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	Vladimir Andrés Garmendia Fernández
Project Title	Unveiling the deep reefs of Chile: Quantifying the role of temperate mesophotic ecosystems for reef fishes and biodiversity conservation.
Application ID	44497-1
Date of this Report	12 of November, 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
Scientific achievements			X	The objective of conducting extensive fieldwork to study the benthic and reef fish biodiversity of mesophotic ecosystems (for the first time) across more than 3,000 km of the Chilean coast was successfully achieved. We conducted surveys in a total of 12 sites nested in 4 different localities (Punta Patache, Chañaral de Aceituno, El Quisco and Melimoyu). Some modifications were made, but these did not compromise the completeness or quality of the work. For example, certain localities (Punta Angamos and Punta Curaumilla) could not be visited due to logistical limitations; instead, alternative localities such as Melimoyu in Patagonia and Chañaral de Aceituno in the central-northern region were surveyed. In the case of Melimoyu, this addition allowed us to extend the project's latitudinal range into a remote area of southern Chile.
Education and Outreach: Social engagement with local communities			X	We believe this objective was also achieved with great success, as we were able to carry out outreach and educational activities in very remote areas of the country,

				such as Melimoyu in the south and Pisagua and Alto Hospicio in the north, which are often overlooked in the national context.
Conservation: Engagement with stakeholders		X		This objective was partially achieved. One of the main challenges was the difficulty in maintaining consistent communication with representatives from different organizations, as they generally had their own schedules and priorities. Despite this, valuable connections were established with government institutions such as the regional offices of the Ministry of the Environment in Tarapacá (northern Chile), as well as with civil society organizations (Corporación Norte Grande, Wildlife Conservation Society–Chile). I hope these initial connections will serve as a foundation for future collaborations and help ensure a strong continuation of this project.

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

a) Biodiversity baselines and environmental characterisation for mesophotic reef communities (fish and benthic organisms).

A key outcome of this project was the generation of the first biodiversity baselines and environmental characterisation of mesophotic reef communities for the study localities in Punta Patache, Chañaral de Aceituno, El Quisco and Melimoyu. Firstly, from a literature and fish-database revision, and then through technical diving *in situ* surveys, we documented the composition, richness, abundance, and biomass of reef fishes and benthic organisms across depth gradients, which included little-explored mesophotic reefs down to 60m depth. Overall, from literature and databases, we first documented that 1/3 of the global pool species of Chilean

shore-fishes are shallow-water specialists limited to 30 m (Figure 1), suggesting a high vulnerability to human-driven disturbances such as habitat fragmentation (kelp forest harvesting) or overfishing. They potentially do not have ecological niches in mesophotic reefs where to escape. From our *in-situ* surveys, we found that depth drives diversity decreases via species filtering (nestedness) and not replacement (turnover; Figure 2). The environment characterisation of reefs across depth strata (Figure 3) suggest that low oxygen concentration might constrain fish diversity and abundance in deep mesophotic reefs, especially in the north (see figure) where severe hypoxia occurred from 25m depth. The exception to this pattern was in the Patagonia, where mesophotic reefs presented oxygen-rich waters (>7.5mg/L). This finding highlights the vulnerability of mesophotic biological communities to low-oxygen concentrations, particularly in regions where salmon aquaculture farms are deployed, generating hypoxic conditions. In contrast to mesophotic communities from the other localities here assessed that drives under natural hypoxic waters, the Patagonian mesophotic reefs might be extremely vulnerable to these human-caused conditions. Another interesting result highlight Chañaral de Aceituno(29ºS) as a diversity hotspot across depth beyond shallow reefs. likely due to higher oxygen and as a biogeographic convergence zone.

These results provide a critical foundation for understanding species distribution patterns, ecological and biogeographical processes, and potential refugia in deeper reef habitats along Chile's coast. The resulting dataset might support future ecological assessments, long-term monitoring programmes, and evidence-based conservation planning for these vulnerable and understudied ecosystems. Although we were able to cover an extensive latitudinal span, we recognise that the number of localities must be improved in future efforts to better represent each ecoregion.

