PATTERNS, CAUSES, PERCEPTIONS AND COSTS OF HUMAN LARGE CARNIVORE CONFLICT IN THE CHITWAN NATIONAL PARK, NEPAL

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Institute of Science and Technology

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2021

DECLARATION

I hereby declare that the work presented in this thesis entitled **"Patterns, causes, perceptions and costs of human large carnivore conflict in the Chitwan National Park, Nepal"** has been done by myself, and has not been submitted elsewhere for the award of any other degree. All the sources of the information have been specifically acknowledged by references to the author(s) or institution(s).

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This thesis submitted by Ms Parwati Tiwari entitled **"Patterns, causes, perceptions and costs of human large carnivore conflict in the Chitwan National Park, Nepal"** has been approved as a partial fulfilment of the requirements of Master's Degree of Science in Zoology with special paper "Ecology and Environment".

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LIST OF ABBREVIATIONS

BNP	Bardia National Park
CNP	Chitwan National Park
DHM	Department of Hydrology and Meteorology
DNPWC	Department of National Parks and Wildlife conservation
GIS	Geographic Information System
GLM	Generalized Linear Model
GPS	Global Positioning System
HLCC	Human Large Carnivore Conflict
KTWR	Koshi Tappu Wildlife Reserve
PA	Protected Areas
ShNP	Shuklaphanta National Park
TAL	Terai Arc Landscape
US$	United States Dollar

ABSTRACT

One of the major management problems in and around protected areas is intensifying conflict of local people with wildlife, especially large carnivores. Livestock depredation and human fatalities caused by attack of carnivores are found to be serious obstacle in conflict management. This study aims to explore the patterns, costs, causes and perceptions of human large carnivore conflict in Nawalpur area of Chitwan National Park. Pattern of livestock loss and human casualties due to large carnivores (*Panthera tigris* and *Panthera pardus*) were analysed using the secondary data reported to Chitwan National Park since 2001 to 2019. Total 60 pugmarks were identified from sign survey out of which 38 were of tiger and 22 were of leopard which showed the occurrence of carnivores around human residence. During 19 years of study period, total 521 incidents caused by large carnivores was reported which include 33 human casualties and 488 livestock depredation. Tiger was responsible for maximum conflict incidents in Nawalpur. Total US$17524.41 has been spent as relief for human deaths and injury whereas US$ 13702.18 has been used to compensate livestock depredation in Nawalpur area by Chitwan National Park. Questionnaire with 150 victims of large carnivore conflict revealed loss of 238 livestock and avian stock and four human casualties. Economic loss of 44327.59 US$ due to livestock depredation was estimated from questionnaire survey where per household loss was found to be 295.51US$. Conducting awareness program about the compensation scheme of government and educating local communities about large carnivores, their behaviour and wildlife conservation would be helpful to minimize conflict in the study area.

1. INTRODUCTION

1.1 Background

Human large-carnivore conflict (HLCC) is increasingly significant challenge to the conservation practitioners. Conflict occurs when human and wildlife has adverse effect on one another due to spatial overlap or competition for resources (Suryawanshi *et al.*, 2013). Human large carnivore conflict becomes serious when human casualties and livestock depredation are involved in life of local community (Bhattarai and Fischer, 2014). Bengal tiger (*Panthera tigris*) and Leopard (*Panthera pardus*) are the main conflict causing large carnivores found only in few protected areas and adjoining forests of lowland Nepal (Jnawali *et al.*, 2011). Similar type of diet requirement by these species (*Panthera tigris* and *Panthera pardus*) might assist in reducing their numbers. Studies in diet composition of tiger and leopard in Chitwan reveals prey preference of these species (Bhattarai and Kindlmann, 2012). Tiger favours for large and medium sized prey whereas leopard favour small sized prey and also sometimes medium sized. Competition for medium sized prey in scarcity of large prey impels leopards to proceed towards peripheral areas where easy encounter with local and their livestock is possible anticipating carnivore conflict (Karanth and Sunquist, 2000). Human intrusion in habitat of wild prey species causes decrease in prey abundance for tigers in the terai region of Nepal (Barber-Meyer *et al.*, 2013). HLCC has aroused a global decline in population of large carnivores (Koziarski *et al.*, 2016). Large home range and huge diet requirement of large carnivores might be the main reason of conflict (Inskip and Zimmermann, 2009). Competition of carnivores with humans for spatial and resource requirement can have significant economic impacts. The aggressive nature of carnivore can sometimes kill humans which generates the antagonistic behaviour towards the presence of carnivores near human residence (Lagendijk and Gusset, 2008).

Living very closely to humans, fights for space and resources, leading conflict can be the main cause of adult carnivore mortality in and around protected areas. And the close border between human residence and protected areas is hotspot for conflict (Gurung *et al.*, 2008). In Nepal, wildlife conflict is considered as major problem in many protected areas and community forest as local people are unable to access the local resources which they were using long time before being legally banned from their use (Lamsal, 2012). Conflict between humans and wildlife is one of the most important threat to survival of large and

highly endangered animals like tiger, leopard, rhino, elephant which are directly involved in conflict. Human carnivore conflict mostly occur from livestock depredation, human injuries caused by carnivores, illegal grazing and fodder collection and lack of understanding between local people and protection unit (Distefano, 2005).

People residing near protected areas often directly bears the cost and have less ability to deal with the losses (Karanth and Nepal, 2012). Information about the factors associated with conflict and the place of frequent occurrence is important for conservation manager of conflict (Dickman, 2010; Mateo-Tomás *et al.*, 2012). Human fatalities caused by predators i.e. carnivore another vital cost in some areas, the result of which are even worse because the victims are adult male who are the main source of income in the family. Beside this, in many rural societies livestock has cultural importance exceeding its economic worth where loss cannot be easily compensated through economic means alone (Galaty, 1982; Löe and Röskaft, 2004). Carnivores that enter into human settlements and kills their livestock, sometimes even human are not directly killed; many protected area manager prefer translocation (Madhusudan and Karanth, 2002). In recent years, many nations have implemented strict rules following dramatic carnivore population decline. The cost of managing human carnivore conflict according to preservation strategies can also be high as many nonfatal methods are complicated and expensive to maintain (Treves and Karanth, 2003).

Chitwan National park (CNP) covers major parts of tiger conservation landscape, embodies Churia habitat which is important corridor linking Valmiki Tiger Reserve in India and Parsa National Park in east. Cooler microenvironment in summer and availability of perennial water resources has created suitable habitat for wild prey and dispersing tiger population in Churia range (Karki *et al.*, 2015). Prey density in few protected areas of Nepal where tigers are found seems to be less than half the prey density required to sustain government target population i.e.250 (DNPWC, 2016). This might force tigers to move outside of the protected areas resulting severe human tiger conflict (Aryal *et al.*, 2016). Wildlife attacks on people, crops and livestock depredation are obstacle to local community support for conservation (Lamichhane *et al.*, 2019) so, there is need for solutions to human carnivore conflict to ensure that local communities do not unjustly bear adverse effect of conservation which can result opposition to conservation. Thus, to ensure the success of conservation effort. There is need to confirm the benefits of local people is extensive, since dissatisfaction of single individual living with wildlife can lead to failure of conservation

initiatives. Local participation in mitigating programs to enhance social tolerance towards wildlife and also discussion for the uplift of alternative economic sources and quick compensation for the loss would be the effective way to reduce human large carnivore conflict in buffer zones. Conservation policies should be strongly based on complete understanding of conflict pattern. This study reveals the pattern of human large carnivore conflict since past 19 years, identifying main cause of conflict, determining the cost and also understanding the attitude of local people towards the management plan of national park as well as buffer zone policy.

1.2 Rationale of the study

Human carnivore conflict is one of the major obstacles in protected area management. Negative attitude of people towards unstable government rules and regulations have led to the increased wildlife conflict in the buffer zone of Chitwan National Park (Acharya *et al.*, 2016). In the surrounding areas of national park, human density is increasing and the density of tiger and leopard inside the park is also high which has caused the frequent economic loss and safety threats in the surrounding communities (Lamichhane *et al.,* 2019). Low economic status of local people around the buffer zone compels them to depend on the resources of the protected forest which automatically increases the chance of encounter with conflict species. This interaction between human and large carnivore leads conflict pattern. Large carnivores are highly threatened due to habitat loss, decreasing prey abundance and collapsing territory of big cats (*Panthera tigris* and *Panthera pardus*). The increased negative human- large carnivore interaction has challenged the management practices of the protected areas. Though many research on conflict management has been conducted in various parts of Nepal (Adhikari et al., 2018; Bhatta and Joshi, 2020; Kandel et al., 2020; Ruda et al., 2020), Nawalpur, important buffer zone of Chitwan National Park is hotspot of carnivore conflict where significant scientific study is lacking. A better understanding is very crucial to overcome conservation challenge. This study aimed to fulfil these gaps in research and explored the status of conflict in Nawalpur area that help to minimize human carnivore conflict.

1.3 Objectives of the study

1.3.1 General objectives

The general objective of this study was to explore the patterns, causes, perceptions and costs of human-large carnivore conflict in Nawalpur area of Chitwan National Park, Nepal.

1.3.2 Specific objectives

The specific objectives of this study were to:

1. Explore the patterns and costs of human-large carnivore conflict in Nawalpur area
2. Determine the causes of human-large carnivore conflict in Nawalpur area.
3. Investigate the perceptions of local people towards human-large carnivore conflict in Nawalpur area

2. LITERATURE REVIEW

Tigers (*Panthera tigris*) and leopards (*Panthera pardus*) are major carnivores killing livestock in Asia (Madhusudan and Karanth, 2002). Global pattern of human carnivore conflict (Treves and Karanth, 2003) indicated human carnivore conflict as a political challenge as public opposition could block the translocation, reintroduction and natural recovery of carnivores in the natural habitat. Public involvement in carnivore policy could have salutary effect but might also have negative outcome. So, the importance of principle of adaptive management for the conservation of wildlife in human dominated ecosystem can be observed.

2.1. Patterns and cost of human large carnivore conflict

The study of Dar *et al.* (2009) predicting the patterns, perception, and cause of human carnivore conflict in Pakistan showed leopard as the main predator among four carnivores species. Mainly goats and sheep were lost due to carnivore attack. Most of the depredation was occurred during May and July. Though leopard was main predator, high economic loss was caused by black bear as it mostly killed more expensive type of livestock.

Kumar and Chauhan (2011) reported human causalities caused by leopard in different forests of Mandi District, India for period of 20 years (1987-2007). Leopard caused 162 human causalities. Among them, 13 people were killed and 149 were injured. There were 4967 attacks and 8905 livestock killed mainly goats, sheep, and cows and others with few cases were ox, buffalo, claves, horses, mules, donkey.

Koirala *et al.* (2012) conducted human-leopard (*Panthera pardus*) conflict in Annapurna Conservation Area, Nepal, during 2009 and 2010. The results showed that leopard killed more livestock than any other predator. The highest losses to leopard were suffered in winter, and in grazing land, with Goats being the major victim. The highest financial impact was associated with predation on Goats, with leopard accounting for 95% of total monetary loss to predators over the two-year study period.

The compensation pattern of human wildlife conflict in central India identified the potential conflict hotspot, influential factors and spatial probability of crop and livestock loss. The main highlight of this study was that estimated crop and livestock loss and compensation distribution were higher for households located inside buffer more likely for the tiger related incidents (Karanth *et al.*, 2013).

Bhattarai and Fischer (2014) explored that 12 people were killed and four injured by Tiger attacks between 1994 and 2007 and four tiger were killed due to the human tiger conflict in between 1989 to 2009 in Bardia National Park, Nepal.

Alexander (2015) described the threats posed to humans by snow leopard in Qilianshan, China. Herding livestock was the major livelihood activity in all villages where loss of livestock due to carnivore attack seemed to be common event affecting livestock compared with natural disaster or disease. Most depredation were attributed to lynx while snow leopard held less responsibility. So, households and herder expressed positive attitude towards conservation of snow leopard where as they held negative attitudes towards lynx, wolves and bears for their protection.

Acharya et al. (2016) examined patterns of human injury and death caused by large mammals using data collected from a national survey available in Nepal over five years (2010–2014). The results show that elephants and leopards are most commonly involved in attacks on people in terms of attack frequency and fatalities. Although one-horned rhinoceros and bears had a higher frequency of attacks than tigers, tigers caused more fatalities than each of these two species.

