

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	David Wechuli
Project title	Potential impacts of climatic change on the foraging efficiency of species of bats.
RSG reference	24732-1
Reporting period	May 2019
Amount of grant	£5000
Your email address	WCHDAV004@myuct.ac.za
Date of this report	30/05/19

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
Compare echolocation calls for bat assemblages' in different biomes.				Using the innovative multiple microphone arrays, echolocation data for 14 species was recorded except for two species i.e. <i>Hipposideros caffer</i> and <i>Cleotis percivali</i> . The two species have highly directional calls.
Relate climatic conditions such as temperature, relative humidity, wind speed and atmospheric pressure to echolocation calls.				Climatic conditions affect echolocation parameters such as frequency and intensity that determine the operational range of echolocation signals. This limits prey detection ability and ultimately affect bats foraging efficiency. Signal emitted by bats at high frequencies e.g. rhinolophids in biomes with high humidity and low temperatures, are highly attenuated and vice versa
Measure intensity (source levels) and determine the prey detection distances within & among species across biomes.				For the first time on the African continent, the intensities at which bats emit echolocation signals was determined. Intensity is a crucial parameter that determine detection distance of prey. The newly developed array system together with a custom-made script enabled us to generate call intensities as source levels. Preliminary results reveal variation in intensities and detection distances across biomes depending on the prevailing environmental conditions (temperature and humidity). For example, low duty cycle (LDC) bats that emit signals at low frequencies and higher intensities to detect insect prey further. Unlike LDC bats, the high duty cycle bats echolocate at higher frequencies, but they also put in high intense calls to compensate for frequency dependant atmospheric attenuation. A comprehensive report on Intensities and detection distances

				shall be availed upon completion of data collection and analysis from one more site.
Identify and map some threats to natural habitats.				I noticed and documented potential disturbance to natural habitats. In certain areas e.g. sudwala, caves are regularly visited for tourism and the increasing access is due to little vegetation buffer between the caves and open savanna. Recent natural fire outbreak at Knysna affected a larger portion of the forest that host several disused mineshafts, where bat colonies roost. I observed a fluctuation in bat population, indicating the magnitude of the effect of fire to natural habitats and resident animals including bats.
Promote conservation awareness.				Together with my team, we interacted with members of local community, leaders of bats interest group at KwaZulu-Natal, park and nature reserve field guides and rangers. Considering their role in wider conservation effort, they serve as a link with local community with capacity to educate them as well. We shared our knowledge about bats response to different climatic conditions. This was valuable opportunity to enlighten park rangers and field guides who had little knowledge about bats. Local knowledge on the ecological roles of bats as suppressors of insects in the larger sugar cane plantations in southern parts Durban was augmented. We also emphasised the role of bats as pollinators and seed dispersers of plants. I look forward to conduct one major outreach programme in July 2019 during the last field trip at Dehoop nature reserve.

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

In the middle of my data collection period, I experienced some technical challenges with the recording equipment that forms an integral part of my project. First, the omnidirectional microphones and signal calibrators exhibited variation in

their performance that warranted checking their sensitivity in a state-of-the-art soundproof chamber. Both the signal calibrator and the microphones were first tested at Bristol University to check their sensitivity before putting into use for field studies in South Africa. As components age and equipment undergoes changes in temperature or mechanical stress, performance gradually degrades. Regular calibrations allows tracking the trend of performance of both the calibrator and the microphones. A calibration check with a stable speaker to establish a record of the operation of their sensitivity and check for changes in the microphone sensitivity for the nights I collected data was crucial. Therefore, I arranged travel in liaison with my co-supervisor Marc Holderied who is based at the University of Bristol UK to resolve the impasse. While at Bristol, I also learnt the multiple steps involved using custom-made script developed by Marc. The script enables generate intensities of echolocation calls and calculate bat's prey detection distances.

Secondly, it was unfortunate that my laptop had technical setbacks because of low access memory and slow operating system which could not effectively run a custom-made script on MATLAB and Avisoft SASLab Pro software. This is crucial software to analyse echolocation data and generate intensities (source levels) to determine detection distances of bat assemblages across biomes. Hence, I sought an approval from Rufford's grant and events manager to allow slight adjustment of my budget to meet the costs of new laptop.

