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Spatio-temporal patterns of common leopard attacks: A case study from Aadhikhola Rural Municipality, Syangja

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KEYWORDS

Common Leopard attacks Kernel Density
Predator-proof corrals
Risk zonation
Safety analysis

ABSTRACT

Information on the spatio-temporal patterns of attacks in certain areas contributes to the designing and implementation of effective mitigation measures. The aim of this study was to assess spatial distribution of Common Leopard attacks to highlight conflict risk zone and temporal trend in Aadhikhola Rural Municipality of Syangja districts from 2016 AD to 2019 AD. Data was collected as registered cases caused by Common Leopard at the Division Forest Office, Syangja according to the Wildlife Damage Relief Guideline, 2013 AD. Total cases were 187 with the highest incidents (n=66) in ward no. 4 (Bangsing). The highest cases occurred in summer (44%) followed by spring (20%). By month the highest number of attacks occurred in July (22%) followed by June, May. Most of the attacks occurred inside livestock sheds (84%), during day time (69%), with goats being the major prey. Kernel Density Estimation (KDE) was used for safety analysis. Kernel density attack layer was reclassified using the geometric interval algorithm to generate five risk zones of leopard attacks. Wangsing, Deurali, Faparthum, Setidovan were very high risk zone for leopard attacks. Predator-proof corrals/ enclosures and improved herding and guarding practices are suggested to reduce livestock losses.

Introduction

Human wildlife conflict is "the interaction between people and wildlife that causes negative impact on people, wildlife and the environment; it is one of the obstacles for biodiversity conservation" (Silwal et al. 2017). Human wildlife conflict exists in all areas where human and wildlife coexist and share the limited resources, irrespective of geographical regions or climatic conditions (Western and Pearl 1989). Conflicts vary according to geography, land use pattern, human behavior, habitat and behavior of wildlife species (WWF 2006). It is more serious in case of mega species that required large amount of food and wide home range including seasonal migration (Karanth et al. 2013). Human population growth and continued shrinkage of habitat have brought wildlife and humans together

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which further generates conflicts (Madden 2004; Bowen-Jones 2012). The problem of Human Wildlife Conflict is not an old issue, it is becoming more critical and can be observed anywhere (Shrestha 1994). The patterns of Common Leopard attacks were significantly uneven and around 90% of attacks occurred outside protected areas (Ruda et al. 2018). In places where people and wildlife share the same landscape for resource usage, the wildlife induces s negative impacts on people and vice versa. In addition, wildlife damage leads to resentment and people resort to retaliatory killings, even of endangered species (Ruda et al. 2020). The consequences can be damage by economic loss, injury or death of a family member resulting in serious psychological trauma and adverse effects and livestock depredation (Chardonnet et al. 2002). If damage severally affects the livelihood of local communities, getting their active support, which is essential for conservation, will be difficult (Mishra 1997). In order to decrease such damages some effective measures must be developed and brought into practice. Without spatial mapping and geo-spatial connections, spatial interactions between human and Common Leopard cannot be studied. A spatial statistical approach identifying high-priority conflict hotspot is also widely adopted (Miller 2015). Human wildlife conflict is a serious threat to the survival of endangered species and human's mankind in the world (Madden 2004). Human wildlife conflict exists in all areas where human and wildlife coexists. Regardless of increasing conflicting situation in Nepal there have been only limited studies on the conflict dynamics and most of them are concentrated only in the protected areas thus creating gaps in conservation outside protected areas. As per the incidents recorded in Division Forest Office, Syangja, Aadhikhola Rural Municipality experienced more livestock damage from Common Leopard than by any other predators; however the possible risk zonation associated in this site was unexamined. Spatial-temporal analysis explores movement of Common Leopard to the human landscapes and provides locations, where the attacks were concentrated (Miller 2015). Thus, the aim of this study was to investigate the possible geospatial connections between the livestock depredation and its surrounding impact zone due to Common leopard attack.

