Barun Biomeridian Research Project:

Informing Sustainable Community Adaptation to a Changing World

Summary of Five-Year Complied Report
(April 2019 to March 2024)

Near threatened Asiatic Golden Cat *Catopuma temminckii* walking towards upward through a bamboo and ferns grove in Chyamlima Station at 2,512 m, Barun Valley on 07 June 2023

Submitted to:
Department of National Parks and Wildlife Conservation
Ministry of Forests and Environment
Government of Nepal

By:

The East Foundation

Future Generations University

April 2024

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Team member installing Song Meter Mini (Bioacoustic device) in the Barun Dovan station, Barun Valley

Prepared by:

Nawang Sing Gurung Hari Basnet
Surendra Gurung Khagendra Sangam
Dukpa Thikepa Bhote Luke Taylor-Ide

The East Foundation (TEF)
Khandbari, Sankhuwasabha, Nepal
&
Future Generations University (FGU)
Franklin, West Virginia, USA

Submitted to:

Department of National Parks and Wildlife Conservation (DNPWC)
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ABBREVIATIONS AND ACRONYMS

- BBRP: Barun Biomeridian Research Project
- BBT: Barun Bachaon Team
- BZCFUG: Buffer Zone Community Forest User Group
- COVID-19: Coronavirus Disease-2019
- DNPWC: Department of National Parks and Wildlife Conservation
- FGU: Future Generations University
- IUCN: International Union for Conservation of Nature
- LCC: Local Coordination Committee
- LEK: Local Ecological Knowledge
- FLLN: Feel, Listen and Look at the Nature
- MBNP: Makalu-Barun National Park
- NGO: Non-Governmental Organization
- SCALE: Systems for Communities to Adapt Learning and Expand
- SEED: Self Evaluation for Effective Decision-making
- TEF: The East Foundation

EXECUTIVE SUMMARY

The Barun Biomeridian Research Project is a collaborative between Makalu-Barun National Park, Buffer Community Forest User Groups, The East Foundation, and Future Generations University, with permission from the Department of National Parks and Wildlife Conservation, Ministry of Forests and Environment, Government of Nepal, and with financial support from Robert Fleming Equity and Empowerment.

The Global climate changes and biodiversity declines; this evidence base grows more conclusive yearly. Climate monitoring focuses on a global level, but the consequences of climate change are local, down to individual life forms and rural communities. Data and authenticated methods to gather locally specific data are absent locally. Unknown is how these changes affect specific local areas around the project site.

This report summarizes progress from three perspectives: 1. Using notable technological advances devices "Capturing Nature's Secrets through the Lens of Camera Traps, Unlocking Climate Secrets with Temperature Humidity Loggers, and hearing to the nature by bioacoustics," 2. National/international Science experience, and 3. Local knowledge from community engagement and adaptations.

The Project is progressing in identifying local climate change by studying "Biomeridians" transects that span multiple elevations and ecosystems. These transects provide the potential opportunity to observe how local plants and animals adapt to changing temperatures, weather patterns, migration of wildlife, and indicators from Songs of the Bird. The Project monitors a transect along the Barun River, which travels from the Makalu glacier to Barun Dovan, the confluence of the Barun and the Arun Rivers below Shyaksila village.

The Bioacoustic, Temperature, Humidity, and motion sensor camera traps were installed in different sampling locations along the Barun River (Yeti Foot Trail) in 2018/2019 in collaboration with MBNP, Buffer Community Forest User Groups, and the local community. The Project conducted training on virtual device installation, camera trapping methodology and device maintenance for local youth, and collected data for three months. The Data on Temperature Humidity, Songs of the Birds, and Camera trap photos are identified by the BBRP field staff and experts consulted to confirm the images, names and reports submitted to DNPWC and MBNP.

This report is compiled from April 2019 to March 2024 for the final five-year report. The Project has achieved significant progress but needs more time to see the results of climate change indicators, analyze the data and develop specific artifacts/publications on particular mammals by 2027, and synthesis and integration of the five-year report by March 2029.

Progress of the Pilot Phase Project April 2019 to March 2024:

The Barun Valley, located in MBNP, boasts a unique biodiversity due to its elevation gradient. To study the environment of this region, 11 stations have been established, and the most extensive devices have been used to collect data on temperature, humidity, bioacoustics, and camera trapping in Nepal. Additionally, we practiced FLLN (Feel, Listen, and Look at Nature). The BBRP, using studies, is perhaps the most extensive continuous monitoring initiative in Nepal. From April 2019 to March 2024, several devices, including permanent stations, have consistently tracked mammal species and recorded Data. Notably, the uniqueness of this Project lies in its monitoring devices spanning elevation gradients from 1269 to 4300 meters, a distinctive feature not only in Nepal but also on a global scale.

Mammals (Camera Trapping):

A total of 26,875 photos of 107 GB of data have been collected from a camera trap survey in the Barun Valley. Among these, 10020 photos have 32 species of mammals, and 1,396 photos have 27 bird species. Twelve species recorded in the Barun Valley are either nationally or globally threatened or data deficient. Among them, seven species (Dhole, Himalayan Red Panda and Himalayan Musk Deer are endangered species, and Mainland Serow, Leopard, Himalayan Black Bear, and Clouded Leopard are globally Vulnerable) are threatened species in the IUCN Red List of Threatened categories. Among all the species, the Dhole, Spotted Linsang, Asian Golden Cat, Tibetan Blue Bear, and Clouded Leopard were the first species for which photographic evidence was obtained from the MBNP area. Altogether, 19 species have been recorded from Kali Khola station, followed by Paireni, Ramite Danda and Bagare stations with 15 species each, while Hinju Camp has recorded 14 species. Similarly, Dhap Khola records only four species, while Deurali Danda records five species. There is significant potential to delve into the ecology and behavior of rare species mentioned above. Projects such as reducing conflict with the Himalayan Black Bear will help locals develop a more positive attitude toward this species.

Birds (Bioacoustics):

Bioacoustics is a scientific field that has proven highly valuable in avian research and conservation. This discipline involves the study of sounds produced by living organisms, primarily focusing on their behavior, communication, and environment. Analyzing bird vocalizations and calls can help identify various species, monitor changes in their populations, gather valuable information about habitats, and detect shifts in their distribution, as well as the impact of climate change and human disturbance on their survival and reproduction. Bioacoustics plays a crucial role in understanding and preserving the natural world by providing valuable information about biodiversity, behavior and the health of ecosystems.

In Barun Valley, 11 bioacoustics devices are programmed to record audio for a continuous period of 5 minutes, followed by a 10-minute rest interval, repeating this cycle throughout the day. This results in collecting four audio samples per hour and 94 samples daily. From 2019 to 2024, we have collected 223,794 files (each file is 5 minutes long), containing 1,118,970 minutes of audio clips. These files occupy a total of 5787.2 GB of data. One hundred sixty-one bird species were recorded from Barun Dovan (1269m) to the tree line area of Yak Kharka (4300m).

EarthHz Website was developed to access Microsoft Azure Data Lake cloud-based storage for listening and labeling through the EarthHz website. Later, an artificial intelligence model was used to analyze species' presence in large amounts of recorded audio data. The initial analyses focused on identifying the calls of the few birds (examples are provided for Satyr Tragopan cuckoos and owls in the progress report), and the placed calls were used to train a computer model that can automatically learn to recognize these calls, which allows for quick and efficient analysis of many hours of bioacoustics data.

For example, results showed that the Lesser Cuckoo was found 300 meters above its expected range, and the Large Hawk Cuckoo was found 900 meters above its expected range, which provides evidence to support the hypothesis that birds may move to higher elevations to find more suitable habitats, one of the indicators of climate change.

Strengthen the Capacity of Local Communities:

Communities surrounding MBNP are actively engaged in the local climate change dialogue, protecting wildlife and interested in community-lead efforts to support adaptation to changing conditions such as Buffer Community Forest User Groups, mother/women groups, youth groups and local field staffs have undergone comprehensive training in the efforts to provide climate change awareness and training to groups and committees who live surrounding the Buffer Zone area of the Park.

The Project trained local field staff on device monitoring, maintenance, operation, and installation during various fieldwork collaborations with MBNP officials and staff. It includes selecting sites for device installation, mastering installation techniques, and gaining knowledge of species identification and data management.

Community awareness-building, sustainable forest management, harvesting, and coexistence training were conducted in collaboration with MBNP. As a result of various community engagement, training, and awareness initiatives, the groups, committees, and local community's understanding of Barun's biodiversity and its significance has significantly increased but needs more exploration and establishment.

Additionally, they have gained insights into minimizing interactions with wildlife, fostering a more harmonious coexistence, and are interested in environment

conservation related to health and agriculture. When the local community recognizes the value of their Barun and the diverse species it harbors, it fosters a sense of respect for their natural surroundings. Implementing a community awareness program and bringing them together in biodiversity conservation can reduce anthropogenic pressure on this pristine wildlife and the coexistence of wildlife and humans.

The Project Shared Information with Wider Audiences:

The local community is crucial in safeguarding its biodiversity. Therefore, it is essential to share information and awareness training with them. Doing so empowers them to become partners or stewards of their environment, taking responsibility for its protection and well-being. Also, we shared essential aspects that involve sharing valuable information with the government's scientific community. Proper communication contributes to the broader scientific knowledge base, fostering collaboration and the exchange of insights among communities, researchers, and experts.

Established significant stakeholders in the Project, collaboration, and playing important roles by Partnership between government line agencies, community groups, and scientists is essential for a united effort to resiliently plan and respond to local shifts in weather and changing resources such as MBNP, Buffer Zone Management Committee, Bhot Khola Rural Municipality-4 and Buffer Community Forest User Groups and Local Coordination Committees and Barun Bachaon Taskforce.

Learning, Challenges, and Future Action Needed:

The Barun Valley's biodiversity is one of the best in the world. Yet, monitoring from 1269 to 4300m requires more time to apply learning and equipment. This valley is one of the pristine habitats for wild animals, and it requires community-based protection and management because poachers occasionally enter the valley to hunt wild animals, collect hill frogs, gather wild honey, and harvest wild vegetables. Some camera traps were lost initially and partially damaged, and the cards were taken out. We began community awareness building and management training for the Buffer Zone community.

Few devices are deployed above 3500 m in the upper Barun Valley, which limits the collection of critical data on this threatened habitat in the Barun Valley due to climate and topography, Winter Snowfall, and monsoon landslides, making it challenging for the team to access higher elevations and leading to inconsistent results. The Yeti trail needs to continue to be more regularly maintained up to Yak Kharka, as vegetation overgrowth occurs yearly due to high moisture and humidity.

Our learning is that camera traps are often placed in areas with a higher probability of capturing animals, without considering other parameters. Yeti Trail has a significant

elevation range and will be taken into consideration while deploying the camera traps. A few critical areas (bottlenecks) and important corridors have been identified; therefore, camera trap stations should be established to monitor these vital areas and track animal movements.

The global pandemic (COVID-19) has affected our data collection in 2020. Routinely, data collection could not be conducted more than a few times.

Recommendations:

Based on our lessons learned and suggestions from partners, the Project needs more time and equipment to monitor additional climate change indicators and sampling sites. Apply research findings in practical community adaptation, publications, sharing, and learning within national and international scientific communities and community resilience. More permanent sites should be established to capture the biodiversity of the Barun Valley, taking into consideration elevation, habitat, and bottleneck areas where animals migrate. The Project also identifies suitable sites in the upper Barun Valley to study the ecological functioning of upper temperate specialist species and to understand altitudinal migration patterns, which can be related to climate change and impact the environment, health, agriculture, and other aspects.

To consistently improve research performance, maintain and extend Yeti trails for smooth data collection in cooperation with local groups, committees, municipalities, and MBNP. Several critical areas, such as streams, face flooding during the monsoon season, and the installation of simple wooden bridges could greatly aid in safely navigating these risky areas.

1. Introduction:

The Barun Biomeridian Research Project is part of a global research project. Over the last five years, FGU and TEF have established a monitoring network in some of the world's most biodiverse and vulnerable regions, led by the BBRP in MBNP, Nepal. This is the first biomeridian case study Project in the MBNP, Nepal, and a significant global biodiversity hotspot. The primary objective is to develop an observational framework that enables scientists and communities to comprehend whole-ecosystem change in multiple locations and adapt to the impending climate crisis; Nepal is now leading this effort through the BBRP.

2. Rationale:

Climate change creates an urgent need to understand the entire ecosystem's processes, as many parts of nature and humans must adapt to changing conditions simultaneously. These years of dramatic change in many ecosystems have led to tremendous habitat and biodiversity loss. Retaining biodiversity and adapting to, and mitigating, climate change are paramount challenges of this generation.

3. Biomeridian Concept:

A mountain slope encapsulates the natural diversity from tropical to polar, mirroring latitudinal shifts in vegetative and animal complexes within short vertical distances. Mountain communities are, therefore, at the center of many of the effects of climate change. Traditional laboratory scientific observations of change use control without change or baseline observations before the change occurs. As the Earth undergoes climate change, there is no control. Change is already happening in many places without baseline observations to document the original state. A bio-meridian, or biological meridian measuring change across a gradient, is a measurement framework for complex adaptive systems of ecology and their responses to climate change. By observing along a bio-meridian, we gather information across a range of states, serving as a substitute for control or baseline data. Day and night data are collected-audio, camera, temperature, and humidity data. Data analysis provides information for increasing global understanding of how human activity affects natural systems. Long-term impacts include helping local stakeholders and scientists better understand species distribution and behavior, and the engagement of local communities.

In the long term, this project aims to document ecosystem shifts resulting from climate change. Despite a planet overflowing with large datasets, adequate tools do not yet exist to inform understanding of local change. Bioacoustics enables us to explore areas that human ears cannot reach and listen. This project uses technology for research and action to preserve the swiftly disappearing voices of nature and local knowledge. Three devices document biodiversity by capturing more than what would generally be observed by human ears or camera traps. The focus thus far has been on birds because they instinctively adapt to the natural world as they travel across ecozones and seek optimal food and habitat. MBNP is at

the edge of the ranges of many bird species. Therefore, species may be shared in other countries, such as Bhutan, India, and Tibet, yet they are rare or near extinct in Nepal.

4. Barun Biomeridian Formation:

To establish an international network of biodiversity monitoring transects – arrays of instrumentation stations along mountain transects - FGU chose the Barun Valley in Nepal and developed partnerships with local communities, as well as collaboration with TEF, a local Non-Governmental Organization. Barun Valley is one of Nepal's most biodiversity-rich pristine valleys in the MBNP area. Long-term monitoring along this transect will lead to a continually growing understanding of how flora and fauna adjust to anthropogenic and climate change. On the other hand, combining data from scientific instrumentation with local knowledge enables people to develop increasingly effective responses to ecosystem destabilization on a changing planet.

5. Overall Objectives:

The overall objectives were to utilize scientific observations along transects to establish a baseline, examine biodiversity and changing dynamics using devices, and establish partnerships with local communities as co-equal investigators and users of the resulting data, thus democratizing the climate change and biodiversity dialogue. Provide training to encourage the development of the socio-ecological resilience and adaptive capacity of local communities in a changing environment.

