CERC Technical Report No. 11

Living with large carnivores

Snow leopard predation on livestock in the Spiti Trans-Himalaya

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International Snow Leopard Trust

nature conservation foundation

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Abstract: Predation by large carnivores on livestock and their retaliatory persecution by pastoralists is a worldwide conservation concern. Relatively poor understanding of the ecological and social underpinnings of this human-wildlife conflict hampers effective conflict management programs. The endangered snow leopard *Uncia uncia* is involved in conflicts with people across its mountainous range in South and Central Asia, where pastoralism is the predominant land use, and is widely persecuted in retaliation. We examined human-snow leopard conflicts in Spiti region of the Indian Trans-Himalaya, where livestock outnumbers wild ungulates, and the conflict is acute. We quantified the snow leopard's dependence on livestock by assessing its diet in two areas that varied in the relative abundance of livestock and wild ungulates. We also surveyed the indigenous Buddhist community's attitudes towards the snow leopard in these two areas. Our results show a relatively high dependence of snow leopards on livestock. Higher proportion of the snow leopard's diet (58%) was livestock in the area with higher livestock (29.7 animals km^{-2}) and lower wild ungulate abundance (2.1-3.1 bharal *Pseudois nayaur* km^{-2}), compared to 40% of diet in the area with relatively lower livestock (13.9 km^{-2}) and higher wild ungulate abundance (4.5-7.8 ibex *Capra ibex* km^{-2}). We found that the community suffering greater levels of livestock losses was comparatively more tolerant towards the snow leopard. This discrepancy is explained by the presence of a conservation program in the former site, as well as by differences in the economic roles of livestock between these two otherwise closely related communities; the latter is more dependent on livestock as a source of income and thereby less tolerant of the snow leopard compared to the former which is more dependent on cash crops. Our results have implications for conflict management strategies. They indicate that relative densities of livestock and wild prey may be reasonable predictors of the extent of depredation by the snow leopard. However, difference in the extent of depredation, by itself, is not an adequate measure of the intensity of conflict even in apparently similar cultural settings.

Living with large carnivores: snow leopard predation on livestock in the Spiti Trans-himalaya

Introduction

The increasing interface between humans and large carnivores is resulting in a world-wide escalation of human-carnivore conflicts (Madhusudan & Mishra 2003; Treves & Karanth 2003). Carnivores often cause serious economic losses by preying on livestock. For example, coyotes (*Canis latrans*) in North America (Windberg et al. 1997), mountain lions (*Felis concolor* ssp.) in South America (Mazzolli et al. 2002), wolverines (*Gulo gulo*) and wolves (*Canis lupus*) in Europe (Landa et al. 1999; Merrigi & Lovari 1996), foxes (*Vulpes vulpes* ssp.) in Australia (Greentree et al. 2000), tigers (*Panthera tigris*) in south Asia (Bagchi et al. 2003) and lions (*Panthera leo*) in Africa (Patterson et al. 2004) get into conflict with humans due to livestock depredation. Large carnivores are often specialized for ungulate predation, and, therefore, readily take to killing livestock when opportunities arise (Treves & Karanth 2003). Furthermore, domestication is believed to have led to a decline in the anti-predatory abilities in livestock, making them particularly vulnerable to predation compared to wild ungulates (Landa et al. 1999; Zohary et al. 1998). There are other proximate causes responsible for escalating the levels of carnivore predation on livestock, such as an increase in local abundance of carnivores, increase in livestock populations, or decline in wild prey populations (Madhusudan & Mishra 2003). Livestock owners often have strong negative attitudes towards carnivores (Mishra et al. 2003; Naughton-Treves et al. 2003).

Inadequate understanding of ecological and social issues of human-carnivore conflicts often hinders the formulation of effective conflict resolution and conservation management strategies. For instance, even basic understanding of the extent of livestock depredation, the relative importance of livestock in carnivore diet, or the attitudes of livestock owners towards carnivores, is often lacking (Madhusudan & Mishra 2003). There is an urgent need for inter-disciplinary applied research (e.g. Hotte & Bereznuck 2001; Nyhus et al. 2003; Ogada et al. 2003) that can assist in developing appropriate conflict management strategies (Treves & Karanth 2003).

