

Final Evaluation Report

Your Details	
Full Name	José Gabriel Martínez-Fonseca
Project Title	Filling spatial and ecological information gaps in threatened forest-sensitive bat species and endangered ecosystems in Nicaragua
Application ID	40860-1
Date of this Report	13-September-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
Collect occurrence data from previously unsampled locations in Nicaragua				We sampled 35 sites in novel areas in the country, collecting information from 61 bat species and 1000+ individuals. This fills distribution gaps for many species and these data complement our original dataset for landscape analysis.
Collect bat fecal samples to provide novel ecological data for understudied species				We collected 53 fecal samples from 17 species which provides an important addition to our fecal gene banking. These samples will be used for DNA-based diet analysis and the samples from new localities offer new species and the possibility to study dietary differences for the same species occupying different ecosystems. We hoped to collect more samples, especially those species with strong forest associations but captures of these species were low.
Train Nicaraguan biologists and students in bat research technology and methods, including data collection, data analysis, and interpretation of results.				We conducted a workshop with 9 Nicaraguan biology and veterinary students. I also created a new key for bat identification in Nicaragua that is currently being refined for publication. All these materials will be available free of charge for anyone interested.

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

Corresponding with our three main goals, our three main outcomes were:

a). **Collect bat occurrence data from previously unsampled locations in Nicaragua.**

We created a new dataset for bat occurrence with 35 new localities (Figure 1) and 1023 individuals of 61 different species (55% of all known bat species of the country) from understudied areas of Nicaragua. This new dataset includes among other things:

- A new country record of a bat species for Nicaragua (*Uroderma davisii*) which is now the bat species #112 for the country (Martínez-Fonseca et al., 2020).
- New records of rare species in Nicaragua (3rd known localities for *Artibeus inopinatus*, *Eumops aripendulus* and *Eumops underwoodi*; 4th known locality of *Centronycteris centralis*; 8th known locality of *Molossus nigricans*). These species are also rare in Central America, so these are important records to fill in gaps in their known distribution.
- The rediscovery of an endemic bat species (*Rhogeessa permutandis*) and second locality known for the species extending its known range over 100 km. This species was described in 2019 from specimens collected in 1972 and its status was unknown since the area has experienced dramatic changes in forest cover. Because of this, this bat species was considered potentially extinct (Baird et al., 2019).
- Significant range extensions for *Peropteryx macrotis* (first record in the Caribbean lowlands), *Noctilio leporinus* (first record in the north Caribbean lowlands), *Natalus mexicanus* (first record in the Caribbean lowlands), *Macrophyllum macrophyllum* (first record in arid forest) *Molossus molossus*, *Myotis elegans*, and *M. nigricans* (first record in Caribbean pine savanna).
- The "discovery" and exploration of the largest cave (by volume) known in Nicaragua (Cerro Waylawás), as well as the largest bat colony known to date (San Juan de Limay). Both sites were sampled to document bat species. Together with colleagues of the Nicaraguan Bat Conservation Program, we are seeking official recognition of the cave system as a site important for bat conservation by the Latin American Bat Conservation Network (RELCOM).

b). - **Collect bat fecal samples to provide novel ecological data for understudied species.**

During the surveys we collected 53 faecal samples from 17 bat species. These samples were transported to Northern Arizona University to add to our previous samples that we will use to provide an understanding of the dietary needs of each species. These samples can also be used in the future to corroborate taxonomic identity (species ID) of bat populations in Nicaragua. This is something that will improve the representation of material from the country scientific collections.

c). - **Train Nicaraguan biologists and students in bat research technology and methods, including data collection, data analysis, and interpretation of results.**

Workshop training nine young biology and veterinary students. To conduct the workshop I created a material including presentations, images, and a Nicaraguan bat identification key. These materials are freely available for scientist and professors

that might want to conduct additional training or can use it to help guide their own research in Nicaragua.

