Exploring the Dynamic Coexistence of Humans and Wildlife: Understanding Causes, Nature, and Strategies for Managing Human-Wildlife Interactions in Ganderbal, Jammu and Kashmir

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Abstract: This study addresses the rising Human-Wildlife Conflict (HWC) in the human-dominated landscape of Ganderbal district, Jammu, and Kashmir, India, enhanced by human population growth, land-use changes, and increased wildlife populations. This study initiated in response to a specific incident in July 2021 when leopard lifted a girl child and the research spans from July to December 2021. Camera trap installation, questioner surveys, interviews, field observations, and conflict data from the Wildlife Protection Department. The study provides comprehensive insights into the nature, magnitude, and causes of HWC. Out of the eight species recorded in 13,00 captures of camera trap, the highest encounter rates were observed for the Indian crested porcupine and Red fox, while the Kashmir gray langur and common leopard showed the lowest rates. Conflicts were predominantly associated with the Himalayan black bear, peaking during crop harvest in September and October. Questionnaire surveys with 150 individuals and households revealed that land-use conversion from agriculture to horticulture contributed significantly to conflict, constituting 36% of all studied conflict types. Between 2015 and 2021, leopard/bear attacks resulted in 23 injuries and two deaths, predominantly occurring within 3 km of forests or dense plantations. Only 17% of respondents received compensation and reported satisfaction with human-wildlife coexistence. Predation on goats and sheep during winter was attributed to the Himalayan black bear, Himalayan brown bear, and leopard, while Golden jackals and red foxes targeted poultry. Traditional methods were employed by farmers for crop and livestock protection. The study underscores the critical need for effective mitigation strategies and highlights the complex interplay between human activities, land-use changes, and wildlife conservation in the context of.

Keywords: Compensation, Human-wildlife conflict, Mitigation, Camera traps, Land-use change

Human-wildlife conflict (HWC) occurs when the needs and behavior of humans and wild animals impact negatively on each otherand when wild animals damage crops, threaten, kill or injure people and domestic animals, or when humans make disturbances in wild animal habitats (Madden and Quinn 2014). Conflict is becoming a critical problem due to the growing rural population in and around wildlife habitats (Dickman 2010). Human-wildlife conflicts are not evenly distributed throughout the landscape as they depend on the proximity of wild animal habitats, animal species, and seasons of the year.The history of human-wildlife interaction, more popularly known as human-wildlife conflict, is as old as the existence of human beings on the earth. Now this interaction has become a significant problem due to the decrease of free spaces throughout the world with increasing residency areas close to the forests (Redpath et al 2015). Crop feeding, property damage, livestock predation, and human casualties are the most common forms of conflict with wild animals (Ogutu et al 2014). Among these, human injury

or death and livestock predation are the most serious forms of conflicts (Nyhus 2016). This makes people act negatively toward wildlife by poisoning, shooting, and trapping them. Such acts bring numerous social, economic, and ecological consequences (Messmer 2009). The number and type of damage caused by wildlife vary according to the species, season, and availability of resources (Mwamidi et al 2018).The major governing factors of the conflict are habitat loss, degradation, and fragmentation of animal habitat through human activities, animal husbandry, horticulture expansion, conversion of agricultural land to horticulture, over-exploitation of natural resources, and increasing developmental activities (Nyhus 2016). Most developed and developing countries are facing issues of conflict (Ogutu et al 2014).

Human-wildlife conflicts are a serious problem across the Kashmir Valley. Mostly Himalayan black bear (*Ursus thibetanus laniger*), common leopard (*Panthera pardus*), Himalayan brown bear (*Ursus arctos isabellinus*), and Indian

crested porcupine (*Hystrix indica*) have been implicated as the major wildlife species involved in HWCs. Presently, local communities do not get enough benefit from wildlife resources as they may not be aware of the potential for wildlife-related economic enterprises. There has been no is detailed investigation completed to identify the cause of the conflicts, their consequences, and strategies to mitigate them. The current research comprehensively documents the nature, extent, and roots of Human-Wildlife Conflict (HWC) in the Kashmir Valley, providing a crucial baseline for effective management and promoting positive coexistence between humans and wildlife. This study addresses the need for wildlife conservation and management, benefiting local communities and various organizations involved in environmental well-being.

