# Final Evaluation Report

| Your Details | |
|---|---|
| **Full Name** | Sanjeev Baniya |
| **Project Title** | Acoustic survey and monitoring to lay the foundation for conservation of the endemic Csorba's mouse eared bat (*Myotis csorbai*) in Nepal. |
| **Application ID** | 29622-1 |
| **Date of this Report** | February 13, 2023 |

**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 |
|---|---|---|---|---|
| Building a call library of cave-dwelling bats | | | | Audiomoths were placed at the entrance of each cave, and hence a valid library was built. The library along with call data will be published along with cave-exiting activity. |
| Roost surveys to locate Myotis csorbai use of caves at landscape level | | | | 47 caves were visited from an elevation of 500 - 2500 m to locate roost sites for *Myotis csorbai*. Altogether eight caves were found to host *Myotis* cf. *csorbai*. Further capture/ genetic studies are required for confirmation of this cryptic species. This result along with data from other sympatric species will be published. Furthermore, a master's thesis was conducted from the collected data. Two research papers will be written after further analysis. |
| Foraging areas of Myotis csorbai. | | | | We conducted roost surveys at the landscape level where we focused on 47 caves instead of only Kailash cave. This was done because this species tends to use different caves at different times and were most often not observed inside Kailash cave. Focusing on the surrounding of a single cave wouldn't allow the use of Audiomoths at different cave sites. |
| Conservation outreach (poster presentation, workshops, cave visitation surveys) | | | | Interaction with District Forest office, Millennium trek committee, Kailash cave management committee, Siddha cave management committee, Mahendra cave and Bat cave management committee were done throughout this project. Although hit hard by the COVID outbreak, we were able to conduct this study after 2022. Moreover, these results were presented as poster in the study area and will again be presented in Student Conference on Conservation Science (SCCS), UK. |

| | | | | |
|---|---|---|---|---|
| Interview with local people to gain information about their perception and attitude towards caves and bats post COVID. | | | | Over 300 interviews were taken from over 15 cave surroundings to understand perception and attitude of different stakeholders of these caves. This research was also conducted as a bachelor's level thesis. A research paper is being written now. |
| Cave management plans | | | | Cave management guidelines will be made available through a book in the future. We have already disseminated relevant roosting pattern information of studied caves to local people. We'll soon publish a book on caves in Nepal and guidelines to manage these caves. |

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

**a).** *Myotis* cf. *csorbai* was found to not use caves during the winter. It could possibly migrate to caves in other regions whose microclimatic characteristics are suitable for prolonged torpor. In spring, however, most caves were being used. Bats not only used these caves as a roost site but also exited more frequently as shown by passive acoustic monitoring. By phases, first phase = peak winter, second phase = late winter and third phase= spring.