Mitigating human tiger conflict of (Dhungana *et al.*, 2016) explored the pattern of compensation payment made to victims or their families, compensation of livestock loss and impact of removal of tiger in CNP. The study revealed that high amount of compensation was utilized on human fatalities followed by payment of livestock depredation. Death of majority of removed tigers from CNP indicated huge impacts of tiger removal. In the study of Dhungana *et al.* (2018), human casualties showed no significant difference among years, seasons or months but livestock loss varied among months which revealed highest loss in July (15%, n=54) and lowest in August (n=13).

Study of Lamichhane *et al.* (2018) analysed loss of humans, livestock and property by wildlife during 1998-2016 which showed insignificant declining trend of wildlife attacks on humans and livestock. Most of human deaths were caused by tiger and more than 90% of livestock loss was caused by both tiger and leopard. A total of US$ 403648.51was spent for relief distribution to victims and their relatives.

Dhungana *et al.* (2019) conducted study on livestock depredation by leopard around CNP which disclose total 424 livestock loss during 10 years of study period (2007-2016) in the buffer zones of CNP. During 2007-2010, 11 peoples were injured due to leopard attack.

About 87% of livestock loss were of goats followed by 9% pigs and 4% cattle. On the basis of relative availabilities of livestock, expected depredation rate due to leopard varied significantly among species which implied 20% more loss of goats than expected, pigs 113.3% more than expected while cattle 82.7% less than expected depredation rate. Livestock loss differ significantly among months and year but no significant variation among seasons. Livestock loss was peaked in the month of June-July and November-December accounting 23.3% and 25.9% of all losses respectively whereas less loss was observed in February. Total economic loss resulted from livestock depredation by leopard in CNP seemed to be US$24,621 but only US$19,719 was distributed to the public as compensation towards loss by authorities. 55.9% of all depredation events were fully compensated, 42.5% partially compensated and 1.6% were not compensated.

In Bardia National Park (BNP), of 297 total respondents, 131 (44%) of household heads reported the case of livestock and poultry loss either from predator attack or other factors like disease and flooding. 85% of total 92 cases of predator attack involved leopards whereas tigers were involved for 8% of the cases. Tiger killed cattle (n=7) and 12.5% buffalo (n=1) predator attack varied significantly among seasons, summer and winter were more common (46% & 35% respectively) than in monsoon (19%). Total economic loss from predator attack in BNP was found to be US$14,573 (Upadhyaya *et al.*, 2020)

2.2. Cause of human large carnivore conflict

Illegal transaction of forest products from park, livestock grazing inside PA, illegal hunting and fishing, crop damage and threats to human and animal life were the main cause of conflict in CNP (Stræde and Helles, 2000).

Factors associated with human killing tigers (Gurung *et al.*, 2008) investigated the ecological and sociological aspects of human killing in central lowlands of Nepal. Human killing events in Chitwan National Park from 28 years was collected which showed most human deaths occurring within one kilometre of forest edge as human use of forest within this zone seemed to be higher than in the interior forest. They identified the occupation of degraded habitat, physical impairment and aggressiveness towards human as factors that might have predisposed tiger to kill people. Their study revealed the trend of human deaths that have increased significantly in the buffer zone since 1998 because of forest restoration. Nearly half people killed were grass and fodder collectors. Tamang and Baral (2008)

reported livestock depredation by large carnivore was a serious issue and the major source of park- people conflicts in BNP during 6 years' period (1993- 1998).

Regular human intrusion in the park boundary, declining population of large prey species compelling tiger to prey on medium sized prey (prey of leopard) as a result leopard ventured in the periphery of park for food. This resulted increased human large carnivore conflict in CNP (Bhattarai and Kindlmann, 2012).

Forest fragmentation and heterogeneous landscape have low prey density which results in high human-large carnivore conflict. Acharya *et al.* (2016) revealed tiger attack on unique location less fragmented forest whereas leopard attack in highly fragmented and heterogeneous landscapes. Tiger attacks mostly occurred once in one location (89%, n=40).

From the study of (Dhungana *et al.*, 2018) on human tiger conflict in CNP found that more than half (53.7%) of victims were attacked during fodder or fuel wood collection while nearly half (48.2%) of victims were attacked in buffer zone forest where human intrusion was high in surrounding.

2.3. Perception of people towards carnivore conflict

People's perception towards large carnivore conservation can be influenced by the extent of loss they have faced because of these species. Greater the loss higher would be the intolerance towards conflict species (Røskaft *et al.*, 2007). Co-existence of human carnivore in the South Africa (Lagendijk and Gusset, 2008) gave diverging perception of local people. About 41% of total respondent (n=90) had positive attitude towards the carnivores because they liked seeing predators as a part of nature. Negative attitude was particularly due to the fear of humans and livestock losses to the predators especially lion. Despite the lack of conservation education and livestock losses, almost all (96%) respondent thought the importance of protecting carnivores from becoming extinct.

Socio-economic conditions are important in explaining people's attitudes to conservation. For example, in Nepal, people living closer to the Chitwan National Park were more negative towards it than those with larger landholdings, who visited the park less frequently and who lived further away (Bhattarai and Kindlmann, 2013). Maximum monetary loss from livestock depredation by common leopard in Annapurna Conservation Area triggered negative response in local people towards conservation of common leopards (Koirala *et al.*, 2012). Study along Khata Forest Corridor explored that majority of public demanding to capture and kill or keep problematic tiger in zoo. Other demand for improved

compensation scheme and proper monitoring of problem tigers (Wegge *et al.*, 2018). Wildlife attacks on human and economic loss often result reduced support of local people for conservation (Lamichhane *et al.*, 2018). Study of Dhungana *et al.* (2018) on determining risk of predator attack in BNP, found the positive response on predator attack from educated and self sufficient respondents than others.

Response of local people towards carnivores also depends on their occupation. A study of Chetri *et al.* (2020) on factors influencing local perception of snow leopards and Himalayan wolves found that local with sole source of income like animal husbandry were more negative towards conflict animals. And respondents with additional sources of income expressed more positive response. Education status of respondents had played crucial role in understanding importance of carnivores.

3. MATERIALS AND METHODS

3.1 Study area

Chitwan National Park and its Buffer Zone located in south Central region of Nepal which spreads over Chitwan, Parsa, Makawanpur and Nawalparasi districts. These districts respectively comprise of 74.04%, 15.45%, 6.97% and 3.54% of the total area of the park. The geographical location of the National Park is between N 27° 20' 19" to 27° 43' 16" longitude and E 83° 44' 50" to 84° 45' 03" latitude whereas the geographical location of buffer zone is between N 27° 28' 23" and 27° 70' 38" longitude and E 83° 83' 98" and 84° 77' 38" latitude (CNP, 2019). CNP is the prime habitat for the large viable population of tigers and leopards across TAL (Karki *et al.*, 2015). About 80% of the park is dominated by forest including sal forest, riverine forest and mixed hardwood forest. Also 12% of park covered by grasslands, 5% exposed surface and 3% waterbodies (Thapa, 2011). It is a World Heritage Site which includes approximately 70 mammal species, over 546 bird species, 47 species of reptiles, 55 amphibians and 120 species of fish (CNP, 2019). The park is divided into Amaltari, Kasara, Sauraha and Madi sectors for management.

The study was carried out in Amaltari sector of CNP located in Nawalpur district. Nawalpur (Nawalparasi east of Bardaghat Susta) is a district located in Gandaki Province of Nepal. Study has been focused in following Buffer Zone User Committees (BZUC) of Amaltari sector; Lamichaur BZUC, Sikhrauli BZUC, Siswar BZUC, Amaltari BZUC, Nandabhauju BZUC, Gosaibaba BZUC and Daunnedevi BZUC.

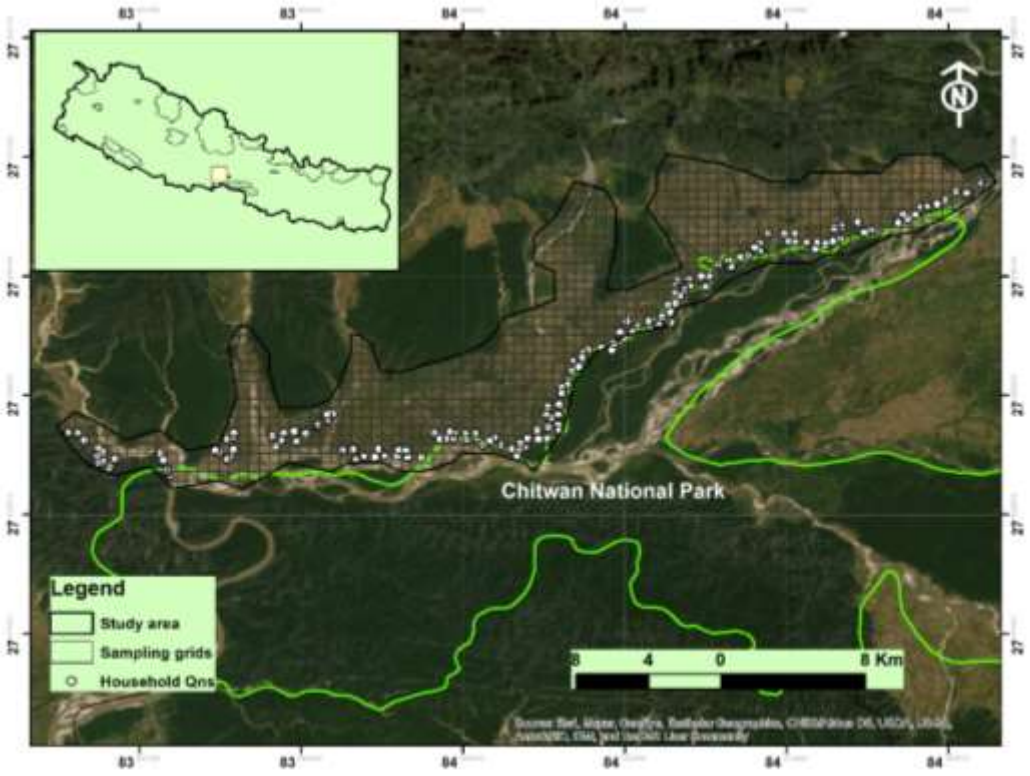


Figure 1. Map of study area showing sampling locations for questionnaire survey

3.1.2 Climate

Nawalpur district has warm and subtropical climate. The average annual minimum temperature of the district is 18.4° C whereas average maximum temperature is 28.55° C. Maximum temperature was 34.2° C in the month of April and minimum temperature was 9° C in the month of January.

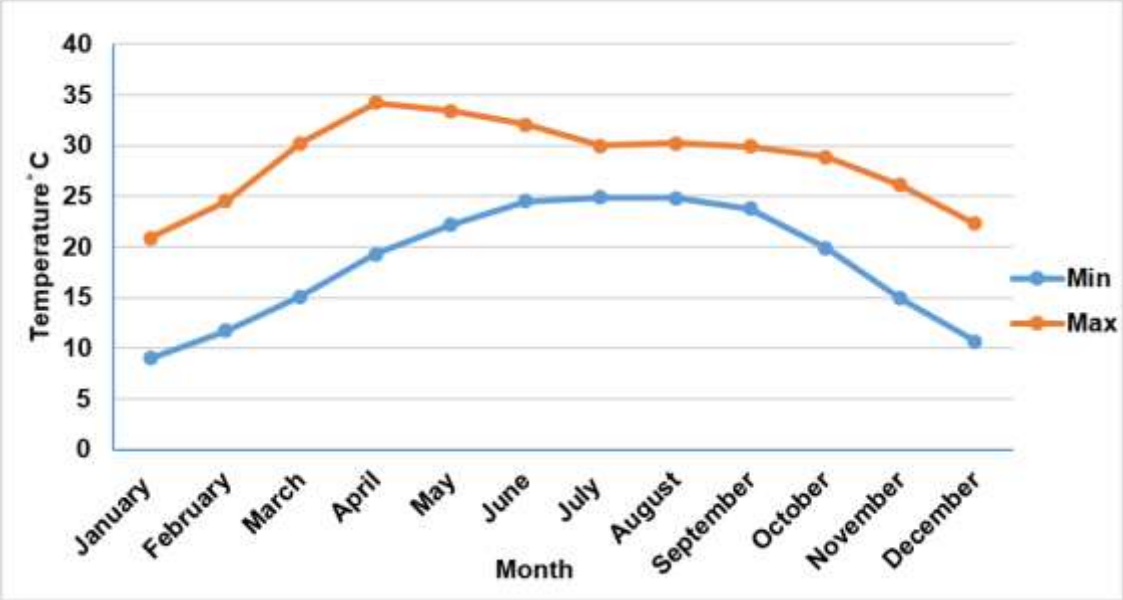


Figure 2. Monthly minimum and maximum temperature of Nawalpur district (Kawasoti station, 2020, Source: DHM, 2020)

3.1.3 Rainfall

Nawalpur district have very good amount of rainfall in summer and very little in winter. Annual mean rainfall of the district was 211.75 mm in 2020. Maximum rainfall was 640 mm in the month of July and minimum was 13 mm in the month of November and December in 2020.

