Final Evaluation Report

Your Details	
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Project Title	Conservation of ancient lineages in ecologically dynamic scenarios
Application ID	37744-1
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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
Model the current and future ecological niche to identify and map vulnerable populations to forecasted climate trends.			X	We performed the modelling in four time periods: the last glacial maximum (LGM), current, and future in short and long terms, with two possible scenarios of greenhouse gas emission (ssp126 and ssp585) from 148 *Fitzroya* and 291 *Pilgerodendron* records. The results revealed a decline of both species into the future, particularly in the longer-term scenarios with the most drastic projections (ssp585). This indicates a loss of areas inhabited by populations, with the northern region being the most affected. In particular, Pilgerodendron shows a tendency to migrate southwards, due to its greater range of distribution.
Detect drought-adapted genotypes using GBS analysis.			X	We detected associations between climatic factors and genetic variants in potentially adaptive genes, highlighting those related to proteins involved in the response to abiotic stress, such as drought, as well as growth and reproduction functions.
Compare old molecular with new genomic techniques to review populations' conservation status.		X		A preliminary comparison was made between old molecular techniques and new genomic techniques to assess the conservation status of populations between *Austrocedrus* and *Pilgerodendron*. A more detailed

				analysis of *Fitzroya* populations at the molecular level is still needed to be able to make a more exhaustive comparison with the methods used in the past for the three species of Cupressaceae of Patagonia.
Perform experiments on *Astrocedrus* seedlings, i.e. the least vulnerable studied species, from contrasting precipitation regimes to detect drought adaptive differences			X	The seeds germinated and the seedlings were grown in common garden conditions for 24 months. Seedlings from humid forests grew larger than those from dry forests, suggesting differences in the genetic base. In addition, genetic differences were found between the two types of forests with potentially adaptive genes, suggesting that natural selection maintains divergence under contrasting climatic conditions.
Design climate-adjusted conservation and restoration plans that ensure the future sustainability of temperate dry and wet forests			X	Regions that are predicted to remain suitable can serve as future climate refuges, highlighting the importance of protecting these hotspots. Connectivity between populations of *Pilgerodendron*, facilitated by gene flow, underscores the need for conservation efforts to focus on maintaining or restoring corridors for natural genetic dispersal, along with *in situ* conservation measures. Long-term conservation plans should consider assisted migration or habitat restoration in areas that are projected to remain climate-stable. In addition, the drastic reduction of suitable habitat predicted for 2100 in the SSP 585 scenario calls for immediate actions to mitigate the impacts of climate change on this ancient

				conifer species, which plays a crucial role in the ecosystems of southern South America.

2. Describe the three most important outcomes of your project.

a) **Impact of climate change on species distribution:** The species studied are projected to experience a significant loss of their ecological suitability ranges in the future due to climate change. However, opportunities for migration to the south are on the horizon, where environmental conditions could allow species to thrive or, at least, sustain themselves. In particular, a large loss of suitable areas is anticipated in northern populations of *Pilgerodendron* in Argentina, underscoring the urgent need to implement conservation and management actions to mitigate these effects. Similar analyses are currently being performed in Fitzroya to assess its response to future climate scenarios

b) **Gene flow and adaptation to more arid environments:** Despite the high gene flow rates observed among *Austrocedrus* populations, the potentially adaptive genes found in dry-most ranges of the species could favour their prevalence in more arid environments. Species are adapted to a particular environmental gradient, suggesting that they have the potential to continue evolving to sustain themselves in these stressful environments. Significant associations have been found between their genetic characteristics and climatic and edaphic factors, which reinforces the idea that these species can adapt to slight changes in the environment.

c) **Genetic variability and its importance for survival under drought conditions:** Common garden experiments with *Austrocedrus* indicate that the genetic variability observed in individuals from contrasting environments at the plant and genomic level plays a key role in the survival of populations which can facilitate: (i) rapid adjustments and local adaptation of populations, (ii) assisted transfer of seeds from drought-resistant populations to other affected populations, and (iii) identification of drought-resistant-related genes that could be used in tree breeding programs.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

During the development of the project, several unforeseen difficulties arose that affected both data collection and analysis. One of the main ones was access to some sampling sites due to logistical constraints, especially in Los Glaciares National Park, where a lack of adequate sampling strategies and a single navigator with health problems made it difficult to collect samples. In addition, an attempt was made to work with the Naval Prefecture, but it was not possible to coordinate the necessary access due to bureaucratic issues. To solve this problem, it was decided to collect samples from more accessible areas, without the need for navigation on Lake Argentino. We consider that these samples are still representative of the populations of Santa Cruz province, which allowed us to continue with the collection without compromising the integrity of the study.