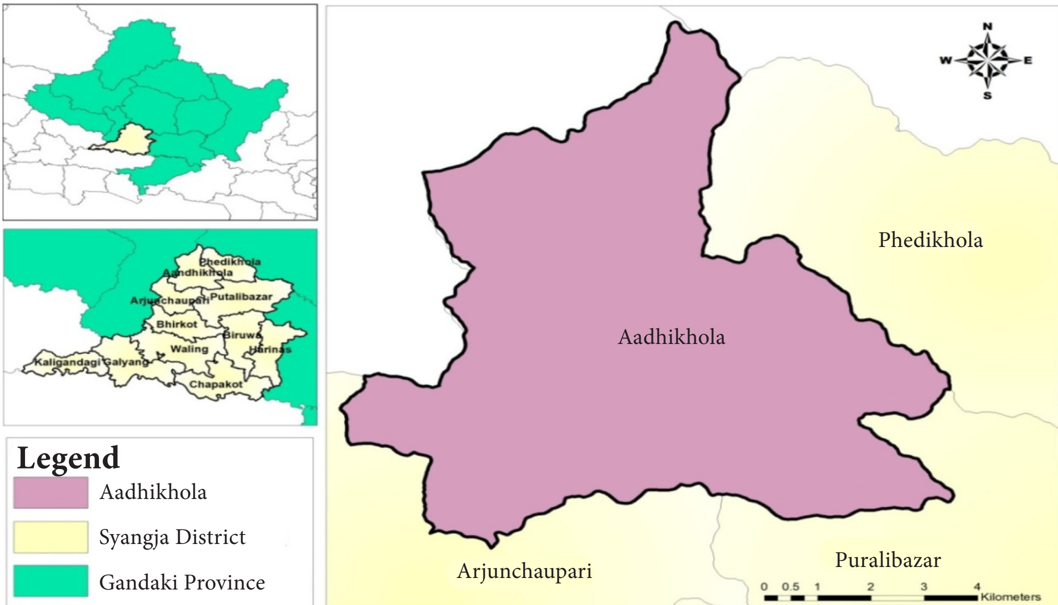

Figure 1: Study Area

Material and Methods

Study area

The study area Aadhikhola Rural Municipality lies in Syangja district, Gandaki Province, Nepal (Figure 1). It lies at latitude 28°06' North and longitude 83°45' East. It covers an area of 69.61 sq.km. The study focused on five wards of Aadhikhola Rural Municipality (Panchamul, Chilaunebas, BichariChautara, Wangsing Deurali, Setidovan, Faparthum). According to one popular folk legend, Aandhikhola River is believed to be originated from the tears of Shravan of the Ramayana. The local economy depends on subsistence farming and forest resources such as fodder, fuelwood. The main crops grown are paddy, maize, millet. Most of the residents are farmers and also rear livestock such as goat, buffalo, and cow.

Research design

The individual methodological step involves both fieldwork associated with the collection of data and subsequent geospatial analysis based on the design. The growing availability of KDE in GIS (Geographic Information System) applications, the perceived accuracy of its hotspot identification, and the aesthetically pleasing and easily understandable output make KDE very popular (Hart and Zandbergen 2014).

Data collection

Data was collected from the Division Forest Office, Syangja according to the Wildlife Damage Relief Guideline, 2013 between 2016 to 2019. The Global Positioning System (GPS) coordinates for each incident site were determined with the help