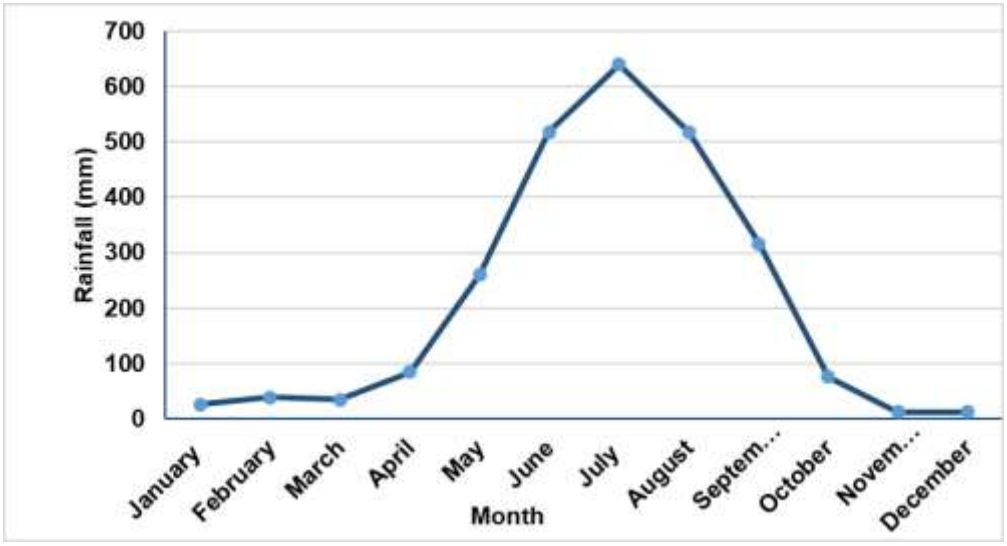


Figure 3. Monthly rainfall of Nawalpur district (Kawasoti station, 2020, Source: DHM, 2020)

3.1.4 Humidity

The mean annual humidity of Nawalpur district in the year 2020 was 73.83%. The most humid month was July (89%) and least was April (50%) in the district.

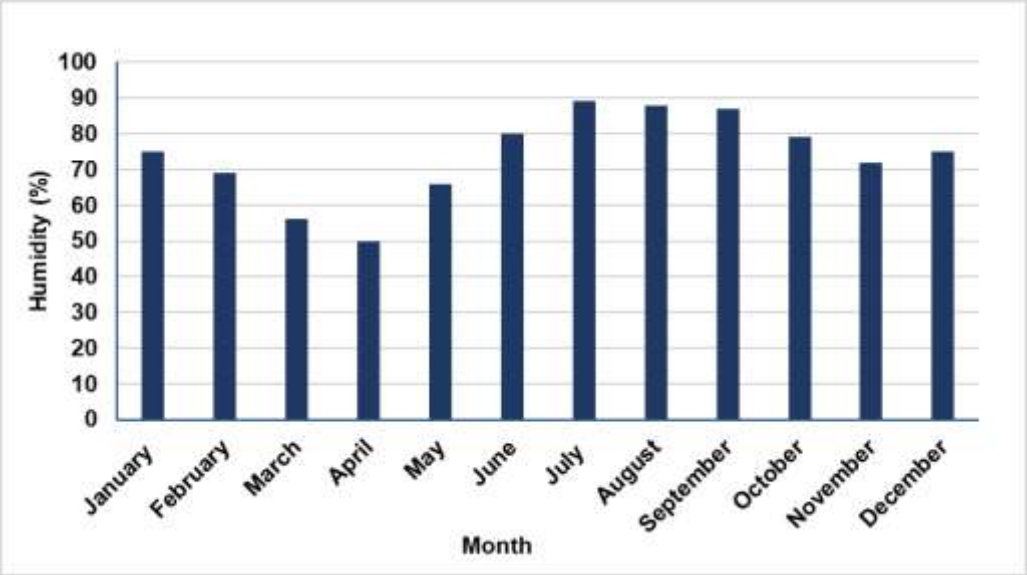


Figure 4. Monthly humidity of Nawalpur district (Kawasoti station, 2020, Source: DHM, 2020)

3.2 Methods

3.2.1 Preliminary survey

A preliminary survey was carried out in October, 2019 for the identification of most probable conflict sites of large carnivores (*Panthera tigris* and *Panthera pardus)* in the study area. The survey included field observation and interactions with local people. Information required for the further research was collected.

3.2.2 Data collection

Both primary and secondary data were collected. Primary data were collected through sign survey of conflict species (tigers and leopards) and through household questionnaire survey.

3.2.2.1 Primary data collection

3.2.2.1.1 Large carnivores sign survey

Sign survey was conducted from 1st February, 2020 to 25th February, 2020. Presence signs of large carnivores (pugmarks, scratch, scats and scent marks) was observed and identified in the periphery of buffer zone user communities and along the route of Narayani River. The sign survey has been carried out in the seven Buffer Zone User Committee (BZUC) of Chitwan national park viz. Sikhrauli BZUC, Siswar BZUC, Lamichhaur BZUC, Amaltari BZUC, Nandabhauju BZUC, Gosaibaba BZUC and Daunnedevi BZUC. GPS coordinates of large carnivore pugmark was noted wherever found in the field and also picture of signs were taken (Gionee S6). Soft grounds such as near water, muddy ridge was used to detect the presence of the species (Mooty *et al.*, 1984). Based on the pugmark length and breadth, conflict species were measured (Measuring tape) and identified.

3.2.2.1.2 Household questionnaire survey

Purposive sampling method was used to conduct the questionnaire survey (Rai and Thapa, 2015). Household who lost livestock and were victims of large carnivore attacks between 2014-2020 were visited. Grid of (500×500) m^2 was generated over study area using Arc GIS and victims nearest to each grid centre were selected for the survey. During preliminary survey, most people residing within one kilometre of park boundary were found to be victims of large carnivore conflict. So, the grid points lying within that area of buffer zones were chosen. The nearest victim household to the centre of grid was navigated using GPS device (Garmin etrex 10).

The questionnaire survey was conducted during October-November 2020. The prime purpose of the survey was to investigate the extent of HLCC and to understand the people's attitude towards large carnivore conflict. If there was no victim household nearer to the selected grid points, that point was excluded from the survey. Prior consent of respondent was taken verbally before starting the interview. All the households agreed to participate in the survey.

A semi structured questionnaire was prepared to collect data from the victim households of study area. Total 150 respondents were involved in the survey. In most of the cases, the head of family was interviewed. In the absence of the head of family, the information was collected from the adults present in the location to obtain the real field scenario. Demographic profile of respondents such as age, gender, ethnicity, occupation, education

level and household information such as livestock owned, forest resources used, husbandry practices (stall fed or grazed outside) was collected through questionnaire (Appendix 1). Also, understanding of the respondents towards large carnivores, compensation scheme of national park and their attitudes towards carnivore conflict was also compiled. Specific information related to species attacked, the number killed, location of attack (outside or home) and time of attack (morning, afternoon and night) was reported. Respondents report of large carnivore attacks were based on sighting of conflict species, pugmarks, sounds or wounds observed.

3.2.2.2 Secondary data collection

Data on large carnivore attacks on humans and livestock and economic loss reported to CNP authorities and BZUC from past 19 years (2001 to 2019) was collected. The incidents of attacks were reported by victims themselves or by their relatives through applications to the local authorities to claim the relief amount. And the BZUC verified the incidents of attacks and after relief was given as per the guidelines of government of Nepal.

3.3 Data analysis

The analysis of data involved the tabulation of all information collected through primary and secondary sources. All the information has been collected in form of semi-structured forms, and photographs. Collected data were sorted into different type of loss such as human death and injury, livestock depredation number, large carnivores involved in depredation. Education status, occupation, ethnicity and age groups of respondent was classified. Surnames of the respondents was used to derive ethnicity of victims categorized as Bhramin/Chhetri, Janajati/Adibasi, Dalit and Marginalized groups. The economic values of livestock loss from study area was calculated by using farm get price allocated in the local market (Table 3).

Simple statistics such as percentage and frequency count were used to analyse gathered data from household. Distance to nearest forest and water sources from victim household was calculated by using google earth. Student t-test was used to compare frequency of livestock depredation caused by tiger and leopard. Generalized linear model was used to determine the prey preference of tiger and leopard using R software (Team, 2020). Pearson Chi-Square test was employed to examine difference in frequency of livestock attack in different time of the day Variation in the people's perception with respect to their education

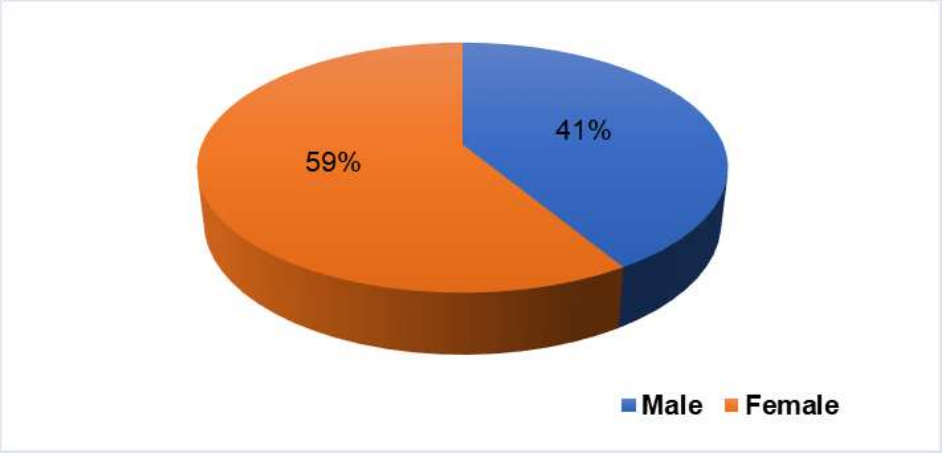
status, age group and occupation was examined from Pearson Chi-Square test. Ordinary least square (OLS) regression was performed to predict the livestock depredation pattern. Pearson Chi-Square test and OLS regression was performed by the use of past software on computer. Results are presented graphically in form of tables, figures and text in a descriptive way. The Arc GIS software was used to prepare the map of study area as well as to show the presence of carnivores in the study area.

4. RESULTS

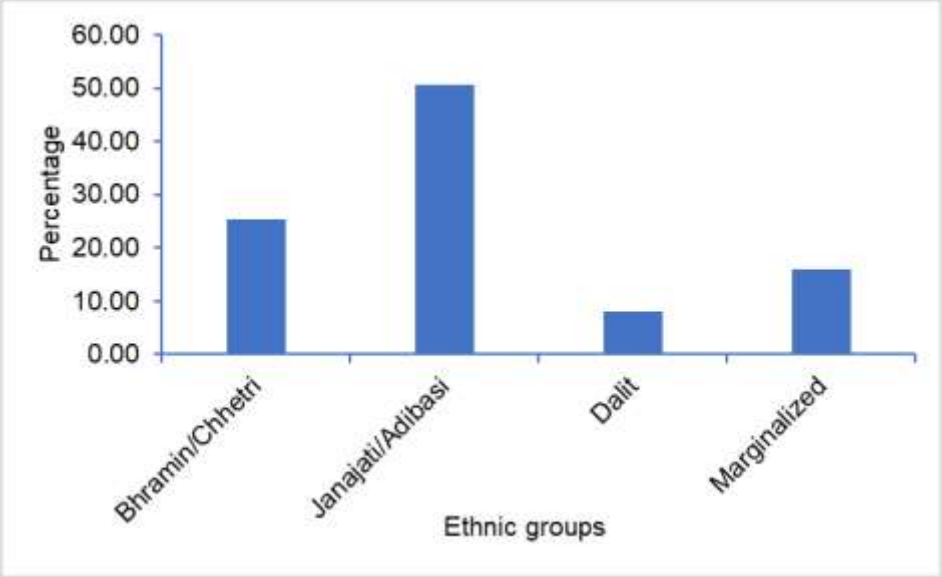
4.1 Demographic profile of respondents

Altogether 150 informants (62 males and 88 females aged between 16 to 83 years) who were victims of livestock depredation and human fatalities were interviewed from the different buffer zones of Nawalpur district. Among them, 146 peoples were victims of livestock depredation and 4 were of human fatalities. They belong to different ethnic groups such as Brahmin/Chhetri, Janajati/Adibasi, Dalit and marginalized ethnic groups. Respondents with primary level of education were highest (42%) and were least with secondary level of education (12%). About 75% of respondents were involved in farming occupation and other were involved in other occupation like services, business and daily wages (Figure 5). Average family size of the respondents from the study area was six members.