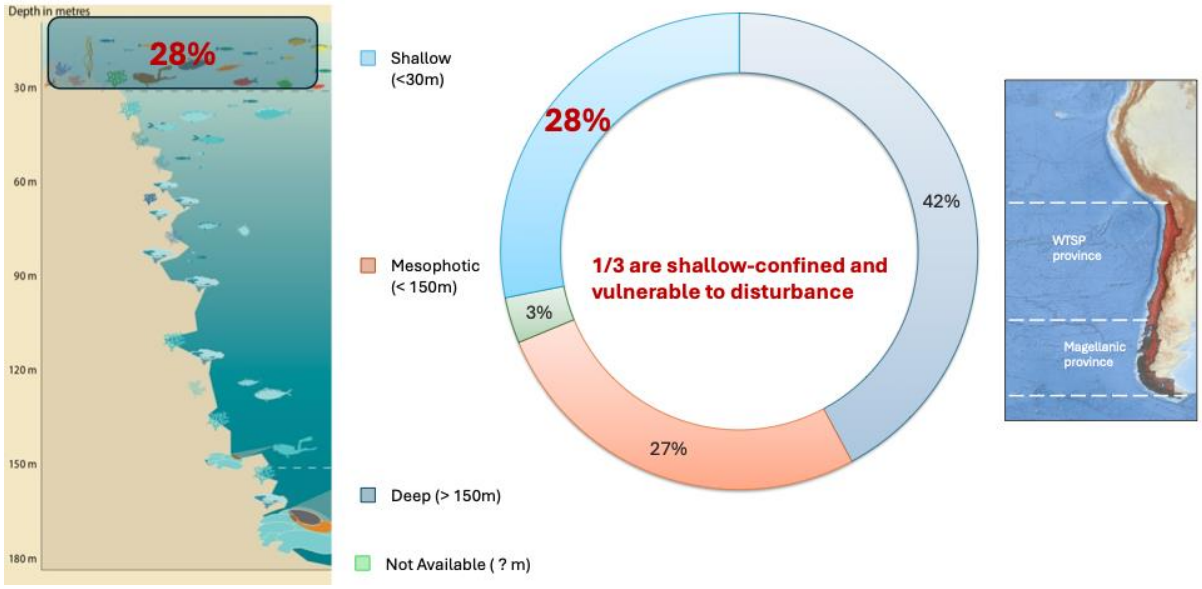

Figure 1. Maximum depth distribution of continental shore-fishes of Chile from literature and fish database revision (fishdatabase.org, biogeodb.stri.si.edu).

