

The Rufford Foundation Final Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Esteban A. Guevara
Project title	A participative approach to study the response of plant – bird interactions to climate change in the Tropical Andes: phase II
RSG reference	21176-2
Reporting period	April 2017 – May 2018
Amount of grant	£ 4986
Your email address	esteban.guevara@wsl.ch
Date of this report	18.05.2018

1. Please 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
Local volunteers trained				A total of 10 local volunteers have been trained in research techniques such as camera setting, flower counts and video analysis.
Monitoring protocols implemented				Two field protocols aimed to quantify floral resource abundance and plant/hummingbird interactions were successfully implemented at four sites during this project
Scientific manuscripts published				One manuscript about the feeding ecology of the Critically Endangered black-breasted puffleg was accepted for publication in the Journal of Field Ornithology (https://doi.org/10.1111/jfo.12208). This work reports findings from previous Rufford Grant, an additional paper on flower visitation rates is in preparation
Project results dissemination				To date we have only performed outreach activities at local venues i.e. small workshops with volunteers, landowners, students and local authorities. We expect to broaden the scope of outreach activities by participating in the upcoming meeting of the Ecuadorian Ornithological Society and Mindo Bird Fair (October 2018). Also as the complete results will be obtained after all data is processed we expect to have more opportunities to spread our main findings in the upcoming months

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

Field equipment failure. - Our study sites are located along an elevation gradient in a very humid tropical region, these humid conditions are detrimental for electronic equipment like plot watcher cameras that we have been using to record plant-hummingbird interactions. Considering that the field equipment that has been used for this project is the same that were used in previous Rufford grant, the risk of equipment failure was high. Indeed we faced some equipment failure during this new season of data field collection but thanks to a collaboration with Dr Catherine Graham at the Swiss Federal Research Institute (WSL), we have been able to replace some of the equipment that have been damaged and fortunately project activities were not affected. Also several measures have been taken to avoid equipment failure due to humidity, for instance we store equipment in boxes with silica gel, we also keep the plastic envelope that came with cameras and use it as external protection in the field. We anticipate that these measures will reduce the need to replace equipment, but if project activities get to continue we might need to obtain additional funding for replace the equipment.

Delays in project activities. - The simultaneous collection of camera data has been possible due to the involvement of local volunteers. This has allowed the generation of a comprehensive database of plant-hummingbird interactions. The generation of this database has demanded a great inversion of time, especially for video download and *processing*, which in turn has generated some delay in data reporting. Dr Ben Weinstein who is one of our collaborators, have helped with this issue by improving the efficiency of Motion Meerkat (Weinstein 2015) analysis. Consequently we have switched from the use of Motion Meerkat to Deep Meerkat which is a convolutional method based on neural network analysis (Weinstein in press). Ultimately this change has allowed us to process video and imagery output more efficiently.

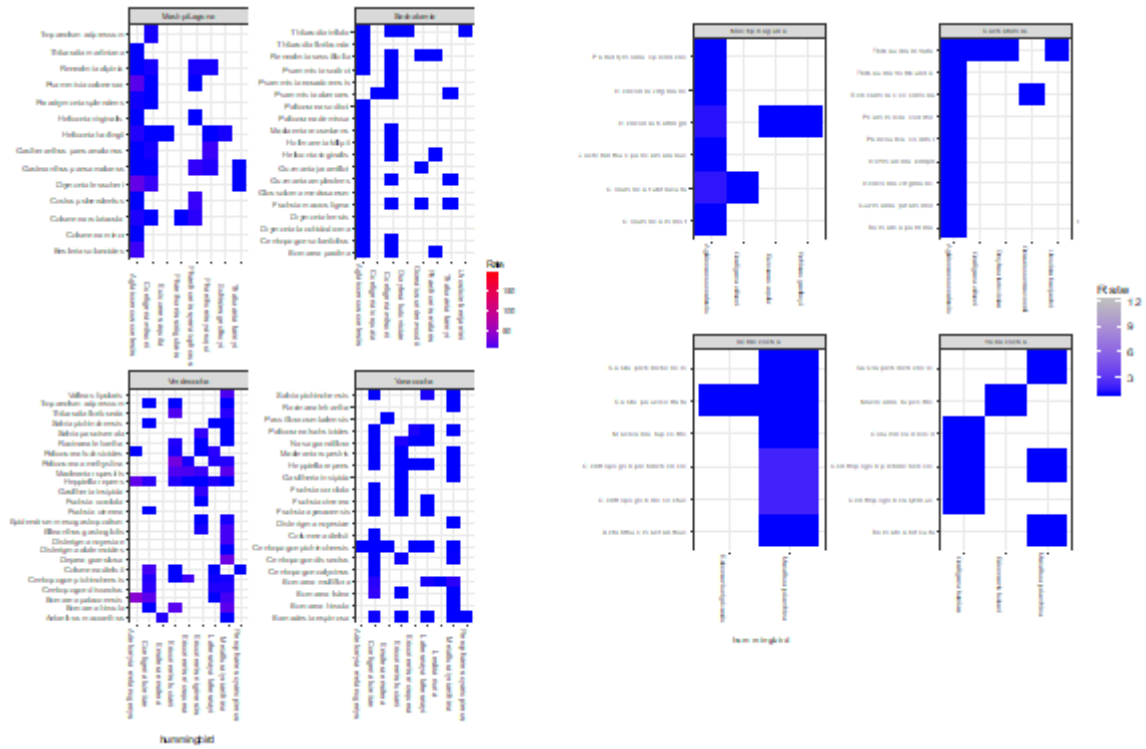
Data collection by local assistants. - Most of our assistants that were in charge to move cameras within transects have not had the opportunity to use plot watcher cameras neither mobile GPS before. It took some time for them to get to understand the importance to follow the field protocols and take into account all details associated with scientific data collection. To overcome this challenge we conducted workshops specifically designed to train them in camera and GPS use, we also took the opportunity to let them share experiences among assistants from different field sites. We also prepared a printable one-page summary of important things to remember when working with cameras and GPS a summary sheet of thing to do so they can take to the field.