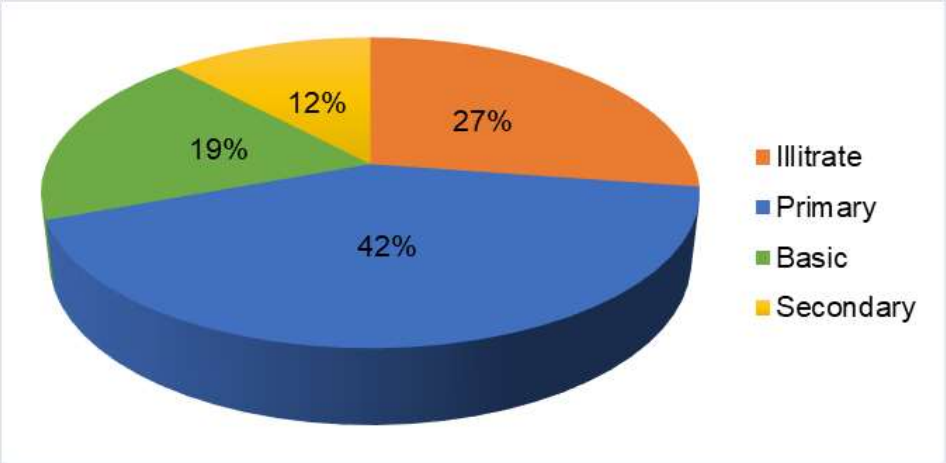
a. Gender



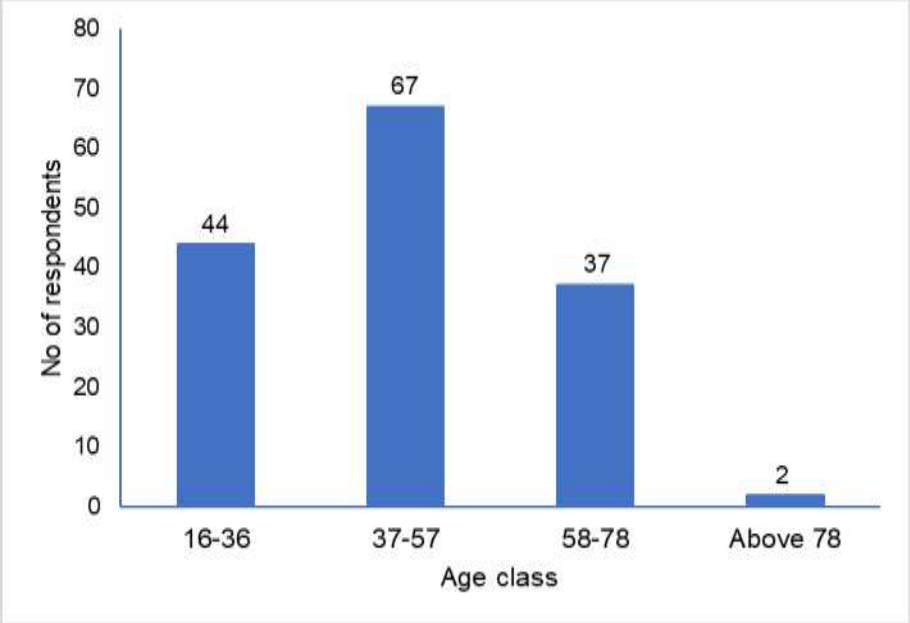
b. Ethnicity



c. Education Status



d. Age group



e.

Occupation

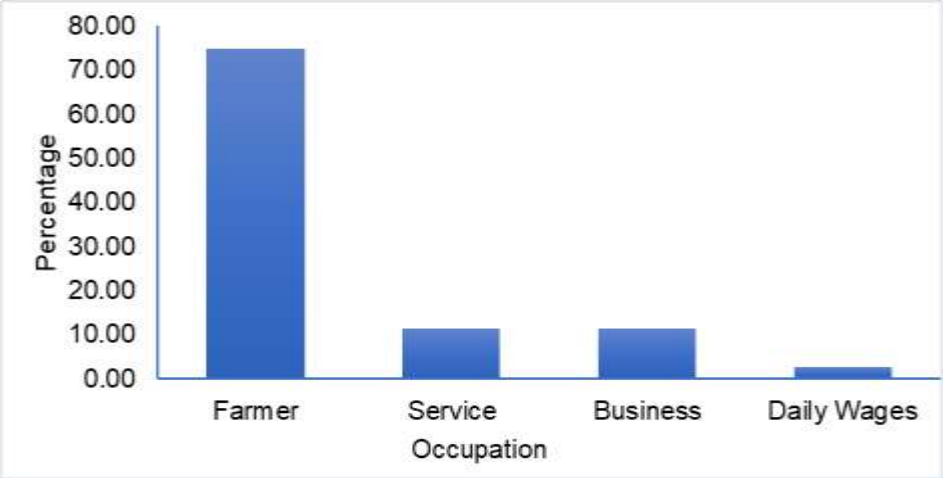


Figure 5. Demographic profile of the respondents, a) Gender b) Ethnicity c) Education status d) Age group e) Occupation of respondents

4.2 Pattern of human large carnivore conflict

Between 2001 and 2019, total 521 incidents of human and economic loss by large carnivores (*Panthera tigris* and *Panthera pardus*) were reported to BZUC or CNP authority (Table 1). In total, 314720.4 USD was paid to victims as compensation for their loss over period of 19 years.

Table 1. Loss due to large carnivores in the Buffer zones of Nawalpur District

Conflict Species	**Human casualties number**	**Livestock depredation number**
Tiger	13 deaths 15 injuries	370
Leopard	5 injuries	118

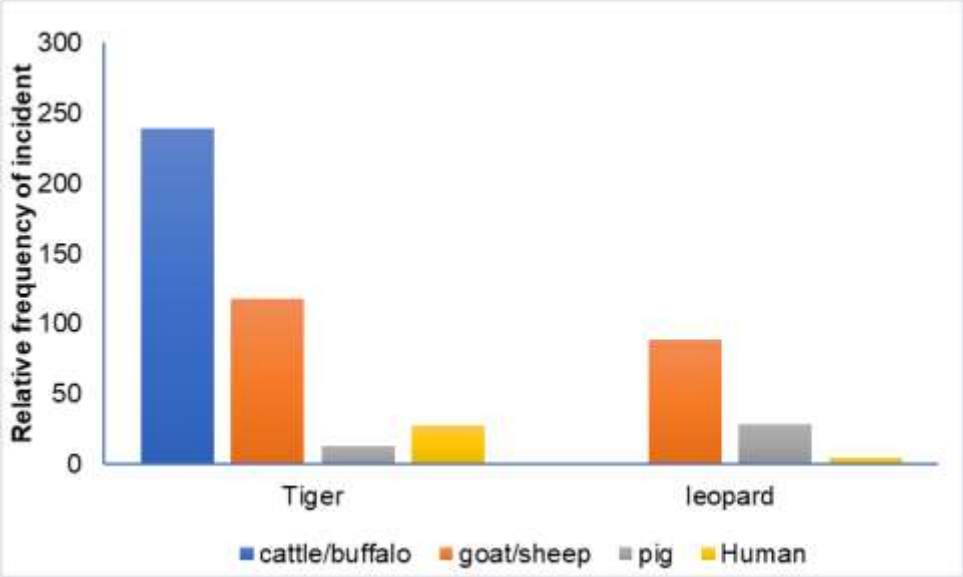
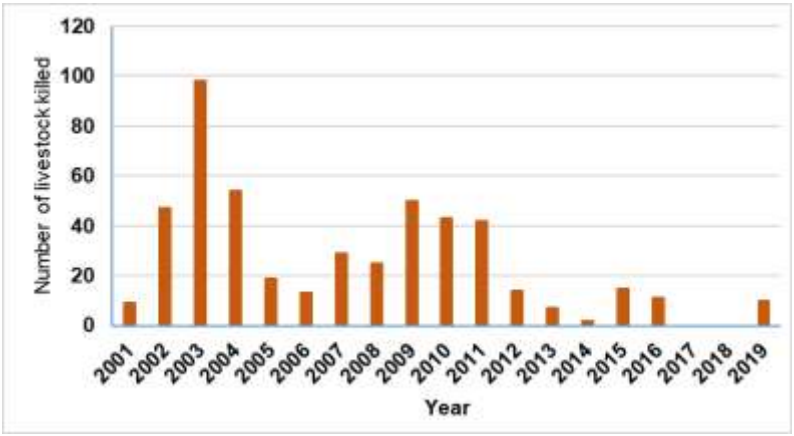


Figure 6. Relative frequency of incidents of livestock depredation and injury or death of local people caused by tiger and leopard

4.2.1 Livestock depredation

Total 488 incidents of livestock depredation were recorded over 19 years of period from the seven buffer zones located in Nawalpur district. In duration of 19 years, tiger seemed to be more problematic than leopard with high number of predation (370) in total. Cattle/buffalo was highly depredated by tiger followed by goat/sheep and pig whereas depredation caused by leopard was highest with goat/sheep followed by pig (Figure 6). The annual frequency of livestock depredation by tiger was significantly higher ($t=2.228$, $df=20$, $p=0.037$) compared to leopards but in recent 6 years (after 2013) leopard caused more livestock depredation. Here, livestock includes goat, sheep, pig and cattle (buffalo, bull, ox, cow). Livestock depredation number reported to the buffer zones or CNP authority from Nawalpur was highest in 2003 (98) and no any livestock depredation was reported to the concerned authority from Nawalpur in the year 2017 and 2018. A total of US$ 13702.18 was paid as compensation to victims for livestock depredation by large carnivores in Nawalpur during 2001-2019. Per household loss was US$ 30.314 in the study area during 19 years.

a)



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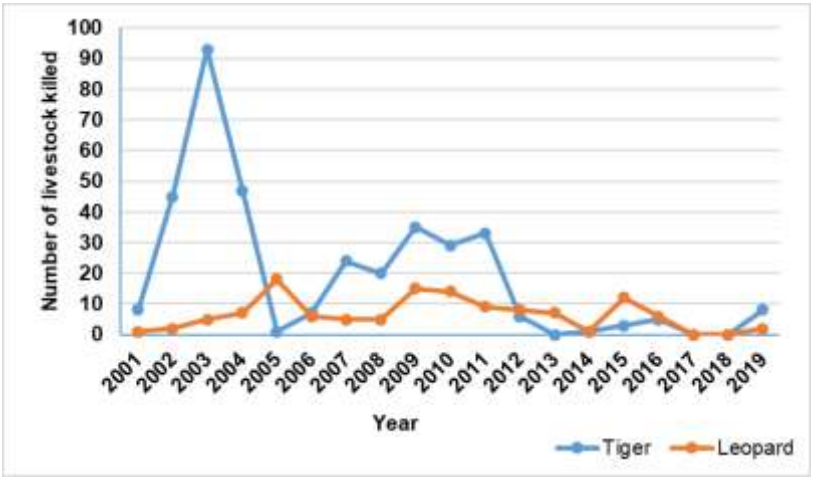

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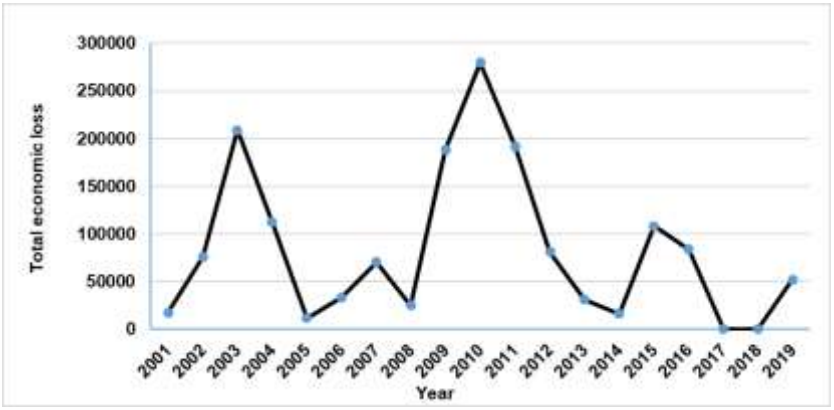

Figure 7. Livestock killed during 19-year period in the buffer zones of Nawalpur, a) Total number of livestock killed over years b) Number of livestock killed by tiger and leopard over years, c) Total economic loss from livestock depredation over years.

