

## 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](mailto:jane@rufford.org).

Your Details	
<b>Full Name</b>	Manuel Vivanco Bercovich
<b>Project Title</b>	Surfgrass Under Threat: Developing Conservation Tools by Monitoring Seagrass Meadows in Baja California (Mexico)
<b>Application ID</b>	43604-1
<b>Date of this Report</b>	26 <sup>th</sup> November 2025 ("Revised version – January 2026")

**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
<p>Unveiling Resilience: Investigating how well PM resist current global and local threats will provide valuable insights into updating their conservation status</p>				<p>Three field monitoring campaigns were completed across multiple sites (n = 4) along Baja California peninsula. Preliminary findings show no retraction of meadows and relatively high shoot density and structural continuity at several locations, suggesting short-term resilience. Coverage maps and biomass data were generated (Annex II). Long-term monitoring is still needed to assess interannual trends.</p>
<p>Anticipating Future Trends: By using IPCC climate change scenarios, we'll forecast potential future trends for PM, supporting preventive management strategies</p>				<p>A paper titled "Crossing thermal limits: functional collapse of the surfgrass <i>Phyllospadix scouleri</i> under extreme marine heatwaves" was submitted to the <i>Journal of Experimental Botany</i>. The study used IPCC-based marine heatwave projections to anticipate physiological thresholds and future vulnerability of <i>Phyllospadix</i> populations across Baja California. Preprint is available on bioRxiv and included as Annex III.</p>
<p>Developing a Multivariate Index: The creation of the "SURFMEX" index will provide a rapid and efficient tool to track PM health over time, facilitating informed management decisions</p>				<p>The SURFMEX index was developed using data from three laboratory experiments exposing <i>Phyllospadix</i> to a range of thermal conditions. We modeled physiological responses (e.g., photosynthetic rate, chlorophyll fluorescence, respiration) and identified key predictors of foliar growth using GAMMs and Random Forest models. Field data confirmed that visual coverage is a strong proxy for biomass (<math>R^2 = 0.80</math> for aboveground biomass), supporting its inclusion in the index. While SURFMEX remains in a proof-of-concept phase, it provides a solid foundation for a scalable tool to inform adaptive management and conservation of <i>Phyllospadix</i> meadows.</p>
<p>Quantifying Unknown Value: Shedding light on the crucial but underestimated ecosystem services PM deliver, such as oxygen production, carbon and nitrogen capture, and fishery support, will highlight</p>				<p>Carbon storage was estimated using total biomass and seagrass coverage data, revealing a value of <math>11.4 \text{ Mg C}_{\text{org}} \text{ ha}^{-1}</math> for <i>Phyllospadix</i> meadows, surpassing typical values for tropical seagrasses (<math>2.5 \text{ Mg C}_{\text{org}} \text{ ha}^{-1}</math>) and kelp forests (<math>4 \text{ Mg C}_{\text{org}} \text{ ha}^{-1}</math>). However, estimates for nitrogen content and fishery support are still pending, as additional field and laboratory analyses are required to fully assess these services. These are planned for the next phase (2026).</p>