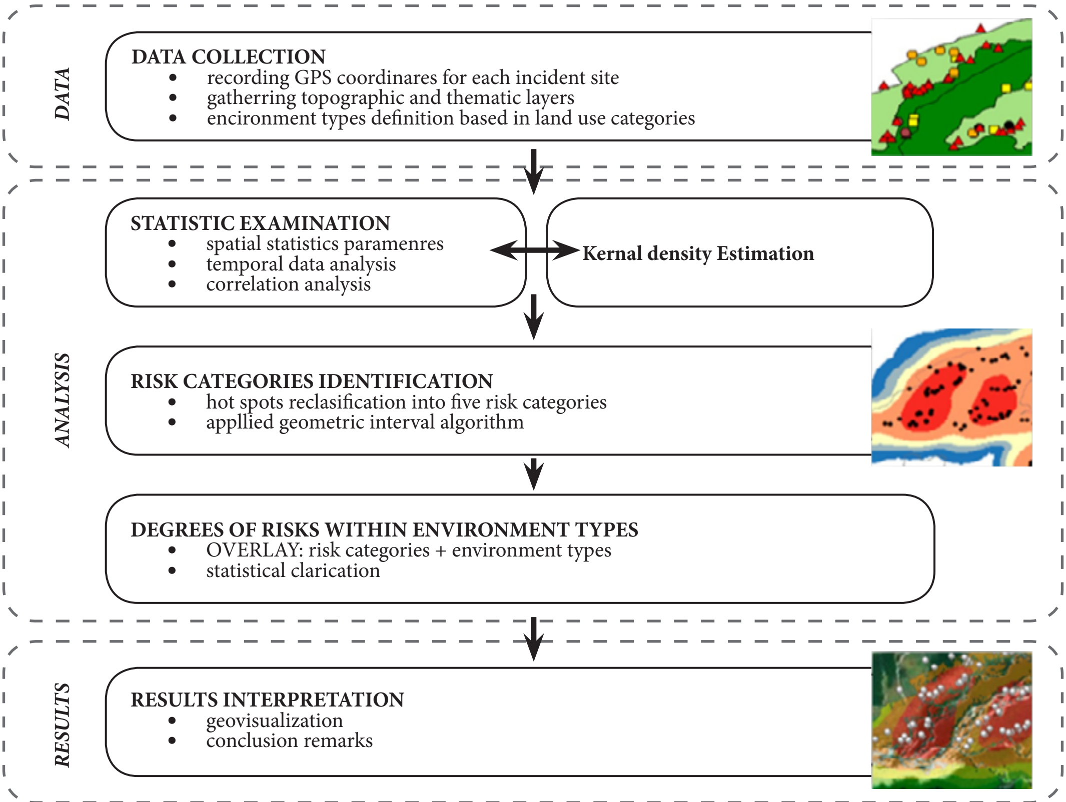

Figure 2: Methodological Flowchart of the research Adopted from Ruda et al. 2018

of the victim or the victim's representatives/or eye witnesses. Landsat Multispectral Scanner System (MSS) and Thematic Mapper (TM) satellite imageries were selected for the environment analysis of study area.

Data analysis

Based on incident data, descriptive temporal data analysis was conducted, followed by examining spatial patterns of attacks and dependencies between incidents and landscape characteristics in order to predict zones with different levels of attack risk.

This study relies on analyzing point data in terms of spatial statistics and spatial analysis for risk assessment of their spatial patterns using geostatistical techniques. (KDE) was used for hotspot mapping and safety analysis. The growing availability of KDE in GIS (Geographic Information System) applications, the perceived accuracy of its hotspot identification, and the aesthetically pleasing and easily understandable output make KDE very popular (Hart and Zandbergen 2014). Arc-GIS10.4 was used to prepare incident distribution and conflict risk zone map, MS- Excel was used to analyze incident data and interpreted using simple statistical tools (pie-chart, bar graph). Google Earth was used to check and quantify GPS data.

Subsequently, we worked with the hypothetical postulate that Common Leopard attacks are mostly located differently in present environment (e.g., accessible and rich in food, land use categories). Available land

