

Final Evaluation Report

Your Details	
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Project Title	Comprehensive Reference Call of Southern Bhutanese Bats.
Application ID	30360-2
Grant Amount	£6,000
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Date of this Report	18 March 2020 – 18 March 2021

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. Establishment of Comprehensive Reference Call.				<p>Every captured species was measured and their morphological characteristics (see example photos 1, 2 and 3; rest of the captured species will be disclosed in the publication) documented following Bates and Harrison (1997) "Bats of the Indian Subcontinent". We recorded their calls by using a Pettersson M500 UltraSound Bat detector. In total, we could document 21 different species (four fruit bats and 17 insectivorous bats - Appendix 1). We have library calls from 17 different species (four from <i>Hipposideros</i> spp., one from <i>Kerivoula</i> sp., one from <i>Megaderma</i> sp., one from <i>Myotis</i> sp., two from <i>Pipistrellus</i> spp., six from <i>Rhinolophus</i> spp., one from <i>Scotophilus</i> sp., and one from <i>Tylonycteris</i> sp.,).</p> <p>Full call parameters and morphological measurements will be disclosed in the publication in the relevant journal.</p>
2. Surveyed roosts (caves and old human building structures) to study types of species occupied in it.				<p>In total, we made 17 cave surveys (six of boulder caves, three talus caves, four cavern (limestone) caves, three crevices and one cylindrical-like tunnel formed by fallen meteoroids (pers. com. with villager during field work), and eight old human houses. From these many roosts, we have recorded <i>Hipposideros</i> spp., <i>Rhinolophus</i> spp., <i>Rousettus</i> sp., <i>Pipistrelles</i> spp. and <i>Megaderm</i> sp. (See also Figure 2).</p>
3. Deployment of Trappings by harp traps and mist netting in different habitats (Forest, agricultural land and river trails).				<p>We undertook 15 trappings in each habitat (forest, agricultural, river trails) with same trapping efforts from 18:00 to 22:00. We compared the capture rate by mist net (3m × 14m) and harp traps (1.4m × 1.4m). Results will be published in the journal.</p>

<p>4. Community Awareness campaign on importance of Bat population in ecosystem.</p>				<p>Day 1: Door-to-door Awareness on Importance of Bats (Theme "Covid-19 is Zoonotic, But NOT because of Bats") was conducted on 6th April 2020 followed by Day 2 in another village on 14th April 2020. In total, our campaign team could cover about 40 households randomly (see also in 1st Report, Photo 5).</p> <p>On 8th August 2020, we presented a research symposium on this very project to all the staff (58 staff) of PMSS and 10 science teaching staff from Karmaling Higher Secondary School, head of the local government accompanied by two representatives from different villages (one official from forestry department and BPCL manager). In total there were more than 70 who participated in symposium.</p> <p>On 28th November 2020, we presented a research symposium on to all the students of classes IX and X (182 students in total). In this presentation, the main point was focused on the importance and benefits of the project to work towards conservation of bat population in the future (Appendix 2).</p>
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2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

During the study period, we encountered few unforeseen hardships as listed below:

a) Unforeseen difficulties related to the accumulation of equipment.

After the release of financial support from The Rufford Foundation, I could not gather equipment, specifically the ultrasound bat detector as per our specified timescale in the proposal (01/03-02/04/'20). I had to wait for a month to order equipment. Due to the rising pandemic situation around the world, I could not place an order to buy an ultrasound bat detector from the relevant company in the UK. However, Dr Pipat Soisook from Thailand (researcher team for the project), was so kind enough to arrange necessary equipment supply for the project from Thailand and thus we were able to undertake acoustic recordings for the comprehensive call library. Above all, none of the team from abroad (Dr Paul Bates from UK, Dr Sara Bumrungsri and Dr Pipat Soisook, PSU, Thailand) could make their visit to the study sites as the country restricted the entry of tourists due to first COVID-19 cases reported on March 6th, 2020. Since then, I was fully supported and motivated by the team through other means of communication (through

online, such as messengers, email, online apps). Thus, our project was successfully completed through their unconditional support to this very study.

b) Unforeseen difficulties related to cave surveys.

