

**HUMAN-LEOPARD CONFLICT IN PALUNG TAR MUNICIPALITY
IN GORKHA DISTRICT, NEPAL**



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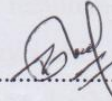
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I hereby declare that the work presented in this thesis entitled has been done by myself, and has not been submitted elsewhere for the award of any other degree. All the sources of the information have been specifically acknowledged by references to the authors or institutions.

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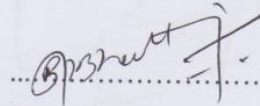
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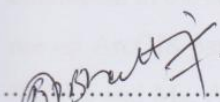
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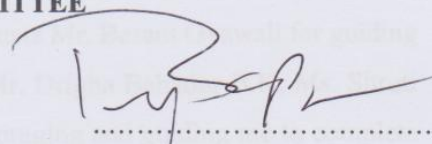
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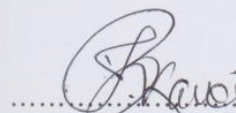
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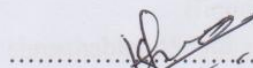
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LIST OF ABBREVIATIONS

Abbreviated form	Details of abbreviations
BS	Bikram Sambat
CF	Community Forest
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DFO	District Forest Office
GIS	Geographic Information System
GPS	Global Positioning System
HLC	Human Leopard Conflict
HWC	Human Wildlife Conflict
IUCN	International Union for Conservation of Nature
km	Kilometer
KTWR	Koshi Tappu Wildlife Reserve
m	Meter
MNP	Machiara National Park
PAC	Problem Animal Control
SNNP	Shivapuri Nagarjun National Park
TAL	Terai Arc Landscape
VDC	Village Development Committee
WWF	World Wildlife Fund

ABSTRACT

Human-Wildlife Conflict is a common phenomenon from the past and has become a significant problem throughout the world. Livestock depredation, property damage and human casualties are the most common forms of conflict. Human-leopard conflict is a major issue in the Palungtar Municipality. This study had been conducted from December 2018 to June 2019 using structured questionnaires and focal group discussion. Questionnaire surveys were conducted in 265 households at seven mostly affected villages of Palungtar Municipality: Khoplang, Aapipal, Palungtar, Gaikhur, Chyangling, Dhuwakot and Mirkot. Altogether 21 transects were drawn to represent different habitats of Palungtar area, where the direct and indirect signs of the species were recorded. Signs of Leopard were recorded on both sides of transect within ten meters. A total of 45 signs was obtained in the seven different Community Forests of the study area, indicating the presence of the Leopard. About 79% households suffered livestock depredation problem from Leopard in the study area. There were 375 domestic animals were killed and 49 domestic animals were injured due to Leopard attack from 2016 to 2018. Chyangli Village was the most affected village for livestock depredation and Khoplang Village was the least affected for livestock depredation. A total of two human attack cases was recorded. Linear regression ($R^2= 0.93$, $F=12.56$, $P=0.03$) was used to analyze the distribution of Leopard. More than half (63%) of the respondents had positive attitude towards the presence of Leopard conservation. It assessed the tolerance level and perception of the local people towards Leopard conservation by mitigating human-leopard conflict. This study was also designed to explore the status of Leopard (*Panthera pardus*) in the study area. This study aimed to explore the human-leopard conflict in terms of livestock depredation, human casualties and other causes of human-leopard conflict. Major causes of Leopard decline are due to deforestation, forest fire, low prey species, habitat degradation, poaching, killing and others. Afforestation, habitat conservation, awareness program for local people and regular monitoring of Leopard might help to reduce the human-leopard conflict.

Key words: Leopard, Palungtar, Conflicts, Livestock depredation, Household survey.

1. INTRODUCTION

1.1 Background

Human-Wildlife Conflict (HWC) is an interaction between people and wildlife that results in negative impacts on human's social or economic life on the conservation of wildlife populations or on the environment (Athreya et al. 2007, Pokharel 2015). IUCN World Parks Congress (WPC 2004) defines human-wildlife conflict as occurring “when the needs and behavior of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife”. HWC is emerging as a significant wildlife management issue. It results in severe impacts on communities in the form of crop depredation, property damage and loss of livestock (Pandey et al. 2017). HWC have two major factors that caused the conflicts. They include push and pull factors (Saabon et al. 2011). The push factor occurs when the wildlife habitat is destroyed by human for urbanization or economic activities and the over hunting activities also make wildlife feel insecure to stay in their own habitats. The pull factors occurs when wildlife itself intrude into the human area because they are attracted to agriculture crops and livestock that have been freed randomly (Hassan et al. 2011). According to World Wildlife Fund (WWF), HWC is one of the main challenges to the survival of many species. It has visible indirect or hidden impacts as well (Barua et al. 2013). Hidden impacts include disruption of livelihood and food security through crop or livestock loss. It also involves health impacts, transaction (time and money spent in mitigation measures and claiming compensation) and opportunity cost (lost income) and are often psychological or social in nature (Barua et al. 2013, Upadhyay 2013). The cases of HWC increase annually (Goldthorpe & Neo 2011) in the Gorkha district, especially in the Palungtar Municipality.

1.2 Human-Leopard Conflict

Human-Leopard Conflict (HLC) is the most serious problem for conservation of cats globally (Pokharel 2015). Conflict between humans and Leopard (*Panthera pardus*) is a complex issue. Conflict influenced by political and social attitudes, the biology of the species, and management action (Athreya & Belsare 2007, Kabir et al. 2014). The human-carnivore conflict is an alarming global issue for conservationist as many carnivore species are at the brink of extermination (Treves & Karanth 2003). In Nepal, Leopards mostly attack in the midland regions such as mid hills, and lesser Himalaya (Maskey et al. 2001).

HLC has two dimensions one is human safety and livelihood issue and second one is protection and conservation of the threatened species (Suthar et al. 2018).

1.2.1 Distribution and status of Leopard in Nepal

Nepal is home for three species of Leopard: Leopard *Panthera pardus*, Clouded Leopard *Neofelis nebulosa* and Snow Leopard *Uncia uncia*. Out of these three species: Leopard is the most common, which is not only limited to forest or heavy covers but also thrive well in open country. It is also called forest Leopard (Ghimirey 2006). Leopard is an opportunistic animal. It has a flexible diet and can also sustain on wild prey species such as Ghoral (*Naemorhedus goral*), Northern red muntjac (*Muntiacus vaginalis*), Wild Boar (*Sus scrofa*), Jungle fowl (*Gallus gallus domesticus*) and Langur (*Semnopithecus* spp.) and other small prey species (Kumar 2011, Bhandari 2015). Leopard is present in Nepal mainly at areas below 4400 m (Jnawali et al. 2011). It is widely distributed large felid, which abundantly uses human dominated landscapes (Dahal & Gurung 2017). The presence of a species like the Leopard in a human dominated landscape will invariably lead to some predation on domestic animals (Athreya & Belsare 2007). They are involved in conflicts with people due to their large home ranges, adaptability for diverse stand anthropogenic pressure and decline in natural prey base (Mondal et al. 2018).

1.2.2 Distribution and status of Leopard in the world

The Leopard, *Panthera pardus* Linnaeus, 1758 is a widely distributed large cat found in Asia, Africa, Middle East and South Eastern Europe (Nowel & Jackson 1996, Sunquist & Sunquist 2002). It is the most widespread large carnivore (Myers 1976), due to its highly adaptable hunting and feeding behavior (Bertram 1999, Hayward et al. 2005). Leopard has been classified as a threatened species in the IUCN Red list data book. The IUCN classifies the Leopard as Vulnerable and recognizes nine subspecies (Miththapala et al. 2001, Jacobson et al. 2016). It is common in the forests across Himalayas. It is most common of the big cats and it remain in Appendix 1 of CITES because of its extensive hunting had depressed populations in several part of Africa (Myres 1976). Leopards are normally associated with areas of rocky hills, mountains and forests but they also penetrate deserts where they are restricted to the moist water courses (Nowell & Jackson 1996, Swanepoel 2008).

1.2.3 Causes of human-leopard conflict

Human landscapes, wildlife territories, increasing interaction of man and wild animals and this factors increased levels of conflict (Habib et al. 2015). Globally, large felid predators face three major threats: decrease in prey population, direct persecution by man, and habitat degradation and fragmentation (Nowell & Jackson 1996). These three factors are likely to operate together since they are predominantly products of anthropogenic disturbance (Mazzolli et al. 2001). Conflicts between human and wildlife in the world are escalating due to increasing human population, loss of natural habitats, scarcity of forage resources and due to increase in wildlife population locally (Rodgers 1989, Saberwal et al. 1994, Agarwal et al. 2011). The large home ranges of Leopards often result into competition with humans, predominantly in areas where livestock rearing overlap with Leopard home range (Karanth et al. 1999, Polisar et al. 2003, Qamar et al. 2010). In Africa and other developing areas of the world, fast growing human population, settlements and accompanied habitat fragmentation are reducing the wildlife habitats (Hill et al. 2002, Mwamidi et al. 2012). The major types of wildlife damage on the human being are predation of domestic animals, crop damage and sometimes killing of humans (Madden 2008, Gobosho et al. 2016). Many ecological, biological, and anthropogenic factors are the main causes of the global decline of carnivore species (Cardillo et al. 2004). Some other causes of conflict include deforestation, forest fire, loss of natural habitat and habitat degradation, pesticides, poaching and in some regions, recovering wildlife populations resulting from successful conservation programs (Athreya & Belsare 2007, Inskip & Zimmermann 2009, Kabir et al. 2013).

HWC bring many social, economic and ecological consequences. Crop and property damage and livestock depredation are common effects resulting in huge economic losses worldwide. The effects gradually weaker the political support for conservation in protected areas and may call for eradication of the problem animal (Treves & Bhattarai 2009). Frequency of livestock depredation incidents may depend on the relative abundances of predators, wild prey, and livestock. Depredation incidents may decrease when predator densities decrease with increasing human population densities (Woodroffe 2000, Sidhu et al. 2017). Increase in livestock depredation may also result from low wild prey availability or high livestock numbers in a landscape (Bagchi & Mishra 2006). Low wild prey abundance may be caused by hunting for trophies or meat or because of competition for resources with domestic species. Other factors reported to influence conflict are distance to

grazing pastures, guarding of livestock, and bad weather (Mazzolli et al. 2002, Wang & Macdonald 2006). Major causes of Leopard decline due to shooting, poisoning, accidental snaring, and road accidents occur mostly on or outside the borders of unfenced reserves and are particularly common where reserves are surrounded by areas supporting high densities of people (Harcourt et al. 2001, Ogada et al. 2003). Indiscriminate poaching of wild ungulates for meat, skins, horns, and medicine has caused decline of Leopards' natural prey populations (Kala 2005, Kala & Kothari 2013).

1.2.4 Mitigation measures of human-leopard conflict

Prevention of conflict between humans and wildlife has been a challenge for management authorities and local community and very less success has been documented (Manral et al. 2016). The mitigation of HLC is an important issue in the management of biodiversity and protected area. The conflict takes many forms ranging from loss of crop, livestock and human casualties. Mitigation measures may not be universal because of differences in socio-political, cultural, economic and geographic situations between the localities (Bhattarai 2009). Leopard *Panthera pardus* management in Nepal is facing many challenges and they have highly diversified diets and are extremely adaptable to various ecological conditions (Hayward et al. 2006). Common mitigation measures for crop protection were night watching, fencing, scare devices and for livestock protection were closer watch on animals, guard animals and fencing (Karanth et al. 2013). Conservation of forests, reforestation/afforestation programs, and sustainable forest management can minimize human wildlife conflict. Climate change mitigation strategies such as reducing emissions from deforestation and forest degradation and trans-boundary landscape conservation have the possibility of exacerbating human-wildlife conflicts (Miles & Dickson 2010).

Osborn and Parker (2003) divide defensive measures into two broad categories: passive and active. Passive methods have been designed to prevent the movement of wildlife into agricultural land by the use of barriers such as different types of fences and digging trenches (Nyhus et al. 2000). While on the other hand, active methods include chasing away wildlife by making noise through shouting, banging tins and patrolling fields (Hill 2000). Effective management of conflict will have to strike a balance between minimizing serious conflict (attacks on people) and the long-term conservation of the Leopard species (Athreya et al. 2004). Problems of HWC were three worldwide strategies or methods including prevention, mitigation and protection strategies. A prevention strategy attempts to

circumvent the conflict. They includes eradication of the wild animals, managing the size of the population through killing or controlling reproduction, regulated harvesting or cropping, fertility control, guarding crops and livestock and so on. However, mitigation strategies attempt to reduce the level of impact and lessen the problem with the main difference between the two options being the moment at which the measure has been implemented. On the other hand, protection strategy is implemented when the conflict is certain to happen or has already occurred include; Problem Animal Control (PAC), translocation of wildlife, incentive programs, insurance programs, compensation systems and community based natural resource management schemes (Ogada et al. 2003, Ocholla et al. 2013). Adaptive management of HWC needs to be more responsive to conflict; more proactive in using research, best practices and other resources, and more assertive in learning about, developing, and implementing solutions (Madden 2004).

Palungtar Municipality people mainly depend upon the agricultural activities in addition to rearing livestock. The livestock depredation is the major problem in the Palungtar Municipality area. Therefore, a detailed study was carried out to identify the extent of HLC and people's perception towards wildlife to make effective recommendation for reduction and mitigation measures of HLC in the study area.

1.3 Objectives

1.3.1 General objective

The main objective of this study was to assess the human-leopard conflict in Palungtar Municipality.

1.3.2 Specific objectives

- To determine the distribution of Leopard in the study area.
- To investigate the causes and impacts of human-leopard conflict.
- To explore the local people's perception towards the Leopard and its conservation.

1.4 Limitations of the study

There were some limitations during the study; some major limitations are as below:

- The sign distribution and livestock damage was only possible to be identified in this study.
- Only few villages were possible to be sampled during this study due to limited time.

1.5 Rationale of the study

Human-Leopard Conflict has been recorded in the Palungtar Municipality, since around 8 or 10 years. Leopards are serious problem to people and their livestock in Palungtar. It has both direct and indirect costs for human beings. It is rapidly becoming a critical threat to the survival of many globally endangered species particularly large and rare mammals. In Nepal, research on human-leopard conflict has been done less compared to other Asian regions (Bhattarai 2009). Many studies have found that human and carnivore conflicts are more severe in such sub-optimal habitat (Nyhus & Tilson 2004). Conflicts possess serious challenges to conservation of biodiversity around the protected areas. This study focuses to envisage the degree of conflict in the Palungtar Municipality of Gorkha district and understand the perception of local communities residing in the vicinity of Leopard habitat. It also suggests, further to better Leopard conservation strategies through conflict mitigation.

