Livestock Depredation by Large Carnivores in Kargil, Indian Trans-Himalaya: Patterns and People's Perceptions

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Abstract: Livestock depredation by large carnivores is an important livelihood concern among Trans–Himalayan pastoralists. The livestock depredation by the snow leopard and Tibetan wolf in the Chiktan Valley, Kargil, Ladakh, where human–wildlife conflict is rampant but poorly understood was assessed. The study was carried out through open-ended structured interviews in December 2021. The carnivores killed a total of 161 livestock in three years. Sheep and goats (86%) were the primary victims. Snow leopard was the most important predator (60 %). However, wolf is the most despised, perhaps due to occurrence of relatively higher incidences of depredation events. Wolf killed animals more in the open pastures (58), while the snow leopard killed inside the corrals (83). Livestock were killed mostly in the winter (42%) and autumn (26%). Each of the total 80 household incurred an estimated monetary loss of approx. Rs. 11800 annually due to depredation. The strengthening of livestock corrals to reduce depredation and sensitizing local communities on conflict mitigation strategies as important conservation interventions is recommended.

Keywords: Snow leopard, *Panthera uncia*, Tibetan wolf, *Canis lupus chanko,* Agro-pastoralism, Kargil, Livestock depredation

Carnivore-caused livestock mortality and consequent economic loss dates back to medieval times when humans started domesticating livestock (Anand and Radhakrishna 2017). It is considered a serious global problem, as affected farmers resort to retaliatory killing (Treves and Karanth 2003, Karamanlidis et al 2011, Carter and Linnell 2016). Such actions result in extermination of carnivores from certain areas, as observed in the case of wolves *Canis lupus* in Northern America (Musiani and Paquet 2004, Chavez and Gese 2005), bears *Ursus arctos* in Europe (Zedrosser et al 2011), lions *Panthera leo* and spotted hyenas *Crocuta crocuta* in Africa (Holmern et al 2007). The issue of human-carnivore conflict in the Indian Sub-Continent, which has an agrarian economy, is very acute. Anand and Radhakrishna (2017) documented that nearly 90% of inhabited area in India affected by human– wildlife conflict. Several species such as snow leopard *Panthera uncia*, Tibetan wolf *Canis lupus chanko* and Himalayan brown bear *Ursus arctos isabellinus* face similar threats of persecution in retaliation of livestock killing (Jackson and Wangchuk 2004, Namgail et al 2007, Bargali 2012, Habib et al 2013). Investigating the trend of human – wildlife conflict (HWC) in India, Anand and Radhakrishna (2017) reported over 69% conflicts occurring outside protected areas whereas only 31% of conflicts are reported from PAs. Such increase in livestock depredation by large carnivores outside protected areas has been attributed to the increase in their population due to strict carnivore conservation laws (Treves et al 2004, Wang and Macdonald 2006). But predation on livestock is predicted to increase if population of natural prey species is low and access to alternate prey species such as livestock is easy (Bereczky et al 2012). Moreover, misidentification of underlying threats such as disease and political instability in addition to inconsistent and sparse data on HWC make this problem more complex (Dar et al 2009, Carter et al 2012).

Ladakh in the Trans-Himalayas (TH) is a mosaic of different habitats where wild and domestic herbivores extensively share the same rangeland resources. Here predation on livestock by wild carnivores is a major conservation issue. Seven large carnivore species in the region are known to prey on domestic livestock. Moreover, irate farmers resort to retaliatory killing yet its occurrence at a regional level is not known. Heavy livestock mortality due to snow leopard *Panthera uncia* in the Indian Trans – Himalaya is reported from Spiti, Himachal Pradesh (Mishra 1997), Gya-Miru area in Eastern Ladakh and Hemis National Park in central Ladakh (Jackson and Wangchuk 2004). In addition to these, Tibetan wolf and Eurasian lynx *Lynx I. isabellinus* are also reported to kill livestock in these areas (Namgail et al 2007, Jamwal et al 2019)..

In general, data on human-wildlife conflict in Kargil is scarce, although people reported livestock depredation by bear, wolf and snow leopard. The wolf often kill livestock in rangelands while grazing whereas snow leopards often enter

corrals at night. Additionally, they reported that snow leopard ambush livestock while grazing in pastures. Jackson and Wangchuk (2004) attributed high livestock depredation by wild carnivores in Ladakh to poorly constructed livestock corrals (sheds) and poor herding practices. However, understanding of the underlying causes of livestock depredation in the Kargil district remains rudimentary. Therefore, in present study livestock depredation by large carnivores in the Chiktan Valley of Kargil District to understand spatio – temporal patterns of depredation, its economic impact and peoples' attitude towards wild predators.

