# FIELD VERIFICATION OF KIMATHANKA CORRIDOR FOR SNOW LEOPARD (*Panthera uncia*, Schreber, 1775) IDENTIFIED IN MAKALU BARUN NATIONAL PARK, NEPAL



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**Submitted to**

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## RECOMMENDATION

It is my pleasure to mention that Ms. Deepa Pun has carried out the thesis entitled **"Field Verification of Kimathanka Corridor for Snow Leopard (*Panthera uncia*, Schreber 1775) Identified in Makalu Barun National Park, Nepal"** under my guidance and supervision. This is the candidate's original work, which brings out important findings essential for biodiversity conservation in remote mountain region. To the best of my knowledge, this thesis has not been submitted for any other degree in any institution. I recommend that the thesis be accepted for the partial fulfillment of the requirement for the Degree of Master's Of Science in Zoology Specializing in Ecology.

Date: 8 september 2019

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## LETTER OF APPROVAL

On the recommendation of Supervisor Dr. Mukesh Kumar Chalise, this thesis submitted by Ms. Deepa Pun entitled **" Field Verification of Kimathanka Corridor for Snow Leopard (*Panthera uncia*, Schreber 1775) Identified in Makalu Barun National Park, Nepal "** is approved for the examination in partial fulfillment of the master's degree of science in zoology with special paper ecology.

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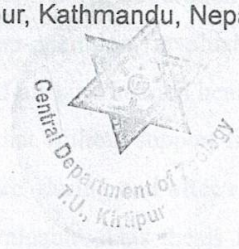


## CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Ms. Deepa Pun entitled" **Field Verification of Kimathanka Corridor for Snow Leopard (*Panthera uncia*, Schreber 1775) Identified in Makalu Barun National Park, Nepal** "has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Ecology.

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## DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

Date: 8 September 2019 .....

**Deepa Pun**

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**Deepa Pun**

# ABSTRACT

The landscape analysis and mapping of Snow Leopard has identified 14 habitat corridors and 11 critical sites in Eastern Himalaya landscape. Among 14 identified habitat corridors Kimathanka is one of them which lie in core area and buffer zones of Makalu Barun National Park (MBNP). Through spatial analysis and habitat mapping the MBNP is believed to have total 852 $km^2$ favourable habitats for Snow Leopard. The study was carried out for the field verification of the identified Kimathanka corridor in Eastern Himalaya Landscape (EHL). Indirect sign survey method for assessing habitat occupancy, line transects method for prey survey and HHs questionnaire survey & FGD for Socio-economic survey were applied during survey period. Total 13 survey grids of each 16 $km^2$ were overlaid on most potential habitat of Snow Leopard in Kimathanka corridor out of which only 10 survey grids were accessible. Ten lines transects of total 21.6km length was followed during the survey period. Total 46 carnivore signs were collected in survey period out of which seven signs (Scat) were identified as signs of Snow Leopard with encounter rate 0.324 per km. Twenty two scats and 11 pugmarks of carnivores remained unidentified as most of the signs were destroyed by the rainfall as the survey was conducted in monsoon season ($23^{rd}$ June - $2^{nd}$ August 2018). Fourteen types of prey species were encountered. The domestic animals were most abundant in the study area. The signs of Wild Boar were encountered the most with encounter rate 0.509 per km. The economic loss per household in Hatiya (NRs. 21,937 per year) was high, followed by Chumsur with NRs. 6,253 per year and Kimathanka with NRs. 2,725 per year. Economic loss per household per year for livestock was high in Chumsur (NRS. 38,333) than Kimathanka (NRs. 16,500) and Hatiya (NRs. 7,600).

# TABLE OF CONTENTS

# LIST OF TABLES

**Tables** **Title of table** **Page no**

# LIST OF FIGURES

**Figure Title of figure page no**

# LIST OF PHOTOGRAPHS

# LIST OF ABBREVIATIONS

| Abbreviated forms | | Details of abbreviation |
|---|---|---|
| asl | : | Above Sea Level |
| BZ | : | Buffer Zone |
| CITES | : | Convention on International Trade in Endangered Species |
| DNPWC | : | Department Of National Parks and Wildlife Conservation |
| EHL | : | Eastern Himalaya Landscape |
| FGD | : | Focus Group Discussion |
| GIS | : | Geographic Information System |
| GoN | : | Government of Nepal |
| GPS | : | Global Positioning System |
| GSLSEP | : | Global Snow Leopard and Ecosystem Protection Program |
| HHs | : | House holds survey |
| HWC | : | Human Wildlife Conflict |
| ISLT | : | International Snow Leopard Trust |
| IUCN | : | International Union for Conservation of Nature and Natural resources |
| KCA | : | Kanchenjungha Conservation Area |
| Km | : | Kilometre |
| M | : | Meter |
| MBNP | : | Makalu Barun National Park |
| MoFSC | : | Ministry of Forests and Soil conservation |
| SL | : | Snow Leopard |
| SLEMP | : | Snow Leopard and Ecosystem Management Plan |
| WWF | : | World Wildlife Fund |

# 1. INTRODUCTION

## 1.1 General background

The Snow Leopard (*Panthera uncia*, Schreber, 1775) is an elusive, shy and solitary species. It is the flagship species of high Himalayas spearheading environmental conservation momentum across one of the most ecologically fragile landscapes on the planet – the high mountains of Asia. As a wide ranging, apex predator, it plays a pivotal role in structuring ecosystem processes and is thus considered as indicator of health and sustainability of mountain ecosystem (SLEMP 2017). They are low in density, sparsely distributed and are found in hostile or inaccessible habitat (Jackson 1996) which is rugged and fragile landscape of Himalayas with energy- deficient environments of high altitudes.

They show mostly crepuscular activity pattern. They are active through much of the day in areas with few people but become nocturnal when their habitat becomes disturbed (Jackson and Chundawat 1999). It prefers steep terrain broken by cliffs ridges and gullies. Terrain features serve as day time resting sites for social marking including scrapes, scats (faces) and scent sprays (Jackson and Ahlborn 1998).

Occupancy simply is the proportion of areas, patches or sample units that is occupied. The Occupancy surveys involve searches of sample areas (Grids) of designated size over a relatively short time interval (e.g., 2-5 consecutive days) to search for sign or other evidence the area is being used by snow leopards. Simply stated, the researcher tallies the proportion of sample areas or units at which snow leopards (or their sign) were detected during each visit to estimate the species' overall detection probability and occupancy rate. When indexed to relevant habitat factors (e.g., slope steepness, landform ruggedness or prey abundance), these data can be more easily extrapolated to a wider area for deriving a relatively robust index of abundance (including the probabilities of occurrence) (SLC 2019).

The corridor is an area of habitat connecting wildlife populations separated by human activities or structures (such as roads, development, boundary or logging). This allows an exchange of individuals between populations preventing inbreeding, extinction and facilitating re-establishment of populations aiding to genetic diversity (Aars 1999). The main purpose of implementing habitat corridors is to increase biodiversity. When the habitat areas of the species are broken up by the human interference, population numbers of the species becomes unstable and many animals and plants species becomes

endangered. Hence by connecting the fragments, the population fluctuations can be reduced as corridors provide opportunity to colonize better habitat, better mates for interbreeding and space for migration (Aars 1999).

Food is the main factor that determines the distribution of animals. There must be sufficient prey to support the predator population (Jackson and Hunter 1996). The prey species maintain ecosystems by influencing vegetation structures, plant species composition and nutrient cycling. Moreover, prey species in wild plays a vital role in determining the density and survival of the Snow Leopard. The Snow Leopard is an opportunistic predator capable of killing prey more than three times its own weight. Therefore it may prey on most herbivores found in the same range except for fully grown Yak and Wild ass. The food habit studies indicate that the primary prey of Snow Leopard consists of the dominant wild ungulates of the region, along with a variety of smaller birds and mammals. The principle prey of Snow Leopard is Blue Sheep (*Pseudois nayaur*) in many parts of Nepal and it also preys on Markhor *( Capra falconeris),* Serow ( *Capricoris),* Himalayan Tahr (*Hemitragus jemlahicus),* Musk deer *(Moschus chrysogaster)* (Chundawat and Rawat 1994).

Theoretically, Snow Leopards naturally attack livestock as their secondary prey only when their prey is either depleted or hard to find. Therefore, its dependency on domestic Livestock increases conflicts with the local communities and has resulted in increased retaliatory killing. This has been an important issue in Snow Leopard conservation throughout its range. Snow Leopards have been reported to kill livestock in most parts of their range but the extent of this predation and its impact on local herders is poorly understood (Mallon 1984). Hence sometimes, SL makes their diet to domestic goats, sheep, calves and sub-adult yak, colt and sub adult horse (Aryal et al. 2014).

Human-wildlife conflict (HWC) is the confrontation between humans and wild animals, usually resulting in crop and livestock depredation, property damages, human injuries, and retaliatory killing or capturing of wildlife (Elliot et al. 2008). It is a contentious issue between the conservationist and the local community through which the conservation initiatives are implemented. It is a worldwide problem. In Nepal, HWC is a major problem in most protected areas and often results from the inability of local communities to access the local natural resources they were using from time immemorial before being legally barred from their use after the post–World War II legalization of protected areas (Lamsal 2012, Timalsina and Ranjitkar 2014). Human-wildlife conflict mitigation

measures are direct methods, such as fencing, guarding, digging trenches, and removal of wildlife, and indirect methods in the form of compensation and incentives, local participation, research, and environmental education (Treves 2007).

SL is listed as a vulnerable species by the international union for conservation of nature (IUCN 2017) and included in Appendix I of the convention on international trade in Endangered Species of Wild Fauna and Flora (CITES). The species is also fully protected by the Government of Nepal (GoN) through National Park and Wildlife Conservation (NPWC) Act (1973)/ Fifth Amendment (2017). Although it is listed as vulnerable species, its future is still uncertain due to ongoing anthropogenic (Li et al. 2014, Suryawanshi et al.2014), and climatic pressure (Forrest et al. 2012, Li et al. 2016) to their population and habitat. To address both conventional and emerging threat and also to address current and future environmental issues in high central Asia, the Snow Leopard range countries commit to work together through the Global Snow Leopard and Ecosystem Protection Program (GSLEP) in "Bishkek Declaration" of 2013 (SLEMP 2017). The GoN has identified three conservation landscapes Namely; Eastern, Central and Western for completing the GSLEP's vision into action and aims to secure 100 breeding age Snow Leopards in each through active involvement of local communities in each landscape (DNPWC 2017).

The Eastern Himalayas Landscape (EHL) extends from the Bhotekoshi and Trishuli river of the Langtang National Park (LNP) in Central Nepal through Gaurishankar Conservation Area (GCA), Sagarmatha National Park (SNP), Makalu Barun National Park (MBNP) to Kangchenjunga Conservation Area (KCA) in eastern Nepal. The northern boundary of EHL is contiguous with the 35,000 $Km^2$ Quomolangma Nature Preserve of China and towards the eastern part it is connected to the Snow Leopard habitat of Sikkim and Bhutan (ICIMOD et al. 2017). From the regional prospective, the Snow Leopard habitats is EHL are thus important bridge between the western and central Snow Leopard populations of Himalaya range. SLEMP has identified 14 habitat corridor and 11 critical sites in EHL, among which Kimathanka corridor is one of the identified corridor.