Study area: This study was initiated after a 10-year girl was lifted by a leopard in the Ganderbal district of Jammu and Kashmir. Ganderbal (34°13'48"N and 74°41'7"E) is located at an altitude of 1,590 meters in the Sindh valley. The district is spread from Safapora in the West (34°15'11.57" N and 74°39'14.71", with an altitude of 1596 meters) to Zojila in the East (34°15'48.07" N and 75°25'25.15" E with an altitude of 3313 meters). Ganderbal is flanked by district Baramulla in the west, Srinagar in the south, Bandipora in the north-west, Harmukh Mountain in the north, and Kargil in the east. The total geographical area of the Ganderbal district is 1,059 sq. km and it is the smallest district by area in the state. This study includes the data of all the district as taken from wildlife protection department Sindh division Ganderbal based on opportunistic questioner sample of 150 persons directly or indirectly related to wildlife and conflict.

District Ganderbal has a moderate temperature in summer and experiences severe cold in winter months. The average annual temperature of the Sindh Valley is 11°C. In peak summer the average temperature is 21°C in July, and this is the hottest month of the year. While in winter, the average temperature remains around 0.3°C. January is the coldest month of the year. The annual rainfall is around 700 mm. Precipitation is the lowest in October, with an average of 92 mm. In July, the precipitation reaches its peak, with an average of 440 mm. During winter, the district experiences plenty of snow (10 to 50 cm), which falls from the middle of December till late February almost every year. Ganderbal has a topography that ranges from the cold desert with treacherous lofty mountains barren of any vegetation in areas adjacent to district Kargil, and temperate climate in the rest of the district. Ganderbal has about 45,361 households and 298,000 population among which 20% of population belongs to schedule-tribe living close or inside the wildlife habitats. Agriculture is the mainstay of the economy of the

district. Farming is the main contributor of the GDP of the district with 316 sq. km under cultivation of horticultural and agricultural crops. Thousands of nomads move to upland pastures in the district during summers with their livestock. As they reside in remote and inaccessible areas, they come in direct contact with wildlife and are the source of Human-wildlife interaction.

Methodology: The study employed a comprehensive data collection strategy, integrating primary and secondary sources. Primary data acquisition involved camera trap deployment, field observations, and questionnaire surveys. Fifteen camera traps were strategically positioned in and around the vicinity where a leopard-inflicted incident occurred, utilizing a systematic survey approach. These camera traps, comprising Cuddeback 20MP X-Change Color Day & Night Model 1279 and Spypoint Force-20 Trail Camera Brown, LIT 109, were randomly placed on roads, orchards, and trails toward the forest in neighboring villages. The traps operated continuously for 30 days and were monitored weekly. Field observations were conducted to confirm information from interviews, ensuring the accuracy and reliability of on-site data.Secondary data, sourced from the Department of Wildlife in Jammu and Kashmir, provided additional insights into registered cases of human-wildlife conflict. Key informant interviews targeted individuals reliant on agriculture, wildlife protection personnel, and members of the local community. Facilitated discussions and focus groups enabled a nuanced understanding of community perspectives on human-wildlife interaction. The research encompassed most of close forest villages in the Ganderbal district, with a specific focus on 150 households identified as being involved in conflicts based on wildlife protection data.

Data analysis incorporated both qualitative and quantitative methodologies, encompassing simple descriptive techniques and the calculation of encounter rates derived from camera trap data. Encounter rates, or camera trapping rates, were computed as the ratio of independent photographs to the number of trap days, with consecutive photographs of the same species at the same site considered independent with at least a 1-hour interval between them. The analytical framework included mean percentages and encounter rates, contributing to a comprehensive understanding of the dynamics of human-wildlife interactions in the study area.

