

Final Evaluation Report

Your Details	
Full Name	Angie Paola Penagos López
Project Title	Endemic Owls from the Threatened Brazilian Atlantic Forest: effect of land cover on their occupancy and conservation
Application ID	31780-1
Date of this Report	December 23, 2024

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
1. Generate detailed information on the target species that help in understanding the main factors that influence their habitat occupancy during the breeding season				We conducted a comprehensive passive acoustic survey across four protected areas in the southern Atlantic Forest, monitoring 71 sampling points over breeding season. Using autonomous AudioMoth recording units, we collected acoustic data during the breeding season. We obtained 13632 hours of recording. We measured key variables including temperature, relative humidity, precipitation, cloud cover, and moonlight percentage, as well as landscape metrics like, NDVI, forest cover and human disturbance. Sound recordings were analyzed using automated species recognition through Arbimon platform and Raven Pro software, allowing us to determine owl occupancy patterns and the environmental factors influencing their presence during the breeding season. Our habitat suitability analysis using NDVI (Normalized Difference Vegetation Index), a reliable indicator of vegetation density and forest health, revealed varying occupancy patterns among owl species. <i>M. choliba</i> showed consistently high occupancy probabilities (0.72-0.84) in areas with dense vegetation cover, while <i>S.</i>

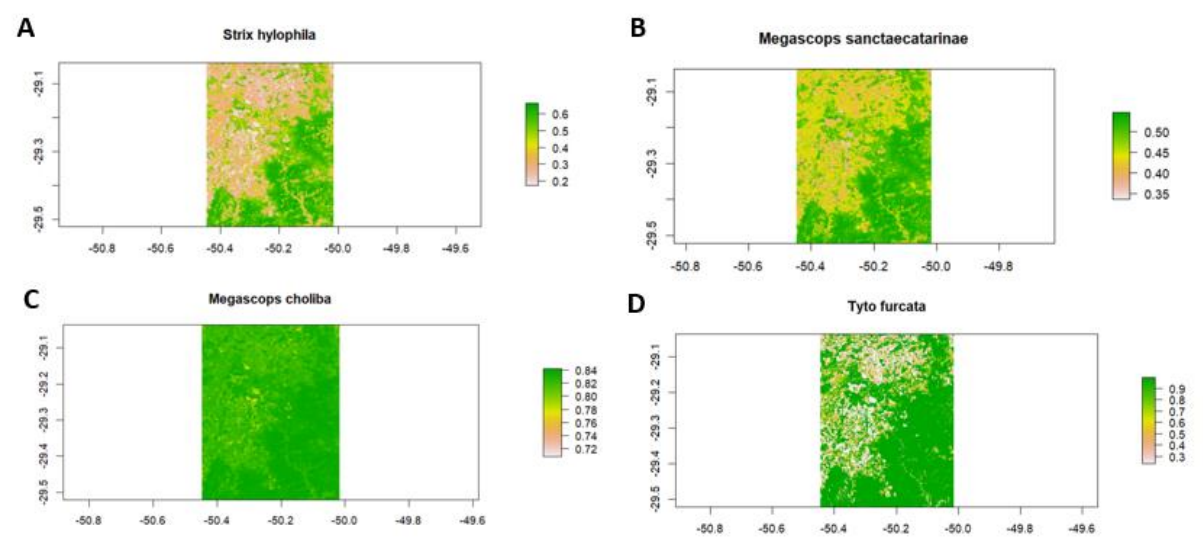
				<p><i>hylophila</i>, <i>M. sanctaecatarinae</i>, and <i>T. furcata</i> displayed more heterogeneous distributions (0.2-0.5) across the landscape gradient, suggesting species-specific responses to forest structure and vegetation density.</p>
<p>2. Identify potentially priority areas for the conservation of the target species and their habitats at a local scale (Protected Areas)</p>				<p>Through ecological niche modeling, we identified priority conservation areas for endemic owls across protected areas in southern Atlantic Forest. We found that Araucaria Moist Forests and Serra do Mar Coastal Forests will serve as crucial climate refuges as they contain the largest mountain ranges that will facilitate both latitudinal and altitudinal species migration in response to climate change. These regions maintain lower temperatures, higher humidity levels essential for owl survival, and harbor the largest remaining Atlantic Forest fragments. Our models predicted all owl species will experience significant range reductions under future climate scenarios, with the Rusty-barred Owl (classified as Near Threatened) being most affected. Current protected areas will become less effective, with representation dropping below the 10% conservation target for all species. These findings highlight the urgent need to strengthen protection in these southern regions that will act as key climate refugia.</p>
<p>3. Establish an efficient protocol for owl acoustic monitoring, which will</p>				<p>We partially established an acoustic monitoring protocol through field demonstrations to protected areas staff on</p>