Inaccessibility of the study sites caused by geographical barriers such as hills/mountains and the rivers stopped us reaching certain places for sampling. In the present study sites, the cave roosts are mostly found in unsafe locations, especially near flowing rivers. Due to monsoon rain, the swollen rivers had risen above a level where two sites had to be left without assessment until the condition subsidised in next autumn season. Other difficulties were mostly in the talus caves where there were higher risks of falling boulders. The team had to be very cautious and vigilant during surveys, especially in those talus caves. We used safety helmets for protection from falling objects in the caves.



Figure1. Another spot where we encountered elephant dung on the way to Shaktikhola for data collection on July 10, 2020. The way was led by Mr Asha Gurung from Mindrupling.

c) High risk of encountering wildlife during data collection.

In southern Bhutan, especially in Samdrup Choling under Samdrup Jongkhar district, is an area prone to human-wildlife conflict, specifically with the Asian elephant (*Elephas maximus*) and wild mithun (*Bos frontalis*) (T. Dendup, pers.

obs.). It was quite risky at the time of data collection from the areas prone to conflict (there were death cases by elephant as per the locality. Source: pers. cumm. with locality). However, there weren't any animals that could be spooked at close range that could lead to an attack, though we encountered very fresh elephant dung for several times (**Figure 1**). We always ensured by asking local people whether they had seen elephant or mithun in their areas prior to our fieldwork. Thus, no casualty happened during our study.

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

The most important outcomes from the project are as follows:

i). Call reference library of echolocating bats for the region.

The finding would be a baseline for acoustic studies for the future researchers to work on and monitor bats acoustically in the region. Importantly, the findings will contribute to acoustic research knowledge and the collection of comprehensive reference calls from the southern region of Bhutan. Thus, echolocation calls of bats from different regions that differ due to geographical variations would be known and this helps to fill the gap in future research work. All seven call parameters such as call duration (d), frequency of maximum energy (FmaxE), frequency at half of call duration (Fmiddle), frequency at the beginning of call (Fstart), highest frequency (Fhighest), minimum/end frequency (Fmin) and call interval were measured following Preatoni et al. (2005). However, in this report call parameters from 4 genera are revealed (Appendix 3) so as to maintain confidentiality for the publication. The parameter measurement from all the recorded species will be disclosed in publication in the suitable journal.

ii). Roost assessment and monitoring in the region.

After locating roosts in different sites during the study, especially caves (Figure 2), hereafter it will be easier for monitoring and assessment when required, or else if it is needed to carry out further studies to work towards conservation of different roosts. For example, if we need to study different types of roosts such as winter roosts, transitory or even nursery roosts, it's easier for relocation hereafter. Thus, to take actions towards the conservation of different roosts by figuring out the threats due to anthropogenic activities in the region. Moreover, from the study, it is known that most of the roosts are far from human settlements though we recorded at least two talus caves and two cervices which were vacated by the colony recently due to human disturbance such as farm road construction and expansion of agricultural activities, (T. Dendup, pers. obs.) Therefore, further monitoring and assessment of roost is important in the region.



Figure 2. Active different roosts in different sites during the study occupied by different species in talus caves, cavern (limestone) cave, crevices and even in a cylindrical like cave formed by fallen meteoroids.

iii). Public education on conservation of nature for bats through awareness campaign.

During our door-to-door campaign (Appendix 4) and research symposiums, we have collected data based on previous knowledge and ideas about bats. In total, we have collected questionnaire survey data from 461 individuals (70 school staff during research symposium conducted on 8th August 2020, 182 from class 1X and X students during research presentation conducted on 28th November 2020 and the rest from 209 individuals from villages during the door-to-door awareness campaign) (see also 1st report). The results revealed that most of the people in the region have very limited knowledge of bats (Figure 3). Most knew of only one type of bat and those who know ≤ 5 based their identification on fur colouration and body size (red, black, yellowish, big or small). Surprisingly, there was no one who knew of the existence of ≥ 10 species even though the country has already listed around 65 bat species (Wangchuk et al, 2004).