6. Methods:

The BBRP installed three devices, transect stations, and a holistic approach to data collection, centered on three fundamental principles: Feel nature, look at nature, and **listen to nature** (Figure 1). Each principle utilizes specialized tools to capture diverse aspects of the ecosystem, providing a comprehensive understanding of biotic interactions through evidence data.

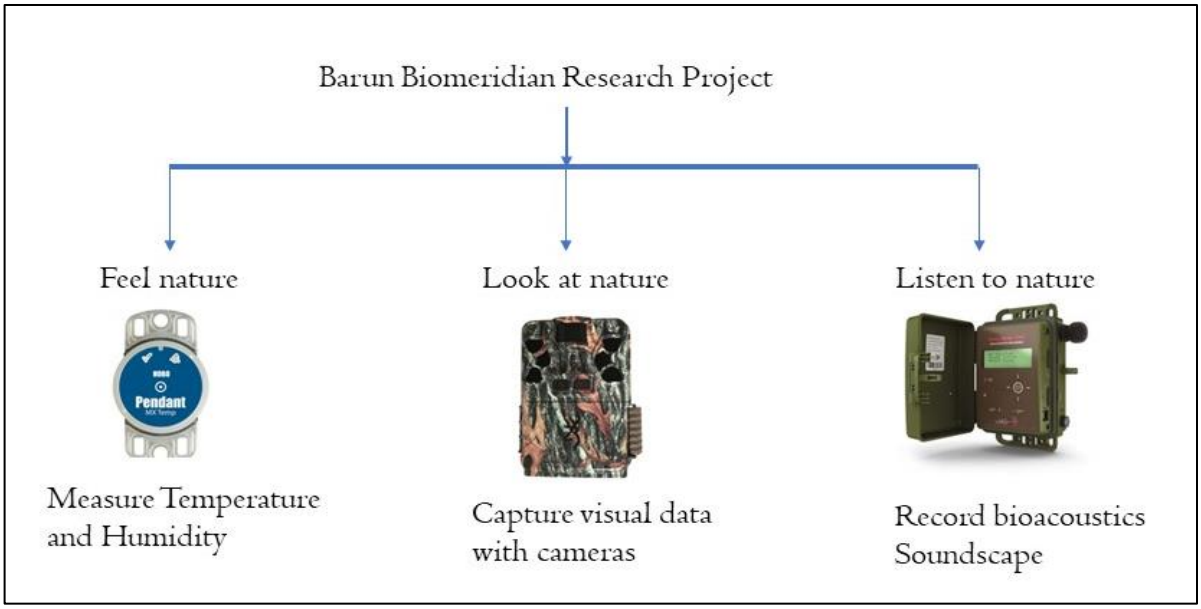


Figure 1: The approach used to collect data in Barun Valley

A. <u>Meteorological Data</u>:

By measuring temperature and humidity, the project learned insights into the intricate nuances of the ecosystem's physical state, including seasonal changes, microclimates, and overall environmental health. A total of eight HOBO data loggers (meteorological data recorders) were installed on the reference trees, with one in each plot. The loggers collect temperature and relative humidity data every 15 minutes, 24 hours a day. HOBO MX2301 model loggers were installed in five stations, while HOBO Pendant loggers were installed in other sites. In November 2019, the MX2301 model loggers were upgraded to MX2301A, and HOBO Pendants were replaced with HOBO MX2301A (for details, see Project Achievement Report October 2019 to March 2020).

B. <u>Camera Trapping</u>:

By capturing images of wildlife, vegetation, and ecological dynamics, and collecting Data. Altogether, eight camera traps were installed along the trail, with three permanent and the remaining five relocated to better sites each season (Figure 2). The cameras were primarily focused on the lower Barun Valley and were selected based on animal signs in the area. The traps were placed 30-45 centimeters above the ground, but were modified based on location and elevation. For example, camera traps were placed relatively higher where winter snow covered the landscape. The camera traps were programmed to take three photographs per trigger and were operated 24 hours a day. All vegetation was cleared before placing the camera traps to avoid false triggers. All photos were manually sorted, and species identification was made manually in the field. A sequence of photographs of any species occurring

after an interval of fewer than 60 minutes from the previous picture was considered an independent event.

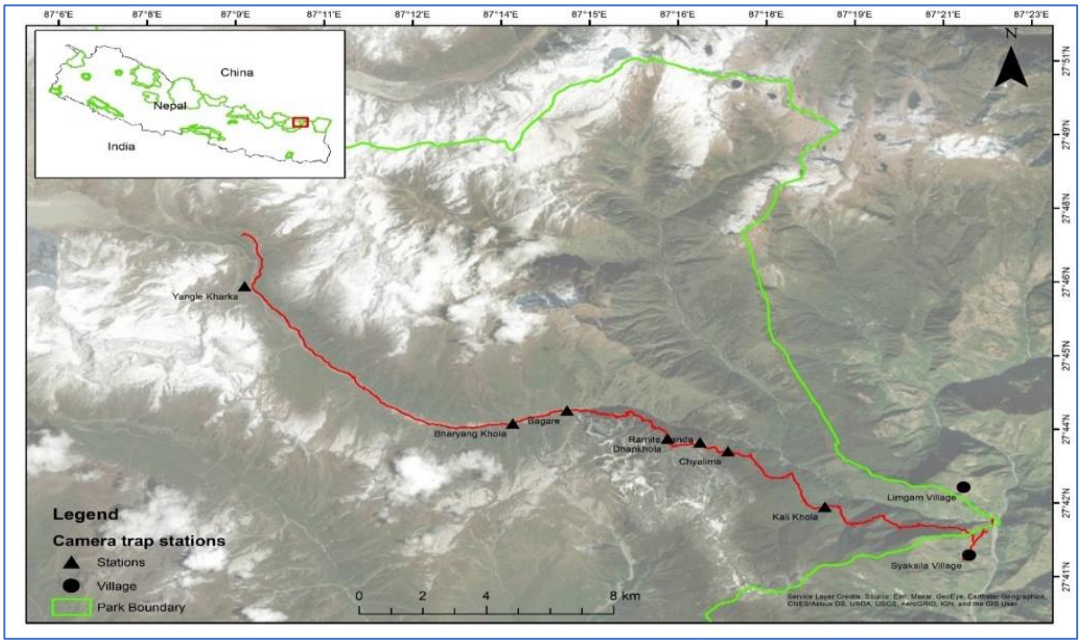


Figure: Figure 2: Camera trap stations in Barun Valley

C. Bioacoustics:

Eleven bioacoustics stations have been established to study the acoustic environment of this region, ranging from 1,269 meters to 4,300 meters, each equipped with SM4 Mini or Song Meter SM4 devices (Figure 3). These stations are placed across the elevation gradients, providing a comprehensive understanding of the acoustic environment across different altitudes. In addition, some stations have been placed in special habitat types, such as Chyalima, which is dominated by bamboo forests and is known to be a suitable habitat for the Satyr Tragopan and the Red Panda. The Bioacoustics Song Meter SM4 and Song Meter Mini are used to listen to or record the sounds of nature, focusing on birds. The bio-acoustics devices are programmed to record audio for a continuous period of five minutes, followed by a 10-minute interval of rest, repeating this cycle throughout the day. This results in collecting four audio samples per hour and 94 samples daily.

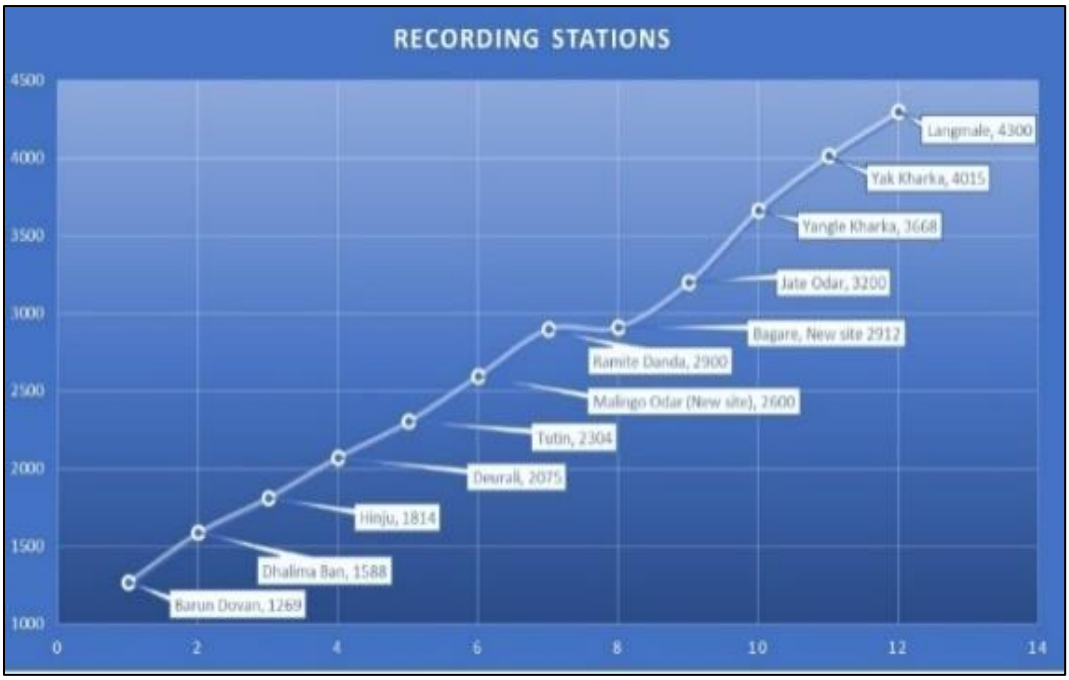


Figure 3: Bioacoustics stations in Barun Valley

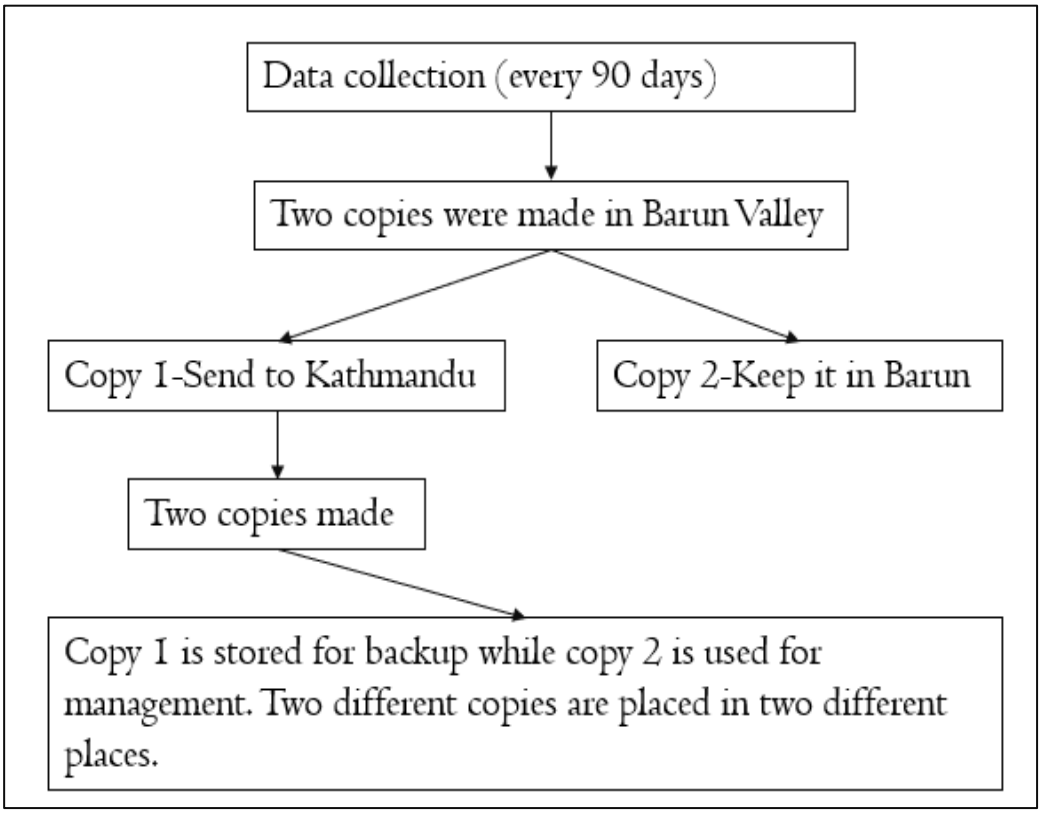


Figure 4: Data management process in Barun Biomeridian Research Project

Results

A. Meteorological Data:

To date, we have collected 695,451 samples from the Barun Valley. Volume of data on temperature and relative humidity data by year, meteorological dataset by site and year, meteorological dataset by site and month (Progress Report, April 2021-March 2023). Example: Temperature in Barun Dovan. The Barun Dovan has experienced an average yearly temperature increase of 0.74 °F, from 62.66 °F to 63.40 °F, between the years 2018 and 2019 (Figure 5). (Detailed account is given in Progress Report, April 2021-March 2023).

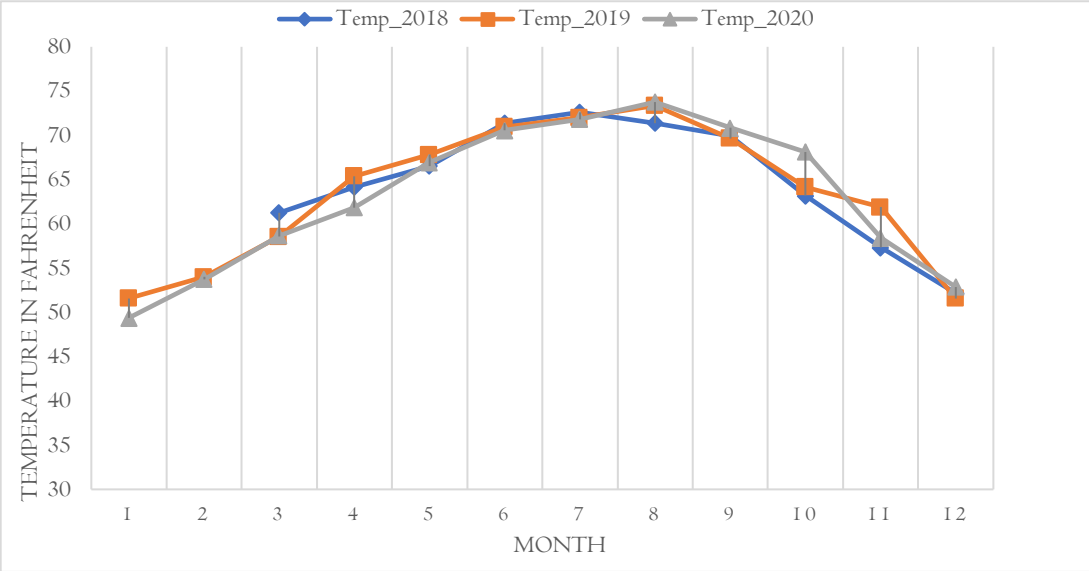


Figure 5: Temperature in Barun Dovan between 2018-2020

B. Camera Trapping:

A camera trap survey conducted from 2018/2019 to 2023/2024 in the Barun Valley collected 30,261 photos, totaling 134 GB of data. Among these photos, false triggers (vegetation growth and movement, sun shadows, and different climatic conditions) have collected 16,592 (55%) photos, totaling 59.8 GB of data. Mammals were captured in 10,020 photos, totaling 51.3 GB, followed by birds with 1,396 pictures, totaling 7.49 GB. Likewise, 1329 images totaling 7.73 GB were taken during the monitoring process, while others (humans, cattle, and insects) collectively made 865 photos, representing 3% of all the images (Figure 6). The majority of these photos (12,070) were taken in 2022, while 2023/2024 accounts for 51.9 gigabytes, which is the largest among all (Table 1). The larger file size in 2023 is attributed to the inclusion of videos, particularly in Kali Khola and Bolangma Danda where our camera traps were configured to capture videos at 45.6 MB per recording. Notably, in 2020,

data is solely available from the Bagare area, as data from other locations, was lost due to the crash of hard drives.