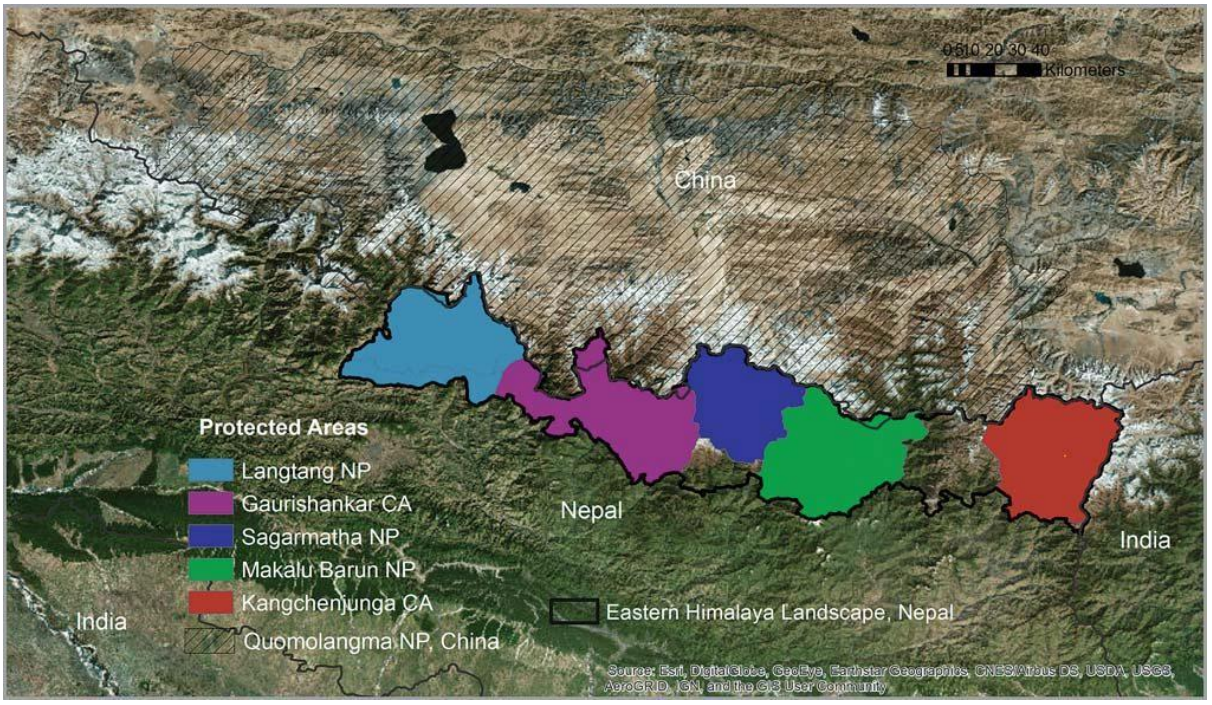


Figure 1. Eastern Himalaya Landscape (Source: SLEMP 2017-2026)

## 1.2 Statement of Problems

The critical conservation sites and corridors of Snow Leopards has been identified and mapped by SLEMP in EHL using spatial analysis but those areas still need to be verified and studied for the status and distribution of Snow Leopard in ground levels. A detailed assessment of Snow Leopard's distribution and its advanced ecological monitoring in the SLEMP identified areas has not been carried out yet. The sufficient studies regarding the prey have not been carried out which leads us to rare information regarding the problems confined within it in study area.

The density and trends of anthropogenic pressure in the areas identified by SLEMP to be the critical for Snow Leopard are still to be studied in detail. The landscape level conservation has not achieved desired impact due to inefficient and insufficient technical and socio-economic data. The key factors causing the HWC and livelihoods vulnerability is still unidentified. Hence the implementation of short term and long term conservation laws and initiatives seems difficult.

## 1.3 Objectives

### *1.3.1 General objective*

To assess the ecological and socio-economic status of the Kimathanka corridor with special focus on Snow Leopard's habitat occupancy, its prey abundance and human wildlife conflict.

### *1.3.2 Specific objectives*

a) To assess habitat occupancy of Snow Leopard in Kimathanka corridor
b) To assess prey abundance of Snow Leopard in Kimathanka corridor and
c) To know human wildlife conflict around Kimathanka corridor.

## 1.4 Significance of study

The studies on Snow Leopard are in increasing trend. Various studies regarding Snow Leopard are undertaken in Nepal as well. But intensive studies on Snow Leopard in MBNP are rare. A study in field verification will serve as the milestone for the verification of the identified critical habitat and corridors for Snow Leopard. The availability of the Prey Species determines the presence and absence of the predators hence, the study of the Prey abundance will be helpful in prey base analysis and point out the problems confined within. Information on HWC and extent of damages faced by the people will help the concerned authorities to design appropriate initiatives to solve the problems.

## 1.5 Limitations of the Study

The study was conducted in monsoon season. The rainfall affected the survey in large scale as the difficult terrains of the Snow Leopard was even harder to transverse and some of the most potential sites like Lukchik couldn't be surveyed. The flooding and erosion swept away bridges in many places making the sites inaccessible. Moreover, this survey was conducted only in one season. Hence the data collected may not reflect the whole picture of the other seasons and whole areas. Moreover, continuous rainfall damaged the signs left by animals due to which 22 scat signs and 11 pugmarks could not be identified.

The monsoon season is the season of cultivation of paddy and millet. Every individual were busy in agricultural farming due to which less number of respondents were available during day. At night most of them were intoxicated with alcohols or other beverages and was not appropriate time for questionnaire survey as they were unable to reply correctly to the questions. Since they were tired from the work they prefer not to give answers. Hence, information collection regarding HWC was not easy.

# 2. LITERATURE REVIEW

## 2.1 Occupancy survey

The presence of the signs in the particular area may it be indirect or direct provides an indication of presence of large cats (Jackson and Hunter 1996). Once the data about the presence and absence over different seasons are collected then habitat modeling and distribution map of SL can be prepared (Jackson and Hunter 1996). SL are not always detected when occupying/using the space so it is usually impossible to confirm whether the species is absent or the species being present but undetected during the time of survey. The two processes occurring in the general sampling situation are occupancy and detectability. Occupancy provides the data related to the presence/absence of the species from sites during survey while detectability ia an aspect of surveying protocols which will be regarded as a nuisance parameter (MacKenzie et al. 2006). Occupancy models can be used to understand SL distribution. The main factor that affects the distribution is sampling error and imperfect detection. The imperfect detection can be ignored using logistic regression, MaxENT and random forest (MacKenzie 2018).

Barber-mayer et al. (2012) conducted survey on influence of prey depletion and human disturbance on tiger occupancy in Nepal. The average estimate of the probability of tiger site occupancy was 0.366 and the probability of detection estimate was 0.65 per 1km searched. Modeled tiger site occupancy ranged from 0.04 in areas with relatively lower prey base and higher human disturbance to 1 in the areas with a higher prey base and lower human disturbance. They estimated tiger occupies just 5,049km$^2$ of 13,915km$^2$ potential tiger habitat.

Lamichhane (2018) surveyed northern Arun east critical habitat and Thudam corridor to estimate the habitat use and examine the relative influence of prey and human disturbances on habitat use. The single season model was used following MacKenzie model to estimate the habitat use by SL. The model average estimate of probability of habitat use by SL was calculated as 0.63 with its naïve estimate as 0.41. The prey factor had positive influence while human disturbance had negative influence on habitat use by SL.

Bailey et al. (2003) conducted research on terrestrial Salamanders where he used detection non detection data to estimate proportion of area occupied in Great Smoky mountain National Park. They found species detection probabilities for terrestrial salamanders are <1 and vary across time, space, species and sampling methods.

Linzey and Kesner (1997) studied on population and habitat occupancy patterns of small mammals in five woodland-savannah habitats of Sengwa Wildlife research area.

Fourteen species of small mammals were recorded using mark and recapture live trapping. The habitat occupied by an individual species during the season of lowest density was always the same as the one in which it reached its highest density.

The site occupancy rate was estimated by (O'connell et al. 2006) using species specific detection probabilities for meso- and large terrestrial mammal species on cape cod Massachusetts, USA. The estimated site occupancy rates were similar among sampling methods for most species when detection probabilities exceeded 0.15.

Adhikari (2018) estimated probability of habitat use by SL and perceived impact of climate change its critical habitat in Arun East of Nepal by using sign survey, focus group discussion and interview methods. The survey yielded a native estimate of 0.27 and 0.49 by incorporating other covarites like prey and human disturbances. Among 15 sampled grids 5 grids had probability of occupancy more than 0.05 whereas 10 had occupancy less than 0.50.

## 2.2 Abundance of Prey species

Snow Leopard's food requirements are roughly 1.5-2.5 Kg/day (Jackson and Ahlborn 1984), thus 550-900 kg food is required per year. It seems that 13-22 individuals of wild sheep or goat prey species (adult weight, 55kg) would be required per year. A population of 130-220 adult sheep would be necessary to support one Snow Leopard over a year (Emmons 1987, Fox 1989).

The SL is an opportunistic predator capable of killing prey up to three times its own body weight (Fox 1989). There are regional differences in prey taken, but its main prey are Blue sheep (*Pseudois nayaur*), Asiatic Ibex (*Capra ibex sibirica*), Argali (*ovis ammon*), Marmots (*Marmota spp*), Pika (*Ochotona spp*), Hares (*Lepus spp*) and game birds like Snow cocks (*Tetragallus spp)* and Chukur Patridge, (*Alectoris Chukar*) (Schaller et al. 1989). Shehzad et al. (2012) recorded Siberia Ibex (70.4%), domestic goat (17.3%),Argali (8.6%) and one bird species Chukar (1.2%) as prey species in Mongolia. Oli et al. (1991) recorded Blue sheep (51.6%), Himalayan Marmot (20.7%), Royle's Pika (16%) and 13.6% of domestic spp. including Ox, Sheep, Goat, Horse and Yak in Annapurna Conservation Area (ACA) Nepal. Himalayan tahr, Musk Deer and Cattle were found to be the major prey species in diet analysis of Snow Leopard (Lovari et al. 2009) in SNP Nepal.

Bhardwaj et al. (2010) estimated relative abundance and habitat use of Blue Sheep in Gangotri National Park of India. They used 11 hill trails to estimate relative abundance parameter and recorded 120 groups with 1,184 individuals. They were found to be most

abundant wild ungulate.

Oli and Rodgers (1996) studied seasonal pattern in group size and population composition of Blue Sheep in Manang, Nepal. Where they found the overall mean size was 15.6, but it varied seasonally, with significantly smaller groups in winter than in other seasons. The mixed groups were most numerous in all seasons and there was no evidence of sexual segregation.

Kandpal and Sathyakumar (2010) assessed the distribution and relative abundance of mountain ungulates in Pindari Valley, India using trail sampling and scan count to estimate the distribution and relative abundance of mountain ungulates for Blue Sheep and Himalayan Tahr. For Musk Deer indirect evidences were used to determine presence and absence and relative abundance. The habitat map of the study area was prepared on GIS domain and the locations of sightings and signs were plotted to show the distribution pattern of mountain ungulates. The Blue Sheep were abundant than Himalayan Tahr and Musk Deer.

### 2.3 Corridor use by mammals

The research on use of Riparian corridors and vineyards by mammals in California examined 21 riparian corridors been used as corridors by mammals (Hilty and Merenlender 2004). Unbaited remotely sensed triggered cameras were used to determine occurrence of predator species. The mammalian predators' detection rates were 11 folds higher in riparian study area than the Vineyards which concluded the maintenance of riparian corridors.