<p>their true economic and ecological significance.</p>			
<p>Establishing a Water Quality Gauge: Proposing PM as bioindicators of coastal water quality will aid in runoff management.</p>			<p>Although the project collected valuable environmental and physiological data, direct assessments of water quality, such as nutrient concentrations, turbidity, or chemical pollutants, were not included in this phase due to logistical and analytical constraints. Consequently, we were unable to evaluate <i>Phyllospadix</i> as a bioindicator of coastal runoff or anthropogenic pollution. However, our monitoring plan was deliberately designed to include both urban-influenced and relatively pristine sites, enabling comparative assessments that may reveal patterns of degradation in the long-term. These contrasting conditions will help identify potential water quality impacts on surfgrass meadows over time.</p>
<p>Contribute to Global Knowledge: Advancing understanding of seagrass resilience in a changing world and benefiting conservation efforts worldwide.</p>			<p>Through a combination of field monitoring, controlled laboratory experiments, germination trials, spatial mapping, and multivariate modelling, the project generated novel and high-resolution ecological knowledge on <i>Phyllospadix</i> resilience to climate stressors. These results advance global understanding of temperate seagrass responses to marine heatwaves, warming thresholds, and environmental variability. The development of the SURFMEX index provides a replicable framework for monitoring seagrass health, while the spatial coverage maps offer the first multi-site baseline for surfgrass meadows in Baja California. Findings have been disseminated through seminars, outreach activities, an international award (UNESCO MAB), and a manuscript currently under peer review, ensuring that the knowledge produced contributes meaningfully to global seagrass conservation science.</p> <p>A policy brief was not developed within the project timeline. As the project progressed, we realized that although the data collected were strong and informative, additional results—particularly on carbon storage and biodiversity associated with surfgrass meadows—are needed to produce a policy brief that would be truly useful and relevant for decision-makers. In hindsight, the original timeline for this output was ambitious. We therefore chose to postpone the policy brief to ensure it is based on a more complete and meaningful dataset. We expect to develop and share it after the summer 2026 field campaigns, once these additional analyses are completed.</p>

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

- **Outcome 1 – Improved ecological understanding of surfgrass responses to climate and anthropogenic stressors**

One of the main scientific outcomes of this project is a manuscript currently under peer review in the *Journal of Experimental Botany*, titled “Crossing thermal limits: functional collapse of the surfgrass *Phyllospadix scouleri* under extreme marine heatwaves.” This study uses IPCC-based marine heatwave projections and controlled mesocosm experiments to demonstrate how repeated and intensified warming events drive a physiological breakdown in surfgrass, including losses in photosynthetic efficiency, growth, and survival. These results provide robust experimental evidence of the thermal vulnerability and resilience limits of *Phyllospadix* populations in Baja California under realistic climate change scenarios. In parallel, we conducted an unplanned but highly informative germination experiment using seeds collected during the first field season from five populations distributed along a latitudinal gradient (San Juanico, Bahía Tortugas, Isla San Gerónimo, Tres Emes, and Todos Santos Island). Seeds were exposed to four temperature treatments (18, 22, 26, and 30 °C) in mesocosms. Lower temperatures (18–22 °C) consistently promoted higher germination success, whereas elevated temperatures (26–30 °C) drastically reduced germination, especially in the warm southern sites. These findings indicate that early life stages of *Phyllospadix* may be even more sensitive to warming than adults, with potential consequences for recruitment and long-term population persistence. This experiment will form the basis of a second manuscript planned for submission in 2026.

Field monitoring and mapping further strengthened our ecological understanding of surfgrass responses across space. Three seasonal campaigns at four core meadows (Todos Santos Island, Tres Emes/Ensenada, Bahía Tortugas, and San Juanico) generated baseline data on meadow structure (coverage, biomass, shoot density) and environmental conditions. Time series of seawater temperature from submerged HOBO loggers document seasonal variability and thermal anomalies since 2019, while kriging-based coverage maps reveal clear differences in meadow continuity and fragmentation among sites. Strong correlations between visual coverage and aboveground and total biomass ( $R^2$  up to 0.80) show that simple, non-destructive mapping can serve as a powerful proxy for surfgrass standing stock. Together, these experimental, germination, and monitoring datasets provide a multi-scale, integrated picture of how *Phyllospadix* meadows respond to climate and local stressors, and establish a solid ecological baseline for future long-term monitoring and conservation planning.

- **Outcome 2 – A multivariate index (SURFMEX) to assess meadow condition**

The SURFMEX index was developed as a multivariate tool to quantify surfgrass ecological condition under varying environmental and thermal regimes. Its foundation is based on three controlled laboratory experiments in which *Phyllospadix* individuals were exposed to a gradient of temperatures representing present-day conditions and projected marine heatwave scenarios (18, 21, 25, and 29 °C). Across these trials, we measured key physiological variables—including photosynthetic rate, chlorophyll fluorescence parameters, respiration, and daily oxygen production—and modelled their relationships with foliar growth using

Generalized Additive Mixed Models (GAMMs) and Random Forest algorithms. These analyses revealed a consistent suite of indicators with strong predictive power for growth, such as effective quantum yield, maximum oxygen production, and daily productivity, as well as negative predictors including basal fluorescence and compensation irradiance. These variables form the physiological backbone of SURFMEX and provide a mechanistic basis for assessing thermal stress responses.