Generalized Linear Model (GLM) for livestock selectivity of tiger showed positive relation with cattle/buffalo and goat/sheep but not for pigs. Relationship between tiger and cattle/buffalo depredation was highly significant ($z=6.878$, $p<0.0001$). Livestock preference of leopard indicated positive relation with pigs and goat/sheep. Pig was more highly selected by leopard ($z=8.549$, $p<0.0001$) followed by goat/sheep ($z=6.654$, $p<0.0001$)

Table 2. Generalized linear model with binomial distribution and logit function showing livestock selectivity of tiger and leopard in buffer zones of Nawalpur

Item	**Estimate**	**Z-value**	**P value**
Tiger			
Goat/Sheep	0.5032	1.449	0.1473
Pig	-1.0133	-1.784	0.0745 .
Cattle/Buffalo	4.4664	6.878	**<0.0001 *** **
Leopard			
Goat/Sheep	1.6594	6.654	**<0.0001 *** **
Pig	3.8747	8.549	**<0.0001 *** **

(Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1)

The families in the study area mainly depend upon the forest, agricultural products and livestock rearing. About 87% of the respondents had owned livestock like goat, sheep, cow, buffalo, pigs and chickens. Respondents had total 1275 livestock among them 59 Cow/Ox, 189 Buffalo/Bull, 450 Goats, 74 Sheep, 33 Pig and 473 hens/duck.

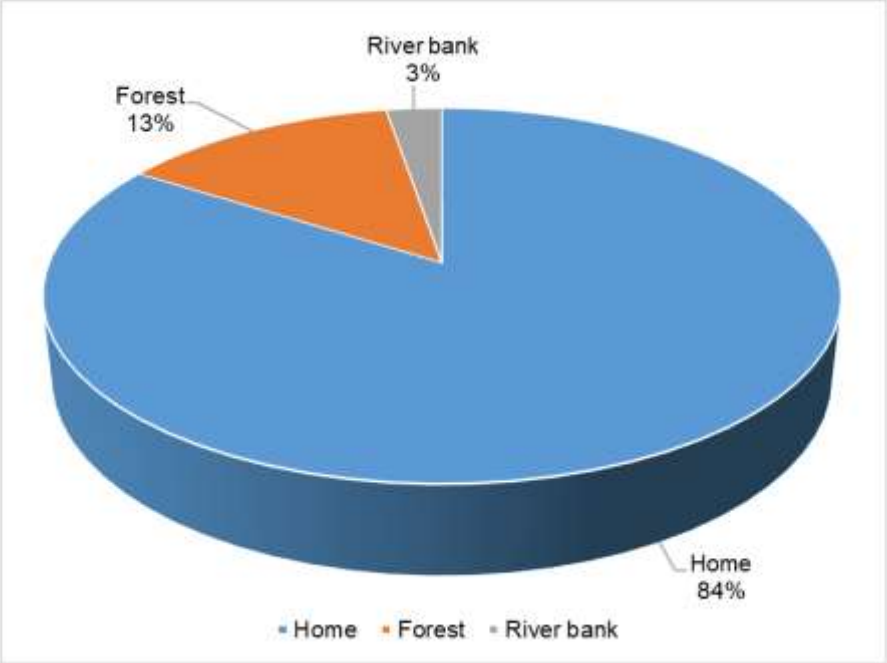

Figure 8. Location of livestock depredation

Most of the livestock depredation reported from questionnaire survey were caused inside stall (84%, n=150) (Figure 8). Total 238 livestock and avian stock were killed from last six years in the study area in which 3% were buffalo, 24% cow/ox, 66% were goat/sheep, 3% pig and 5% poultry (Figure 9). Tigers were responsible for 53% of depredation incidents and leopards for 47% of incidents. Only 58% of respondents claimed for the compensation of livestock depredation. Long and expensive procedure of reporting was the main reason of respondents for not claiming compensation.

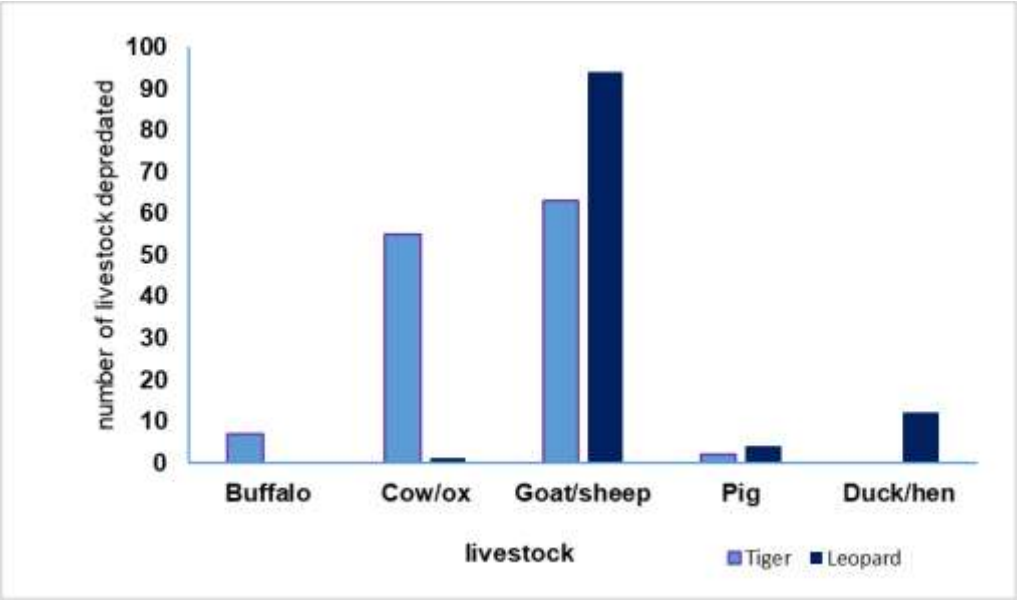

Figure 9. Number of different livestock depredated by tiger and leopard in the study area

4.2.2 Economic value of livestock loss

Total economic loss from livestock and avian stock depredation was found to be 44327.59US$ (NRs. 5142000) from study area (Table 3). The average per household loss was US$ 295.5172 in which loss of US$ 235.6322 contributed by *Panthera tigris* and US$ 59.88506 by *Panthera pardus*.

Table 3. Estimating economic loss for livestock depredation

Livestock	**Number of killed**	**Farm get price in NRs.**	**Total loss in NRs.**	**Total loss in US$**
Buffalo	7	100000	700000	6034.483
Cow/Ox	56	50000	2800000	24137.93
Goat/Sheep	157	10000	1570000	13534.48
Pig	6	10000	60000	517.2414
Hen/Duck	12	1000	12000	103.4483
Total	238		5142000	44327.59
Per HH	1.5867		34280	295.5172

4.2.3 Time of livestock depredation

Most of the livestock depredation incident occurred during night (88%) and least in the morning (5%) (Figure 10). A significant difference on the frequency of livestock depredation incidents caused by large carnivores (χ^2=7.5072, df=2, p=0.023) was observed between number of incident of depredation and time of the day.

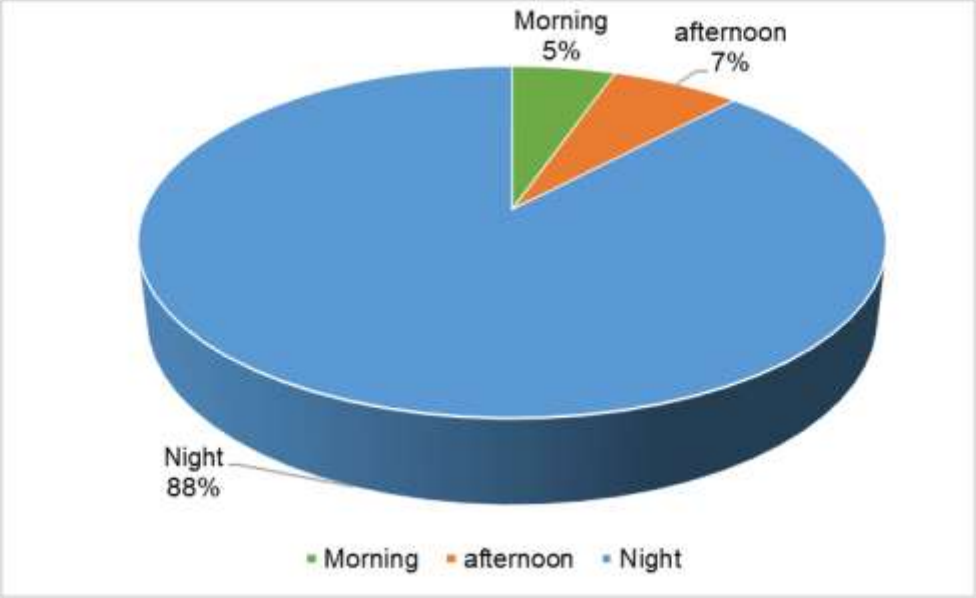

Figure 10. Number of incidents in different time of the day

4.2.4 Human deaths and injury

A total of 33 large carnivore attacks with an annual average of 0.68 human deaths and 1.05 human injuries were recorded between 2001 and 2019 from buffer zones of Nawalpur. All human death and 75% of injury was caused by attack of tiger and leopard was responsible for 25% of human injury. Total four human casualties were reported from questionnaire in the study area which include two human deaths and two human injury (Table 4).

Table 4. Human casualties caused by large carnivores in the study area

Gender	**Age**	**Activity**	**Location**	**Remarks**
Female	55	Walking in road	Agricultural field	Injured by tiger
Female	56	Collecting fodder	Forest	Death by tiger
Male	36	Working near forest	Field	Injured by tiger
Male	72	Firewood collection	Forest	Death by tiger

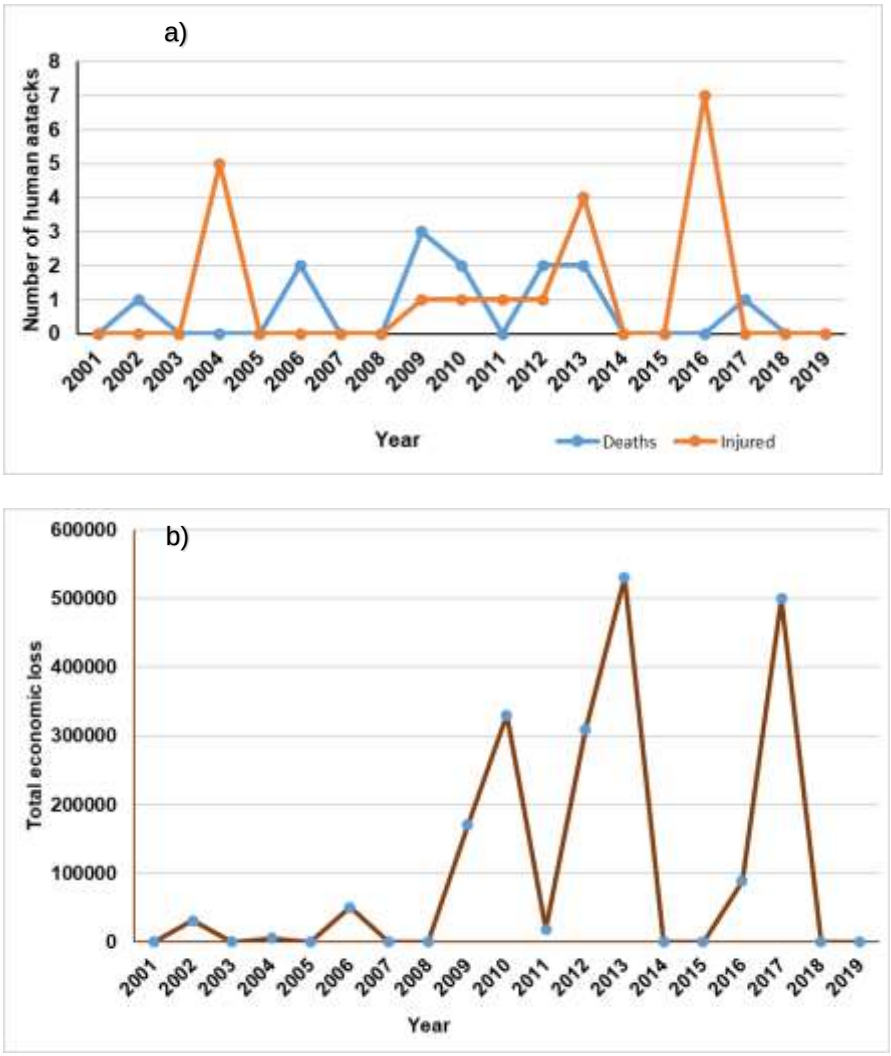

Figure 11. Loss from large carnivores over years, a) Number of human deaths and injury per year, b) Total economic loss from human fatalities

Total US$17524.41 was spent for human deaths and injury as compensation in study area by Chitwan National Park since 19 years (2001-2019). Highest amount (US$ 4535.897) was spent in 2013 for human loss by large carnivores from Chitwan National Park.