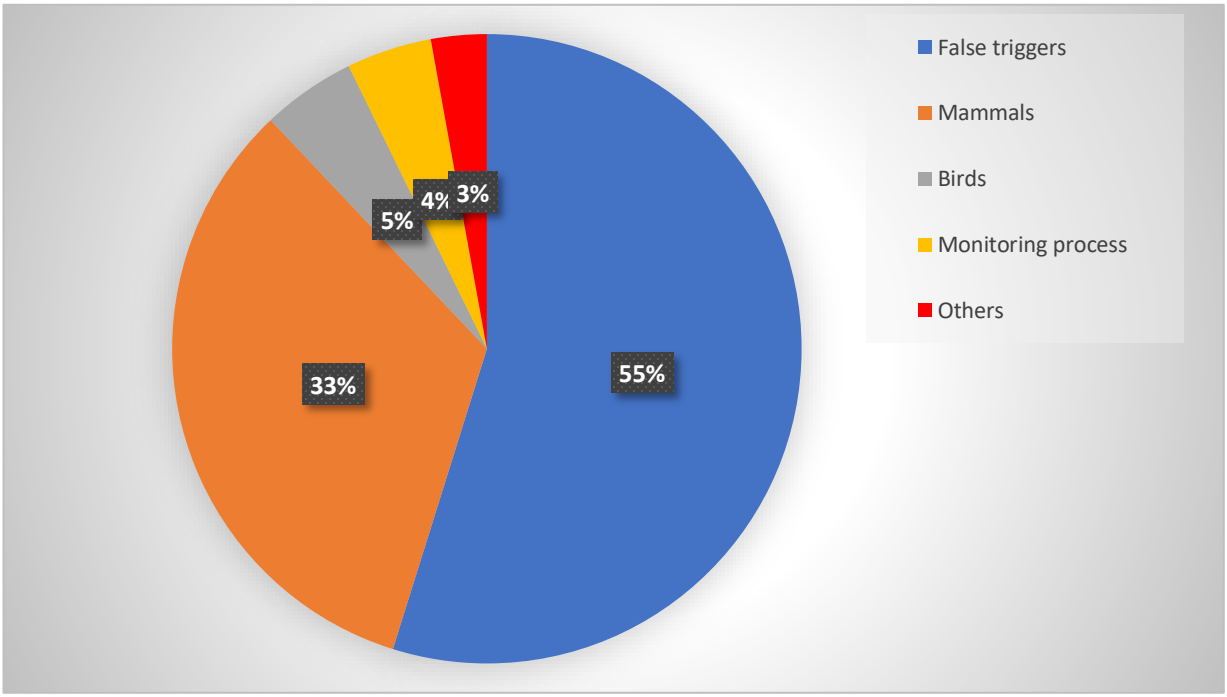


Figure 6: Camera trap survey results in Barun Biomeridian Research Project

Table: 1 Camera trapping by year, no. of files and size and folders

S.N.	Year	Size (GB)	No. of files	No. of photos (Mammals)	No. of Species
1	2018	4.28	820	538	15
2	2019	34.5	6676	2543	19
3	2020	1.3	757	20	6
4	2021	10	3451	445	15
5	2022	32.8	12,070	3822	23
6	2023	51.9	6487	2637	22
7	Total	134.78	31,459	10005	32

a) <u>Species Diversity:</u>

Together, 32 mammal species are recorded in the Barun Valley (Annex 1). Three species, the Himalayan Goral, the Northern Red Muntjac, and the Mainland Serow, are the most dominant in the Barun Valley, respectively. These three species account for nearly 80% of all the mammals recorded in Barun. Among these, the Himalayan Goral, which accounts for 40% of all the mammals recorded in the Barun, is notable. On the Other hand, Spotted Linsang, Wild

Boar, Tibetan Blue Bear, Asiatic Golden Cat, Himalayan Red Panda, Dhole, Siberian Weasel, Yellow-bellied Weasel, Leopard, Indian Hare, Himalayan Crestless Porcupine, and Red Giant Flying Squirrel have the lowest no. of photos captured in the Barun Valley.

b) Threatened Species:

Twelve species in the Barun Valley are either nationally or globally threatened or data deficient. Among them, seven species are listed as endangered in the IUCN Red List of Threatened Species (Table 2).

Table 2: Threatened species in Barun Valley.

SN.	Species	Red List	
		Global	National
1	Dhole/Wild dog	EN	EN
2	Himalayan Red Panda	EN	EN
3	Himalayan Musk Deer	EN	EN
4	Mainland Serow	VU	DD
5	Leopard	VU	VU
6	Himalayan Black Bear	VU	EN
7	Clouded Leopard	VU	VU
8	Brown Bear	LC	CR
9	Himalayan Tahr	NT	NT
10	Assamese Macaque	NT	VU
11	Himalayan Goral	NT	NT
12	Asian Golden Cat	NT	DD

c) Species diversity in different stations

The camera trap stations at Kali Khola (N = 7291), Yangle Kharka (N = 6838), and Ramite Danda (N = 4799) have been operational since 2019, resulting in the highest number of photos. Even though YangleKharka has the highest photo count, this is attributed to false triggers caused by vegetation movement. The lower photo count in DhapKhola is due to the camera trap at this station being active for only two seasons. The Deurali station was also established in 2023, accounting for its relatively lower photo count (Table 2). Among the recorded mammals, 4730 photos have been captured from Kali Khola, which is the highest number of photos captured in Barun Valley, followed by Ramite Danda (N=1019), Hindu Camp (N=871), and Bagare stations (N=773). It should be noted that the Hinju Camp station was established and has recorded species data for only two seasons, in 2022. On the other hand, DhapKhola was only able to record 15 photos of mammals, while DeuraliDanda has 155 mammal photos (Table 1).

Altogether, 19 species have been recorded from Kali Khola stations, followed by Paireni, RamiteDanda, and Bagare stations with 15 species each, while Hinju camp has recorded 12 species. Similarly, Dhapkhola records only four species, while Deurali Danda records five species (Table 3, 4).

Table 3. Mammals' diversity in different stations.

S.N.	Stations	Elevation	Species recorded
1	Hinju Camp	1814	Assamese Macaque, Clouded Leopard, Himalayan Goral, Leopard Cat, Mainland Serow, Masked Palm Himalayan Civet, Nepal Gray Langur, Northern Red Muntjac, Orange Bellied Himalayan Squirrel, Yellow-throated Marten, Rodent sps, Unknown Mammals
2	BolangmaKhola	2,094	Assamese Macaque, Himalayan Black Bear, Himalayan Goral, Mainland Serow, Nepal Gray Langur, Northern Red Muntjac, Orange Bellied Himalayan Squirrel, Yellow-throated Marten
3	Deurali	2075	Assamese Macaque, Mainland Serow, Northern Red Muntjac, Orange Bellied Himalayan Squirrel, Yellow-throated Marten
4	Paireni	2143	Asiatic Golden Cat, Assamese Macaque, Clouded Leopard, Himalayan Goral, Indian Hare, Leopard Cat, Mainland Serow, Nepal Gray Langur, Northern Red Muntjac, Orange Bellied Himalayan Squirrel, Rodent sps., Tibetan Blue Bear, Unknown Mammals, Yellow-bellied Weasel, Yellow-throated Marten, Himalayan Crestless Porcupine
5	Kali Khola	2,006	Asiatic Golden Cat, Assamese Macaque, Clouded Leopard, Particolored Flying Squirrel, Himalayan Black Bear, Himalayan Goral, Leopard Cat, Mainland Serow, Masked Palm Himalayan Civet, Northern Red Muntjac, Orange Bellied Himalayan Squirrel, Red Giant Flying Squirrel, Rodent sps., Siberian Weasel, Spotted Linsang, Squirrel Species, Unknown Mammals, Yellow-throated Marten
6	Cyamlima	2480	Asiatic Golden Cat, Clouded Leopard, Himalayan Black Bear, Himalayan Goral, Mainland Serow, Northern Red Muntjac, Orange Bellied Himalayan Squirrel, Squirrel Species, Wild Boar

7	RamiteDanda	2,818	Spotted Linsang, Mainland Serow, Northern Red Muntjac, Himalayan Goral, Assamese Macaque, Himalayan Tahr, Nepal Gray Langur, Red Fox, Yellow-throated Marten, Orange-bellied Himalayan Squirrel, Royle's Pika, weasel sps. and rodents sps.
8	DhapKhola	2,894	Himalayan Black Bear, Assam Macaque, Himalayan Goral, Yellow-throated Marten
9	Bagare	2,909	Assamese Macaque, Dhole, Himalayan Black Bear, Himalayan Goral, Himalayan Musk Deer, Himalayan Tahr, Leopard, Leopard Cat, Mainland Serow, Nepal Gray Langur, Red Panda, Rodent sps., Squirrel Species, Unknown Mammals, Yellow-throated Marten
10	YangleKharka	3,882	Bats, Himalayan Black Bear, Himalayan Tahr, Mainland Serow, Red Fox, Red Panda, Rodent sps., Squirrel sps., Yellow-throated Marten

Table 4. No. of photos captured and no. of mammals recorded in each station.

S.N.	Stations	No. of Photos	No. of mammal's photos	No. of Species
1	Hinju	2413	871	12
2	DeuraliDanda	630	155	5
3	Paireni	1257	504	15
4	Kali Khola	7334	4730	19
5	Ramite	4637	1019	15
6	BolangmaDanda	481	219	8
7	DhapKhola	401	15	4
8	Bagare	5080	773	15
9	Cyamlima	2613	286	9
10	YangleKharka	4387	148	9

d) Bird species recorded in camera traps and Bioacoustics. A total of 27 different species were recorded during the camera trap survey (Progress Report II, Appendix 2).

C. Bioacoustics

From 2018 to 2024, we have collected 223,794 files (each file is 5 minutes long), containing 1,118,970 minutes of audio clips. These files occupy a total of 5787.2 GB of data. In 2020, we were unable to collect the data smoothly as our two-year permission had expired, and COVID-19 restrictions delayed the renewal and data collection process (Table 5; Progress Report, April 2021-March 2023).

Table 5. The volume of data recorded each year in the study area.

Year	Total file	Size (GB)
2018	44500	1399
2019	38693	1106
2020	22555	797.9
2021	37695	1112.3
2022	62,482	1131
2023	31,533	444
Total	237,458	5990.2

Bird species in Barun Valley

A total of 186 bird species were recorded at our study sites using various survey methods (Annex 4). Among them, 161 species have been recorded from field surveys, 54 species were recorded from Bioacoustics surveys, and 15 species were recorded from camera trapping data. Among them, eight species were recorded from all three survey methods.

Among these species, the Himalayan Vulture, Satyr Tragopan, and Rufous-throated Wren-babbler are globally Near Threatened species, while the rest are of Least Concern. Moreover, the White-browed Piculet and Rufous-throated Wren-babbler are nationally Critically Endangered species, while the Broad-billed Warbler and Yellow-vented Warbler are nationally Endangered species. At the same time, Himalayan Vulture, White-gorgeted Flycatcher, Slaty-bellied Tesia, Black-headed Shrike Babbler, Satyr Tragopan, and Pygmy Blue Flycatcher are nationally Vulnerable species (Table 1).

a) Bio-acoustic Data Analysis Framework

Processing large amounts of bio-acoustic data (see Bioacoustics Data section 2.3.3) is not possible without a computer. The Songs of Adaptation project has developed a framework for understanding these data. The framework includes several tools first implemented as part of the Barun Biomeridian Research Project, but is now applicable to a wide range of sites and applications worldwide. The first tool allows you to listen to the audio data without needing to download it to a local computer. The second tool is a method for labeling the data. If an expert listens to the data and identifies the species, they can label the data with the

corresponding species name. The labeled data are then used to train an Artificial Intelligence (AI) Model which can quickly identify similar audio samples in the large data sets. Due to the magnitude of data collected in long-term bio-acoustic studies, using a single computer to store and analyze the data is not possible. For this reason, the framework built for this project is based on cloud-based data storage and analysis. The two major components are as follows:

- EarthHz, a website for collaborative online data listening, labeling, and analysis for the model. See EarthHz here: https://data.songsofadaptation.org/
- EarthHz Neural Network model for communities to learn, train the model, and get results for informed adaptation in a changing world.

Bioacoustics Data Analysis in the Barun. This project has designed a framework for analyzing bioacoustic data in the Barun to study the presence of species. This section describes each step, the successes and challenges, and preliminary examples:

1. Collect and listen
2. Label and train
3. run and verify
4. visualize

Although the results are not yet research grade, the report below focuses on preliminary examples (such as the Satyr Tragopan and Lesser Cuckoo) for the early testing of the model and framework. Much has been learned from the early tests, and much work remains to be done to improve the tools for action in the communities.

1. Collect and Listen

Four bird species are presented here as an example to test the tool.

I. Satyr Tragopan: Tragopan satyra
II. Lesser Cuckoo Cuculus poliocephalus
III. Himalayan Cuckoo: Cuculus saturatus
IV. Collared Owlet: Glaucidium brodiei

For example, Figure 7 displays a spectrogram of the Satyr Tragopan (a nationally protected species), which produces repeated, deep, wailing, drawn-out calls, wah, waah! Oo-ah! Oo-aaaa! Raising in volume and becomes more protracted until it becomes almost a shriek; also, a wah, wah uttered at any time of the day. This call is represented by a spectrum of repeated, deep wailing, drawn-out calls, Wah, and short notes, ranging from 406 Hz to 2437 Hz.