In parallel, field monitoring strengthened the structural component of the index. Coverage and biomass data collected across three seasons and four meadows demonstrated robust correlations between visual coverage and aboveground biomass ( $R^2 = 0.80$ ) and total biomass ( $R^2 = 0.73$ ), indicating that georeferenced photographic surveys can serve as a powerful and cost-effective proxy for estimating surfgrass standing stock. These findings support the inclusion of coverage and spatial continuity as structural indicators within SURFMEX, complementing the physiological metrics derived from the laboratory work. Mapping outputs, such as kriging-based coverage models, further revealed clear differences in meadow condition among sites, reinforcing the relevance of spatial structure for ecological assessment.

With both components combined, SURFMEX is currently at a robust proof-of-concept stage. The next step is calibration and validation using the expanding field dataset from 2025, allowing us to refine sensitivity scores and integrate structural and physiological indicators into a unified index. Although full operational implementation will require additional monitoring cycles, the development of SURFMEX represents a major methodological advance for surfgrass conservation: it provides an empirically grounded, scalable, and replicable framework capable of supporting future long-term ecological assessments, early-warning detection of stress, and adaptive management decisions for *Phyllospadix* meadows across Baja California and beyond.

- **Outcome 3 – Strengthened outreach, community engagement, capacity building, and international recognition through high-quality research**

The project placed strong emphasis on outreach, capacity building, and community engagement, ensuring that scientific results were translated into broader awareness and stewardship at the local scale. Throughout the project period, undergraduate students, early-career researchers, educators, and coastal community members were actively involved in field monitoring, spatial mapping, sample processing, and outreach activities. This not only expanded the project's operational capacity but also strengthened local human capital for long-term surfgrass conservation.

Undergraduate students from UABC played a central role in field operations, participating in underwater surveys, GPS-based mapping, biomass sampling, photo-quadrats, and laboratory processing. Their participation provided essential hands-on training in marine ecology and seagrass methodology, while fostering a new generation of coastal conservation practitioners.

The project communicated its scientific progress through three scientific seminar presentations, facilitating dialogue with researchers and promoting interdisciplinary exchange. In addition, four public outreach events helped disseminate ecological knowledge to non-specialist audiences, strengthening public understanding of the ecological importance of *Phyllospadix* meadows and the threats they face.

To reach a broader audience, the project maintained an active presence on Instagram (@surfgrass.project), where monitoring updates, maps, field photos, and

explanatory posts were shared regularly. Tagging The Rufford Foundation in relevant posts also helped increase international visibility of the funded work.

A major outreach milestone was the community surfgrass mapping workshop held at San Miguel Beach (Ensenada), where local participants learned about surfgrass ecology, basic mapping techniques, and the importance of coastal monitoring (Annex IV). This event fostered meaningful community engagement and contributed to local capacity building.

Finally, the project's scientific quality and conservation relevance were recognized internationally when it received the 2025 UNESCO MAB Young Scientist Award (Annex V). This distinction reflects the broader impact of the work, highlighting its contributions to ecosystem-based management, climate resilience, community involvement, and innovative methodological development. The award significantly elevated the project's international profile and supports its future expansion and collaboration potential.

Overall, the project successfully combined high-quality scientific research with meaningful community engagement and capacity building, ensuring that its conservation impacts extend from the local to the international level.