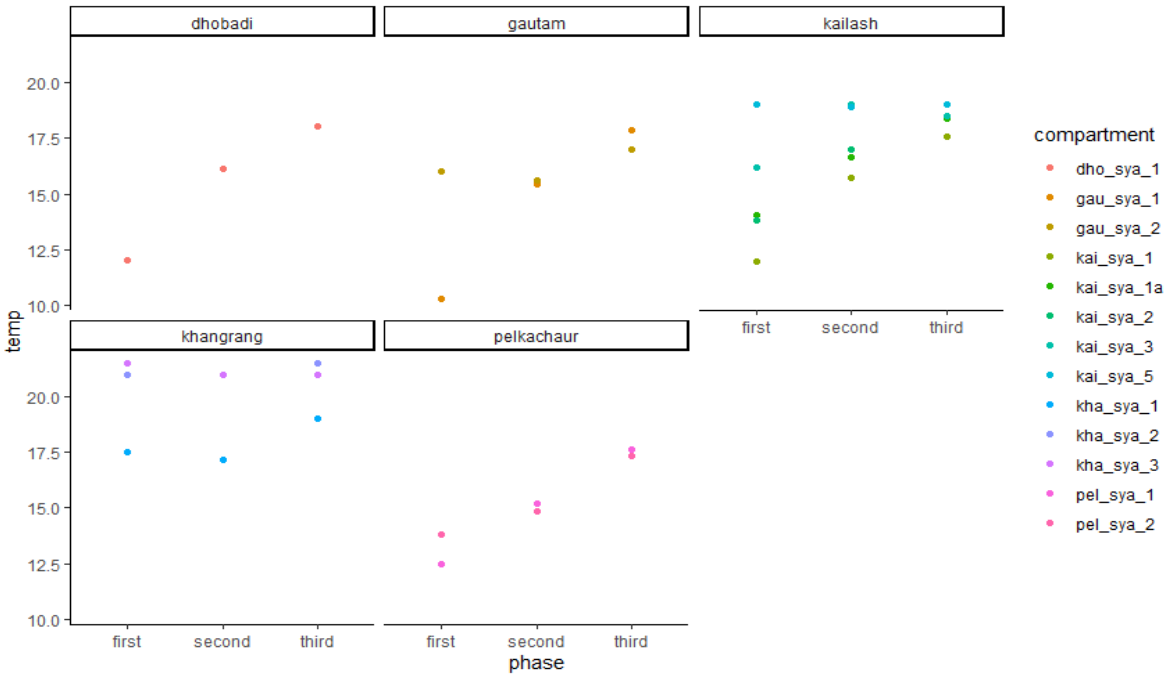



*Figure A: Microclimatic temperature differences in different phases at different compartments in Kailash and neighboring caves in Syangja district.*