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

- a) *Group of local assistants trained.* - A group of 16 have been trained both in flower census methods and camera setting for plant-hummingbird interactions monitoring. This group of people is composed by local assistants (seven), reserves managers (four), landowners (two) and students and young professionals (three). A subgroup of four people mostly students and young professionals have been also trained in the use of motion detection software and are able to run video analysis independently. This group of collaborators

has delivered an extensive dataset that we are still processing. For the continuation of project field monitoring activities it is important to count on well trained individuals that are able to work independently. Local assistants are, in all cases, people that are employed in local reserves and who live near the study sites, which facilitated the implementation of monitoring activities in several places simultaneously. If project activities are to continue (i.e. results dissemination) it is important to foster the cooperation with local stakeholders at different levels including landowners, reserve managers, local authorities and general public.

- b) *Extensive database of plant-hummingbird interactions.* - With data processed until January 2018 we have recorded 4078 interactions among 60 plants and 21 hummingbird species. The bulk of interactions recorded were concentrated in transect located in Sachatamia and Verdecocha transects (Figure 1a), both located at mid and high elevations respectively. The camera monitoring also allowed us to record a poorly documented ecological type of interaction among plants and hummingbirds, which is nectar robbery by hummingbirds (Arizmendi et al 1996), also known as piercing since hummingbird access nectar through piercing holes in the base of the corolla. These piercings are made by either flower piercers (birds in Thraupidae family *Diglossa* sp. or *Diglossopsis* sp.) or by hummingbirds themselves. Two short-billed hummingbirds were consistently recorded piercing in flowers, the violet-tailed sylph (*Agelaiocercus coelestis*) and the Tyrian metaltail (*Metallura tyrianthina*) (Figure 1b).
- c) *Phenology of flower seasonal abundance is better understood.* - We successfully implemented a flower census protocol which was designed to quantify the variation of floral resources for hummingbirds along broad spatial scales. The information obtained from flower census allowed us to visualize seasonal patterns of flower availability at different elevation belts within the project region (Figure 3). From these figures we learn that peaks of resource abundance varied along elevation belts. As such, peaks of flower abundance occurred around February and March at the lowest elevation (i.e. 800 -1000 m.), around October at the mid elevation belt (i.e. 1400 - 2400 m.) and around June and July at the highest elevation belt (i.e. 3000 - 3500 m.). This difference on timing of pulses of flowers might help to explain altitudinal movements that are performed by some hummingbirds and will allow us to explore if hummingbirds could track changes on flower abundance by changing its specialisation patterns across space and time.



A B

Figure 1. Plant-hummingbird interactions recorded using plot watcher cameras in four 1.5 km transects, during the period April 2017 – April 2018, rate measure represents the average counts of interactions per day. A) Legitimate visits of hummingbirds to flowers B) Piercing on the corolla base.