2. LITERATURE REVIEW

2.1 Distribution of human-leopard conflict

In Nepal, detailed status of Leopard has not been known yet. However, according to Shah et al. (2004), Leopards are present in 75 districts of Nepal out of 77 districts except Okhaldhunga and Dhanusha, this data is based on sighting report local views, news and literature including book and published reports. Athreya (2006) and Bhandari (2015) found that Leopards are territorial animals and when displaced, they have a tendency to seek out their original territory, which may be hundreds of kilometers away. Similarly, Ghimire (2006) concluded the presence of Leopard in the study area and indicating many evidences such as pugmark, scats and scraps. He reported that 39.46% local people agree in Leopard acting as a supportive to the tourism development, ecological balance, biodiversity conservation etc. while 30.26% people think that there are no benefits of Leopard. According to Jacobson et al. (2015) the Leopard (*Panthera pardus*) has broad geographic range, remarkable adaptability, and secretive nature and also found that they not only are several subspecies and have regional populations critically endangered but, also the overall range loss is greater than the average for terrestrial large carnivores. Irshad et al. (2018) studied the occurrence of Leopard (*Panthera pardus*) in Abbaspur Area, Azad Jammu and Kashmir. They confirmed at six out of twelve sampling sites surveyed and found many evidences including pugmarks, cave/den, and dead bodies (two carcasses and one skin) of the animal.

2.2 Causes and impacts of human-leopard conflict

Tamang and Baral (2008) recorded that among the 484 households surveyed, 66.5% reported 442 livestock loss over a six-year period. About 45% of the total livestock loss occurred during the summer season. Tigers (*Panthera tigris*) and Leopards (*Panthera pardus*) were the two major predators in the area: Tigers killed larger livestock while Leopards killed smaller livestock. Kumar and Chauhan (2011) recorded the human casualties caused by Leopard in different forests of Mandi District, India for the period of 20 years (1987-2007). Leopard caused 162 human casualties. Among them, 13 people were killed and 149 were injured. 4967 attacks and 8905 livestock were killed including mainly Goat (*Capra aegagrus*), Sheep (*Ovis aries*), Cow (*Bos taurus*) and others were Ox (*Bos taurus*), Water Buffalo (*Bubalus bubalis*), Mule (*Equus asinus*), Horse (*Equus*

caballus) and Donkey (*Equus asinus*). According to Koirala et al. (2012), the results of the study on Human-Leopard (*Panthera pardus*) Conflict studied in Annapurna Conservation Area in 2009 and 2010 showed that Leopard killed more livestock than any other predator. The highest losses to Leopard occurred 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. Human-carnivore conflicts over livestock depredation are increasingly common. Khorozyan et al. (2017) obtained data on 39 attacks, which included a total loss of 31 Sheep and 36 Goats in 17 villages and addressed this issue by studying individual Leopard (*Panthera pardus*) attacks on Sheep and Goats in 34 villages near Golestan National Park, Iran. They also found that 95.5% of losses were inflicted in forests when Sheep and Goats were accompanied by Shepherds (92.5% of losses).

Acharya et al. (2016) studied the human-wildlife conflicts in Nepal and patterns of human fatalities and injuries caused by large mammals. In Nepal, people are also attacked by large mammal species such as Tigers (*Panthera tigris*), Leopards (*Panthera pardus*), Rhinoceros (*Rhinocerotidae*), Elephants (*Loxodonta*) and Bears (*Ursidae*). In similar studies, habitat degradation and fragmentation, depletion of natural prey species, poorly managed harvests, illegal trade of Leopard skins and HLC have contributed to the decline. In Nepal, Leopards are killed legally as well as illegally because of the threats they pose to livestock and on very rare occasions, to human life (Constant 2014, Constant et al. 2015). Partasasmita et al. (2016) found that the populations of Leopards continue to decrease over time in Girimukti Village, Sukabumi, Indonesia. This decline was caused by many factors, such as decreasing animal prey and habitat loss. Due to a lack of animal prey, Leopards frequently enter villages to find food including livestock. Therefore, some conflicts between HLC have frequently occurred, and in many cases the Leopard has been hunted by the villager. Habib et al. (2015) explained the rising levels of man-animal conflicts at various locations of Kashmir valley in India are due to close proximity between humans and wild carnivores particularly Leopard and Asiatic black bear (*Ursus americanus*). They were mainly involved in causing several forms of conflict. The human population growth and expansion, habitat degradation and fragmentation, land use transformation and increasing densities of livestock grazing in protected areas are considered as the major causes of man carnivore conflicts. Gunawan et al. (2017) studied conflict between humans and Leopards in Western Java, Indonesia. The conflict between humans and Leopards is rising as deforestation is

increasing for agricultural use in this area and others causes followed by fragmentation and habitat loss of Leopards.

2.3 Perception of local people towards Leopard conservation

One hundred forty eight respondents ranked Leopard as the most problematic predators that affected them (87.9%), then Black bear (10.1%) and Fox (*Vulpes vulpes*) (2.0%). The majority (93%) of respondents thought that the frequency of Leopard attacks on livestock had increased since the establishment of MNP in 1996. Most (70%) respondents attributed this increase to the degradation and loss of forest habitat, while some (24%) cited wild prey base decline (Dar et al. 2009). Hussian et al. (2018) reported that most farmer (89%) experienced damage to their property, as a result of the actions of wild animals. Unlike damage to crops, many households in the study area lost their domestic animals to predators. 40.38% respondents reported Leopard (*Panthers pardus*) as the major wildlife species preying on their domestic animals and attacking on human. Similarly, most of the respondents were not happy with the compensation scheme, owing to the meagre amount they got but, several affected people showed a positive attitude towards the presence of Leopards in Rantagiri district (Donikar et al. 2011).

2.4 Mitigating measures of human-leopard conflict

According to Mishra (1984) the conflict of wildlife park management and local people is more in Nepal in compare to most of the developing world. Conflict between people and felids is one of the most urgent wildcat conservation issues worldwide, yet efforts to synthesize knowledge about these conflicts have been few. Inskip and Zimmermann (2008) found that the evidence of conflict is affecting 75% of the world's felid species. For management strategies to be effective, a thorough understanding of the dynamics of human-felid conflicts is necessary. MoA (2008) studied the population control of problem wild animals, creation of clean buffer zones between the forest and agriculture fields, compensation on livestock depredation and establishment of community volunteers to monitor fields at critical periods during the growing seasons and awareness and training for farmers were the effective techniques to reduce the Human wildlife conflict.

Similarly, The Rajaji-Corbett Corridor in the Terai Arc Landscape (TAL), which is a globally important eco-region (Olson & Dinerstein 2002) has significant populations of Tigers (*Panthera tigris*) and Leopards (*Panthera pardus*, Johnsingh et al. 2004). Malviya and Ramesh (2015) studied that there are many conflict resolution strategies, which can be

applied in the study area. In terms of managing human–leopard conflicts, fencing around villages would be a preventive measure. Other preventive measures are manipulation of habitat to discourage Leopards from entering human settlements. This would involve weed management, as weeds such as lantana (*Lantana camara*) provide cover to Leopards. Pandey et al. (2017) discussed in occurrence and conflict management of human-wildlife conflict. Analysis of human-wildlife conflict management and it refers to the interaction between wild animals and people and the resultant negative impact on people or their resources, or wild animals or their habitat. They define two conservation methods: firstly, sensitization programs should be organized to educate both rural and urban residential area, and secondly, wild animals' habitat should be conserved.

Banikoi et al. (2017) and Treves (2007) explained two mitigation measures: 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. While direct methods reduce the severity and frequency of wildlife damages, indirect methods raise people's tolerance for conflicts with wildlife, employed to prevent livestock depredation including cash compensation, indirect compensation through integrated conservation and development programs, and selective sustainable extraction of resources. Kishwan (2013) included the different mitigating methods of wildlife conflict: Awareness generation and involvement of people's teamwork in tackling conflict, establishment of emergency response mechanism, management of crowd, management of the animal, capture and handling of the trapped animal, release or translocation of captured Leopard, transportation of captured animal, monitoring of translocated Leopards and avoidable "Rescue" of Leopards. These guidelines have been effective to minimize the human wildlife conflict.

3. MATERIALS AND METHODS

3.1 Study area

3.1.1 Location

Palungtar Municipality lies in Gorkha district of Gandaki Province, Central Nepal. It was established in 2014 (2071 BS) and is divided into 10 wards. It is geographically hilly region and occupies a total area of 158.62 km². It is surrounded by the Gorkha Municipality in the east, Tanahu district in the west, Lamjung district and Siranchowk Rural Municipality in the north, and Gorkha Municipality and Tanahun district in the south. Palungtar Municipality has a total population of 38,244 (CBS 2011) and is situated at latitudes: 28.049°, 28.01361° North, longitudes: 84.2926°, 84.490560° East and 228 meter to 1000 meters altitude from above sea level (RERL 2018).

Palungtar Municipality has 71 community forests. All these community forests occupy a total of 3936.93 hector area, 9100 households and 52,298 benefited populations from Community Forest (Fiscal year 2074/075). The study site lies vertically from lower altitude to higher altitude encompassing mainly seven affected villages such as Palungtar-1: Khopalng, Palungtar-2: Aapipal, Palungtar-4: Palungtar, Palungtar-6: Gaikhur, Palungtar-10: Mirkot, Palungtar-7: Chyangli and Palungtar-8: Dhuwakot that includes Annapurna Community Forest, Kanlaban Community Forest, Aamadada Community Forest, Kaamdheni Community Forest, Deurali Community Forest, Kalika Community Forest and Thuloban Community Forest respectively. Most of these village people mainly depend upon agriculture and livestock rearing. Palungtar Municipality had a homogenous ethnic group such as Brahamin, Chhetri, Kumal and Mixed community (Figure 1).

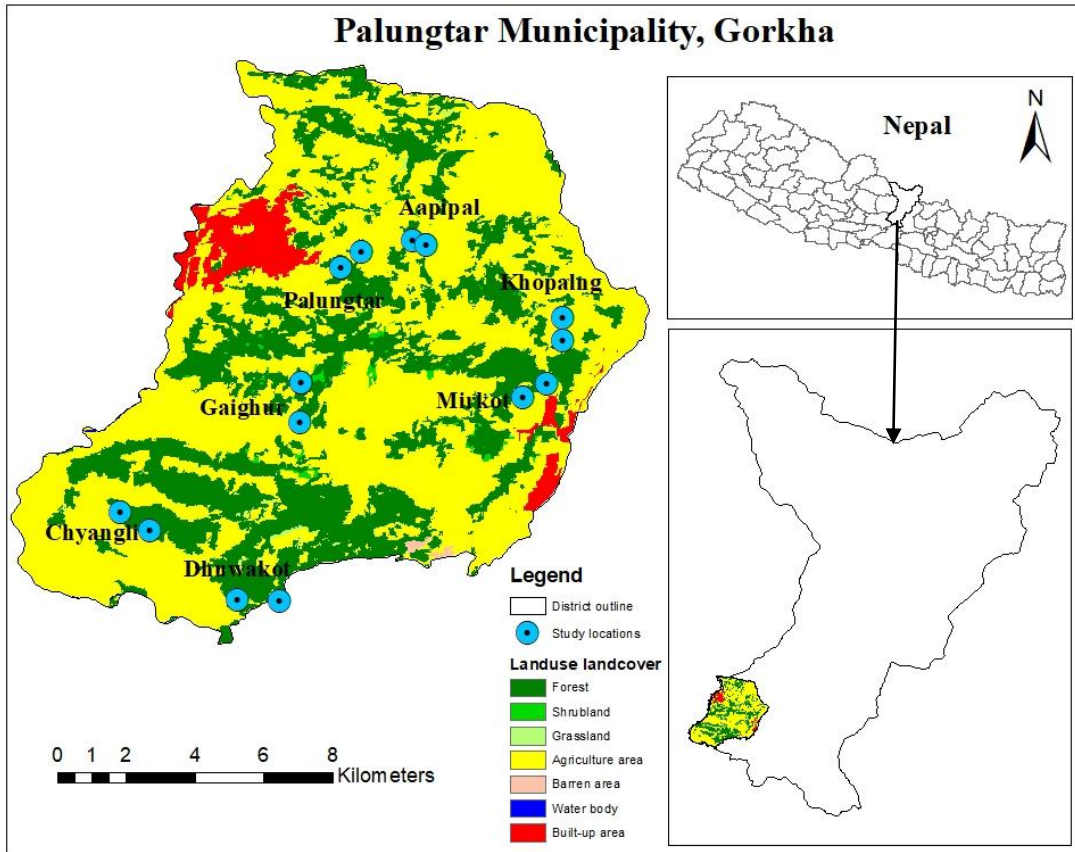


Figure 1: Map showing the study area.

3.1.2 Climate

The Palungtar Municipality falls on tropical zone ranging from 300 to 1000 m elevation where the climate is temperate. It has a climate with warm days followed by cool nights and mornings. Generally rainy season starts in June and ends in September, average rainfall was 909.98 mm. During summer, temperature reaches to 32^o c and in winter it drops to 9^o c and average humidity was 64% (DHM 2019).

3.1.3 Flora

Of the five vegetation zones of Nepal, the Gorkha District of Palungtar Municipality lies in the tropical forest zone. The Community Forest of Palungtar Municipality is one of the biodiversity rich area. This Community Forest is mainly covered by the Sal forest. The forest comprises of climber, herb, shrub and tree plants. Sal forest: Sal (*Shorea robusta*) is dominant tree species in this area. Sal forest is predominant mixed with Katus (*Castanopsis indica*), Chilaune (*Schima wallichii*). Other plant species found are Kutmiro (*Litsea monopelata*), Pipal (*Ficus religiosa*), Tanki (*Bahunia purpurea*), Koiralo (*Bahunia variegata*), Amba (*Pisidium guyava*), Bans (*Dendrocalamus strictus*), Bilaune (*Maesa*

chisia), Sisnoo (*Urtica dioca*), Simali (*Vitex negudo*), Angeri (*Lyonia ovaliforiya*) (CCPL 2010).

3.1.4 Fauna

The Palungtar Municipality is rich in faunal diversity. It comprises of different wildlife as the Leopard (*Panthera pardus*), Jungle Cat (*Felis chaus*), Squirrel (*Sciurus carolinensis*), Porcupine (*Hystris indica*), Jackal (*Canis aureus*), Lokharke (*Rautufa indica*), Yellow-Throated Martin (*Martes flabigula*), Northern red muntjac (*Muntiacus vaginalis*), Rhesus Macaque (*Macaca mulatta*) etc. Bird diversity includes Kalij (*Lophura leucomelanos*), Parakeet (*Melopsittacus undulatus*), Titra (*Francolinus* spp.), Bulbul (*Pcynonotus cafer*), Jungle fowl (*Gallus gallus domesticus*), etc. according to the report of DFO (Division Forest Office), Gorkha (Fiscal year 2074/075).