RESULTS AND DISCUSSION

Wild mammals in human-dominated landscape: In the semi-urban village community of Ganderbal district, Jammu and Kashmir, the study utilized 15 camera traps over one month to document wildlife encounters. A total of 1,302

photographs of seven wild animal species were captured by camera traps during the period. The Indian Crested Porcupine exhibited the highest encounter rate (0.815), followed by the Red fox (0.704) and the Jungle cat (0.593) (Table 1).

Nature and extent of human-wildlife conflict/interaction: A total of 51 conflicts/interactions with the Himalayan black

bear were recorded in the study area from 2015 to 2021: among which 45 conflicts lead to loss of economy to the local people (Fig. 3). This has a great negative impact on the conservation of wildlife in the region. Efforts were made to study the temporal and spatial use of the landscape by humans and wild animals using camera traps. Rhesus macaque (*Macaca mulatta*) and Kashmir gray langur (*Semnopithecus ajax*), two primates, showed different habitat-use patterns. The Rhesus macaque was using areas close to human habitation and in fallow land, while Kashmir gray langurs were captured in natural habitats and orchards far from habitation. Carnivores were captured in almost all habitat types, except for the Himalayan Black bears which were never captured in areas near human settlements and fallow landand were in orchards close to the forest. The Indian crested porcupine was seen in all habitats in the study area, from human settlements to forests. Primates were seen during day time while as Indian crested porcupine and carnivores were not observed during the day. They were seen in camera-traps during night, mostly at dusk and dawn (Fig. 4). Among the 175 respondents surveyed, conflicts between humans and wildlife were most frequent during the evening, accounting for 39% of reported incidents, followed closely by the morning with 36%. Daytime encounters
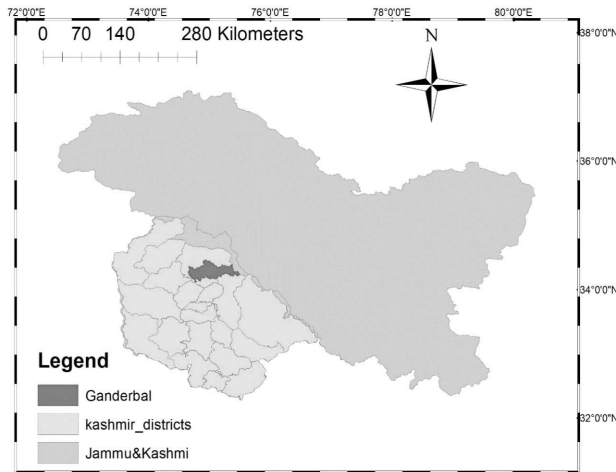
Map 1. Study area map showing Ganderbal in Jammu and Kashmir