strengthen conservation plans and will guide the work of Protected Area's staff in their implementation				recording unit setup and placement. We provided technical guidelines and created an educational YouTube video detailing the acoustic monitoring methodology to support long-term implementation. More in-depth training is needed, so we recommend implementing a comprehensive bioacoustics course for protected area personnel to strengthen their technical capacity in acoustic monitoring.
4.Help in designing and strengthening management plans for owls within Protected Areas in the Atlantic Forest Biosphere Reserve (AFBR). This is in accordance with the Brazilian National Action Plan for the conservation of birds of prey				Through habitat occupancy modeling and acoustic surveys, we partially achieved this objective by identifying key local-scale factors affecting owl presence within protected areas. Our findings provide managers with specific guidelines about habitat requirements and environmental variables influencing owl occupancy, enabling evidence-based management decisions. While we have generated valuable information that complements broader climate modeling results to support protected area management strategies, additional work is still needed to fully integrate these findings into management plans. This initial phase establishes a strong foundation for continued collaboration with protected area managers to strengthen owl conservation efforts.
5.Promote conservation efforts linked to the objectives of the				We successfully promoted conservation efforts by establishing strategic partnerships that amplify our research impact.

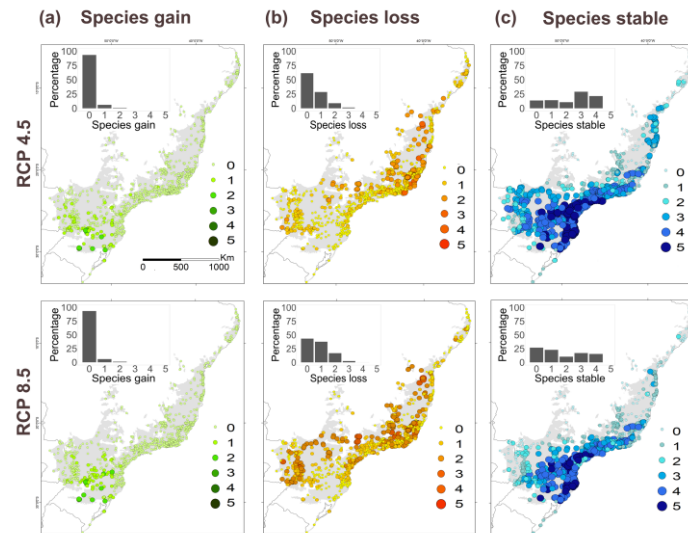
<p>Brazilian National Action Plan for the conservation of birds of prey and the management plan for the Biosphere Reserve of the Atlantic Forest</p>				<p>Through connections with the Global Owl Project, Buhos en Foco, Red de Ornitólogas colombianas, Red Brasileira de Ornitólogas, and Red de Rapaces Neotropicales, we created strong international links that strengthen owl conservation initiatives. Our participation in various congresses, symposia, and specialized workshops on owl research and conservation has helped develop collaborative frameworks that extend beyond our initial study area. These partnerships and academic engagements enable knowledge exchange and demonstrate our commitment to leveraging local research for broader conservation impact across the Neotropics.</p>
<p>6.Generate tools (e.g. brochure, poster, Informative talks) that foment the knowledge and conservation of owl species and their habitats in the local communities, staff of Protected Areas and the general public.</p>				<p>We successfully used social media to promote owl conservation, establishing the "Corujas da Mata Atlantica" Instagram page that has reached 3,146 followers. The page shares field activities, research findings, educational content about endemic owl species, and conservation messages. We presented our results at scientific conferences and participated in academic events to share our findings with the scientific community. To increase public engagement, we organized a giveaway of "Kit amigos das corujas" kits containing notebooks, cups, and sticker sets featuring endemic Atlantic Forest owls. This combined approach of digital</p>

