso Forestal Argentino</i> en Mendoza 2023; and at the Reunión Argentina de Ecología (RAE) en Bariloche 2023.
Publish results in a peer-reviewed journal				We submitted a manuscript to the journal <i>Forest Ecology and Management</i> for review

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

The main problem we faced during the project is the economic crisis in Argentina because it directly affected the project budget. In December 2021, we budgeted the project costs at an exchange rate valued at £ (GBP) 1 = \$ (ARS) 134.58; In May 2022 we received the grant at an exchange rate valued at £ 1 = \$ 145.11; and at the end of the project in April 2024 the exchange rate was valued at £ 1 = \$ 1087.33. From the beginning to the end of the project, the national currency was devalued by approximately 807.9 %. This situation caused a considerable increase in the price of goods and services included in the budget, for example, the price of diesel (£ / Liter) went from £/l 0.65 to £/l 1.08 (67 % increase).

To meet the proposed objectives and to reduce expenses, we choose to desist from the acquisition of the following goods: Apple iPad 5th generation, TruPulse 200L Laser Rangefinder, GPS Garmin GPSMAP 64sx, Suunto PM-5/360 PC Clinometer, LogTag HAXO -8 Temperature/Humidity Recorder. Thomas Veblen and Andrés Holz donated a laser rangefinder and 34 temperature/humidity sensors for the project.

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

- 1) We discovered that the abundance of seedlings of *A. araucana*, *N. obliqua* and *N. pumilio* is low in areas burned at high severity because of poor survival of seed trees. The abundance of *A. araucana* resprouts is also low in areas burned at high severity; in contrast, the abundance of *N. obliqua* resprouts is more abundant in these areas. High severity fires can divert the succession trajectories of *A. araucana* and *N. pumilio* towards non-forest states (e.g. grasslands or shrublands) or invasive pine forests that are typically more flammable.
- 2) We discovered that sowing *A. araucana* seeds in the austral spring significantly reduces seed predation compared to sowing in fall, which favours seedling emergence and survival.
- 3) We found that seedling survival is twice as high near downed logs compared to far from downed logs in high severity burned areas. We found that the soil moisture near fallen logs is three times greater than that far from the trunk. These findings allowed us to provide feedback to the restoration plans for the *A. araucana* forests in Ñorquinco.

4. What do you consider to be the most significant achievement of this work?

The most significant achievement of our project was to contribute with science-based knowledge to the reforestation plan carried out by the "Pewen Project" at the PNL to restore *A. araucana* forests affected by fires. Using the results obtained in this project we contributed to the design of reforestation protocols that were used in a series of plantations that were carried out in 2022, 2023 and 2024; and which are planned to be used in 2025. The information that is part of the reforestation plan involves the identification and georeferencing of vulnerable areas that require restoration, the identification of favourable microsites for sowing and planting, the determination of the appropriate seasons for sowing and planting, and the planting technique and design. We actively participated by informing, advising and collaborating in four plantations, where we helped in the reforestation of 75 ha of severely burned *A. araucana* forests with more than 20000 plants (produced in a nursery).

We also highlight that our project contributed to collaborative work, consolidating alliances with members of the Mapuche Ñorquinco community, volunteers from the

AAP, technicians from the PNL and other researchers from the Biodiversity and Environment Research Institute (INIBIOMA). With these actors we plan to continue restoring the burned area of Ñorquinco, we plan to plant 3000 *A. araucana* plants in September 2024. During 2025, we plan to do reforestation in other burned sites. In this way, that is, through collaborative management we can lay the foundations for adaptive management of the protected area at a local and regional scale.

Links documenting our achievements:

<https://www.instagram.com/p/C0B789IMxF0/>
(@pnlanin)

<https://www.instagram.com/p/CsD7A3kM4HZ/>
(@pnlanin)

<https://www.instagram.com/p/Cr-4BUBMcHZ/>
(@pnlanin)

<https://www.instagram.com/p/CsCluoqpA8Y/>
(@amigosdelapatagonia)

<https://www.instagram.com/p/CxoxZGkMlI3/>
(@amigosdelapatagonia)

<https://www.instagram.com/p/C7UcYmKJAZM/>
(@amigosdelapatagonia)

<https://www.instagram.com/p/C7XfzzGJZaD/>
(@pnlanin)