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

- a) Using innovative technology, we generated new knowledge on how bats adjust intensities of their calls in the face of changing climatic conditions (temperature and humidity). Preliminary results show that bats can adjust calls at varied intensities that determine the operational range as they pursue their prey. Although I have not completed the analysis of data collected, in the end I will have a robust data finding that would be shared through published articles and conferences.
- b) We now have a record of bat species and distribution pattern across different biomes. The species were identified and characterized based on call parameters including an additional component (i.e. intensities) that was not previously known for bats in South Africa. The echolocation call library of South Africa's bat assemblages shall be updated with newly acquired information to enrich scientific knowledge.
- c) Potential threats natural habitats, specifically disturbance of roosting sites, are documented. For instance, the fire outbreak that engulfed forested areas of Knysna in Western Cape Province had grave impact on biodiversity. A bigger section of forest reserve was burnt and only small pockets of scattered vegetation available, leaving most of the caves and disused mineshafts (where bats roost) unprotected. Most of these caves and shafts at Knysna had no bats but others evidently with small bat populations. A similar trend of dwindled bat population was also observed at Sudwala caves in Mpumalanga province. These magnificent caves are popularly known for tourism throughout the year

because of their beauty and are spacious to host several activities e.g. wedding ceremonies, music concerts. Exceptional scientific studies where accurate paleo-environmental and paleo-climatic reconstructions are done in these caves. Regular visits, therefore, pose potential disturbance to bats roost site and ultimately threaten the survival of inhabitants.

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

This project helped us establish links with local people in different localities. It was only possible to locate some of the roosting sites after liaising with some local community members. Three leaders of a bat interest group in KwaZulu-Natal assisted us to locate a tunnel where bats roost, deep in a sugar cane plantation. They were enthusiastic to learn about our project, where a rare innovative technology is currently used to generate new knowledge to better understand bats response to changing climatic conditions. We were confident that they would share what they learnt with other community members during their voluntary outreach programme in bat education.

5. Are there any plans to continue this work?

Yes, this project forms a significant part towards my PhD programme. Echolocation data are still under process to generate intensities of bats from one more biome after the last field trip. Despite the challenges of recording bats with highly directional calls *i.e.* *Hipposideros caffer* and *Cleotis percivali*, I will further consult with experts in microphone array systems on possible ways I can record the two species in my last field trip. Once all species are recorded, I will synthesise analysed data and compare the response bat assemblages across biomes with different climatic conditions.

One component that I could not execute but rather critical is how bats respond to vegetation clutter. Vegetation complexity (acoustically cluttered habitats) together with climatic conditions influence emitted acoustic signals. I look forward to investigating the combined effect of the physical environment to bats acoustic signals and how they adjust echolocation parameters (frequency and intensities). As a long-term plan I would require finances and, I endeavour to seek support to facilitate this noble idea.

I have keen interest in conservation of bats and I purpose to extend a similar study to other parts of Africa through collaboration. With extensive surveys using new technology, I will be able to provide additional information that can be fed into management plans of natural habitats. As part of monitoring effects of global warming, it is particularly critical to continue to assemble information on the basic biology of bats over time. Because climate change will likely affect the efficacy of existing and future conservation efforts of bats, more investigations will go a long way to providing robust data in support of conservation goals

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

I plan to submit two manuscripts for publication in peer-reviewed journal. Together with my team, we already developed a description of bat species for a desert biome. We submitted the document to the park management to incorporate information in brochures and magazines. Also, I will share comprehensive results with parks and nature reserves manager where I conducted research. My abstract was accepted to give an oral presentation during the 18th International bat research conference (IBRC), scheduled on 28th July to 1st August 2019 in Phuket, Thailand.

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

The grant was used for a 9-month data collection period from June 2018 to February 2019. I adjusted the field work schedule following my travel plans to University of Bristol, UK to calibrate microphones and signal generator that I use in the field. I have already scheduled the last field trip to one more site to finalise data collection as envisaged. An outreach programme will also be conducted during the same period of data collection at Dehoop nature reserve where field guides and local community members shall attend. The two major activities are planned to take place in July 2019.