				<p>outreach, academic participation, and public engagement proved effective in raising awareness about owl conservation among diverse audiences.</p>
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Objective 1. Predicted habitat occupancy probability maps for four owl species (A: *Strix hylophila*, B: *Megascops sanctaecatarinae*, C: *Megascops choliba*, D: *Tyto furcata*) in southern Atlantic Forest. Green colors indicate higher NDVI values and higher occupancy probability (0.5-0.9), while beige/light colors show lower values (0.2-0.4)



Objective 2. Distribution of gain, loss, and stability of endemic owl species in the Atlantic Forest biome under RCP 4.5 and RCP 8.5 scenarios for 2070 across Protected Areas. Maps show. Circle size and color intensity indicate greater number of species. Bar charts show percentage of Protected Areas (n=1154) for each value class. Note: Protected Areas in southern Atlantic Forest display higher species stability in the future



Objective 3. Training and capacity building activities. **A.** Field demonstration of AudioMoth deployment techniques. **B.** Project driver and community member learning about the purpose and functionality of wildlife recording devices, demonstrating inclusive knowledge sharing. **C.** Initial setup and configuration of AudioMoth units for wildlife monitoring. **D-E-F.** Protected area staff and volunteers receiving practical training on recorder installation and retrieval protocols in the Atlantic Forest. **G.** Virtual workshop session. **H.** Educational video produced for YouTube showcasing the importance of automated recorders as innovative tools for biodiversity research and conservation.



Objective 5. Scientific networking and collaboration initiatives in owl research: **A.** "Owls in Focus" research meeting. **B.** Global Owl Project partnership meeting. **C.** Brazilian Women Ornithologists Network gathering. **D.** Colombian Women Ornithologists Network meeting, strengthening international collaboration in Neotropical owl research.



Objective 6. Collection of promotional items from the Atlantic Forest Owls Project, including custom-designed stickers, t-shirts, and coffee mugs with owl illustrations that help spread awareness about Brazilian Atlantic Forest owl species.



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

a). This study represents the first assessment of occupancy for these endemic owl species in the Atlantic Forest biodiversity hotspot using bioacoustics tools. Comprehensive data on factors influencing owl occupancy were generated through acoustic monitoring at 74 sampling points in four protected areas, providing crucial baseline information for these poorly studied endemic species.

b). Climate-resilient areas were identified in the Atlantic Forest, with the South (particularly the Araucaria Moist Forests and Serra do Mar Coastal Forests) being the main critical refugia for owl conservation, enabling evidence-based recommendations for protected area management.

Article

Penagos López, A. P., Jiménez García, D., & Carlos, C. J. (2024). Current and future effectiveness of protected areas for the conservation of endemic owls from the

c). Effective outreach platforms were established through social media (reaching over 3,000 followers), educational materials, and international research networks, creating lasting connections that strengthen owl conservation efforts throughout the Neotropics.

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

The global pandemic caused an unexpected delay in the project's start, and we were only able to begin our fieldwork in October 2021. This delay was compounded by significant setbacks in the manufacturing and delivery of our automated recording equipment due to pandemic-related supply chain issues. Fortuitously, this extended waiting period aligned with the time needed to receive our equipment. We capitalized on this delay by refining our research methodology, with special attention to optimizing our acoustic monitoring protocols for protected areas. We developed more efficient sampling designs and improved our data analysis techniques. Furthermore, we used this time to participate in relevant courses and conferences, which helped solidify our knowledge and skills for data analysis. This methodological refinement and additional training allowed us to maximize data collection efficiency once fieldwork resumed, helping us mitigate the impact of the compressed timeline.