Another finding from the questionnaire survey based on 'how useful bats are?', indicated that the responses 'no idea' followed by 'harmful' were significantly higher than the other two descriptions (helpful and both) despite the important roles played by bats (**Figure 4**). The findings clearly indicated that people had very limited information about bats (be they educated or uneducated citizens). Therefore, this project has disseminated information on the importance of bats as pollinators, pest suppressors, bio-indicators, and their guano as fertiliser and so on. Thus, the project has contributed to the field of public education on importance and conservation of bats in the region.

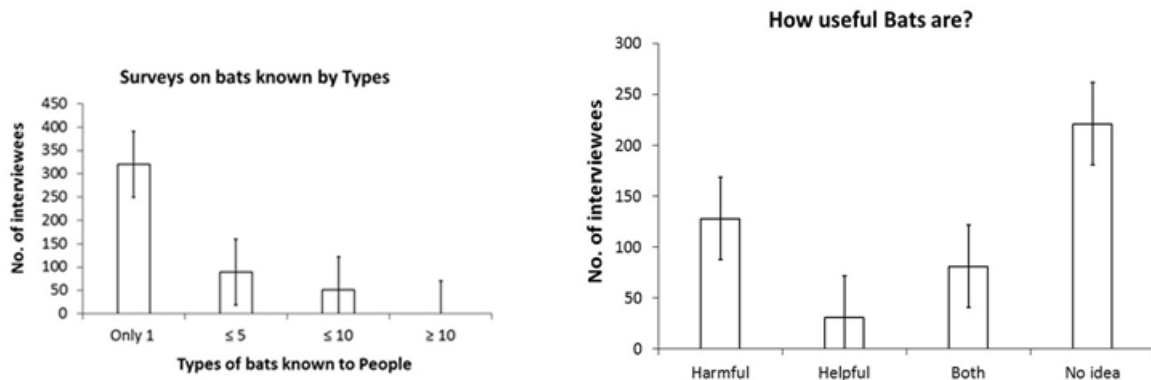


Figure 3. Bats known to people in the region. Figure 4. Are bats friendly?

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

Foremost thing, prior to our field work we hired local people to guide us throughout our field survey from different villages as and when sites were in their area. Therefore, during the field visits there was ample time to share with them awareness on the importance and conservation of bat communities or populations.

Importantly, during this project we conducted awareness campaigns on 6th and 14th April 2020 in two different villages (see Appendix 4). On the first day, we covered 25 households in the villages called Sukuni which is located 26°52'42.15"N; 91°38'37.72"E accompanied by Mr Tashi Tshering, a school teacher, and Mr. Jamyang Gyeltshen, the Head of Local Government of Samdrup Choling Block. On the second day (accompanied by Mr Dorji Wangchuck, school teacher, and Mr Asha from Mindrubling village), we visited around 15 households in the village called Mindrupling (26°51'42.45"N; 91°42'36.72"E) under the Samdrup Choling sub-district, Bhutan (also refer to 1st report submitted on 15th July 2020). Moreover, I also conducted a research symposium on 8th August 2020 with around 70 people. On 28th November 2020, I made presentation at a Research Symposium to all the students of classes IX and X (182 students in total) (see also Appendix 2). In this presentation, the main points focused on the importance and benefits of the project to work towards conservation of bat population besides their importance in an ecosystem.

5. Are there any plans to continue this work?

Data collection is done as of now for the project. However, call analysis/measurement of call parameters is yet to finish (call analysis will probably be completed by the end of April 2021; see also Appendix 3). The following month I will be engaged in preparing a manuscript for the publication in a relevant journal. Another important work could be roost assessment and monitoring that would be greatly beneficial to bat ecology in the region. More importantly, I have a tentative plan to conduct my final research symposium in April 2021 after the first draft of our manuscript has been completed.