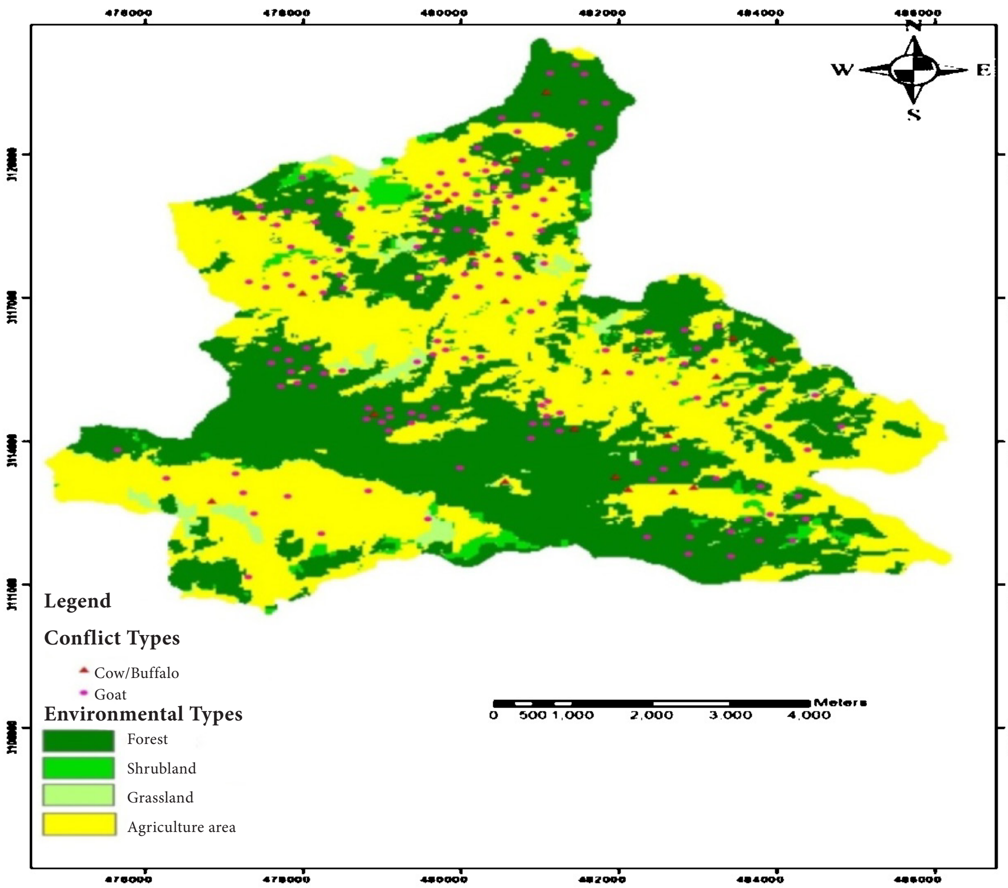

Figure 3: Distribution of the incidents

use categories were grouped into following environment categories.
Forest land
Shrub land
Grass land
Agriculture area

Results

Incidents distribution

Altogether 187 leopard attacks occurred in Aadhikhola Rural Municipality, Syangja during 2016-2019. Figure 3 and Table 1 shows that the attacks distributions were high in ward no.4 (i.e. Bangsing) and followed by ward no. 2 (Chilaunebas) and ward no.3 (Bichari Chautara). Common Leopard attacks were mostly located in forest environmental types.

The highest (n=95) and the lowest (n=15) number of attacks occurred in 2017 and 2016 respectively (Table 1).

Table 1: Distribution of the incidents

Ward No./Name	2016	2017	2018	2019	Total
1 (Panchamul)	0	1	7	2	10
2 (Chilaumebas)	0	22	13	7	42
3 (Bichari Chautara)	5	13	6	1	25
4 (Wangsing Deurali)	4	35	20	5	64
5 (Setidovan)	1	12	9	2	24
6 (Faparthum)	5	12	3	2	22
Total	**15**	**95**	**58**	**19**	**187**

Of the total incidents, 164 goats, 23 Cow/Buffalo had been killed by Common Leopard and no human injuries had been recorded between 2016 and 2019 in Aadhikhola Rural Municipality (Figure 4). 84% of the attacks occurred in Cowshed/House and 16% in Khet/Bari (Figure 5).

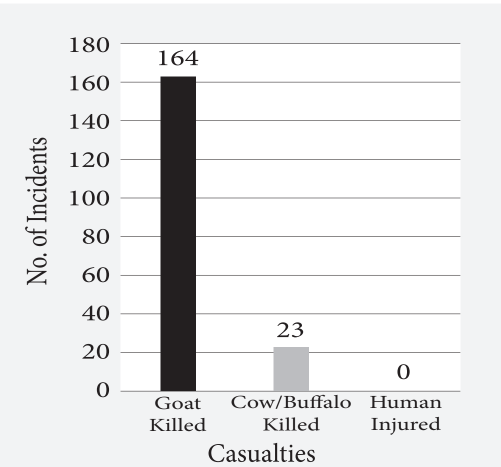

Figure 4: Types of Conflict

Figure 5: Attacks occurrence by location

Temporal patterns of Common Leopard attacks

The attacks recorded were unsteadily patterned across seasons and months. The highest numbers of attacks occurred in summer (44%) and lowest attacks took place in autumn season (17%) (Figure 6 a). Most of the attacks occurred in July (22%) followed by June, May (Figure 6 b).

More than two-third of the attacks i.e. (69%) occurred during day time, followed by 31% of attacks occurred in night time (Figure 6 c).

Risk zone analysis of Common Leopard attack

Kernel density was used to calculate a magnitude per unit area from attacks; using a kernel density functions to fit a smoothly tapered surface to each point, because suitable reclassification can generate significant zones showing a higher probability of wildlife attacks (Figure 7). The kernel density attack raster layer was reclassified using the geometric interval algorithm, the frequency distribution was exponential, and therefore geometric intervals were most appropriate into five categories: very low risk, low risk, medium risk, high risk and very high risk. In total area of 69.61 sq. km 4% of the study area is very high risk area (Wangsing Deurali, Faparthum, Setidovan), followed by 8% of the total area is high risk area (BichariChautara) and 12% medium risk area (Chilaunebas) 14% low risk area and 42% very low risk area.