MATERIAL AND METHODS

Study area: The Chiktan Valley (34.4571 N and 76.5197 E) of Kargil District is located in western Ladakh at a distance of *ca.* 70 kms from the district headquarters. Spanned over an area of 400 KM^2 we included villages in between Kanji Nala stream and Indus River, of the proposed Nindum Wildlife Sanctuary and Elevation ranges from average 2800 meters at Sanjak m asl to 5500 m asl in Nindum. The terrain on the northern side of the valley is rugged while those in the south are undulating. Thus, the southern part supports Ladakh urial (*Ovis vignei vignei*), while the northern part supports Asiatic ibex (*Capra ibex sibirica)*. Besides these, smaller prey species such as long-tailed marmot(*Marmota caudata)*, cape hare (*Lepus capensis*), pika (*Ochotona* spp.) and other rodents are also present.

Major predators include snow leopard, Tibetan wolf and red fox (*Vulpes v. montana)*. Precipitation in the valley is mainly in the form of snow in the winter (November to March), when 3-5 feet of snow accumulate on the ground. Vegetation in the region is characterized by sub-alpine desert steppe and alpine meadow with low primary productivity. The area is virtually devoid of forest cover except for isolated patches of junipers *Juniperus* spp. and planted varieties of poplar (*Salix* spp.) and birch (*Betula* spp.) along major water courses. There are willow and juniper trees all along the Kanji River (Fox et al 1991, Hartmann 2009), although juniper trees were sparsely distributed.

People are dependent on agriculture and livestock farming for livelihood. Water for irrigation, drinking and livestock is sourced from Kanji River. Sheep, goat, yak, cow, horse and donkey are the main livestock types reared by farmers. Poultry rearing is also common in the region. Agriculture provides food (barley, wheat and vegetables) whereas silviculture provides timber and fuel wood (willow and poplar). Rangelands are used year round for livestock grazing, avoiding only if snow exceeds to obstruction level for livestock movement. They are herded communally in each village. Traditionally pastures are divided among villages. Movement of sheep and goats are regulated in pastures whereas cow, yak hybrids and horse are free to roam in the catchment area of the Valleys.

Data were collected from six hamlets in Hagnis, Kukshow, Pacharik, Chiktan, Samrah Khangral, Staktse in December 2021with open – ended structured interviews. Both women and men from 80 households participated in the questionnaire survey. The area was stratified into three zones: rocky cliff and valley mouth (Zone-1), open near ridgelines (Zone-2) and open valleys without obstructions (Zone-3). The vulnerability of livestock to predators varies across a village and we randomly selected different households in the outer, middle and inner areas of a village.

For every livestock depredation case, recorded the zone including name of carnivore and livestock type, number killed, year, time and site of depredation. The distance of the house from the nearest gorge opening was recorded to measure vulnerability and signs used to authenticate predator in case killing occurred in their absence. Besides this, interviewed six elders from the survey villages to understand livestock herding practices in the Valley.

Further, we cross checked livestock depredation reported by a household from neighbors and the village headman. This verification was necessary as respondents exaggerate the number of livestock loss to predator, perhaps in the hope of getting monetary compensation from the government (Bhatnagar et al 1999). Possibility of such inflation was also minimized through building a rapport with the villagers by spending some time with them before carrying out the survey. Moreover, a local guide explained the purpose of the interview to the villagers. Additionally, in order to evaluate economic loss per household due to depredation, market survey was carried out to know market value of different livestock types.

Prey selection by predators was tested using modified chi-square test: log-likelihood chi-square test (Manly et al 1993). In case of rejection of the null hypothesis (no selection), Bonferroni-adjusted 95% confidence intervals were constructed to determine which animals were killed selectively. The livestock type was killed more than expected based on its relative abundance if the lower confidence interval was greater than its population proportion, whereas it was killed less than expected when the upper confidence limit excluded its population proportion.

RESULTS AND DISCUSSIONS

Patterns of livestock depredation by large carnivores: In 2021, eighty households in the seven villages owned 944 livestock, which translates to an average herd size of 12

livestock per household. Most of the households owned cows (98%) and sheep/goats (99%). Yak hybrids and donkey were owned by 44 and 18% of the households, respectively. Horse was owned by only 4% households. Sheep and goats (77%) followed by cow (14%) were the most abundant livestock type (Table 1). The villagers incurred a total loss of 161 livestock heads or 22.50% of the total livestock population over a period of three years (January 2019 to December 2021). This amounted to a loss of 2.01 livestock/ household/year. Overall, snow leopard was the most important predator accounting for (60%) of the total loss, followed by Tibetan wolf (37 %). Livestock loss to other carnivores were negligible only 4% (Table 2). Such patterns of livestock depredation by wolf were also reported from Spiti, Himachal Pradesh (Mishra 1997) and Gya – Miru, Ladakh (Namgail et al 2007). Additionally, livestock depredation by wolves is also reported from the Tibetan plateau, Europe and North America (Li et al 2015). There were significant difference in vulnerability of livestock types to predators (Muhly and Musiani 2009). Sheep and goats were the main victim (86%) followed by cow (5%) and horse (1%). Likewise, sheep and goats (Meriggi and Lovari 1996) were killed significantly more than expected from their relative abundance. Overall, snow leopard killed sheep and goat more than expected as the lower confidence interval for this livestock type was greater than population proportion. However, snow leopard killed cow and yak hybrids less than expected, as their population proportion exceeded the upper confidence limits. They never killed horse and donkeys. Similarly, Tibetan wolf killed donkeys and horse more than