Here, we examine from both ecological and social perspectives, an acute human-wildlife conflict involving the snow leopard (*Uncia uncia*). This is a globally endangered large carnivore (IUCN Redlist), and a flagship for conservation of wildlife in Asia's highlands. The snow leopard is involved in conflicts with pastoralists throughout its range (Fox et al. 1991; Mallon 1984; Mishra 1997; Mishra et al. 2003; Mishra & Fitzherbert 2004; Oli et al. 1994; Schaller et al. 1988b; Schaller et al. 1988a). Losses caused by the snow leopard are particularly damaging since they occur in regions with underdeveloped economies, and this creates antagonism towards conservation efforts in general (Pratt et al. 2004). Pastoralists often have strong negative attitudes towards the snow leopard, and retaliatory persecution in defense of livestock threatens its survival (Mishra et al. 2003).

The economic loss due to large carnivores (snow leopards and wolves *Canis lupus*) in Spiti region of the Indian Trans-Himalaya (c. 12,000 km^2) was earlier estimated to be relatively high (US$ 128 per family annually), amounting to about half the per capita income of the state (Mishra 1997; World Bank 1996). Large areas in Spiti have been declared as nature reserves, but the land is owned by the local tribal people who continue to exercise their traditional rights and privileges. Such "paper-parks" can achieve conservation only to the extent in which people occupying them participate in it (West & Brechin 1991). But, as existing governmental schemes of financial compensation for livestock depredation is plagued by shortages of funds and can recompense only 3% of the loss to the people (Mishra 1997), it is critical to evaluate the socio-economic aspects of the snow leopard – human interface here.

In Spiti's rangelands, the density of livestock is often several times greater than that of wild ungulates, which is perhaps the most important cause of the high level of conflict (Mishra 1997). The region has seen declines in wild herbivore density and diversity due to competition from an overstocked livestock population (Bagchi et al. 2004; Mishra et al. 2001; Mishra et al. 2002; Mishra et al. 2004). Given the low relative abundance of wild ungulate prey compared to livestock, to what extent is the snow leopard dependent on livestock for food? Is the extent of livestock depredation related to the relative abundance of livestock vis-à-vis wild prey? Does the community suffering greater livestock depredation have stronger negative attitudes towards the snow leopard? We examine these three questions in this paper by comparing the nature and extent of snow leopard-human conflict in two sites

in Spiti that differ from each other in the abundance of livestock and wild prey, and in the relative economic value and roles of their livestock (Bagchi et al. 2004).

Methods

Study site

The catchment of the River Spiti is a part of the Trans-Himalayan region in the state of Himachal Pradesh, India. It is flanked by the Greater Himalaya to the south and west, Ladakh in the north, and Tibet in the east; with average altitude between 3900 and 4300 m. An agro-pastoral community has inhabited the region for 2-3 millennia. The livestock assemblage in Spiti includes yak, cattle, cattle-yak hybrids, horse, donkey, sheep and goat. During winters, a majority of the animals are stall fed; and most cases of depredation occur in the pastures while grazing during spring-summer and autumn.

Large carnivores include snow leopard, wolf, and red fox (*V. vulpes*). Lying in the rain shadow of the Himalaya, the region is cold and arid, with most of the precipitation in the form of snow. Spiti experiences severe winters with temperatures dropping below -30^0C. Being cold and arid, the vegetation is characterized as 'dry alpine steppe' (very sparse above 4800 m).

The catchments of the Pin River in Spiti form the Pin Valley National Park (PVNP, 32^0N 78^0E) which constituted one of our study sites. The terrain here is rugged and most of the area has an inclination between $30^\circ$and 60°. PVNP has a single wild ungulate, the ibex (*Capra sibirica*), and the large carnivores here include the snow leopard and the red fox. Here we estimated animal densities and collected snow leopard scats from an intensive study area of c. 27 km^2. The nearby Kibber Wildlife Sanctuary (KWS, 33^0N 79^0E) formed our second study site. The landscape in KWS is relatively rolling, interrupted by a few cliffs. The dominant wild ungulate in KWS is the bharal (*Pseudois nayaur*), along with a very small population of ibex (*c.* 20 animals). Amongst carnivores, KWS has the snow leopard, red fox, and seasonal activity of wolves. The intensive area here covered 31 km^2.