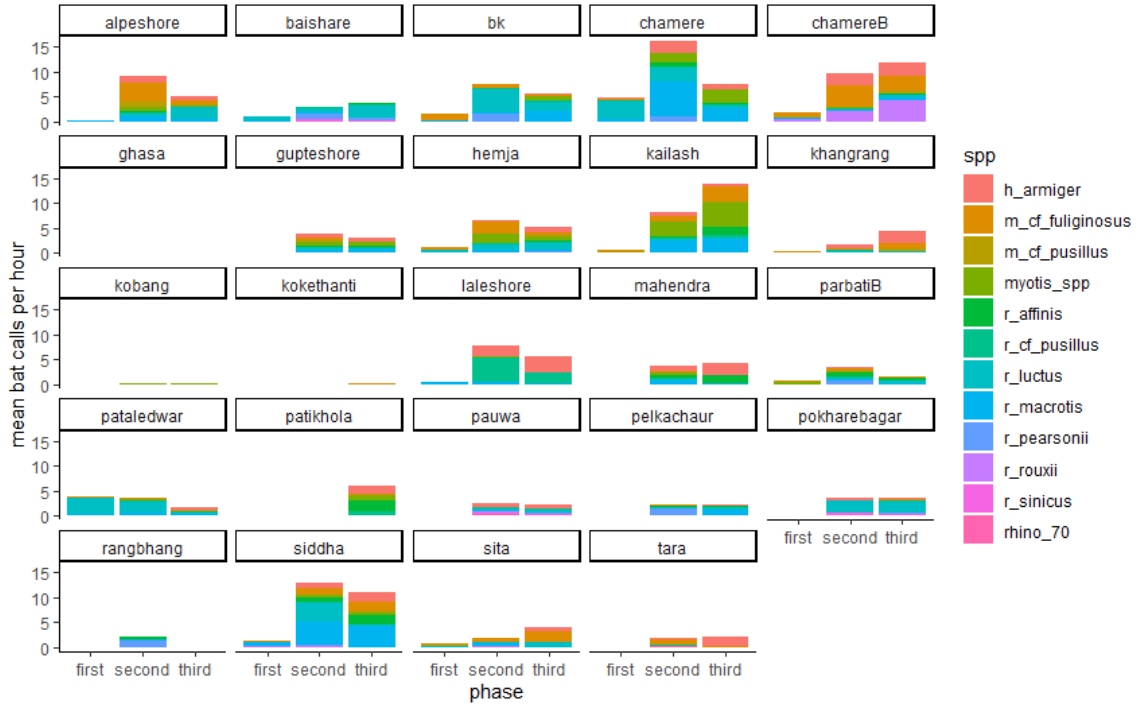



*Figure B: Activity of bats at 23 different caves in three different phases.*

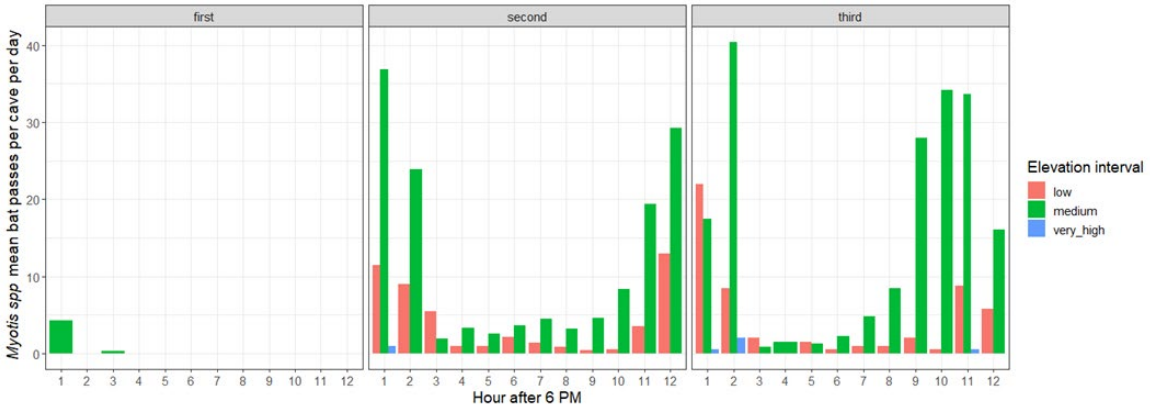



*Figure C: Within night activity for Myotis cf. csorbai in peak winter (first), late winter (second), and spring (third) phases.*

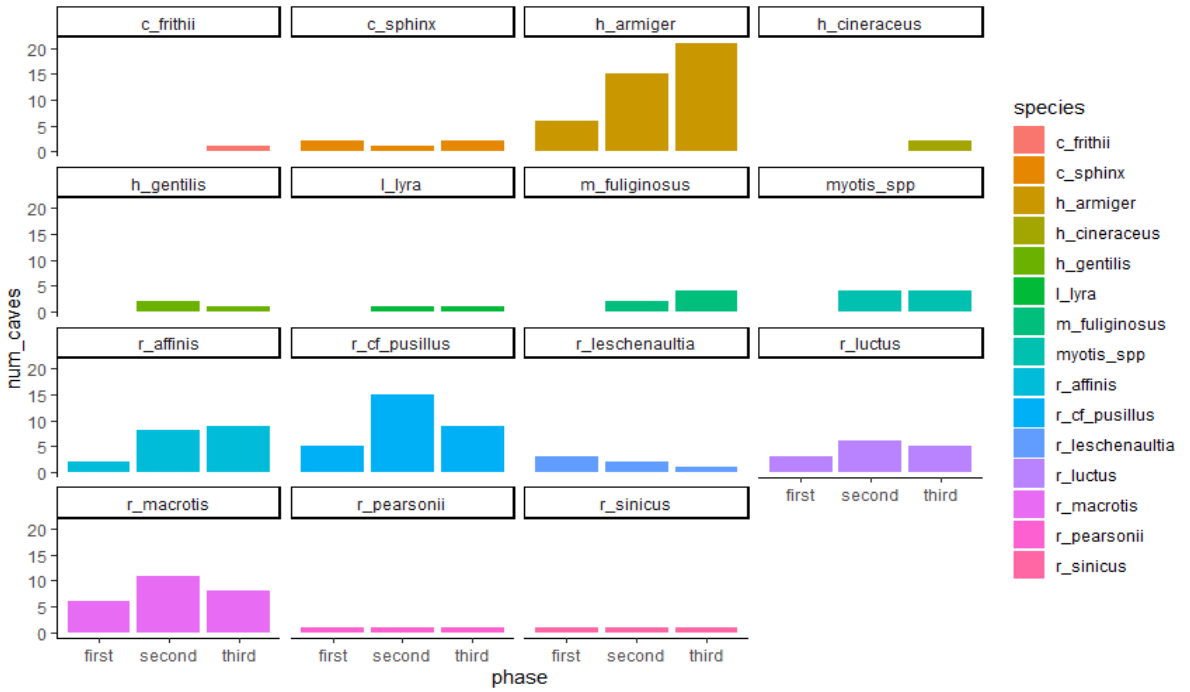



*Figure C: Number of caves used by different cave dwelling species in the study area. Myotis cf. csrobai was not seen in any caves in winter but occupied 3 caves each in late winter and spring phases.*

**b).** Using single season data to determine a bat cave vulnerability index (BCVI) could backfire in terms of conserving population of different bat species. Because most bats varied the use of roosts in different seasons, the cave prioritisation for conservation should also change accordingly. For example: prioritising hibernacula during winter and maternity roosts during spring.

