Bats and Chiuri of Chepang Heritage Trail: The Mutualistic Relationship between fruit-eating bats, chiuri and indigenous Chepang community.

Final Project Report

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ACRONYMS AND ABBREVIATIONS

CFUG	Community Forest User Group
DBH	Diameter at Breast Height
DoFSC	Department of Forest and Soil Conservation
GPS	Global Positioning System
KII	Key Informant Interview
NCSC	Nature Conservation and Study Center
SWC	Social Welfare Council

EXECUTIVE SUMMARY

During our previous study, the Chepang communities reported the decline of Chiuri trees and bat population in their locality. Recent news article (Khanal, 2021) mentioned that the declining number of chiuri trees in the wild is affecting honey production for the local beekeepers as well. Similarly, local observation, overharvesting of bats, climate variation, urbanization and degrading forest resources were considered crucial factors for this decline. It was also identified that the majority of Chepang people lacked knowledge about bat's role in pollinating Chiuri. Results indicated anthropogenic and environmental factors to have a major impact on the bat population of Shaktikhor.

The traditional practices of Chiuri production were observed to be disappearing, especially among the younger generations. In addition, superstitious beliefs on bats as bad omen seem to have escalated the negative perception of bats further in the prevalence of COVID-19 pandemic outbreak. This challenges the conservation efforts on bats that are already facing negligence in research. As much as it is essential for general people to understand the importance of bats, it is even more significant for communities like Chepang to value the species. The aim of the project is to spread awareness about fruit-eating bats' role in the ecosystem and conserve the Chepang-chiuri-bats interrelationship in the mid-hills of Nepal. The specific objectives of the project are:

- Document fruit-eating bats' role in ecosystem as pollinators and seed dispersers
- Survey the distribution and abundance of chiuri trees in the project area
- Conduct chiuri sapling plantation within the project area
- Spread awareness about fruit-eating bats' role in pollination and seed dispersal of chiuri.

Documenting the foraging of bats in chiuri plants provides visual data to emphasize bat conservation and will become an asset to communicate bat conservation among the general public out from the scientific community. KII with Chepang people provided in-depth information about their culture, relationship with chiuri and perception of bats in their community. It helped in collecting information from a wide range of people - including Chepang community leaders, professionals or residents - who have first hand knowledge about the community. The key informant interview revealed information about different uses of Chiuri in the past and present. In addition to household use, Chiuri's value was also embedded in Chepang's age-old customs. Tradition of giving Chepang daughters Chiuri as dowry prevailed in different parts of the Chepang

community. Participants admitted to the tradition of bat hunting in the Chepang community. However, hunting has expanded to non-Chepang communities as well and bat meat is eaten as a delicacy by different ethnic groups in the local market. The local participants although were oblivious about the role bats played in chiuri production, they didn't have any negative perspective on fruit-eating bats. A vegetation survey based on Quadrat sampling method was conducted by dividing the project area into seven trail routes that fall within the Chepang Heritage Trail. A total of 243 plant species were recorded from the project area out of which majority were herb species (43.62%), followed by tree species (28.8%), shrubs (22.63%), climbers (3.7%), wood climbers (0.82%) and woody plants (0.41%). About 595 chiuri trees were observed in the most prominent space of the project area and other than chiuri trees, 44 species of other wild edible fruits were found. A total of 100 saplings of Chiuri were planted in different community forests within the project area. CFUG members actively took part in the plantation process and care for these saplings was handed to them.

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1. Introduction

Our baseline study in Shaktikhor in 2019 and 2020, examined the critical relationship the Chepang community shares with nature and wildlife. Bats, in particular, are significant for this community for two reasons; 1. as a food source for the Chepang people and 2. as an important pollinator of Chiuri (*Diploknema butyracea*), or Butter Trees, one of the most important plants used by this community. Chiuri is used by Chepangs for medicine, food, agriculture and cultural traditions. Bats, particularly medium-sized fruit-eating bats such as *Rousettus leschenaulti*, and *Eonycteris spelaea* are the major pollinators of Chiuri plants.