Douglas Hamilton et al. (2005) researched on elephants to understand how mammals satisfy their need for space in fragmented ecosystem by using corridors to maintain viable population. They used GPS in 11 focal African elephants in Kenya and examined that unfenced elephants had distinct home sectors linked by travel corridors. The viability of many mammalian metapopulation may depend on linkage provided by corridors and animals move significantly faster along the corridors.

Khata biological corridor has been confirmed used by Bengal tiger, elephant and one-horned rhinoceros (WWF 2008). The khata corridor connects Bardia National Park with India's Katarniyaghat Wildlife Sanctuary.

## 2.4 Human wildlife conflict

The livelihoods of the communities in the Trans-Himalayan region of Nepal are largely dependent on an agro-pastoral system. This leads to the seasonal movement patterns of the livestock coinciding with the elevational movements of wild ungulates and Snow Leopard. The overlap leads to the predation of livestock to carnivore provoking the retaliatory killing by villagers which may significantly affect the viability of predator's numbers in that region (Aryal et al. 2014). Thus crop raiding and livestock depredation is a major source of conflict between humans and wildlife (Oli et al. 1994; Gillingham and Lee 2003). Loss of the livestock is a direct loss to herders as livestock are an important part of the local economy (Jones 2015). Due to loss of livestock native peoples have negative attitude towards wildlife and most of them are inclined towards the removal of problematic animals (Joshi 2018, Rai 2018). In all cases depredation was done by SL in Arun north critical habitat of Nepal SL are in major threat (Joshi 2018), Whereas Asiatic Black Bear in Arun South (Rai 2018).

A study done by (Ikeda 2004) in KCA found that 56% of the livestock in average were preyed on by Snow Leopard in 2001. This automatically creates the feeling of retaliation in the herders' mind. Pastoralists often have strong negative attitudes towards the SL, and retaliatory persecution in defense of livestock threatens its survival (Mishra et al. 2003).

The SL faces multiple threats in the Himalayan region, from habitat degradation, loss of prey, the trade in pelts, parts and live animals, and conflict with humans, primarily pastoralists (WWF 2006). As large carnivores are forced to live in increasing proximity to humans, competition for space and ungulate prey species lead to conflict. Such conflict can be the most important cause of adult carnivore mortality in and around protected areas, and most conflict incidents occur when animals range around and beyond protected area borders into human-dominated landscapes (Gurung et al. 2008).

Crop loss by wildlife is common in the adjoining areas of parks and reserves which are considered as one of the main reasons of park people conflict. Due to limited grassland areas within park boundaries and highly nutritious supplement of crop grown in the adjacent agricultural areas made possible that the wild animals may be forced to expand their defence on the peripheral agricultural land of the park (Sukumar 1990). Not all the individual of particular species raid the agricultural field. Only those animals with home range that encompasses cropland can do so (Jackson 1990).

# 3. MATERIALS AND METHODS

## 3.1 Study area

The study area Kimathanka Corridor (latitude 27° 50' 381" N and longitude 77° 15' 12" E) lies in the upper Arun valley in Bhotkhola Rural Municipality at Sankhuwasabha District. The study area lies inside the Makalu Barun National Park which was established in 1992. It is the world's only National Park which includes both tropical forest and snow-capped peaks. It extends from Arun valley in the south east located at an altitude of 435 m to peak of Makalu which has an altitude of 8,025 m and covers an area of 1,500 $km^2$ in Solukhumbu and Sankhuwasabha Districts. The National Park is surrounded by a Buffer zone (BZ) to the south and south east with an area of 830 $km^2$ (Carpner and Zomer 1996). Towards the northern side the National Park shares the international border with Qomolangma National Nature Preserve of the Tibet Autonomous Region. The National Park treasures inaccessible valley of the Barun Valley which has last remaining pristine forests and alpine meadows (Carpner and Zomer 1996). The location of study area and grids to be surveyed is shown in figure 3 while figure 2 represents Makalu barun national park and study area.

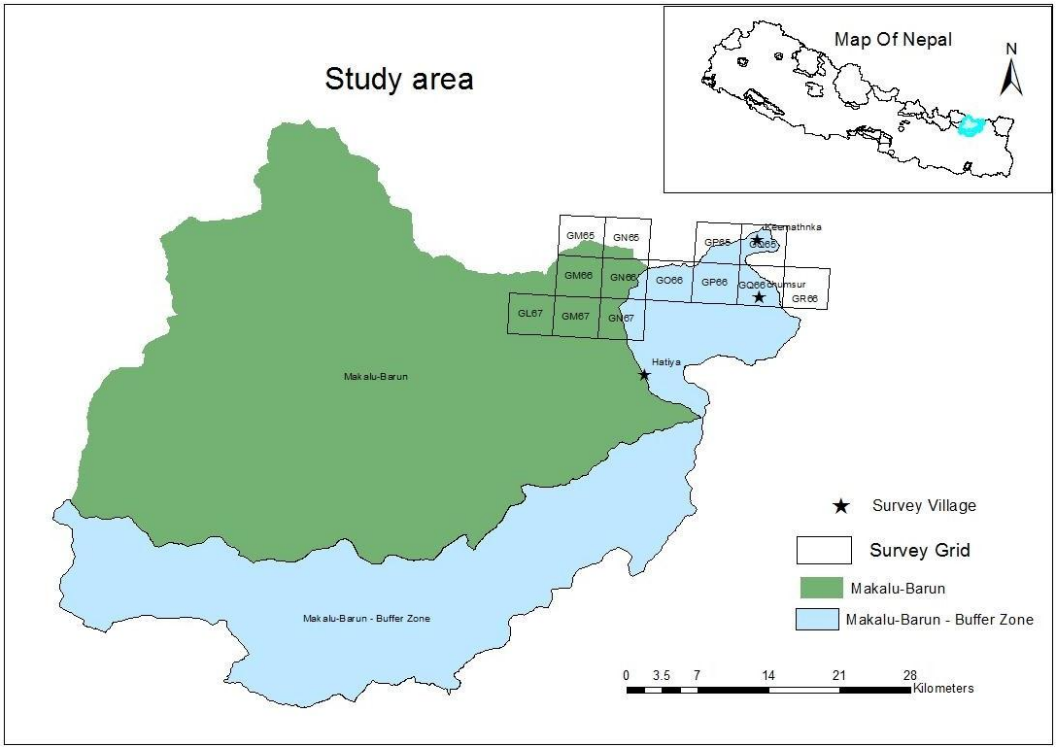


Figure 2. Map of study area

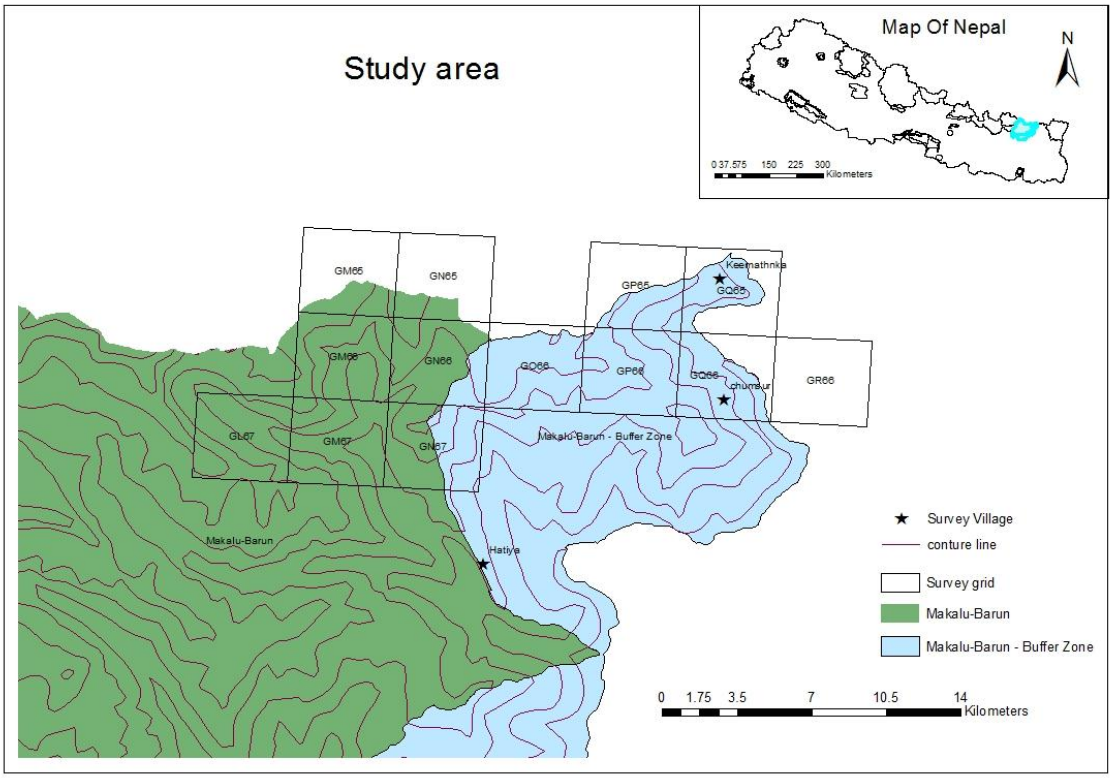


Figure 3. Location of Study area showing the grids to be surveyed

### *3.1.1 Survey villages*

#### *3.1.1.1 Hatiya*

Hatiya lies in Bhotkhola rural municipality of Sankuwasahba district situating in Koshi zone of North-Eastern Nepal. It lies towards South-East slope and has an altitude of 1592m asl. With GPS point 27°44'16"N and 87°20'16"E. The village is dominated by Bhotey, only two households were found to be of Dalits. The total population of the village is 1021 with 497 females and 524 males. The population belonging to age group (16-64) is the highest with 58% followed by age group (6-16), (>6) and (<64) with 22%, 13% and 6% respectively.

There is a single primary government school in village. Most of the children are sent to city areas for better education. Hence, there is a rare chance that you encounter children playing in groups unless there is long vacation. The literacy rate of Hatiya is 64% with only 4% of population educated higher than higher secondary level.

Main source of income is trade of cardamom followed by farming, animal husbandry and

others. Except for two dalits household, every other household have cultivated cardamom. The cardamom is sold for Rs.1000 per kg. Paddy (*Oryza sativa)*, millet (*Eleuusine coracana)*, potato (*Solanum tuberosum)* and maize (*Zea mays)* are major crops cultivated. The expenditure is mostly for education of the children in city areas followed by food, health issues and others. Cattle (*Bos Taurus)* were found to be reared mostly followed by Pig (*Sus scrofa)*, Goat (*Capra aegagrus hirccus)* and Poultry (*Gallus gallus domesticus)*.

#### *3.1.1.2 Chumsur*

Chumsur is a small village lying in the south-east slope with an altitude of 2516m asl. and GPS point 27°48'16" N and 87°25'05" E. It is situated in Bhotkhola rural municipality and is combined with Hong gong VDC of Sankhuwasabha district of Koshi Zone. Whole village is settled by janajati (Bhotey). The population of age group (16-64) is high with 54%, followed by age group (0-6), (6-16) and (>64) with 25%, 20% and 2% respectively.

There is a governmental school up to class three and for further studies the students need to leave the village. The literate percentage of the village is 32% as many of the villagers were taught through the informal education by Nepal government. Those literate people were able to write their names and some of them were able to read simple Nepali language books. The people educated less than class five were 25% and those educated between (6-12) were 17%.