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

Several unforeseen challenges arose during the implementation of the project, primarily related to logistical constraints and extreme weather conditions:

- **Site substitution due to environmental conditions (Summer 2024).** During the first expedition, we reached Magdalena Bay (MAG) as planned, but underwater visibility was far below the minimum required for mapping or photographic surveys. To avoid compromising data quality, MAG was excluded from subsequent campaigns and replaced by two alternative sites—San Juanico (SJU) and Bahía Tortugas (BTO)—which offered better conditions and allowed us to maintain the intended spatial coverage of the project.
- **Winter visibility and access limitations (Winter 2025).** By winter 2025, MAG had already been removed from the sampling plan. However, SJU presented poor visibility, preventing safe and meaningful underwater work. To adapt, we focused efforts on the three accessible sites, Todos Santos Island (TSI), Tres Emes/Ensenada (3MS), and Bahía Tortugas (BTO), ensuring continuity in core data collection even under suboptimal seasonal conditions.
- **Extreme weather interruption (Summer 2025).** During the summer 2025 season, a tropical cyclone affected southern Baja California, interrupting the first planned field trip. This required an additional expedition to complete the work. Ultimately, we successfully monitored all four target sites (SJU, BTO, 3MS, and TSI) during the second attempt, but at the cost of extended travel and logistical effort.
- **Increased analytical workload and processing delays.** The volume of material collected during the field campaigns was larger than originally anticipated, resulting in a substantially higher workload for biomass, sediment, and elemental analyses. This extended the time required for laboratory processing beyond the

initial project timeline. Priority variables were completed on schedule, while the remaining samples are being processed as part of ongoing work at the Marine Botany Laboratory.

- **Stakeholder workshop.** No formal stakeholder workshop was conducted within the project timeline. In retrospect, organizing a full multi-institutional workshop at an early stage proved to be ambitious, particularly before completing core field campaigns and analyses. A formal stakeholder meeting (rather than a workshop) is planned for 2026, once additional results are available.

Despite these challenges, the overall goals of the project were met or exceeded, and the experience gained informed adaptive adjustments to both our monitoring protocol and analytical pipeline for future efforts.

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

The project actively involved local communities, particularly fishers, students, and coastal residents, in various stages of monitoring and outreach:

- **Community-based fieldwork:** Field expeditions were conducted in coordination with local fishing cooperatives in Ensenada and Bahía Tortugas, strengthening relationships with those who depend on healthy coastal ecosystems. Their logistical support and local knowledge were essential to accessing remote surfgrass meadows.
- **Student training and capacity building:** Undergraduate students from the Universidad Autónoma de Baja California (UABC) were actively trained and involved in surfgrass mapping, biomass sampling, and sample processing. Their participation provided hands-on experience in marine ecology and field survey techniques, helping build local scientific capacity. In addition, the team organized a community Seagrass Mapping Workshop during a beach festival at San Miguel beach, where students, youth, and coastal residents participated in a citizen-science activity and learned the basics on how seagrass mapping is performed.
- **Public outreach and science communication:** Throughout the project, we participated in local science events—including Casa Abierta IIO, Noche de Ciencias, and Semana de Ciencias—where we engaged a wide audience through talks, demonstrations, and interactive activities on seagrass ecology. Our dedicated Instagram account (@surfgrass.project) also served as an accessible platform to share updates, infographics, field stories, and educational content in Spanish, helping connect with coastal stakeholders, divers, students, and the broader public.

#### **5. Are there any plans to continue this work?**

Yes, we plan to continue this work beyond the original project timeline, subject to future funding availability. A new monitoring campaign is already planned for summer 2026 to update spatial and physiological data from surfgrass (*Phyllospadix*) meadows. We also aim to expand the current protocol to include assessments of

associated fauna and to further quantify ecosystem services such as carbon and nitrogen storage and fisheries support.

To help sustain and build upon this work, we were honored to receive the UNESCO MAB Young Scientist Award (2025), which will support specific components of the upcoming research. However, we are also preparing a second application to the Rufford Foundation to ensure continuity and broaden the project's impact.

