

## Final Evaluation Report

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Your Details	
<b>Full Name</b>	María Eugenia lezzi
<b>Project Title</b>	Improving connectivity in the Argentinian Atlantic Forest: delimitation of corridors and priority conservation areas for big mammals in a productive landscape.
<b>Application ID</b>	28547-1
<b>Date of this Report</b>	10/18/2022

**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. Select a group of medium to large-sized mammal species that are particularly sensitive to landscape transformation				I selected a group of six species: lowland tapir ( <i>Tapirus terrestris</i> ), ocelot ( <i>Leopardus pardalis</i> ), Azara's agouti ( <i>Dasyprocta azarae</i> ), red brocket ( <i>Mazama americana</i> ), black-eared opossum and jaguar ( <i>Panthera onca</i> ). I selected the first five species based on multivariate analysis and previous information (Iezzi et al. 2019). I also selected the jaguar because it is a critically endangered species and because it is possible to have very complete information about the species' natural history (e.g., dispersal distances).
2. Estimate or investigate different species characteristics and variables that can affect their occurrence in the landscape (connectivity models' inputs)				I did a literature review about the natural history for each species and, using GIS and occupancy models with previous data, I estimated the relative environmental impact of the production land uses. With this information, I generated "resistance matrices" for each species using different approaches. These matrices are essential inputs for the connectivity models. I also delimited all forest fragments that would be the "nodes" for the connectivity models and estimated their attributes based on the species occupancy. After this step, I decided to exclude the jaguar from the following analyses since the occupancy models did not give the expected results and it was impossible to estimate an adequate resistance matrix for the species.
3. Model and delimit potential corridors for each species in the productive landscape that connect the forest				Unfortunately, because of the pandemic, I did not make the trip I had planned to work in collaboration with the laboratory of Dr. Steve Palmer and Prof. Justin Travis, at the University of Aberdeen, UK, to use the RangeShifter platform. Thus, I decided to

<p>fragments ("nodes") with GIS and the RangeShifter platform.</p>			<p>change the connectivity analysis approach and used graph theory. Using this approach, I detected forest patches that are important because of their contribution to habitat availability and connectivity for each species (e.g., stepping stones). As a result, I generated a forest prioritisation map that summarises these results, combining results from all species.</p> <p>I published these results in a peer-review conservation journal: Iezzi, M.E., Di Bitetti, M.S., Martínez Pardo, J., Paviolo, A., Cruz, P., De Angelo, C., 2022. Forest fragments prioritization based on their connectivity contribution for multiple Atlantic Forest mammals. <i>Biol. Conserv.</i> 266, 109433. <a href="https://doi.org/10.1016/j.biocon.2021.109433">https://doi.org/10.1016/j.biocon.2021.109433</a></p>
<p>4. and 5. Field validation using camera traps and comparison between models results and observed data.</p>			<p>I had some delays in these activities because there were difficulties to develop fieldwork during the pandemic because of national regulations. Also, the change in the planning and the remote work with my advisors generated some delays in the analyses so I finished the previous step by mid-2021. To optimise the time and resources, I decided to merge this project fieldwork with an institutional Biodiversity Observatory aimed at monitoring wildlife communities and with Paula Cruz's project which is aimed at studying small felids populations within the production landscape. We finished fieldwork in March 2022.</p>
<p>6. Simulation of management scenarios.</p>			<p>Unfortunately, because of the pandemic, I did not make the trip I had planned to work in collaboration with the laboratory of Dr. Steve Palmer and Prof. Justin Travis, at the University of Aberdeen, UK, to use the RangeShifter platform so I couldn't develop the simulation of management scenarios. I hope to be able to accomplish this objective in the future.</p>
<p>7. Generation of Recommendations to policy- and decision-makers and forest company owners through workshops.</p>			<p>With the results obtained in step 3, I developed a forest prioritisation map that will be of great use to decision-makers and private landowners. I already have published these results in a peer-review conservation journal, and, with the help of</p>