expected, lower confidence interval for these livestock types was greater than its population proportion. Cow and yak hybrids were killed less than expected, as its population proportion exceeded the upper confidence limits. Wolves killed sheep and goats in proportion of its relative abundance (Table 3). Although, sheep and goats were killed by both wolf and snow leopard, the number of livestock killed per incident were higher for the snow leopard. Such high losses per incident were also reported from other parts of Ladakh, Himachal Pradesh and Tibet (Namgail et al 2007 and Li et al 2013). Most of the livestock killed by the snow leopard were sheep and goats. This could be attributed to the depredation by snow leopards inside corrals that mostly sheltered sheep and goats. Although livestock depredations by snow leopard was higher than wolf, people lamented livestock depredation by wolf more woefully.

Spatio-temporal pattern of livestock depredation: Out of the three zones, maximum livestock depredation occurred in

Table 2. Major carnivores involved in livestock depredation in the Chiktan Valley, Kargil, Ladakh

Species	Snow leopard	Tibetan wolf	Others
Sheep/goat	91	42	5
Cow	2	5	1
Yak hybrids	3	3	0
Donkey	0	7	0
Horse	0	2	0
Total killed	96	59	6
Percent killed	60	37	4

Table 1. Livestock types and their percentage losses in the Chiktan Valley, Kargil – Ladakh

Livestock type	Population	Percent population	Number Killed	Percent killed
Sheep/goat	727	77	138	86
Cow	129	14	8	5
Yak hybrids	66	7	6	4
Donkey	20	2	7	4
Horse	2	0.0001	2	1
Total	944	100	161	100

Table 3. Livestock populations (proportions) killed by major carnivores)\ in the Chiktan valley, Kargil – Ladakh (Bonferroni confidence limits)

Species	Population proportion (n = 944)	Snow leopard			Wolf		
		Proportion killed (n = 95)	Lower	Upper	Proportion killed (n = 60)	Lower	Upper
Donkey	0.021 (20)	0.000 (00)	0.000	0.000	0.119 [+] (07)	0.093	0.144
Cow	0.137 (129)	0.021 [−] (02)	0.020	0.022	0.085 [−] (05)	0.071	0.099
Yak hybrids	0.070 (66)	0.031 [−] (03)	0.029	0.033	0.051 [−] (03)	0.045	0.056
Sheep & Goat	0.770 (729)	0.948 [+] (91)	0.942	0.954	0.712 [o] (42)	0.614	0.809
Horse	0.002 (02)	0.000 (0)	0.000	0.000	0.034 [+] (02)	0.031	0.036

n = total number of livestock, figures in the parenthesis indicates population of each species, proportion = figures in parenthesis / n, [+] = killed more than expected, [−] = killed less than expected, [o] = killed in proportion to abundance

Zone- 2 (Open near ridgeline areas; 58%), followed by Zone-1 (Rocky cliff and Valley mouth; 37%), and Zone-3 (open areas without obstructions; 5%). Snow leopard killed livestock mostly in villages near rocky cliff (54%) whereas wolf killed livestock in villages near open ridgeline areas (78%). Snow leopard never killed livestock in open valleys. Out of the 161 livestock killed, 52% were killed in corral and the rest (48%) in open areas (Table 4). Snow leopard killed livestock, mostly at night, inside corral (87%5). Wolf killed livestock mostly during daylight in open areas (97 %). Pattern of livestock killing varied across seasons. Maximum depredations occurred in winter (42%) followed by autumn (26%), summer (18%) and spring (14%). Snow leopard killed livestock mostly in winter (48%) and the least in summer (1%). Wolf killed livestock mostly in summer (49%) and the least in spring (4%). However, livestock killed in autumn by both the species, snow leopard and wolf, were 29 and 25% respectively (Fig. 1).