During our previous study, the Chepang communities reported the decline of Chiuri trees and bat population in their locality. Recent news article (Khanal, 2021) mentioned that the declining number of chiuri trees in the wild is affecting honey production for the local beekeepers as well. Similarly, local observation, overharvesting of bats, climate variation, urbanization and degrading forest resources were considered crucial factors for this decline. It was also identified that the majority of Chepang people lacked knowledge about bat's role in pollinating Chiuri. Results indicated anthropogenic and environmental factors to have a major impact on the bat population of Shaktikhor.

Adding to this, bats have gained a bad reputation ever since COVID-19. As such, it is important to spread awareness of bats' role in the ecosystem in the Chepang community and the larger audience. Similarly, Chepang communities need to come forward as the guardians of these flying mammals in order to protect their culture and unique belief system associated with Chiuri which in turn is interrelated complexly with the fate of bats.

The Chepang share a special bond with these mammals and as pollinators, they serve an important cultural ecosystem service to the community. Lack of proper understanding about bat's role for chiuri production and regular killings of bats threatens its population, chiuri production in the local area as well as the community itself, which are dependent on both animal and plant species. "Seeing is believing," by digitally documenting the bat's role in the ecosystem, the complex relationship they share with the chiuri and Chepang community, the project will be able to spread direct evidence on fruit-eating bats' role in the ecosystem among the Chepang community and the larger audience throughout the country.

2. Objectives

The traditional practices of Chiuri production were observed to be disappearing, especially among the younger generations. In addition, superstitious beliefs on bats as bad omen seem to have escalated the negative perception of bats further in the prevalence of COVID-19 pandemic outbreak. This challenges the conservation efforts on bats that are already facing negligence in research. As much as it is essential for general people to understand the importance of bats, it is even more significant for communities like Chepang to value the species. The aim of the project is to spread awareness about fruit-eating bats' role in the ecosystem and conserve the Chepang-chiuri-bats interrelationship in the mid-hills of Nepal. The specific objectives of the project are:

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3. Study Area

The project was conducted in Icchyakamana and Kalika Municipality of Chitwan District in Province number 3 of Nepal. Province 3 is one of the 7 provinces of Nepal established by the country's new constitution declared as of 2015. The province is mostly hilly and mountainous and covers about 14% of the country's total area and has forest patches of deciduous, coniferous, alpine and woodland forests. Chitwan District is known to be particularly rich in flora and fauna, housing Nepal's first national park: Chitwan National Park and supports species diversity of rare mammals like Bengal Tiger, Gharial, Asian Rhinoceros and more. The people inhabiting the district are predominantly farmers focused on cultivating mainly cash crops.

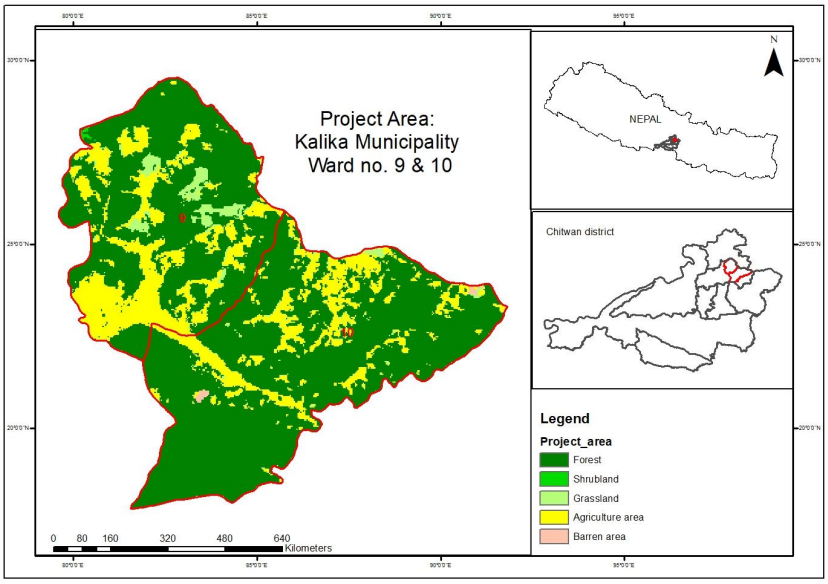

Fig. 1. Project Field Area

Around 26km north of the National Park is situated the project site: Shaktikhor VDC. The area extends from 300 to 2500 meters in altitude and experiences a tropical to subtropical climate (Rijal, 2010). Three overall forest types are present in the area, namely: Sal (*Shorea robusta*), mixed broadleaved and pine forests. The area has a small population of wildlife, including barking deer (*Muntiacus muntjak*), jackals (*Canis aureus*), rhesus monkey (*Macaca mulatta*) and common langur (*Semnopithecus schistaceus*) (Rijal, 2010). Bats are prominent in the community as they not only act as food source for the indigenous community, but play a vital role in pollination of the Butter Trees.