Fig. 1. Camera trap images of wild mammals from the intensive study area

comprised 19% of conflicts, while night incidents were notably lower at 5.5%. This data suggests a temporal pattern in human-wildlife conflicts, with higher occurrences during the transitional periods of morning and evening, possibly influenced by factors such as wildlife behavior, human activities, and environmental conditions. Understanding these patterns can be crucial for implementing targeted mitigation strategies to reduce conflicts and promote coexistence between humans and wildlife. Seasonal variation in conflict decreased during winter and increased in summer and autumn months as less agriculture and horticulture activities take place in winter. Based on five-year data collected from the Wildlife Protection Department and surveys, the highest number of human-wildlife interactions
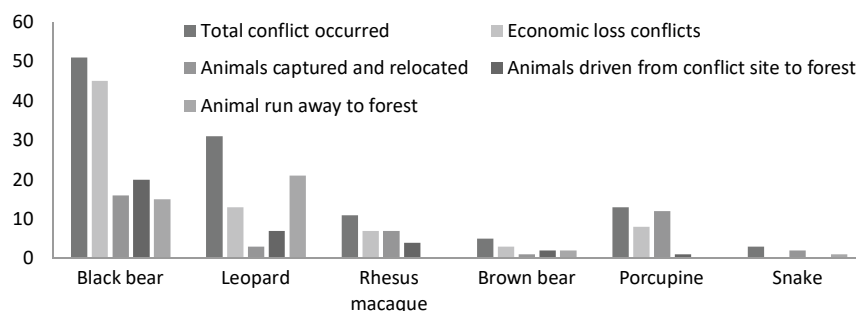
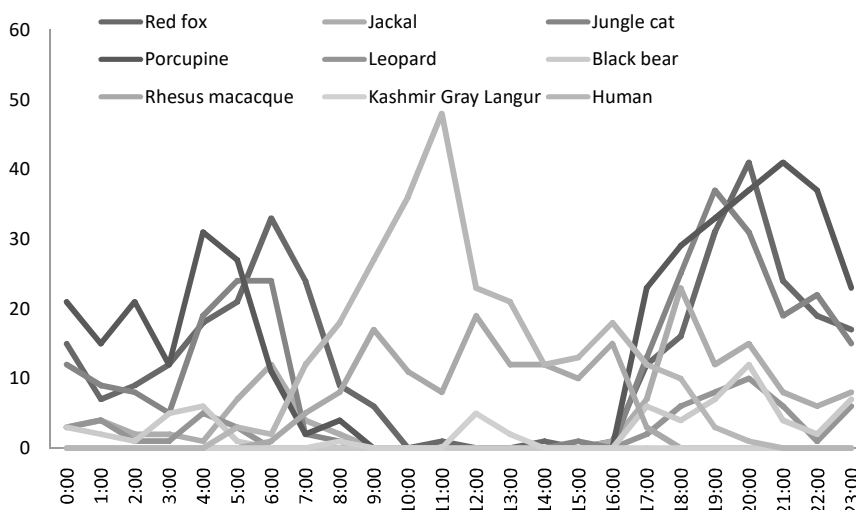**Fig. 2.** Conflict cases with range of economic/human loss and relocation of animal

Fig. 3. Temporal segregation and coexistence of human and wild animals (n=2256, including camera-trapped pictures of humans)

Table 1. Encounter rate of wild mammals

Species	Scientific name	Local name	Observations	Encounter rate
Indian crested porcupine	*Hystrix indica*	*Teer Janwar*	367	0.815±0.32
Red fox	*Vulpes*	*Loow*	317	0.704±0.24
Jungle cat	*Felis chaus*	*Leash*	267	0.593±0.13
Golden jackal	*Canis aureus*	*Shaal*	117	0.26±0.22
Rhesus macacque	*Macaca mulatta*	*Ponz*	115	0.255±0.12
Himalayan black bear	*Ursus thibetanus laniger*	*Haput*	60	0.133±0.11
Leopard	*Panthera pardus*	*Suh*	56	0.1244±0.20
Kashmir gray langur	*Semnopithecus ajax*	*Wandur*	8	0.017±0.07

occurred in September and October (Fig. 5) as autumn is the main harvesting season of crops and fruits.

Mostly men were injured during conflict (71 %) as compared to women (29%) as more men work in the field and orchards than women. Males are involved in guarding of crops while females generally do not participate in this activity. Regarding the age-class, labourers and farmers from 20 to 50 year old were mainly effected by the wild animal interactions (44%). Young people below 20 years were involved in 22 percent of the cases, while people above 50 years had 34% interaction. Most of the interactions were fortunately with no human loss or injury (82%). However, 16% interactions resulted in injury to human being, and 2% percent resulted in death. Human casualty and injury attacks by wild animals were significantly associated with the location where the people were present at the time. The substantial majority of conflicts, constituting 60%, were reported to have transpired within a close range of the forest, specifically within 3 kilometers. Furthermore, 33% of conflicts were documented at a moderate distance, falling between 3 to 6 kilometers from the forest. A smaller proportion, amounting to 6%, occurred beyond the 6-kilometer mark. This spatial distribution highlights the significance of the immediate vicinity of forests as a hotspot for human-wildlife conflicts, underscoring the importance of targeted

management strategies in this close proximity. During or post conflict, no death of wild animal was reported as the animals were rescued by the Wildlife Protection Department and relocated to safe places. Some of the animals were driven back to the forests. However, some natural and accidental deaths were reported from study area (Table 2). The 11 wild animal deaths in four years, were mostly due road accidents.

