

Final Evaluation Report

Your Details	
Full Name	Giulliana Appel
Project Title	Activity of aerial insectivorous bats in response to climate conditions, prey-predator interaction and moonlight intensity in Amazon fragmented environment
Application ID	23598-1
Grant Amount	£4924
Email Address	giuappel@outlook.com // giu.appel@gmail.com
Date of this Report	01/08/2020

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
Six expeditions in dry season of 2017				It was not possible to begin the field expeditions in this period because I didn't have all the necessary equipment.
Six expeditions in rainy season of 2018				I did 10 expeditions to compensate for the expeditions that were not made in 2017.
Six expeditions in dry season of 2018				I did 10 expeditions.
Six expeditions in rainy season of 2019				I did 10 expeditions.
My sample effort will be 240 nights with 12 hours recordings, totalizing 2880 hours of recordings				I did 30 expeditions with 224 nights of sampling and 2912 recording hours. Number of nights (N) for each habitat type: continuous forest (58), fragment forest (55) and secondary forest-matrix (57).
The ultrasound recorders will be installed in continuous forest, fragment forest and matrix (secondary forest) of Biological Dynamics of Fragments Forest Project (BDFFP).				I installed one ultrasound recorder (SM2Bat+ Wildlife Acoustics) in each habitat type and I had three replications for each the habitat type. Per example: three sampling units of continuous forests, three sampling units of fragments and three units of secondary forest totalling nine sampling units in BDFFP.
I will collect insects with Malaise traps, and I will put a playback of bat predator in all the sample units				I installed four Malaise traps in each ultrasound recorder. I only put these malaise traps in expeditions of dry season of 2018 and rainy season of 2019 due the large volume of insects (totalling 33511 aerial insects). The playback of bat predators was made in the same expeditions (dry season of 2018 and rainy season of 2019) totalling 166 nights of sampling.
Bat recordings will be identified				I had more than 39000 bat calls, corresponding to 13 bat species and nine acoustic complexes. Those species and acoustic complexes were part of

			seven families (Vespertilionidae, Emballonuridae, Molossididae, Thyropteridae, Furipteridae, Noctilionidae and Mormoopidae).
Statistical analyses will be done in the end of expeditions (June-July 2019) and I hope to do these parts in University of Salford helped by Dr. Christopher Meyer			I went to University of Salford with a scholarship of CAPES (Brazilian funding) for 6 months in 2019-2020. I began the data analysis and I learned new statistical analyses. I was assisted by my co-advisor Dr. Christoph F. J. Meyer.
Two high quality papers			I am still analysing the data. I will defend my PhD on June 2021, so I want to have at least one paper submitted.

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

The most difficult part in the field was the installation of the bat predator experiment. The field expeditions were made later than we expected because we needed to think about the best equipment to this experiment. For this experiment, I installed a sound player (JBL clip 2) and programmed it with a cell phone to play a vocalization of an owl species for 1 minute every 15 minutes of the night. Even though the JBL is waterproof, some nights the player didn't play all night and I discovered it was due to the excessive humidity. During the rainy season I put a roof of palm leaves to prevent the player getting wet and it seemed that this solved the problem. However, I had problems with the batteries of the JBL, even when I installed a portable battery protected by a plastic box. I noticed that the specific portable batteries are more resistant than others, so I needed to spend more to buy better batteries.

The field logistics of BDFFP is good with helpful people like the drivers, field technicians and logistics people (Rosely, José Camargo and Ary). The rainy seasons are more difficult because of the wet roads. Even so, my fieldwork was conducted well. The acoustic recorders worked most of the time; only 11 sampling nights gave a problem and had to be removed. Problems on some recordings are very normal to happen and because of that we made a greater effort with sampling hours than we expected at the beginning.

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

The preliminary results are showing that habitat type and insect biomass are the factors that most influence activity of the Amazonian aerial insectivorous bat species. Even the secondary forest is well developed; few species use this habitat and probably this is related to less biomass of aerial insects compared to primary forest and fragments. The preliminary results indicate that the persistence of aerial insectivorous bats in disturbed habitats is longer than we expected. Additionally, our project showed that aerial insectivorous species in general are a group of bats very sensitive to habitat disturbance. The insect biomass changes significantly between

the rainy and dry seasons with higher insect biomass in the rainy season. In the results we aimed to analyse how season effects bat activity in a different paper. The first paper that I aim to submit is about the effects of predators, insects and habitat type on bat activity and the second paper is focusing on the seasonal effects on insect and bat activity.