Smaller mammals occurring in both our study sites included pika (*Ochotona roylei*) and Tibetan woolly hare (*Lepus oiostolus*). Ground dwelling birds like Himalayan snowcock (*Tetraogallus himalayensis*) and Chukar partridge (*Alectoris chukar*) are also potential prey of the snow leopard.

Ungulate abundance

By door to door censuses in villages, we enumerated the total head of livestock that graze in the rangelands in the two areas and calculated their densities in the village rangelands. Density of bharal in our study area in KWS (31 km^2) was estimated through annual censuses conducted in 1998 and 2000 (Mishra et al. 2004). Ibex density in our study area in PVNP (27 km^2) was estimated through censuses in 1999, 2000, 2002 and 2003. All censuses were conducted in winter or spring, when wild ungulates congregate in relatively lower, snow-free areas (Mishra et al. 2004).

Snow leopard diet

Diet of snow leopard was assessed from undigested remains in scats. Snow leopard scats, identified on the basis of shape, size and associated signs like scrapes and pugmarks, were collected from ridges and cliffs between November 2001 and May 2002. Very old or disintegrating scats and those whose identity was ambiguous were not included for analysis. Confusion in predator identity is often caused by the presence of sympatric carnivores and wolves are seasonally active in KWS. However, wolves use relatively flat and rolling terrain and do not use ridges and high cliffs from where scats were collected. Resultantly, the confusion between scats of snow leopard and wolf can be considered to be minimal in this study.

Hair remains of prey were used for species identification (Mukherjee et al. 1994) with the help of reference samples and photographic keys (Oli 1993). Shape, size, colour, structure of cuticle and medulla of hair were used for identification. No attempt was made to identify species from feathers or wool found in the scats. Data were recorded in terms of frequency of occurrence (proportion of total scats in which an item was found) of individual prey species in scats by examining 10 hairs at random from each scat. Presence of vegetal matter was noted, but not included in further analysis. Similarly, unidentified hairs were not included in the analysis. To assess the adequacy of sample sizes (number of scats examined), we iteratively recorded the occurrence of prey items in 5 randomly chosen scats at a time, and repeated the procedure until all scats were sampled and cumulative frequencies obtained (Bagchi et al. 2003).

For estimating the relative importance of prey species in the diet, we considered the number of scats produced by snow leopards to be related to the body size of prey consumed (Floyd et al. 1978). The biomass of prey consumed by a snow leopard to produce a single field-collectible scat was assumed to be similar to that of cougars (*Felis concolor* ssp., Ackerman et al. 1984) as they have similar body size (body length, cougar: 0.8-1.3 m, snow leopard: 1.0-1.3 m). The biomass Y (kg) of prey consumed to produce a single field collectable scat was estimated by the linear relation **Y= 1.980 + 0.035X**, where X is the average body weight of the prey species involved (Ackerman et al. 1984). This correction factor enables the conversion of frequency of occurrences of prey items in scats to relative biomass and relative number of prey consumed (Bagchi et al. 2003; Karanth & Sunquist 1995; Oli 1994). Relative number of prey consumed was calculated from daily food requirements of snow leopard. A felid of the size of a snow leopard requires about 1.5 kg of food per day, and thus needs 548 kg in a year (Jackson & Ahlborn 1984; Schaller 1998). For this, it has to kill prey equivalent to 822 kg since about a third of ungulate body weight is inedible (assuming smaller prey like birds and rodents are completely eaten, Emmons 1987; Schaller 1998). Contributions of an individual prey species to this annual requirement was calculated based on relative biomass consumed, and subsequently divided by average body weight to obtain the number of individuals consumed (Schaller 1998). The body weights of the potential prey species were taken from literature (Mishra et al. 2002; Oli 1994).

Pastoralists' attitudes

We assessed the livestock owners' perception of the conflict and their general attitude towards conservation through interviews in the largest villages around the two protected areas. A total of 37 families (c. 40% of total population) in the village Kibber and 20 families (c. 35% of total population) in Sagnam Village (Pin Valley) were interviewed. Villagers were questioned about details of livestock they had lost to assess the extent of livestock losses. We also asked them what mitigation measures they would find most useful and how should these measures be implemented to have the desired effect. In order to evaluate the intensity of human-wildlife conflicts, we asked people about their opinions on conservation of predators and wild herbivores around their villages and also about the legal Protected Area status of their village lands. A negative opinion (dislike) was scored as -1, a positive opinion (like) was scored +1, and if someone was indifferent or had no definite opinion on the issue

(or neutral), the response was scored as 0. Assigning such scores to peoples' responses has been found useful in understanding the factors that influence local attitude towards carnivores (Marker et al. 2003). From these, an overall average opinion was calculated (possible range between -1 and +1), and compared with 0 using Student's t-test. These are represented as a questionnaire in Table 1.