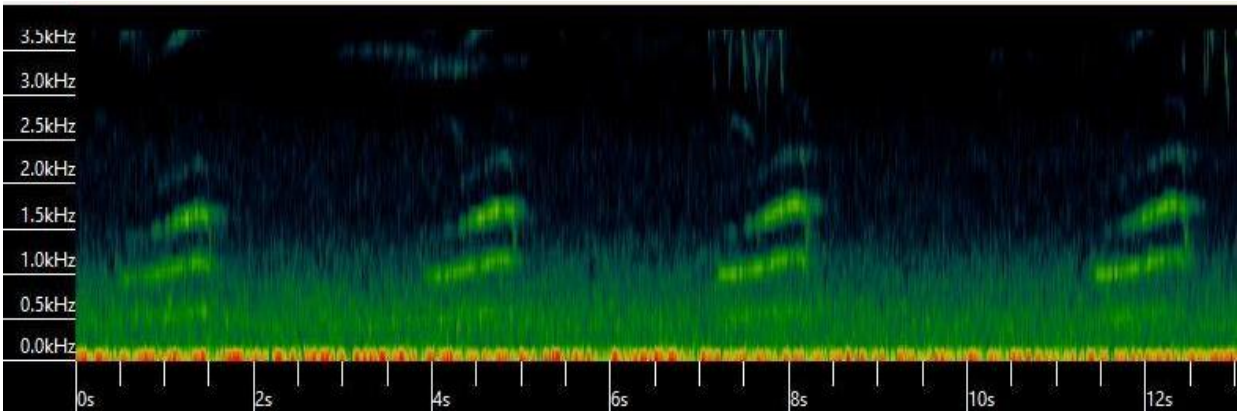


Figure 7: A spectrogram of Satyr tragopan showing deep wailing drawn out call Wah short notes right around the 406 Hz frequency to 2437 Hz.

Figure 8: Satyr Tragopan in courtship display.

The Satyr Tragopan, scientifically known as Tragopan Satyra and locally referred to as Munal in Nepali, holds a precarious status in the realm of biodiversity (Figure 8). Classified as "Near Threatened" by the International Union for Conservation of Nature (IUCN) and deemed "Vulnerable" on a national level, this bird has garnered attention as a priority species for protection in Nepal. Unfortunately, the population trend is on a concerning decline, with estimates suggesting fewer than 1000 individuals exist. The Satyr Tragopan thrives in the challenging terrain of moist, temperate broadleaved and rhododendron forests characterized by dense undergrowth, including bamboo. Restricted to elevations ranging from 2,590 to 3,800 meters, conservation efforts become crucial to preserving its habitat and reversing the alarming population decline.

The species were chosen based on their global status as well as simple vocal behaviors that are easier to train in machine learning. Breeding season for the species lasts from the third week of March to the second week of May. The breeding of the tragopan may be triggered by an increase in temperature and precipitation in the spring. In the future, an increase in temperature before the actual breeding time may have an impact on the species' breeding behavior. Monitoring the species and temperature in the area could help us determine how Satyr Tragopan and other indicator species become vulnerable as the region's temperature rises in the future.

1. Label and Train the AI

Manual Identification of Satyr Tragopan is based on the habitat and elevation as well as the temporal calling pattern of the species. Cluster analysis was done using the Kaleidoscope software. Based on the cluster analysis, manual identification was done for each identified call of Tragopan. These identified calls were uploaded to EarthHz, and labeling was done. Two hundred thirty-two spectrograms were manually labeled to represent the Call and song of Satyr Tragopan Tragopan satyra.

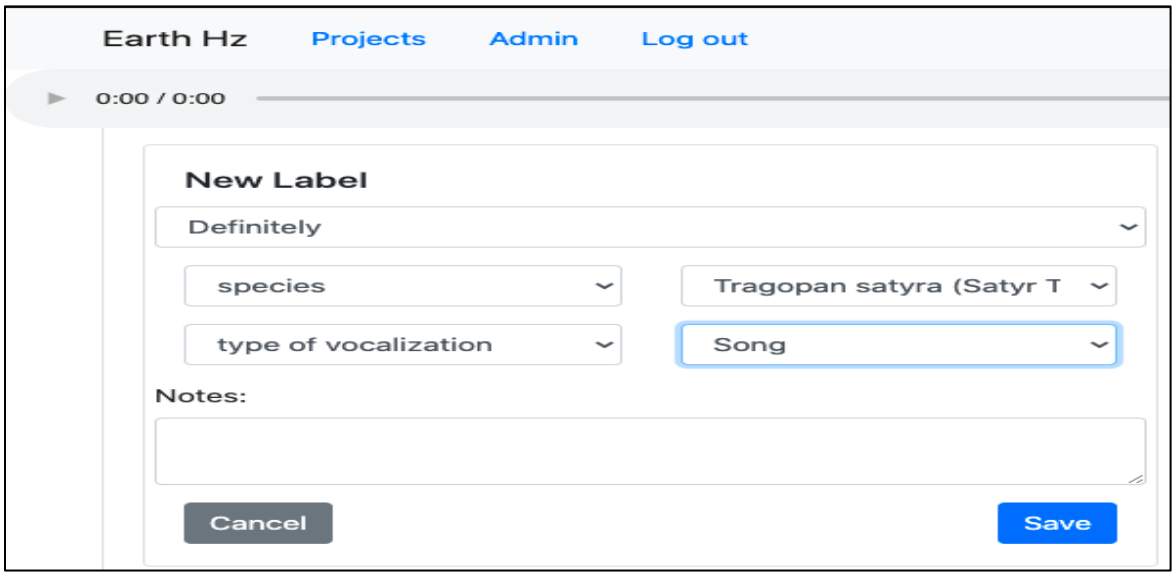


Figure 9: Labeling interface on EarthHz

2. Run and Verify Results

Satyr Tragopan results are not yet accurate enough to be used for research. They will be verified manually again, and then the second stage of remodeling will be completed to obtain the final outputs.

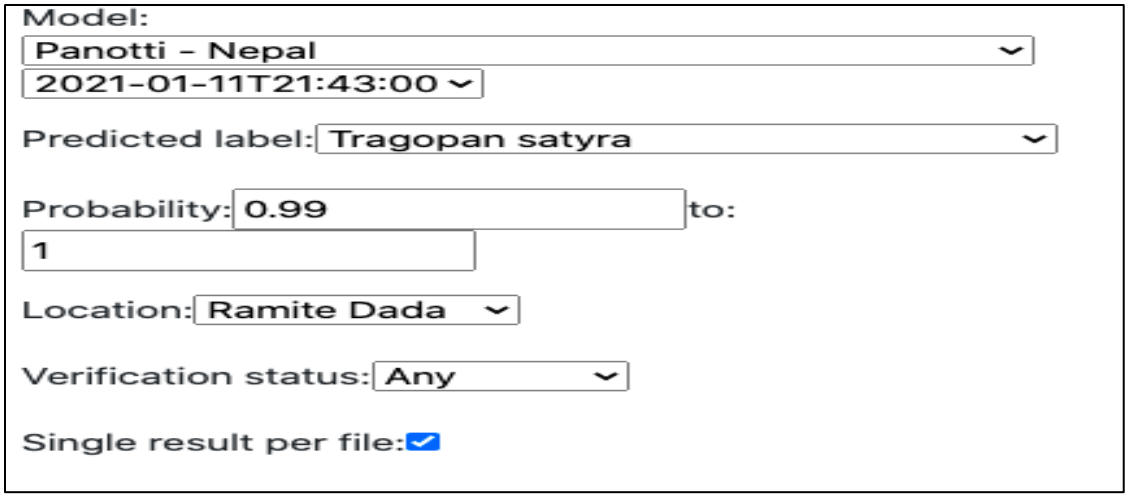
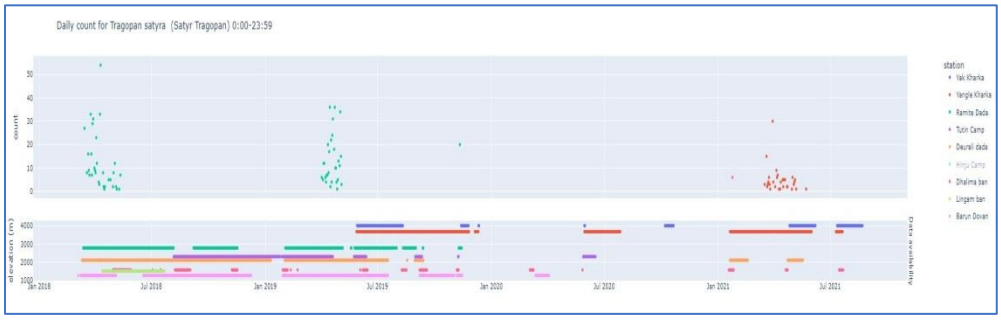


Figure 1 Interface to Results of Tragopan satyra at Ramite Station on EarthHz

AI Model Results

All together 941 sound clips of Satyr Tragopan were detected from Ramite Danda and Yangle Kharka station in Barun. Among them, 84% of the clips were recorded from Ramite Danda, and the rest were recorded from Yangle Kharka. Moreover, 98% of sound clips of Satyr Tragopan belong to advertisement calls during the breeding season (March to May), while the contact call of Satyr Tragopan was recorded in November, outside the breeding period of the species. Similarly, in 2018, we got 395 calls of Satyr Tragopan, 403 in 2019, and 143 calls were recorded in 2021. However, due to a lack of 2020 data, no sound clips have been recorded from any of these stations (Figure 1). Among the total calls, 264 calls were recorded in March, 543 calls were recorded in April, 114 calls were recorded in May, and 20 calls were recorded in November.

Figure 11: Daily count recorded in different season in different time interval



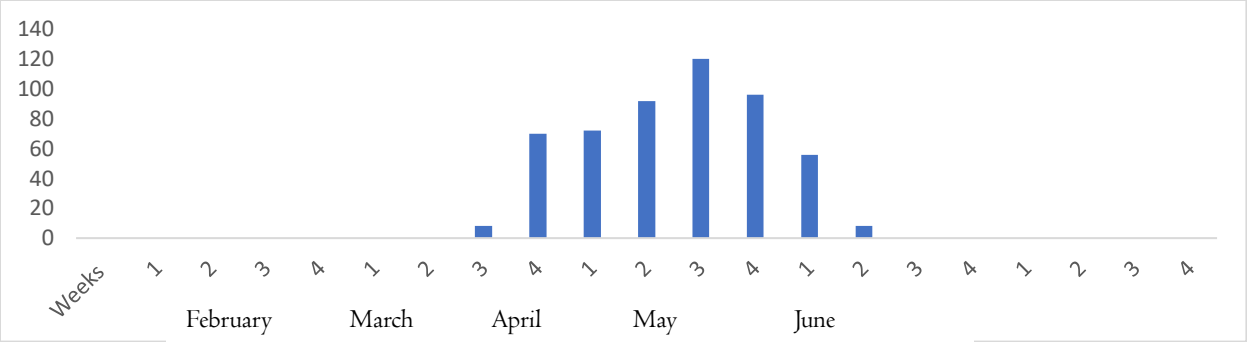


Figure 2: Advertisement call of Satyr Tragopan during breeding season.

Daily Vocal Pattern of Satyr Tragopan

The tragopan started calling in the dawn from 04:44 hrs, and the last call was heard at 18:44 hrs. The frequency of calls peaks just before sunrise and sharply declines after sunrise. Additionally, the dusk call started at 17:35 hrs and peaked just after sunset, sharply declining then (Figure 13). However, the frequency of dawn calls was higher than that of dusk calls, indicating that the dawn call count survey is most effective around 45 minutes earlier than sunrise, which is the best time for surveying the Satyr Tragopan.

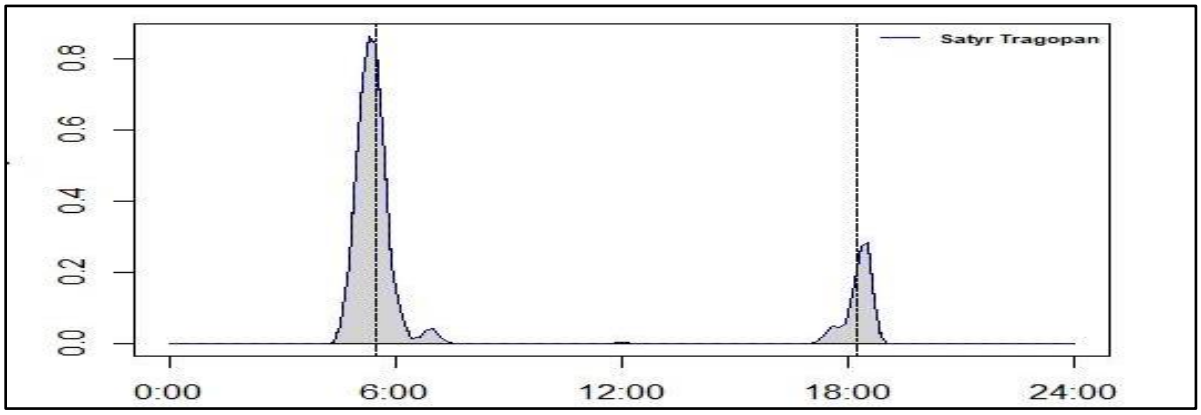


Figure 13: Daily vocal pattern of Satyr Tragopan showing their calling behavior during dawn and dusk

Lesser Cuckoo

Scientific Name: Cuculuspoliocephalus
IUCN Status: Least Concerned
National Status: Least Concerned
Habitat: Forests, both broadleaf and pine, scrub, second growth; in Ussuriland, in broadleaf forests of birches (Betula), hornbeams (Carpinus), maples (Acer), and oaks (Quercus)
Elevation Range: 1200-3660 m Recorded station: Deurali Danda, Hinju Camp, Lingam Ban, Ramite Danda, Tutin Camp, and Yangle **Photo by V. Arun/ Naturalist**

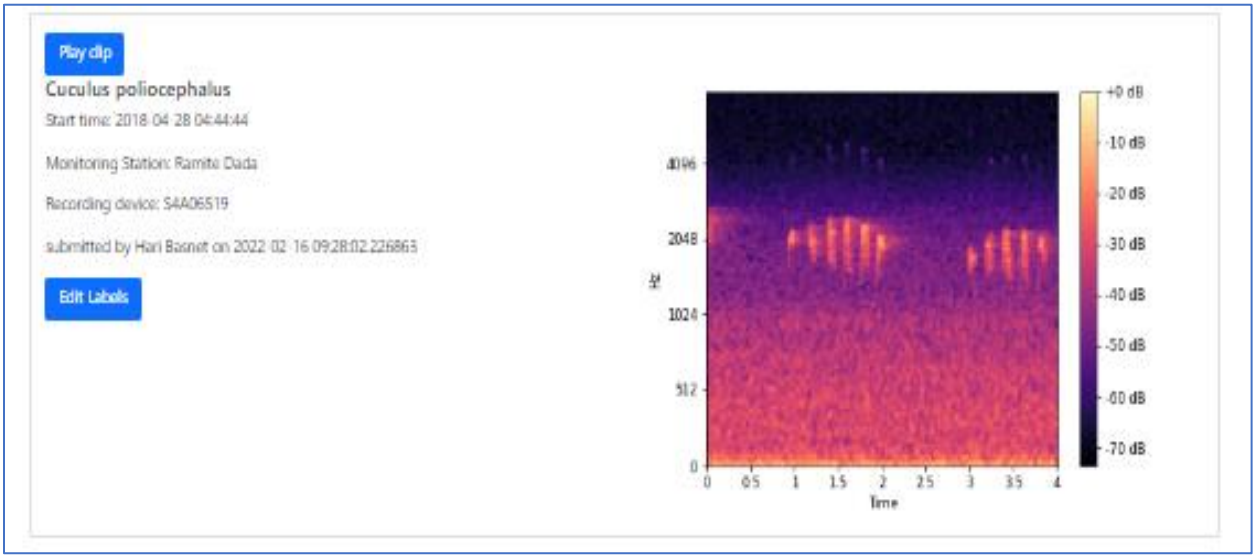


Figure 14: Spectrogram of Lesser Cuckoo (*Cuculuspoliocephalus*)

Altogether 14964 sound clips of the Lesser Cuckoo were recorded from six stations. Among them, Deurali Danda has recorded 41% of all the calls, followed by Hinju Camp at 29%, while Lingam Ban and Tutin Camp have recorded less than 1% of all the calls. Moreover, 6160 (41%) calls were recorded in 2018, 4944 (40%) calls were recorded in 2019, and 2860 (19%) calls were recorded in 2021. The first call of the Lesser Cuckoo in Barun Valley was detected on 22 April, while the last call was detected on 20 July. On average, the Lesser Cuckoo stayed 82 days in Barun Valley (Table 7). Moreover, the lowest elevation for the Lesser Cuckoo was 1550 m in Lingam Ban, while the highest elevation was Yangle Kharka at an elevation of 3680 m.