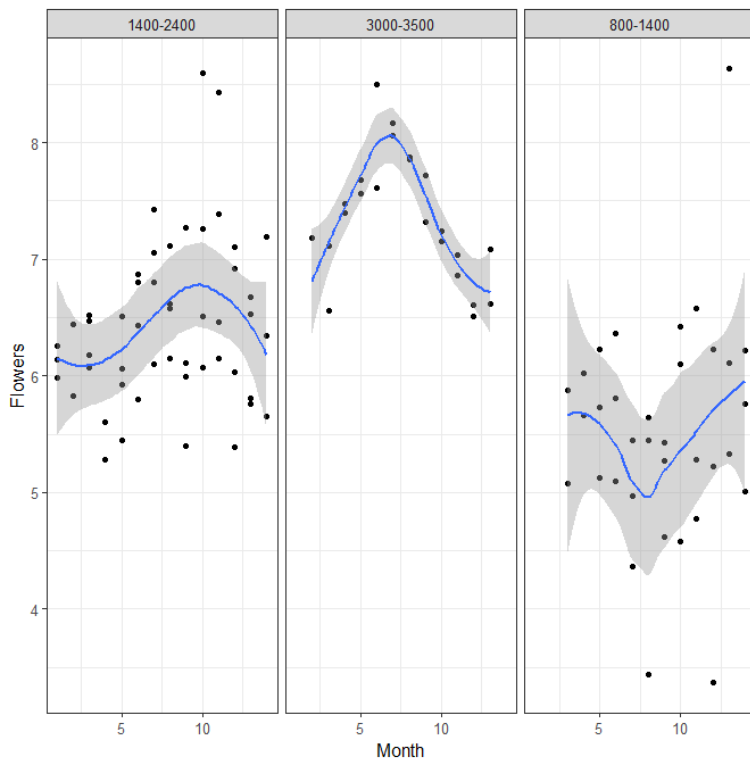


Figure 2. Seasonal patterns of flower abundance along elevation gradient in the northwestern Andean region of Ecuador. Data collected among February April 2017 – April 2018

d) *Training opportunities*

for undergraduate and graduate students. - The first and current phase of Rufford projects allowed the involvement of undergraduate students who became trained in techniques to study plant-hummingbird interactions, both field and computational methods. One of this students is close to present his dissertation (June 14th) which is related to secondary extinctions in plant-hummingbird networks, data for his dissertation was obtained thanks to Rufford first grant, in the upcoming months we expect that two other students complete their BSc thesis on related topics, and they will use data collected during the second grant. Since March 2018 I am officially a PhD student at the Swiss Federal Research Institute (WSL) and Swiss Federal Institute of Technology Zurich (ETHZ). The two Rufford grants have been really important for me since I get the chance to be in the field, understand the ecological system and relate it to land use practices. This information has been extremely useful to develop the ideas for my PhD research plan, which I had presented on May 28th. In summary funding from Rufford Foundation has translate it into education opportunities for me and three other BSc students.

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

Two members of Alambi community (Rolando Hipo and Silvio Calderón) participated actively during project field season. Rolando's help was critical to identify flowering patches as well as to learn about flowering periods of certain species especially at Yanacocha transect. Since Rolando is also member of Nono Parish his training and environmental awareness are critical for the future management of local natural resources. Interventions on additional sites had restricted to contact with land owners and reserves managers, since there are no actual communities at Sachatamia and Mashpi lodges.

5. Are there any plans to continue this work?

Yes. During the implementation of this work, we kept close communication with researchers performing similar investigations. Dr Catherine Graham and her student former Dr Ben Weinstein are engaged in studying bird-plant networks along an elevation gradient in the western Andes of Ecuador. Dr Graham recently obtained funding to expand the research area and continue with data collection for one more year in additional sites within the project region. Therefore, monitoring at our study transects in Yanacocha, Verdecocha, Mashpi and Sachatamia will continue for two years more and likely the project will collaborate with the field assistants that were trained during Rufford grants. Additionally, and in the scope of my dissertation, I will be performing fieldwork from August 2018 to January 2019 in the same study region.

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

We plan to disseminate the outcomes of this project through different venues and for different audiences including environmental authorities, local stakeholders, academics and general public. Official reports, as well as photographic database will be delivered to the Ministry of Environment in the scope of official research permits granted for this project. Note that for previous Rufford grant a report and corresponding supporting material have been already submitted to the corresponding environmental authorities. During this year and the first half of 2019 there are a handful of bird-related events that have been traditionally part of Aves y Conservacion outreach agenda. We will take opportunities from these events to disseminate the main findings of our research through public. These events include, but are not limited to, Global Big Day (May 2019), World Bird Festival (October 2018), and NatGeo Year of the Bird (every month during 2018). To reach local stakeholders we plan to participate in the Mindo Bird Fair (October 2018) and a second workshop with field assistants is planned for January 2019. For more specialised audiences we plan to participate in the upcoming meeting of the Ecuadorian Ornithological Society (August 2018) and the Rufford Small Grant Conference (January 2019).