On the other hand, an additional challenge was the lack of time and resources to carry out a greater number of samplings in the province of Chubut, which limited the geographical coverage of the study. However, the collection of samples in a

representative and private area was prioritized. In the future, new strategies could be implemented to cover more sites in Chile, which would expand the understanding of the genetic distribution of species throughout the region.
In addition, genetic analysis presented technical difficulties related to the computational capacity to handle large volumes of sequencing data. To address this, part of the Rufford funding went toward the purchase of a computer with increased memory capacity and disk storage. However, the time required to process and analyse the data was longer than initially anticipated, which delayed some deadlines in the project.
Finally, an additional challenge was the loss of purchasing power due to inflation in Argentina, which affected the budget available for some project activities. Despite these economic setbacks, it was possible to adjust expenses and prioritize essential activities, allowing the project to continue its course successfully.

4. Describe the involvement of local communities and how they have benefitted from the project.

Throughout the project, we worked collaboratively with different owners of private reserves and national parks, promoting the involvement of local communities in the conservation of the species studied and in the understanding of their genetic diversity.
One of the main work sites was the *Estancia El Cóndor* in Santa Cruz province, where access is difficult, but the population of species remains highly conserved due to access restrictions. In this place, a genetic study had never been carried out previously to assess the state of diversity and vulnerability of the species, so this project represented an opportunity to generate scientific data that could be used in the management of the conservation of local biodiversity.
In *Corcovado* Chubut province, the plants are fenced, which helps prevent cattle from browsing and contributes to their preservation. This site had been the subject of previous studies, but only of a descriptive type, without a genetic approach. The project therefore provided valuable new information on the status of populations at the genetic level. The owners of the area were very committed and actively participated in the sample collection activities, which enriched the understanding of the species and their vulnerability.
In *Cordon Serrucho* Rio Negro province, an area that had already been the subject of previous genetic and descriptive studies, the local indigenous people actively collaborated without problems, and being a nature reserve area, the support of the members of the community was essential for the proper development of the project. The collaboration with this site made it possible to deepen the genetic analysis of the species and evaluate their evolution in a protected context.
Lago Escondido Rio Negro province was also a key private property in the study, where, as at other sites, no previous genetic studies had been conducted. The owners assisted in both accessing and understanding the importance of the work, which was reflected in the publication of a video on their Instagram page, where we explained and promoted the importance of scientific research.
In addition, we worked together with the National Park Administration, who provided logistical and strategic support in the collection of samples, as well as advice on the management of the populations. After each visit, detailed reports were prepared on the work carried out, suggestions to improve the situation of the populations, such as the repair of fallen fences that allowed the entry of bagual cattle, and the control of browsing in the outbreaks. Finally, in the Lago Puelo National Park at Chubut province, a talk to the local community is being organized on the use of Alerce

wood for the construction of stringed instruments by luthiers, which will allow us to continue strengthening ties with the local community and raise awareness about the conservation of natural resources in the region.
This collaborative approach not only benefited the project by providing access to key sites for research but also allowed local communities to gain knowledge about the genetic diversity of species and how to better manage their natural resources to ensure their conservation.

5. Are there any plans to continue this work?
Yes, there are plans to continue this work. We are very motivated by the continuity of the project. In particular, we have managed to capture the interest of other landowners to preserve these species and establish nature reserves dedicated to endangered species. In addition, the challenge of incorporating more populations from Chubut province is of great interest, since, due to constraints of logistics, time, and funds, this region could not be completely covered in the current study. In particular, areas within Lago Puelo National Park may contain valuable old-growth *Fitzroya* trees that could represent a significant genetic diversity reservoir of the species. It would also be very valuable to have the support and collaboration of colleagues in Chile to carry out a more comprehensive analysis of the species throughout its range. Also, analysing possible migration sites of these species to the south due to climate changes would significantly expand the understanding of their dynamics and conservation needs throughout the region.