Himalayan Cuckoo

Photo by Hari Basnet

Scientific Name: Cuculussaturatus
IUCN Status: Least Concerned
National Status: Least Concerned
Habitat: Canopy of mixed coniferous/deciduous forest, larch taiga, thickets, subtropical woodland near streams, open wooded areas and orchards, often in hill country.
Elevation Range: 1500-3300 m
Recorded stations: Deurali Danda, Hinju Camp, Lingam Ban, Ramite Danda, and Yangle Kharka.

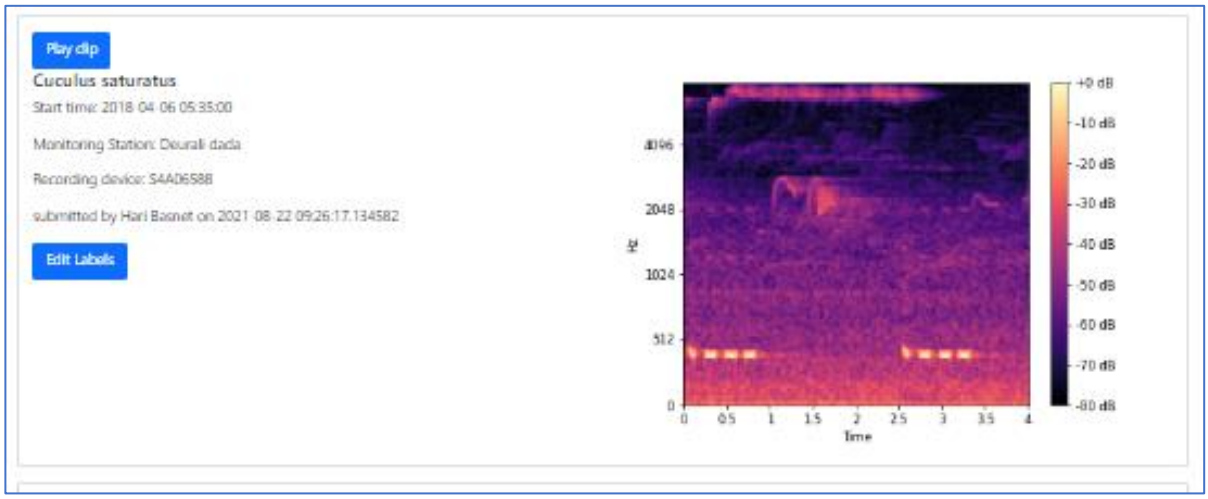


Figure 15: Spectrogram of Himalayan Cuckoo (*Cuculussaturatus*)

Altogether 5641 sound clips of the Himalayan Cuckoo were recorded from five stations. Among them, Deurali Danda recorded 35% of all the calls, followed by Hinju Camp at 26% while Ramite Danda recorded around 7% of all the calls. Moreover, 2753 (49%) calls were recorded in 2018, 490 (8%) calls were recorded in 2019, and 2437 (43%) calls were recorded in 2021. The first call of a Lesser Cuckoo in Barun Valley was detected on 24 April, while the last call was detected on 19 June, and the average Himalayan Cuckoo stayed 81 days in Barun Valley.

Table 6. Number of calls of cuckoos recorded in different station and different years

Station /Year	Lesser Cuckoo	Percent	Himalayan Cuckoo	Percent
Deurali Danda	**6165**	**41%**	**1986**	**35%**
2018	1215		1165	
2019	4813		284	
2021	137		537	
Hinju Camp	**4277**	**29%**	**1455**	**26%**
2018	3350		256	
2019	529		62	
2021	398		1137	
Lingam Ban	**72**	**<1%**	**1071**	**18%**
2018	72		1071	
Ramite Danda	**2092**	**14%**	**404**	**7%**
2018	1523		261	
2019	569		143	

Tutin Camp	**33**	**<1%**		
2019	33			
Yangle Kharka	**2325**	**16%**	**764**	**13%**
2019	2325		1	
2021			763	
Grand Total	14964		5680	

Table 7. Arrival and departure date of Lesser and Himalayan Cuckoo in the Barun Valley.

Year	Species	First Call	Last Call	No. of days	Average
2018	Lesser Cuckoo	22-Apr	20-Jul	89 Days	82 Days
2019		24-Apr	14-Jul	81 Days	
2021		4-May	18-Jul	75 Days	
2018	Himalayan Cuckoo	26-Mar	19-Jun	85 Days	81 Days
2019		1-Apr	13-Jun	73 Days	
2021		24-Mar	17-Jun	85 Days	

Similarly, 409 calls of the Lesser Cuckoo were recorded in April, 8,033 calls in May, 6,198 calls in June, and 324 calls were recorded in July, while no calls were recorded from July to March. Similarly, 2713 (48%) calls were recorded in April, 2451 (44%) calls were recorded in May, while only 463 calls (8%) were recorded in June, and no calls were recorded from July to February (Figure 16)

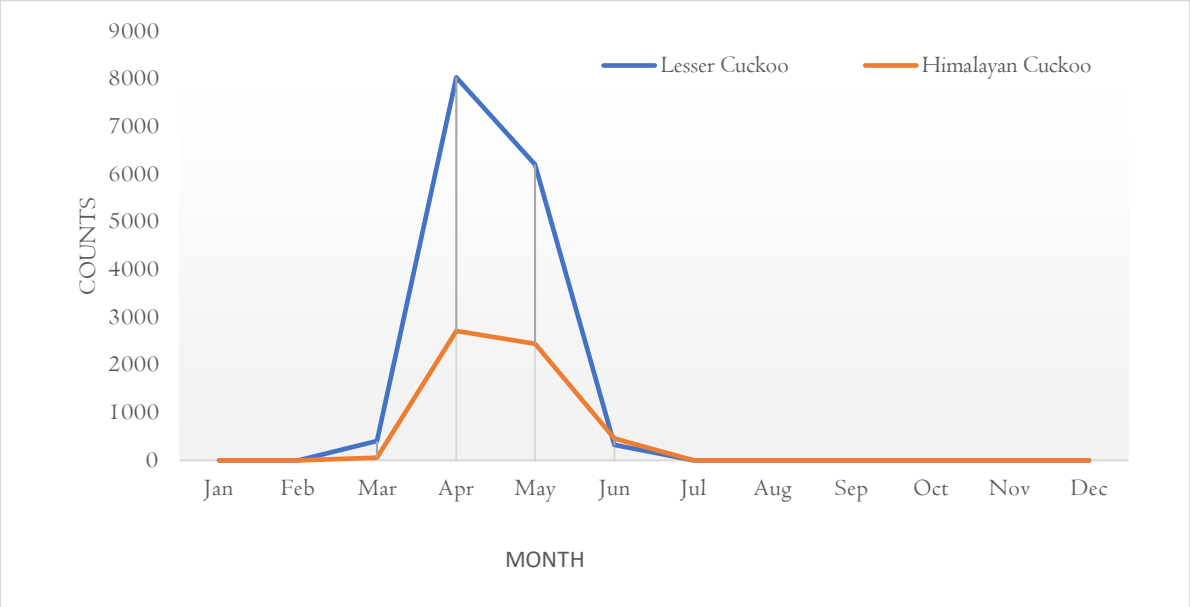


Figure 16: Vocal pattern of Cuckoos in Barun Valley

Collared Owlet

Photo by Hari Basnet

Scientific Name: Glaucidium brodiei
IUCN Status: Least Concerned
National Status: Least Concerned
Habitat: Montane and submontane forest (including oaks, rhododendrons, firs, open forest edge, woodland, and scrub.
Elevation Range: 1350-2750 m
Recorded station: Lingam Ban, Deurali Danda, Hinju Camp, Ramite Danda, and Yangle Kharka

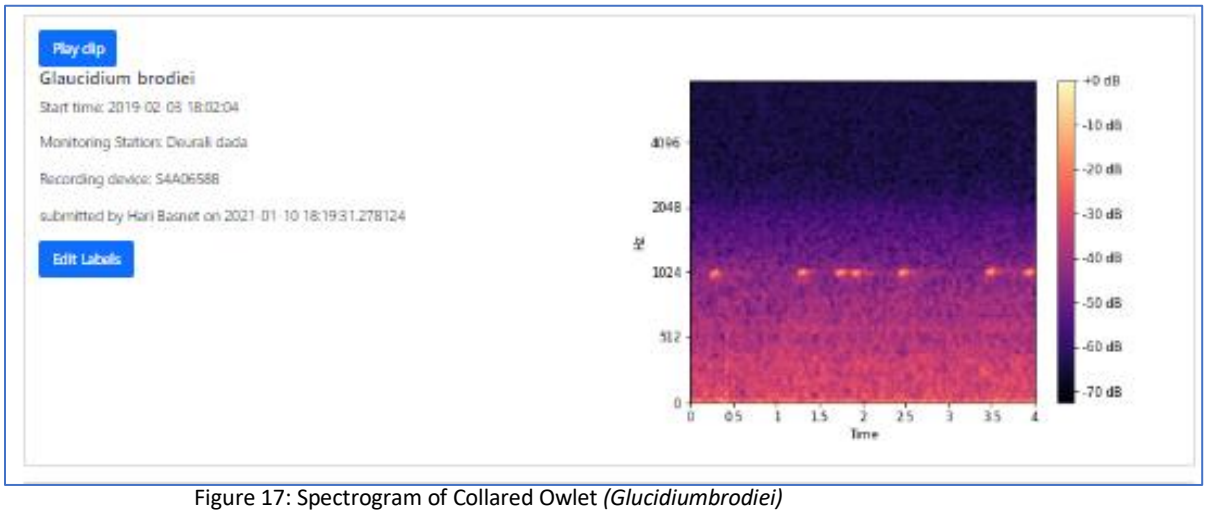


Figure 17: Spectrogram of Collared Owlet *(Glucidiumbrodiei)*

A total of 3214 sound clips of Collared Owlet were recorded from five stations (Table 8). No call was recorded from the lower elevation stations, Barun Dovan, Dalima Ban, Lingam Ban, and one higher elevation station, Yak Kharka. Among them, DeuraliDanda has recorded 40% of all the calls, followed by Hinju Camp at 28%. YangleKharka and RamiteDanda recorded the least at 4% and 3%, respectively. Moreover, 310 (10%) calls were recorded in 2018, 2243 (70%) calls were recorded in 2019, while 661 (21%) calls were recorded in 2021.

Table 8. Number of calls of collared owlet recorded in different stations and different years.

Stations	Counts	Percentage
Deurali Danda	1270	40
2018	149	
2019	939	
2021	182	
Hinju Camp	900	28
2018	69	
2019	472	
2021	359	
Ramite Danda	88	3
2018	67	
2019	21	
Tutin Camp	836	26
2018	25	
2019	811	
Yangle Kharka	120	4
2021	120	
Grand Total	3215	

Most of the Collared Owlet calls were recorded from February and March (N = 2469), which represented 77% of the total calls recorded in Barun Valley. However, only three calls each were recorded in July and Sept, while no calls were recorded in August. From the graph below, the breeding season of the Collared Owlet starts in January, peaks in February and March, and ends in April. The species is then less vocal during May-December.

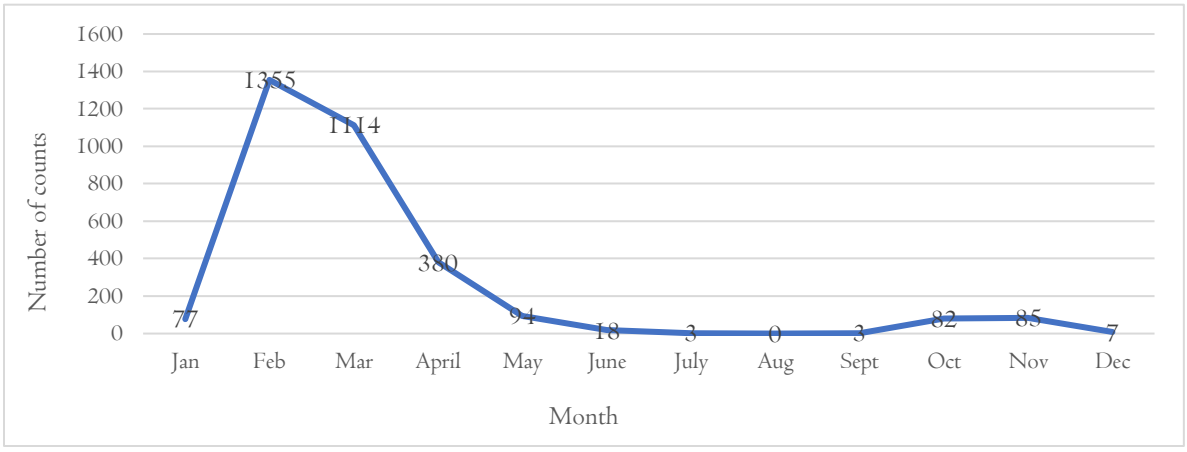


Figure 18: Advertisement call Collared Owlet during breeding season.

Conclusion:

Satyr Tragopan is distributed in Ramite Danda and Yangle Kharka stations. Ramite Danda (2860 m) is the best place for Satyr Tragopan, followed by Yangle Kharka, among all stations.

1) Satyr Tragopan breeding calls can be heard for about two months, beginning on March 15 and ending on May 12.
2) One hour before sunrise in the last week of March to the second week of April is the best time to conduct a breeding survey of the Satyr Tragopan.

Lesser Cuckoo are more vocal in May (54%) while Himalayan Cuckoo are more vocal in April (48%).

3. Deurali Danda provides the best habitat for the Lesser and Himalayan Cuckoo.
4. Both species' arrival, departure, and total days spent in the Barun Valley were similar.
5. Lesser Cuckoo is more common than the Himalayan Cuckoo in the Barun Valley

The record of Lesser and Himalayan Cuckoo in Yangle Kharka (3,882m) is probably one of the highest elevation records for the species in the world.