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

Our project actively engaged with a diverse range of local stakeholders, fostering a strong connection between research and community. We interacted extensively with protected area staff, many of whom are local community members, sharing our findings and methodologies to enhance their conservation efforts. Our outreach extended to private landowners surrounding the parks where we had sampling sites, including farmers, hotel owners, and teachers, raising awareness about owl conservation beyond protected boundaries (Figure 1). We collaborated with undergraduate student volunteers in protected areas, providing them valuable field experience (Figure 2). Additionally, we established a volunteer program for data processing and scientific outreach, offering hands-on research experience to interested individuals (Figure 3). To broaden our impact, we distributed owl-themed stickers, conducted environmental education workshops for university students and school students of different ages: aged 10-11 and 13-15 (Figure 4), and maintained an active social media presence (Figure 5). This multi-faceted approach to community involvement not only enriched our research with local knowledge but also left a lasting educational legacy in these areas. By integrating local communities into our project, from data collection to dissemination, we've fostered a sense of ownership and pride in local biodiversity, potentially leading to more sustainable, community-driven conservation efforts in the Atlantic Forest region.



Figure 1. **A.** Meeting with the owners of Cambará EcoHotel, demonstrating local business engagement. **B.** The scenic waterfront view of Cambará EcoHotel, showcasing sustainable tourism infrastructure. **C.** Entrance to Cabanas do Casarão, representing local tourism partnerships. **D.** Historic Café do Vô Marcial, preserving cultural heritage in the buffer zone. **E.** Site visit with a landowner near Serra Geral National Park. **F.** Landowner property near Pro-Mata Protected Area. **G.** Landowner property near Aparados da Serra National Park. **H.** and **I.** Farmer property near São Francisco de Paula National Forest.



Figure 2. Volunteers supporting monitoring and conservation activities at Aparados da Serra, São Francisco de Paula, and Serra Geral National Parks in Rio Grande do Sul, Brazil.



Figure 3. Call for volunteers to support scientific data processing and analysis at Atlantic Forest Connection Project.



Figure 4. Environmental education and capacity building activities: **A.** Owl mask workshop with students aged 10-11 years; **B.** Endemic species creative workshop with students aged 13-15 years; **C.** University student workshop at Botanical Garden; **D.** Virtual species distribution modeling course for biologists.

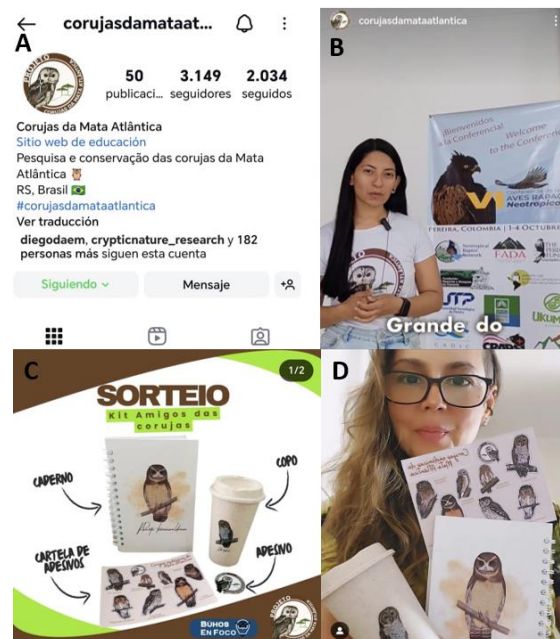


Figure 5. Social media engagement through the "Corujas da Mata Atlântica" Instagram profile: **A.** Account statistics showing 3,149 followers. **B.** Academic event promotion. **C.** Giveaway announcement. **D.** Giveaway winner displaying prizes: notebook, mug, and sticker set featuring Atlantic Forest endemic owl species.