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

We have actively disseminated our findings through multiple channels throughout the project, ensuring that results reach scientific, management, and community audiences. Oral presentations at academic seminars, poster sessions at scientific conferences, and participation in public science outreach events have provided opportunities to share preliminary results and engage with diverse stakeholders. In addition, we organized a community-based seagrass mapping workshop at San Miguel beach, which deeply engaged students, and coastal users in hands-on monitoring activities and strengthened local stewardship. During the project, we initiated direct communication with key institutional stakeholders involved in protected area management (CONANP) and fisheries management (INAPESCA and IMIPAS), sharing preliminary findings and discussing the relevance of surfgrass monitoring.

Our dedicated Instagram page (@surfgrass.project) has steadily grown and remains an accessible platform for communicating progress and results to broader audiences. We frequently share visuals, maps, field updates, and key ecological insights, helping raise awareness about surfgrass conservation and the challenges these ecosystems face. Tagging The Rufford Foundation in relevant posts also increases the visibility of its support and impact.

Looking ahead, we plan to continue disseminating results through peer-reviewed scientific publications. Two manuscripts are currently in preparation: One focused on seagrass spatial coverage, biomass, and blue carbon content, based on the extensive mapping and analytical work conducted during the project. Another examining the thermal sensitivity of early life stages, derived from the germination experiment using seeds collected across a latitudinal gradient.

In 2026, we plan to present these results at national scientific meetings, further strengthening the project's visibility and contributing to the global understanding of *Phyllospadix* ecology and resilience. Community engagement will also continue through new outreach events, citizen-science activities, and training opportunities for students and local coastal users. Additionally, a magazine article focused on the ecological role, ecosystem services, and conservation importance of surfgrass meadows is planned for 2026, once the main scientific results are fully consolidated

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

Looking ahead, several key steps are essential to consolidate the progress achieved during this project and to ensure long-term conservation of *Phyllospadix* meadows in Baja California:

- **Maintain long-term monitoring to capture interannual variability.** The three campaigns completed so far provide a strong baseline, but long-term datasets are essential to detect trends, recovery trajectories, and responses to episodic disturbances such as marine heatwaves, storms, and runoff pulses. Maintaining annual monitoring at the core sites (TSI, 3MS, BTO, SJU) will be critical.
- **Expand the assessment of ecosystem services.** Preliminary carbon stock estimates indicate that surfgrass meadows store more organic carbon than many tropical seagrasses and kelp forests. Further work is needed to quantify nitrogen cycling, fishery support values, and economic valuation, which can help position *Phyllospadix* meadows within coastal resource management frameworks.
- **Strengthen community-based monitoring and local stewardship.** The mapping workshops and student involvement demonstrated strong community interest. Developing a citizen-science component, using simple coverage surveys, snorkel-based mapping, or drone imagery, would help maintain continuous datasets and increase ownership of surfgrass conservation.
- **Complete the validation and operationalization of the SURFMEX index.** The next phase requires integrating the 2025 field data into the multivariate framework, refining indicator weights, and performing sensitivity and validation tests. Establishing threshold values for “good,” “intermediate,” and “degraded” meadow condition will allow SURFMEX to function as a practical monitoring and management tool.
- **Foster regional and international collaborations.** Building on the visibility gained through this Rufford-funded project, and reinforced by the UNESCO MAB Young Scientist Award, the next steps include strengthening collaborations with national and global seagrass networks (Raíces Marinas, Red Mexicana de Pastos Marinos, MarineGEO, Seagrass-Watch, Project Seagrass). These partnerships will support comparative analyses, methodological harmonization, and broader-scale conservation initiatives.

## 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?

Yes. The Rufford Foundation logo was actively used and consistently acknowledged throughout the project. The logo appeared on all seminar presentations, the scientific conference poster and in every post shared on our dedicated Instagram page (@surfgrass.project), where the Foundation's official account was also tagged. Also, its support is highlighted in the acknowledgements section of the manuscript currently under peer review. Furthermore, during outreach activities, such as the community seagrass mapping workshop and public science events, the Foundation's support was verbally acknowledged, helping reinforce its role in enabling the project.