Community Engagement for Capacity Building of the Community

The Buffer Community Forest User Groups within the Buffer Zone of MBNP have been integral to BBRP, contributing to participation, collaboration, and ownership of the research program. The Project team formed an informal Local Coordination Committee (LCC) comprising representatives from three local Forest User Groups: Thulo Chandane, Longba-Temba, and Tutin, which encompass the villages of Lingam, Mangkhim, Shyaksila, and Simbung, respectively, in the project area. The objectives of LCC were to coordinate with forest user groups for research, to educate them on conservation, to develop their capacity, and to engage them in sustainable livelihoods, thereby minimizing forest dependency and promoting biodiversity.

The Project team discussed with LCC and the above-mentioned forest user groups to share information about the research and co-creation of a community engagement program aimed at enhancing their capacity building and livelihood opportunities. Based on the participatory meetings and discussions with LCC and the above forest user groups, the following activities were organized for the forest user groups through their LCC.

I. Sustainable Forest Management Training:

Fifteen representatives from three forest user groups, comprising five villages, as well as additional local police staff and one village member from the Rural Municipality, participated in the training. The training was fully facilitated by the Park's Chief Warden and Assistant. Warden and supported by the BBRP research team.

The training was based on theoretical learning, group work discussion, and practical sessions to engage the participants in learning and action models. The training outlined:

- The introduction and purpose of community forests based on government guidelines,
- The forest development plan, the sustainable approach to forest management,
- Best practices and opportunities of community forest, survey and identification of special forest resources,
- The proper method of extracting timber and harvesting forest products,
- Protecting herbal plants, community survey of forest product users.

The participants were involved in group discussions to relate their actions with learning and planning for improvement. At the end of the training session, participants were taken for practical research to measure trees and identify timbers for harvesting for different purpose. In the final session, forest user groups develop an action plan and presented to implement their learning and improve the management of their forest. The participants were recognized with certificate for successful completion of the training.

II. Sustainable Harvesting Training:

After the forest management training, the forest user group implemented its plan of action. During their implementation, they shared about difficulties in harvesting and measuring timbers, and requested follow-up training.

To help them better harvest, sustainable forest harvesting training was organized for 13 members from Forest User Groups, 2 Rural Municipal elected ward members, and three women from women's groups. The professional team of the park office facilitated the training. During the training, participants were reoriented on the government's policy for harvesting forest products, types of forests, measuring trees for different purposes, types of timbers, proper harvesting of timbers and plants from the forest, restricted timbers and herbal plants, and the uses of timbers and plants for the community.

During the training, participants shared their practices of forest product harvesting, and facilitators helped them understand the disadvantages of these practices. At the end of the training, participants presented their learning and developed a forest harvesting improvement plan, along with a commitment from each forest user group.

III. Bamboo Tree Plantation:

Bamboo is crucial for the community to maintain their daily living source, culture, and traditions, and to minimize landslides. Like other plants, bamboo reduces the impact of carbon. However, the bamboo plantation was considered a challenge because the senior citizens in the community believed that unmarried youths were not supposed to plant bamboo. If they grow, they might not be able to have children. Eventually, the project team was able to convince the community about the benefits of bamboo for their use and to reduce the impact of carbon. The senior members of the community lead the plantation process, and the youths help them with the preparation. The team distributed 190 bamboo saplings to 73 members of three forest user groups. The team also trains the recipient on planting, caring for, and harvesting the bamboo. Most of the communities have planted bamboo for the first time in their area, and they are excited to take advantage of it, as well as proud to be part of an eco-friendly community by growing bamboo.

IV. Fruit Tree Plantation

In response to the demand of forest user groups, 300 fruit tree saplings (apple, walnut, apricot, and pear) were provided to the groups. The saplings were collected from the Government's Temperate Horticulture Nursery Center at Daman. This venture was also a sampling test in the area. The fruit saplings were also shared with women's and youth groups.

V. Timur (Black Pepper) Plantation:

During the training on wildlife conservation, the community expressed the challenges of crop raids by wild animals. As a result, they have not used their lands in full potential for

Growing cash crops, they face difficulties in their livelihood, and as a result, they start entering the park to poach and collect wild vegetables without proper harvesting methods. The participant demanded feasible herbal products that are safe from wild raids and can be commercialized. After a discussion with the government's agricultural professional on this issue, it was recommended to test the Black Pepper plantation in the area. If it's safe and successful, there will be an opportunity for the community to sell products and process oil locally, adding value. Based on a recommendation, forest user groups were given Black Pepper seeds to produce saplings and distribute them to their members to test the feasibility. In the next phase of the research project, the three forest user groups will be provided with more seeds to grow in their empty land and in the community forest for commercial purposes.

VI. Livestock Support to Forest User Groups:

Livestock is identified as one of the potential livelihood opportunities for people living in the Buffer Zone, enabling them to generate income and reduce their dependency on nature-based resources. Some community members raise livestock for feasts to celebrate their social and cultural events. During the meeting, Forest User Groups shared that due to the low quality of breeding bucks, they were unable to breed for commercial purposes, and it was expensive for individuals to purchase breeding bucks and pigs. The team and group together decided to buy breeding bucks and breeding piglets in partnership. This will enable them to cross-breed their goats and pigs, achieving higher fertility, faster growth rates, and larger newborns, thereby commercializing their livestock. To develop a shared understanding and transparency, the project team and groups create guidelines for raising and utilizing this breeding livestock in a group, ensuring that every member of the community can use it for breeding purposes and benefit from it.

As planned, the forest user group managed transportation, and the project team purchased and distributed three breeding bucks and sixteen breeding piglets to nineteen members of the three forest user group representatives. The project team organized an orientation program for group representatives to inform them about proper shelter, hygiene, diet, medication, caring for newborn babies, and how to cross-breed indigenous goats and pigs. They were also given initial medicines to help these animals adjust to a new location.

VII. Awareness and Sensitization of Threatened Animals to Forest User Group members:

To raise awareness about wildlife conservation in the community, the following programs were organized.

a) **Wildlife Conservation Education to Forest User Groups**

The research team visited the villages of three forest user groups and educated them about the protection and preservation of rare and endangered animals that exist in the conservation area. They were informed about the importance of wildlife to maintain

biodiversity, the advantages/opportunities of having these animals in their social identity, and the well-being of nature.

The participants discussed human-wildlife conflict, including crop raids and attacks on humans and cattle by wild animals. The team also discussed adapting the crop pattern to minimize crop raids by wild animals and to prevent harm to them. The forest user group members and project team planned for two actions: i) fruit plantation in their garden to support their food security, and ii) bamboo plantation in their ideal land to reduce carbon emissions and also use multiple products for their daily use. Both of these activities can also be an income-generating opportunity for the community.

b) **Conservation education to Students**

In coordination with a local secondary school (Shree Krishna Secondary School at Gola), conservation education sessions were organized for students of grades 8, 9, and 10. They were taught about rare and endangered animals and why they need to be protected, how they contribute to the ecosystem, and the future consequences of losing these special animals. Due to human-wildlife conflict, some students have a negative opinion about having wildlife near their community. The session helped them understand the significance of wildlife and their role in protecting it to save the region's exceptional biodiversity. Students shared their learning about the importance of a positive attitude towards animals. They committed to educating their families and friends to protect and preserve these animals and natural resources for the future. The principal and teachers also appreciated the opportunity to organize conservation education for their students and teachers.

I. Cooperative Orientation to Forest User Group Members

The forest user group members are not actively involved in social and economic activities, apart from a few meetings related to forest resource use. So, for identifying an opportunity to unite them for the social and economic cause. The project team and group members held a meeting to discuss the institutional development of the groups. During the meeting, participants were encouraged to work cooperatively with the purpose of saving credit and promoting environmental conservation. Since this is a lengthy process, members must have a clear understanding of the cooperative concept. The project team decided to organize cooperative training for the forest user group members.

An orientation on the "Multi-Purpose Cooperative Concept" was organized to help group members understand cooperatives and encourage them to plan for establishing their own cooperatives. Forty participants from forest user groups, the local community, and stakeholders attended the training. The participants learned about the cooperative's basic functions and legal requirements. After the training, forest user

group members and the local community will explore opportunities and prepare to establish multipurpose cooperatives within the community.

II. Vegetable Farming Training

Green vegetables are the best source of nutrition for the mother's and the child's health. However, most families in the community did not grow vegetables. Even if some families are growing vegetables, they lack the knowledge and skills to get better production throughout the year. The overharvesting of wild vegetables may pose a risk of missing special plants, forest products, and wildlife in the future. The people's lack of knowledge about the consequences of this loss and their limited skills for alternative livelihood options could be consequential factors in the decline of biodiversity. Training on Sustainable Vegetable Farming was organized to help community people grow vegetables on their land. So that they can be independent of their vegetable production and consume nutritious vegetables to improve the nutrition of mother and child, and that can also be an opportunity to generate income in the future by commercializing it.

Three forest user groups and five mother groups participated in the training at different phases. The training was facilitated by a local JTA (plant science) from the agriculture service center. During the training, participants learn about:

- Setting up the vegetable tunnel on a terrace farm with local resources,
- Planting vegetable (cabbage, cauliflower, red chili, radish, and mustard leaves) seeds for germination inside the tunnel and in an open farm,
- Managing the distance and height of the plantation,
- Use of local medicinal insecticides, care during the growth of plants, and use of organic fertilizer for the plants.

The participants appreciated and were motivated to learn the proper method of vegetable farming. After the training, participants develop an action plan to implement their learning and set up a demonstration vegetable farm in their community. The participants were provided with nursery development materials, seeds (cabbage, cauliflower, red chili, radish, and mustard leaves) to set up the demonstration farm, and farming tools. There are now 13 vegetable nurseries in the community to grow vegetable seedlings and distribute to community members for vegetable production. Additionally, local schools have established demonstration vegetable farms, which students and teachers manage. With the permission of the Department of National Parks and Wildlife Conservation (DNPWC) and Makalu Barun National Park, the FGU and TEF conducted a preliminary feasibility study in the Barun Valley in 2018, and a five-year pilot phase project from April 2019 to March 2024. The study recommended continuing the work for an extension period. Hence, based on the study's findings and lessons learned, and fitting with the MBNP's management plan (2017-2022). We proposed a BBRP extension for five

years, encompassing scientific work, community engagement, and training, to meet the long-term objectives and goals outlined in the proposal.

Main achievements

1) Camera trapping and bioacoustics studies in Barun Valley are one of the longest continuous monitoring projects that run for five years. Since 2019, 10 devices, including three permanent stations, have consistently tracked mammal species. Notably, the uniqueness of this project lies in its monitoring devices spanning elevation gradients from 1269 to 4300 meters, a distinctive feature not only in Nepal but also on a global scale.

2) Spotted Linsang, Clouded Leopard, Dhole, Asiatic Golden Cat, and Brown Bear (subspecies Tibetan Blue Bear) for the first time for the Makalu Barun National Park, updating its checklist.

3) Collected data on seven globally and eight nationally threatened species. Among these, Dhole, Himalayan Red Panda, and Himalayan Musk Deer are Endangered species, and Mainland Serow, Leopard, Himalayan Black Bear, and Clouded Leopard are globally Vulnerable species. Furthermore, eight species are nationally threatened, while two species are nationally Data deficient.

4) Recorded Mainland Serow at the elevation of 3,850 m asl, whose elevation range is reported to be between 200 m asl and 3,000 m asl. Furthermore, the record of the Brown Bear (Tibetan Blue Bear) at the elevation of 2,100 m asl is the lowest elevation record of the species in the world.

5) Collected 30,261 photos of 134 GB of data, including 10020 photos of mammal species. A total of 32 mammal species have been identified, excluding rodents and bats from Barun Valley. Among these Himalayan Goral (N = 3,930) and Mainland Serow (N = 1,758) photos, the highest number of images captured by any project can be found. No. The number of photos recorded for the rare and elusive Clouded Leopard (N=42) could be the highest in the world in terms of the number of camera traps.

6) We have collected 223,794 files (each file is 5 minutes long), containing 1,118,970 minutes of audio clips. These files occupy a total of 5787.2 GB of data. This extensive dataset holds immense potential for advancing bio-acoustic technology. Its richness offers a nuanced exploration of biodiversity and ecological dynamics, positioning research at the forefront of cutting-edge advancements in the field.

7) Altogether 186 bird species were recorded from our study sites through different survey methods in the Yeti Foot Trail.

8) A User-friendly EarthHz platform was developed, and machine learning and Artificial Intelligence were tested to recognize seven birds in the Barun Valley. Successful acoustic detection of regionally rare bird species (Yellow-vented warbler Phylloscopus cantator, and Rufous-throated wren-babbler Spelaeornis caudatus), through deep convolutional neural networks.

9) The initial analyses showed that the Lesser Cuckoo was found 300 meters above its expected range, and the Large Hawk-cuckoo was recorded 900 m above its expected range, which provides evidence to support the hypothesis that birds may move to higher elevations to find more suitable habitats, one of the climate change indicators. In 2020, we were unable to collect the data smoothly as our two-year permission had expired, and COVID-19 restrictions delayed the renewal and data collection (Progress Report, April 2019 March 2021 and April 2021-March 2023).

Lesson learning and Challenges

Barun Valley biodiversity is one of the best places in the world. Yet, monitoring the Yeti Trail, spanning from 1269 to 4300m, using 10 camera traps, is limited to discovering more species and consistently capturing photos in Barun Valley.

Furthermore, two camera traps are deployed over 3500 m in the upper Barun Valley, which limits the collection of critical data on this threatened habitat in the Barun Valley due to climate and topography. Snowfall begins in November and persists until April or May, posing challenges for the team to access higher elevations, which leads to inconsistent results. Heavy snowfall devices are often buried in snow and can be completely damaged. The Barun Valley is one of the inaccessible areas in Nepal. Navigating the Yeti Trail within this valley poses significant challenges due to the trail not being correctly opened. The trail traverses rugged terrain, presenting difficulties during the monsoon season due to the high flow of streams and landslides. After winter, fallen trees impede movement, and certain shadowy areas retain heavy, unmelted snow, creating further obstacles. In Yeti Trail, vegetation grows quickly because the valley has a high level of moisture and humidity. Due to this, undergrowth vegetation can grow rapidly and become quite dense, creating challenges for camera-trapping studies. As camera traps are left for at least three months, the vegetation grows quickly during the monsoon season, and the movement of plants triggers the sensors, creating false recordings. Additionally, the overgrowth of vegetation can sometimes make it difficult to spot small species, such as squirrels and weasels.

Although Barun Valley is one of the pristine habitats for wild animals, local poachers occasionally enter the valley to hunt them and collect wild vegetables and hill frogs. Some of the camera traps were lost, partially damaged, or had their memory cards removed. The global pandemic (COVID-19) has affected our data collection in 2020. Routine data collection was not conducted on a few occasions.

- The project needs to focus on studying specific species and add more camera traps in the region if funding allows.
- Camera traps need to be placed based on areas where there is a higher probability of capturing animals without considering other parameters. Yeti trail has a great elevation range, but the elevation needs to be considered while deploying the camera traps, and a few critical areas (Bottleneck) are missed. The project aims to consolidate planning strategies into practice over the next five years.

