Final Evaluation Report

Your Details	
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Project Title	Landscape evaluation for stingless bee nest maintenance and honey quality in urban areas
Application ID	36332-1
Grant Amount	£ 5746
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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
Pilot experiments			x	
Experiment setup			x	Over a six month period (spring and summer), three collections and releases of 45 bees were carried out for each meliponary (n = 135/meliponary), in non simultaneous experiments (only one site per day).
Field data collection (1st phase)			x	Bees were released in randomized, color-coded groups across three distance zones from the colony, over three seasonal stages. Their return was monitored with high-resolution video recordings to measure both the number of bees returning and the time taken. We collected pollen and honey samples to detect plant species used as resources and pollution amount in the honey, respectively. The study recorded the return of 924 bees, of which 356 returned from up to 300 m from the hive, 299 300 to 600 m, and 269 from 600 to 900 m. We still have not found significant results regarding road flow analysis.
Organization of spatial data			x	Each release point was surrounded by a 150 m RC, classified by distance zones, and carefully mapped using satellite imagery plus field validation to

				ensure accurate land use and cover analysis.
Data Analysis			x	The bees collected mostly Myrtaceae, with emphasis on *Eugenia* (native) and *Eucalyptus* (exotic). The 45 honey samples showed no toxic metals. About half of the released bees returned, with higher success closer to the hive. Significant relationships ($p < 0.05$) were found with trees, houses, forest patches, warehouses, grass, paved areas, soil, towers, and roads.
Manuscript publication			x	I am still working on two more manuscripts
Scientific dissemination of the project			x	Please see item 7
Presentation at conferences and events			x	Please see item 7

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

The field data collection phase required more time than initially anticipated due to challenges posed by the COVID-19 pandemic, which complicated efforts to contact and visit participants. Additionally, atypical weather conditions—particularly frequent rainfall—further delayed progress. Following pilot experiments, the initial experimental setup was revised to better suit the study's objectives. Despite these hurdles, we successfully managed the adjustments and completed the data collection stage. During data analysis, some information was lost due to difficulties in interpreting video recordings, such as variations in bee movement speed and changes in lighting. Nevertheless, we gathered a robust dataset that provided more than sufficient information to support our survey.

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

1. Urban landscape elements affect bee navigation and movement, influenced by factors such as soil impermeabilization and the verticalization of built structures.
2. Mass-flowering plant species, particularly those in the Myrtaceae family, are crucial for sustaining *Melipona quadrifasciata* populations in urban environments.
3. The bees in our study successfully produced honey within the city, and the molecular composition of the honey met the standards established by the national health agency.

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

Our study reveals that bees must adapt their typical movement behaviors in response to structural changes in urban landscapes and habitats. Understanding how navigation systems function across different bee species and landscape contexts provides valuable insights into their biology. This knowledge is essential for developing effective conservation strategies. In urban environments, it can inform the creation of connectivity plans that support pollinator movement and ecological resilience within cities.

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

The project's partner beekeepers were very happy and excited to be able to participate. We have exchanged very rich experiences both regarding the maintenance and care of bees in meliponary, as well as the biology and ecology of the species.

6. Are there any plans to continue this work?

Yes. We have been evaluating which questions remain to be studied and how to answer them.

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

The results obtained have been published in scientific journals and presented in congresses and meetings:

1) Arena, M. V. N.; Toppa, R. H.; Martines, M.; Alves-dos-Santos, I. (2023). Release experiments as an indicator of flying activities of stingless bees in urban areas. Frontiers In Sustainable Cities, 4(1103835):1-10. https://www.frontiersin.org/articles/10.3389/frsc.2022.1103835/full
2) Rani-Borges, B., Arena, M. V. N., Gomes, I. N., Lins, L. H. F. de C., Cestaro, L. de S. C., Pompeo, M., Ando, R. A., Alves-Dos-Santos, I., Toppa, R. H., Martines, M. R., & Queiroz, L. G. (2024). More than just sweet: current insights into microplastics in honey products and a case study of Melipona quadrifasciata honey. Environmental Science: Processes and Impacts, 26:2132-2144. https://doi.org/10.1039/d4em00262h *

* *This manuscript is the result of a collaboration with Rufford grantees Barbara Rani-Borges and Ingrid Gomes, established during the First Rufford Foundation Learning Event in 2017.*

3) Arena, M. V. N.; Toppa, R. H.; Martines, M.; Silva, C. I.; Matias-da-Silva, E. C.; Alves-dos-Santos, I. (2025). Not green enough: Urban green areas fail to sustain the diet of Melipona quadrifasciata. Urban Forestry & Urban Greening. Under review

Data from this project are available on the Center for Open Science platform – OSF (https://osf.io/ywj9e/). Science communication content can be accessed via Instagram @mari.ecologia.

The documentary "The City and the Bees" is currently in production. It showcases the project and its main findings for public appreciation and will be freely available on YouTube (https://www.youtube.com/@mari-arena). This video has been widely spread in social media (Instagram, Facebook, Tiktok, WhatsApp). The documentary

premiere took place on November 13, 2025, at UFSCar in Sorocaba, with the screening followed by a roundtable discussion with invited participants. We received very positive feedback from the audience, which consisted of 70 people, mainly university students as well as members of the external community. In the next stage, a presentation is scheduled to take place in the Cientec Park in São Paulo (December 13, 2025), and presentations are being organized with the author's participation in elementary schools.

The results have not yet been shared for integration into public policies, as the data are still under analysis. However, we intend to disseminate them upon completion of my thesis, with the expectation that they will contribute to the implementation of meaningful conservation practices.

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 during all my PhD period, from 2021 to 2025, which was the predicted time.

9. Budget:

[Intentionally removed]

10. Looking ahead, what do you feel are the important next steps?
We look to expand our research to other urban areas with varying landscape configurations to better understand how bees adapt across different environments. Strengthening collaborations with urban planners and policymakers will be essential to incorporate ecological connectivity into city development, promoting pollinator-friendly habitats and green corridors. Additionally, enhancing public engagement through educational outreach—such as the upcoming documentary and social media initiatives—will help raise awareness and foster community involvement in pollinator conservation, ensuring that scientific insights translate into meaningful action for biodiversity in urban settings.

11. 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, we used the logo in the production of divulgation material for the project and the Foundation was tanked in the aknowledgements section of the scientific article.

12. Please provide a full list of all the members of your team and briefly what was their role in the project.
MSc Mariana Victorino Nicolosi Arena – Doctorate student and head of the project.
Prof. Dr. Isabel Alves-dos-Santos – Supervisor professor.
Prof. Dr. Rogério Hartung Toppa – Co-supervisor professor.

Prof. Dr. Marcos Roberto Martines – Statistical analyst.
Prof. Dr. Cláudia Inês da Silva – Pollen expert.

13. Any other comments?

I would like to once again express my sincere gratitude to the Rufford Foundation for their trust and generous support. The grant was instrumental in enabling the successful development and execution of our project, and we deeply appreciate the opportunity to carry out this important work.