Changes in Biotic potential scores of caves across seasonal phases

| *First Phase* | *Second phase* | *Third phase* |
|---|---|---|
| ChamereA | ChamereA | ChamereA |
| Chamere | Millenium | Mahendra |
| Millenium | Chamere | Birendra |
| Siddha | Mahendra | Patikhola |
| ParbatiB | Siddha | Gupteshore |
| Hemja | Baishare | Siddha |
| Baishare | Gupteshore | Kailash |
| Patikhola | Patikhola | Khangrang |
| Kailash | Alpeshore | Alpeshore |
| Khangrang | Pataledwar | Baishare |
| Laleshore | ParbatiB | Laleshore |
| Pataledwar | Sita | Gautam |
| Tara | Crazy | ParbatiB |
| Alpeshore | Kailash | Siddha_bhim |
| Gupteshore | Laleshore | Kumari |

*Figure D: Changes in biotic potential scores and prioritization across phases for 15 caves with the highest scores in each phase. The green arrows resemble an increase*

*in the prioritization index via biotic potential scores, red represents a decrease, and black represents a constant. The caves in green represent the caves that weren't in the top 15 in the first phase but were prioritized in the latter phases. As can be seen in the figure, the ranking of each cave changes in accordance to the change in species composition at different times. Using a static index, therefore, is not sufficient for prioritizing caves.*

**Table 1:** Biotic vulnerability scores based on the framework given by Tanalgo et al. 2018. For score reference, please look at that paper.

| Cave | Accessibility | Cave opening | Effort | Tourism | Cave use | Land use | temples | BV score | Status |
|---|---|---|---|---|---|---|---|---|---|
| Chamere | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1.428571 | A |
| Mahendra | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1.428571 | A |
| Crazy | 2 | 3 | 3 | 2 | 3 | 2 | 4 | 2.714286 | B |
| Kumari | 1 | 1 | 2 | 3 | 3 | 3 | 4 | 2.428571 | B |
| Hemja | 2 | 1 | 2 | 4 | 3 | 4 | 4 | 2.857143 | B |
| Sita | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2.428571 | B |
| Patikhola | 3 | 1 | 1 | 3 | 3 | 4 | 2 | 2.428571 | B |
| Lovely | 1 | 3 | 3 | 4 | 4 | 4 | 4 | 3.285714 | C |
| Birendra | 1 | 2 | 2 | 2 | 3 | 2 | 4 | 2.285714 | B |
| Siddha | 1 | 1 | 3 | 1 | 2 | 2 | 1 | 1.571429 | A |
| Pataledwar | 1 | 4 | 3 | 3 | 4 | 2 | 2 | 2.714286 | B |
| Bk | 1 | 1 | 1 | 4 | 4 | 2 | 4 | 2.428571 | B |
| Millenium | 3 | 3 | 1 | 2 | 3 | 4 | 4 | 2.857143 | B |
| Siddha_Bhim | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2.142857 | B |
| ChamereA | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2.142857 | B |
| Kailash | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | B |
| Gautam | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | B |
| Khangrang | 3 | 2 | 1 | 4 | 4 | 4 | 4 | 3.142857 | C |
| Pelkachaur | 1 | 2 | 1 | 4 | 4 | 4 | 4 | 2.857143 | B |
| Gupteshore | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1.428571 | A |
| Alpeshore | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2.285714 | B |
| Laleshore | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1.857143 | A |
| ParbatiA | 1 | 2 | 3 | 4 | 4 | 2 | 4 | 2.857143 | B |
| ParbatiB | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1.571429 | A |
| Milanchowk | 1 | 1 | 1 | 3 | 4 | 1 | 2 | 1.857143 | A |
| Tara | 3 | 1 | 1 | 4 | 3 | 3 | 4 | 2.714286 | B |
| Pauwa | 2 | 2 | 3 | 3 | 4 | 3 | 4 | 3 | C |
| Andhere | 1 | 2 | 1 | 4 | 4 | 4 | 4 | 2.857143 | B |
| Baishare | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | A |

**c).** The perception of local people towards bats have not changed in older age groups. Most older people that lived at the vicinity of cave roosts didn't have a negative perception about bats even after COVID- 19. The younger age group people, however, had negative attitude towards bats. This could possibly be because of their use of social media and the news that maligned bats after COVID-19.