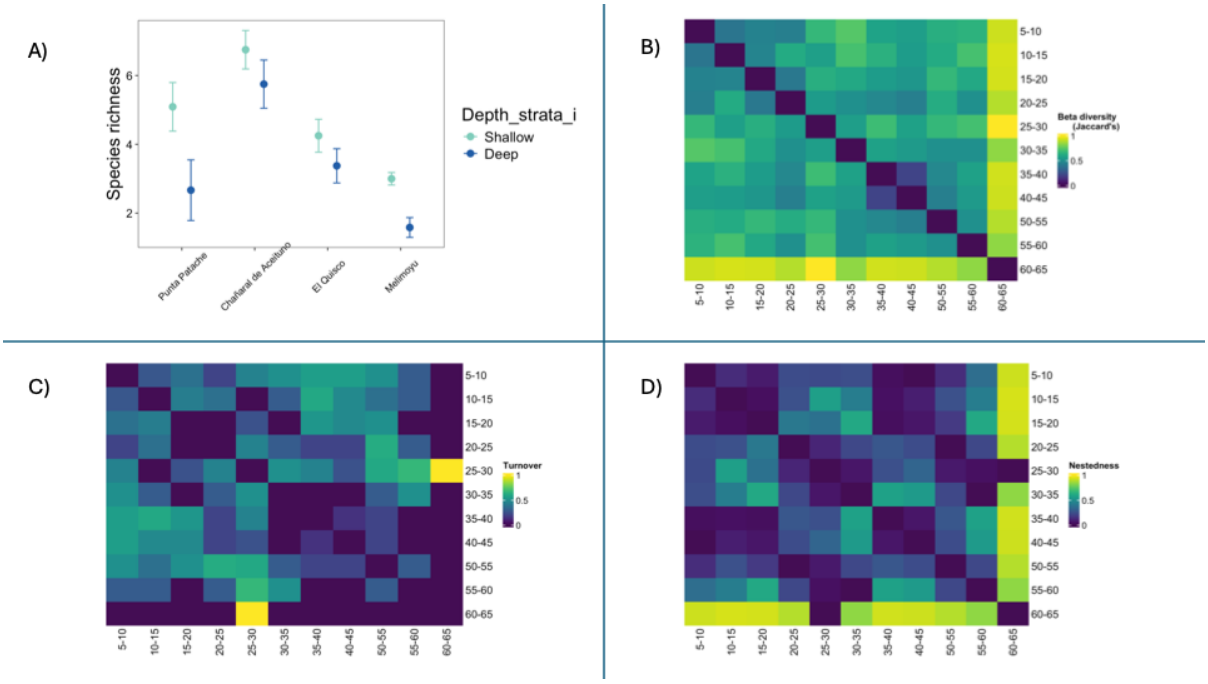

Figure 2. Species richness and Beta-diverstiy patterns. A) Species richness of shallow and deep (mesophotic) fish assemblages along the latitudinal gradients surveyed (Punta Patache ~20°S, Ch. de Aceituno ~29°S, El Quisco ~33°S and Melimoyu ~44°S).B) Overall Jaccard's dissimilarity of species composition across depth. C) Turnover and D) nestedness components of beta-diversity patterns.

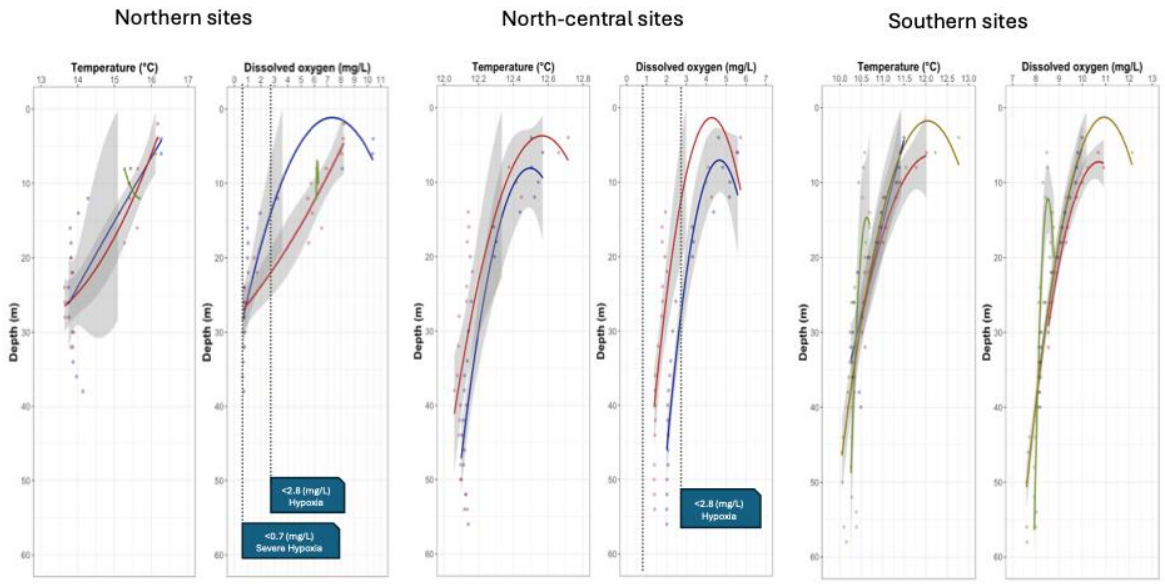

Figure 3. Environmental characterisation in terms of temperature (°C) and dissolved oxygen (mg/L) of study sites.

b) The successful performance of "Exploradores de lo Profundo" at two schools of the furthest northern locality (see photos below).

Another major achievement was the successful delivery of the outreach and education programme "Exploradores de lo Profundo" in two schools located in the most remote northern locality of Chile. This initiative introduced students and teachers to marine biology, deep-reef exploration technologies, and marine science/conservation concepts, which they had previously rarely had access to. Through hands-on activities, interactive lessons, and discussions with researchers, students (and teachers) gained awareness of the importance of marine biodiversity, mesophotic ecosystems, and environmental stewardship. The programme strengthened ocean literacy, inspired curiosity about scientific careers and local marine biodiversity, and reinforced the social value of conducting science outreach in underserved communities.