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

- **Dr. Manuel Vivanco Bercovich – Project Leader.** Responsible for overall project coordination, field planning, data collection, laboratory analyses, statistical analysis and modelling. Led the temperature experiments, germination trial, mapping design, manuscript preparation, and all reporting to The Rufford Foundation. Oversaw student involvement, outreach activities, and dissemination efforts.
- **Dr. Jose Miguel Sandoval-Gil – Principal Scientific Advisor.** Provided scientific oversight and methodological guidance across all research components. Supported the design of field surveys, physiological experiments, and analytical approaches. Contributed expertise in seagrass ecology, coastal ecosystem monitoring, and experimental design. Facilitated laboratory access, equipment, and institutional support through the Marine Botany Lab at UABC.
- **Bsc. Jessica Anayansi García Pantoja – Field Coordinator.** Coordinated field logistics, led SCUBA-based monitoring activities, and supported the acquisition of biological samples, environmental data, and georeferenced photographs. Conducted species identification, seagrass structural measurements, and mapping tasks. Assisted with data processing, equipment maintenance, and community engagement events. Her AAUS training and extensive diving experience were essential for ensuring safe and efficient fieldwork.
- **Undergraduate Students (UABC Marine Botany Lab) – Field and Laboratory Assistants**  
A rotating group of undergraduate students supported field operations, including transect surveys, photo-quadrat imaging, GPS-based mapping, and basic equipment handling. In the laboratory, they assisted with biomass sorting, sample drying, elemental analysis preparation, and data entry. Their involvement strengthened capacity building and contributed significantly to field productivity and community outreach.
- **Local Community Participants – Outreach and Citizen-Science Collaborators**  
During the community surfgrass mapping workshop and public outreach events, local stakeholders, divers, educators, and coastal users contributed to mapping efforts, ecological discussions, and awareness-building. Their participation strengthened the project's social impact and supported the development of community-based stewardship initiatives.

## 10. Any other comments?

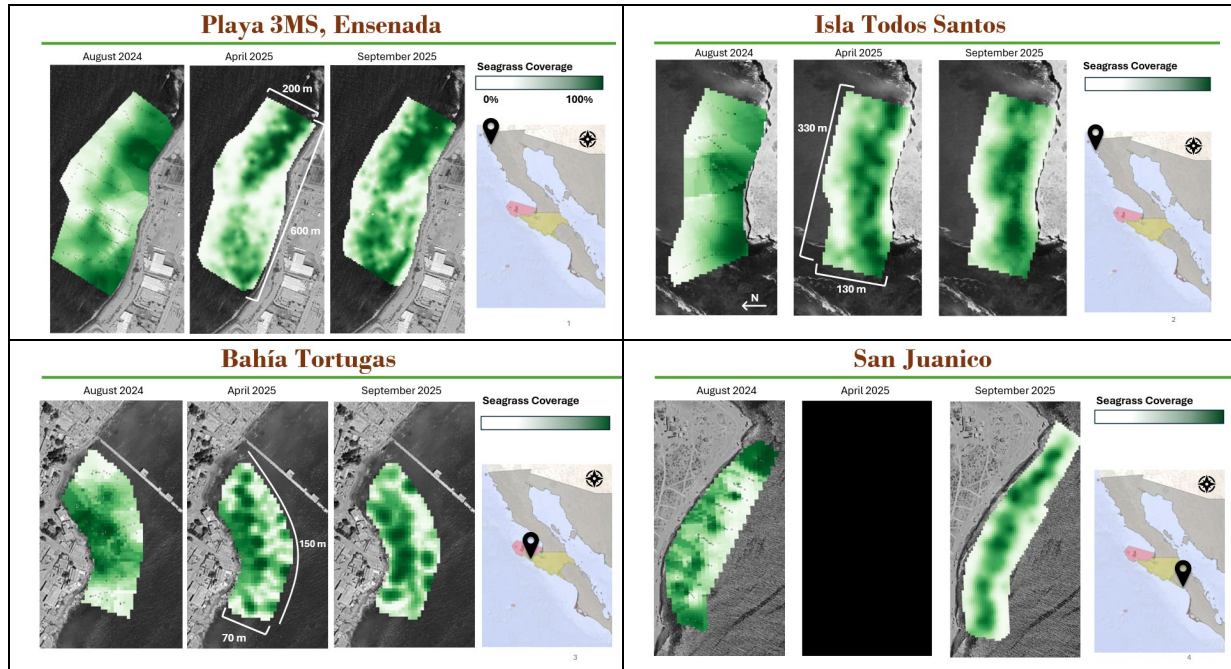
This project greatly benefited from the support of The Rufford Foundation, which enabled the establishment of the first multi-site monitoring program dedicated to *Phyllospadix* meadows in Baja California. Beyond generating new scientific knowledge, the project strengthened local capacity, empowered students and community members, and created the foundations for long-term ecological monitoring in a region where surfgrass ecosystems remain critically understudied. The flexibility of the Rufford grant was essential for adapting field logistics to variable ocean conditions and for incorporating unexpected opportunities, such as the germination experiment, which yielded valuable insights into early life-stage vulnerability under warming scenarios.