Livestock depredation differed across space and time. Snow leopard, the most important predator killed livestock in open as well as in corrals, whereas wolf killed livestock mostly in open areas. Also, more number of livestock were killed in areas close to open ridgeline followed by rocky cliff. Thus, livestock are more vulnerable to wolves when they graze in open areas, and they are more vulnerable to snow leopard near cliffs. Thus, their herding practices need to be improved to prevent depredation by wolf, while the corrals need to be strengthened to protect livestock from snow leopard. Overall, lax livestock herding practice is the root cause of livestock depredation in the region. Pertinently, a single individual; often children herd large group of sheep and goats in the rangelands thus making the livestock vulnerable to depredation (Jackson and Wangchuk 2004). Moreover, vulnerability of livestock depredation in winter also increases due to preferences of lower elevation by carnivores, particularly snow leopard in this season.

**Economic loss and people's attitude towards predators:** The villagers incurred an economic loss of approx. Rs. 35600/ household due to depredation during the study period, which translates to an annual economic loss of approx. Rs. 11800/household. The estimated losses were based on approximate market value of the animals at the time of survey. Yak was the most valuable animal with a market value of approx. Rs. 82000 followed by cow (58000), horse (25000), donkey (15000), and sheep and goats (14500). The average annual monetary loss of Rs. 11800 per household due of depredation represents 23% of the average per capita annual income in the erstwhile state of Jammu and Kashmir (Economic Survey, J and K, 2013 – 14). Nonetheless, in an area with limited livelihood options, this amounts to a

substantial loss. In a similar study in Gya – Meru, Ladakh, Namgail et al (2007) reported annual monetary loss of 18 % of the average annual per capita annual income. Similarly, in Kibber (Himachal Pradesh), India, reported loss attributed to depredation was 11% of the average annual per capita income of the state (Mishra 1997).

Most of the individuals interviewed to find out peoples' attitude towards large mammals expressed negative attitude towards the predators wolf and snow leopard on account of livestock depredation. Most of the respondents advocated for their persecution or trapping. On the contrary twenty three percent individual adored snow leopard followed by wolf (18%). Respondents expressed positive attitude (85%) towards urial and ibex also. Similar, attitude on account of depredation and economic losses are also reported from other areas of the Ladakh (Namgail et al 2007), Nepal (Aryal et al 2014) and Tibet (Li et al 2015). Moreover, despite the high rate of livestock depredation nobody received any compensation till the end this study. Those who applied for monetary compensation reported that the procedure of filing cases is complicated and compensation received are minimal. Further did not come across any incident of retaliatory killing of snow leopard in the area. However, informants reported that people allegedly resort to killing of wolf. Communal killing or *Lings* is a common method used to kill wolves in the valley. Such activities are most often carried out during spring season targeting sub adults and cubs. There was no observation on pit traps as reported from Gya –

Table 4. Spatial variation in livestock depredation by different carnivores in the Chiktan valley, Kargil, Ladakh

Location	Snow leopard	Wolf	Others	Total
Open	12	58	6	76
Corral	83	2	0	85
Total	95	60	6	161
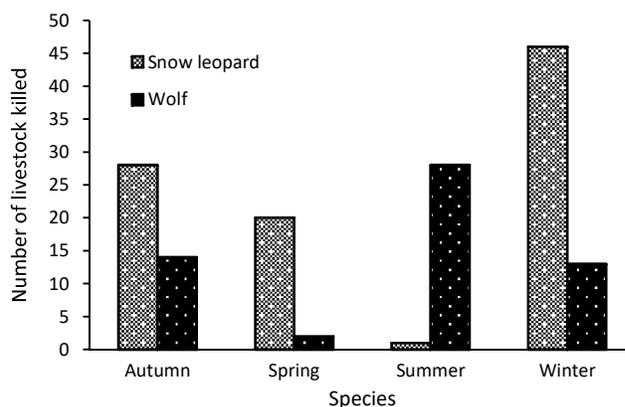
Fig. 1. Seasonal variation in livestock depredation by large carnivores in the Chiktan valley, Kargil. Ladakh

Miru area of Ladakh (Namgail et al 2007) and Spiti, Himachal Pradesh (Mishra 1997) except report on the practices of hunting wolf pups by angry farmers in the area. Altogether, the practice of retaliatory killing still exists as livestock killing is frequently reported and monitoring and mitigation measures are not spread evenly to curb it.

CONCLUSION

Snow leopard is the most important predator in the Chiktan Valley of the Indian Trans – Himalaya. Snow leopard killed sheep and goats more than expected, while it avoided other livestock types. Snow leopard mostly killed livestock inside corral at night. This occurred most often in winter season in villages near ridgeline and valley cliffs. Wolf killed livestock in open areas often in daytime compared to snow leopard. They killed all livestock types and killed livestock mostly in summer season. Lax herding practices is the primary reason for livestock depredation in the valley. Additionally, hunting of wolf pubs is a primary conservation threat that needs to be addressed in the region. Improvement in corral structure, compensation mechanisms and initiating a livestock insurance scheme combined with conservation education programe will be required to change people's attitude towards large carnivores. This will help in curbing retaliation of wolf pubs besides garnering local support in conservation of threatened species in the region.

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