Final Evaluation Report

We ask all grant recipients to complete a project evaluation that helps us to gauge the success of your project. This must be sent in **MS Word and not PDF format**. 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 – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please DO NOT fill in and submit this form until the project has been completed.

Complete the form in English. Note that the information may be edited before posting on our website.

Please email this report to jane@rufford.org.

Your Details	
Full Name	Monica Emilia Torres Almazán
Project Title	Enhancing Canopy Ecosystems: Integrating Vascular Epiphytes into Habitat Restoration for the Conservation of *Abronia campbelli*
Application ID	44095-B
Date of this Report	10/10/2025

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
Document vascular epiphyte diversity and abundance across *A. campbelli's* habitat range.			■	Surveys completed across elevation zones identified 43 vascular epiphyte species. This provided quantitative data on species richness and abundance to guide habitat restoration.
Assess the effectiveness of employing bromeliad transplants as a tool for habitat restoration in young forests comprising native tree species.			■	Bromeliad transplantation trials achieved a 95% survival rate, confirming the feasibility of integrating adult epiphytes into young forest stands.
Construction and implementation of a greenhouse for the propagation of native epiphytic plants.			■	The greenhouse was completed, equipped, and is now propagating key epiphyte species for future restoration efforts.

2. Describe the three most important outcomes of your project

a) **New ecological insight:** We successfully identified 43 species of vascular epiphytes that form the critical canopy microhabitat for *Abronia campbelli*. This discovery provides a blueprint for restoring epiphyte-rich ecosystems, guiding our efforts to recreate the complex environments that are essential for the species' survival. We also documented the distribution and ecological roles of key epiphyte species across elevation zones critical to the conservation of *A. campbelli*. In the low zone (1750 m), *Tillandsia usneoides* was identified as a dominant epiphyte, covering approximately 10% of trees with foliage and becoming the primary coverage when trees shed their leaves, underscoring its vital role as habitat for *A. campbelli*. In the high zone (1950 m), *Tillandsia usneoides* is absent, but other epiphyte species, including *Tillandsia orogenes*, *Werauhia werckleana*, and *Arpophyllum giganteum*, cover a larger proportion of trees, offering a more structurally complex environment potentially capable of supporting denser *Abronia* populations.

b) **Applied innovation:** Demonstrated a successful strategy for accelerating canopy recovery through bromeliad transplantation, achieving a 95% survival rate**.** The bromeliads were transplanted just before the onset of the rainy season, and six

months into the experiment, preliminary observations indicate that over 95% of the bromeliads have successfully attached to their new hosts and continued their life cycles without significant disruption. New growth, inflorescences, and seed production are comparable to those observed in undisturbed bromeliads from the source locations. By deliberately reintroducing adult epiphytes early in restoration efforts, we can address this challenge by providing localized seed sources, enabling continuous seed dispersal and establishment of new epiphyte populations

c) **Building restoration capacity:** A greenhouse dedicated to the propagation of the key species identified in this project has been successfully constructed. To ensure the successful operation of the greenhouse, FUNDESGUA participated in capacity-building visits to a local commercial producer of bromeliads. The facility is fully operational, and we anticipate the first generation of seedlings by 2026, further supporting our long-term restoration efforts. Building on the promising results of our bromeliad transplant experiment, where over 95% of adult bromeliads successfully adapted to new hosts, we are confident that epiphytes cultivated in the greenhouse can be similarly transplanted into recently reforested areas. Establishing bromeliads early in the reforestation process has the potential to accelerate the development of suitable habitats, enabling young trees to support *A. campbelli* populations much sooner than would occur naturally. This accelerated strategy could play a critical role in reducing the extinction risk for this critically endangered species.

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

Quantifying the relative abundance of vascular epiphytes presented one of the main technical challenges of the project. These plants grow high in the canopy of century-old trees, vary greatly in size and condition, and can number in the hundreds on a single host, making traditional count-based methods unreliable. To overcome this, we developed a high-resolution, non-destructive photogrammetric workflow that integrates gigapixel imaging, image processing, and three-dimensional reconstruction to quantify the area occupied by each species.