We identified 13 species and nine acoustic complexes in the habitats of BDFFP. No species that we recorded is threatened with extinction, but we recorded six species that are classified as Data Deficient by IUCN. The six species were *Peropteryx trinitatis*, *Myotis simus* (combined in an acoustic complex of *Myotis* sp.), *Lasiurus egregius* and *L. ega* (combined in an acoustic complex of Vespertilionidae), *Eumops maurus* (combined in an acoustic complex of Molossidae) and *Thyroptera lavalii* (combined in an acoustic complex of Thyroptera). These species are very rare in samples in Amazonian inventories, but we need the collection of the specimens to confirm these records, especially to the species that were combined in acoustic complexes. We have a ultrasound library (https://ppbio.inpa.gov.br/en/Bat_Library) so that some recordings made in my field expeditions will be available for people and bat research.

The arthropod data collected in the dry season of 2018 was used by an MSc student (Karina Kethelen). She identified the insects to order level and analysed the effects of fragmentation on the arthropod orders, and more specially in the families of Diptera. She detected no significant differences in taxonomic composition between the three habitats, but at the specific level the Tabanidae species *Dichelacera cervicornis* was identified as indicator of primary forests. Although there is habitat disturbance in the landscape, the development of the secondary forest can favour arthropod dispersal among the habitats.

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

We worked with two field technicians (Ocirio and Jairo) who are from the region of Manaus. These two men have kids and families who depend on their work and we paid a determined value per day in the field. During most of the field trips, the food we took to the field was left over and we told them to always take it to their family. Ocirio work with me in most of the expedition for 18 months, so most of the period he was occupied. As some researchers asked him to go on expeditions, his 25-year old daughter began the work of field assistance on other expeditions, increasing the family income.

We bought the food supply for the expeditions in the local market near Manaus, even though the price was slightly higher than big markets of Manaus. This attitude meant we could collaborate with the local business and small producers, and logistics were facilitated because they delivered to the Institute (INPA) the day before the expedition.

The arthropods collected were used by a student from Manaus (Karina Kethlen) to complete her MSc degree at Federal University of Amazonas (UFAM). Therefore, this

project helped with the dissertation of a local biologist that probably will benefit her to enter at the job market of the region.

5. Are there any plans to continue this work?

Yes. The next steps of the project will be:

- Defend my PhD and submit in an international journal at least one paper of this project until June 2021.
- Submit a note on the natural history of bat tents found during my field expeditions to *Mammalia*.
- Analyse the effects of climatic conditions (air temperature, rainfall, wind and barometric pressure) on bat activity with comparisons between the habitats (continuous forest, fragments and secondary forest).
- Compare the abundance and biomass of insect between day and night. As we collected every period of the day, we aimed to identify if the malaise traps have differences in collecting diurnal and nocturnal insects.

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

I will present my PhD in a public audience in the National Institute of Amazon Researches (INPA) - Manaus. I plan to publish the results in national and international journals, and I want to publish at least four papers of this work and one natural history note to *Mammalia*. Indeed, I intend to publish the results of every published paper on popular websites, especially in website of INPA and news sites of Amazonian region. Some results I want to present in conferences and video conferences, I have scheduled one webinar that I will explain about truths of bats and a little bit of this work.

I also got a grant from National Geographic, so when I have published results, I intend to send to the staff for a possible publication in the Brazilian website of NatGeo. Lastly, I will share the results and picture of this work in all my social medias, like Facebook, Instagram and Twitter.

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

We used the Rufford grant during the fieldwork. We planned to do the fieldwork between August 2017 to May 2019 (four seasons – two dry and two rainy seasons). We made trips between February 2018 to May 2019, and due the large amount of ultrasound recordings and arthropod data, we decided to make it three seasons instead of four. Even when we made it three seasons in the field, we increased the night sampling in each season and in each habitat obtaining 224 sampling nights – a number very similar that which we planned (240 sampling nights). I spent 1 year analysing all the ultrasound recordings (2912 recording hours) and cutting the expedition of one more season was essential for finalising the identification of bat species in the recordings.