5. Are there any plans to continue this work?

Our commitment to Atlantic Forest owl conservation extends far beyond this project. I recently began doctoral studies at the Federal University of Rio Grande do Sul, where I will continue and expand our research on Atlantic Forest owls. This work will focus on a primary axis: passive acoustic monitoring as a key tool for Neotropical owl

conservation, along with a more in-depth analysis of owl detection and occupancy along the Atlantic Forest's latitudinal gradient. This represents a natural progression of our current work, leveraging our established methodologies and community connections. Throughout this new phase, we will maintain our commitment to public engagement through our "Corujas da Mata Atlântica" social media profile, ensuring our findings reach a wide audience. By broadening our focus while remaining rooted in the Atlantic Forest region, our aim is to generate comprehensive and practical insights that will significantly advance owl conservation efforts. This ongoing work will not only contribute to scientific understanding but also provide valuable tools for conservation professionals, policymakers, and local communities, creating a lasting impact on owl conservation in the Atlantic Forest.

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

- **Social Media Outreach:**

We consistently shared results, updates, and educational content through our "Corujas da Mata Atlântica" profile. We distributed branded stickers and t-shirts to increase visibility and engagement.

Link:

<https://www.instagram.com/corujasdamataatlantica/profilecard/?igsh=MXQ4dXB1YTBmOTkzdg==>

Additionally, we developed an educational booklet featuring endemic owl species of the Atlantic Forest to local communities, schools, and stakeholders around protected areas. This booklet serves as a practical tool for species identification and conservation awareness, helping to connect local communities with owl conservation efforts in their region.

Link:

<https://drive.google.com/file/d/1YGQvYz8OCDi-qezszdm9-SvgaoweKocf/view?usp=sharing>

We also created an educational video about the importance of automated recorders for monitoring Atlantic Forest owls, which serves as a valuable resource for raising awareness about our innovative monitoring methods.

Link: <https://youtu.be/2ruHBfx5iuY>

- **Peer-Reviewed Publication:**

We published results from the master's thesis in the prestigious journal Ibis: Penagos López, A. P., Jiménez García, D., & Carlos, C. J. (2024). Current and future effectiveness of protected areas for the conservation of endemic owls from the Atlantic Forest. Ibis, 166(1), 200-217.

The article is available at: <https://onlinelibrary.wiley.com/doi/abs/10.1111/ibi.13249>

- **Institutional Repository:**

We made the full thesis available in the Universidade Federal do Rio Grande do Sul repository, ensuring open access to comprehensive research findings.

Link:

<https://lume.ufrgs.br/handle/10183/245909>

- **Scientific Conferences and Symposia:**

We presented our findings at multiple national and international conferences, fostering knowledge exchange and collaboration within the scientific community.

- XXIII Seminar on biological research.
February 3 to 5, 2021
Planning for conservation in a biodiversity hotspot: the case of the endemic owls of the Atlantic Forest
- VII Colombian Congress of Ornithology
August 10 to 12, 2022
Endemic Owls of Atlantic Forest: Climate change impacts and effectiveness of protected areas in their conservation
- III International Conversation The birds connect to the world from myths and legends. "Owls and owls"
November 21, 2022
Endemic owls of Atlantic Forest: a silent threat to its long -term conservation
- IV Brazilian congress of biological sciences online
July 05 to 08, 2023
Protected areas in the Atlantic Forest: effectiveness in the conservation of owls.
- II Ornithological Congress of the Americas
August 01 to 04, 2023
Early studies with the fluctuating asymmetry of the Burrowing Owl *Athene cunicularia* in Brazil.
- VI Neotropical Raptor Conference
October 01 to 04, 2024
Protected areas as key to identifying and prioritizing climate refugia for the conservation of endemic Atlantic Forest owls.

- **Protected Area Reporting:**

We submitted detailed reports to the SISBIO system, directly informing each protected area where we conducted fieldwork

This ensured that our research directly benefited on-the-ground conservation efforts.