3.1.5 Geology and soil

Palungtar Municipality lies in a hilly region with steep terrain and some flat lands. The land-use of Palungtar is dominated by agricultural area covering 40.83% out of which only 10% is irrigated while 31% is yet to be irrigated. This is followed by Forest area (31.35%), Pasture land 18 (7.42%) and Barren land (6.75%). The pastureland consists of 7.42%, which is usually used for grazing the livestock while 6% of the total area is covered by barren land where there is no settlement or agricultural production (RERL 2018). Deep lateritic and forest soil was found in Southern part of Palungtar Municipality, and tundra soil was found in Northern part of Palungtar Municipality.

3.2 Materials

During the field study, the materials used were GPS, Questionnaires sheet, Measuring tape, Camera, Notebook, Pen.

3.3 Research design

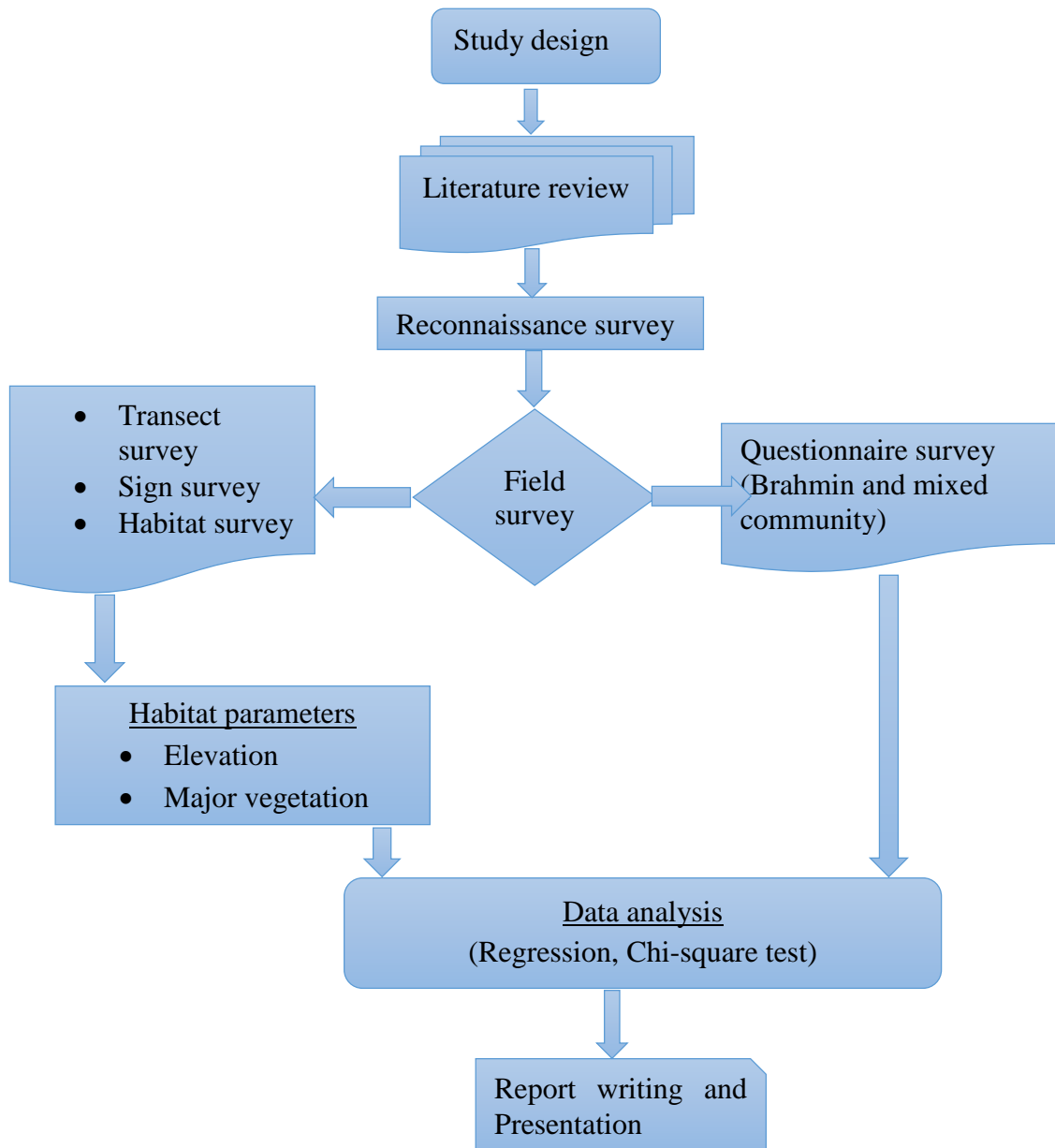


Figure 2: Research design of the study area

3.4 Research methods

3.4.1 Reconnaissance survey

A reconnaissance survey was conducted before the initiation of the field work. Preliminary information about forest types, Leopard's occurrence and conflict status was gathered through informal meeting with the secretary of DFO, Municipality secretary and the local

people. Such information was useful to design the sampling framework. The reconnaissance of forest areas of Palungtar was conducted in the month of December 2018 to identify the affected areas by Leopard and to gather some ecological information of different forest areas.

3.5 Data collection

Data was collected by primary method. It was collected through the field visit and direct observation. Primary data was collected by the following methods.

3.5.1 Primary data collection

3.5.1.1 Leopard survey

The data on presence/absence and abundance of the Leopard species was collected by visual encounter survey and sign survey. Both surveys were conducted along with transects. Palungtar Municipality lies in hilly geography, so it was not feasible to mark and monitor straight line transects. Therefore, abundance of Leopard was estimated by walking on forest trails, fire area and grassland. Location along with presence/absence sign of Leopard was taken through direct and indirect methods. Looking for footprints and pugmarks, soft grounds such as near water and muddy ridge was used to detect the presence of the species (Mooty & Karns 1984). The location, where the marks were found was noted with Global Positioning System (GPS).

3.5.1.2 Transect design

Leopard sign survey was carried out in the community forest of Palungtar Municipality of Gorkha district. The field survey was conducted from December 2018 to June 2019. For transects design, the resource map of the area was consulted. The different land-use types representing the habitat of Leopard identified. To remove the biasness, transects were designed in such a way so that transects represent every land use types and thus represent different habitats of Leopard. During the field survey, presence of the Leopard signs in the study area such as pugmarks, scrapes, scats and carcass were recorded. Total 21 transects were drawn on the basis of different habitats in seven CFs (Annapurna CF, Kanlaban CF, Aamdada CF, Kaamdhenu CF, Kalika CF, Thuloban CF and Deurali CF) and these transects gave sample evidences of Leopard's presence in the study area. Short transects were better therefore, such transects were established in the forests nearby conflict areas (WWF Nepal 2001). Each transect length was 100 m horizontally. Three transects were drawn in one community forest and in one transect, total distance was one km. Ten meters

on both sides of transect was also observed for the signs of the Leopard. Local trails were used as transects. Direct and indirect signs such as scats, scrapes, pugmarks, footprint etc. were recorded in the field survey. The locations where the signs point were noted with GPS.

3.5.1.3 Questionnaire survey

The structured questionnaire survey was followed randomly with the local people. Two sets of question were prepared, one for local people and another for community forest office. Questionnaire survey was conducted using both close and open-ended questions and they having multiple options. About 265 questionnaire survey were carried out at the isolated seven affected villages namely Khopalng, Aaipal, Palungtar, Gaighur, Chyangling, Dhuwakot and Mirkot. The questionnaire survey was conducted to investigate human-leopard conflict in the study area and availability status of natural resources to the local community and awareness towards biodiversity conservation. Information on total household numbers were obtained from sub-division Community Forest office. This survey was conducted from December 2018 to February 2019. At that time, winter being the harvesting season, it was very difficult to meet some farmers at home for interview. Since the season was dry and cold, farmers were in the crop field during the morning time. Therefore, a majority of the interviews was conducted at daytime during which, the day temperatures raise to maximum levels. The respondents' age class distribution was 19 years of age to above 80 years of age. Out of the 265 respondents, only 78 (29.43%) were female (Appendix IV).

3.5.1.4 Group discussion

During the field survey, focus group discussion were organized forming four focus group in the study area. One group was formed by involving members of Division Forest Office staffs and other groups included villagers. The main aim of the group discussion was to investigate varieties of information regarding the Leopard activity pattern, livestock depredation, cause of conflict, management of conflict and peoples' role in conflict management. Livestock depredation strategies adopted by local people towards HLC were also assessed through household survey and direct observation.

3.5.1.5 Key informant survey

Key informant survey was conducted exclusively with those available during the household survey. Interviews with the local people were conducted to know the status of human-leopard conflict. Questionnaire regarding the status of conflict, causes of conflict, attitudes

towards Leopard and their role in conflict management especially for elderly people, farmers, school teachers and local leaders.

3.5.1.6 Sampling of household survey

For household survey, seven affected villages of the Palungtar Municipality were selected. From these seven villages, 265 total households were chosen using a random selection process. These numbers were later selected using a random number table. The list of each household was obtained from the community forest staffs. The total number of household selected by the random selection process in each village was represented in the study area (Table 1).

Table 1: Household survey

S.N.	Name of village	Total households	Sample households
1.	Gaikhur	552	26
2.	Mirkot	612	30
3.	Chyangli	1297	30
4.	Dhuwakot	719	32
5.	Khoplang	623	39
6.	Aapipal	1194	39
7.	Palungtar	1044	69

3.5.2 Secondary data collection

The secondary data was collected through different literature and journals, report and dissertation works from CDZ, TU.

3.6 Data analysis

All the collected data were checked, refined and then entered in MS office Excel 2010 sheets. All these conflict data were analyzed by using MS office Excel 2010 and PAST software. Data was assessed using descriptive statistics like frequency, percentage and presenting in the form of chart, table form and bar diagram. For Leopard sign survey, the locations where the marks are found were noted with GPS along transect and these points were interpreted in map by the use of Arc GIS 10.4 software on computer. To analyze the relationship between the attitude of people in the conservation area, their education level

and gender, the Pearson Chi-Square test and sign distribution were used in linear regression method.

Livestock loss calculation

$$\text{Total livestock holdings} = \frac{\text{Sum of total number of livestock}}{\text{Total number of surveyed household}}$$

$$\text{Average number of livestock killed per household} = \frac{\text{Sum of total number of killed livestock}}{\text{Total number of surveyed household}}$$

4. RESULTS

4.1 Distribution of Leopard in the study area

Out of 21 transects, 19 scats of Leopard were found in nine transects whereas no any scats were recorded in remaining 12 transects. For scrape, four transects did not account scrape of Leopard whereas remaining 17 transects accounted 19 scrapes. For pugmark and carcass, 16 transects did not account sign of Leopard and remaining five transects accounted five pugmarks and only two transects accounted two carcasses (Appendix II). The scrapes were most abundantly recorded with 19 followed by scat (19), pugmark (5) and carcass (2) (Figure 3). The study provided many evidences, which clearly indicated the presence of Leopard in the study area. Total 45 signs were recorded in 18 transects. The density of signs recorded was 2.14 signs per transect. Among 21 transects only 18 transects determined 45 signs of Leopard in total distance 21 km with average one sign/km.

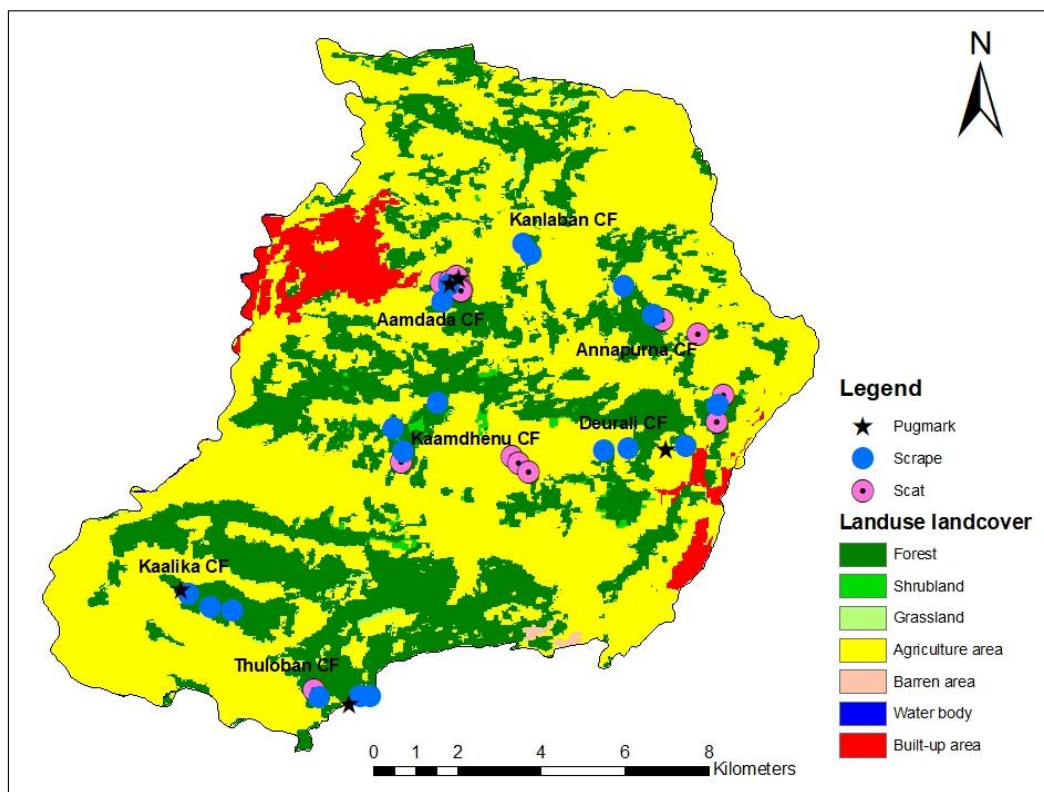


Figure 3: Map showing the distribution of Leopard signs

4.1.1 Distance between signs and village

The linear regression analysis was done to find out the relation between the sign of the Leopards and distance from the village. The result showed that distance to the village or Leopards habitats is the major determinant of the intensity of the sign distribution by Leopards. The sign distribution of Leopard was found significantly high ($R^2= 0.93$, $F=12.56$, $P=0.03$) near the village area (Figure 4).