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Plastic pots for storing aerial insects	561	141	-420	I used fewer plastic pots than I expected, and I found cheap prices in a store of Manaus.
Ultrasound loudspeaker L60 Petterson	88		-88	Not used.
Data logger Decagon EM50 with sensor VP4	595	297	-298	I bought five HOBO data loggers in Brazil. I thought that it was necessary more money because we need to pay the taxes. But I found these HOBO data loggers cheapest than buying imported.
D Duracell Batteries (for ultra-sound recorder)	1050	500	-550	I used less batteries than I expected, only 11 nights had problems, so it was not necessary to buy more batteries. Indeed, I bought batteries on sale which made the budget cheaper.
SMM-U1 Ultrasonic Microphone	900	900		We need five new microphones to our ultrasound recorders.
Field assistant	1730	3200	+1470	The price for day was R\$120, a little more expensive than I expected. Although, Ocirio and Jairo were experienced field assistants of BDFFP and were highly necessary for the success of 224 days of sampling.
Total	4924	5038	114	Exchange rate was 1£ = R\$ 7,09

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

The data that I collected to this project will be useful to use in research post-PhD. As I cannot analyse all the effects of fragmentation, climate conditions and prey-predator interaction on bat activity in my PhD, I want to submit a proposal to

analyse all the variable effects aiming at a post-doc position. Unfortunately, right now the opportunities of post-doc positions in Brazil are scarce but I hope to get a post-doc position in another country. My final goal is to get a professorship in a Federal University of Brazil, but this market is very competitive, and I believe that I need more scientific papers in my curriculum.

Understanding how the climate conditions affect bat activity in each habitat will be necessary to see the effects of climate change in the future. So, before my PhD I want to develop research to understand the relationship of climate change and bats, especially in Amazonian forest. I have an interest in working with the roosts and bat tents that I found in BDFFP, in central Amazonia we have few data of these bat tents and it is fundamental understand how the fragmentation and habitat-disturbance influence the persistence and distribution of bats roosts. Therefore, even though I have a large amount of data, I would like to make a future field expedition in BDFFP to evaluate the distribution of these bat roosts.

Finally, I have interest in working in environmental education in the region of Manaus. Me and other two researchers (one is Tainara Venturini Sobroza, researcher also funded by Rufford) got a grant from National Geographic to make a gamebook for public schools in Manaus. This gamebook will talk a little bit of bats, and the goal is to demystify the negative image that people have about bats and understand the importance of bats in an urban area (as insect controllers). Indeed, we have an idea to construct a book and probably we will raise new funds for it.

10. 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. Recently, the logo was used in the defence of dissertation of Karina Kethelen of Federal University of Amazonas and it was highlighted in the written version of her master's degree. Her presentation was online due the pandemic and it was in April 2020. I used the logo in my public presentation of PhD qualification in 2017, and I will use again in my PhD defence in the next year (June 2021). Also, in next year, I want to present the results in video conferences and conferences, so I will announce the logo in future presentations highlighting the importance of the RF support. We will thank the RF in future submitted papers and in the written version of my thesis.

I will put some recordings in our virtual ultrasound library (https://ppbio.inpa.gov.br/en/Bat_Library), therefore I will put the logo of Rufford Foundation support in this website.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Giulliana Appel - Principal investigator of the project. I was the main responsible for all the phases of the project (Conceptualization, funding acquisition, methodology, field expeditions, investigation, ultrasound identification, statistical analysis, visualization, evaluation report writing, paper writing and editing).

Paulo Estefano Dinelli Bobrowiec - Giulliana's PhD advisor. Contributing with the project in: Supervision, conceptualization, methodology, field expeditions, investigation, statistical analysis, visualization, paper writing and editing.

Christoph F. J. Meyer – Giulliana's PhD co-advisor. Contributing with the project in investigation, statistical analysis, visualization, paper writing and editing.

Karina Kethelen – Master student that assisted with fieldwork expeditions and identified the arthropods orders of the dry season of 2018.

Ocirio de Souza Pereira – Field technician, accompanied me in 80% of field expeditions.

12. Any other comments?

I would like to thank Rufford Foundation for the kindness of the staff during the project and for the confidence in my research. Your grants are so important for conservation research and researchers in undeveloped countries; me and all my colleagues are very grateful to this opportunity. In Brazil, we are passing by a political and environmental crisis where funds like yours are helping students and researchers to develop their career and to develop the knowledge about conservation of biodiversity of the Amazon. In the next pages, I put pictures of my field expeditions that will be recorded in my memory forever and ever. I hope that someday everyone can visit the Amazonian forest one day! Thank you again!!