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

My priority is to publish in the most relevant journal to help to bridge the gap in the field of bat conservation in Bhutan. At a local level, I am going to attend any research symposium that is being conducted to share my findings with the community, officials or other relevant institutions. For example, we received a mail from UWICER-DoFPS, Bhutan (The Department of Forest and Park Services) on December 16th, 2019 to present our findings based on the first phase of the project (Patterns of foraging activity of Insectivorous bats in Remnant forest in the Sub-tropical zone of Bhutan). We have already submitted our abstract for the programme. However, the host could not organise the symposium due to Covid-19 pandemic. Similarly, we have other relevant institutes such as CNR-College of Natural Resources and NBC-National Biodiversity Centre. Thus, I would kindly share the findings and conservation implications related to our studies to work towards the conservation of bats in Bhutan.

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

The grant was utilised from March 2020 to March 2021 as per the timescale for the project. However, £196.159 is still reserved for the final research presentation that is tentatively planned in the month of April 2021. This symposium is very important to the community/relevant institutions to share the findings specifically on threats over the bat ecology/habitats in the region.

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
1. Research Equipment				
Petterson M500 = £459.00	£2415	£2874	+£459	Budget inflation due to the price differences. All the equipment is fully used throughout the field work effectively and efficiently. Note: Rest of the amount (£459.01) adjusted from accommodation, subsistence payments for field assistant, Wages for local travel, fuelling etc.
Petterson's BatSound v4.x = £269.00				
Nikon AF-S VR 70-300mm, f/4.5-5.6G, IF-ED = £524.00				
Stereo cable (3.5mm) = £2.99				
Harp trap, Mist-nets (10 nos.), Mist net pole (1				

pair), alkaline batteries of 9v, AAA batteries of 1.5 = £ 1499.00				
Safety equipment (gloves, masks, boots, hand sanitizers, headlight and touch....) = £120.00				
Awareness campaign				
Familiarization workshop to team (not included foreigner team member). = £89.00	£1500	£1707	+£207	Budget inflation is likely due to pandemic where the team must conduct door to door campaign.
Door to door campaign including fuel for the transportation and refreshment = £699.00				
Research symposium (including preparation and refreshment) = £520.00				
Final Research presentation (including preparation and refreshment) = £399.00				
Other				
Subsistence payments for field assistant, Wages for local travel, fuelling etc. (£640.00)	£1100	£640	-£459	Budget surplus was adjusted to deficit budget of £459.01 on research equipment.
Accommodation and meals (included refreshment) during fieldwork. (£555.00)	£750	£555	+£195	Budget surplus was adjusted to deficit budget of £207.00 on awareness campaigns (£12.00 adjusted from Final Research symposium budgeting)
Final Research symposium to share findings (after the manuscript writeup,	£208	£196	-£12	Tentative day and week for the symposium is set in the 4 th week of April month 2021.

probably in the month of April 2021) = £196.159				Audience (yet to decide): Karmaling Higher Secondary school or Samdrupcholing Range Office staff, Ministry of Agriculture and Forest, Bhutan.
TOTAL	5973	5972	-1	

Notes:

- Fund Received on 24th March 2020.
- Currency value on the day received £1 = Nu. 87.95 (Bhutanese currency).
- Actual amount in pound sterling = £ 6000 (Nu. 527700.00)
- Amount received in joint account = £ 5973.139 (Nu. 525337.55)
- Transection charges deducted = £ 26.861 (Nu. 2362.425)

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

Several studies have reported that undisturbed forests are biologically diverse systems which provide important habitats for different bat species (Kunz and Lumsden, 2003; Lacki et al., 2007 Heim et al., 2015; Mendes et al., 2017) and have noted negative impacts on species due to a rise in an anthropogenic activity (Fenton et al., 1992; Kunz and Lumsden, 2003; Mendes et al., 2017). However, the presence of patchily distributed agriculture in the forest dominated landscapes results in a mosaic of foraging habitats for insectivorous bats (T. Dendup pers. obs.) that play nightly active roles in pest control in farmland (Russo, et al., 2018). Therefore, future studies in the region should be working towards the conservation of roosts and stressing the importance of bats through public education.

i). Roost surveys: During our field studies, most of the roosts have been disturbed due to human activities or natural calamities in the region. To date, no roost assessments and monitoring have done from the region. Therefore, roosts surveys in the region must be carried out scientifically to categorise different roosts (e.g.: winter roosts, transitory or even nursery roosts) for the assessment and monitoring in future to gear towards conservation of bats in the region.

ii). Public education: This project reveals a minimal knowledge of and more negativity towards bats by the community (see Figures 3 and 4) which may lead threats to bats. Therefore, besides roosts assessment and monitoring, public education on the importance of bats in our ecosystem is equally important for the conservation of bat diversity in the region.