4.3 Cause of large carnivore conflict

Several reason of large carnivore to come out of the forest were reported. According to the respondents, searching of easy prey (62%) was the main conflict reason, followed by lack of prey in wild (19%), incompetent to prey in wild (12%) and habituated man eater carnivore usually come out of the forest (7%) (Figure 12). Old, weak and diseased carnivores are incompetent to prey in wild due to which they come out of the forest for easy prey.

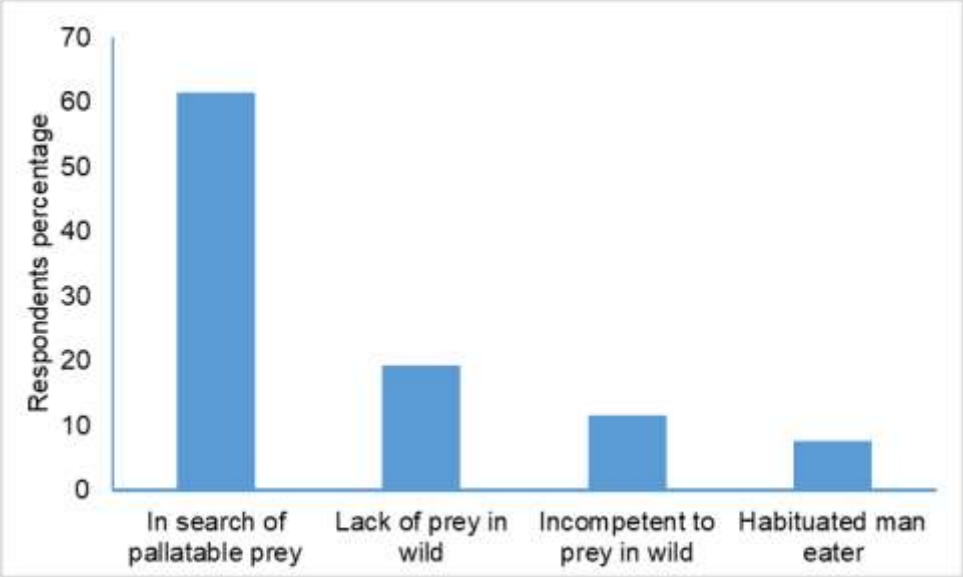

Figure 12. Cause of large carnivores to come out of forest

4.3.1 Distribution of carnivores signs in the study area

All together 60 pugmarks of large carnivores were detected in the study area. Out of which 38 were of tigers and 22 were of leopards (Figure 13). The observed signs of carnivores were distinguished on the basis of pugmark length and breadth. All these signs were found near the water resources in flood plain areas. Pugmarks were not sighted in areas far from forest and nearer to human settlements and agricultural field.

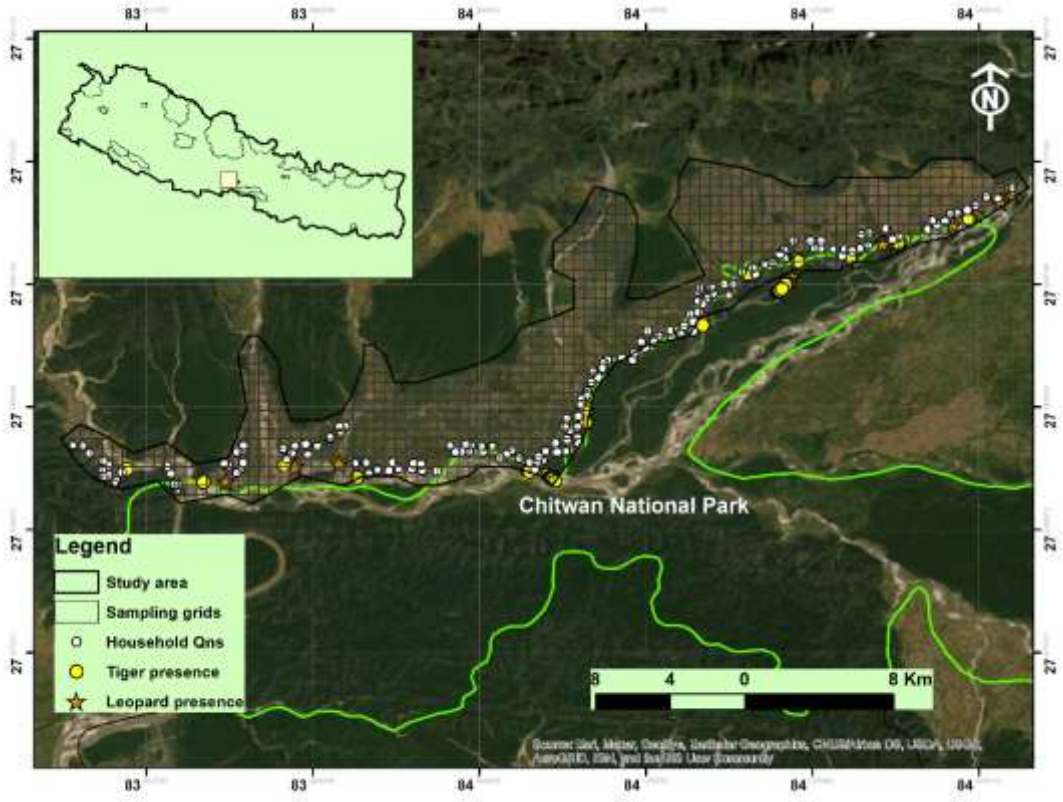

Figure 13. Distribution of tiger and leopard signs in the study area

4.3.2 Forest resource collection

Respondents of the study area were highly dependent on the forest resources. People were highly dependent (91%) on forest products like grass, firewood, edible fern (*Matteuccia struthiopteris),* saal leaf (*Shorea robusta*) whereas 9% didn't collect any of the forest resources (Table 5). Human invasion in the habitat of large carnivore is prevalent in the study area. This is one of the cause of HLCC in the study area.

Table 5. Resource collection by respondents

Forest Products	**Usage (%)**
Grass	23
Firewood	23
Grass/ firewood	39
Other products	6
None	9

4.3.3. Livestock rearing method

Among respondents owning livestock in the study area, 55% (n=130) feed their livestock at stall, 20% grazed in riverbank, 16% grazed in forest and 9% on their own field (Figure 14). In total still 45% of respondents from study area rear their livestock outside corrals which might be easy prey for the large carnivores.

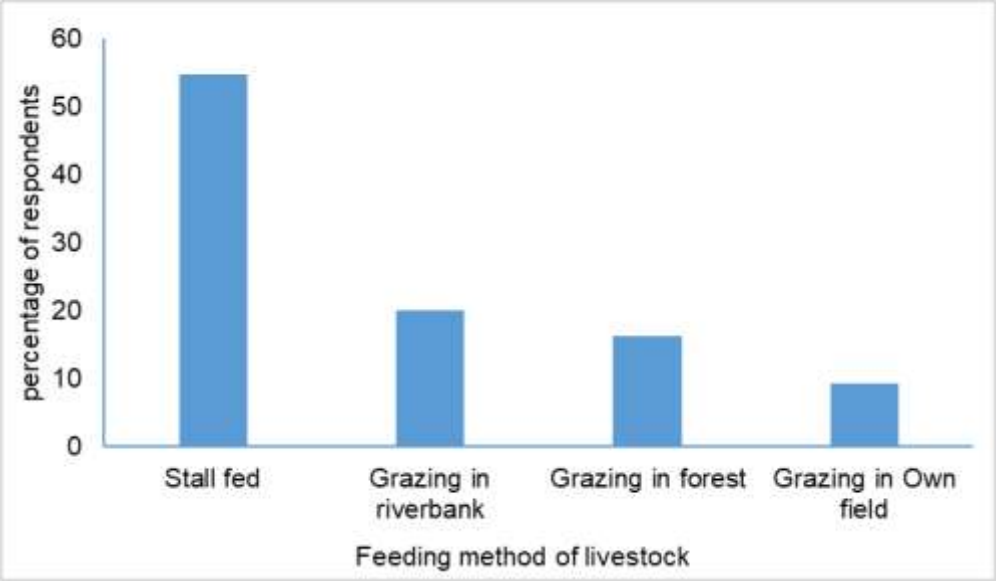

Figure 14. Different methods of livestock rearing adopted by respondents

4.3.4 Distance to nearest water resources

Ordinary Least Square (OLS) regression analysis at 95% bootstrapped confidence interval showed that distance to nearest water body is negatively correlated with the number of livestock killed (r^2= 0.22, p=0.0001). With the increasing distance to water body from household, number of livestock depredated seems to be declining.

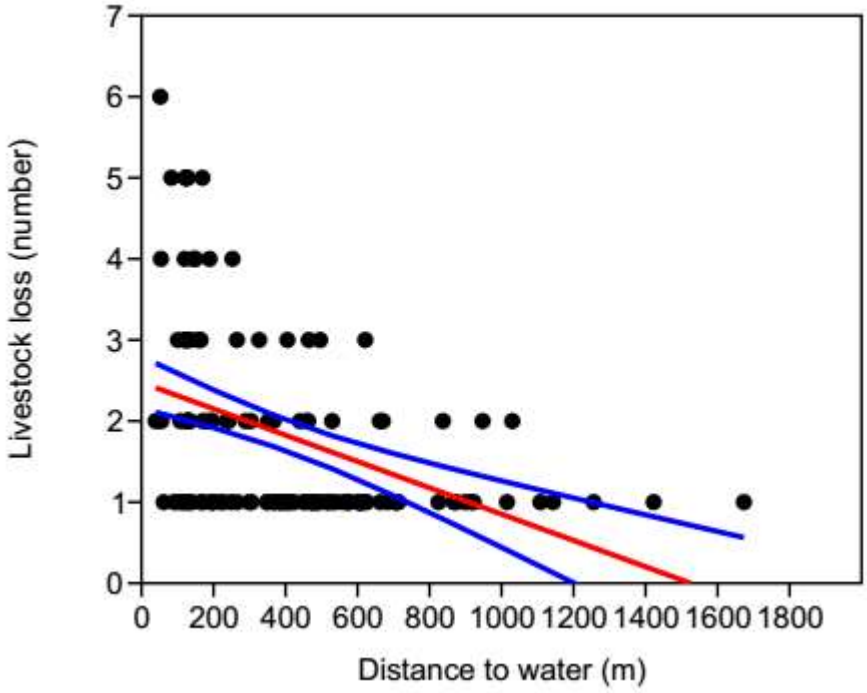

Figure 15. Relation between the livestock loss and distance to water (y = -0.0016x + 2.4749, r^2= 0.22, t=-5.1719, p=0.0001)

4.3.5 Distance to forest

Ordinary Least Square (OLS) regression analysis at 95% bootstrapped confidence interval (N=1999) showed that distance to forest is negatively correlated with the number of livestock killed (r^2= 0.21, p=0.0001). With the increasing distance to forest from household, number of livestock depredated seems to be declining.