All the villagers depend on agriculture and mostly cultivated crops are Potato, Rice, Millet, Naked-barley (*Hordeum vulgare)*and Maize. They have stopped cultivating maize nowadays. The main reason behind this was a person was found dead by Bear attack during guarding maize and no compensation from GoN. The agricultural products do not meet the needs of the people. They also cultivate Chiraito and sell it to earn money. The living standard of the people is low. They are far from the reach of the development infrastructures like road, health post, electricity, communication. They have to go either to China for buying the goods or come to Lingam and Chepuwa. Since there is no roads for transportation they carry goods themselves or by the mule. If they have to go to China for buying the goods then they need to walk one whole day and border is open only on Wednesday and Saturday. In case of Chepuwa and Lingam they also need to walk for a day but the products are expensive. Hence, they use the Chinese products rather than the Nepalese. They rear goat, ox, pig and Poultry. Animal rearing has been greatly reduced in the village due to the depredation by the wild predator in large numbers.

They are combined with the Honggong Village and counted as one. Both the villages are very far from each other. None are the representatives of the rural municipality. Living standards are very low. All houses are roofed with the bamboo mat and some with the tin. The telephone signals appears when the days are sunny and clear. Some of the people have migrated to some other parts of the country and some to India as well for better opportunities. People complained that they were living in the same country as other but still they are treated as if they do not belong here (Nepal).

#### *3.1.1.3 Kimathanka*

Kimathanka lies in the South-East slope with an altitude of 2557 m asl. with the GPS point of 27°51’23’’N and 87°25’05’’. It lies in Bhotkhola rural municipality of Sankhuwasabha district of Koshi zone and ranges from the bank of Arun River to the check post of National Park in Kimathanka. The population of age group (16-64) are large in numbers. The literacy is low as 35% of the peoples are illiterate and 14% are literate. They can read and write only and were educated by informal education by the government of Nepal. 30% of the people are educated up to class five, 18% up to 12 class and only 2% above 12 classes. There is a government school up to class five. The millet is cultivated to make chhaang and also to make alcohol. The millet is sold for high price in Kimathanka and China as well.

The main source of livelihood is trade and wage labour. The border is open every Wednesday and Saturday each week. Every person can visit China for about five hours. During those periods, the trade is done and the people engage in the wage labour as well. The people of the Nepal (Kimathanka) work in border areas of China. Since the China value of Chinese currency is higher than that of the Nepal, they earn more if they work there. They are paid 100 to 300 Fegur (1 Fegur= NRs 16) per day. Although the currency of China is called Renminbi, it's unit is called Yuan. People in Kimathanka term the Chinese currency as the Fegur. The border cities where the trade is done are Channga and Dendang. The people of the Kimathanka trade Yarsagumba, Lekali Garlic, Millet and hand crafts on regular basis whereas they trade Muga, Leeches, cardamom, and other wild medicinal herbs during the seasons of harvest only.

The Kimathanka is a trade hub for the Nepalese community in the Himalayan regions. During the trading season, the people from the western Himalayan regions also come to

Kimathanka for trade. In past marriage used to take place between the people of the two countries but it was reported that the girls were trafficked to China and Korea through fake marriages. So to prevent human trafficking, Nepalese authorities have set up some standard rules for such cross-boundary marriages, including the need of police reports and letters from the home ministry and Chinese Embassy in Kathmandu. Hence, cross boundary marriages are rare nowadays.

Cow, goats and poultry are most common livestock in the village. The domestic animals are reared for meat. The transhumance herding practise is followed; during the winter seasons the livestock are brought back to the villages whereas during the summer seasons the livestock are left to forage in the pasture lands of China i.e, 1 to 2 days far from Kimathanka.

The lifestyle of the people living in Kimathanka is extravagant. Almost all the people are addicted to some intoxicants. Women use some powder (tobacco like) to smell through their nose. Men take chhyang, alcohol and beer. Small children too take chhyang. Instead of water they consume soft as well as hard drinks there.

Every household in Kimathanka has solar power energy which was supported by the Chinese Government. They have also supported in building the police station and provided computers and other facilities inside the village area. They also have helped the school of Kimathanka by providing books, copies, desk benches and many more. There is a primary level school present in the village. For higher education the children move to Lingam and some to Khandbari. Chinese government has been very kind to the people in Kimathanka. There is a health post in the village run by Nepal government.

### *3.1.2 Climate*

Makalu Barun National Park lies in the eastern climatic zone of the Himalayas, where monsoon occurs from June to late September. On those months, annual precipitation within this region is generally high (4000mm). Precipitation is highly variable and strongly influenced by orographic effects associated with the complex mountainous terrain. The National Park are generally outside of the tropics, the deeply cut river valleys are characterized by tropical climatic conditions due to orographic blocking of cold winter air from central Asia. The tropical and sub-tropical zone is frost free, with average monthly mean temperatures above 18°c throughout the year for elevations below 1000m (Zomer et al. 2001).

### *3.1.3 Vegetation*

Makalu Barun National park exhibits a high diversity of forest types ranging from Dipterocarp monsoon forest to subalpine conifer. The types of forests are of following types:

- **Tropical forest**: It is found below the altitude of 1,000m. Sal forests are dominant here.
- **Subtropical forest**: It is found between 1,000 to 2,000m altitudes. The dominant vegetation found here are *Schima* and *Castonopsis.*
- **Lower and upper temperate forest**: The temperate forests are found between 2,000 to 3,000m with predominantly broadleaf evergreen species of Oak and Laure families and broadleaf deciduous forest of Maple and Magnolia.
- **Subalpine forest**: It ranges from 3,000 to 4,000m and has the dominant forests of Himalayan Birch, East Himalayan fir, Juniper and Fir.
- **Alpine Pastures**: The alpine pastures range above 4000m and have dwarf Rhododendron and Juniper, aromatic herbs and delicate wildflowers. The region above 5,000m comprises mainly rock and ice with little vegetation (Jha 2003).

### *3.1.4 Fauna*

The MBNP has a wide diversity of faunal species. There are 315 species of butterflies, 43 species of reptile, 16 species of amphibians and 78 species of fish (Jha 2003). Ornithologist have recorded 440 bird species ranging from eagles and other raptors to white- necked strokes and coloured sunbirds in National Park. There are 16 rare or protected birds species including Spiny babbler (*Turdoides nepalensis)*, Sultan tit (*Melanochlora sultanea*), Deep blue kingfisher (*Alcedo meninting*) etc (Bhuju et al. 2007). There are 88 species of mammals including Snow Leopard (*Panthera uncia*), Musk Deer (*Moschus chrysogaster*), Barking, Deer (*Muntiacus muntjak*), Ghoral (*Naemorhedus goral*), Wild Boar (*Sus scrofa*), Asian Golden cat *(Catopuma temminckii*), Red Fox (*Vulpes vulpes*), Hanuman Langur (*Semnopithecus spp*), Jungle Cat (*Felis chaus*), etc (Jha 2003).

### *3.1.5 Socio-economic Aspects*

Makalu Barun National Park extends in two districts namely, Solukhumbu and Sankhuwasabha. The buffer zone of MBNP was declared in 1999 and has an area of 830km$^2$. There were 12 VDCs with 6,000 households and 32,000 populations (Bajimaya 2006). Ethnic communities like Limbu, Sherpa, Bhotey, Gurung, Tamang are found as dominant. They speak their own mother tongue.

Occupation for living is livestock rasing and farming. They rear livestock and follow transhumance system of grazing. Livestock movement is between 3,000-5,000m elevation from May – September and in winter, they shift in lower elevation at 2,000m. The number of days spent in each pasture varies as it depends on availability of grass and weather. The collected hay in October is used as fodder in winter seasons when the livestock are at low elevations.

Farming is another day to day life doings. They cultivate crops like, millet, paddy, maize, barley, Cardamom etc. cardamom is one of the most important aspect for trade. They earn money through the trade of cardamom.

### *3.1.6 Tourism*

Makalu Barun valley has epic contrasting features which are believed to have pristine forest. The view of high waterfalls cascading into deep gorges is the attracting point for tourists. The waterfalls are followed by weather- beaten rocks rising proudly from lush green forest and the carpet of colourful flowers beneath the snow white peaks. The ecotourism was promoted as a way of expanding off-farm employment opportunities for local people while at the same time minimizing negative environmental impact. The Makalu Base Camp Trek is popular for tourists in MBNP. It is an ideal choice for avid trekkers and nature enthusiasts who seek solance and tranquillity in pristine natural habitat.

## 3.2 Methods

### *3.2.1 Ecological survey*

#### *3.2.1.1 Survey block design*

The survey was conducted by dividing the areas into survey grids of 4x4 km (16 $km^2$) (Jackson et al. 2005, Janecka et al. 2011) overlaid on the potential distribution of Snow Leopard habitat generated by the result of Snow Leopard surveys conducted by Department of National Parks and Wildlife Conservation (DNPWC) with support from WWF Nepal. Each grid had been coded with unique alphanumeric codes (e.g. GU65) to increase the flexibility of addition and deletion of grids as per the field situation respect to accessibility and Snow Leopard activity. Furthermore, the grids were scrutinized based on habitat suitability and field access in ArcGIS (Barber-Meyer 2012). Each grid, based on the Snow Leopard habitat availability was surveyed by sign methodology- looking for direct and indirect signs of Snow Leopard and its associated primary co-variates such as prey, co-predators and human impact (Barber-Meyer 2012). Other associated covariates like topography (aspect, slope, ruggedness) and habitat types were also recorded. If a survey grid is covered by 100% Snow Leopard habitat then the grid must be surveyed for 4 km. The survey scale was calculated based on the site access varied by severe ruggedness of Himalayan terrain. A simulation model was also run by GENPRES ver. 8 to calculate the adequate sampling occasion and number of survey grids required to ensure data fit in occupancy estimating models (single season correlated detection model, #sites- 47, #surveys- 20, #psi- 0.75; #p- 0.01, analyse-simulate by cohort, no. of simulation- 1000) (Hines 2006). The survey scale was subdivided into spatial replicate segments of 100 meters and to avoid spatial-auto correlation each recorded observation was not duplicated until the next segment is reached (Hines et al. 2010). The survey period for each grid was minimum 1 day for a single grid and may vary based on field situation.

Prior to the field survey, a local Focus group discussion (FGD) was conducted in the nearest settlement of the survey sites and specific discussion related to Snow Leopard's movement and activity centres was also be discussed. The survey in each grid was conducted in random location inside the grid (preferably from the edge) and an assigned km was surveyed. Preferably high Snow Leopard movement and activity sites were chosen to survey which are mostly trails, ridgelines, cliff trails and cliff bases (Jackson et al. 2005). Signs like pugmarks, faeces, scrapes, kill sites, mating calls, scent marks (urine

sprays) and direct sightings were recorded along with any wild animal's signs by handling G.P.S, camera and binocular. The details about the survey are listed in the table 1 given below:

Table 1: Survey grid information

| Total Grids | Nearest Settlements | Occupancy Grids |
|---|---|---|
| 13 | Hatiya<br>Chumsur<br>Kimathanka | GL67, GL65, GM67, GM65, GM66, GN65, GN66, GN67, GO66, GP65, GP66, GQ66, GR66 |

#### *3.2.1.2 Prey count method*

In this method the possible line transects were followed and the prey numbers were counted and recorded using the pre-prepared data sheets. Prey abundance was counted using fixed point count method from appropriate vantage point. The GPS and Binocular were used to count their number including age and sex structure. Both probable domestic and wild prey were counted in the study area. The indirect signs of Prey species (droppings, hoofmarks, dung, nest, scrapes, etc) were also recorded.