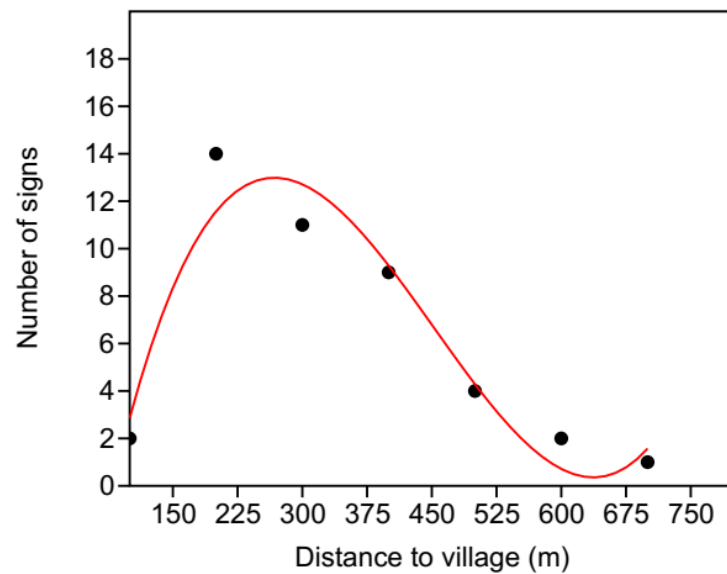


Figure 4: Relationship between the distance from the village and Leopard signs in the study area

4.1.2 Number of dead Leopard in the study area

In the field survey, five dead Leopards were found in different sites of Palungtar Municipality from 2012 to 2019. Four dead Leopards were found in Mirkot and Dhuwakot village and one dead Leopard was found in Chyangli village (Appendix II). The maximum number of Leopard were losses in summer season and these dead Leopards were found in grazing land.

4.2 Socio-economic condition of Palungtar Municipality

4.2.1 Socio-economic characters

Altogether 265 households interviewed, 187 (70.56%) were male and 78 (29.43%) female respondents. They include 22.64% Chhetri, 12.45% Brahmin, 40% Janjati and 24.91% Dalit. These seven study sites had total of 6703 households, among them 265 households

were selected. Agriculture is the main occupation in the area with many households engaged in dairy and livestock production. The major kinds of livestock in these villages are 74% Goat, 14% cattle and 11% buffalo whereas the average number of livestock per household was 7-9.

4.2.2 Different places of resource collection

From the analysis of the questionnaire survey, respondents used own land for the collection of resources. The result showed that 30.19% respondents collected grass for livestock from Community Forest, 56.60% respondents collected grass from own land and 13.21% respondents collected grass from others land. Similarly, among 265 respondents for fuel wood collection, 36.60% collected from Community Forest, 55.85% collected from own land and 7.55% collected from others land. Likewise, for wood collection, 78.87% respondents collected from Community Forest, 16.98% respondents from own land and 4.15% respondents from others land (Figure 5).

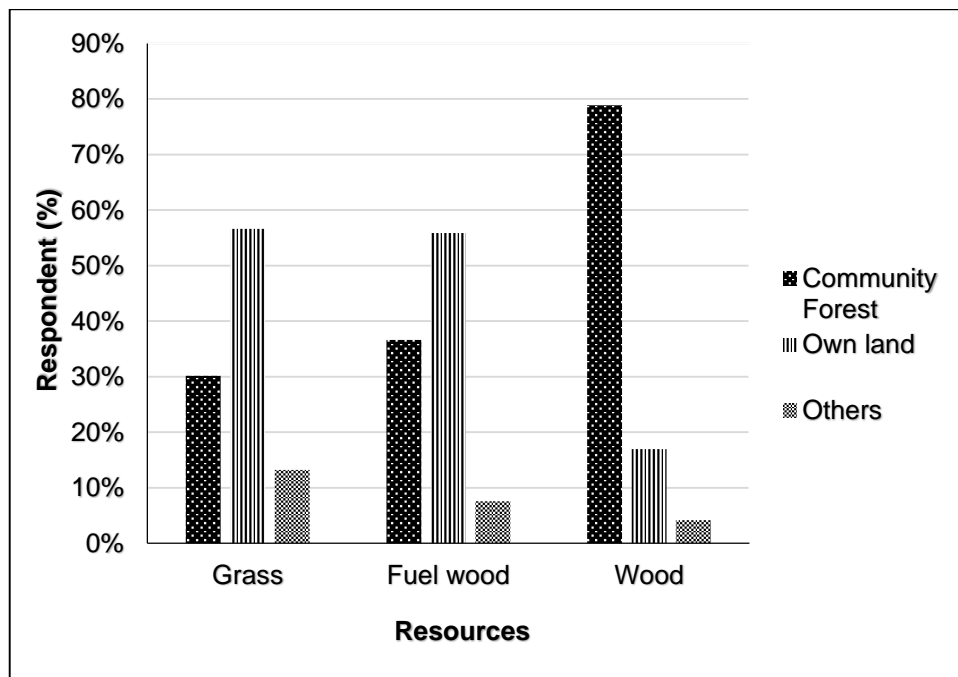


Figure 5: Respondents collection resources from different places in the study area (n=265)

4.2.3 Problem from Leopard

Among 265 households, 84% HHs suffered livestock depredation problem from Leopard (Table 2). Leopards are the main predator of livestock depredation in the study area. The Leopard in the study area frequently affected the local people.

Table 2: Problem from Leopard

	Yes	No	Total
Livestock, Avian stock and Pet animal depredation (N=265)	222 (84%)	43 (16%)	100%
Human Casualties	Two persons were injured		

4.2.4 Livestock holding

Majority of people around Palungtar area depend on animal husbandry. Among them many household keep six- seven Goats, nine- ten Chickens, one or two Cows, and one pair of Ox for ploughing. From the analysis of the questionnaire (n=265), the Goat was reported as dominant animal in villages of Palungtar Municipality (Appendix III). The average domestic animals Cow, Buffalo, Goat, Pig (*Sus domesticus*), Chicken (*Domesticus domesticus gallus*) and Dog (*Canis lupus*) holding of sampled households was 17.47 (Cattle 1.12, Goat 7.14, Buffalo 1.15, Pig 0.09, Avian stock (Chicken) 7.83, Pet animal (Dog) 0.14). Goat and Chicken were the highest in number followed by Cattle, Buffalo, Dog and Pig (Figure 6).

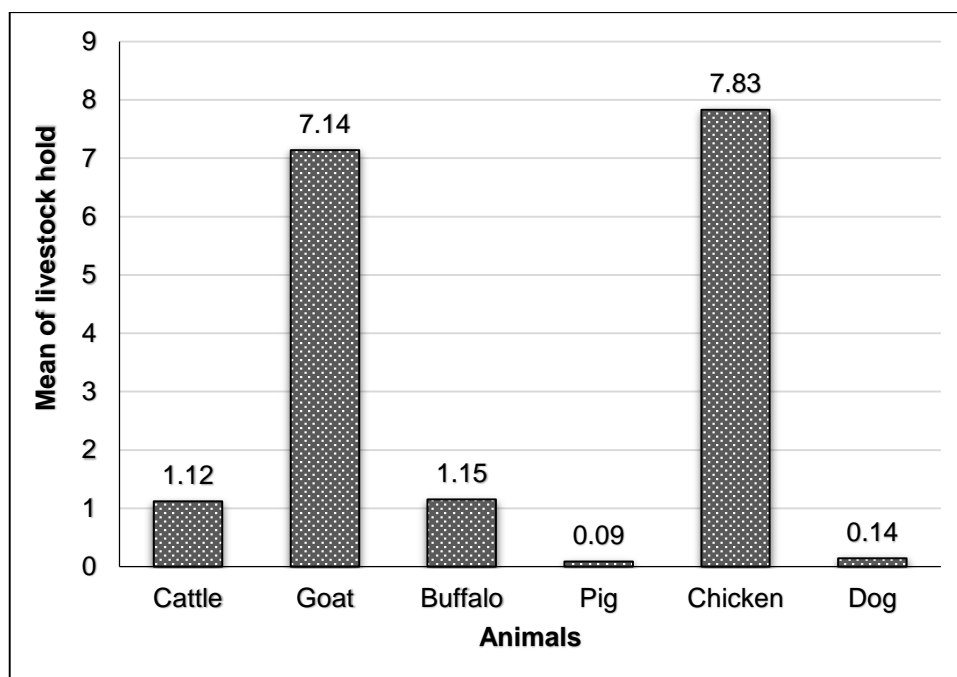


Figure 6: Average number of domestic animals per household

4.2.4.1 Trend of livestock grazing

In the study area, about 112 households (42.26%) did free grazing of their livestock in the forest, 81 households (30.57%) did free grazing in grasslands and 21 households (7.92%) in private land. Few households 51 (19.25%) did not graze their livestock or use stall-feeding (Figure 7). Maximum number of respondents grazing livestock kept a close watch but few respondents did not keep any watcher.

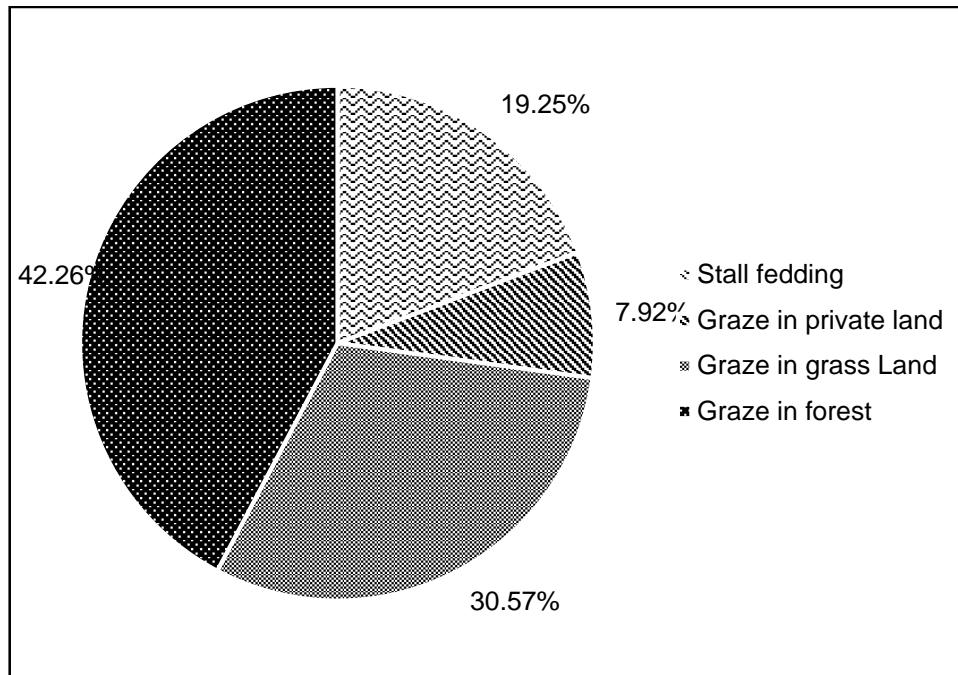


Figure 7: Trend of livestock grazing in the study area

4.3 Livestock depredation

From questionnaire survey, it was found that most of the predation by Leopard were found in the summer season. Leopard (*Panthera pardus*) was the main predator for depredation of livestock, avian stock and pet animal. However, loss of Chicken was found in all the seasons. Leopard attacked the Cow/Ox, Buffalo, Goat, Avian Stock and Pet animals during past three years in Palungtar Municipality. Leopard killed 283 livestock, 52 avian stock and 40 pet animals in past three years. Out of 222 households, one hundred fifty seven households reported a total loss of 270 Goats within three years because of Leopard depredation. Similarly, four households lost three Pigs in the same period. Seven households lost nine Cows and 28 households lost 40 Pet animals (Dogs) in this period. In addition, 26 households reported 52 avian stock (Chicken) losses by Leopard. Leopard did not kill Buffalo in the past three years (Appendix III). The mean loss of livestock (0.03, 1.02, 0.01 for Cattle, Goat, Pig) by Leopard depredation per household was 1.06 and mean

losses of others domestic animals by Leopard depredation per household was 0.19 and 0.15 for Chicken and Dog respectively for the past three years. The total mean loss was 1.4 head of domestic animals per household (Figure 8).

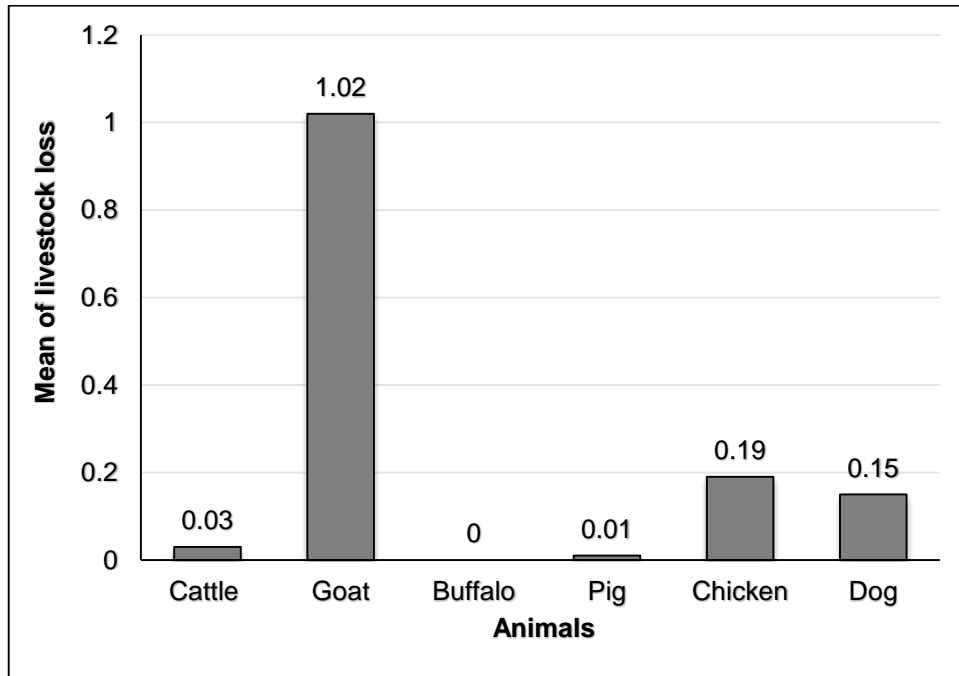


Figure 8: Mean losses of livestock by Leopard

The livestock depredation peaked during 2017 while 2016 was the year with lowest depredation (Figure 9). There were 46 livestock and three pet animals injured due to Leopard from 2016 to 2018 (Table 3). Goat was easiest prey species of Leopard and highest compared to other livestock (Appendix III).