Crop and livestock damage: Crops were not equally affected by wild animals. Apple was the most favored crop, followed by maize and grapes. Himalayan black bear, Himalayan brown bear, Rhesus macaque and Indian crested porcupine animals feeding on crops. Black bear was the most commonly crop feeder which causes the most damage, followed by the Indian crested porcupine. They damaged crops during night and dusk/dawn, when people are absent from farmlands. The respondents of the survey conducted in Sonamarg and Sarbal ranked the Himalayan brown bear as the third crop feeder, followed by Rhesus macaque. Kashmir gray langur did no damage to r crops/orchards as were mostly in forests and away from the human dominated landscapes. Peak conflict damage was seen during autumn followed by summer, and crops showed varying seasonal damage to different extent.

Himalayan brown bear and Himalayan black bear attack sheep and goats, while leopard killed oxen, cows, buffalo,
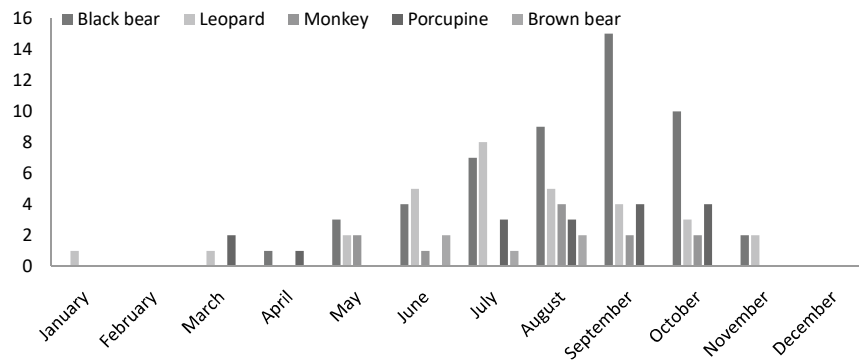

Fig. 4. Percent seasonal variation of human-animal interactions observed in the Sindh Valley conflicts (n=175)
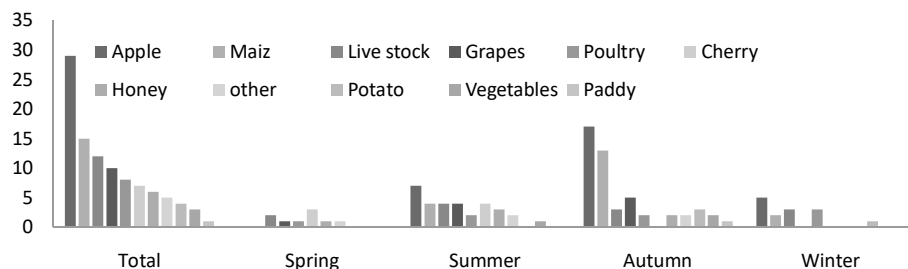

Fig. 5. Seasonal rank of crop feeding and predation by wild animals

domestic dog and horses, besides sheep and goats. Killing of livestock by carnivores is exacerbated by the decline of natural prey due to habitat destruction and poaching. Golden jackal, red fox and jungle cat (*Felis chaus*) were the main 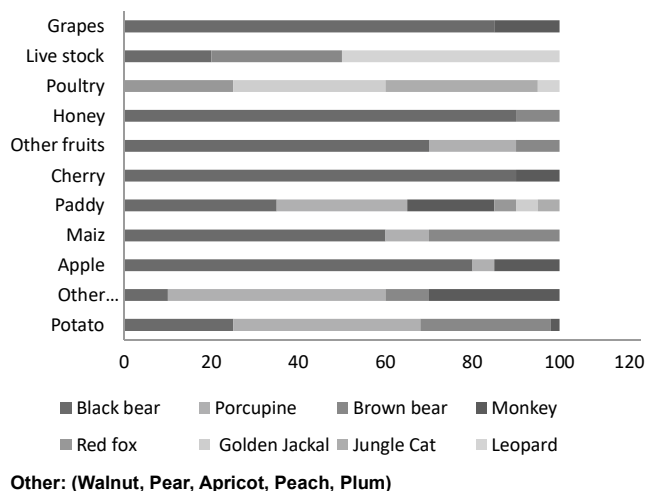threat to poultry, resulting in continuous economic drain to farmers (Fig. 7, 8). Livestock predation was influenced by the movement of shepherds (*chopans* and *bakerwals*) to meadows. Mostly sheep and goats were preyed upon, with a few cases of horse predation (Fig. 10).