Discussion

We documented the spatial and temporal pattern of Common Leopard attacks. The number of attacks by Common Leopard varied and fluctuated. Patterns of attack were similar

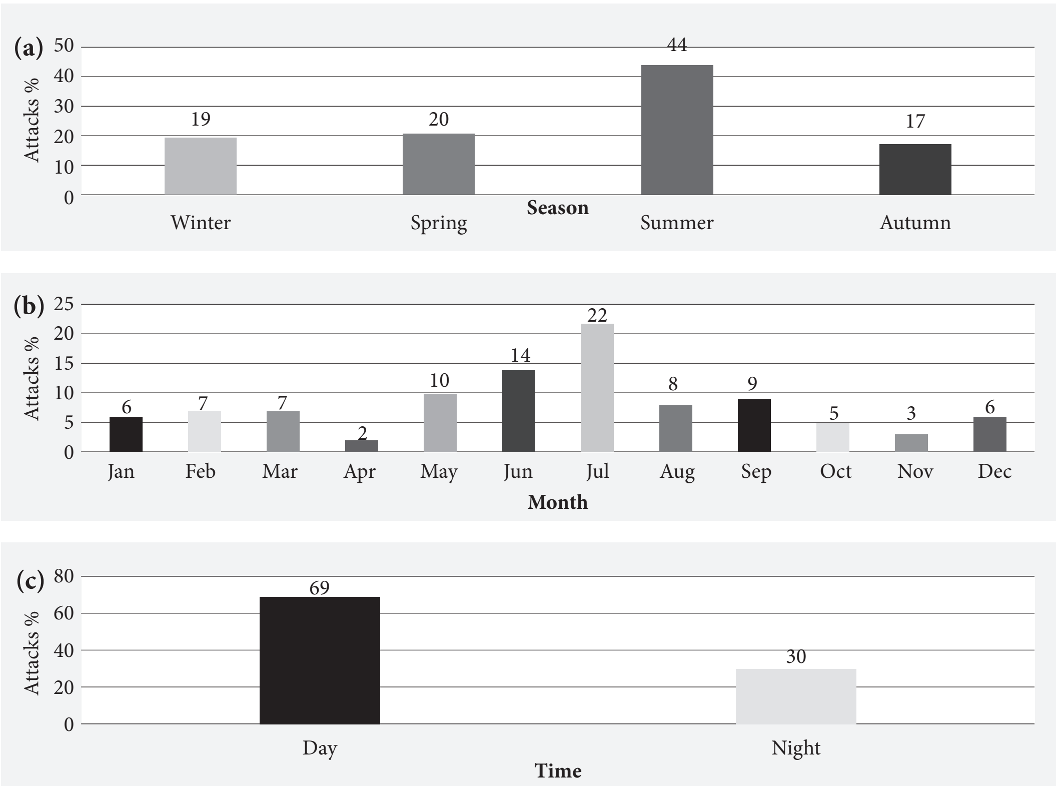

Figure 6: Temporal patterns of leopard attacks (a) Season (b) Month (C) Time

across species, with most attacks occurring in the day time. Ward no. 4 was the riskiest zone with highly depredated species goat followed by cow/buffalo. The potential causes of attacks and riskiest zones include the proximity of forest near human settlements and increment of trees in abandoned land. Major incidences of goat in our study might be because of its body size that resemblance with deer species (Peterson et al. 2010). Majority of attacks occurred in cowshed during day time as most of the residents are farmers and are mostly involved in outdoor activities during day time leaving their livestock in unprotected and weak corrals. The highest numbers of attacks occurred in summer (Figure 6 a). This finding coincides with (Park et al. 2012) where the highest depredation was recorded in summer season that gradually decreased toward autumn due to availability of natural prey species. The Mid-hill forest patches are close to human settlement and are generally not part of the protected area system. Households within highly wooded areas, especially those close to or within forest areas of Aadhikhola Rural Municipality, Syangja are most at risk. Studies have shown that leopards