### *3.2.2 Socio economic survey*

Focus group discussion and household interview was employed for socio economic survey. Checklist and questionnaire for FGDs and household survey were prepared before the survey. Both checklist and questionnaire comply with the objectives and the guiding research questions provided under this study.

#### *3.2.2.1 Focus group discussion*

Altogether 3 FGDs were carried out one in each village. In each FGD, more than 9 participants were invited for discussions. Participant selection was done based on following criteria

1. Age should be more than 25 years (the assumption is that the participant of these group can well-acquainted with research site and socio-economic information we are looking for).

2. Only one participant from one household

3. Invite both male and female participants (The assumption here is that different gender have different kind of knowledge and experience)

4. Invite local government and other relevant stakeholder representative, if they exist in that village.

#### *3.2.2.2 Household Survey*

Sampling was done to determine the number of household to be surveyed. Sample size was determined by using sample size determination formula. Probability proportional to size or population was used to determine the number of sample to be selected in each village.

Sample size was determined at the confidence level of 95% with a marginal error of ±5% and response distribution of 50% and total number of households found in 3 villages of the study site.

Sample size calculation formula

$$n = \frac{NZ^2P(1-P)}{Nd^2 + Z^2\,P(1-P)}$$

Where,
n = Total sample size

N = Total number of households (sampling units)

d = Maximum acceptable error (Value used in this case is 0.05)

Z = Z-value and

P = Probability (Value used is 0.5 to give maximum sample size)

Based on the assumptions used for sample size determination, 102 households are selected for this study. After the determination of overall sample size, we have identified and present the sample HHs for each village using probability proportional to size principle in table 2.

Table 2: Possible sample size of each Survey village

| **Village name** | **Expected HHs** | **sample HHs** |
|---|---|---|
| Hatiya | 100 | 60 |
| Chumsur | 20 | 12 |
| Kimathanka | 50 | 30 |
| Total | 170 | 102 |

### 3.3 Data Analysis

Primary and secondary data were collected for the study from 23rd June 2018 to 2nd of August 2018. Primary data were collected by field survey on pre designed Grids, questionnaire survey, Focus group discussion and direct observation.

Secondary data were collected from MBNP office on various check posts, different journals, research articles, bulletins published from different offices and department, newspapers and book.

The collected primary and secondary data have been processed by statistical methods. Microsoft excel was used to analyse the data and results were presented in tables and charts wherever possible. Following formulas were used in calculation of:

Sign encounter rate: $\frac{Total\ signs\ of\ specific\ animal}{Total\ distance\ (km) walked}$

Per household crop loss in NRs: $\frac{Total\ loss\ of\ crop\ in\ NRs}{Total\ number\ of\ surveyed\ household}$

Per household livestock loss in NRs: $\frac{Total\ economic\ loss\ due\ to\ loss\ of\ livestock\ in\ NRs.}{Total\ number\ of\ surveyed\ households}$

# 4. RESULTS

## 4.1 Snow Leopard Habitat occupancy

Total 13 grids were designed for verification of Kimathanka corridor out of which only 10 grids were surveyed during the study period. A total of 21.6 km was walked inside the grids of total area 160 $km^2$. In each survey grid, one line transects was followed. The maximum distance walked on the single grid was 2.7 km and minimum distance walked was 1 km with an average of 2.16 km per grid. Since the field survey was conducted during monsoon season, there were quite a few challenges.

The indirect signs like faecal samples, scrapes, foot prints, etc were observed and captured in photographs with its GPS reading and noted down in the datasheet prepared. Total 14 wild animals were identified through indirect signs, direct sighting and vocalization. The encounter rates of those encountered animals during field survey were listed and calculated. (Annex 1)

Seven scats of Snow Leopard were encountered at Churpik Dada (GO66) and Lakshmi Pokhari (GN66) during the study period whose encounter rate was 0.324 per km with an elevation range of 4100-4200 m of alpine steppe habitat. The locations of those seven scat samples are listed below in table 3. Moreover, the GPS points were plotted in the study area and presented as figure 4 below.

Table 3: Location of Snow Leopard signs

| **Grid No** | **Location** | **GPS recordings** | | | **Habitat type** |
|---|---|---|---|---|---|
| | | **Latitude** | **Longitude** | **Altitude(m)** | |
| GN66 | Lakshmi Pokharai | 27.83372N | 87.30482E | 4202 | Alpine steppe |
| GO66 | Churpik Dada | 27.80878N | 87.31952E | 4188 | |
| GO66 | | 27.80889N | 87.31946E | 4187 | |
| GO66 | | 27.80959N | 87.32270E | 4185 | |
| GO66 | | 27.80892N | 87.31985E | 4187 | |
| GO66 | | 27.80892N | 87.31943E | 4185 | |
| GO66 | | 27.80980N | 87.32363E | 4208 | |

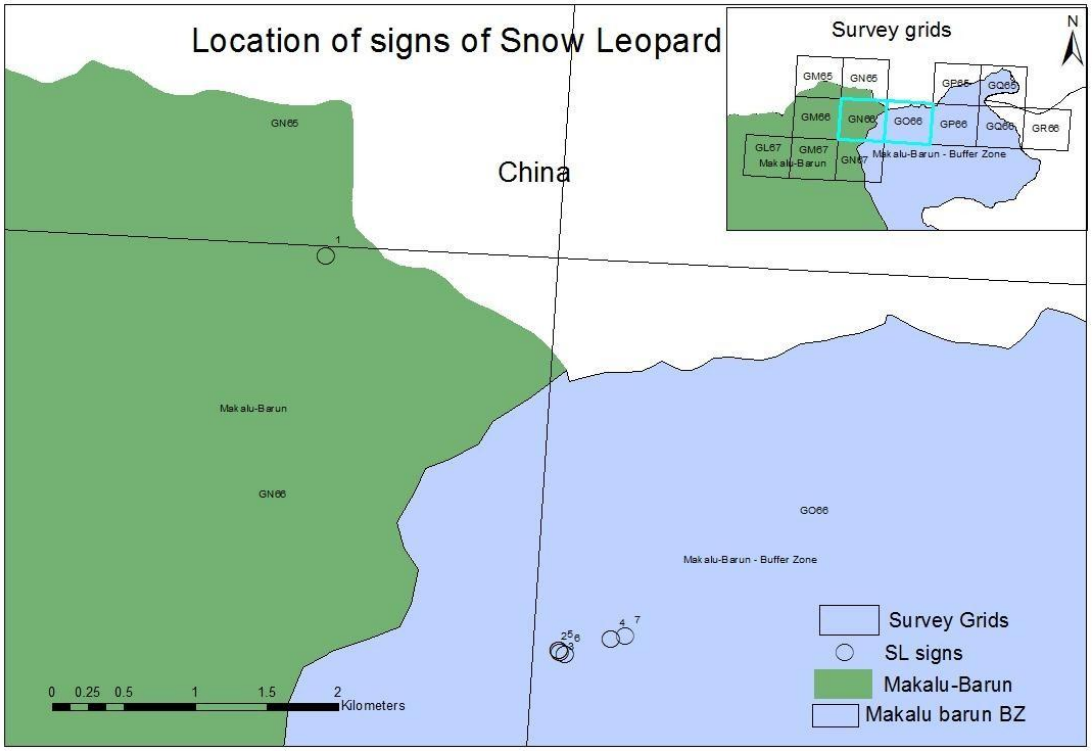


Figure 4. Enlarged view of grids with SL signs presence point

The sample size was very low to conduct the occupancy analysis for Snow Leopard but the Snow Leopard has been using small portion of the area under the survey as per interview with the livestock herders and other local people using those high pastures. The Household survey, FGD in the village nearby and random questions to the herders in the pastures claimed that they had seen Snow Leopard and its sign towards the Yangla Kharka and Lukchik (GL67 Survey Grid). Lukchik was inside the grid which we could not survey as the bridge that connected the survey Grid GL67 was swept away by flooding and erosion.

Twenty two scats and 11 pugmarks remained unidentified with their encounter rate 1.018 per km and 0.509 per km respectively. It is usually hard to identify the scats just by looking. It would be biased if those signs were randomly named based on hunch. Moreover, the signs were damaged by rains and the moisture made it even harder to identify but the unknown signs could be of Snow Leopard, Wolf (*Canis lupus*), Red Fox, Golden Jackal, Marten (*Martes),* Common Leopard (*Panthera pardus)* and domestic animals.

## 4.2 Prey Abundance

Survey of prey species was also carried out simultaneously with the occupancy survey. Ten grids were surveyed with an area of 16 $km^2$ each. A total of 23.1km was walked inside 160$km^2$. A single line transect was followed in each grid. During the survey period 14 prey species were encountered out of which five of them were domestic and the remaining were wild. The domestic prey species were Chauri, Dzo, Yak, Sheep and Goat while the wild prey species were Musk Deer, Wild Boar, Ghoral, Jharal, Snow Cock, Blood Pheasant, Danphe, Plain Blacked Thrush and Pika. The abundance of the directly sighted animals according to the age structure is listed in table 4 below.

Table 4: Abundances of directly sighted prey species with age structure in study area

| **Species** | **Female** | **Young** | **Yearling** | **Young male** | **Adult male** | **Unidentified** | **Total** |
|---|---|---|---|---|---|---|---|
| Chauri | 57 | 20 | 13 | 0 | 0 | 3 | 93 |
| Dzo | 0 | 0 | 3 | 14 | 60 | 7 | 84 |
| Goat | 20 | 8 | 23 | 15 | 5 | 10 | 81 |
| Snow cock | 2 | 2 | | | | | 4 |
| Yak | 13 | 5 | 2 | 1 | 3 | 0 | 45 |
| Blood Pheasant | 1 | 3 | - | - | - | - | 4 |
| Plain Black thrush | 1 | - | - | - | - | - | 1 |
| Pika | - | - | - | - | - | 1 | 1 |
| Wild Boar | - | - | - | - | - | 1 | 1 |
| Ghoral | 2 | 1 | - | - | - | - | 3 |

Total 317 numbers of individual preys of SL through direct sighting were counted. Among which the domestic animals were more abundant than the wild animals. Along with the recording of the directly sighted animals indirect signs were also recorded. The indirect signs like faecal samples, sound, hoofmarks, dung and nest were recorded. The encounter rates of the signs were listed below in table 5.

Table 5: Abundance of the signs of Prey species with their encounter rate

| S.N | Species | Scientific Name | Sign encounter rate |
|---|---|---|---|
| 1 | Jharal | *Hemitragus jemlahicus* | 0.277 |
| 2 | Cattle | *Bos taurus* | 0.370 |
| 3 | Ghoral | *Naemorhedus goral* | 0.185 |
| 4 | Goat | *Capra aegagrus hircus* | 0.138 |
| 5 | Musk Deer | *Moschus chrysogaster* | 0.046 |
| 6 | Sheep | *Ovis aries* | 0.231 |
| 7 | Snow Cock | *Tetraogallus spp* | 0.046 |
| 8 | Danphe | *Lophophorus impejanus* | 0.046 |
| 9 | Wild Boar | *Sus scrofa* | 0.509 |

The signs of Wild Boar were most frequent with its encounter rate 0.509 per km followed by cattle (0.370), Jharal (0.277 per km), Sheep (0.231 per km) and followed by others species. Since the survey time was monsoon season, the domestic animals were in summer pastures in high elevations and encountered the most in both direct sighting and the indirect sign recording. Types of signs encountered during study period were shown in figure 5.