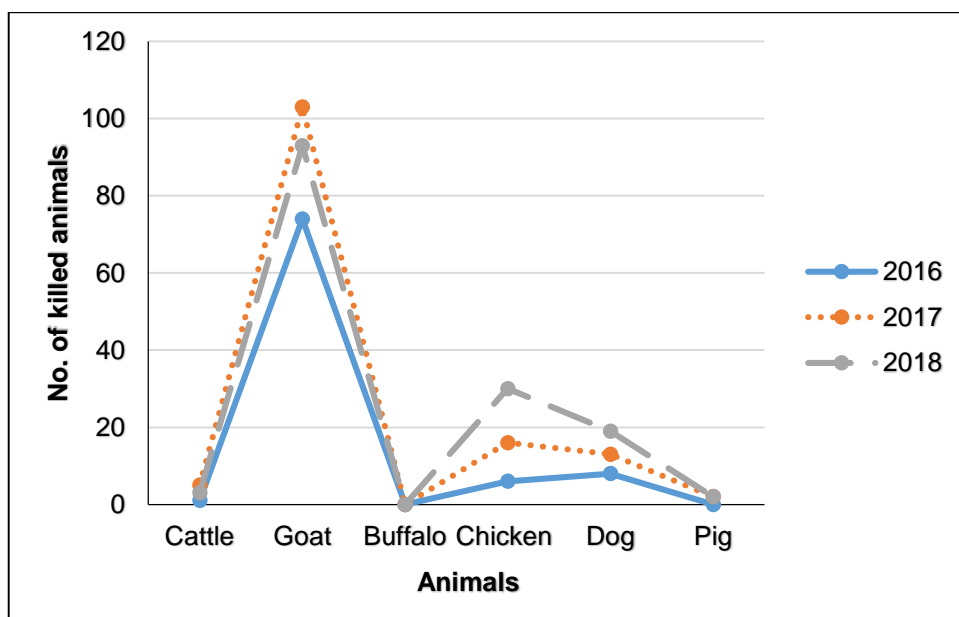


Figure 9: Trend of the livestock depredation during different years in the study area

Table 3: Number of livestock injured by Leopard during last three years

Animals	No. of injured domestic animals		
	2016	2017	2018
Cattle	0	4	0
Buffalo	1	1	0
Goat	9	19	10
Dog	1	1	1
Pig	1	0	1
Total	12	25	12

4.3.1 Different sites of livestock depredation

A total of 375 domestic animals were killed by Leopard from 2016 to 2018 in seven villages (Appendix III). Chyangli Village had the highest livestock depredation, which has total loss of animals 64 in number. Khoplang Village had the lowest livestock depredation, which has total loss of animals 44 number (Figure 10). On average, 125 domestic animals (94 livestock, 17 avian stock and 13 pet animals) were killed by Leopard in the study area per year.

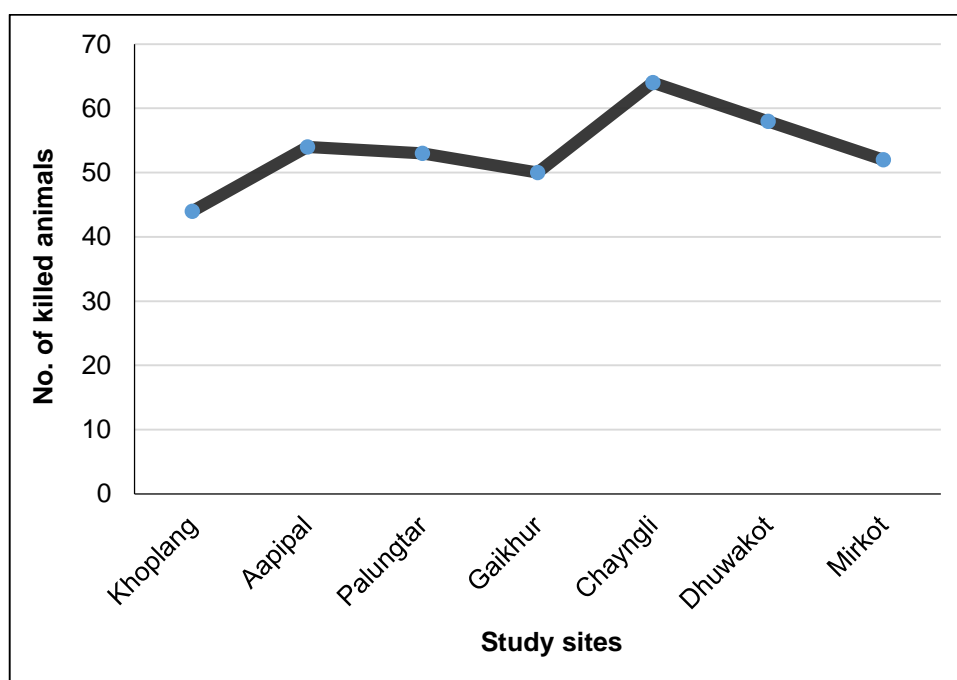


Figure 10: Livestock depredation in different villages

4.3.2 Seasonal intensity of livestock depredation

More cases of conflicts were reported during the winter season. In the winter season, day time and night time attack of Leopard was high in summer while the morning and evening time attack was high in the winter. There were 32.83% cases reported in summer season, 25.28% casualties reported in monsoon season and 41.89% cases were reported in winter season (Figure 11).

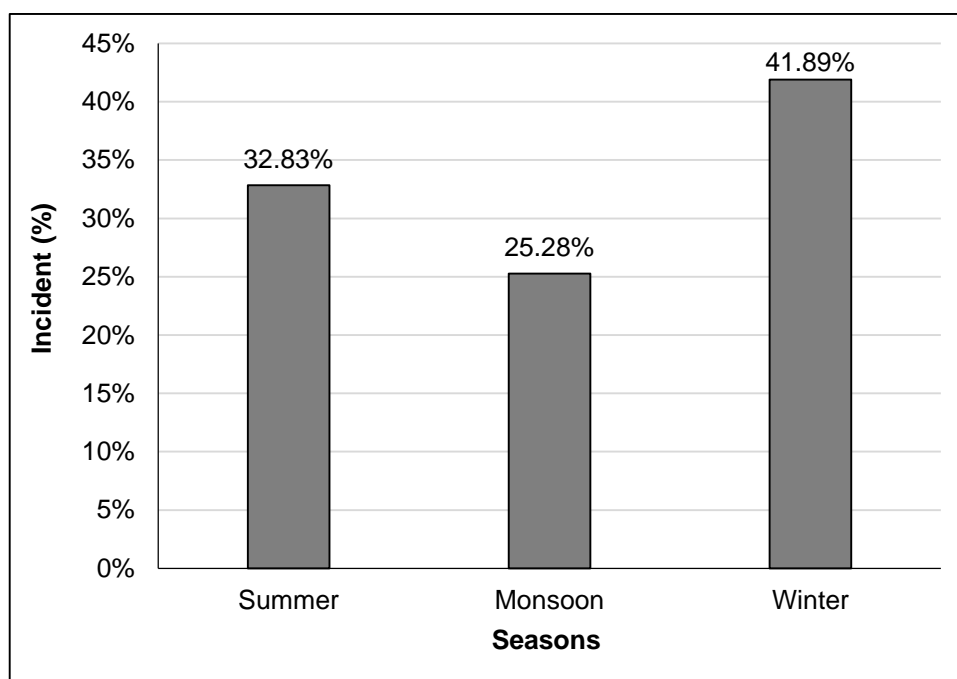


Figure 11: Season-wise frequency of livestock depredation

4.3.3 Time of livestock depredation

Highest number 71 (26.79 %) of the livestock, avian stock and pet animals were killed at day time 12 PM-3 PM, and least number, 7 (2.62%) of the livestock, avian stock and pet animal were killed at early morning time at 6 AM-9 AM while at night time from 9 PM-12 AM 62 (23.40%) livestock, avian stock and pet animals were killed which is the second highest number. The other attack time were 9 AM-12 PM, 3 PM-6 PM and 6 PM-9 PM and these results showed that number of livestock attacked were 21 (7.93%), 46 (17.37%) and 58 (21.89%) (Figure 12).

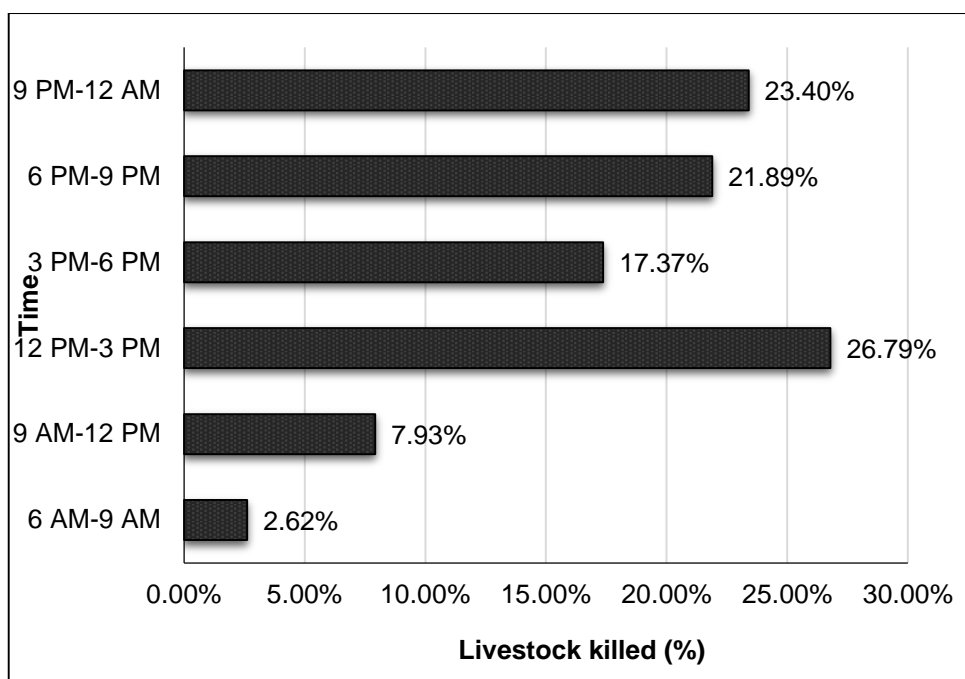


Figure 12: Frequency of livestock, pet animal and avian stock depredation relative to time

4.3.4 Human casualties

In general, attacks by Leopard were significantly associated with the location where the people interact with the natural resources (forest), farmland and home. All attacks of Leopard to people were inside the forest or nearby the forests. A total of two cases of attack (two injuries) were recorded from Palungtar area. These data were obtained through key-person interview with community leaders and villagers. Among these, two injured cases were found in Chyangli Village and Dhuwakot Village (Table 4).

Table 4: Human casualties by Leopard attacks in Palungtar from 2012-2018 (Source: local people, Community Forest office, local government)

S.N	Name/identity	Age	Sex	Activity of victim	Where	Remarks
1.	Narayan Kumal	41	M	Grass cutting	Crop field	Injured
2.	Sonam Upreti	20	F	Picnic programme	Jungle	Injured

4.4 Causes of human-leopard conflict

About 42.64% respondents mentioned the causes of Leopards visiting the human settlements, as lack of prey species in forests and 38.49% mentioned it as due to deforestation and the other respondents mentioned different causes like forest fire, poaching and others are 11.32%, 6.42% and 1.13% respectively (Figure 13).

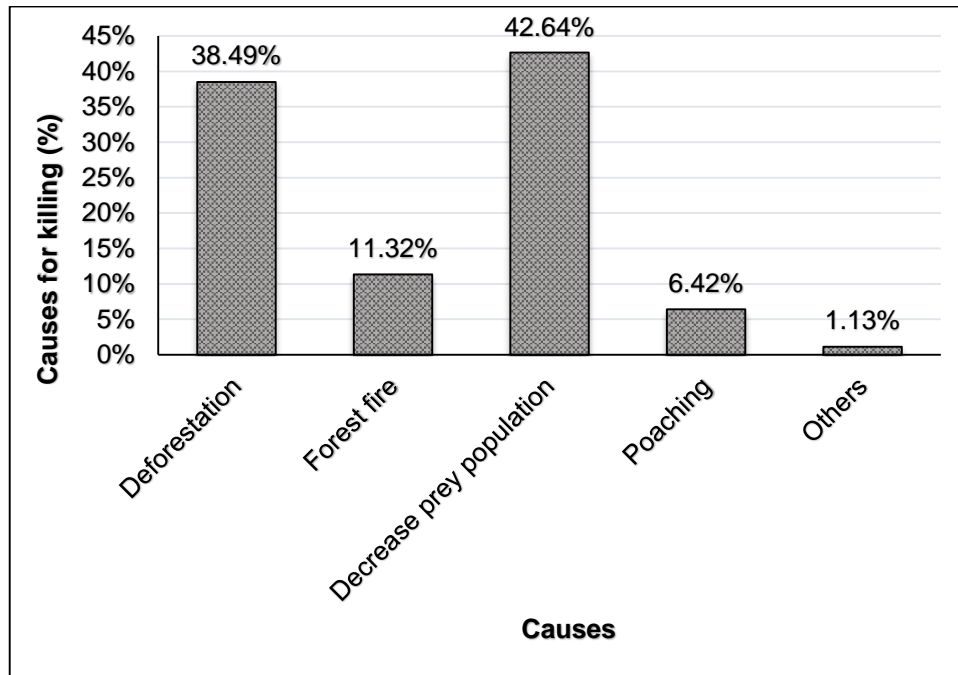


Figure 13: Factors affecting Leopard population in the study area

4.4.1 Causes of killing of Leopard

More than 44.15% respondents said that Leopards were killed for retaliation, 18.11% for trade of body parts, and 37.74% respondents said they were killed to reduce the potential risk of attack on humans and their livestock (Figure 14).