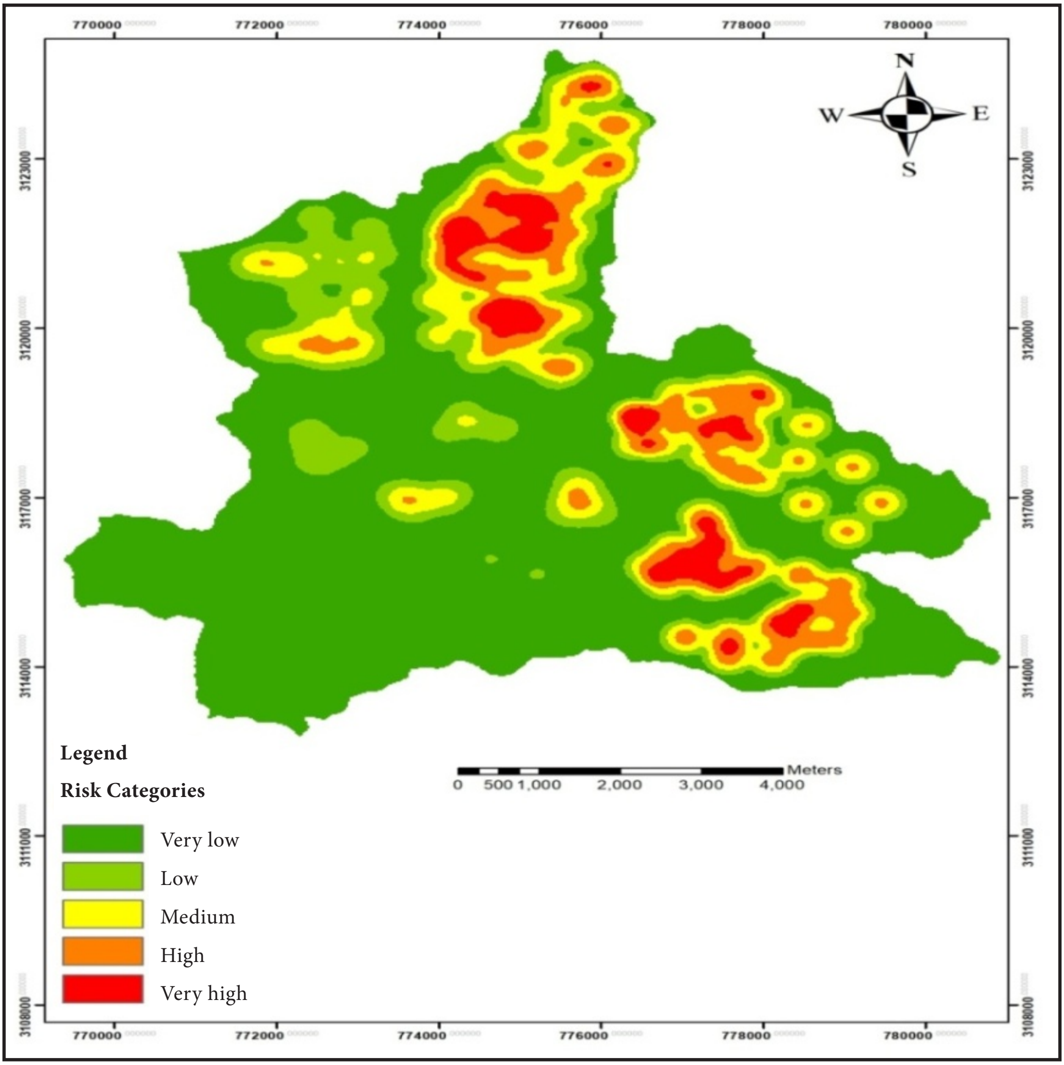

Figure 7: Kernel density estimation of leopard attack in study area

can live in human-modified landscapes and the extent of human-leopard conflicts is associated with the depletion of nature prey populations, the scarcity of water and livestock herding and guarding practices (Acharya et al. 2016). The chief reason behind losses and attacks in livestock from Common Leopard includes lack of knowledge and understanding on the behavior of Common Leopard, its nature and habitat among the people of this region and practice of poor shedding.

Conclusion

Based on the findings of this study, in Aadhikhola Rural Municipality the depredation of livestock by Common Leopard strongly varies with season, month and time. The highest losses to Common Leopard were suffered in summer, with goats being the major prey in cowsheds during day time. The correlates of livestock depredation are poorly constructed livestock sheds, increment of tree cover on abandoned land and nearby farmlands (Khet/ Bari). Households within highly wooded areas, especially those close to or within forest areas are most at risk. Wangsing Deurali, Faparthum, Setidovan area are at very high risk area from Common Leopard attacks. Wildlife conflict can never be ruled out but implementation of effective mitigation measures i.e. predator proof corrals prioritizing high conflict areas helps in risk reduction.

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