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?

During the research symposiums (on 8th August and 28th November 2020), I used the Rufford Foundation logo (Appendix 5) and presented with an acknowledgement of RF as a major funding source for the project. Moreover, the Rufford Foundation will

be acknowledged my paper. I have mentioned in the acknowledgement part in my first accepted manuscript, AC-00426-2020-03, by Acta Chiropterologica RF as a main funding source for our 1st research project).

11. Please provide a full list of all the members of your team and briefly what was their role in the project. 12. Any other comments?

Research Team/address	Role	Remarks
Dr. Pipat Soisook, Researcher, Curator of mammals, Princess of Maha Chakri Sirindhorn Natural History Museum, Faculty of Science, Prince of Songkla University, Thailand.	His contribution was immeasurable in this very project such as: equipment gathering, species identification based on morphological measurement, helped in bat echolocation measurement in bat sound program.	
Asst. Professor, Dr. Sara Bumrungsri of Prince of Songkla University, Songkhla with expertise in Ecology, Thailand.	He would be working as the main editor of our manuscript for publication in relevant journal.	Not yet finish our write up (under process)
Dr. Paul Bates, Director of the Harrison Institute, United Kingdom;	Provided guidebook 'Bats of the Indian Subcontinent' by Bates and Harrison (1997) which is authentic and more reliable for the region.	
Dr. Joe Chun-Chia Huang, Faculty of Resource Science and Technology, University Malaysia Sarawak.	Species identification, acoustic recording and sound analysis.	
Mr. Tashi Tenzin, Principal, Phuntshothang Middle Secondary School, MoE, Bhutan;	Manager for accommodation during fieldtrips.	
Mr. Dorji Wangchuck, School teacher Phuntshothang Middle Secondary School, MoE, Bhutan;	Field assistant	
Mr. Tashi Tshering, School teacher Phuntshothang Middle Secondary School, MoE, Bhutan;	Field assistant	
Mr. Asha Gurung, villager from Mindrupling, Samdrupcholing, Bhutan.	Field guide	Replacement of Mr. Bikash

12. Any other comments?

I, on behalf of my project team members would like to express our deep gratitude to The Rufford Foundation for providing financial support without which the project would not have been accomplished the way it is now.

The team is also thankful to all the referees: Dr Amit Jaisi, Lecturer at Walailak University, Thailand, Mr Pema Khandu, Wangbama Central School, Department of Science, Genekha, Thimphu, Bhutan and Mr Choki Gyeltshen, Senior Biodiversity Officer, National Biodiversity Centre, Ministry of Agriculture and Forests, Serbithang, Thimphu, Bhutan. We are also thankful to Dr Rohit Chakravarty, bat biologist, Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany, for their unconditional support.

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Appendix 1. Checklist of captured bats in this project. * *Rhinolophus* sp is a new record in Bhutan (species ID will be disclosed in the journal).