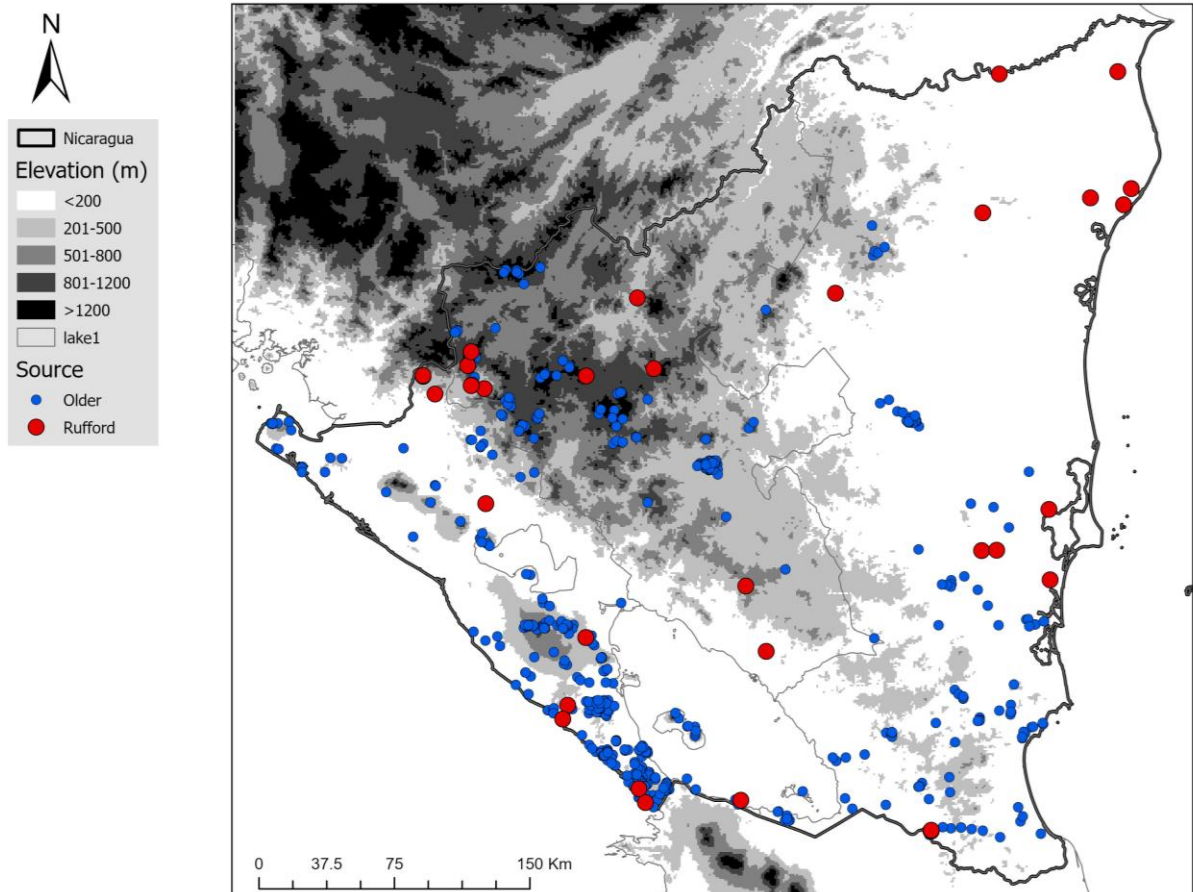


Figure 1. Map with historical (blue) and new, Rufford-funded (red) sites sampled for bats. Rufford-funded (recent) points indicate sites sampled using The Rufford Foundation funds.

Additionally, there are other outcomes that were produced by this effort, two major ones are:

- We identified two areas that are important sites for bat conservation and that could be recognized as such by the Latin American Network for Bat Conservation (relcomlatinoamerica.net). We have submitted a petition for one of these sites called Cerro Waylawás, which is probably one of the largest cave systems in the country, and houses at least five bat species including a colony of *Phyllostomus hastatus* (greater spear-nosed bat) which is a forest associated species.

- Because of the success of the workshop, I was invited to teach another workshop in Guatemala (more details bellow) which resulted in new connections and the discovery of a new bat species for that country. We also created connections with two ichthyologists who came to Nicaragua and joined us in some of the expeditions adding information about the fauna of these understudied sites.

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

Overall, the project went well and according to plan. Some of the difficulties encountered during the project were changes in the costs of supplies and the amount of time needed to access some of the sites we were planning to survey. Among the main costs were those of fuel; gas prices fluctuated since our original budget and some of the roads we needed to travel were much slower, took longer, and required more fuel to traverse. Although most roads were in relatively good condition, some were still very slow and increased costs of transportation and getting resupplies.