In the north, we could implement our outreach and educational programme "Exploradores de lo Profundo" to 15 students + 3 teachers in Pisagua and to 135 students + 5 teachers in Alto Hospicio. Additionally, we reached about 30 people during outreach activities in Melimoyu. In total we probably reached about 200 people directly through face-to-face outreach activities.

Figure 4. Teachers training in the northern schools.

Figure 5. Classrooms co-implementation of "Exploradores de lo profundo" alongside teachers to the students from both schools. (Pisagua: 15 students; Alto Hospicio: 135 students from 3 classes' groups). **[Intentionally removed]**

Figure 6. Remote monitoring and support of "Exploradores de lo profundo" by our outreach and scientific team with teachers' coordinators from both schools (Kathia and Tamara).

c) The establishment of a network for future collaborations related to the conservation of mesophotic reefs.

Although we were unable to hold a closure meeting/workshop where we gathered the different actors relevant to future management and conservation strategies, we believe the project enabled the development of new, valuable partnerships. Some strong collaborations were established with local stakeholders (fishers, tourism and diving centres), primary schools, government authorities of the Ministry of Environment, and social/environmentalist organisations (Corporación Norte Grande, Fundación Meri, Wildlife Conservation Society WCS | Chile), laying the groundwork for ongoing knowledge exchange, co-designed research initiatives, and joint conservation strategies in the future for mesophotic ecosystems in Chile. We are confident that this network will support and facilitate upcoming expeditions, data sharing, student and teacher training, and overall contribute to the long-term awareness, protection, and scientific understanding of mesophotic ecosystems in Chile.

FIGURE 6. Networking meeting between WCS members and Vladimir Garmendia (Rufford granted) for the exchange of ecological information related to fish diversity in the northern region of Tarapacá.

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

- Logistical and technical challenges associated with the diving operations arose, particularly in the two most remote regions (Patagonia and Tarapacá). In general, the technical diving infrastructure in Chile is still limited, which makes it difficult to secure essential supplies for rebreather diving (e.g., gases and sorbent material) or equipment maintenance (spare parts), especially when conducting extensive field research. To address these constraints, I carefully planned and optimised each field expedition, transporting all necessary equipment and consumables from our research base (ECIM in Las Cruces, on the central coast). For example, because no facilities were available to refill trimix cylinders in these remote areas, we purchased additional tanks in advance and transported them to the field sites to ensure a sufficient supply of mixed gas for the duration of our surveys.

- The decision to implement "Explorers of the Deep" in some of the remotest schools in Chile, which are often overlooked in scientific and outreach initiatives, presented notable challenges related to cost-efficiency and logistics. Specifically, we needed to coordinate the availability of two schools willing to collaborate within a reasonable timeframe (~one week), to avoid increasing per diem and travel costs and ensure the feasibility of delivering the programme in this remote region. By aligning visits, we were able to conduct the introductory educational activities (face-to-face) in both schools during a single trip to the north of our outreach team (Cele, Mayra and I). This logistical challenge was successfully addressed through clear communication and careful coordination with teachers and school principals. Furthermore, an initial exploratory visit that I undertook to present the project and its educational activities (see Appendix) was crucial to building trust, securing institutional support, and ensuring meaningful engagement. Although reaching these remote communities required greater effort, it strengthened

the project's social impact by engaging students who rarely benefit from this type of scientific outreach project.

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

Students and teachers from two schools in the northern localities (Pisagua and Alto Hospicio) were involved in our 4-week educational program "Exploradores de lo profundo".
Additionally, several local families with children from Melimoyu town (Patagonia) participated in our outreach activity during the expedition. We presented audiovisual material and live organisms in aquariums collected during our surveys in the area, to depict the largely unknown biodiversity to the local people. We also performed ludic activities to present the research equipment and methodologies (Figure 7). We believe they have benefited from these educational and outreach activities, including learning about the fascinating marine biodiversity that exists in their territories. It is highly unlikely that people want to protect in the future what they do not know. In this sense, it was rewarding and unexpected for us to receive comments from both children and adults about how surprised and grateful they were to learn about marine life diversity that they had no idea existed in the proximity of their coasts. Some of them stated that they had never visited the beach or the coast (Alto Hospicio school).
Another benefit of the "Exploradores de lo profundo" experience is that the children involved may develop an interest in science, exploration, and nature, as our approach focuses on fostering curiosity and creativity to explore the unknown twilight reefs in Mesophotic Ecosystems. We also recognised the student and teacher's teamwork, giving them a printed and framed picture (50x70cm) of Chilean mesophotic reefs photographed during our surveys (Figure 8).