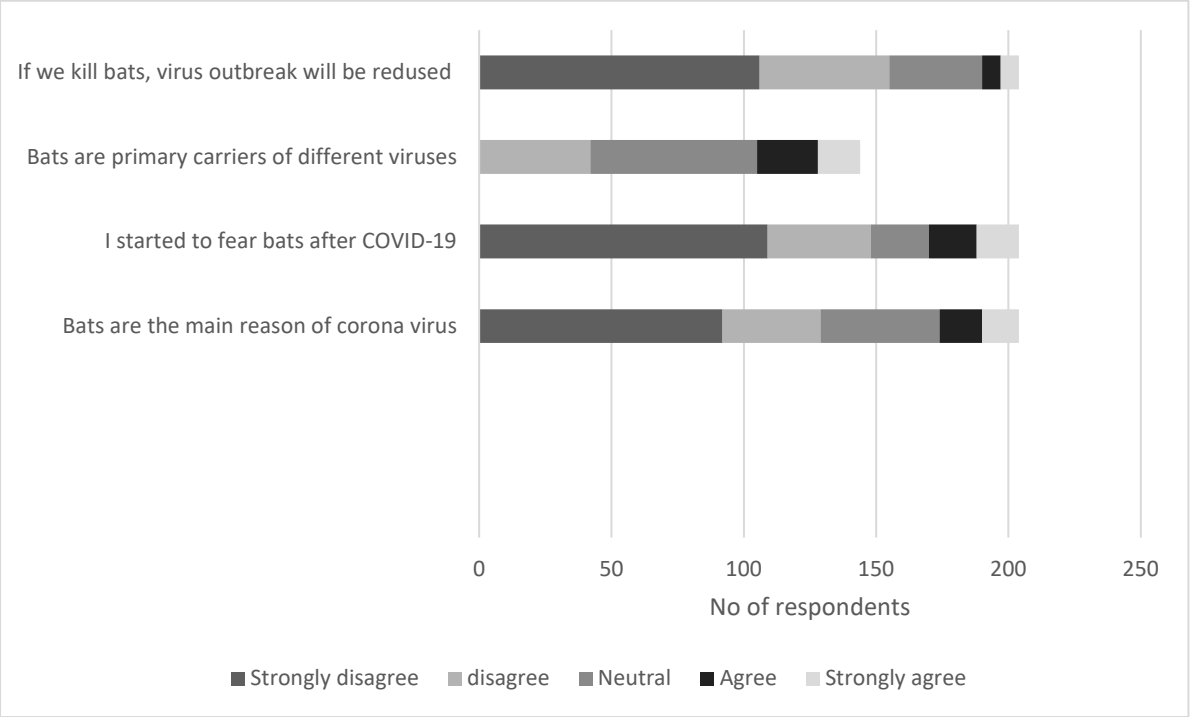



Figure E: Perception of local people about bats after COVID-19.

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

The most difficult part of this study arose after COVID-19. This is why all the field work had to be delayed ensuring good health of researchers, local people and bats. Because of this situation, we followed the guidelines provided by the IUCN SSC Bat Specialist Group and were unable to capture bats. We ensured minimal disturbance to roosting bats while conducting both roost and acoustic surveys. Furthermore, we couldn't conduct enough passive acoustic monitoring in the surrounding areas of the caves due to lack of enough cave samples where the target species was present. We intended to supplement acoustic monitoring with capture surveys but were unable to conduct the capture study due to COVID-19 situation.