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
Dell Laptop		1143	+1143	The purchase of laptop wasn't budgeted for earlier. Unfortunately, the laptop that was in use experienced technical setbacks because of low access memory and slow operating system which could not effectively run a custom-made script on MATLAB and Avisoft SASLab Pro software's. I sent a request to the grant and events administrator to allow adjustment on my budget to meet the costs.
Allowance for project assistants	714	840	+126	
Hire 4WD vehicle	1129		-1129	The university of Cape Town provided a vehicle for field work
Vehicle maintenance	1200	980	-220	The balance will be used fuel field vehicle during my last field trip July 2019

Stationary and print outs	30	44	+14	Additional items such as masking tapes, ropes were purchased besides budgeted ones.
Meals during field work	400	580	+180	The rising costs of food items translated into more funds to meet our budget
Accommodation	1000	980	-20	Slight savings made by sharing accommodation.
Batteries AA & AAA	50	36	-14	Purchased more batteries (AAA & AA) to power a portable weather station and head lamps
Head lamps	50	74.86	+24.86	Purchase price was higher.
Ethyle acetate	7	7	+7	Not bought instead I used previous supplies in store
T-shirts	350	440	+90	More T-shirts will be procured and distributed during the last outreach programme in July.
Poster	70	70	70	To be printed after all data is compiled
External hard drive	0	82	+82	Not budgeted for but was used for store echolocation data as back up
Total	5000	5277	+277	Remaining funds is budgeted for last field trip activities

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

As I indicated earlier, my last field trip is scheduled in July 2019. The completion of data analyses shall follow and embark on write-ups.

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?

So far, I haven't used Rufford Foundation (RF) logo in any material because the results are not fully compiled. However, in all future publications, presentation at research conferences and community outreach, RF log will be used, and that time RF will receive publicity.

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

Nikita Finger - Nikita trained me how to use complex equipment with the associated software for acoustic data recording and analyses. Her acquaintance with many different parts of South Africa because of previous extensive travels was an added advantage during logistical arrangements. She helped during first two biomes we collected data. However, she could proceed for subsequent trips because of personal family matters that needed her attention. So, I had to engage another assistant in her place.

Tshifhiwa Netshongolwe – Tshifhiwa was handy in logistical arrangements of field trips-sending emails to secure research permits and book accommodation. She also helped in actual field activities during data collection.

Victor Mutavhatsindi - Victor immensely assisted in data collection. His experience in use of microphone array was valuable. Additionally, as a native South African, Victor speaks native languages and he assisted during our interaction with local community members.

David Jacobs – David's wealth of knowledge and a wide range of expertise and experience in bat research was invaluable by giving guidance. He provided other resources i.e. multiple microphone array system, portable weather station among other field equipment to necessitate my project. The grant from Rufford was received and effectively administered by him on my behalf and the University of Cape Town. As my thesis supervisor, David will ensure I successfully complete the remaining part of this project to achieve the primary objectives.

12. Any other comments?

I acknowledge and appreciate the Rufford Foundation for their generosity. The grant supported the project at a significant level that allowed me to explore expansive biomes of South Africa to establish crucial baseline data.



Multiple microphone arrays system



Left: Ultrasound gate receiver connected to laptop. Right: Set up of multiple microphone arrays to record echolocation calls of free flying bats in a foraging site in Fynbos biome at Dehoop Nature Reserve.



Left: Set up of multiple microphone arrays to record echolocation calls of free flying bats in a foraging site in Fynbos biome at Dehoop Nature Reserve. Right: A portable weather station to record weather parameters (temperature, relative humidity, atmospheric pressure and wind speed) at the same while recording echolocation calls.



Recording echolocation calls of free flying bats as they emerge from the roost (disused mineshaft) at Lekkersing, in a desert biome.



Left: Meeting with field guides and rangers at Knysna forest reserve. Right: Visiting the coastal caves with field assistants and rangers at Knysna.