<https://aapatagonia.org.ar/un-hito-en-el-bosque-de-araucaria-araucana-de-norquinco/>

<https://aapatagonia.org.ar/crece-la-comunidad-que-restaura-el-bosque-de-araucaria-araucana-mas-de-100-personas-plantamos-3300-nuevas-nativas-desde-la-ong-nos-reunimos-junto-a-nuestro-voluntarios-con-el-parque-nacional-lanin/>

5. Briefly describe the involvement of local communities and how they have benefitted from the project.

Since the start of the project in 2022, I have interacted with members of the Mapuche Ñorquinco community, with more than 80 AAP volunteers, with NLP

technicians, with more than 50 Biology and Environmental Management students from Aluminé, and with nine PhD students from CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas). In September 2022, during a reforestation day, I presented my project "*Araucaria araucana* ecosystems at risk: climate and land use changes increase vulnerability" to the actors. The actors expressed their interest and highlighted the relevance of this project, as well as expressed their concern about the situation of these forests in the current context of global change.

Together with the main actors we carried out four plantations (in September 2022, May 2023, September 2023 and May 2024). Each plantation lasted 3 days, and more than 100 people participated in each one, and consisted of planting *A. araucana* plants (exceeding 20,000 plants in 75 ha of burned forests). The participants formed groups of five people, and each group moved plants to the indicated places, and planted them. Seed sowing was carried out with CONICET doctoral students and was planted in the fall and spring of 2022. Approximately 15 people participated in the plant survival monitoring at the end of each summer.

We adopted the tradition of holding "educational workshops and talks" at each plantation. The AAP gave recreational-participatory educational workshops on waste management, food web, hydrological cycle, among others. Members of the Mapuche Ñorquinco community and the PNL taught us about the cultural and spiritual importance of *A. araucana* to the Mapuche communities. In these talks, the members of this project presented preliminary results of the sowing and planting experiments, which served to inform the actors and plan the following plantations. The talks we presented were:

-Castro M, Veblen T, Holz A, Paritsis J. 2022. *Araucaria araucana* ecosystems at risk: climate and land use changes increase vulnerability. School 72-Ñorquinco Community.

-Castro M, Veblen T, Holz A, Paritsis J. 2023. Advances and results of restoration in Ñorquinco. School 72-Ñorquinco Community.

-Castro M, Veblen T, Holz A, Paritsis J. 2023. Study of seeds and seedlings in the field. 2023. School 72-Ñorquinco Community.

-Paritsis J. Fires and climate change in north-west Patagonia. 2023. School 72-Ñorquinco Community.

-Castro M. *Araucaria* regeneration: What are we learning? 2024. School 72-Ñorquinco Community.

During November 2023 we participated in the talk-workshop "Exchange of knowledge about the biocultural ecosystem of Pewen" held at school 72 of the Ñorquinco community. On that occasion we met again with the actors to take stock of what we had achieved and what remains to be done. We highlight that the most important achievement was to consolidate the joint work between the actors and focus efforts on the informed reforestation of severely burned areas of *A. araucana* forests.

- Veblen T, Castro M, Franco G, Holz A, Mundo I, Paritsis J. 2023. Dynamics and growth of *Araucaria* forests in Ñorquinco: Implications for the future under the current context of climate change. School 72-Ñorquinco community

6. Are there any plans to continue this work?

We are very motivated by the continuity of this project. In September 2024, we will participate in a new plantation. During 2025, we plan to continue monitoring the plantations (recording the survival and growth of the plants) and carry out new plantings both in the current sites, to compensate for the loss of plants due to mortality, as well as in new sites. With the Mapuche Ñorquinco community and the PNL we intend to start a project called "Self-management of the *Araucaria araucana* forests"; which objective is for the community to offer unique experiences (planting, sowing) to visitors, to involve tourists who visit the place as active actors. This conservation approach would generate multiple social and economic benefits and the empowerment of key actors, not only for the resident but also for the visitors (they would have the possibility of living unique experiences of scientific and cultural tourism, acquiring environmental and cultural knowledge, participating first hand being the protagonist).