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

The local communities at the periphery of Kailash Cave in Syangja district benefitted from this research by gaining insights about the use of those caves by different species of bats. We informed the communities about eco-cave tourism. As there were caves with different structural characteristics, we developed ideas to ensure that both cave-tourism and bat conservation were done together. For example: the lower storey of

Kailash cave was occupied by *Myotis* cf. *csorbai* while the upper storey was mostly unused during some months. Cave tourism was therefore recommended to take place in the months where bats were not using those sites. In case of Kailash cave, we recommended winter to be the best time for tourism related activities. Furthermore, we provided mammalian data to the management committee as a part of their biodiversity assessment in the area. One citizen scientist was provided with enough skills to help him monitor these caves through roost and acoustic surveys. Finally, the local communities were provided with information about safety measures inside caves to minimise virus transmission possibilities.

**5. Are there any plans to continue this work?**

Yes, there are plans to continue this work. During this work, we studied the roosting patterns of cave dwelling bats using dataloggers and acoustics. The obvious next step would be to understand the mechanisms behind use of such roosts through physiological approaches (for example: hibernation energetics). Moreover, the number of records for *Myotis csorbai* presence was very low. Using GPS telemetry could further elucidate about the movement ecology and habitat use by these data deficient species. Finally, one potential work that we could not do was to look at the effects of different land use types on the taxonomic, functional and phylogenetic diversity of bats in the study area. We, therefore, aim to use spatial replicates of different habitats to understand the assemblage and activity of bats.

In terms of conservation and local participation, we would love to scale this regional cave level study to nationwide cave study. By doing so, we will not only accumulate data on use of caves but also look at the dynamics of cave use at different latitudes within the Himalayas. Developing skilled manpower near cave roosts would further ensure minimal disturbance to caves while also ensuring income generating tourism related activities. Disseminating this research to a wider audience would require gathering more data and publishing a book in the local language, which again is part of our next plan.

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

We are planning to share most of the results by publishing them in scientific journals and writing a book on caves and bats in Nepal in native language. These results were already presented in conservation related festivals such as Nepal Owl Festivals. In the immediate future, these results will be presented in Student Conference on Conservation Science (SCCS), University of Cambridge, UK. We are already in touch with online news sources here in Nepal, and articles in native language will be published as soon as we analyse further data on other species of bats. The results are already shared as a part of a master's thesis in National Centre for Biological Sciences (NCBS) Bangalore, and as workshops to undergrad level students in Institute of Forestry, Pokhara.

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

I think the immediate next steps would be:

a) Continue to use the micro-sites where we sampled microclimatic data as permanent stations to understand the impact of climate change. The collected data could act as a reference but will require continuous monitoring to understand the responses of cave-dwelling bats (especially *Myotis csorbai*) in the light of climate change.
b) Scale up cave-related studies to entire mid-hills of Nepal to study the roosting patterns of bats at a national level.
c) Prioritise caves in accordance to the use of roosts in different seasons, and make efficient local and district level policies for eco-cave tourism.
d) Understand the mechanisms behind the patterns of roost use by bats.
e) Study the areas surrounding the caves to study the foraging preference of different guilds of bats. If possible, use GPS tags to expound the movement decisions made by bats for torpor, reproduction and cave-exits.

**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?**

Yes, I did. I used the logo for my master's level dissertation, owl festivals, workshops, online discussions, posters, etc. Yes, this helped in publicity of The Rufford Foundation in both rural and urban Nepal.

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

Sanjeev Baniya: Team leader, and was involved in developing study plans, field work, data entry, analysis, work shop management, posters and presentations, and paper writing.

**Kushal Neupane:** Research Assistant - was involved in field work, data entry, and social surveys.

**Dr. Pushpa Raj Acharya:** Primary Supervisor - helped us with feedback related to sampling strategy.

**Sanish Gautam:** Field Assistant - was engaged in data collection and social surveys.

**Nils Bouillard:** Advisor - helped with acoustic analysis.

**Bal Kumar Gurung:** Citizen Scientist - helped with field work. He helped us with locating caves and bats in the study area.