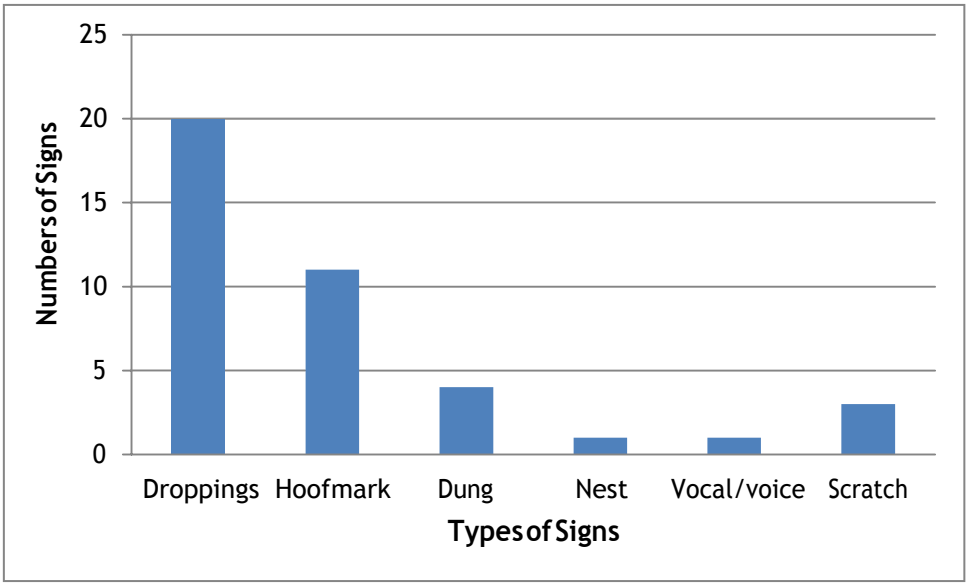


Figure 5. Types of sign of prey species encountered during survey

The droppings of the wild ungulates (20) were recorded the most followed by the hoofmark (11), Dung (4), scratch (3) and others. The droppings of the Jharal were found most followed by Sheep, Goat, and Musk Deer.

## 4.3 Human wildlife conflict

Every household have experienced varying degree of conflict with the wild animals in survey villages. The damages by wildlife invite conflict leading to negative attitude towards them. The difficulties faced by the people were crop raiding, livestock depredation and life threat.

### *4.3.1 Hatiya*

Total 60 households were surveyed for HWC data collection. Major difficulties due to wildlife in Hatiya were crop raiding and Livestock depredation.

**Crop depredation**

In total 87% of the households suffered from crop raiding by wild animals. The households that didn't suffered from crop raiding (13%) are those whose agricultural lands are in middle of whole agricultural lands or are in middle of the village. The crop depredation in Hatiya was calculated and presented in table 6.

Table 6: Table showing the active crop raider with respective crops their volume, cost and the percentage of household suffered by those animals in Hatiya

| **Animals** | **Crops** | **volume (kg)** | **NRs** | **HHs Suffered (%)** |
|---|---|---|---|---|
| Musk Deer | Millet | 853 | 1,13,730 | 10 |
| | Paddy | 147 | 14,700 | |
| Barking Deer | Potato | 200 | 10,000 | 63 |
| | Millet | 1151 | 1,53,463 | |
| | Paddy | 698 | 69,800 | |
| Large Indian Civet | Cardamom | 462 | 4,62,000 | 23 |
| Monkey | Maize | 1,574 | 1,57,400 | 52 |
| | Millet | 121 | 16,133 | |
| | Cardamom | 278 | 2,78,000 | |
| Black Bear | Maize | 255 | 25,500 | 8 |
| Sparrow | Paddy | 35 | 3,500 | 3 |
| Wild Boar | Millet | 90 | 12,000 | 8 |
| Total Economic loss (NRs.) | | | 13,16,226 | |
| Economic Loss Per Household (NRs.) | | | 21,937 | |

The deer was the most active crop raider which has affected 63% of the village by ravaging paddy, millet and potato followed by monkey (52%) destroying maize, millet and cardamom and Asian Palm civet (23%) destroying cardamom. They exactly knew which animal did the crop raiding by looking the way animals handled the crops during the raiding e.g. Bear accumulate the maize in one corner and starts eating. Mainly monkey and kala (Large indian civet) are threat to cardamom. Monkeys tear down the Cardamom plants whether it's young or adult whereas the kala (Large Indian civet) eats the fruits parts during night. Deer dig up the soil and eats potatoes. They even eat millet during the day. The most raided crop was Millet (2215kg), followed by Maize (1829kg), Paddy (880kg), Cardamom (740kg) and potato (200kg).

**Livestock depredation**

Livestock depredation was less in Hatiya as most of them do not rear animals in large numbers. Only 13% of the households have suffered from livestock predation. Black Bear and Snow Leopard were main predators for livestock (Table 7).

Table 7: Livestock depredation in Hatiya

| **Predator** | **Livestock** | **Number** | **Total economic loss (NRs.)** |
|---|---|---|---|
| Snow Leopard | Cow | 2 | 40,000 |
| Black Bear | Cow | 15 | 3,00,000 |
| | Goat | 2 | 16,000 |
| | Chauri | 4 | 1,00,000 |
| Total Economic Loss (NRs.) | | | 4,56,000 |
| Economic Loss per Household (NRs.) | | | 7,600 |

Black Bear was major threat to the reared animals. Twenty one animals were lost to Black Bear in 2017. The animal depredation was both during grazing in the pastures and near house. Mostly animals were predated upon on pasture lands.

Due to heavy crop depredation, 55% of people reported that they don't like to see wild animals while only 45% of them had positive attitude towards the wild animal's i.e, they only liked to see animals that don't hamper their crops and livestock. The people in Hatiya were much disappointed towards the animals. The animals raided their crops both in days and the nights. Killing is not allowed due to presence of the National park office with officers and the police officers. Crop raiding is high in the village. Still they have not claimed for relief as they think it is long and tiring procedure. People in Hatiya don't support the idea of National Parks. They blame National park for their losses as they are prohibited to kill wild animals which cause those losses.

According to the study, fencing (67%) was found to be the most effective method used to protect crops during the day followed by guarding by man (24%) and scare crow (7%), while fencing (45%), scarecrow (26%) and Noise (17%) were used as the effective methods during night. In Hatiya they do two types of fencing which are sapling and Chitro (Bamboo or Nigalo mat) fencing. In case of the livestock, guarding by human

(63%) followed by shed (23%), fire (4%) and fencing (4%) were used as the effective methods during the day whereas construction of shed (94%) and guarding by the human (6%) were used as the effective methods during nights. In spite of these methods being practiced, wild animals continue to depredate their crops and domestic animals.

### *4.3.2 Chumsur*

Twelve households were surveyed during study period. People suffer 100% crop raiding from wild animals like Barking Deer, Black Bear, Monkey, Ghoral and wild boar. The table 8 illustrate the percentage HHs suffering from respective animals.

Table 8: Active crop raider with respective crops and percentage of HHs suffered by wild animals in Chumsur

| **Animals** | **crops** | **% of HHs suffered** |
|---|---|---|
| Barking Deer | Millet | 100% |
| | Potato | 75% |
| | Naked Barley | 25% |
| Black Bear | Maize | 17% |
| Monkey | Maize | 17% |
| | Potato | 75% |
| Ghoral | Millet | 8% |
| Wild Boar | Millet | 25% |

Millet and potato are main crops cultivated in Chumsur. It was cultivated in every household and is also the highly depredated crops. The crops are raided both on day and night. Now they cultivate on lands that are near their houses and some small areas near Arun River, other lands were left fallow or abandoned. The economic loss per households by crop raiding in Chumsur is shown in table 9 whereas the economic loss per households by livestock depredation is shown in table 10.

Table 9: Total raided crops volume with its respective amount in Chumsur

| **Crop** | **Volume (kg)** | **Total economic loss** |
|---|---|---|
| Millet | 684 | 63,838 |
| potato | 240 | 4,000 |
| Naked-barley | 90 | 7,200 |
| Maize | 66 | Nobody sells |
| Total economic loss (NRs.) | | 75,038 |
| Economic loss per households(NRs.) | | 6,253 |

Table 10: Livestock depredation in Chumsur

| **Predators** | **Killed animals** | **Numbers** | **Total economic loss (NRs.)** |
|---|---|---|---|
| Common Leopard | Goat | 10 | 80,000 |
| Black Bear | Goat | 20 | 1,60,000 |
| Clouded Leopard | Goat | 15 | 1,20,000 |
| | Cow | 5 | 1,00,000 |
| Total economic loss (NRs.) | | | 4,60,000 |
| Economic loss per household (NRs.) | | | 38,333 |

Leopard and Black Bear depredated Goat during summer season while the Goat was in the community forest. Black Bear depredated 40% animals, rest 60% were depredated by Leopards.

The Fencing (Sapling and bamboo mat) and Guarding by the humans were equally reported to be effective for the crop protection. Livestock depredation was protected by people through noise (58%) and guarding by human (42%) during day while at night building the permanent shed were preferred more and effective protection was 80%. None of the respondents have permanent shed for livestock.

### *4.3.3 Kimathanka*

**Crop raiding**

Kimathanka is far from forest area hence frequent encounter with the wild animals are rare. Only 5% of the villagers have suffered from crop raiding and 23% from livestock depredation. The livestock were predated in high pasture lands in China during summer.

Table 11: Animals responsible for crop raiding with respective crops their volume and amount in kimathanka

| **Animal** | **crops** | **Volume (kg)** | **Total economic loss (NRs.)** |
|---|---|---|---|
| Black Bear | Maize | 45 | 4,500 |
| Red Monkey | Maize | 35 | 3,5000 |
| | Millet | 35 | 7,000 |
| Musk Deer | Millet | 90 | 18,000 |
| | Paddy | 345 | 34,500 |
| Wild Boar | Millet | 50 | 10,000 |
| Total economic loss (NRs.) | | | 1,09,000 |
| Economic loss per household (NRs.) | | | 2,725 |

Total 600kg crops were raided by wild animals whose monetory value is equal to NRs. 1, 09,000. The economic loss per household is 2725 per year (Table 12). The most raided crop was Paddy (345kg) followed by Millet (175kg) and Maize (80kg). Some villagers whose agricultural lands were at the edges of the village protect their crops by fencing and guarding by human during day and fencing, scare crow and guarding by human during nights.

**Livestock depredation**

Table 12: Livestock of Kimathanka depredated in 2017

| **Predator** | **Livestock** | **Numbers** | **Total economic loss (NRs.)** |
|---|---|---|---|
| Snow Leopard | Cow | 3 | 60,000 |
| Black Bear | Cow | 30 | 6,00,000 |
| Total economic loss (NRs.) | | | 6,60,000 |
| Economic loss per household (NRs.) | | | 16,500 |

The animals were depredated when they were in summer pasture. Black Bear was the main predator for livestock depredation with 90% depredation rate and 10% animals were depredated by SL. Economic loss per household was found to be NRs. 16,500. In a single year 33 cows were depredated whose monetory was equal to NRs. 6, 60,000 (Table 12).