			<p>a science communicator, we developed an illustrative report and an interactive map (online) that was shared with the Ministry of Ecology of Misiones Province, the NGOs Fundación Vida Silvestre Argentina and Aves Argentinas and the forestry company Arauco S.A. and was published through social media and the CONICET webpage. I had logistic problems organising a workshop with all stakeholders together, so I shared the results one by one with the different institutions.</p> <p>I also participate in the Tri-national Atlantic Forest Restoration Network virtual meetings where I also expect to share my results.</p>
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**2. Describe the three most important outcomes of your project.**

The main outcome of my project was a map of forest fragment prioritisation based on habitat availability and connectivity for sensitive mammal species. With this map, we could identify those areas where conservation actions should be implemented to promote connectivity for the mammal assemblage and achieve a sustainable production landscape. I also generated single-species prioritisation maps that are available if there is a special interest in developing a conservation plan for a particular species. With these maps I generated:

- a). A peer-reviewed journal article.
- b). An illustrative report to stakeholders.
- c). An interactive map (online) with all information easily accessible.

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

Due to the pandemic, I couldn't travel to work in collaboration with the laboratory of Dr. Steve Palmer and Prof. Justin Travis, at the University of Aberdeen, UK, to use the RangeShifter platform to delimit corridors (objective 3) and to simulate management scenarios (objective 6). To address this limitation, I decided to change the analytical approach at the time of developing the prioritisation. I used graph-based connectivity models to prioritise forest fragments according to their contribution to habitat availability and connectivity for the mammal species. In contrast to the simulations that were planned to develop using the RangeShifter platform, this approach has the limitation that does not consider the perception range of the species and uses deterministic models. However, it had the advantage that I could estimate and combine different connectivity indices that resulted in a useful tool to evaluate the relative importance of habitat patches for maintaining habitat availability and connectivity. Graph-based indices have a good balance between

the amount of input data they require and the detail in the information outputs they can provide, and the prioritisation of patches based on them can easily be incorporated into land management plans and protected area planning.

These changes in the analytical approach and the remote work with my advisors generated some delays in the analyses so I finished the previous step by mid-2021 and I couldn't start the fieldwork as scheduled. Also, fieldwork and the purchase of imported equipment (camera traps) and supplies were impossible to accomplish during the pandemic because of national regulations. To optimise the time and resources, I decided to merge this project fieldwork with an institutional Biodiversity Observatory aimed at monitoring wildlife communities and with Paula Cruz's project which is aimed at studying small felids populations within the production landscape. Both projects are using camera traps so cameras could be placed within the forest fragments following my project survey design but meeting their objectives as well. By combining the projects, I tackled the problem of buying and importing the camera traps (I changed the allocation of the funds mainly to fuel and other fieldwork supplies) but in contrast, caused delays in starting the fieldwork.

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

The main result of this project is a spatially explicit tool that proved useful to decision-makers to take conservation actions. These conservation actions will involve local communities (mainly farmers) since most of the priority unprotected forest fragments belong to private lands. I expect that local NGOs, such as Fundación Vida Silvestre Argentina (FVSA), will work with the local farmers that are owners of the highly important forest fragments to encourage and help them to apply and get national economic incentives for maintaining and protecting the forest within their properties. An excellent example of this involvement of local farmers through FVSA in this study area was the implementation of Martínez Pardo's research project (Martínez Pardo et al. 2017a) that analysed habitat connectivity for jaguars (*Panthera onca*) and generated management tools to improve the effectiveness of five main corridors for the species at the local scale. In this case, FVSA acted as an intermediary between researchers, local farmers, and the government of the Misiones province (Martínez Pardo and De Angelo 2017b). FVSA still works with the local farmers encouraging them to apply for economic incentives for protecting the forest and to change their production management to promote more "permeable" crops surrounding the native forest fragments in these corridors.

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

Yes, I took advantage of the delay in starting fieldwork, and I combined it with fieldwork related to new projects in the same area. As part of a project led by Paula Cruz, we expect to survey the impact of different land uses on the different species studied by placing camera traps in different crops. We are interested in better understanding how different crops affect mammal movement to generate management recommendations to improve connectivity between the priority forest fragments. With the results of my current project, we obtained information about mammal occupancy within the different forest fragments surrounded by different

contexts, but we don't have empirical data about mammal use of the different land uses so we expect to obtain this information expanding the camera trap survey. To follow this initiative, we expect to get GPS collars for ocelots (and perhaps for other medium-sized species as well) to better understand their movement capabilities in production environments.