Fishers and diving centres were directly involved during the fieldwork campaigns (Figure 9), providing logistical support, particularly in the localities of Punta Patache in the north (Tarapacá region) and Chañaral de Aceituno (Atacama region). In the case of the fishers from Punta Patache, who aim to foster tourism in the area as an alternative source of income in the future, we also supported them with audiovisual materials from our surveys that they requested.

Figure 7. Local community participation in scientific and outreach activities during expedition in Melimoyu (Patagonia.) **[Intentionally removed]**

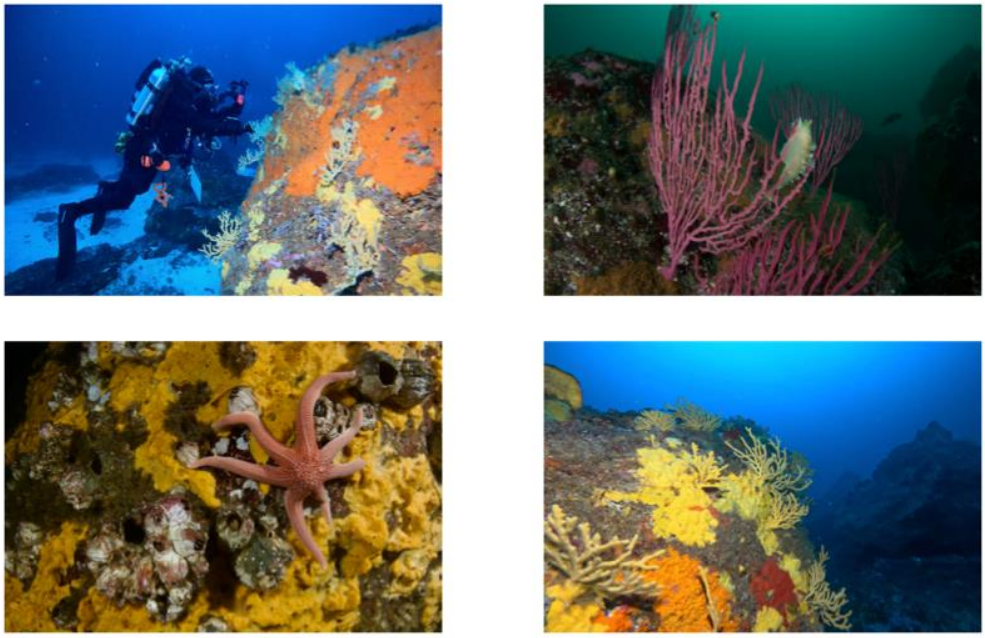

Figure 8. Printed and framed picture (50x70cm) of Chilean mesophotic reefs photographed during our surveys, for students' classes that participated in "Exploradores de lo profundo".

Figure 9. Local community involvement in scientific activities during expedition in Punta Patache (Tarapacá).

5. Are there any plans to continue this work?

Definitely! The study and conservation of mesophotic ecosystems (MEs) are still in their early stages worldwide, and this is particularly true along the Chilean coast. This first Rufford grant allowed us to take a significant initial step in describing the ecological and environmental patterns of MEs across a broad latitudinal range, raising awareness of their biodiversity, inspiring interest among local communities, and planting a seed of scientific curiosity in schools from remote areas.

However, continued efforts are needed to achieve long-term, meaningful impacts. Consequently, we aim to continue this work by applying for additional funding that will enable us to expand on what we have begun in these Chilean localities and to connect with other ongoing projects in mesophotic reefs of Latin America, such as those in the Galápagos and Brazil.