# 5. DISCUSSION

## 5.1 Occupancy and distribution of Snow Leopard

The landscape analysis and mapping of Snow Leopard Habitat in EHL identified 14 habitat corridor and 11 critical sites among which Kimathanka corridor is one of them. Kimathanka corridor lies inside the buffer zone of MBNP. The MBNP has total 853 $km^2$ suitable habitats for Snow Leopard (Forrest et al. 2017). Recent satellite telemetry study carried out in KCA also substantiated the functionality of Kimathanka corridor (SLEMP 2017). Snow Leopards highly cryptic colouration, elusive nature, solitary behaviour and sparse distribution in remote and inaccessible mountain range make the survey extremely difficult. So, it is a perfect subject for radio telemetry (Jackson 1996) but it is costly. Hence, sign survey method was applied for the verification of identified Kimathanka corridor.

During the study period 10 out of 13 grids were visited and followed 10 line transects with a total length of 21.6 km (Mean transect length was 2.16 km) and total area 160 $km^2$. Forty six carnivore signs were collected, out of which seven Scats sample were identified as the signs of Snow Leopard. Twenty two scats samples and 11 pugmarks remained unidentified.

Similar sign survey method was conducted in northern Arun east critical habitat and Thudam corridor of Nepal by Lamichhane (2018) in 12 grids of 16 sq. km which resulted in 10 signs of SL from five of the grids. Same method was applied in Mongolia (McCarthy and Mukhtsag 1997) where 23 survey sites were visited and 102 transects were followed with 101.1 km total length to record 933 scrapes, 623 faecal sample and 62 scent sprays. The study in upper Indus valley on SL sign abundance resulted about 1.3-2.9 scrapes per km from valley floor (Fox and Chundawat 1998). Various studies on Snow Leopards were conducted in Nepal using sign survey method. Study conducted in LNP (Khatiwada 2004) identified 90 signs of Snow Leopard collected from five survey block with 25 transect of total length 1250 m. Upadhyay (2010) conducted similar survey in upper Mustang and found total 200 signs (45 Pugmarks, 93 Scrapes, 49 Scats, 10 Urine Sprays, 1 rock scent, 1 hair sample and 1 kill) of SL in four survey blocks with 33 transect of 18.47 km length. The revival of extinct population of Snow Leopard was reported by the survey which started from 2004 in Sagarmatha National Park using sign survey methods. They followed 24 transects in 33 sites and discovered 56 Snow Leopard

Signs and 17 signs incidentally in other areas (Ale et al. 2007). Khatiwada et al. (2007) followed 36 line transects of total length 15.21km in three survey blocks and collected 104 signs of SL (77 Scrapes, 20 Scats, 2 Scent marks, 3 Pugmarks and 2 hair) to conduct survey of SL and Blue Sheep in KCA.

The signs encountered during this survey period were low because the survey was conducted in monsoon season. Due to rainfall the difficult terrain of Snow Leopard was hard to transverse and had a high chance for the signs to be damaged. Also, rainfall limited the access to the most potential Snow Leopard sites as flooding swept away the bridge that connected the sites. Moreover, when the survey is conducted in warmer season there is a high risk of signs being destroyed by the herds of livestock as they are in summer pastures at high altitudes (Fox 1989). This study was conducted for single season in a small area. Hence, this study cannot give a whole picture of MBNP and cannot relate to other seasons.

The results would have been more fruitful, if it could be compared with the previous findings of same sites. But this wasn't possible, as there was no previous study in the same site. A single sign survey rarely provides answers to the questions in various aspects. An advanced study in proper season should be conducted in order to properly study about the SL. In survey grid GO66, most of the signs were encountered because of ideal physical features of landscape where predator can easily view prey and attack easily.

## 5.2 Prey abundance

Fourteen types of prey species both wild and domestic were identified in this study conducted in 10 survey grids with total area 160 $km^2$ and 10 surveys line transect of total length 21.6 km. The directly sighted species were counted from appropriate vantage points and indirectly signs were recorded and encounter rates were calculated. Jharal, cattle, Ghoral, Goat, Sheep, Musk Deer, Snow Cock, Danphe, Wild Boar were recorded through signs with the encounter rate of Wild Boar (0.509 per km) being the highest followed by Cattle (0.370 per km), Jharal (0.277 per km), Sheep (0.231 per km) and others. The species identified as prey of the Snow Leopard in this study are similar with others studies (Devkota et al. 2013 and Oli et al. 1993).

The domestic animals were encountered often as compared to the wild animals. The

rainfall greatly affected the movements of wild animals. The signs of wild ungulates were only observed around their shelter. Every shelter of the ungulates were impossible for us to reach hence, study in monsoon season was disadvantageous for this survey. Moreover, the fog during the survey period decreased the visibility of the animals in study area. This study counted larger domestic animals as the prey species of the Snow Leopard as the diet analysis in different regions have concluded presence of Cow, Dzo/Dzomo, yak, Horse, Donkey in diet of SL (Anwar et al. 2011, Bagchi and Mishra 2006, Oli et al. 1993).

The presence of livestock has both pros and cons for SL. They facilitate the Snow Leopard by their presence as they may be potential easy prey in lax herding practise, but in contrast degrade the pasture lands and compete with wild ungulates which are potential base for Snow Leopard survival.

## 5.3 Human wildlife conflict

### *5.3.1 Crop raiding*

Crop raiding and Livestock depredation are serious yet the most common reason of HWC (Strum 1994, Gillingham and Lee 2003). The residents in the buffer zone of MBNP are victims of conflict (Ghimirey et al. 2018). The economic loss per households per year in Hatiya (NRS. 21,937) is higher than Chumsur (NRs. 6,253) and Kimathanka (NRs. 2,725).This estimated economic loss does not include direct losses to other agricultural products such as pulses, Vegetables and fruits and indirect economic losses of the farmers for their time spent in raising crops, surveillance or cost of other crop protection strategies.

This crop raiding is considerably higher in three villages than the loss per household experienced by the farmers of LNP (NRs. 2,000) (Regmi and Kandel 2008) but lower (NRs. 60,199.74) than in buffer zones of MBNP on Assamese Macaque conflict (Ghimirey et al. 2018). Average loss due to crop damage in 2017 was NRs. 11,553 in Arun east of Taplejung district (Shrestha 2018) which is higher than Chumsur and Kimathanka but less than Hatiya.

Such considerable differences in the amount could be because of high value cash crop of buffer zone of MBNP (Ghimirey et al. 2018) cardamom (1Kg Cardamom=NRs. 1000). The reason behind the high economic loss per household (NRs. 21,937 per year) in Hatiya

is also due to same reason. People in Chumsur and Kimathanka do not plant cardamom hence they have less economic loss through crop raiding.

In Chumsur, due to fear of crop depredation, hectors of farmland, usually isolated land parcels which are far from the settlement and surrounded by or adjoining to forests, were found to be fallow, abandon and / or left as ranch throughout the study area. Hence, the crop production itself is low with less economic loss per household (NRs. 6,253) per year. Moreover, because of the fear of Black Bear, they have stopped cultivating Maize.

In Kimathanka, crop raiding by wildlife was rare inside the village as village is large and the farm lands are near to the settlements. The paddy is raided the most in comparison to other because they cultivate paddy near the bank of Arun River which is at the edge of the village. Hence the economic loss per household per year in Kimathanka is NRs. 2,725 per year.

### *5.3.2 Livestock depredation*

Animal husbandry is main source of livelihood in Himalayan region. Economic loss per household per year in Chumsur was higher (NRs. 38,333) than Kimathanka (NRs. 16,500) and Hatiya (NRs. 7,600). The Black Bear was blamed (Hatiya 92%, Chumsur 40% and Kimathanka 90%) for livestock losses in survey year. The study in Upper Mustang estimated economic loss of US$ 44213 in two year period and 75% of the losses were attributed to SL (Aryal et al. 2014). Similarly, the economic loss per household is less in the study conducted in ACA, where the livestock predation per household was US$ 95 in 2009 and US$ 42 in 2010 with Leopards blamed for 94.9% of the losses (Koirala et al. 2012). The economic loss per household per year (US$ 1112.54) in Panchase area (Adhikari et al. 2018) was higher than Hatiya and lower than Chumsur and Kimathanka.

In this study, livestock were depredated in summer pasture as Seasonal movement patterns of livestock, from higher to lower elevations, coincided with elevation movements of wild ungulate prey and predators. This leads to habitat overlap and competition between prey species (Aryal et al. 2014).The loss of livestock to Snow Leopard is mostly during June to September after livestock arrives in summer pastures at high altitudes as the security is less as compared to the winter pastures. Various studies

around world support results of this study i.e livestock depredation by Snow Leopard and other wild Predators (Oli 1991, Aryal et al. 2014, Oli 1994, Anwar et al. 2011).

The study area was buffer zone of MBNP with the National Park office in village hence during the questionnaire survey people hesitate to provide information about the poaching, setting traps and retaliatory killing of wild animals. But in private conversation with the police officers, they shared that poaching is being carried out secretly. They know that the poaching is being done but cannot do anything as they have to live in that village (Security issue). Moreover, people provide various excuses for poaching. While interacting with the people they informed us that, in the name of fencing some of them plant the trap for animals. They trapped the animals then kill them and bring meat during night by removing the skin in forest to avoid evidences of the kill. Hence, information regarding the human conflicts was not recorded.

### 5.4. Management Implication

Most of the areas under the survey were buffer zone and core areas of MBNP. Although people were illiterate, they were aware about the National Parks and its rules which they were afraid of. There were many loop holes in the formulations of the rules of MBNP. We encountered many people who were in search of the Yarsagumba without the permission from MBNP. During survey period, many people had view that the officers of the National Parks are protecting their animals in papers and posters only; as they were unaware about the secret illegal activities going on inside the park. The laws and policies regarding the wildlife should be enacted rather than making it limited to the papers only.

The crops were highly depredated by the wild animals in the buffer zones. The locals living in those buffer zones are highly dissatisfied by the National Park, and they blame National Park for not giving permission to kill problematic and most abundant animals. The locals in the study area have negative attitude towards wild animals, and were in view that they belong to the NP. Public participation should be involved in the mass awareness programs and question answer session should be held stating the problems and its solution in the local levels.

# 6. CONCLUSION AND RECOMMENDATIONS

## 6.1 Conclusion

The identified corridor was verified using sign survey method. Total 46 carnivore signs were observed and recorded, of which seven signs (Scat) were identified as the signs of Snow Leopard (encounter rate=0.324 per km) in grids GO66 and GN66.

The directly sighted prey species were counted from appropriate vantage point in line transects. Eleven prey species were observed during study period. Those prey species were counted using 10× binocular. During line transects walk, the indirect signs of nine prey species were identified and recorded in data sheet. Wild Boar was more abundant with its encounter rate 0.509 per km.

Crop raiding and livestock depredation were the main reason behind HWC in buffer zone of MBNP. Economic loss due to crop raiding by wild animals in Hatiya was found to be higher than Chumsur and Kimathanka; while economic loss due to livestock depredation was higher in Chumsur followed by Kimathanka and Hatiya.

## 6.2 Recommendations

From the survey experiences following recommendations were made:

a) Occupancy survey by sign survey method is favourable in autumn and spring seasons in the Himalayas.
b) The mass awareness should be done with full public participation describing pros and cons of wildlife. The Schemes about compensations should also be made clear.
c) Locally available alternatives for controlling human wildlife conflicts should be utilized. People in Hatiya informed that during the blooming of certain types of plants in forest the wild ungulates rarely enters the village. Hence the authorities of National park should focus on afforestation of such plants to decrease human wild life conflict.