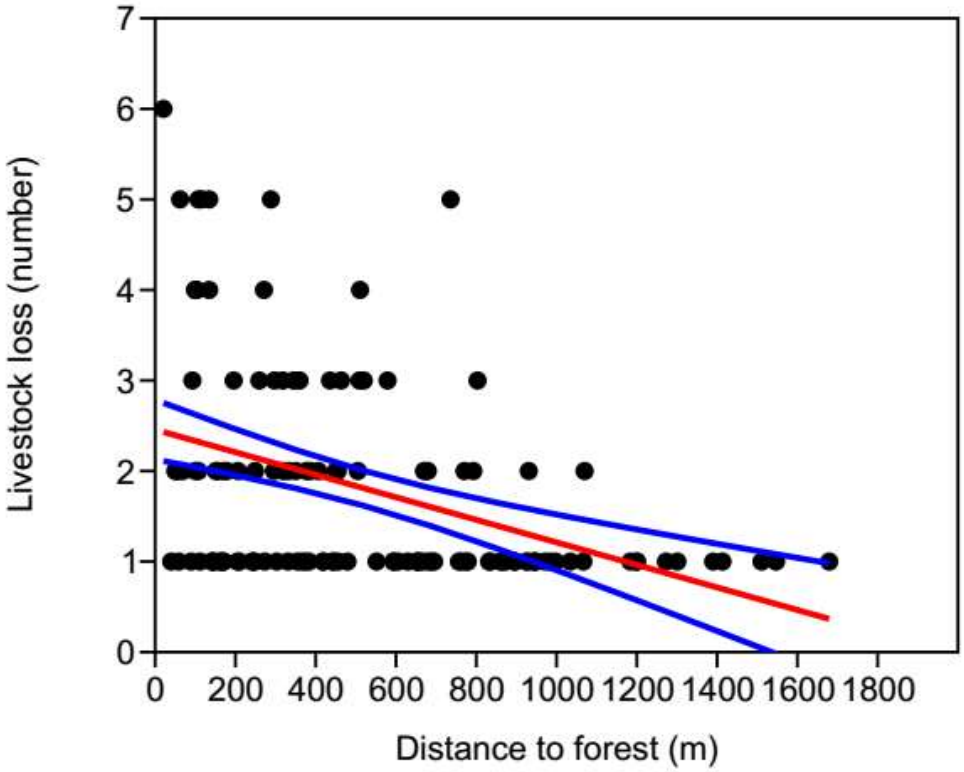

Figure 16. Relation between the livestock loss and distance to forest (y = -0.0012x + 2.457, r^2= 0.21, t= -4.8705, p= 0.0001)

4.4 Perception of respondents towards large carnivores and human large carnivore conflict

Of the total respondents, 64% liked the presence of large carnivores in the forest while 36% of them didn't like their presence because of fear of attack and livestock depredation. Most of the respondents (95%) were highly positive for the right of large carnivores to live in the forest. Perception of local people for the right of large carnivores to live in forest in terms of education status and age groups showed significant differences (χ^2=13.67, df=6, p=0.032 and χ^2=16.48, df=6, p=0.011) respectively but was insignificant in terms of occupation (χ^2=2.76, df=6, p=0.83). 97% of the respondents agreed for the collection of revenue from large carnivores for the park. Significantly different response of people was observed on the basis of education and age group (χ^2=13.7, df=6, p=0.032 & χ^2=12.82, df=6, p=0.04) respectively but was not significant on the basis of their occupation (χ^2=9.18, df=6, p=0.16).

When the respondents were asked about their willingness to participate in buffer zone management program, maximum respondents (59%) agreed for the participation while 29% showed neutral response. Opinions of respondent reveal high significant difference in willingness to participate in buffer zone program with respect to education level and occupation (χ^2=32.31, df=6, p<0.0001 & χ^2=22.58, df=6, p=0.0009) respectively but was not different among age groups (χ^2=10.14, df=6, p=0.11). Despite the fact that all the respondents were victims of large carnivore attack, 73% disagreed for the termination of problem species in case of severe conflict as they understood the importance of large carnivores to maintain natural beauty. Local people perceived significantly different thinking according to education status, age groups and occupation respectively (χ^2=13.5, df=6, p=0.035, χ^2=31.75, df=6, p<0.0001 & χ^2=12.46, dg=6, p=0.052).

About 65% of the respondents were positive for the increasing population of the tiger and leopard in recent years. Impression of respondents on increasing large carnivore population was notably different according to education level, age groups and occupation (χ^2=14.62, df=6, p=0.024, χ^2=16.99, df=6, p=0.0093 & χ^2=14.05, df=6, p=0.02). About half of the respondents (46%) disagreed with the statement of government relief is helping victims as the process of claiming compensation is long, complex and expensive. They said that cost of complaining is higher than their relief amount. While 37% agreed in government relief scheme is helping victims and 17% were neutral about it. In terms of education, age groups and occupation view of respondents on government relief program was significantly different (χ^2=16.38, df=6, p=0.012, χ^2=12.95, df=6, p=0.04 & χ^2=19.14, df=6, p=0.003)respectively. Of the total respondents, 55% were neutral in the question asking about efficiency and sufficiency of government and national parks program for the mitigation of human large carnivore conflict. 35% of respondents disagreed and only 10% agreed with the efficiency and sufficiency of government mitigation program. The knowledge on the sufficiency and efficiency of mitigation measures varied significantly among different age groups, education level and occupation of respondents (χ^2=12.8, df=6, p=0.046, χ^2=30.9, df=6, p<0.0001 & χ^2=22.58, df=6, p=0.0009) respectively.

Table 6. People's perception towards large carnivores

Questions	Education	Age group	Occupation
Wildlife have right to live in forest.	χ^2=13.67, df=6, p=0.032	χ^2=16.48, df=6, p=0.011	χ^2=2.76, df=6, p=0.83
Large carnivores attracts tourist and bring revenue to park.	χ^2=13.7, df=6, p=0.032	χ^2=12.82, df=6, p=0.04	χ^2=9.18, df=6, p=0.16
Participation in the buffer zone management program.	χ^2=32.31, df=6, p<0.0001	χ^2=10.14, df=6, p=0.11	χ^2=22.58, df=6, p=0.0009
In case of severe conflict, problem animal should be terminated.	χ^2=13.5, df=6, p=0.035	χ^2=31.75, df=6, p<0.0001	χ^2=12.46, dg=6, p=0.052
Tiger and leopard population should be increased in future.	χ^2=14.62, df=6, p=0.024	χ^2=16.99, df=6, p=0.0093	χ^2=14.05, df=6, p=0.02
Government relief for loss done by large carnivores is helping victims.	χ^2=16.38, df=6, p=0.012	χ^2=12.95, df=6, p=0.04	χ^2=19.14, df=6, p=0.003
Mitigation measure for conflict is adequate	χ^2=12.8, df=6, p=0.046	χ^2=30.9, df=6, p<0.0001	χ^2=15.86, df=6, p=0.014

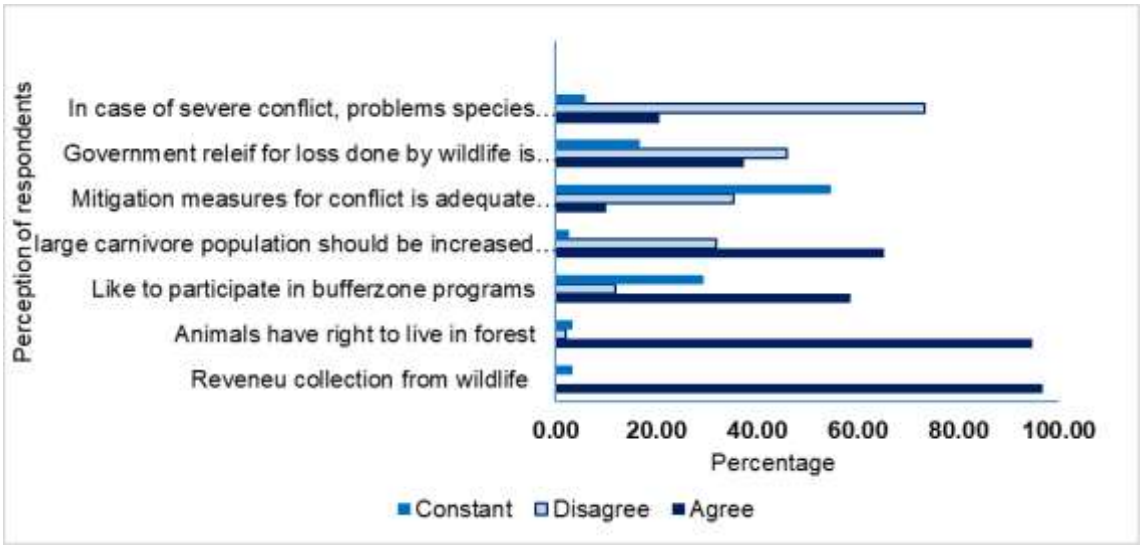

Figure 17. Perception of peoples towards Large carnivores and conflict

4.4.1 Relief Scheme

Of the total respondents, 96% were aware of the relief distribution program of national park for the economic loss caused by wildlife. The relief amount provided by concerned authority was not enough for 69% of the respondents in the study area. When respondents were asked about the time to get relief amount, 3% were unaware of it, 47% of respondents replied very long time (more than a year), 44% of them replied long time (more than 6 months and less than a year) and only 6% said short time (below 5 months) (Figure 18).

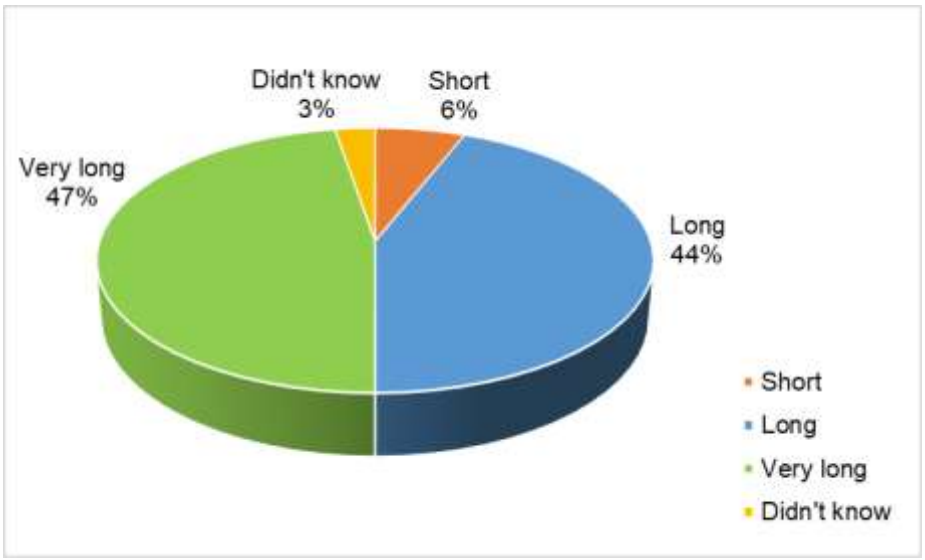

Figure 18. Perception of respondent on duration of relief distributed

During questionnaire, only 58% of respondents had claimed for the compensation of their livestock loss. Among claimed respondents, 46% of them had not received compensation amount till date.

5. DISCUSSION

5.1 Patterns and causes of large carnivore conflict

Annual average livestock loss by large carnivores in buffer zones of Nawalpur was found to be 25.21 during 2001-2019. Total economic loss from the study area in 19 years was US$ 314720.4. Tiger was responsible for the most of the livestock depredation (75%) events. But after 2013, leopard seemed to be more active in livestock depredation activities than tigers. Similar study of Lamichhane *et al.* (2018) reported loss of 123 livestock annually during 1998-2016 in CNP where tiger caused more depredation incidents than leopard. But in recent year (after 2014) depredation caused by leopard were higher than tiger as rising population of tiger might have pushed leopard towards park boundary where it can encounter with livestock easily. Here, most of the livestock killing reported from questionnaire survey occurred at stall during the study period. Tamang and Baral (2008) also reported more livestock loss inside corrals than outside in Bardiya National Park (BNP) which resembles with my finding.

Tigers were main predator of livestock reported by respondents in this study area. Goat/sheep was the primary prey (66%) of the large carnivores where leopard was prime predator of goat/sheep. In contrary to these results, leopard was responsible for the most of the livestock depredation (Odden *et al.*, 2010; Upadhyaya *et al.*, 2020) in BNP. Leopard was found to be the main predator of livestock in Bhutan and Pakistan (Wang and Macdonald, 2006; Dar *et al.*, 2009). Similar result was observed in Pakistan where goats were the primary prey (57.3%) of the leopard (Dar *et al.*, 2009).

The number of large carnivore attack on livestock in my study area was high during night time (77%). This result was supported by (Kumar and Chauhan, 2011) as 74.5% of livestock killing occurred at night time in Mandi district, India. Most of the lion attack in Tanzania was documented during night time (Packer *et al.*, 2011). Similar trend of attacking livestock at stall during night time was observed in Pakistan (Dar *et al.*, 2009). Likewise, Lamichhane *et al.*(2019) also observed more activities of large carnivores during night time in CNP.

Number of livestock depredation seems to be decreasing in recent 5 years of time in the study area. Rising trend of local people to rear livestock at stall might have prompted

reducing livestock loss due to large carnivores. Similar outcome of decreasing livestock loss was mentioned by (Dhungana *et al.*, 2019) in CNP as consequence of increasing stall feeding practice, rearing of improved breed and restriction of livestock grazing in buffer zone forest. Livestock depredation rate and involvement of local people in foreign employment was negatively correlated as it lowers dependency of local on forest resources. Furthermore strict policy of park and community managed bufferzone forest helped in lowering depredation rate in CNP (Lamichhane *et al.*, 2018).