Table 1. Questionnaire used in the study

Questions related to local perception of the conflict due to depredation	
1.	Have snow leopards ever killed your livestock? Yes/No
2a.	Have snow leopards killed your livestock during 2002-2003? Yes/No
2b.	If yes, please provide details of the animals killed (species and numbers)
3a.	Do you think that such losses are severe and need to be reduced immediately? Yes/No
3b.	If yes, who should intervene in finding suitable solutions? Government agencies/Self or local village and tribal councils/ Both/Others (please specify)
3c.	What can be a suitable remedial measure? Please specify
4	If you know any incidents of retaliatory persecution of snow leopards, please provide details of approximate date, locality, and number of animals killed.
Questions related to local attitudes towards wildlife and conservation	
5.	Please indicate your attitude towards the snow leopard: a- Dislike (should be eradicated) b- Indifference (no strong opinion) c- Like (should be conserved)
6a.	Are you aware of legal protection afforded to wildlife around you? Has Protected Area status around your village had any adverse effect on you?
6b.	Please indicate your attitude towards Protected Area status around your village: a- Dislike (legal status should be dissolved) b- Indifference (no strong opinion) c- Like (legal protection should be continued)
7a.	Is wildlife hunted in your area? Yes/No
7b.	If yes, then who hunts? If no, then what deters people from hunting? Fear of legal status/ Religious considerations/ Other (please specify)

Results

Prey abundance

Bharal density (± SD) in KWS, the area with low wild prey abundance and high livestock abundance, was 2.6 ± 0.2 km^{-2}. Livestock density here was 29.7 animals km^{-2}. The ibex density in PVNP, the area with high wild ungulate abundance, was 6.1 ± 0.9 animals km^{-2}, while livestock density was 13.9 animals km^{-2}. Wild ungulate density in PVNP was thus more than twice that of KWS, while the livestock density was about half.

Snow leopard diet

A total of 95 snow leopard scats were analyzed: 44 from KWS and 51 from PVNP. Four species of wild prey and 5 domestic species were identified in the scats (Table 2). Bharal, birds and donkey were the most frequently encountered items in KWS, while ibex and horses were commonly found items in PVNP (Table 2). The relative contribution of each species to the snow leopard's diet stabilized after approximately 40 scats were examined; so our sample sizes are deemed adequate to represent snow leopard diet in these two areas. Vegetal matter was encountered in 25.5% of scats from PVNP and 27.3% in KWS. Wool was also commonly encountered in the scats (31.3% in KWS and 13.0% in PVNP). Of the total hairs examined, 9% could not be identified in the scats from KWS and 4% from PVNP. About half the scats (50% of scats from KWS and 58% from PVNP) contained remains of a single prey species, while all other scats had 2 or 3 prey species.

Table 2. Diet of snow leopards in two areas of Spiti, India – Kibber Wildlife Sanctuary and Pin Valley National Park based on analysis of prey remains in scats (sample size in parentheses). Percent contribution of each prey in diet is calculated after correcting for differences in body sizes of prey. Relative no. of individuals killed are calculated from average daily food-requirements of the snow leopard. All calculations are explained in the text.

	Wild				Domestic				
	Bharal	Ibex	Hare	Birds	Yak/ cattle	Horse	Sheep	Goat	Donkey
Average body weight (kg)	55	76	3	1.5	250	248	35	34	90
Kibber Wildlife Sanctuary									
Frequency of occurrence (n = 44 scats)	9	4	3	7	3	2	2	4	6
% of diet	19.8	10.5	3.5	8.0	18.1	12.0	3.6	7.1	17.3
Relative no. of animals killed	2.6	0.9	9.6	44.9	0.6	0.4	0.8	1.5	1.6
Pin Valley National Park									
Frequency of occurrence (n = 51 scats)	0	29	2	0	1	6	1	2	2
% of diet	0.0	57.0	1.8	0.0	4.6	27.4	1.4	2.7	4.4
Relative no. of animals killed	0.0	5.0	4.9	0.0	0.2	0.8	0.3	0.6	0.4

Wild prey contributed 42% of the snow leopard's diet in KWS, while domestic livestock contributed 58%. Donkeys, horses, yaks and other cattle contributed substantially to the snow leopard's diet (Table 2). In PVNP, ibex was the major prey species (57% of diet), and wild species contributed to 60% of the diet. Dependence on livestock was still considerable (40%), especially on horses (Table 2).