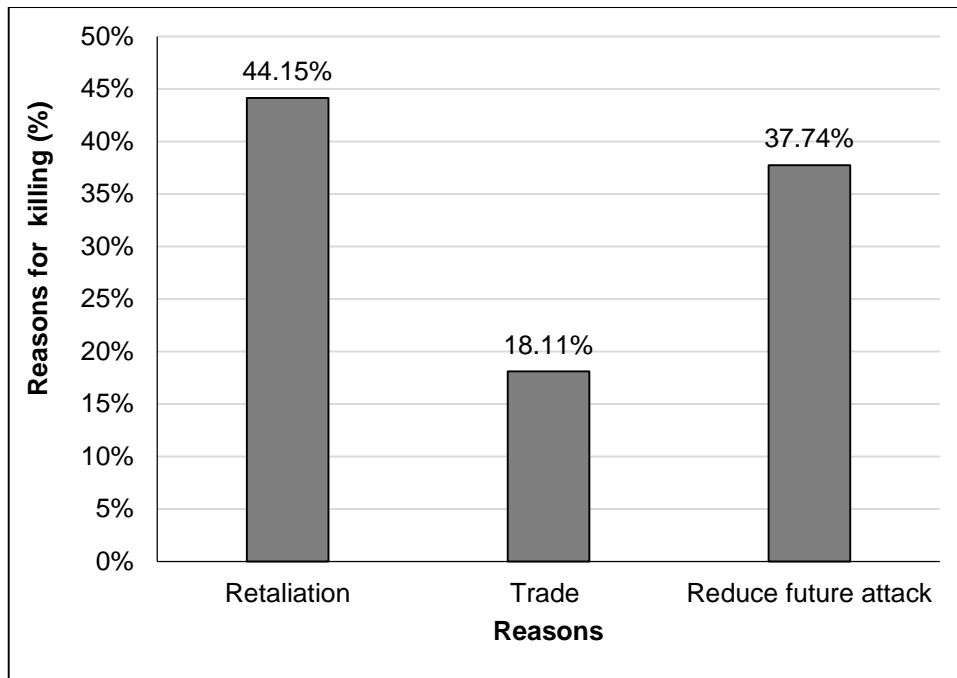


Figure 14: Causes of killing of Leopards (n=265)

4.5 Perception of local communities on Leopard conservation

Local people's general attitude towards presence of Leopard was good. More than half of (63.02%) of respondents liked Leopard while 36.98% respondents disliked Leopard due to human-leopard conflict (Figure 15). Although the study from household survey indicates that very little proportion of respondents would try to get rid of the animal or kill them. It means they were positive towards Leopard conservation. Among 167 respondents who liked Leopards, the questionnaire results indicated that Leopards have ecological value and their presence indicate a healthy ecosystem (67.66%), they are endangered and their number is decreasing (17.37%), they are beautiful and charismatic (8.98%), revenue and jobs through ecotourism (4.19%), they have religious value in Hindu culture and are a symbol of might (1.80%) (Figure 16). Among 98 respondents who did not like Leopards, the majority of them (66.32%) attributed to Leopard attacks against livestock, (31.64%) attributed they attack human and (2.04%) attributed they cause crop damage (Figure 17). Perception on Leopard conservation and education were significantly associated (Pearson chi-square $\chi^2 = 3.6019$, $df = 1$, $p = 0.057$). More people with high education supported the conservation of Leopards. Similarly, perception and gender showed a significant association (Pearson Chi-square $\chi^2 = 36.081$, $df = 1$, $p = 1.89E-09$). Male respondents were more positive than female to conserve the Leopard. Altogether 64.91% respondents liked

Leopard living in Community Forests and the rest, 35.09% respondents did not like the idea (Figure 18).

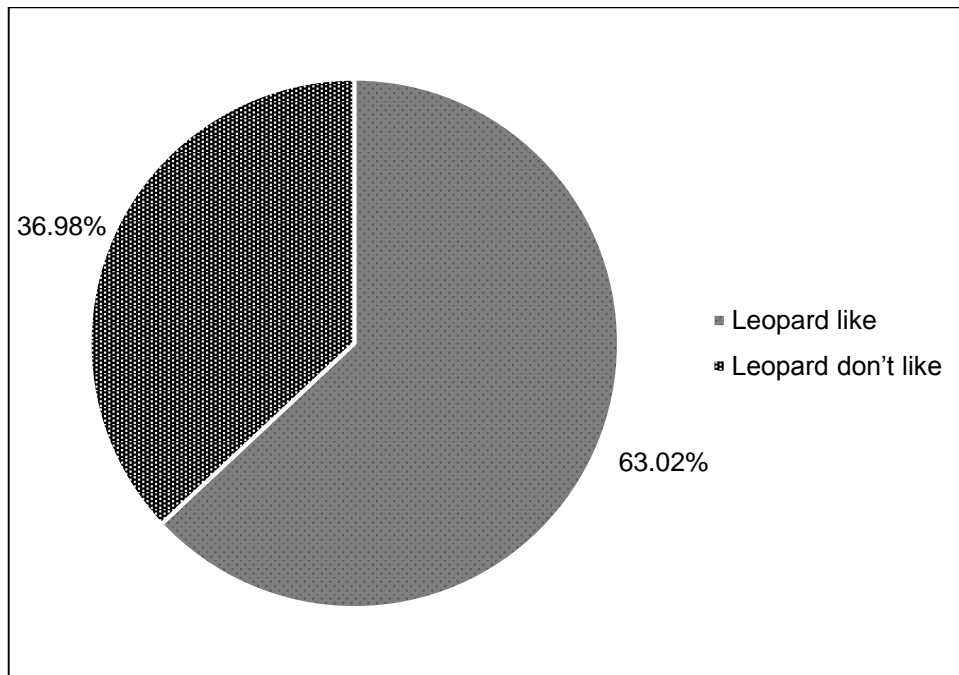


Figure 15: Local people's perceptions towards Leopard in the study area

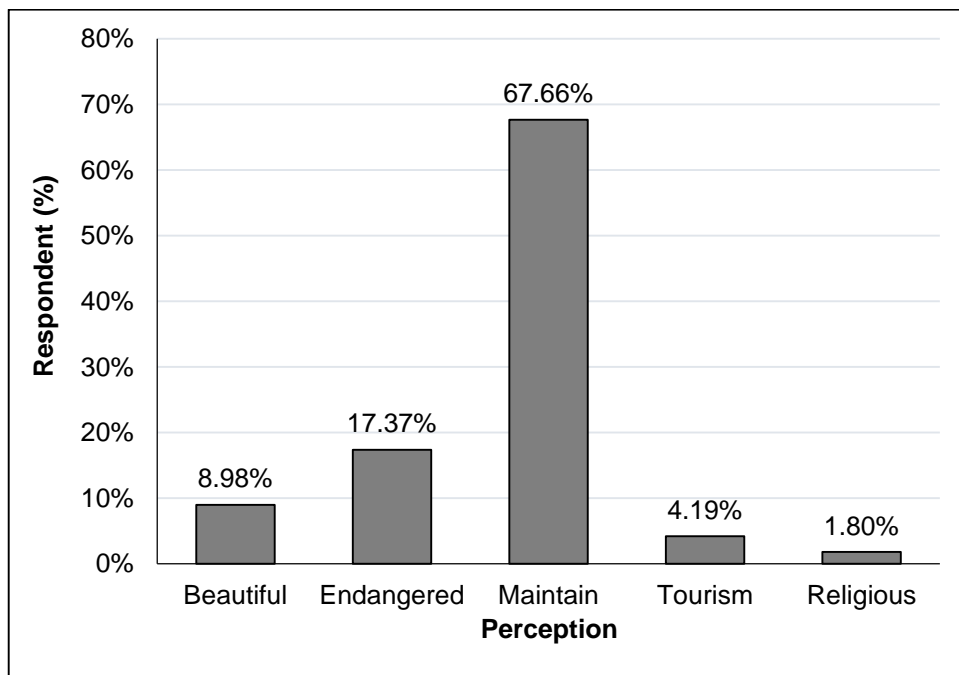


Figure 16: Perception of local people/why you like Leopard (n=167)

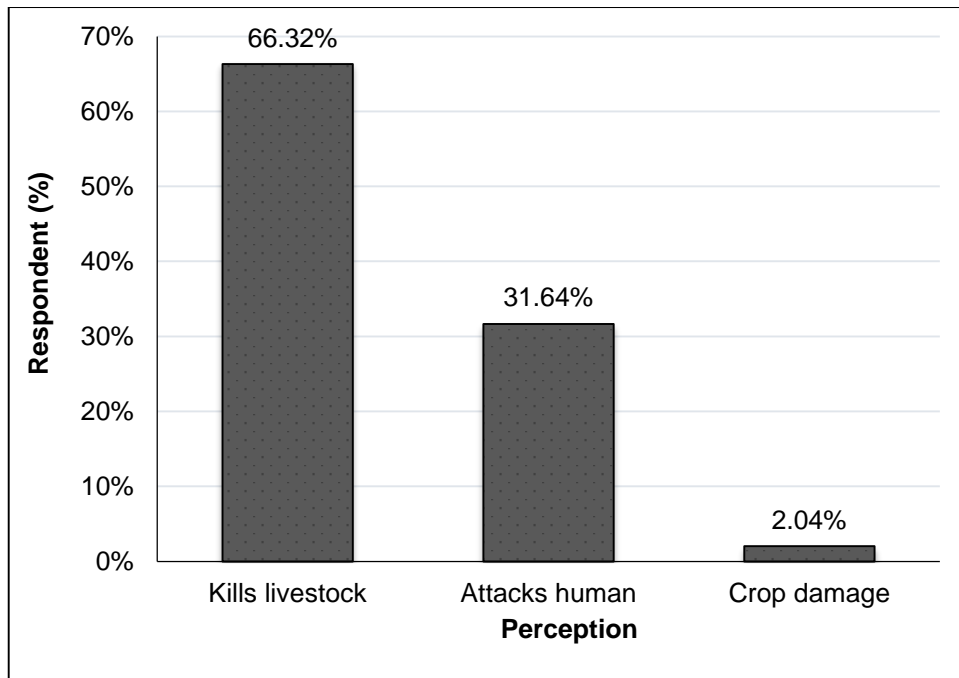


Figure 17: Perception of local people/why you do not like Leopard (n=98)

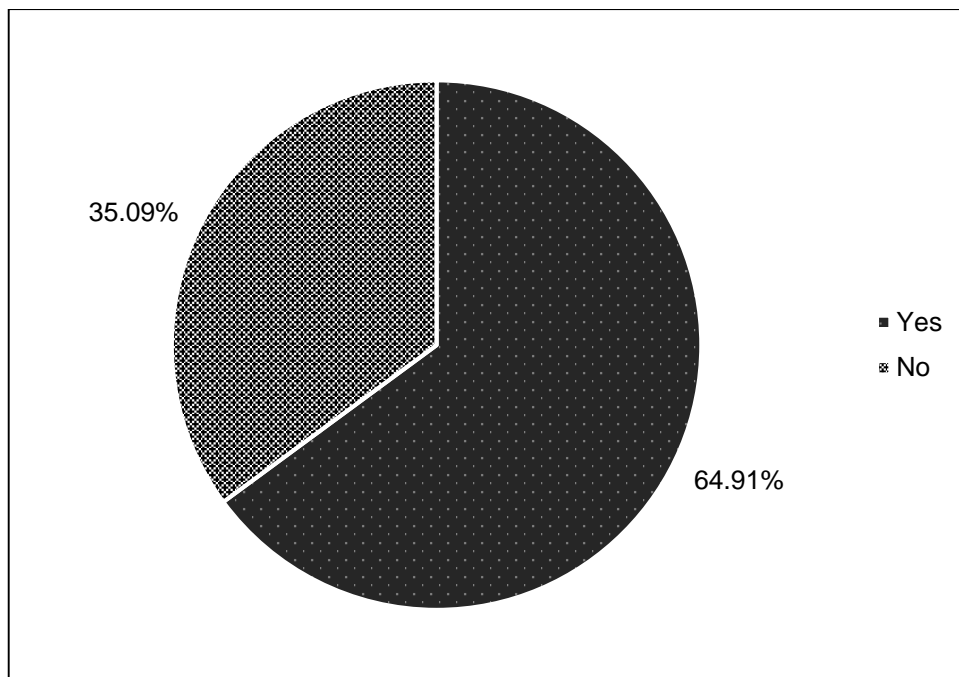


Figure 18: Perception of local people/Leopard in Community Forest (n=265)

4.5.1 Knowledge among local people on Leopard behavior/ecology

For Leopard behavior ecology, this study found that the local people had a good understanding on certain aspects of Leopard ecology. Leopards were encountered at any time, day and night but the highest encounter was during the night. Regarding the time when Leopards came out, 35.47% of people indicated that they came out at night time, 15.09% people indicated that they came out in evening time, 19.25% people indicated that they came out at mid-day and 30.19% people indicated that they came out in morning time (Figure 19). The results showed that about 41.89% noted the increase of Leopards in the surroundings, 27.55% indicated a decrease in number of Leopards and 11.32% said that don't know while the remaining 19.24% of the total respondents claimed on constant population of Leopards in their area as they see at least two Leopards annually near their forest and settlement area (Figure 20).

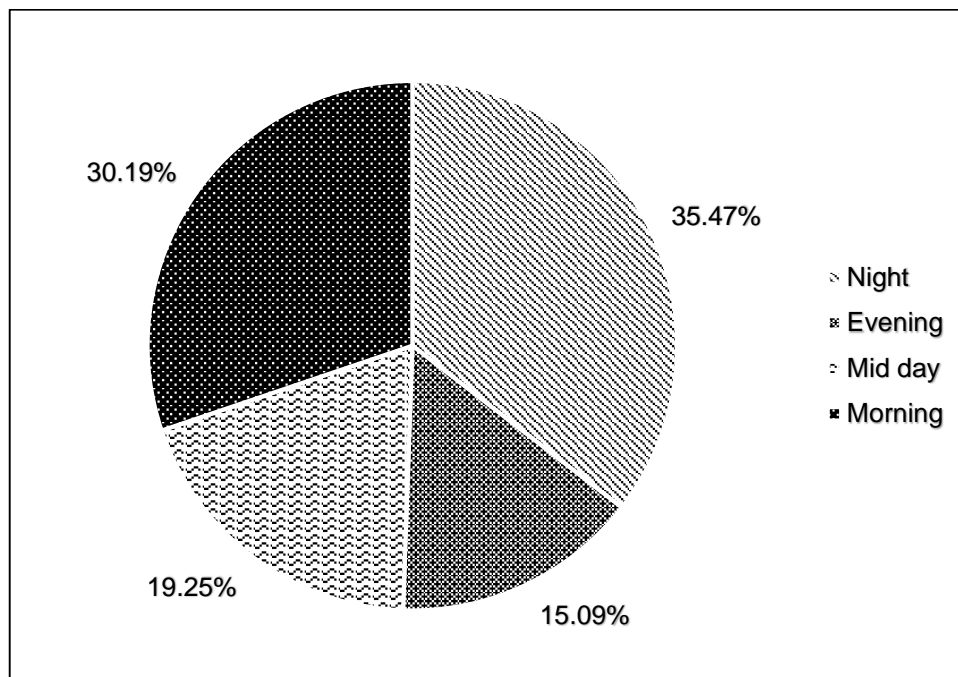


Figure 19: Time of a day of Leopard's movement towards village (n=265)

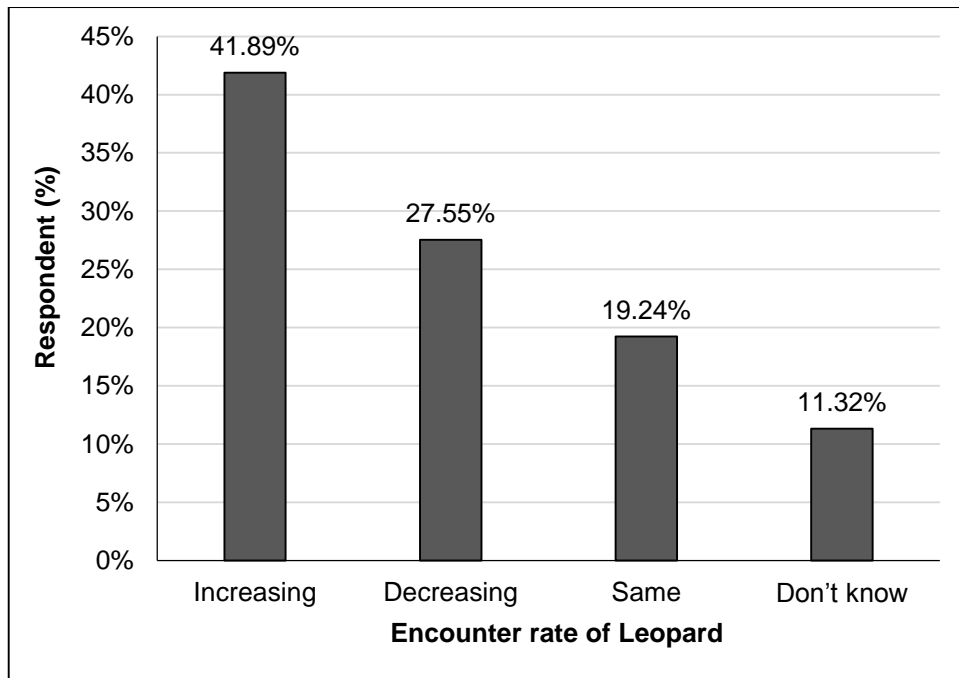


Figure 20: Encountering Leopards in the study area

4.6 Mitigating measures of human-leopard conflict

There was a mixed response of respondents to conflict management strategy to be applied for reduction of increasing HLC in the Palungtar Municipality. Based on questionnaire survey, 85.66% households expressed strong dissatisfaction over problem Leopard management and only 14.34% of households expressed satisfaction with the Leopard management (Figure 21).