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

So far, I have had the opportunity to share these results with both general and scientific audiences, at national and international levels. In Chile, I presented the scientific and outreach outcomes to the scientific community at the "Estación Costera de Investigaciones Marinas" (ECIM-UC) in Las Cruces (central coast), where I am currently conducting my doctoral studies. The feedback has been very positive and supportive for future work. Furthermore, Dr. Robert Lamb (UF) invited me to present this data as part of a Seminar Talk at the School of Forest, Fisheries, and Geomatics Sciences at the University of Florida, USA (on September 12, in Gainesville, FL).
Additionally, this data comprises the first chapter of my PhD thesis, which I must submit in August of next year. Therefore, the next step is to publish these findings in a peer-reviewed scientific article, which I am currently working on.
Other scientific meetings where we present parts of the results derived from this project were the

- Indo-Pacific Fish Conference, 8 to 14 June 2025, Taiwan
- II Latin American Workshop on Mesophotic Reefs, 13-17 October 2025, Brazil.

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

The next important steps build directly on the foundation we have established. They are divided into key scientific and outreach priorities:

Scientifically, we must move from description to understanding mechanisms and long-term monitoring. The crucial next steps are to increase sampling efforts for better regional representation, establish temporal monitoring of our surveyed sites to track changes, and begin studying the behaviour and movement ecology of key mesophotic fish species. This is vital to understand their role and resilience, especially for species threatened in shallower reefs.
In outreach and education, the next step is to scale up our "Exploradores de lo Profundo" program. We plan to create opportunities for children from different regions, like Tarapacá and Patagonia, to connect and share their local knowledge of mesophotic ecosystems. Fostering this exchange is key to building a generation with a more integrated and large-scale perspective on the conservation of these deep environments.

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?

I included the Rufford logo in every presentation and document where information from this project has been generated (Figure 10 and 11). Moreover, Rufford was mentioned in webpage news and social media posting.

- https://exploradoresdelopr.wixsite.com/entrenamiento/general-8
- https://nutme.cl/2025/02/19/mas-de-100-infancias-de-alto-hospicio-y-pisagua-participaron-del-programa-exploradores-y-exploradoras-de-lo-profundo/
- https://www.instagram.com/p/DBVOJr6ueju/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA==
- https://www.instagram.com/p/DCesbsGO4ql/
- https://www.instagram.com/huiro_undrwtr/p/DDA2t4GOqe7/?img_index=5

Figure 10. Funding and acknowledgments slide of one of the presentations.

Figure 11. Document shared with schools and institutions in the Tarapacá region to present the "Exploradores de lo profundo" educational activities.

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

- Alejandro Pérez Matus: Professor at UC | Chile, PhD supervisor. He contributed as a scientific rebreather diver, conducted UVCs during fieldwork, and provided financial support, co-funding the project.
- Celeste Kroeger: Master's in Marine Biodiversity and Conservation (UC San Diego). She strongly supported the educational and outreach components of the project. Her role was crucial to the overall performance of "Exploradores de lo profundo" in the two schools located in remote northern localities. She participated in the in situ initial activities in schools, introducing and training teachers.
- Mayra Figueroa's role in the project as a marine biologist and educator consisted of leading the educational experience "Exploradores de lo profundo". She participated in the teachers' training from the beginning and then provided remote assistance, maintaining contact with them throughout the following weeks of the program. Her work was remunerated, as it involved long-term duties to successfully implement the "Exploradores de lo profundo" program in the schools.
- Rodrigo Alarcón: Diving Safety Officer at Estación Costera de Investigaciones Marinas UC. He provided technical support for diving plans, logistics and safety procedures for fieldwork activities. He participated as a safety diver in the

northern fieldwork expedition. Rodrigo was involved in the outreach activities as part of the fictional characters in "Exploradores de lo profundo".

- Tomás Walker: Marine biologist, research assistant and technical diver in NUTME. He provided diving support during fieldwork and participated in outreach activities in the southern locality of Melimoyu.
- Kathia Araya: Teacher at "Colegio Metodista Robert Johnson" in Alto Hospicio. She joined to our team during "Exploradores de lo Profundo". Her enthusiasm and leadership were essential in implementing the activity with her students (see Figure 6).
- Tamara Marin: Teacher and diver instructor at "Escuela básica de Pisagua". She joined to our team during "Exploradores de lo Profundo". As Kathia, we recognised her enthusiasm and leadership as crucial for implementing the activity with her students in Pisagua (see Figure 6).

10. Any other comments?

I genuinely appreciate the support of the Rufford Foundation in helping us protect mesophotic ecosystems in Chile through science and conservation. I am personally grateful for the opportunity to generate a more significant social impact from my PhD dissertation.

ANNEX – Financial Report

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