Conflict perceptions

During 2002-03, 43% of the families in KWS and 41% in PVNP had suffered livestock losses. The average loss per family during this period was 1.1 (± 0.1 SE) livestock in KWS and 0.6 (± 0.1 SE) in PVNP. All predation incidents occurred when animals were grazing in the pastures and none within the villages. Almost every respondent (89% in KWS and 100% in PVNP) felt that this level of loss was severe and needed to be reduced. About half of the people wanted the government agencies to intervene in offsetting these losses (47% in KWS and 50% in PVNP). The others felt that the local village council should try and formulate a strategy independently or with governmental support, and they were also open to a possible role for conservation agencies. In KWS, 71% of the respondents felt that a combination of improved herding practices and more efficient monetary compensation in case of a depredation event would be able to reduce the losses. In PVNP, the opinion was divided. About 40% people wanted improvements in herding practices, 35% looked to more efficient compensation of the loss. All respondents expressed dissatisfaction over the existing governmental compensation scheme and did not find it helpful

Attitudes towards the snow leopard

In KWS, 30% of the respondents had a strong negative attitude towards the snow leopard, and considered their eradication as a possible solution. Twenty two percent thought that they should be conserved, while the remaining had no definite opinion. In PVNP, 45% of the people had a strong negative attitude towards the snow leopard, and only 5% felt a need to conserve them, and the others were indifferent. When these were scored (-1, 0, and +1), the overall attitude towards carnivores was not negative in KWS (-0.1±0.1 *SE*, $P = 0.49$, t-test) but significantly so in PVNP (-0.4±0.1 *SE*, $P = 0.007$, t-test).

All respondents were aware of the legal Protected Area status of the land around their village. In KWS, 94% of the people said that this has not affected their lives in any adverse way, while 70% held the same view in PVNP. About half the respondents were indifferent to the issue of continuing this legal protection (50% in KWS and 55% in PVNP). A favourable opinion in support of conservation through legal protection of lands was given by 47% of the people in KWS, whereas 35% of respondents in PVNP wanted the present legal status be dissolved. As a consequence, the overall score was favourable (+0.44±0.1 *SE*, $P<0.001$, t-test) in KWS while it was slightly negative (-0.25±0.1, $P = 0.1$, t-test) in PVNP.

Most people said that hunting or active persecution of wildlife does not occur around their village (97% in KWS, 100% in PVNP). Sixty five percent of people in KWS and 100% in PVNP thought that this was largely due to religious reasons.

Discussion

Our results suggest a very high dependence of snow leopards on livestock in Spiti. Although a majority of India's protected areas have livestock related conflicts (Kothari et al. 1989), these levels (40-58% of diet) are much higher than other predators. For example, tigers are also in conflict with pastoralists in various parts of India, but available data suggest that 10-12% of their diet consists of livestock (Bagchi et al. 2003; Biswas & Sankar 2002).

Even though wild species occur in a major proportion of the scats, the contribution of livestock to total biomass is still very high. This is presumably related to the low diversity (and density) of wild prey available to the snow leopard in Spiti; these have largely been replaced by livestock through overstocking (Mishra et al. 2001). We compared our results of snow leopard diets with those from other parts of Asia like Manang region of the Annapurna Conservation Area in Nepal (Oli et al. 1993), Yushu and Shule-Nanshan regions of Qinghai province in China (Schaller et al. 1988b), and Hemis region of Ladakh in India (Chundawat et al. 1994, Table 3). From Table 3 it appears that the levels of livestock losses are lower in the other regions where marmots are an important prey. This species has gone extinct in Spiti (Mishra et al. 2001; Mishra et al. 2002), and possibly resulted in an increased dependence on livestock.