6. How do you plan to share the results of your work with others?
To share the results of our work, we have an accepted article in a popular science magazine that covers science, the environment, and society called 'Desde la Patagonia difundiendo saberes' (SOBREVIVIR O MORIR DE SED - A. C. Premoli et al., 21(38): 8–16 DESDE LA PATAGONIA DIFUNDIENDO SABERES - VOL. 21 - Nº 38 - 2024 ISSN (print)1668-8848 - ISSN (online) 2618-5385). The work on the common gardens and genomic analysis of *Austrocedrus* has already been published in the Botanical Journal of the Linnean Society (2024, XX, 1–15; https://doi.org/10.1093/botlinnean/boae008). We have submitted a paper to Biological Conservation or Science of The Total Environment, where we present the main findings about *Pilgerodendron* which is under review. Additionally, we are finishing data analyses of a manuscript on modelling and genomic diversity of Fitzroya and in the process of developing a comparative study of the techniques used for the three species in the Cuppressaceae, which we also plan to publish in a high-impact scientific journal.
Beyond scientific publications, we plan to organize a community workshop to share the findings with the general public. This will help raise awareness of the importance of species conservation and engage local stakeholders. In addition, we have created educational materials, such as a video, which can be found on social media, to ensure greater reach and engagement. Spot fieldwork of *Fitzroya* at Lago Escondido https://www.instagram.com/tv/CbYjVv2AcNM/. We are also collaborating with local media outlets, such as Radio Nacional Bariloche, to further amplify the impact of our work and its implications for biodiversity conservation in the region under current threats as human-caused fires. Interview Radio Nacional Bariloche: Forest under fire, a great sadness...studies on the alerce, whose specimens of more than 1000 years old inhabit the Tristeza branch of Nahuel Huapi Lake under fire https://drive.google.com/file/d/1429cDxyzaUqiVQwW1tWTOaBLOoxfgx_N/view.

Also, a regional newspaper published an interview about the impact of fires on *Fitzroya* populations Nota Diario Rio Negro https://www.rionegro.com.ar/sociedad/incendio-en-brazo-tristeza-no-hay-otro-bosque-igual-en-la-zona-norte-del-parque-nahuel-huapi-3426238/. These efforts will ensure that our research not only reaches the scientific community but also contributes to conservation efforts on the ground. Moreover, these activities will help involve local communities, academic institutions, and key actors in biodiversity conservation, fostering a broader commitment to preserving the region's natural heritage.

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

The next step is to finalize the processing of all the data analyses and translate the main conclusions into a technical report. This will serve as a valuable tool for national parks and has the potential to be applied to other private sites. In addition, we will continue monitoring the common garden experiment to track its progress and gather further insights. This ongoing monitoring will provide valuable data for refining conservation strategies and ensure the long-term success of restoration efforts.

8. 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 has and is been used in all oral and printed presentations.

9. Provide a full list of all the members of your team and their role in the project.

- Dayana Diaz: The project leader participated in the construction of the idea and conceptualization of the project. She promoted joint work with the main actors. She was in charge of executing field activities, data collection, and analysis. She led the writing of manuscripts and oral presentations.
- Mariana Fasanella: led the common garden and drought experiment, along with data analysis from *Austrocedrus*.
- Ramiro Ripa: He collaborates with genomic analyses.
- Cintia P. Souto: Participate in the common garden and drought experiment, along with data analysis from *Austrocedrus*.
- Paula Mathiasen: Participated in the construction of the idea and conceptualization of the project. She promoted joint work with the main actors. She was in charge of executing field activities, data collection, and analysis. She participated in the writing of manuscripts and oral presentations.
- Andrea C. Premoli: Participated in the construction of the idea and conceptualization of the project. She promoted joint work with the main actors. She was in charge of executing field activities, and data collection. She participated in the writing of manuscripts and oral presentations.

10. Any other comments?

We would like to express our gratitude to The Rufford Foundation for the grant received, as it was essential in helping us achieve the project's objectives with a strong scientific foundation. Given the socio-political context in Argentina, it is a significant challenge for young scientists to secure funding for their projects. The Rufford Foundation plays a crucial role by providing funds for research in developing countries, where knowledge is most needed, and financial resources are scarce.

Together with the key stakeholders involved in this project, through collaborative management, we have made significant progress in the conservation of conifer species, although there is still much work to be done. For this reason, we hope to apply again for an RSG shortly.