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

RSG was effectively used over 1 year period for most of the proposed activities, especially activities related to data collection in the field. Due to the great amount of data generated the processing of the 100% of this information will take a couple of additional months, up until now we have reviewed roughly 80% of the data gathered. The production of publications and presentations in workshops and meetings are still pending and will take course in the upcoming months (see section 6).

8. Budget: Please 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.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Project Socialization (gas & food two workshops)	120	120	0	
Training Workshops (gas, food, transport, lodging and materials)	477	343	134	
Plant-bird monitoring (gas, food, lodging for 12 occasions x 4 sites)	3839	3696	143	
Data management, analysis and reporting (desktop and 2	550	554	-4	

portable hard drives)				
Publications cost		200	-200	If approved, we would like to use part of the difference from plant-bird monitoring and training workshops as a contribution to cover publication cost (peer-review or outreach material)
Total	4986	4913	73	Exchange rate May 13 th 2018 (1£ = 0.738 USD)

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

Once we get a better understanding on how plant-hummingbird interactions change across gradients of land use and elevation, we learnt that it is time for looking at the plant side, especially how plant productivity change along with changes with interactions with hummingbirds, in order to get a complete understanding of how biodiversity relates with ecosystem process. At this point we are able to explore patterns of plant-bird interactions but to get a complete picture we need to quantify plant productivity, in terms of seed production for instance.

Also, our results now could guide restoration efforts aimed to benefit endangered hummingbird species. For instance we have mainly identified the resources that could be important for threatened hummingbirds like the black-breasted puffleg (Guevara et al., 2017), a next logical step will be working on the propagation of these plants in the landscape and restore degraded habitats. This is a promising activity that could engage local communities and stakeholders. In this context we have prepared a proposal for the Critical Ecosystem Partnership Fund to work on restoration of degraded habitats within the black-breasted puffleg range, the proposal has been reviewed and has reached the second phase of evaluation process.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did The Rufford Foundation receive any publicity during the course of your work?

After the end of the first Rufford funded project we were able to finish a booklet on the natural history of the black-breasted puffleg (see appendix), for this we use the Rufford logo, this material was deliver to local people and students at Nono. I also use the logo to present a talk at two events, the Neotropical Ornithology Congress held at Manaus, Brazil, and the Ecuadorian Ornithology Meeting in Zamora, Ecuador.

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

Tatiana Santander. Tatiana is projects coordinator at Aves y Conservación and advises the implementation of all projects related to research, conservation and education. She collaborated specially during the design of the proposal and has also been involved during training sessions to local volunteers. Tatiana also provided advice on project and budget management.

Rolando Hipo: Mr Hipo is a community leader and a local authority that has been working with Aves y Conservación, since year 2007. Rolando served as a link between the organization and local stakeholder to get their involvement in project activities. Rolando got involved in field data collection as well, and also collaborated during training sessions.

Dr Catherine Graham: Dr. Graham is a senior scientist at the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL). She advised the research component of the project. Dr. Graham is currently my formal PhD supervisor and as such I anticipate that we will collaborate in the future, especially to produce publications from data obtained in the scope of current and previous Rufford grants.

Dr Ben Weinstein: Dr Ben Weinstein is the developer of Motion Meerkat and Deep Meerkat software which we use to process videos obtained from camera monitoring. Dr Weinstein provided assistance in the use of motion/detection software and provided feedback on further ecological questions that could be explored.

12. Any other comments?

Hereby, we include some pictures of our work performed thanks to Rufford grant – phase II.



Left: Local field assistant installing plot watcher camera at Sachatamia transect.
Right: BSc Student collecting data on flower abundance at Yanacocha transect.



Participants of the training workshop held on Mindo on May 2017. The audience of this workshop included local assistants, land owners, reserve managers and bachelor students. Project team members that provided training were Esteban Guevara (first row fourth from the right), Tatiana Santander (second row fifth from the left), Prof. Catherine Graham (second row fourth from the right) and Rolando Hipo (second row first from the right).



Project team member Tatiana Santander explaining the settings for camera and GPS use during training workshop in Mindo.



Female Violet-tailed Sylph (*Agelaiocercus coelestis*) feeding on *Glossoloma medusaeum*



Brown Inca (*Coeligena wilsoni*) feeding on *Centropogon solanifolius* (Campanulaceae)



Male Violet-tailed Sylph (*Aglaiocercus coelestis*) feeding on *Heliconia* aff. *griggsiana* (Heliconiaceae)



Tawny-bellied Hermit (*Phaethornis syrmatorophorus*) feeding on *Fuchsia macrostigma* (Onagraceae)