Relative abundance of wild ungulates vis-à-vis livestock was greater in PVNP than KWS. As expected, snow leopard predation on livestock was greater in KWS than in PVNP, suggesting that the relative density of livestock vis-à-vis wild prey may be a reasonable predictor of the extent of livestock depredation by the snow leopard. However, the local perceptions of the conflict were counterintuitive. People had stronger negative feelings towards the snow leopard in PVNP even though they suffered fewer losses. Their general attitude towards conservation was also less favourable than in KWS. This apparent discrepancy is explained by differences in the economic value of the livestock in these two areas. Traditionally, people in Spiti reared horses for trade, which even today have high value at INR 20,000 (c. US$ 400 each). However, with the advent of cash crops as an alternative source of income, there has been a rapid shift in the capital asset as most people, particularly

in KWS, have given up horse rearing. Cash cropping became popular in the villages around KWS in 1983 and since then the population of horses here has declined from *c.* 250 animals to just 20 by 2004. With the establishment of road network, cash crops arrived in Pin Valley in 1998 and 89% of families have taken it up as it generates a reasonably assured annual income of around INR 18,000 (c. US$ 370) (Bagchi et al. 2002; Mishra 2000). However, 63% of families around PVNP still depend on horses (Bagchi et al. 2002) and any losses due to snow leopards amount to a relatively high economic loss. Our results show that 27.4% of the snow leopard's diet was contributed by horses in PVNP, whereas it was 12% in KWS. Thus, it is likely that people perceive the conflict in terms of the loss incurred upon the most 'valuable' livestock they rear and react accordingly.

Table 3. Comparison of percent frequency of occurrence of different prey items in snow leopard scat from Kibber and Pin Valley in Spiti, India against reports from other regions. These data are compared against reports from Annapurna Conservation Area, Manang, Nepal (Oli et al. 1993), Yushu and Shule Nanshan in Qinghai region of China (Schaller et al. 1988b) and Hemis in Ladakh region of India (Chundawat et al. 1994). Sample size of number of scats analyzed in parentheses.

Prey items	Kibber, Spiti, India (*n* = 44)	Pin Valley, Spiti, India (*n* = 51)	Manang, Nepal (*n* = 213)	Yushu, Qinghai, China (*n* = 46)	Shule Nanshan, Qinghai, China (*n* = 91)	Hemis, Ladakh, India (*n* =173)
Wild						
Blue sheep	20.5		51.6	66.1	43.2	23.4
Ibex	9.1	56.9				
Cervus deer				4.8	1.2	
Marmot			20.7	89.8	40.1	9.8
Hare	6.8	3.9			6.0	3.1
Smaller rodents[1]			23.5		2.4	4.3
Birds	15.9		1.4		0.1	3.1
Smaller carnivores[2]			9.4			
Domestic						
Yak and cattle	6.8	2.0	14.2	9.3		1.2
Horse	4.5	11.8	2.8			0.8
Sheep and Goat	13.6	5.9	0.9	37.8	2.4	12.5
Donkey	13.6	3.9				0.3
Others						
Vegetation	27.3	25.5	19.3	4.8	12.1	41.0
Unidentified	13.6	5.9	5.6	4.8	2.3	

[1]Smaller rodents include Royle's pika (*Ochotona roylei*) and Royle's vole (*Alticola roylei*).
[2]Smaller carnivores include stone marten (*Martes foina*), least weasel (*Mustela nivalis*) and red fox (*Vulpes vulpes*).

Although people resent having large carnivores in their pastures, they do not actively persecute them as in other parts of central Asia (Mishra & Fitzherbert 2004), due to cultural and religious reasons. Our data indicate that greater financial security, particularly arising out

of alternate income sources in otherwise pastoral communities, can mediate people's attitudes towards wild carnivores. It also highlights the importance of understanding the sociological underpinnings of human-carnivore conflict. Assessing the extent of depredation alone is not likely to lead to effective conservation planning, as people's attitude towards carnivores is seen to be embedded in the socio-economic role livestock play in traditional economies.

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The rugged mountains of south and central Asia are the home of the endangered snow leopard. Relatively untouched by industrial development, this region continues to support a traditional pastoral way of life that is rapidly integrating with mainstream markets. Today, throughout its range, the snow leopard is in acute conflict with local communities due to livestock depredation. In this report we investigate the human-snow leopard conflict in the Spiti Trans-Himalaya, from ecological as well as socio-economic perspectives, with the aim of providing information that is relevant for designing effective conflict-resolution strategies.