- **Educational Workshops:**

We conducted workshops for local communities, students, and protected area staff, sharing practical knowledge and fostering local engagement in conservation (Figure 4). Our educational program included:

- Owl mask-making workshop for 10-11 year-old students, introducing owl diversity through creative activities
- Endemic species creative workshop for 13-15 year-old students, focusing on Atlantic Forest owl species
- "Getting to Know Owls" lecture for university students at the Botanical Garden

- Two specialized courses on ecological niche modeling:
 - "Introduction to Ecological Niche Modeling and Species Distribution 2022"
 - "Introduction to Ecological Niche Modeling: Fundamentals and Practical Applications"
- **Collaborative Networks:**
 We actively participated in owl research and conservation networks, facilitating knowledge sharing among researchers and practitioners.
 - Búhos en Foco
 - Global Owl Project
 - Red de colombianas en la ornitología
 - Rede de ornitólogas Brasileiras
- **Future Publication Plans:**
 We plan to submit our latest findings to the journal Biodiversity and Conservation, further expanding the reach of our research.
- **Open Data Initiative:**
 We planned to make our acoustic data available through an open-access platform, promoting further research and collaboration.

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

Looking ahead, we believe the crucial next steps for our research on Atlantic Forest owls are multifaceted. Firstly, we aim to expand our acoustic monitoring efforts across a broader latitudinal gradient of the Atlantic Forest, which will provide a more comprehensive understanding of owl distribution and habitat preferences. Secondly, we plan to refine our bioacoustics analysis techniques, incorporating machine learning algorithms to enhance the accuracy and efficiency of species identification. Thirdly, we intend to strengthen our collaborations with local protected area managers and policymakers, ensuring our findings directly inform conservation strategies. Additionally, we will focus on capacity building within local communities, training citizen scientists to participate in long-term owl monitoring programs. These steps will not only advance our scientific understanding but also contribute to more effective, community-driven conservation efforts in the Atlantic Forest region.

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, we consistently used The Rufford Foundation logo throughout our project materials and activities. We acknowledged the Foundation's support in our Ibis journal publication, during scientific conferences, community workshops, in online updates and social media highlighting its crucial role in making this research possible.

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

- **Angie Paola Penagos López:** I am the Principal Investigator and project coordinator, having designed this research as part of her master's thesis. I lead all aspects of the study, from conceptualization to field implementation, and overall project management.
- **Caio José Carlos:** He is a professor at the Federal University of Rio Grande do Sul (UFRGS), serves as the academic advisor and thesis director, providing crucial scientific guidance and supervision throughout the research process. His expertise helps ensure the project maintains high academic standards and achieves its research objectives.
- **Daniel Jiménez García:** He is a professor of Biometry at the Benemérita Universidad Autónoma de Puebla (BUAP), contributes his specialized knowledge as the statistical analysis expert and research collaborator. He oversees the statistical methodologies and ecological niche modeling components, ensuring robust data analysis and interpretation of research findings.
- **Diego Alejandro Esquivel:** He is a doctoral student at the Federal University of Rio Grande do Sul (UFRGS), serves as co-investigator in this project. His expertise in field operations and research implementation has been vital for the project's success. He coordinates and executes field activities. His logistical support and organizational skills are essential for effective data collection and field research implementation.
- **Rusby Contreras-Díaz:** She is a Post-Doc at the National Autonomous University of Mexico, contributing her specialized knowledge as the statistical analysis expert and research collaborator. statistical methodology with emphasis on occupancy models
- **Luis Osorio-Olvera:** He is a professor at the National Autonomous University of Mexico, contributing his expertise in statistical analysis and research collaboration. He oversees statistical methodology with emphasis on occupancy models.

10. Any other comments?

We would like to express our deepest gratitude to The Rufford Foundation for their invaluable support of our project on endemic owls in the Atlantic Forest. Their backing enabled us to pursue innovative research and engage deeply with local communities, significantly enhancing our impact. The Foundation's trust in early-career scientists has been transformative, allowing us to make meaningful contributions to conservation. We are profoundly thankful for this opportunity to advance our understanding of these enigmatic species and contribute to their protection. Looking ahead, we hope to maintain our connection with the Foundation and continue and expand upon this important project.