Recommendations for the future

- This project has successfully gathered baseline information on numerous threatened species. Now, it is imperative to shift focus towards species-specific studies. There is significant potential to explore the ecology and behavior of rare species, such as the Clouded Leopard, Tibetan Blue Bear, Red Panda, Asian Golden Cat, and Dhole, if funding allows. Furthermore, projects such as reducing conflict with the Himalayan Black Bear will help locals develop a more positive attitude towards these species.
- More sampling sites should be established to capture the biodiversity of Barun with consideration of elevation, habitat, and bottleneck areas from where animals migrate.
- The project should consider some areas in the upper Barun Valley to understand ecological functioning among upper temperate specialist species, as well as help to understand altitudinal migration patterns, which can be correlated with climate change.
- To smooth data collection, Yeti Trails need to continue maintaining several critical areas, such as streams, face flooding during the monsoon season, and the installation of simple wooden bridges could greatly aid in safely navigating these risky areas.
- Community Awareness: When the local community recognizes the value of their Barun and the diverse species it harbors, it fosters a sense of respect for their natural surroundings. Implementing a community awareness program and bringing them together in biodiversity conservation can play a crucial role in reducing anthropogenic pressure on this pristine wildlife
- Sharing information with broader audiences: The local community plays a crucial role in safeguarding its biodiversity. Therefore, it's important to share information with them. By doing so, it empowers them to become stewards of their environment, taking responsibility for its protection and well-being.
- Another essential aspect involves sharing valuable information with the scientific community. By writing journal articles, op-eds, and blogs, we can effectively communicate our findings to a wider audience. This will contribute to the broader scientific knowledge base, fostering collaboration and the exchange of insights among researchers and experts.

Conclusion:

It was exciting working with government line agencies and local communities, and learning from discoveries and findings made possible by advanced technological devices. The community engagement activities have been a significant step in helping the community understand the importance of rare and endangered wildlife and other natural resources of Makalu Barun National Park. They were able to learn about conservation, adopt a more sustainable approach to managing natural resources, and promote biodiversity-friendly behaviors. Simultaneously, the communities living in buffer zone areas have been involved in various livelihood opportunities. So that they have less forest dependency, more income options, and minimize human-wildlife conflict for resources. It's encouraging to observe the community's improvement and appreciate the plan. As this marks the initial phase of community engagement activities, many plantations are still in the testing phase, and it will take some time to strengthen the community. The approval of the next phase of the Barun Biodiversity Research Program will build on these successes to promote biodiversity conservation through community engagement actions.

Example of success: Photographic evidence of five mammals for the first time in Makalu Barun National Park.

Annex

I. April 2019 to March 2021 report
II. April 2021 to March 2023 report.
III. Mammals recorded in Barun Valley.
IV. Birds recorded in Barun Valley.

Annex 3. Mammals recorded in Barun Valley.

S.N.	Species	Total
1	Himalayan Goral	3930
2	Northern Red Muntjac	2189
3	Mainland Serow	1758
4	Rodent sps	596
5	Assamese Macaque	339
6	Himalayan Tahr	240
7	Orange-bellied Himalayan Squirrel	203
8	Yellow-throated Marten	180
9	Leopard Cat	116
10	Flying Squirrel	111
11	Nepal Gray Langur	56
12	Himalayan Black Bear	45
13	Masked Palm Himalayan Civet	43
14	Clouded Leopard	42
15	Unknown species	28
16	Squirrel Species	27
17	Bats	19
18	Red Fox	15
19	Royle's Pika	12
20	Spotted Linsang	12
21	Musk Deer	10
22	Wild Boar	9
23	Tibetan Blue Bear	8
24	Asiatic Golden Cat	8
25	Himalayan Red Panda	5
26	Dhole	3
27	Siberian Weasel	2
28	Yellow-bellied Weasel	2
29	Leopard	1
30	Indian Hare	1
31	Red Giant Flying Squirrel	1
32	Himalayan Crestless Porcupine	

Annex IV. Birds recorded in Barun Valley.

S.N.	Scientific Name	English common name	National category	IUCN Global Category	Observation
1	Falco tinnunculus	Common Kestrel	LC	LC	Field Survey
2	Columba livia	Common Pigeon	LC	LC	Field Survey
3	Streptopeliaorientalis	Oriental Turtle Dove	LC	LC	Field Survey
4	Otus spilocephalus	Mountain Scops Owl	LC	LC	Field Survey
5	Laniustephronotus	Grey-backed Shrike	LC	LC	Field Survey
6	Urocissaerythroryncha	Red-billed Blue Magpie	LC	LC	Field Survey
7	Dendrocittaformosae	Grey Treepie	LC	LC	Field Survey
8	Corvus macrorhynchos	Large-billed Crow	LC	LC	Field Survey
9	Pycnonotusleucogenys	Himalayan Bulbul	LC	LC	Field Survey
10	Cettiabrunnifrons	Grey-sided Bush Warbler	LC	LC	Field Survey
11	Garrulaxleucolophus	White-crested Laughingthrush	LC	LC	Field Survey
12	Acridotheres tristis	Common Myna	LC	LC	Field Survey
13	Saxicola ferreus	Grey Bushchat	LC	LC	Field Survey
14	Niltavamacgrigoriae	Small Niltava	LC	LC	Field Survey/Bioacoustics/Camera trapping
15	Phoenicurushodgsoni	Hodgson's Redstart	LC	LC	Field Survey
16	Chaimarrorniseucocephalus	White-capped Water Redstart	LC	LC	Field Survey
17	Rhyacornisfuliginosa	Plumbeous Water Redstart	LC	LC	Field Survey
18	Myophonus caeruleus	Blue Whistling Thrush	LC	LC	Field Survey/Bioacoustics/Camera trapping
19	Motacilla cinerea	Grey Wagtail	LC	LC	Field Survey
20	Passer montanus	Eurasian Tree Sparrow	LC	LC	Field Survey
21	Tichodromamuraria	Wallcreeper	LC	LC	Field Survey
22	Saxicola torquatus	Common Stonechat	LC	LC	Field Survey
23	Dicrurusmacrocercus	Black Drongo	LC	LC	Field Survey
24	Monticola solitarius	Blue Rock Thrush	LC	LC	Field Survey
25	Copsychussaularis	Oriental Magpie Robin	LC	LC	Field Survey
26	Gyps himalayensis	Himalayan Vulture	VU	NT	Field Survey
27	Phylloscopusxanthoschistos	Grey-hooded Warbler	LC	LC	Field Survey
28	Megalaima virens	Great Barbet	LC	LC	Field Survey/Bioacoustics
29	Megalaima asiatica	Blue-throated Barbet	LC	LC	Field Survey
30	Hypsipetes leucocephalus	Asian Black Bulbul	LC	LC	Field Survey
31	Orthotomussutorius	Common Tailorbird	LC	LC	Field Survey/Bioacoustics
32	Pericrocotusethologus	Long-tailed Minivet	LC	LC	Field Survey/Bioacoustics
33	Hemixosflavala	Ashy Bulbul	LC	LC	Field Survey

34	Yuhina flavicollis	Whiskered Yuhina	LC	LC	Field Survey
35	Dendrocoposmacei	Fulvous-breasted Woodpecker	LC	LC	Field Survey
36	Parus xanthogenys	Black-lored Tit	LC	LC	Field Survey
37	Yuhina gularis	Stripe-throated Yuhina	LC	LC	Field Survey
38	Pycnonotuscafer	Red-vented Bulbul	LC	LC	Field Survey
39	Pomatorhinuserythrogenys	Rusty-cheeked Scimitar Babbler	LC	LC	Field Survey
40	Tesiacyaniventer	Grey-bellied Tesia	LC	LC	Field Survey
41	Pteruthiusflaviscapis	White-browed Shrike Babbler	LC	LC	Field Survey
42	Actinoduracyanouroptera	Blue-winged Minla	LC		Field Survey
43	Seicercusburkii	Green-crowned Warbler	LC	LC	Field Survey
44	Arborophilatorqueola	Hill Partridge	LC	LC	Field Survey/Bioacoustics/Camera trapping
45	Chloropsishardwickii	Orange-bellied Leafbird	LC	LC	Field Survey/Bioacoustics
46	Glaucidium cuculoides	Asian Barred Owlet	LC	LC	Field Survey
47	Eumyiasthalassinus	Verditer Flycatcher	LC	LC	Field Survey
48	Sittacastanea	Chestnut-bellied Nuthatch	LC	LC	Field Survey
49	Falco subbuteo	Eurasian Hobby	LC	LC	Field Survey
50	Aethopygasaturata	Black-throated Sunbird	LC	LC	Field Survey/Bioacoustics
51	Phylloscopuspulcher	Buff-barred Warbler	LC	LC	Field Survey/Bioacoustics
52	Pnoepygaalbiventer	Scaly-breasted Wren Babbler	LC	LC	Field Survey/Bioacoustics
53	Culicicapaceylonensis	Grey-headed Canary Flycatcher	LC	LC	Field Survey/Bioacoustics
54	Pericrocotusflammeus	Scarlet Minivet	LC	LC	Field Survey
55	Psittaculahimalayana	Slaty-headed Parakeet	LC	LC	Field Survey
56	Seicercuscastaniceps	Chestnut-crowned Warbler	LC	LC	Field Survey
57	Dicaeummelanoxanthum	Yellow-bellied Flowerpecker	LC	LC	Field Survey
58	Delichonnipalense	Nepal House Martin	LC	LC	Field Survey
59	Stachyrispyrrhops	Black-chinned Babbler	LC	LC	Field Survey
60	Garrulax striatus	Striated Laughingthrush	LC	LC	Field Survey
61	Heterophasiacapistrata	Rufous Sibia	LC	LC	Field Survey/Bioacoustics
62	Megalaimafranklinii	Golden-throated Barbet	LC	LC	Field Survey
63	Aethopyganipalensis	Green-tailed Sunbird	LC	LC	Field Survey/Bioacoustics
64	Tesiacastaneocoronata	Chestnut-headed Tesia	LC	LC	Field Survey
65	Rhipidurahypoxantha	Yellow-bellied Fantail	LC	LC	Field Survey
66	Garrulax erythrocephalus	Chestnut-crowned Laughingthrush	LC	LC	Field Survey/Bioacoustics/Camera trapping
67	Hypsipetesmcclellandii	Mountain Bulbul	LC	LC	Field Survey
68	Pycnonotus striatus	Striated Bulbul	LC	LC	Field Survey/Bioacoustics
69	Pomatorhinus ruficollis	Streak-breasted Scimitar Babbler	LC	LC	Field Survey
70	Alcippecastaneceps	Rufous-winged Fulvetta	LC	LC	Field Survey
71	Parus monticolus	Green-backed Tit	LC	LC	Field Survey/Bioacoustics

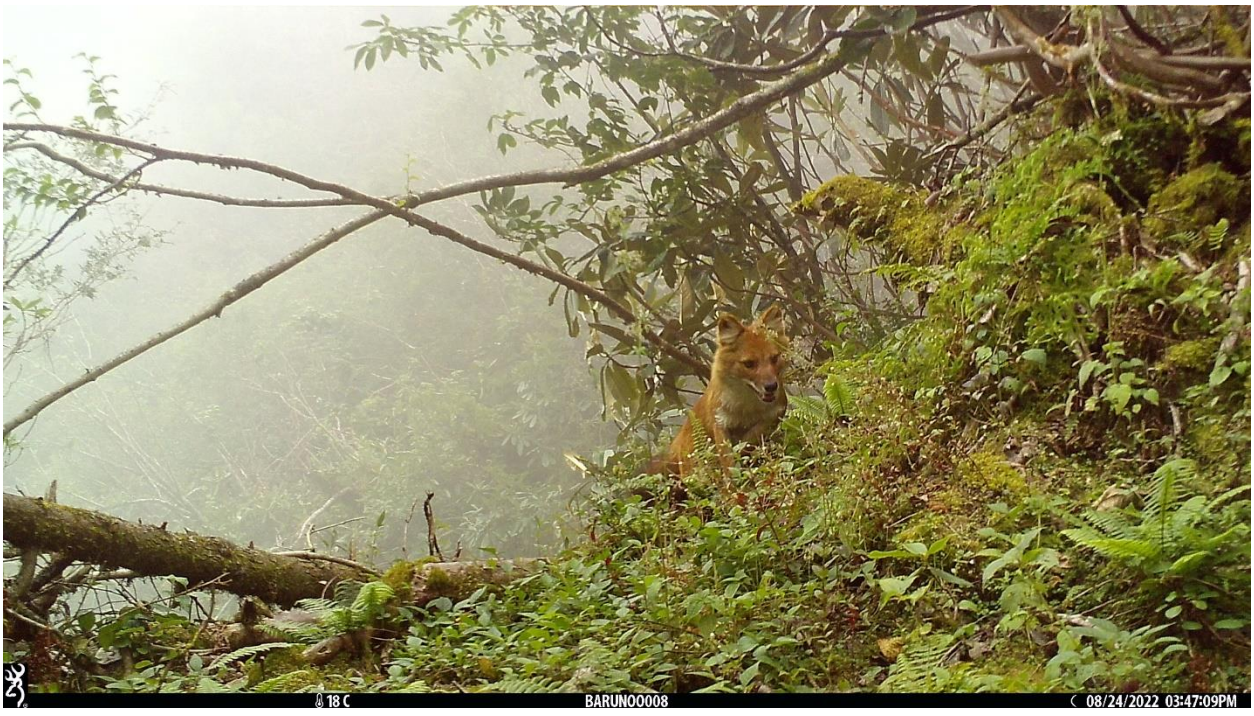
72	Sasiaochracea	White-browed Piculet	CR	LC	Field Survey
73	Enicurus maculatus	Spotted Forktail	LC	LC	Field Survey
74	Stachyrisnigriceps	Grey-throated Babbler	LC	LC	Field Survey/Bioacoustics
75	Dicaeumignipectus	Fire-breasted Flowerpecker	LC	LC	Field Survey
76	Sittahimalayensis	White-tailed Nuthatch	LC	LC	Field Survey/Bioacoustics
77	Aethopygaignicauda	Fire-tailed Sunbird	LC	LC	Field Survey
78	Picuschlorolophus	Lesser Yellownape	LC	LC	Field Survey
79	Enicurusscouleri	Little Forktail	LC	LC	Field Survey
80	Alcippevinipectus	White-browed Fulvetta	LC	LC	Field Survey/Camera trapping
81	Ficedulastrophiata	Rufous-gorgeted Flycatcher	LC	LC	Field Survey/Bioacoustics
82	Treronsphenurus	Wedge-tailed Green Pigeon	LC	LC	Field Survey
83	Glaucidium brodiei	Collared Owlet	LC	LC	Field Survey/Bioacoustics
84	Tarsiger indicus	White-browed Bush Robin	LC	LC	Field Survey
85	Oriolustraillii	Maroon Oriole	LC	LC	Field Survey
86	Haematospizasipahi	Scarlet Finch	LC	LC	Field Survey
87	Yuhina occipitalis	Rufous-vented Yuhina	LC	LC	Field Survey
88	Actinoduranipalensis	Hoary-throated Barwing	LC	LC	Field Survey
89	Ficedulamonileger	White-gorgeted Flycatcher	VU	LC	Field Survey
90	Garrulaxsubunicolor	Scaly Laughingthrush	LC	LC	Field Survey
91	Abroscopusschisticeps	Black-faced Warbler	LC	LC	Field Survey/Bioacoustics
92	Pteruthiusmelanotis	Black-eared Shrike Babbler	LC	LC	Field Survey
93	Actinodurastrigula	Bar-throated Minla	LC		Field Survey
94	Pnoepygaimmaculata	Nepal Wren Babbler	LC	LC	Field Survey
95	Phylloscopustrochiloides	Greenish Warbler	LC	LC	Field Survey/Bioacoustics
96	Tickelliahodgsoni	Broad-billed Warbler	EN	LC	Field Survey
97	Rimatormalacoptilus	Long-billed Wren-babbler	LC		Field Survey
98	Minlaignotincta	Red-tailed Minla	LC	LC	Field Survey
99	Tesiaolivea	Slaty-bellied Tesia	VU	LC	Field Survey
100	Pteruthiusrufiventer	Black-headed Shrike Babbler	VU	LC	Field Survey
101	Accipiter virgatus	Besra	LC	LC	Field Survey
102	Strixnivicolum	Himalayan Wood Owl	LC		Field Survey
103	Turdus boulboul	Grey-winged Blackbird	LC	LC	Field Survey/Bioacoustics
104	Columba hodgsonii	Speckled Wood Pigeon	LC	LC	Field Survey
105	Dendrocoposdarjellensis	Darjeeling Woodpecker	LC	LC	Field Survey/Bioacoustics
106	Blythipicuspyrrhotis	Bay Woodpecker	LC	LC	Field Survey/Bioacoustics
107	Certhianipalensis	Rusty-flanked Treecreeper	LC	LC	Field Survey
108	Seicercuswhistleri	Whistler's Warbler	LC	LC	Field Survey
109	Parus major	Great Tit	LC	LC	Field Survey
110	Phylloscopusmaculipennis	Ashy-throated Warbler	LC	LC	Field Survey/Bioacoustics
111	Phylloscopushumei	Hume's Leaf Warbler	LC	LC	Field Survey