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# PHOTO PLATES

Plate : 1

Landscape of study area

Plate : 2

Researchers in action (Scat recording)

Plate : 3

Goats in Summer Pastures (4000m)


Plate : 4

Old scat of Snow Leopard

Plate : 5

Pugmark of Bear

Plate : 6

Ghoral

Plate : 7

Household survey (Kimathanka)

Plate : 8

Focus Group Discussion (Chumsur)

Plate : 9

Musk Deer Dropping

Plate : 10

Foggy Weather (Cattle 4200m)

Plate : 11

Plain Blacked Thrush

Plate : 12

Blood Pheasant

Plate : 13

Yak

Plate : 14

Survey Team

# APPENDICES

Table 1: list of wild animals encountered during study period

| S.N | Species | Frequency | Encounter rate |
|---|---|---|---|
| 1 | Bear | 3 | 0.138 |
| 2 | Blood Pheasant | 4 | 0.185 |
| 3 | Danphe | 1 | 0.046 |
| 4 | Dhole | 1 | 0.046 |
| 5 | Ghoral | 4 | 0.185 |
| 6 | Jharal | 6 | 0.277 |
| 7 | Martin | 1 | 0.046 |
| 8 | Musk Deer | 1 | 0.046 |
| 9 | Panda | 1 | 0.046 |
| 10 | Pika | 1 | 0.046 |
| 11 | Plain blacked Thrush | 1 | 0.046 |
| 12 | Snow Cock | 1 | 0.046 |
| 13 | Snow Leopard | 7 | 0.324 |
| 14 | Unidentified Pugmarks | 11 | 0.509 |
| 15 | Unidentified Scat | 22 | 1.018 |
| 16 | Wild Boar | 11 | 0.509 |

## हिउँ चितुवाको सम्भावित बासस्थान र जैविक मार्गमा पारिस्थितिकीय सर्वेक्षण
## Ecological survey of snow leopard's critical habitat and potential corridor, ECL

**डाटाशीट: अकुपेन्सी सर्वेक्षण**
**Datasheet: Species Occupancy**

ग्रिड न/Grid no: _____ रेप्लिकेट नं. (Replicate)_____ स्थान/Location: _____ मिति: _____

हिठेको बाटोको प्रकार (Feature followed)_____ बासस्थान (Habitat type): _____

प्रेक्षक/Observers: _____ जि.पि.एस.नं.: _____ समुह नं. _____ समुह लिडर: _____

सुरु जी.पी.एस/Start GPS: Waypoint _____ N _____ E _____ उचाई (मि.) :- ..... सुरुको समय/Start time: _____

अन्तिम जी.पी.एस/End GPS: Waypoint _____ N _____ E _____ उचाई (मि.) :- ..... सकिएको समय/End time: _____

| (खण्ड) (Segment) | (वे प्वाईन्ट) Way point | GPS Coordinates | मांशाहारी प्रजाति Carnivore Species | | शाकाहारी प्रजाति / चिन्हको प्रकार Herbivore Species (Sign type) | | चिन्ह भेटिएको जमिनको कडापन Sign's surface firmness | | | हिडेको बाटोको प्रकार Trail type | उबरखाबर Ruggedness | | | | मोहडा Aspect | | | | बासस्थान Habitat | टिप्पणी Remarks फोटो आइ. डी Photo ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Species प्रजाति | Sign type चिन्हको प्रकार | Species प्रजाति | Sign type चिन्हको प्रकार | Hard कडा | Medium मध्य | Soft नरम | | High अत्यन्त | Moderate मध्य | Rolling पहिरो | Streambed खोला | SW दक्षिण पश्चिम | SE दक्षिण पूर्व | NW उत्तर पश्चिम | NE उत्तर पूर्व | | |
| | | N: E: | | | | | | | | | | | | | | | | | | |
| | | N: E: | | | | | | | | | | | | | | | | | | |
| | | N: E: | | | | | | | | | | | | | | | | | | |
| | | N: E: | | | | | | | | | | | | | | | | | | |
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| | | N: E: | | | | | | | | | | | | | | | | | | |
| | | N: E: | | | | | | | | | | | | | | | | | | |

Note: हिडेको बाटोको प्रकार (Trail type): रिजलाइन (Ridgeline)-R, खोलाकिनार (Streambed)- S, बाटो (Common trail) (T), भीरको बाटो (Cliff trail), घाँसेमैदान (grassland) खोल्सी (Creeks), बासस्थान को किसिम: हिमाली घासेमैदान (हि), झाडीमैदान (झा), सुक्खा क्षेत्र (सु), उप-हिमाली वन (उ) मांसाहारी जन्तु/Carnivore species: हिउँ चितुवा, ब्वाँसो, रातो फ्याउरो, कालो भालु, चितुवा, ढोले, स्याल, अरु बिरालो प्रजाति, अपरिचित, शाकाहारी जन्तु/Herbivore species: नाउर, फ्याउमुसो, कस्तुरी मृग, घोरल, थार, झारल, बँदेल, रतुवा, खरायो, बाँदर, लंगुर, दुम्सी, अपरिचित संकेतको किसिम/Sign type: दिसा / गोबर Dung/Scat (D), जनावरको पाइला (पा) Track (T), कोतारेको निशान (को ) Scrape/scratch (S), आवाज (आ) Call (C), प्रत्यक्ष देखेको (प्र) Direct Sighting (DS) अन्य (O),

**Prey species survey Datasheet**

Surveyor Name: ……. Date: ……..

Grid No: …….. Weather: ……. District: …….

| S.N | Place | Species | Female | Young | Yearling | Young Male | Adult male | Unidentified | Habitat type | GPS | Aspect | Distance to cliff | Elevation | Photo ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
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- Young: 1 years or less, Yearling: 1 yrs. -2 yrs., Young Male: 2 Yrs. – 4 Yrs. , Adult Male: 4 Yrs. and above

## Questionnaire for Household survey

1. Personal information of the respondent:

| | | | |
|---|---|---|---|
| 1.1 Form no.: | | 1.2.Name of interviewer | |
| 1.3. Date | | 1.4.Name of Gaupalika: | |
| 1.5. Ward no. | | 1.6.Name of village | |
| 1.7. Name of respondent | | 1.8.Gender of respondent | Male=1 Female=2 Others=3 |
| 1.9. Name of head of the family | | 1.10. Gender of head of the family | Male=1 Female=2<br>Others=3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.11 Ethnicity | B/C/T=1 Janjati=2 Dalit=3 Others (Specify)……. | | | | | |
| 1.12.1 HH head marital Status | Married=1 Unmarried=2 Widow=3 Divorced=4 | | | | | |
| 1.12.2 No. of family member | Gender | Age | | | | Earning members |
| | | <6 | 6-16 | 16-64 | >64 | |
| | Male | | | | | |
| | Female | | | | | |
| 1.13 Education | Gender | Illiterate | 0-5 | 6-12 | >12 | Literate |
| | Male | | | | | |
| | Female | | | | | |
| 1.14 Duration of stay in this village | <10 years=1 | | | >10 years=2 | | |
| 1.15 Wellbeing Status | Which of the Following Status your family Categorized<br>1. Better Off (Well off)<br>2. Medium<br>3. Poor<br>4. Ultra Poor<br>5. Don't Know<br>6. Not Done | | | | | |

1. Socio-economic status of communities

a) What are the sources of livelihood?

| SN | Sources of livelihood | Yes=1 No=0 | Type** | Extent*** | Rank* |
|---|---|---|---|---|---|
| 1 | Agricultural farming | | | | |
| 2 | Animal husbandry | | | | |
| 3 | Tourism | | | | |
| 4 | Trade | | | | |
| 5 | Government job | | | | |
| 6 | Private job | | | | |
| 7 | Wage labour | | | | |
| 8 | Skill-based work (Sipmulak kaam) | | | | |
| 9 | Remittance | | | | |
| 10. | Others | | | | |

* indicates rank the sources in decreasing rank i.e. 1=highly important; 2=Less important than 1; 3=Less important than 2 and same follows to rank 4, 5.

** indicates type of respective sources. For eg: Agriculture: name of crops. Livestock: Name of livestock. Tourism: type of involvement in case of tourism – homestay, guide, porter etc.

*** Record as applicable. Indicates area / quantity of production in case of agriculture. Numbers in case of livestock.

Human-wildlife interactions

A. Do you see wildlife in your area? Yes=1 No=0

B. If yes, what of the following species?

i. Brown Bear
ii. Clouded Leopard
iii. Common Leopard
iv. Dhole/ Wild Dog
v. Golden Jackal
vi. Asiatic Black Bear
vii. Grey Wolf
viii. Red Fox
ix. Snow Leopard
x. Wild Boar
xi. Blue Sheep
xii. Himalayan Goral
xiii. Himalayan Marmot
xiv. Himalayan Serow
xv. Himalayan Tahr
xvi. Mountain Weasel
xvii. Musk Deer
xviii. Royle's Pika
xix. Nepal Gray Langur
xx. Rhesus Macaque
xxi. Others (specify)…

C. Do you think they are beneficial to you? Yes=1 No=0

D. 1) which wildlife would you like to see around?

i. Brown Bear
ii. Clouded Leopard
iii. Common Leopard
iv. Dhole/ Wild Dog
v. Golden Jackal
vi. Asiatic Black Bear
vii. Grey Wolf
viii. Red Fox

ix. Snow Leopard

x. Wild Boar

xi. Blue Sheep

xii. Himalayan Goral

xiii. Himalayan Marmot

xiv. Himalayan Serow

xv. Himalayan Tahr

xvi. Mountain Weasel

xvii. Musk Deer

xviii. Royle's Pika

xix. Nepal Gray Langur

xx. Rhesus Macaque

xxi. Others (specify)…

2) Why?

1. Increase knowledge by seeing and knowing different type of animals
2. Receive funds for development
3. Sign of healthy environment
4. Earn cash from selling photos
5. Attract tourists
6. My family members receive stipends or scholarships
7. Get employment
8. Recreation
9. Aesthetic value
10. Spiritual and religious value
11. Education value
12. Cultural heritage values
13. Inspiration

E. 1) Do you face losses due to wildlife? Yes=1 No=0

2) If yes, what kind of problems you face with wildlife?

1. Livestock depredation
2. Crop raiding
3. Threat to safety/security
4. General destruction
5. Spread diseases
6. Causes overgrazing

F. 1) If crop loss, what type of crops and extent, and which wildlife are responsible?

| Wildlife | Names of crops | Quantity (mana, pathi, muri, kg) | Loss amount (NPR) | Time (day/night/both) if applicable, and season |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

2) If livestock loss, which livestock were killed and by which wildlife?

| Wildlife | Total number of animals killed and type | No. of attacked animals and type | Age of attacked animals | Location of attack (corral, near home, while grazing in community/govt land) | Attack season | Time (day/night/both) |
|---|---|---|---|---|---|---|
| Snow Leopard ( Simu | | | | | | |
| Himalayan Wolf ( Chengu) | | | | | | |
| Common Leopard | | | | | | |
| Red Fox | | | | | | |
| Wild dog (Dhole) | | | | | | |
| Others | | | | | | |

G. What are the methods or systems you used to protect your crop/livestock against the wildlife?

| S.No | During day | Effectiveness (Rank - 1 to 5) * | During night | Effectiveness (Rank- 1 to 5)* |
|---|---|---|---|---|
| | Crops | | | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| | Livestock | | | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

* indicates 1= Highly effective, 2= effective, 3=Medium, 4= not effective, 5= don’t know