We are also particularly interested in studying the differences between agroecological systems vs. conventional crops to generate relevant information about wildlife-friendly farming. We think that the better way to address this challenge is by studying the benefits of agroecological farming through an interdisciplinary project. We expect to study mammal occurrence within different production systems and, at the same time, with the help of other researchers, we plan to measure their long-term sustainability and the ecosystem services they provide. We will also evaluate the perceptions and acceptance of farmers towards the presence of mammals in their farms, their willingness of changing their management, and the economic yields of the different types of production. We expect this information will contribute to promoting agroecological farming in the Argentinian Atlantic Forest to enhance habitat connectivity within private lands to increase the abundance of sensitive mammal species in the production landscape. These results would complement the current results and would strengthen and expand local NGO work by providing a scientific basis for demonstrating the benefits of wildlife-friendly systems and the effect of different land uses on mammals. In addition, I am working in collaboration with Dr. Fletcher's lab in the Wildlife Ecology and Conservation Department at the University of Florida, USA, where I'm learning different innovative connectivity modelling approaches that I expect to apply in the Argentinian Atlantic Forest. I will take advantage of all the information generated through these projects to elaborate more detailed connectivity models in the areas already detected as important and to evaluate projected management scenarios in the future.

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

I already presented the preliminary results at the Society for Conservation GIS Virtual Conference in 2020 and I published the final results in a peer-reviewed journal article: Iezzi, M.E., Di Bitetti, M.S., Martínez Pardo, J., Paviolo, A., Cruz, P., De Angelo, C., 2022. Forest fragments prioritization based on their connectivity contribution for multiple Atlantic Forest mammals. *Biol. Conserv.* 266, 109433. <https://doi.org/10.1016/j.biocon.2021.109433>. With the information from this article, I developed a short report with infographics and an interactive online map that was shared with the Ministry of Ecology of Misiones Province, the NGOs Fundación Vida Silvestre Argentina, and Aves Argentinas, the forestry company Arauco S.A.:

<https://proyaguarete.maps.arcgis.com/apps/instant/sidebar/index.html?appid=03e09b360f1542cc8ece78b381df054d>

The results were also published through social media, the CONICET webpage, and through interviews with local and national news media:

<https://www.conicet.gov.ar/identificaron-areas-prioritarias-de-misiones-que-deben-conservarse-por-su-alta-biodiversidad/#:~:text=Desde%20el%20a%C3%B1o%202000%2C%20cada,cuidado%20de%20los%20recursos%20naturales>

[https://youtu.be/Zh\\_OlzU6zyA](https://youtu.be/Zh_OlzU6zyA)

<https://www.facebook.com/proyaguarete/photos/a.591123324320433/4544825065616886/>

<https://www.primeraedicion.com.ar/nota/100598144/piden-a-misiones-conservar-nuevas-areas-para-protger-a-cinco-especies-de-mamiferos/>

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

Soon, I expect to help local stakeholders in decision-making based on this project's results. Depending on the institution, I expect the following steps to be different. Local NGOs, such as the Fundación Vida Silvestre Argentina (FVSA) and Aves Argentinas, are interested in conserving the Atlantic Forest remnants in the study area. Both NGOs are currently advocating funds to acquire private lands to create protected areas. People from Fundación Vida Silvestre Argentina and an external private landowner have already told me that they will use my map to choose appropriate land to buy to create private protected areas. I expect them to continue with this initiative using the prioritisation map as a tool for decision-making. Furthermore, FVSA is working to help smaller farmers to apply for economic incentives for protecting the forest and to change their production management in another area further south of the province (in one of the jaguar corridors). I expect that the results of this project will be useful for them to start working with farmers in this northern area as well. On the other hand, the forestry company Arauco S.A. is interested in promoting biodiversity conservation within their lands because of FSC certification standards. I expect that we can discuss different management actions that they could apply to promote mammals' connectivity within their lands.