Human-wildlife conflict/interaction: The main causes of human-wildlife-conflict in the Ganderbal were vast area of the valley has been converted to agriculture in recent decades. Thirty-six percent of the respondent agreed that this is the main cause of human-animal conflict/interaction as wildlife has been displaced. The human settlement close to the forest land enhanced the conflicts (28%) respondent and sixteen percent of the respondents said that human-wildlife conflict/interaction was the result of cutting of trees in the forest, displacing the animals to orchards that can be considered as pseudo-forests. Some of the old orchards provide wild animals better shelter than the nearby forests.The people inside the forests for firewood collection and grass cutting face wild animals, resulting in interactions. Ten percent of the people mentioned this is one of the causes. Non-timber forest product (NTFP) collection and poaching activities were considered as 5% of the causes (Fig. 11).
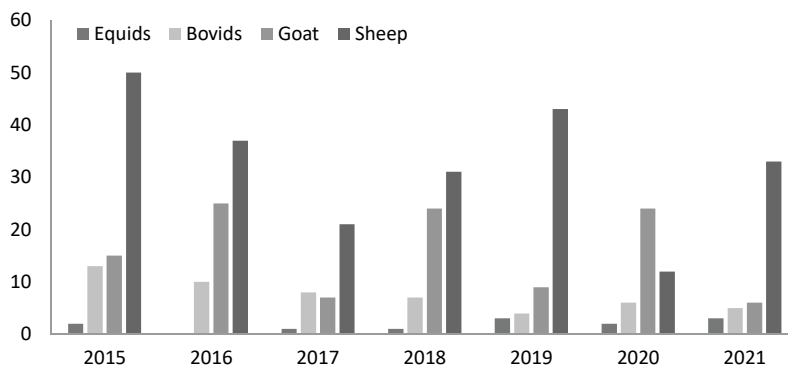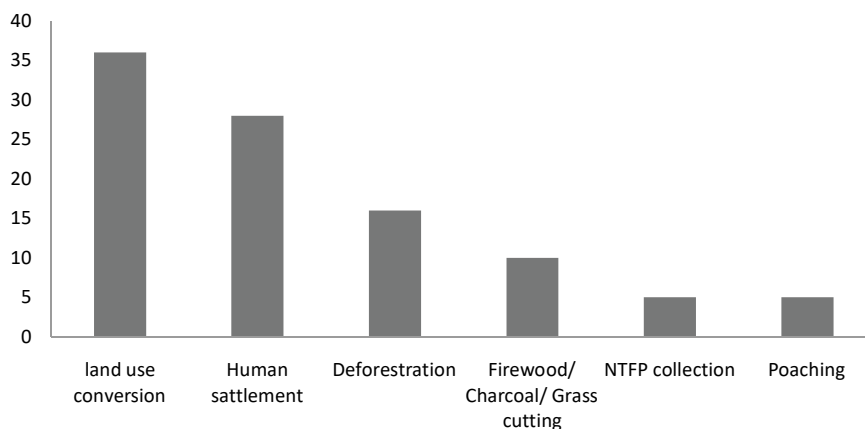

Other: (Walnut, Pear, Apricot, Peach, Plum)

Fig. 6. Interviews and field observations

Fig. 7. Yearly Livestock predation

NTFP= Non timber forest products

Fig. 8. Cause for Human-wildlife-conflict in and around the study area (n=300)

Minimizing and mitigations of human-wildlife-conflict:
Farmers employ various methods to protect crops from wild animals, as evidenced by interviews with locals. The primary approach, adopted by 31% of respondents, involves physical guarding by individuals. Fencing is the second most prevalent method, chosen by 24% of farmers. Chasing (20%), creating smoke (15%), and scarecrows (10%) also contribute to the arsenal of defense strategies. Notably, for mitigating conflicts with Black bears, chasing and smoke have proven effective, whereas fencing was less so due to its susceptibility to breakage by bears. Furthermore, scarecrows are diminishing in popularity as wildlife has adapted to their presence, rendering them less effective in deterring animals from encroaching on crop fields or orchards.