The project has already led to international recognition through the UNESCO MAB Young Scientist Award, underscoring its scientific relevance and the broader conservation importance of surfgrass ecosystems. We are deeply grateful for Rufford's support and look forward to building on these outcomes to advance coastal habitat conservation in Mexico.

**ANNEX I – Financial Report**

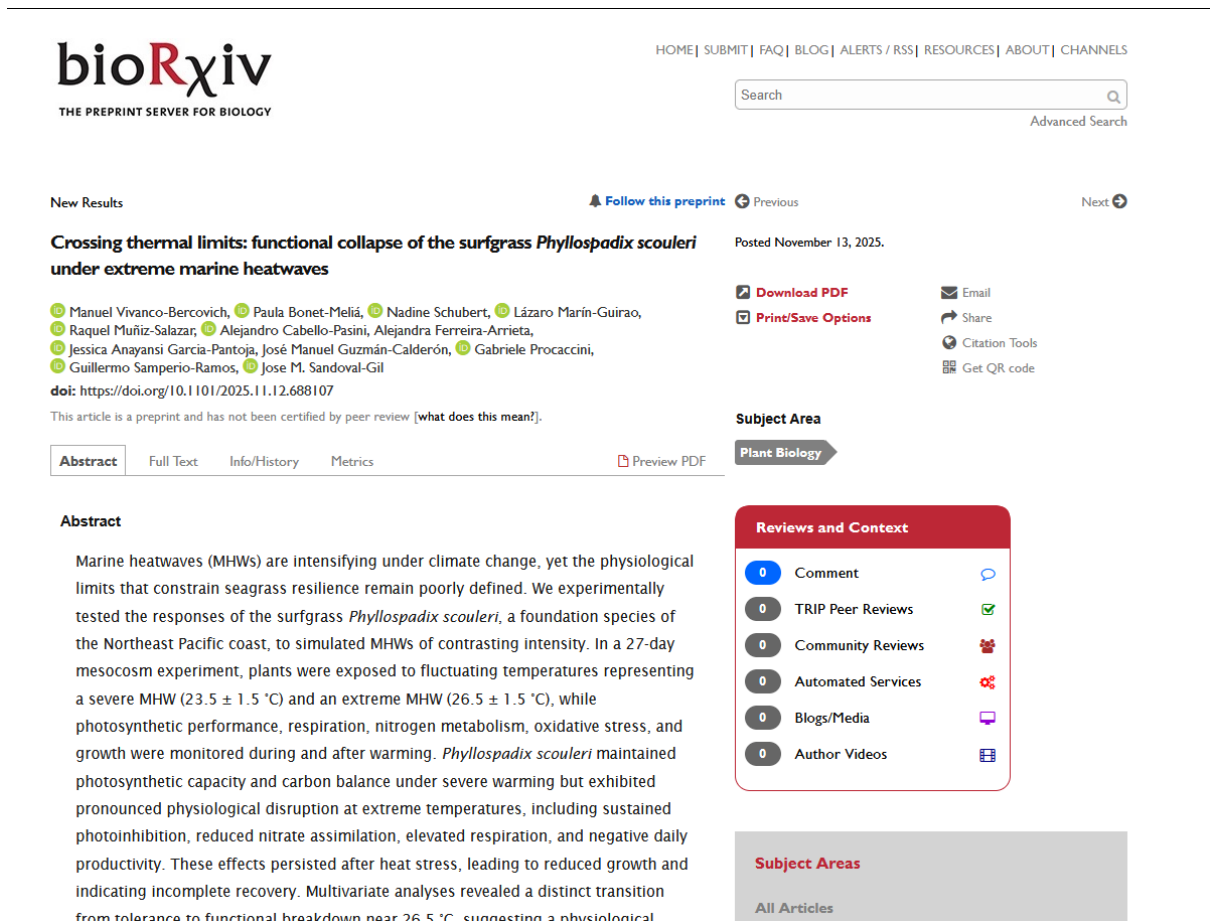
**[Intentionally removed]**

**ANNEX II – Surfgrass coverage maps**



**Figure 1.** Spatial distribution of surfgrass (*Phyllospadix* spp.) coverage at the four monitoring sites (3MS, Isla Todos Santos, Bahía Tortugas, San Juanico) across three survey periods: August 2024, April 2025, and September 2025. Coverage values (0–100%) are shown using a green gradient based on kriging interpolation of georeferenced photo-quadrats. White outlines indicate the sampled meadow extent, and inset maps show the geographic location of each site along the Baja California coastline.

ANNEX III – BioRxiv preprint



The screenshot shows the bioRxiv preprint interface. At the top, the bioRxiv logo is on the left, and navigation links (HOME | SUBMIT | FAQ | BLOG | ALERTS / RSS | RESOURCES | ABOUT | CHANNELS) and a search bar are on the right. The main content area displays the preprint title, authors (Manuel Vivanco-Bercovich, Paula Bonet-Meliá, Nadine Schubert, Lázaro Marín-Guirao, Raquel Muñiz-Salazar, Alejandro Cabello-Pasini, Alejandra Ferreira-Arrieta, Jessica Anayansi Garcia-Pantoja, José Manuel Guzmán-Calderón, Gabriele Procaccini, Guillermo Samperio-Ramos, Jose M. Sandoval-Gil), and a DOI link. Below the title, there are tabs for 'Abstract', 'Full Text', 'Info/History', and 'Metrics', along with a 'Preview PDF' button. The abstract text is visible, starting with 'Marine heatwaves (MHWs) are intensifying under climate change...'