4. Visual Surveillance of Fruit-Eating Bat

Digital technology advancements facilitate the use of video for studying wildlife and the natural environment. Use of camera's motion sensors, time lapse and continuous recordings have been used for different purposes, including animal behavior in their nests and trap sites (Reif and Tornberg, 2006; Kleist et al., 2007; Huckschlag, 2008; Scheibe et al., 2008). Documenting the foraging of bats in chiuri plants provides visual data to emphasize bat conservation and will become an asset to communicate bat conservation among the general public out from the scientific community.

4.1 Field Work

The surveillance started in early December 2021, the period when chiuri plants flower and when fruit-eating bats visit the flowers for its nectar. Previously acquainted locals were asked about the different areas where chiuri trees were flowering and options around the project area were explored. Since electricity was required to connect lights and take pictures and videos of bats, location to capture bats was important to not be too far from the local settlement.

One location was finalized after verifying with the locals that bats were observed after dawn. The selected location wasn't too far from the settlement area and the chiuri trees had enough flowers for bats to feed all night. 3 high-resolution cameras were positioned 45 degrees under the tree, focusing on three different bunches of chiuri flowers. 2 Ample lighting with adjustment features were used to increase and decrease brightness whenever necessary and were placed in two positions under the tree. After a couple of unsuccessful nights, torch lights were also used to spot bats when they arrived around the flowers and flashed when they would hang on the branches to capture the image or video.

Fig. 2. Project team trying to capture bats feeding on chiuri

Surveillance started every evening after sunset and ended around midnight for 7 nights in total. Strong winter winds were encountered some nights and the team had to retreat with no footage.

Few movements of bats were noticed on such strong, windy nights (average wind speed- 1.47 m/s) in comparison to other calmer nights (average wind speed -0.027 m/s). Weatherflow weathermeter was used each night for recording temperature, wind speed and direction.

4.2 Information Dissemination

This was the first digital evidence of the interrelationship between fruit-eating bats and chiuri for Nepal. With the direct evidence collected, the project will be able to raise awareness of the mammals' role in the ecosystem among the Chepang community and the larger audience throughout the country and globally.

Apart from the bat surveillance, the team captured livelihood footage from the project area and interview recordings that were compiled to create a short documentary. It was officially released in NCSC's organizational Youtube channel (Video Link: https://youtu.be/-GhjnVmaQ9c) for mass viewing, while locals were shown personally during workshops at their own convenience. The video is further submitted at Kathmandu International Film Festival (KIMFF) with the objective to spread the information to a wider audience.

5. Key-Informant Interview (KII)

KII with Chepang people provided in-depth information about their culture, relationship with chiuri and perception of bats in their community. It helped in collecting information from a wide range of people - including Chepang community leaders, professionals or residents - who have first hand knowledge about the community.

Prior to the interview, a verbal consent was taken from the informant to record their interview digitally. Individuals were consulted about the topic of discussion, purpose and their input towards the project's activity. Pre-planned semi-structured questions were asked during the interview to make the session guided, although room to discuss other issues were left open when appropriate.

Fig. 3. KII being conducted with local informants

Based on the review of previous study, existing literature, input from community collaborative and experts, a semi-structured draft questionnaire was developed. KII was then performed with 9 individuals from different backgrounds, including bat researcher, local Chepang community members, local government representatives and beekeeping experts. Interviews were taken in their preferred premises (office, home, place of business) and were recorded through audiotape and digital cameras. The recordings were all reviewed and transcribed to point out a few KII Codes for reference. Based on the codes recurring themes were identified in each interview along with passages that represented the sentiments of the interviewee.