112	Pteruthiusxanthochlorus	Green Shrike Babbler	LC	LC	Field Survey
113	Erporniszantholeuca	White-bellied Yuhina	LC	LC	Field Survey
114	Tragopan satyra	Satyr Tragopan	VU	NT	Field Survey/Bioacoustics/Camera trapping
115	Certhiahodgsoni	Hodgson's Treecreeper	LC		Field Survey
116	Nucifragacaryocatactes	Spotted Nutcracker	LC	LC	Field Survey
117	Lophophorusimpejanus	Himalayan Monal	LC	LC	Field Survey/Bioacoustics/Camera trapping
118	Parus ater	Coal Tit	LC	LC	Field Survey
119	Garrulax ocellatus	Spotted Laughingthrush	LC	LC	Field Survey
120	Aegithalosiouschistos	Black-browed Tit	LC	LC	Field Survey
121	Urocissaflavirostris	Yellow-billed Blue-magpie	LC	LC	Field Survey/Bioacoustics/Camera trapping
122	Muscicapellahodgsoni	Pygmy Blue Flycatcher	VU	LC	Field Survey
123	Troglodytestroglodytes	Eurasian Wren	LC	LC	Field Survey
124	Tarsigerrufilatus	Himalayan Bluetail	LC		Field Survey
125	Phoenicurus frontalis	Blue-fronted Redstart	LC	LC	Field Survey
126	Buteo (buteo) burmanicus	(Himalayan Buzzard)	LC	LC	Field Survey
127	Parus rubidiventris	Rufous-vented Tit	LC	LC	Field Survey
128	Parus dichrous	Grey-crested Tit	LC	LC	Field Survey
129	Cincluspallasii	Brown Dipper	LC	LC	Field Survey
130	Phoenicurusschisticeps	White-throated Redstart	LC	LC	Field Survey
131	Mycerobascarnipes	White-winged Grosbeak	LC	LC	Field Survey
132	Garrulaxaffinis	Black-faced Laughingthrush	LC	LC	Field Survey/Bioacoustics/Camera trapping
133	Columba leuconota	Snow Pigeon	LC	LC	Field Survey
134	Accipiter nisus	Eurasian Sparrowhawk	LC	LC	Field Survey
135	Turdus atrogularis	Black-throated Thrush	LC	LC	Field Survey/Bioacoustics
136	Circus cyaneus	Hen Harrier	LC	LC	Field Survey
137	Carpodacus rodochroa	Pink-browed Rosefinch	LC	LC	Field Survey
138	Leucosticte nemoricola	Plain Mountain Finch	LC	LC	Field Survey
139	Prunella strophiata	Rufous-breasted Accentor	LC	LC	Field Survey
140	Ithaginiscruentus	Blood Pheasant	LC	LC	Field Survey/Camera trap
141	Anthussylvanus	Upland Pipit	LC	LC	Field Survey
142	Tarsigerchrysaeus	Golden Bush Robin	LC	LC	Field Survey
143	Anthushodgsoni	Olive-backed Pipit	LC	LC	Field Survey
144	Rhipiduraalbicollis	White-throated Fantail	LC	LC	Field Survey
145	Carpodacus erythrinus	Common Rosefinch	LC	LC	Field Survey
146	Accipiter gentilis	Northern Goshawk	LC	LC	Field Survey
147	Leiothrix lutea	Red-billed Leiothrix	LC	LC	Field Survey

148	Carduelis spinoides	Yellow-breasted Greenfinch	LC	LC	Field Survey
149	Laniusschach	Long-tailed Shrike	LC	LC	Field Survey
150	Zosteropspalpebrosus	Oriental White-eye	LC	LC	Field Survey
151	Priniacrinigera	Striated Prinia	LC	LC	Field Survey
152	Acrocephalusdumetorum	Blyth's Reed Warbler	LC	LC	Field Survey
153	Aegithalosconcinnus	Black-throated Tit	LC	LC	Field Survey
154	Lophuraleucomelanos	Kalij Pheasant	LC	LC	Field Survey/Bioacoustics
155	Picuscanus	Grey-headed Woodpecker	LC	LC	Field Survey
156	Otus lettia	Collared Scops Owl	LC	LC	Field Survey/Bioacoustics
157	Lonchura striata	White-rumped Munia	LC	LC	Field Survey
158	Niltavasundara	Rufous-bellied Niltava	LC	LC	Field Survey
159	Picusflavinucha	Greater Yellownape	LC	LC	Field Survey
160	Aethopygasiparaja	Crimson Sunbird	LC	LC	Field Survey
161	Monticolarufiventris	Chestnut-bellied Rock Thrush	LC	LC	Field Survey
162	Pteruthiusaeralatus	White-browed Shrike Babbler	LC	LC	Bioacoustics
163	Psilopogon asiaticus	Blue-throated Barbet	LC	LC	Bioacoustics
164	Dryobatescathpharius	Crimson-breasted Woodpecker	LC	LC	Bioacoustics
165	Ianthocincla ocellata	Spotted Laughingthrush	LC	LC	Bioacoustics
166	Machlolophusxanthogenys	Black-lored Tit	LC	LC	Bioacoustics
167	Psilopogon virens	Great Barbet	LC	LC	Bioacoustics
168	Ficedulasuperciliaris	Ultramarine Flycatcher	LC	LC	Bioacoustics
169	Pterorhinusalbogularis	White-throated Laughingthrush	LC	LC	Bioacoustics
170	Phylloscopuscantator	Yellow-vented Warbler	EN	LC	Bioacoustics
171	Spelaeorniscaudatus	Rufous-throated Wren-babbler	CR	NT	Bioacoustics
172	Phylloscopusreguloides	Blyth's Leaf Warbler	LC	LC	Bioacoustics
173	Hierococcyxsparverioides	Large Hawk-cuckoo	LC	LC	Bioacoustics
174	Cuculuspoliocephalus	Lesser Cuckoo	LC	LC	Bioacoustics
175	Cuculussaturatus	Himalayan Cuckoo	LC	LC	Bioacoustics
176	Ianthocincla ocellata	Spotted Laughingthrush	LC	LC	Bioacoustics
177	Cuculusmicropterus	Indian Cuckoo	LC	LC	Bioacoustics
178	Grammatoptila striatus	Striated Laughingthrush	LC	LC	Bioacoustics
179	Arborophilarufogularis	Rufous-throated Partridge	NT	LC	Bioacoustics
180	Lanthocinclarufogularis	Rufous-chinned Laughingthrush	NT	LC	Bioacoustics
181	Trochalopteronerythrocephalu m	Chestnut-crowned Laughingthrush	LC	LC	Bioacoustics
182	Ninoxscutulata	Brown Hawk-owl	LC	LC	Bioacoustics
183	Psilopogonfranklinii	Golden-throated Barbet	LC	LC	Bioacoustics
184	Cuculuscanorus	Common Cuckoo	LC	LC	Bioacoustics
185	Carpodacus rubescens	Blanford'sRosefinch	LC	LC	Bioacoustics
186	Zootheramollissima	Plain Thrush	LC	LC	Camera trapping

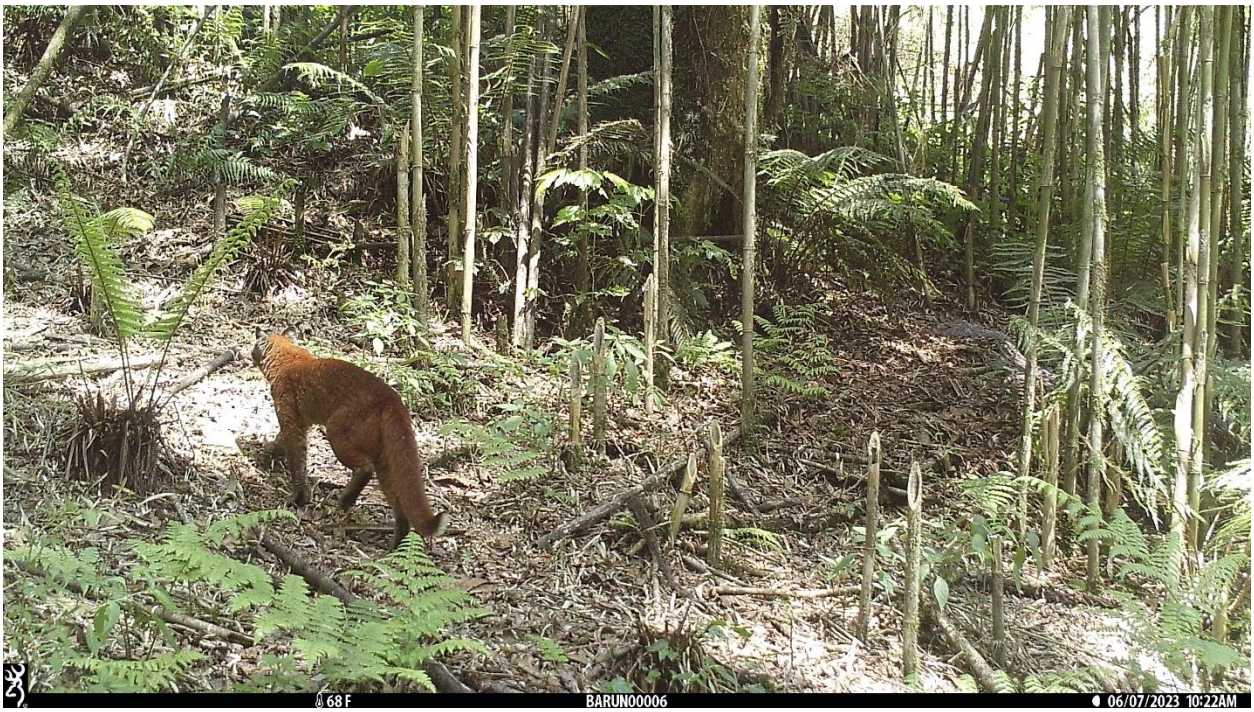
Photo Plates

Clouded Leopard

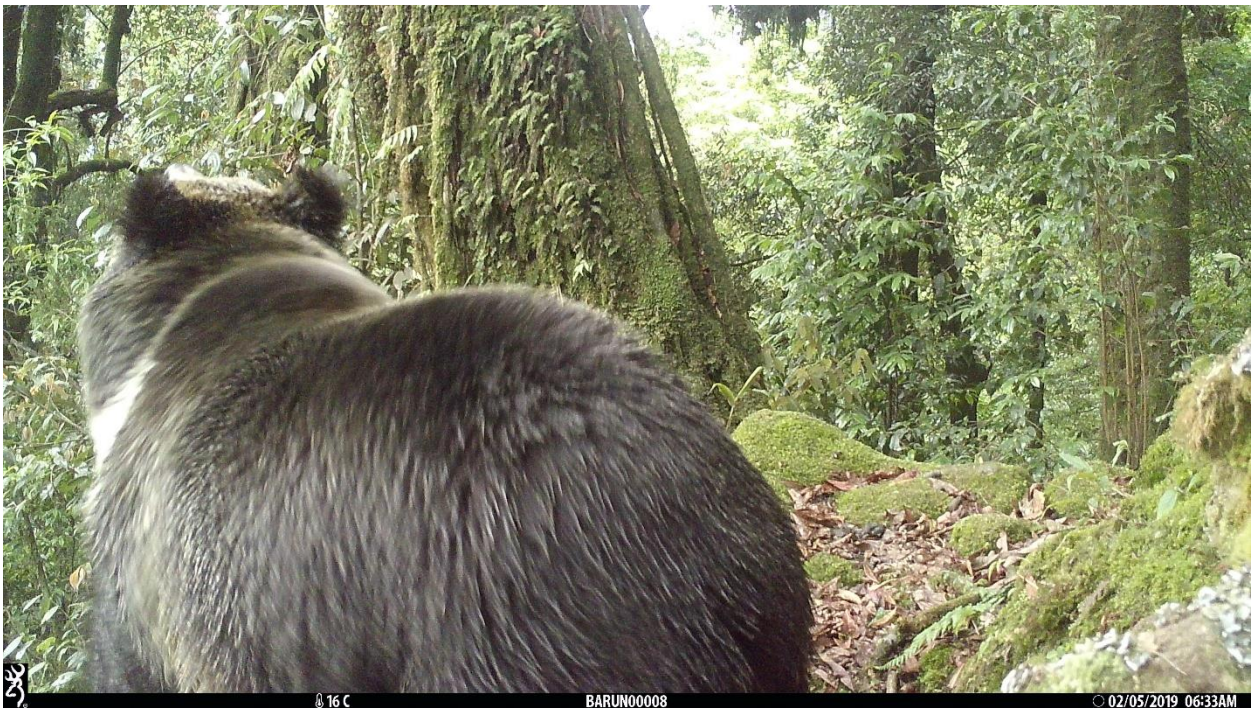


Dhole

Spotted Linsang



Asiatic Golden Cat



Tibetan Blue Bear