. On the right side, there are options to 'Download PDF', 'Print/Save Options', 'Email', 'Share', 'Citation Tools', and 'Get QR code'. A 'Subject Area' section is also present, with 'Plant Biology' selected. A 'Reviews and Context' sidebar shows zero comments, TRIP Peer Reviews, community reviews, automated services, blogs/media, and author videos. At the bottom, there is a 'Subject Areas' section with 'All Articles' listed.

**Figure 2.** Preprint of the manuscript “*Crossing thermal limits: functional collapse of the surfgrass *Phyllospadix scouleri* under extreme marine heatwaves*”, published on bioRxiv in November 2025. The study presents experimental evidence of thermal thresholds and physiological collapse in surfgrass subjected to simulated marine heatwaves.

### ANNEX IV – Community mapping workshop



**Figure 3.** Images from the community-based Seagrass Mapping Workshop held at San Miguel Beach (Ensenada), where students, local residents, and coastal users participated in hands-on seagrass monitoring activities. The event included educational stations, snorkel-based mapping, georeferenced photo collection, and collaborative data interpretation, fostering local engagement and coastal stewardship.

## ANNEX V – UNESCO Award



**Figure 4.** Announcement of the 2025 UNESCO–MAB Prize for Young Scientists, awarded to Manuel Vivanco Bercovich for his research on the ecological role and conservation of surfgrass meadows in the Biosphere Reserves. The recognition highlights the international scientific impact of this Rufford funded project, and its contribution to coastal ecosystem management in Mexico.