5.1. KII Findings

5.1.1. Use of Chiuri

The key informant interview revealed information about different uses of Chiuri in the past and present. Oil production through chiuri seeds was prominent in the past where household members

rarely bought cooking oil from the market and only used chiuri oil. Wooden crushers and wicker baskets were used to press oil and either used for cooking or other auspicious occasions. Moreover, the oil could also be used as an ointment in cuts and bruises. The residue was used as fertilizer for crops. However, this practice has declined to almost extinction today and people rarely produce oil from chiuri seeds.

"Youths today dont know about the whole process of collecting and storing the seeds and crushing them for oil, it is just the older generation who value chiuri oil." - Til Kumari Chepang

In addition to household use, Chiuri's value was also embedded in Chepang's age-old customs. Tradition of giving Chepang daughters Chiuri as dowry prevailed in different parts of the Chepang community. Although the practice is rarely seen today, it is still fondly remembered by many people.

"Lots of chiuri were found in the forest and daughters were gifted with one chiuri tree in their wedding. This was so they could reap the benefits from chiuri fruits and seeds." - Ramjimaya Chepang

5.1.2. Bat Hunting

Participants admitted to the tradition of bat hunting in the Chepang community. However, hunting has expanded to non-Chepang communities as well and bat meat is eaten as a delicacy by different ethnic groups in the local market. Hunting used to be controlled in the past. But the increase of demand in the market and growing population pressured the bat population to its decline.

"Bat hunting was an old tradition. People used to hunt less back then. Before human settlement used to be less here, and even if they hunted, they used to kill very few bats. Now that the human settlement has increased, bats are hunted even more." - Hem Bahadur Chettri

5.1.3. Role of Bats in Chiuri Production

The local participants although were oblivious about the role bats played in chiuri production, they didn't have any negative perspective on fruit-eating bats. They admitted to have observed bats visi chiuri plants in the flowering and fruiting season.

"Bats do no harm. In the flowering season, they feed on the flowers. When the chiuri fruits ripen, bats fly away with the fruit and eat somewhere else. When they do that, they drop the seed of the fruit somewhere else and this helps in spreading of chiuri plants in different areas."- Man Bahadur Chepang

Bat experts interviewed confirmed that although birds and bees also help in pollination of chiuri, bats have a much more important role in production of chiuri.

"Two species of fruit-eating bats, namely. Rousettus leschenaulti and Eonolis spelia are known to help in pollination of chiuri. If you've noticed, chiuri has more nectar in their flowers at night time and because bats are nocturnal animals, they are able to assist in greater pollination in comparison to other day-feeding animals." - Sanjan Thapa

6. Vegetation Survey

Both natural and anthropogenic disturbances are integral drivers of forest dynamics that alter species composition and diversity, which in turn, determine ecosystem productivity and the flow of ecosystem services (Bagchi and Ritchie, 2010; Bagchi et al., 2012). Fragmented and degraded forests with altered forest structure, composition and ecosystem processes are more vulnerable to climate change (Noss, 2001). Distribution and relative abundances of coexisting species for ecologists historically and provides a fundamental property of communities like species richness or abundance (Weiher & Keddy, 1999). The required information is crucial to understand how chiuri's abundance is affecting bat's population in the project area and analyze suitable places for chiuri sapling plantation.

6.1 Sampling Design and Data Collection

A vegetation survey based on Quadrat sampling method was conducted by dividing the project area into seven trail routes that fall within the Chepang Heritage Trail. Distance between two sample plots varied from 200 to 300 meters, according to nature and types of vegetation. Based on the availability of different forest types, the number of sample plots laid varied from 2 to 3 in each elevation band, making a total of 28 sampling plots. One plot of 100 meters square was formed in each of the sampling plots where 10mX10m nested quadrat was made for tree species, 3mX3m for shrubs and 1mX1m for herb species. Any wild edible fruit species present in was also recorded. GPS data, micro-ecological characters and other information including distance from settlement, road,

canopy cover and Diameter at Breast Height (DBH) were also recorded from each sample plot before analyzing the data.