Dr. Carol Chambers from our lab at NAU provided much of the equipment used in the surveys (triple high net set, harp trap); we used part of the grant to ship that equipment from the USA and import it into Nicaragua. New import and shipping costs increased more than we anticipated. However, we believe these materials were important and because they will remain in Nicaragua, we will be able to use them in future years. In addition, the equipment that we shipped could not be found in Nicaragua, so only covered shipping costs with the grant was an advantage since most equipment was a donation from our USA lab.

For the future years, we will need additional supplies, especially mist nets, since many of these were subject to wear and tear. This wear is very significant despite our attempts to repair the nets. The large size of the bats in the Neotropics (and their bite force) meant that they caused considerably more damage to mist nets than their counterparts in North America and Europe. We will seek additional funding sources to cover supplies such as these in the future.

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

We created a positive impact in our local community in two main components:

1. Our workshop, where we were able to train 9 young biology and veterinary students. We originally had planned to train 3 to 4 students, but we received 22 applications, and another 10 people consulted me directly about the possibility of joining the workshop. Some of these people were from other countries including Costa Rica, El Salvador, and Mexico. This is evidence of the great need for these types of specialize trainings and I felt that it was necessary to accommodate as many students as possible while maintaining quality and high levels of individual attention. I was able to invite another 3 colleagues that volunteered their time, so we had 4 instructors and 9 students.

- This allowed for an excellent student-instructor ratio. I also procured pre-exposures rabies vaccines for 4 students so they also could handle bats safely.
2. We involved local guides and rangers during our surveys. Whenever possible, we asked locals for support accessing sites and completing the setups for our sampling. We gave small talks to local communities or families and invited them to watch the work we were doing. We particularly emphasized demystifying bats (e.g., not all bats are vampires as is commonly believed) and provided examples of how bats are beneficial for the daily activities of humans, for example for those growing crops, bats can help pollinate plants and fruits in the area. Overall, we saw a great improvement in the perception towards bats and on several occasions young children communicated that they would like to seek a career working with animals and bats.

5. Are there any plans to continue this work?

Yes, we are preparing a second application for The Rufford Foundation that we hope will provide resources to continue training and sampling of bats in the areas we targeted in this first year. Giving the great success of this first series of expeditions, we believe that there are a number of new discoveries possible and that the training and inclusion of Nicaraguan biologists in this type of work is essential for the development and promotion of conservation.

This first experience also provided a lot of knowledge for us about how to navigate these new areas. We created a network of new local contacts who can help with future scouting and sampling. We also faced some challenges sampling some sites (e.g., swampy areas in pine savanna) that taught us a lot and will allow us to use a more efficient approach in future visits and maximize bat captures.

Lastly, we also saw the great demand for training in this type of work. We would like to expand the opportunities for training to more students and also provide more hands-on time for students of our previous workshop.

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

- a. We plan to publish research results including our capture dataset gathered during this project in a scientific journal. This will also include the first record of *Uroderma davisii* for the country. As an example, this year we published a note on a variety of rare and poorly documented mammal species in Nicaragua that we encountered in the last 10 years (<https://doi.org/10.15560/20.3.706>). With the new findings from this project, we are expecting to publish another note on the geographic distribution of many bat species (e.g., Martínez-Fonseca et al., 2024).
- b. We are adding these data to a landscape analysis manuscript that we plan to submit for publication later this year. This manuscript is the second chapter of my doctoral dissertation (<https://www.proquest.com/openview/e87c3c0109f5a3ef7f27670baf1559d9/>

[1?pq-origsite=gscholar&cbl=18750&diss=y](#)). We are preparing this manuscript to be submitted to the journal *Landscape Ecology*.

- c. I signed up for an oral presentation at the North American Bat Research Symposium (NASBR) in Guadalajara, Mexico (Oct 23-26, 2024) The presentation is titled "Bats and forest fragmentation in Nicaragua: A country-wide landscape analysis" and uses all occurrence data from this project to inform a vast area in the Caribbean and North regions of Nicaragua.
- d. Once our petition for recognition of a novel area for bat conservation with RELCOM, we will publish an article in the Latin American Bat Network bulletin. See application form in attachments.