Preference of livestock by tiger and leopard in the study area were examined by employing numbers of depredation events and species involved in the incident. Tiger selected cattle/buffalo more significantly than goat/sheep and avoided pig as prey while leopard preferred pig and goat/sheep and avoided cattle buffalo. Tiger is a large predator which can easily capture large sized prey like cattle/buffalo while leopard being smaller predator may not be able to defeat large sized prey and can get injured itself. So, leopard selects small and medium sized prey (Karanth and Sunquist, 1995). Similarly, Bhattarai and Kindlmann (2012) found remnant of large and medium sized prey in scat of tiger where as more remnant of small sized prey was observed in leopard scat which indicate the preference of large sized prey by tiger than leopard . Preference of large sized prey like sambar deer, wild pigs and gaur was observed in BNP (Upadhyaya *et al.*, 2018). Coexistence of large carnivores in western thailand was described on the basis of temporal prey selection. Tiger selected large prey like gaur and sambar which remains active particularly during dawn and dusk and leopard preffered small sized prey like barking dear and wild boar which remained active during day (Vinitpornsawan and Fuller, 2020).

Sign survey of large carnivores revealed that a large number of the signs were observed near waterbodies and in the flood plain area which was in close proximity with forest. In area far from forest and nearer to human settlement and agricultural field, very few or no pugmarks of large carnivore was sighted. For example; no any signs were observed in Nandabhauju BZUC as this area is far from dense forest, human settlement found to the edge of buffer zones and maximum area covered by agricultural land where regular human activities can be observed. Avoidance of such area by large carnivores might be due to low availability of prey species, and mostly because of human disturbance. Bhattarai and Kindlmann (2018) found similar type of distribution of pugmarks of tiger in CNP where presence sign of tiger was affected by low availability of prey and human intrusion. Tiger avoided the area of human disturbance like livestock grazing sites, resource collection site

with peoples. Habitation of carnivores in PAs of Arizona was affected by the level of human invasion within PAs; area with less disturbance occupied high number of carnivores and vice-versa (Baker and Leberg, 2018).

Lamichhane *et al.* (2019) observed high density of large carnivores in the park boundary and buffer zone areas of CNP. Availability of palatable prey from nearer residential area was the main suspected reason of high carnivore density in fringe of PA. Similarly use of fringe area by leopard has also been reported from BNP and Shuklaphanta National Park (ShNP) (Odden *et al.*, 2010; Pokheral and Wegge, 2019).

About 90% of the respondents from study area are still depending upon the forest for different type of resources. This induces human distrubance in the habitat of large carnivores leading to increasing HLCC in the study area. Expansion of human activities in natural habitatat of wildlife resulted rising frequency of conflict worldwide (Graham *et al.*, 2005). About 45% of respondents from study area rear their livestock outside of corrals near to forest, inside forest, along river banks and agricultural fields where carnivores have easy asses to livestock. Similar result was observed in the study of Lamichhane *et al.* (2018) where 46.7% of the grazing households graze their cattle in community forest in Chitwan. In Abbotabad district of Pakistan, communities are highly dependent on forest for resource like fuelwood, timber, grass , livestock grazing etc. which facilitated conflict with wild animals (Khan *et al.*, 2018). People in the study area believe that large carnivores come out of the forest in search of easy prey and due to lack of abundant wild prey. Limbu and Karki (2003) also identified lack of sufficient food in the reserve, search of palatable food and lack of fences in the boundary as the main causes of conflict in KTWR.

Distance to forest and water resources is another factor resulting increased HLCC in the study area as most of the household with livestock depredation which occurred at stall was found within 1000 meter from forest and water resources. The number of livestock depredation was higher in the households nearer to forest and water resources. Khan *et al.* (2018) also reported most of the livestock depredation (90%) events happened within 1000m from forest border in Pakistan. Reported human casualties from my study area occurred in forest and agricultural field near to the forest. Similar pattern of attacking human within 1 km of park boundary was reported by Silwal *et al.* (2017) in CNP. Dhungana *et al.* (2018) also reported 67% of the human casualties occurred within one kilometre distance from park boundary and 80% of the events within two kilometer of park boundary in CNP.

Average of 0.68 human death per year and 1.05 human injury per year was observed in 19 years of duration in buffer zones of Nawalpur district which is relatively lower than previously reported in CNP (Lamichhane *et al.*, 2018) since my data only cover the bufferzone of Nawalparasi and large carnivores related incidents are only reported. Silwal *et al.* (2017) reported 68 human attack by tiger and 18 attacks by leopard in CNP during 2003-2013. A total of 54 human causalties by tiger was reported by Dhungana *et al.* (2018) during 2007-2014 and 11 human casualties was reported during 2007-2016 in CNP by Dhungana *et al.* (2019) Mean of 0.15 fatalities per year caused by tiger attack reported from Khata Corridor linking BNP in Nepal and Katarniaghat Wildlife Sanctuary in India during 1993-2013 (Wegge *et al.*, 2018).

5.2 Perception of local people towards large carnivores conflict

Overall attitude of respondents towards large carnivore conflict was positive similar to the study of (Lamichhane *et al.*, 2019). In this study ethnicity and management sector infleunced the attitude of people which appear to be similar finding of my study. The perception of respondents from study area varied significantly in terms of their education status, age groups and occupation (Table 6). Despite the fact that all respondents were victim of large carnivore conflict, most of them showed positive opinion on the survival of large carnivores and agreed for the increasing population of tigers and leopard in my study area which is similar to the study of (Wegge *et al.*, 2018) in Khata Corridor reporting support of 44% of respondents whose family members or relatives were victim of tiger towards tiger conservation. Similary most victims of livestock depredation also supported for the conservation of tigers. About half of the respondents (46%) denied government relief is helping victims as the process of claiming compensation is long, complex and expensive which mirror with the result of (Lamichhane *et al.*, 2019) where more than 75% of the respondents were not satisfied with the current compensation practice.

5.3 Costs of human large carnivore conflict

A total of US$ 13702.18 was spent by CNP as releif for livestock depredation in Nawalpur district during 19 years. CNP spent total of US$ 17524.41 for human casualties caused by large carnivores in the study area. The releif distributed for livestock depredation and human casualties in this study area is much lower than reported by Lamichhane *et al.* (2018) which is US$ 60288.74 for livestock depredation and US$ 305007.77 for human casualties caused by wildlife in CNP during 1998-2016. Since my study covers only Nawalpur area

of CNP and only large carnivores related incidents are reported, the releif distributed in my study area is relatively lower in comparision to data of whole CNP. Similarly, the study conducted by Dhungana *et al.* (2019) reported the loss of US$ 24621 from livestock depredation caused by leopard in CNP during 2007-2016 and annual loss was US$ 2462 where total amount distributed as relief fund of US$ 19719 and US$ 1972 per year. A total of US$ 14573 was estimated to be cost of livestock depredation by predators for 297 surveyed households of BNP (Upadhyaya *et al.*, 2020)

6. CONCLUSION AND RECOMMENDATION

Livestock depredation is the major problem faced by local community due to HLCC in the study area. Local people residing in close proximity to the bufferzone are facing utmost economic loss from livestock depredation (US$ 295.51 per household). They rely on the park resources for their livelihood which induces disturbance in large carnivore habitat resulting HLCC. Disturbance from nearer residence in the water resouces and forest has induced conflict in the study area. Construction of electric or mesh wire fencing along the periphery of the park, restriction of grazing inside park has helped park authority to reduce conflict to some extent. Though most of the local people from the study area were aware of the relief program of government for the victims of wildlife attack, many people didn't claim for their loss, especially livestock loss because of very long and complex process of registering application. The process of claiming for relief is expensive than the amount they receive for their loss. This induces negative perceptions towards parks and wild animals. Thus, effectiveness of the proposed programme and awareness programme related to compensation should be conducted to the local communities. This study suggest the short and simple process of claiming relief so that local people can easily receive it which reflect the positive perception towards wildlife conservation.

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APPENDICES

Questionnaires

Household survey Questionnaire on Human carnivore interactions

Name: Age: Sex: M/F

Address (VDC/ward/tol name): Occupation:

Family size: Religion: Education:

1. Do you have livestock? Yes / No. If yes, how many and what kind of livestock?

a. Cow b. Buffalo c. Pig d. Goat/Sheep e. Other

2. How do you rear your livestock?

a. Stall fed b. Grazing in forest c. Grazing in own field d. Grazing in park

e. Other

3. What types of forest resource do you use?

a. Grass b. Timber c. Firewood d. Medicinal plants e. Others

4. Do you know about livestock insurance? If yes, have you done it?

a. Yes, I have done b. Don't know c. Know, but not done

5. If you have not done, are you interested to do? Yes / No. If No, why?

6. Do you or any of your family member go to forest? Yes / No

7. What time of the day you go in forest?

a. Morning b. Afternoon e. Evening

8. Have you ever seen any carnivores?

Yes……. No……..

9. Do you like if there are tigers & leopards in forest? Yes / No

If No why?

10. Which livestock is mostly attack or killed by carnivores?

11. Do you know anybody in your village who were attacked / killed by tiger or leopard?

Yes…….. No……..

If yes, number of people…….. Where (forest / village / agricultural field)

12. What do you think the reason for large carnivores to come out of the forest?

13. What are the precautionary method that you adopt to minimize the large carnivore damage?

14. Do you know that you get compensation if your livestock is killed or your family member is attacked? Yes…. No……

15. If yes, is it enough for compensation?

16. How long does it take to get compensation?

17. Are you satisfied with the compensation scheme? Yes / No

If no, why?

18. Are you happy with the conflict mitigation measures?

Yes….. No…… If no, what should be done?

19. Which agency will be appropriate for relief distribution?

a. Community forest b. Buffer zone offices

c. National park d. VDC / municipality

20. Do you know about buffer zone programmes and national park?

Yes….. No….. If yes, what are the major activities?

Perception of people

1. Wild animals have a right to live in the forest.

   a. Agree b. Disagree c. Neutral

2. Wildlife attracts tourists and brings revenue to the Park, which benefits us

   a. Agree b. Disagree c. Neutral

3. I would like to participate in community wildlife conflict mitigation programs.

   a. Agree b. Disagree c. Neutral

4. In case of severe conflict, problem animals should be terminated.

   a. Agree b. Disagree c. Neutral

5. Tiger and leopard population should be increased in coming years

a. Agree b. Disagree c. Neutral

6. Government relief for loss done by wildlife is helping to victim families.

a. Agree b. Disagree c. Neutral

7. Mitigation measures for wildlife conflict is adequate

a. Agree b. Disagree c. Neutral

Photographs

	
Photo 1.Tiger Pugmark	**Photo 2. Tiger Pugmark**
	
Photo 3. Leopard pugmark	**Photo 4. Leopard pugmark**

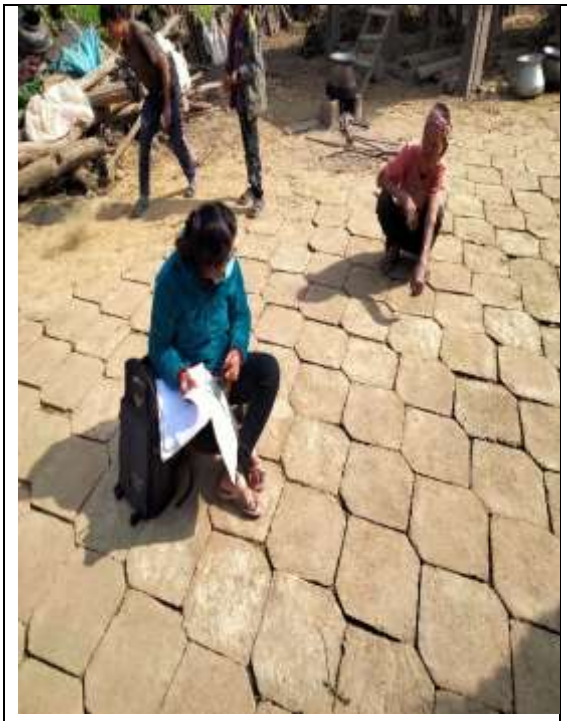	
Photo 5. Interview with victim	**Photo 6. People collecting forest product from CNP**
	
Photo 7. Livestock grazing in Binayi riverbank	**Photo 8. Livestock grazing in Narayani bank**