Using a Canon EOS R7 camera mounted on a motorized gimbal, we captured hundreds of overlapping images from five ground-based stations per tree and processed them in PTGui Pro and Agisoft Metashape Professional to generate stitched panoramas, three-dimensional mesh models, and orthomosaics with sub-centimeter precision. This approach provided reproducible, low-cost, and minimally invasive measurements of canopy composition and structure.

The method achieved high optical and spatial resolution, enabling the identification of many epiphytes to genus or species level directly from imagery, including individuals only a few centimeters in size. Beyond its application to *Abronia campbelli* habitat restoration, this workflow represents an important contribution to tropical ecology by providing a scalable, spatially explicit tool for studying within-canopy microhabitats, regions that were previously inaccessible without climbing-based surveys.

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

We counted on the active involvement of local people throughout the project. All fieldwork was carried out within privately owned lands, with the full support and participation of local landowners. The adult bromeliads used for transplantation were collected from the ground within these properties, and the trees selected for study, as well as the growing forests where transplant trials were established, are all located on their land. This collaboration strengthened local engagement in habitat restoration and promoted a sense of shared responsibility for the conservation of *Abronia campbelli*.

In addition, local youth volunteers participated in bromeliad collection and transplant activities, gaining hands-on experience in field conservation and learning about the ecological importance of epiphytes within the forest canopy. Through these activities, the project fostered environmental awareness, community inclusion, and local capacity to participate in ongoing restoration and research efforts.

5. Are there any plans to continue this work?
Yes. This research forms the foundation for our long-term restoration strategy for *Abronia campbelli*. The methodology and findings are being integrated into FUNDESGUA's ongoing habitat restoration program to enhance canopy recovery in previously reforested areas that have not been naturally colonized by epiphytes. We will continue applying these results to improve the structure and biodiversity of restored forests, ensuring they develop into functional habitats capable of supporting *A. campbelli* populations. In addition, the greenhouse established through this project will continue to operate as a permanent propagation facility for vascular epiphytes, supplying plants for future restoration initiatives within the species' range.

6. How do you plan to share the results of your work with others?
We are currently preparing a peer-reviewed paper to share the methodology developed through this project with the broader scientific community. In addition, we will present the findings at two upcoming events: the Association of Zoological Horticulture (AZH) conference in Tampa, USA (October 2025), and the First Herpetological Congress of Guatemala (November 2025). These presentations will contribute to both international and national discussions on innovative approaches to habitat restoration and the conservation of *A. campbelli*.

7. Looking ahead, what do you feel are the important next steps?
The next steps will focus on applying the methodology developed in this project to a larger sample of trees to obtain more robust ecological data and improve our understanding of epiphyte distribution across the landscape. We also plan to continue restoring habitat within *A. campbelli*'s range, integrating epiphyte propagation and transplantation into all future reforestation efforts to accelerate canopy recovery and enhance habitat quality.

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 was not used in project materials due to the research-focused nature of this phase, and the Foundation did not receive publicity during this period. However, the achievements of this project were made possible thanks to Rufford's support, and we will be highlighting this in two upcoming presentations: at the Association of Zoological Horticulture conference in Tampa, USA (October 2025) and at the First Congress of Herpetology of Guatemala (November 2025). These events will provide excellent opportunities to showcase the research and acknowledge The Rufford Foundation's key role in making it possible.

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

Mónica Torres: Project Coordinator and Principal Investigator. Led the overall coordination and scientific direction of the project, including research design, supervision of fieldwork, and integration of results into FUNDESGUA's broader restoration strategy for *Abronia campbelli*. Oversaw the construction and capacity building for the epiphyte greenhouse operation and prepared reports.

Thomas Schrei: Field Biologist, played a central role in field implementation and data analysis. Led the processing and interpretation of photographic and spatial data from the epiphyte surveys and photogrammetric workflow. Supported bromeliad collection, transplantation trials, and field monitoring, contributing significantly to methodological innovation, consistency, and accuracy in data outputs.

Cristian Ramírez: Nursery and Greenhouse Manager. Assisted in the construction and daily management of the epiphyte greenhouse. Provided technical expertise in the care and propagation of native species and coordinated with local landowners to facilitate restoration and field activities. As a member of the local community, Cristian also served as a vital link between the project team and local stakeholders, strengthening collaboration and community trust.

10. Any other comments?

No additional comments.

ANNEX – Financial Report

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