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

We believe that expanding training to more students in the country and additional training for our previous students is a high priority that could continue promoting research and conservation in the country. We also want to continue increasing the numbers of survey locations and fill gaps in knowledge of bat species distributions in Nicaragua and Central America. We want to secure the designation of Cerro Wayalawás as an important area for bat conservation to protect this cave system and bat colonies.

Finally, we want to seek funding for diet analysis of bats using the faecal samples from this project and previous samples we collected (>300 from >25 species). Ideally this analysis will be part of a graduate student thesis at NAU.

All these novel data will be published and help inform conservation measures for individual species or bat species richness and bat communities.

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?

The logo of the Foundation was used on the announcement, presentations, and training materials of the workshop (see our last report). The logo will be found in all conference presentations such as NASBR and next year's The Wildlife Society annual meeting. The Foundation will be acknowledged in the funding sources sections for each of the upcoming scientific publications.

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

Dr. Carol Chambers: Professor at the School of Forestry, Northern Arizona University (NAU) (https://www.researchgate.net/profile/Carol_Chambers). She is helping with study design and facilitating some of the equipment necessary for the study. She participated in fieldwork for two weeks in the south and northern Caribbean regions.

Dr. Faith Walker: Research Professor at Northern Arizona University and Director of Genetics of the Bat Ecology and Genetics lab and Ancient DNA lab

(https://www.researchgate.net/profile/Faith_Walker). She has offered help as consultant in DNA sample collection and is helping us seek further funding for sample analysis.

Maynor Fernández-Mena (<https://www.researchgate.net/profile/Maynor-Fernandez>) and Julio Loza Molina are biodiversity specialists at the Ministerio de Ambiente y Recursos Naturales. They provided support with permits and coordinated entry to some of the areas we sampled. They also participated during the workshop as co-instructors.

Luis E. Gutiérrez-López, James Arach Hernandez, colleagues with bachelor's degrees in biology from the Nicaraguan National Autonomous University (UNAN-Managua). Participated in all the fieldwork.

Chengpy Wu-Sánchez and Meyling Ramirez-Alegria. Two of the participants of the workshop, members of the Nicaraguan bat conservation program, and 5th year biology students. They participated in the survey of 4 sites in the south Caribbean and the largest bat colony in a mine in the north of the country.

10. Any other comments?

There are many other indirect positive outcomes that are tied to this project that would not have been possible without The Rufford Foundation support.

After we were granted a Rufford Foundation Grant, we also applied and obtained an equipment grant from Wildlife Acoustics. The Wildlife Acoustics grant provided 5 acoustic bat recorders which were deployed in addition to mist nets at each area we sampled. We believe that the funds provided by The Rufford Foundation for fieldwork in Nicaragua were key to obtaining this equipment. The data collected will be the base for a national database of acoustic recordings. We were also able to train Nicaraguan biologist in the use of the acoustics recorders. This equipment will continue to be used in Nicaragua for many years and will be deployed in collaboration with members of the Nicaraguan Bat Conservation Program and biology students.

Thanks to the success of the training workshop in Nicaragua in late 2023, I was invited to collaborate with an organization in Guatemala (Defensores de la Naturaleza; <https://defensores.org.gt/>) and conduct another workshop. We trained collaborators of the organization with some Guatemalan colleagues and, at the same time, document bat species in the Sierra de Las Minas Biosphere Reserve. During this workshop we trained 6 rangers in wildlife techniques (especially bat mist netting and species identification). Thanks to the training and mist netting in this site, we obtained a first record of a bat species (*Myotis volans*) for the country, and the third record of *Myotis auricolus*. Both are the first and third records of the species for Central America too. We have just published these findings ([Trujillo et al., 2024](#)).

Additionally, when planning for field season in Nicaragua in early 2024, I was contacted by an ichthyologist from the University of Florida who was able to join us

in Nicaragua and conduct his own surveys at the same sites we sampled bats. Fishes are another understudied taxa for Nicaragua and now there will be ~200 specimens from these remote areas that will help fill knowledge gaps. We will continue encouraging collaborations with other researchers since logistical costs are lower when traveling together. This also offers opportunities for exchanging information among disciplines while working.

References

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