The nature and extent of the human-wildlife conflict have profoundly impacted humans, wild animals, and the environment in many ways through crop damage, habitat disturbance and destruction, livestock predation, and killing of wildlife and humans. As a result, local communities disliked wildlife inhabiting in their surroundings. The shrinking buffer zone between forests and human settlements is the main factor for increasing wild animals foraying into populated areas. Kashmir has 20% forest cover of its geographical area, with five national parks, 14 wildlife sanctuaries, and 35 conservation reserves. Kashmir has seen a drastic change in land-use patterns in the past three decades, with a complete disregard for wildlife habitats and ecologically sensitive zones. Hence change in land use patterns from agriculture to horticulture is providing food to wild animals outside their natural habitat which leads to the extension of their ranges. The buffer between forests and human habitation has vanished due to expanding apple orchards. Fruits,

particularly apples, are one of the most attractive pursuits for Himalayan black bear. Translocation is used as an alternative to lethal control to manage species of carnivores that are potentially dangerous to humans (Athreya et al 2011). But high mortality rates among relocated animals have been attributed to capture-related stress, injuries, and extensive post release movements (Massei et al 2010). Some medicines used for tranquilizing cause complication to animals, like cardiac arrest, pulmonary odema, hemorrhages, hypoglycemia, brain concussion, adrenalin insufficiency, bloat, capture myopathy, shock may be noticed after minutes to hours/days after chemical immobilization (Macintire et al 2012). After translocation carnivores often reappear in their original home range within a relatively short time (Athreya et al 2011). Some studies suggest that translocated carnivores continue to conflict with humans following their release (Athreya et al 2011). Based on statewide survey in Maharashtra, India, Athreya et al (2011) found that translocations of leopards were associated with increased incidence of human-leopard conflict.

Furthermore, removal does not necessarily decrease the incidence of carnivore-human conflict at the site of removal in the long term and may even transfer the conflict to the release site. Another potential explanation for the increased number of attacks on humans is that leopards moving through unfamiliar human-dominated landscapes are more likely to encounter people. Translocated animals should be tagged and/or radio-collared to find out their post-translocated movement. In Kashmir, such studies are urgently required. To find solutions to man-animal interactions, it is necessary to know the population, demography, distribution and behavior of wild animals (Redpath et al 2013). The predictability of food waste as a resource can trigger population increases of opportunistic

Table 2. Unnatural death of wild animals during last 4 years (2018-2021)

Date	Animal	Location	Cause of death
April 18, 2018	Indian crested porcupine	Repora lar	Road accident
May 10, 2018	Jackal	Byepass Manigam	Road accident
June 12, 2018	Indian crested porcupine	Yarmuqam Manigam	Road accident
September 30, 2018	Himalayan brown bear (m)	Sarbal Sonamarg	Electric current
January 03, 2019	Jackal	Prang road	Road accident
January 26, 2019	Yellow-throated marten	Panzin Kangan	Unknown
October 01, 2019	Himalayan black bear (m)	Shah mohalla rangil Ganderbal	Unknown
March 6, 2020	Golden jackal	Kangan	Dog attack
August 23, 2020	Himalayan black bear (f)	Gutlibagh Ganderbal	Unknown
January 12, 2021	Red fox	Lar	Unknown
September 23, 2021	Himalayan black bear (f)	Sheikh bagh kangan	Road accident
December 16, 2021	Himalayan black bear (m)	Khulmulla Nagbal Ganderbal	Road accident

species, in turn altering predator-predator and predator-prey dynamics (Oro et al 2013, Newsome et al 2015).

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