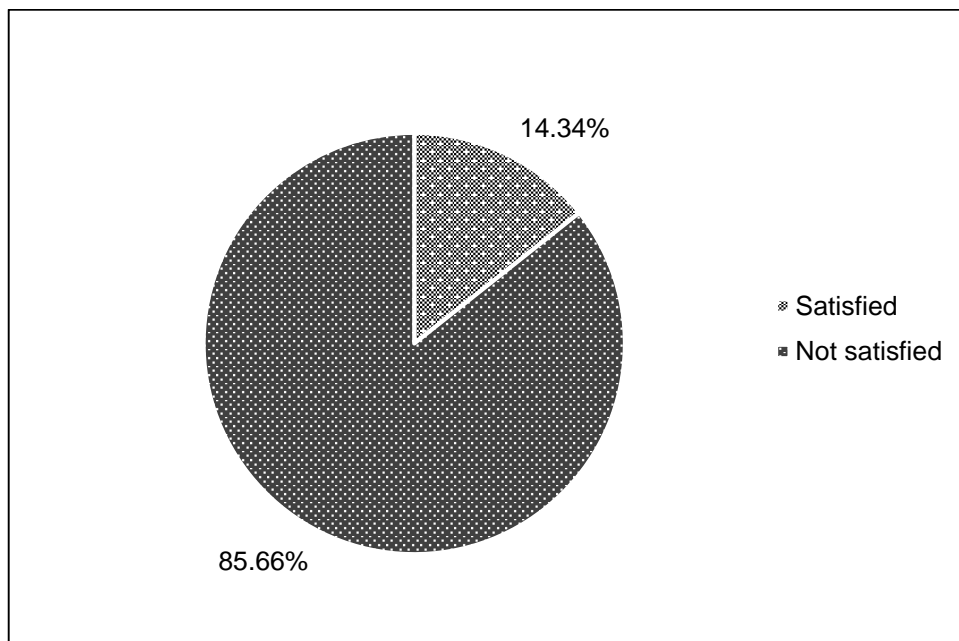


Figure 21: Satisfaction from Leopard management (n=265)

On asked how conflict can be reduced, 59.62% respondents suggested for conservation education to educate people about the conservation value of Leopards and its behavior, 29.06% suggested for doing monitoring to make people aware of the problem and 11.32% suggested to provide relief fund to victims or their family but actually relief fund was found to be provided to about 5/6 households in Palungtar area (Figure 22). All the respondents did not complain to any agency on animal's loss by the wildlife. They did not get any sort of compensation and support (monetary and physical) from any governmental authority's body. They were unknown about who should provide the compensation on livestock loss and human injury.

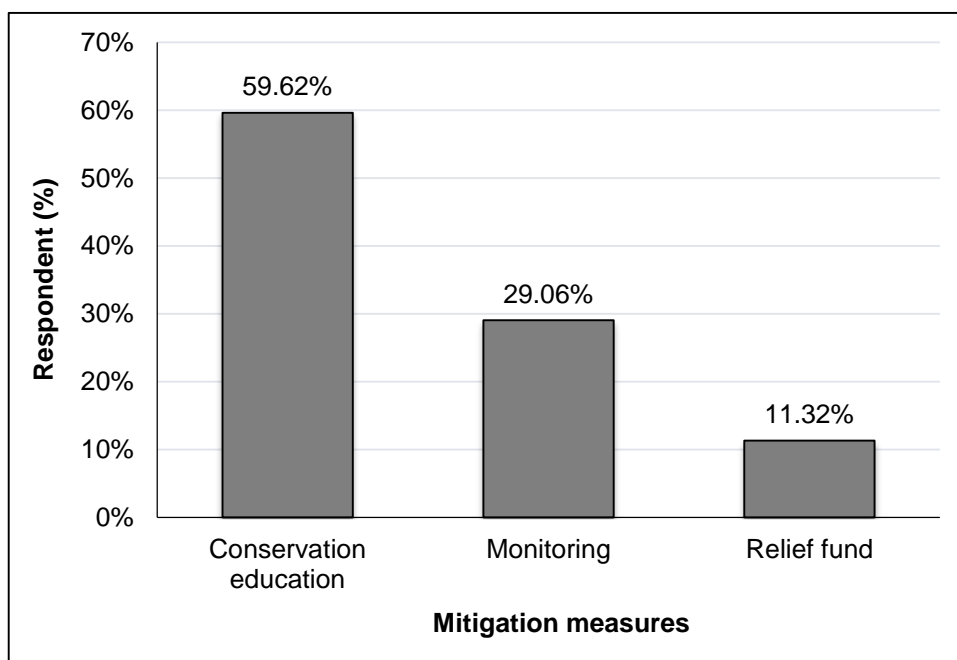


Figure 22: Way of reducing conflict (n=265)

5. DISCUSSION

5.1 Distribution of Leopard in the study area

Leopard prefers those habitat types where agricultural land, bush and forest areas have greater affinity towards prey base that serves as food for them. Altogether, 21 transects were drawn representing different habitats in which the direct and indirect signs of the species were recorded. This study showed that out of 21 transects, three transects did not account any sign of Leopard whereas remaining 18 transects accounted 45 signs of Leopard. According to Khaiju (2017), 12 signs of Leopard were recorded in 13 different transects among which only seven transects determined 12 signs of Leopard in total distance of 2910 m with average 4.12 sign/km whose result type was similar to finding of this study. This might be because, Leopards easily found prey species near human settlement area. Therefore, Leopard's presence was significantly higher in the human settlement area than the forest area. This study accords with Kabir et al. (2013), fifteen fixed transects were monitored on regular basis and the mean encounter rate for the Leopard footprints was 1.6, for scat 2.11. Maximum sightings were recorded between 1452 m to 2936 m elevation. Leopard is the most common large cat. It was not found only limited to forest or heavy covers but also thrive well in open country.

5.2 Causes and impacts of human-leopard conflict

Leopard (*Panthera pardus*) has been found to be the major predator for livestock depredation in the study area. Leopard was found to be the main predator of livestock in Bhutan and Pakistan (Wang & Macdonald 2006, Sangay & Vernes 2008), and in Nepal Ghimire (2006), Awasthi (2014) and Gurung (2002) reported Leopard as the primary predator for livestock. In present study, Leopard killed 283 livestock, 52 avian stock and 40 pet animals in the study area. Around 424 livestock were reported to be killed by Leopards, Goats were disproportionately represented (87.3%), 20% more than expected from their relative livestock population followed by Pigs (8.7%) and Cattle (4%) (Sangay & Vernes 2008, Dhungana et al. 2019) whose result was congruent to finding of this study. Main causes of high livestock depredation rates in the study area were lack of prey species, deforestation, and fragmentation of Leopard habitat, human involvement, and poor husbandry. Open field grazing was also found to be another major factor of conflict. Grazing larger number of livestock in the forest area reduced the quality and quantity of forests, which influenced the conflict in the area. Dar et al. (2009), Ahmed et al. (2012),

Kabir et al. (2013), Chattha et al. (2018) found goat as the main prey species of Leopard. Current study indicates the Goats were the major victims of livestock depredation and killed in significantly higher numbers as compared to other livestock in the study area. The main reason for maximum killing of Goat might be most people leaving their Goats for grazing in forest without any herder and bringing them back only at late evening. The high density of Leopard in Uttarakand has increased intraspecific competition, habitat degradation, forest fragmentation, expansion of human settlement right to the edge of wildlife habitats (Panwar 1979, Johnsingh & Negi 2003, Rishi 2005). Maximum number of livestock depredation occurred in daytime (26.79%) followed by night time (23.40%) and evening time (3.74%). During day time, most of the livestock were taken out for grazing in the open fields or the nearby open wastelands. Kumar (2011), Awasthi (2014) reported that livestock depredation pattern (60.16%) occurred at night time. In Mandi district, India, highest number of killing (74.5%) occurred at night time. Suthar et al. (2018) recorded that the majority of livestock depredation occurred during winter season (45.61%) mainly in October followed by monsoon (35.08%) and summer (19.29%) which was similar to finding of this study. In the present study, highest number of conflict cases occurred in winter season (41.89%) mainly in November and December, because during this time also, open fields grazing was done. A total of two human attacks were recorded from Palungtar Municipality. These two cases are attack by Leopard. The present study has similar result with Adhikari et al. (2018), five cases of attack including one fatal and four injuries were recorded from Panchase area. Among these cases, Himalayan Black Bear contributed 80% of the total attacks and 20% attack was contributed by Leopard. Thapa (2014), Karki and Rawat (2014) accorded with this study. The Leopards attack in wild animals has occurred since 10 years in the study area. Corbett (1948), Ramakrishnan et al. (1999), Kala and Kothari (2013), Qamar et al. (2010) concluded the major factors of decline of Leopard population such as increasing human population and dependence on natural resources, habitat destruction and population decline of Leopard's natural prey species, poor protection practices of livestock and poverty of local people, poaching and killing. In this result is followed by recent study. In recent study, few respondents (27.55%) said that Leopard population is decreasing.

5.3 Perception of local people towards Leopard conservation

In this study, more than half of the respondent's attitude was positive for Leopard whereas other respondents opposed it. According to Wang et al. (2006), livestock losses, together

with crop damage, are considered as major causes of negative attitudes towards wildlife and conservation policy around protected areas. The current study found that about 63.02% of total respondents liked Leopard while 36.98% respondents disliked Leopard due to human-leopard conflict. In contrast, few studies reported that majority of the respondents (64.6%) had positive feelings towards Leopard and only 10.2% had negative feelings towards Leopard in the core area, whereas majority of the respondents (52.3%) had neutral feelings and only 9.1% had negative feelings towards Leopard in the control area. The mean attitude score in both areas was 3.53 neutral to positive feeling to help the Leopard conservation (Yrigha & Baeur 2011, Szinovatz 1997) whose results were similar to finding of this study. More than half of the respondents were positive for Leopard conservation knowing the role of top predator in an ecosystem to control and maintain the ecosystem.

5.4 Mitigation measures of human-leopard conflict

In the present study, there was a mixed response of respondents to conflict management strategy to be applied for reduction of increasing HLC. Conservation education (59.62%) was found to be the major means for management of HLC in the study area. Similar type of study conducted by Pokharel (2015) about 29% (n=105) suggested for the restoration of Leopard habitat through afforestation, 23% for managing preys in their native habitat, 19% suggested for fencing around SNP, 18% suggested for awareness raising activities for local community and the rest 11% suggested keeping problem animal in zoo as conflict management tool. Koirala et al. (2012), Khan et al. (2018) and Lamarque et al. (2009) also suggested for the improvement in livestock husbandry practices, implementation of a livestock depredation compensation program, and programs for improving the conservation of wild prey, which are recommended as mitigation measures for minimizing human-leopard conflict whose result was similar to finding of this study. These types of mitigation practices were able to control severity of damage and it needs long-term strategies. However, maximum number of respondents applied these methods in the study area. Such type of study conducted by different researchers also indicated that education and training activities at different levels, for instance in schools or in adult education arenas would have the objective of disseminating innovative techniques, building local capacity in conflict resolution and increasing public understanding of HWC. These type of skills would help them to deal with dangerous wild animal species and to acquire and develop new tools for defending their crops and livestock (Mardaraj & Sethy 2017). Similarly, avoiding areas with forest cover, good staking terrain and selecting areas with high densities of roads and

close to human habitation should reduce depredation (Boitaniz & Roger 2012). Dar et al. (2009) suggested to minimize livestock depredation by Leopards in the Machiara National Park through long-term conservation of Leopards, they recommended a better management of vulnerable livestock by constructing low-cost corrals, improving stock guarding and increasing night vigilance.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Livestock depredation and human causality are the common forms of conflict. All the respondents said that the problem of livestock depredation increased day by day after establishment of Community Forest. A total of 45 signs was recorded in seven different CFs in the study area, which indicated the presence of the species Leopard. Among 265 respondents, almost 79% people tackled with Leopard problem. The livestock depredation rate was found to be 0.47 head of livestock per household per year. The causes of livestock depredation might be associated with grazing of livestock in the Community Forest and the barren area where Leopards were present.

Leopard was mainly responsible for livestock depredation in the study area. 375 domestic animals were killed in the study area. Leopard in the study area killed 125 domestic animals during a year. Goat, Cow, Pig, Chicken and Dog were the main prey species of Leopard. Goat was the easiest prey species for Leopard. Chyangli village had the highest livestock depredation whereas lowest livestock depredation was seen in Khoplang village. Highest number of conflict cases were observed in daytime (12-3) PM and winter season (41.89%) when most of the livestock was taken out for grazing in the open field in the winter season. Human casualties has also been noticed during this study, Leopards injured total two people and total five dead Leopards were found in the field survey over the seven years. More than half (63.02%) of the local people liked Leopard conservation. Natural prey species of Leopard are decreasing in forest, therefore it started moving towards community areas in search of its prey. Therefore, Leopard's movement and signs were present near settlement area. It was concluded that the Leopard population number is declining day by day. In addition, Leopard's attack on livestock near water sources might be because Leopard may come for water and it finds its easy prey species. Conservation education is found to be vital to make the people aware about Leopard behavior or Leopard ecology. Regular conservation education and monitoring of Leopards to alarm the people to losses can be helpful in human-leopard conflict reduction. Leopards are main predator species, their conservation for the wellbeing of human beings is a must.