Fruit Bats			
Sl no.	Species	No. of individual captured	Morphological measurement
1	<i>Cynopterus horsfieldi</i>	1	Morphological measurement with photos will be disclosed in the relevant journal as repository data from the region.
2	<i>Dycopterus spedicus</i>	3	
3	<i>Enycteris spalaea</i>	1	
4	<i>Rousette leschenaultii</i>	7	
Insectivorous Bats			
Sl no.	Species		
A. Family: Hipposideridae (Leaf Nosed Bats)			
1	<i>Hipposideros armiger</i>	15	
2	<i>Hipposideros cineraceus</i>	2	
3	<i>Hipposideros cf larvatus</i>	4	
4	<i>Hipposideros pomona</i>	7	
B. Family: Megadermatidae			
1	<i>Megaderma lyara</i>	4	
C. Rhinolophidae (Horseshoe Bats)			
1	<i>Rhinolophus affinis</i>	1	
2	<i>Rhinolophus lepidus</i>	3	
3	<i>Rhinolophus luctus</i>	2	
4	<i>Rhinolophus macrotis</i>	2	
5	<i>Rhinolophus pearsonii</i>	6	
6	* <i>Rhinolophus</i> sp	3	
D. Family: Vespertilionidae			
1	<i>Kerivoula hardwickii</i>	3	
2	<i>Myotis muricola</i>	1	
3	<i>Pipistrellus javanicus</i>	2	
4	<i>Pipistrellus spp</i>	6	
5	<i>Scotophilus heathii</i>	4	
6	<i>Tylonycteris pachypus</i>	1	

Appendix 2. Research Symposium conducted on 28th Nov 2020, to all the students of classes IX and X (182 students in total). In this presentation, we focused on the importance and beneficial of very project to work towards conservation of bat population in the future studies besides the importance of Bat population in an ecosystem.



Appendix 3. Mean (\bar{x}), (\pm SD), and range of at least seven call characteristics. However, in the report we have listed from four individuals against to every genus level as to maintain its confidentiality for the publication (All the captured species will be revealed in the publication). The total number of individuals recorded is denoted by letter 'n'.

Species	n		d	FmaxE	Fmiddle	Fstart	Fhighest	Fmin	Call interval	dominate Harmonic	References
<i>Hipposideros</i> sp. 3	4	\bar{x}	4.9	44.5	42.7	44.1	45.8	29.9	97.3	2nd	This study
		SD	0.4	3.0	3.4	4.0	3.8	4.9	12.2		
		max	5.3	48.0	46.0	48.0	49.0	35.0	110.4		
		min	4.4	41.8	39.0	40.0	42.0	24.6	86.3		
<i>Rhinolophus</i> sp. 4	6	\bar{x}	43.3	63.4	61.8	56.9	64.8	43.2	115.6	2nd	This study
		SD	11.1	0.8	1.1	2.5	1.4	3.1	55.1		
		max	58.3	64.9	64.0	59.8	67.7	47.8	178.0		
		min	26.6	62.7	61.0	53.0	64.0	40.5	33.8		
<i>Myotis</i> sp.	5	\bar{x}	4.9	48.5	49.7	65.4	68.0	45.4	78.7	1 st	This study
		SD	1.1	1.1	2.4	5.3	5.3	1.3	6.4		
		max	5.9	50.0	53.0	71.0	73.7	46.5	87.2		
		min	3.6	47.2	47.3	59.0	61.8	43.3	69.4		
<i>Pipistrellus</i> sp. 2	7	\bar{x}	2.7	50.6	54.8	90.0	95.0	41.7	84.8	1 st	This study
		SD	0.7	1.4	8.8	12.8	13.0	1.0	61.4		
		max	3.5	52.6	71.7	107.0	112.5	43.0	219.1		
		min	1.9	48.4	48.0	72.0	75.7	40.3	36.9		

Appendix 4. Awareness campaign conducted on 6th and 14th April 2020 in two different villages, Sukuni and Mindrupling respectively under the Samdrup Choling sub-district, Bhutan.



Appendix 5: Extended my Heartfelt Gratitude to the research team and **Rufford Foundation** during Research symposium (Dated 28th Nov 2020).



Photo 1: A male Greater Asiatic yellow bat (*Scotophilus heathii* - Horsfield, 1831) was captured by mist net from agricultural landscapes.



Photo 2: A female *Megaderma lyra* (E. Geoffroy, 1810) commonly known as a Greater false vampire bat was captured by home-made sweep net (improvised materials) from one of the abandoned houses. She was devouring a limb of frog in the roost (abandoned human house).



Photo 3: Unknown FM bat (f) captured by harp trap from the river trail near in the mid of forested landscape.