**Dr. Joy O'Keefe:** Advisor - she continuously gave us feedback, reviewed the data reports, and suggested analysis.

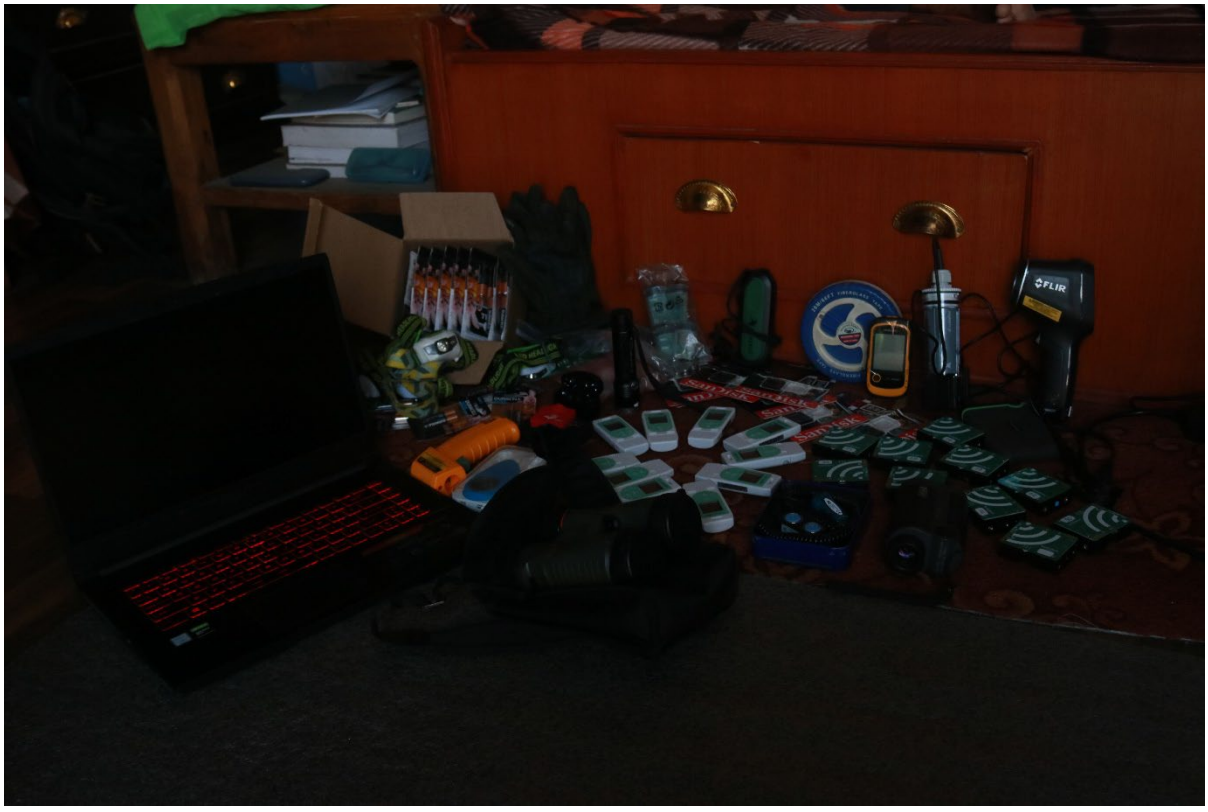
**10. Any other comments?**

Although I continuously was in touch with Rufford committee members with regards to my failure to conduct research during peak covid and post covid times, I apologise for this delay. I want to assure that this project is far from completed in terms of disseminating results. We plan to publish the results in scientific journals very soon, a

draft for a book on caves in Nepal and guidelines to manage it is on the way and will continue to monitor the study area to see the impacts of this research on local people, cave management, and bats. Furthermore, I would like to thank The Rufford Foundation for funding this project. The data collected, apart from providing crucial information on cave-dwelling bats and *Myotis* cf. *csorbai*, will help as a reference in predicting the responses of cave-dwelling bats in the light of climate change.