6.2 Recommendations

- ❖ The trend of livestock depredation was high due to grazing of domestic stock inside the forest.
- ❖ Trainings should be given to people, mainly women on how they can use preventive measures to reduce direct killings of their livestock.
- ❖ Database must be prepared and maintained on livestock loss, human attack and Leopard mortality, along with compensation provision being accessible for villagers.
- ❖ Conservation awareness program should be launched formally either especially for students focusing in curriculum of school or informally for villagers about role of species in food chain mentioning as predators of hilly region.
- ❖ Uneducated people are less positive towards Leopard conservation therefore public awareness programs should be conducted.

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APPENDIX- I

1. Household Questionnaire

Basic information

1. Name of the respondent: _____ Date: _____
2. Occupation: _____ Age: _____ Sex: _____
3. Address: Ward: _____ Municipality: _____ District: _____
- GPS Location: N: _____ E: _____
4. Education: illiterate literate primary secondary higher secondary
University
5. Land owned: with irrigation: _____ without irrigation: _____
6. How much land do you have? (Hector/Ropani) Khet: _____ Bari: _____
7. Do you have livestock/avian stock/pet animals? If yes, fill the number below.

Livestock	Cow	Ox	Goat	Buffalo	Chicken	Dog	Others
Stall-fed							
Total							

8. Where do you go for resource collection?

	Wood	Fuel wood	Grass
Community Forest			
From own land			
Others			

9. Any casualties with leopard in your family in last 10 years? If yes, please give info as below.

	Place (GPS)	Date and time	Sex and age of victim
Injury			
Kill			

Livestock depredation

10. Where do you graze your livestock?

- a) Forest b) Grassland c) Private land d) Stall feeding

11. Do you have any problems from Leopard? a) Yes b) No

12. In which season or month leopard killed most domestic animals?

- a) Summer b) Monsoon c) Winter

13. What are the livestock that are killed / injured by wild animal in last three years? Please write in numbers and local price.

Animals	Total	Killed	Injured	Time of killing	Where	Season	Name of predator	Cost NRs.
Cow & ox								
Goat								
Buffalo								
Chicken								
Dog								
Others								

People perception on Leopard

14. Do you like Leopards? a) Yes b) No

15. If yes, why do you like them?

- a) Beautiful species b) Endangered species c) Maintains ecosystem d) Religious e) Revenue from tourism

16. If no, why don't you like Leopards?

- a) Kills livestock b) Attacks human. c) Crop damage

17. Do you like Leopards in Community Forestry? a) Yes b) No

APPENDIX-II

1. Position of the transects conducted in the study area

a. Annapurna Community Forest –Khoplang

Transect Numbers	Position on GPS (Degree Decimal)	
	Starting Point	End point
1	N: 28.00811 E: 84.56457 Elevation: 541 m	N: 28.02398 E: 84.55989 Elevation: 674 m
2	N: 28.02489 E: 84.56015 Elevation: 663 m	N: 28.03074 E: 84.55186 Elevation: 732 m
3	N: 28.03163 E: 84.55141 Elevation: 757 m	N: 28.03603 E: 84.54501 Elevation: 815 m

b. Kanlaban Community Forest –Aapipal

Transect Numbers	Position on GPS (Degree Decimal)	
	Starting Point	End point
1	N: 28.04388 E: 84.52291 Elevation: 808 m	N: 28.04177 E: 84.52785 Elevation: 852 m
2	N: 28.04143 E: 84.52892 Elevation: 855 m	N: 28.0471 E: 84.53802 Elevation: 837 m
3	N: 28.04361 E: 84.53834 Elevation: 827 m	N: 28.04366 E: 84.54282 Elevation: 818 m

c. Aamdada Community Forest –Palungtar

Transect Numbers	Position on GPS (Degree Decimal)	
	Starting Point	End point
1	N: 28.03252 E: 84.50546 Elevation: 586 m	N: 28.03734 E: 84.51141 Elevation: 692 m
2	N: 28.03123 E: 84.50386 Elevation: 581 m	N: 28.03456 E: 84.50916 Elevation: 694 m
3	N: 28.03690 E: 84.50633 Elevation: 641 m	N: 28.03517 E: 84.51003 Elevation: 703 m

d. Kaamdhenu Community Forest –Gaighur

Transect Numbers	Position on GPS (Degree Decimal)	
	Starting Point	End point
1	N: 27.99371 E: 84.49630 Elevation: 527 m	N: 28.00172 E: 84.49864 Elevation: 661 m
2	N: 28.00362 E: 84.49811 Elevation: 676 m	N: 28.01118 E: 84.49741 Elevation: 869 m
3	N: 28.01208 E: 84.5057 Elevation: 917 m	N: 28.00738 E: 84.51353 Elevation: 847 m

e. Kalika Community Forest –Chyangli

Transect Numbers	Position on GPS (Degree Decimal)	
	Starting Point	End point
1	N: 27.96708 E: 84.45097 Elevation: 443 m	N: 27.96887 E: 84.45398 Elevation: 486 m
2	N: 27.96411 E: 84.45901 Elevation: 464 m	N: 27.96594 E: 84.46603 Elevation: 501 m
3	N: 27.9638 E: 84.46215 Elevation: 451 m	N: 27.96424 E: 84.46009 Elevation: 477 m

f. Thuloban Community Forest –Dhuwakot

Transect Numbers	Position on GPS (Degree Decimal)	
	Starting Point	End point
1	N: 27.94608 E: 84.47927 Elevation: 442 m	N: 27.9463 E: 84.48608 Elevation: 463 m
2	N: 27.94837 E: 84.49142 Elevation: 473 m	N: 27.94582 E: 84.48668 Elevation: 512 m
3	N: 27.94834 E: 84.48931 Elevation: 461 m	N: 27.95067 E: 84.47765 Elevation: 487 m

g. Deurali Community Forest –Mirkot

Transect Numbers	Position on GPS (Degree Decimal)	
	Starting Point	End point
1	N: 28.00515 E: 84.56366 Elevation: 453 m	N: 27.99991 E: 84.55917 Elevation: 497 m
2	N: 28.00084 E: 84.55427 Elevation: 541 m	N: 28.00071 E: 84.54505 Elevation: 666 m
3	N: 27.99943 E: 84.54434 Elevation: 659 m	N: 28.00268 E: 84.53584 Elevation: 751 m

2. Distribution of Leopard sign in the study area

a. Annapurna Community Forest–Khoplang

Transect Number	Leopard Signs	GPS Point (Degree Decimal)			Village distance(m)
		Latitude	Longitude	Elevation (m)	
1	Scat	28.00705	84.5659	517	190
	Scrape	28.01059	84.56616	570	200
	Scat	28.01278	84.56735	600	350
2	Scat	28.02585	84.56205	663	200
	Scat	28.02887	84.55442	681	120
	Scrape	28.02996	84.55241	718	200
3	Scrape	28.03611	84.54604	814	200

b. Kanlaban Community Forest–Aaipal

Transect Number	Leopard Signs	GPS Point (Degree Decimal)			Village distance(m)
		Latitude	Longitude	Elevation (m)	
1	Scrape	28.04522	84.52435	833	280
	Scrape	28.04309	84.52592	838	560
2	No signs	-	-	-	-
3	No signs	-	-	-	-

c. Aamdada Community Forest–Palungtar

Transect Number	Leopard Signs	GPS Point (Degree Decimal)			Village distance(m)
		Latitude	Longitude	Elevation (m)	
1	Pugmark	28.03666	84.50856	625	405
	Scat	28.03687	84.50682	632	500
	Scat/Carcass	28.03682	84.50896	637	370
	Scrape	28.03645	84.50845	625	400
	Scat	28.03734	84.50873	647	360
	Scat	28.03729	84.50967	655	280
2	Scrape	28.03274	84.5069	633	415
	Scat	28.03755	84.51008	663	230
	Scat	28.03763	84.51007	663	225
	Pugmark	28.03771	84.5105	664	190
	Scat	28.03778	84.51059	665	170
	Scat	28.03823	84.51014	669	330
3	Scat	28.03542	84.51118	711	300
	Scat	28.03527	84.51094	712	330

d. Kaamdhenu Community Forest–Gaighur

Transect Number	Leopard Signs	GPS Point (Degree Decimal)			Village distance(m)
		Latitude	Longitude	Elevation (m)	
1	Scat	27.99852	84.49815	630	140
	Scrape	28.00075	84.49855	649	100
2	Scrape	28.00574	84.49641	737	225
3	Scat	27.99973	84.52205	822	75
	Scrape	28.0112	84.506	909	600
	Scat	27.99828	84.52338	836	115

e. Kalika Community Forest–Chyangli

Transect Number	Leopard Signs	GPS Point (Degree Decimal)			Village distance(m)
		Latitude	Longitude	Elevation (m)	
1	Scrape	27.97013	84.45258	501	430
2	Pugmark	27.97115	84.45081	486	240
	Scrape	27.96726	84.45733	467	350
3	Scrape	27.96666	84.46197	493	175

f. Thuloban Community Forest–Dhuwakot

Transect Number	Leopard Signs	GPS Point (Degree Decimal)			Village distance(m)
		Latitude	Longitude	Elevation (m)	
1	No signs	-	-	-	-
2	Pugmark	27.94675	84.48699	485	205
	Scrape	27.94837	84.49142	473	145
	Scrape	27.94834	84.48931	461	300
3	Scrape	27.94808	84.48056	410	140
	Scat	27.94977	84.47949	430	250

g. Deurali Community Forest-Mirkot

Transect Number	Leopard Signs	GPS Point (Degree Decimal)			Village distance
		Latitude	Longitude	Elevation (m)	
1	Scrape	28.00178	84.55923	478	120
2	Pugmark/Carcass	28.00118	84.55507	536	105
	Scrape	28.00138	84.54701	662	125
3	Scrape	28.00089	84.54163	693	340
	Scat	27.99648	84.52543	806	230

3. Some case studies of leopard in the Palungtar Municipality (Source: local people, Community Forest office, local government)

S.N	Lattitude	Longitude	Elevation(m)	Location	Year	Status of the Leopard
1.	27.96586	84.46363	477	Gaulitaar, Dhuwakot	2012	Death
2.	28.00061	84.54999	657	Toribari, Mirkot	2016	Death
3.	27.98809	84.50479	469	Bhorley, Dhuwakot	2018	Death
4.	27.98863	84.50919	533	Lahuredada, Mirkot	2018	Death
5.	27.99219	84.49232	510	Lamatari, Gaighur	2019	Death

4. Scientific, English and Local Names of Species

Scientific Name	English Name	Local Name
<i>Panthera pardus</i>	Leopard	Chituwa
<i>Macaca mulata</i>	Rhesus Macaque	Rato Bandar
<i>Erethizon dorsatum</i>	Porcupine	Dumsi
<i>Canis aureus</i>	Jackal	Syal
<i>Sciurus carolinensis</i>	Squirrel	Lokharke
<i>Muntiacus vaginalis</i>	Northern red muntjac	Harin
<i>Felis chaus</i>	Jungle Cat	Ban Biralo
<i>Herpestes auropunctatus</i>	Small Mongoose	Nyauri
<i>Martes flavigula</i>	Yellow Throated Martin	Malsapro

APPENDIX-III

1. Total no. of livestock, avian stock and pet animals holding in different sites

Study sites	Cattle	Goat	Buffalo	Chicken	Dog	Pig	Total
Khoplang	21	296	52	487	4	1	861
Aapipal	50	312	39	182	3	8	594
Palungtar	44	453	95	432	5	7	1036
Gaikhur	41	131	25	176	2	5	380
Chyanling	46	165	33	281	7	0	532
Dhuwakot	42	316	32	253	12	2	657
Mirkot	53	220	30	265	5	0	573
Total	297	1893	306	2076	38	23	4633

2. Year wise number of livestock, avian stock and pet animal killed by Leopard

Animals	2016	2017	2018	Total
Cattle	1	5	3	9
Goat	74	103	93	270
Buffalo	0	0	0	0
Chicken	6	16	30	52
Dog	8	13	19	40
Pig	0	2	2	4
Total	89	139	147	375

3. Sitewise number of livestock, avian stock and pet animals killed by Leopard

Villages	2016	2017	2018	Total
Khoplang	10	18	16	44
Aapipal	3	15	36	54
Palungtar	11	20	22	53
Gaikhur	17	16	17	50
Chayngli	17	26	21	64
Dhuwakot	15	23	20	58
Mirkot	16	21	15	52
Total	89	139	147	375

APPENDIX –IV

1. Respondents' age class frequency distribution

Age class	Male	Male %	Female	Female %	Total %
19-28	8	3.02	7	2.64	5.66
29-38	35	13.21	17	6.41	19.62
39-48	47	17.74	21	7.92	25.66
49-58	47	17.74	17	6.42	24.16
59-68	37	13.96	7	2.64	16.6
69-78	14	5.28	5	1.89	7.17
79-88	2	0.75	1	0.38	1.13
Total	190	71.7	75	28.3	100

2. Education wise category of respondents

Education Class	Male	Male (%)	Female	Female (%)
Illiterate	29	15.18	23	31.08
Primary	91	47.65	34	45.95
Secondary	35	18.32	11	14.86
Higher Secondary	28	14.66	6	8.11
University	8	4.19	0	0
Total	191	100	74	100

3. Occupation wise category of respondents

Occupation	Total	Percentage (%)
Farmer	179	67.55
Teacher	11	4.16
Business	27	10.18
Government employer	14	5.29
Students	8	3.01
Social	26	9.81

APPENDIX-V



Photo 1: Key informant interview



Photo 2: Interaction with businessperson



Photo 3: Interaction with government employer



Photo 4: Interaction with social healer



Photo 5: Discussion with villagers
Forest



Photo 6: Discussion with staff of Community
Forest



Photo 7: Interaction with teacher



Photo 8: Interaction with farmer



Photo 9: Discussion with staff of district forest



Photo 10: Conducting the transect survey



Photo 11: Grazing near the forest with herder



Photo 12: Grazing near the forest without herder



Photo 13: Fire wood collection from CF



Photo 14: : Kalika CF Office in Chyangli



Photo 15: Deforestation



Photo 16: Forest fire



Photo 17: Scrape of Leopard in Palungtar



Photo 18: Remaining part of prey Goat



Photo 19: Scat of Leopard in Palungtar



Photo 20: Pugmark of Leopard in Palungtar



Photo 21: Scat of Leopard in Khopleng



Photo 22: Pugmark of Leopard in Mirkot



Photo 23: Rescue of Leopard in Bhorley, Dhuwakot Photo



24: Dead Leopard in Lahuredada, Mirkot (Source: DFO, Gorkha)