Fig. 4. Vegetation survey being conducted by field team

6.2 Data Analysis

The species diversity of the forest community was calculated by applying Shannon-Wiener index (H') with the following formula:

H'= -∑ (ni/N)ln(ni/N) = - ∑ Pi ln pi (Shannon-Wiener, 1963), Where, N =Total no of species., ni = number of individuals of species., Pi = ni/N.

Index of dominance was calculated by the following formula:

c = ∑ $(Pi)^2$ (Simpson, 1949), Where, c = Simpson index of dominance, Pi = the proportion of important value of the i^{th} species (Pi = ni/N, ni = number of individuals of each species and N = total number of individuals.

Species evenness was calculated by the following formula:

e =H'/ ln S (Odum, 1967), Where, H' = Shannon -Wiener Diversity Index, S = numbers of k species.

Species richness was calculated by using Margalef's index of richness' (D) with the formula:
D = (S-1)/ln N, Where, S = Total number of species, N = Total number of individuals.

Quantitative data analysis was done by calculating the frequency, density, basal area, abundance and IVI of tree species with some modifications.

6.3 Results

A total of 243 plant species were recorded from the project area out of which majority were herb species (43.62%), followed by tree species (28.8%), shrubs (22.63%), climbers (3.7%), wood climbers (0.82%) and woody plants (0.41%). About 595 chiuri trees were observed in the most prominent space of the project area and other than chiuri trees, 44 species of other wild edible fruits were found. Kutmiro (*Litsea monopetala*) was the most widely distributed tree with highest frequency of 70% and followed by Chiuri (*Diploknema butyracea*), Jhingane (*Eurya acuminata*), Angeri (*Lyonia ovalifolia*), Gogan (*Saurauia napaulensis*) and Sal (*Shorea robusta*).

7. Chiuri Plantation

Recently, it has been reported that there has been a decline in chiuri trees. Beekeepers and locals have confirmed the shifting of the blooming season of Chiuri that is not only affecting the honey production, but also the Chepang households who depend on Chiuri heavily for economic, cultural and livelihood benefits. Fruit-eating bats who depend on these chiuri trees for food are also equally affected and with overhunting of the mammals in the local community causes decline in the overall population of fruit-eating bats. In order to increase food availability for fruit-eating bat populations in the project area, chiuri trees were planted in community forests within the project area in collaboration with the local CFUG members. This collaborative activity was focused on increasing the year round food source of fruit eating bats.

Fig. 5. Chiuri sapling plantation being conducted with CFUG members

A total of 100 saplings of Chiuri were planted in different community forests within the project area. CFUG members actively took part in the plantation process and care for these saplings was handed to them.

8. Limitations

One of the major challenges that arose during the project was to capture the fruit-eating bat in the chiuri flower. Since this was the first time that we were trying to capture the image through a still and/or moving image, we hadn't analyzed the swiftness of the mammal while feeding in the flowers. Bats were extremely quick and it was extremely difficult to capture them in our cameras. We had to use one slow motion video camera and two highly powerful still-image cameras every night for a week to finally capture the shot of fruit-eating bats foraging on the chiuri flowers.

Furthermore, the use of lights was necessary to capture them in our cameras, but bats tend to avoid wherever they experience artificial lights. Hence, we had to use a couple of tactics while using lights. Firstly, we chose adjustable night-lights to shine on chiuri flowers and place one camera on focus. The lights were dimmed while waiting for the bats and when we noticed bats flying, the brightness was increased before taking a shot. Then, we also had to use extremely powerful torch lights to identify the bats and click pictures while doing so.

Finally, there was the extremity of monsoon season right around when vegetation survey was planned. Since this was expected, we shifted our survey right after the monsoon started getting lighter to avoid hazards and risks.

9. Way Forward

Due to the release of our documentary, more youth from the Chepang community have become interested in learning about fruit-eating bats and their significance in the ecosystem. This is a positive output from our work and in order to enhance advantageous outcomes, it is also important to encourage conservation activities among interested youths. Hence, a technical workshop/training on bat monitoring among the youths is necessary to instigate conservation in the project area. Moreover, interrelationship between Chepang-chiuri-bats should not only confine in only the project area, but also expand in other Chepang communities. Therefore, further plan from the project is to train youths in bat monitoring techniques and expand awareness about the mutualistic relationship in other Chepang communities as well.

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