Appendix A: Field pictures


**Picture 1: Kailash cave, the roost site of Myotis csorbai.**




**Picture 2: Research equipment**

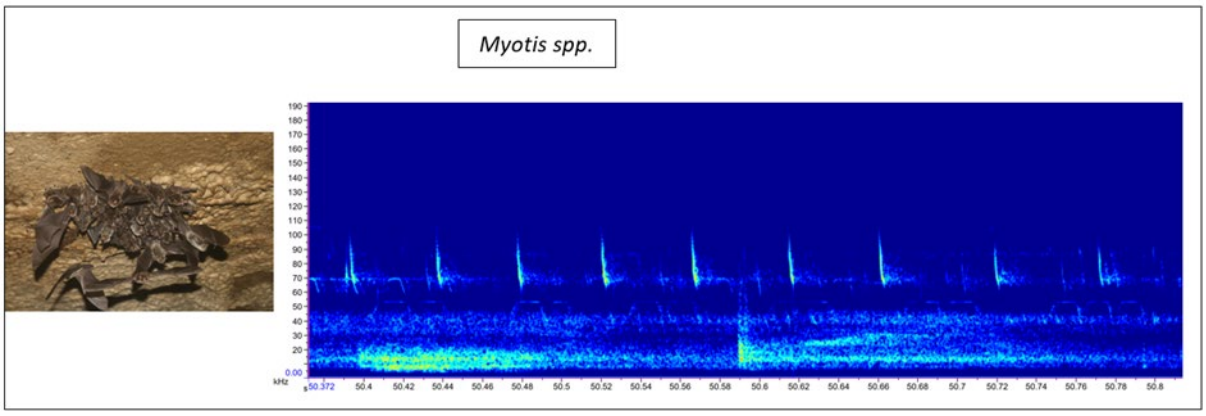
**Picture 3: Surrounding of Kailash cave. Looking for some more caves in the surrounding areas.**

**Picture 4: Exiting caves after looking for the presence of Myotis csorbai inside cave roosts.**

**Picture 5: Setting up Audiomoths near caves.**

**Picture 6: Interview with the local people about bats.**

**Picture 7: Poster presentations and bat-cave workshops.**




**Picture 8: Calls of Myotis cf. csorbai with clustering behavior in the study area.**

**Picture 9: Myotis cf. csorbai and Rhinolophus macrotis in flight.**

**Table 2:** Echolocation call characteristics of cave dwelling bats in Nepal.

| Species | Low frequency (KHz) | High Frequency (KHz) | Peak Frequency (KHz) | Duration (ms) | Delta frequency (KHz) | Number of pulses | Call structure |
|---|---|---|---|---|---|---|---|
| *Rhinolophus cf. macrotis* | 48.544±2.50 | 60.49±1.87 | 59.11±1.97 | 44.4±7.6 | 11.95±1.6 | 79 | FM-CF-FM |
| *R cf. affinis* | 68.24±2.28 | 87.14±0.72 | 85.56±0.73 | 44.77±11.09 | 18.89±2.45 | 88 | FM-CF-FM |
| *R cf. pusillus* | 82.30±2.32 | 104.11±1.1 | 102.80±0.94 | 41.35±5.24 | 21.81±2.40 | 42 | FM-CF-FM |
| *R luctus* | 25.46±0.8 | 30.96 ±0.23 | 30±0.00 | 84.24±14.13 | 4.4±0.9 | 50 | FM-CF-FM |
| *Hipposideros armiger* | 57.31±1.18 | 67.98±1.01 | 66.66±1.09 | 13.12±2.28 | 10.67±1.12 | 78 | CF-FM |
| *H. gentilis* | 104.80±3.46 | 123.55±0.79 | 122.17±0.82 | 7.48±0.92 | 18.76±3.45 | 69 | CF-FM |
| *H. cineraceus* | 128.64±1.7 | 153.84±0.41 | 152.18±0.23 | 5.77±0.46 | 25.19±1.81 | 75 | CF-FM |
| *Miniopterus cf. fuliginosus* | 48.69±2.17 | 104.07±4.89 | 56.30±1.80 | 5.13±0.86 | 56.38±4.46 | 56 | FM |
| *Myotis_cf_csorbai* | 65.6±0.91 | 97.18±3.13 | 69±0.93 | 3.2±0.5 | 31.5±3.68 | 50 | FM |
| *Lyroderma lyra* | 36.57±1.83 | 90.68±2.34 | 41.81±1.15 | 2±0.51 | 54.1±1.21 | 12 | Multi-harmonic FM |
| *Coelops frithii* | 124.83±1.62 | 159.3±1.3 | 138.84±0.8 | 1.47±0.4 | 34.55±2.12 | 23 | FM |