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

Outreach to the local community. We will carry out different outreach activities, such as talks and workshops, both in the Mapuche Ñorquinco community and in other communities, where families (children and adults) can attend. We plan to return to the Mapuche Ñorquinco community in September 2024, within the framework of a new plantation, where we will present the results of the project and announce our future plans in the short and medium term. We will present the results to the PNL through a technical report that will include the results and conclusions of the project.

Scientific publications. The results will be presented at the "INIBIOMA 2024 colloquium", a space to share work in progress, projects, proposals and experiences between research groups from the institute, national/international guests and other research centres, organized by INIBIOMA. We will also present the results at other

national and international conferences. We already submitted a manuscript, related to objective one of this project, to *Forest Ecology and Management* for review and publication. We are also writing a second manuscript regarding seeding and planting experiments that we plan to publish in a peer-reviewed journal (e.g., *Ecological Applications* or *Journal of Environmental Management*).

Scientific networking: During the development of this project, we share our objectives, methodologies, and results with researchers from other parts of the country and the world who work on similar problems in countries such as Chile and the United States. In August 2022, we met with Dr. Mauro Gonzáles from the Universidad Austral de Chile in Valdivia to discuss the methodology of our project. In November 2023, Dra. Amy Concilio from St. Edward's University visited us to learn and chat about our seeding and planting experiments. We also held meetings with Dra. Paola Arroyo-Vargas from the Pontificia Universidad Católica de Chile, who plans to replicate our seeding and planting experiments in Chile. These interactions allowed us to improve our project and generate greater dissemination of it in other regions working on this problem.

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

The grant was used from May 2022 to May 2024. At the beginning of the project, we purchased all the necessary materials and instruments and the plants that we planted at the beginning of the experiments. During the spring/summer of 2022-23 and 2023-24 we made 11 trips to the study area (400 km from our workplace) to set up the experiments, monitor the experiments and participate in the plantings. Compared to the planned duration, the duration of the Rufford grant was adequate and useful to implement the project activities.

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

The next step to take is to process all the data, analyse it and transfer the main conclusions to a technical report. It will be a useful tool for NLP and will have potential to be used in other burned *A. araucana* forests (e.g. Rucachoroy and Tromen fires). The beginning of this project required a great effort, so we are going to continue monitoring the sowing and planting experiment to provide feedback to the restoration plan. With the main actors we intend to incorporate tourists as participatory actors in the restoration of *A. araucana* forests. These actions promote the recovery of tree vegetation and the conservation of *A. araucana* forests in the long term.

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

The Rufford Foundation logo was used in the different talks we gave and in presentations at scientific conferences. In the future, we plan to use the logo in other talks, as well as mentioning The Rufford Foundation in the acknowledgments and funding of manuscripts submitted for publication.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

-Marcelo Castro. Project leader, he participated in the construction of the idea and conceptualization of the project. He promoted joint work with the main actors. He was in charge of executing field activities, data collection and analysis. He led the writing of manuscripts and oral presentations.

-Thomas Veblen. He participated in the construction of the idea and conceptualization of the project. He promoted joint work with the main actors. He participated in the writing and revision of the manuscripts and oral presentations.

-Andrés Holz. Participated in the construction of the idea and conceptualization of the project. He promoted joint work with the main actors. He participated in the writing and revision of the manuscripts and oral presentations.

-Juan Paritsis. Participated in the construction of the idea and conceptualization of the project. He promoted joint work with the main actors. He was in charge of executing field activities, data collection and analysis. He participated in the writing of manuscripts and oral presentations.

12. Any other comments?

We thank The Rufford Foundation for the grant received, as it was essential to achieve the project's objectives with solid scientific bases. Given the socio-political context of Argentina, it is a real challenge for young scientists to obtain financing for their projects. Therefore, The Rufford Foundation plays a key role by providing funds to conduct research in developing countries, where knowledge is most needed and financial resources are scarce. Together with the main actors of this project, through shared management, we managed to take a great step on the path of conservation of *A. araucana*, although there is still a long way to go so, I hope to apply again for a RSG in a next future.



Figure 1. Actors who were part of the project. (@FedeAAP)



Figure 2. Plant survival from planting near a fallen trunk (@Marcelo Castro)



Figure 3. Survival of three seedlings from sowing seeds near a fallen trunk (@Marcelo Castro)



Figure 4. AAP volunteers (@FedeAAP)