As a researcher, I believe that my following steps are to better study how different crops and management practices affect mammal movement to improve connectivity between the priority forest fragments I identified within this project. I am particularly interested in studying the differences between agroecological systems vs. conventional crops to generate relevant information to promote wildlife-friendly farming in the 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?**

In August 2020 I presented the preliminary results of the project during the Society for Conservation GIS Annual Conference (Virtual) where I used the Rufford Foundation logo. Also, The Rufford Foundation is included as one of the funding sources for my recent paper on Biological Conservation and the illustrative report to stakeholders.

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

**Dr. Mario Di Bitetti.** He is the current advisor of my postdoctoral fellowship from CONICET (National Council of Science and Technology of Argentina). He is the Director of the Group of Ecology and Conservation of Mammals (GECOMA) of the Institute of Subtropical Biology (UNaM-CONICET) where I work and has extensive experience in studies of mammal populations using occupancy models with camera-trap data. He had the role of supervision and contributed to the conceptualization of ideas and discussing the results.

**Dr. Carlos De Angelo.** He is the current co-advisor of my postdoctoral fellowship from CONICET (National Council of Science and Technology of Argentina). He is a specialist in landscape ecology focused on large mammals and in the management of geographic information systems (GIS) applied to wildlife conservation. He had the role of supervision and contributed to the conceptualization of ideas, planning how to develop the connectivity models, and discussing the results. He also helped to develop the interactive online map.

**Dr. Paula Cruz.** She is a member of the CelBA (Centro de Investigaciones del Bosque Atlántico) and a researcher of the IBS. She has extensive experience in studying mammal populations using occupancy models with camera-trap data. She contributed by providing camera-trap data from the "Proyecto Yaguareté" (a project of the CelBA focused on jaguar conservation) and she helped when doing fieldwork. She contributed with extra camera traps for the fieldwork.

**Dr. Julia Martínez Pardo.** She is a member of the CelBA and a postdoctoral fellow of the IBS. She has extensive experience with connectivity models, so she contributed to planning the statistical analyses and discussing the results.

**Dr. Agustín Paviolo.** He is a member of the CelBA, leader of the "Proyecto Yaguareté", and a researcher of the IBS. He contributed by providing camera-trap data from "Proyecto Yaguareté".

**Bsc. Diego Varela.** He is the leader of the Biodiversity Observatory of the IBS and helped during fieldwork and contributed with extra camera traps.

For future work, we expect to expand our team by including **Dr. Débora di Francescantonio**, an ecophysiologicalist that would study ecosystems services and crops sustainability, Jonathan von Below, a social scientist that would study farmers' perceptions and willingness, and **Dr. Juan Pablo Arrabal**, a veterinary that would help with capturing and installing GPS-collars to mammals.

## 10. Any other comments?

References:

lezzi, M.E., Di Bitetti, M.S., Martínez Pardo, J., Paviolo, A., Cruz, P., De Angelo, C., (2022). Forest fragments prioritization based on their connectivity contribution for multiple Atlantic Forest mammals. *Biol. Conserv.* 266, 109433. <https://doi.org/10.1016/j.biocon.2021.109433>.



lezzi, M.E., Cruz, P., Varela, D., Di Bitetti, M.S. & De Angelo, C. (2020) Fragment configuration or environmental quality? Understanding what really matters for native mammals' conservation in the Atlantic Forest of Argentina. Oral Presentation in the 2020 Annual Virtual Conference of the Society for Conservation GIS.

Martínez Pardo J, Paviolo, A., Saura, S., De Angelo, C. (2017a) Halting the isolation of jaguars: Where to act locally to sustain connectivity in their southernmost population. doi:10.1111/acv.12354

Martínez Pardo J, De Angelo CD (2017b) Corredor de Conservación Cruce Caballero-Yabotí. Informe técnico. Instituto de Biología Subtropical (UNaM-CONICET). Puerto Iguazú, Misiones, Argentina.