Title: Spatio-Temporal Distribution of Human-Snow Leopard Conflict in Spiti Valley, India

CLP project ID: **0353111**

Study site: Spiti Wildlife Division, Himachal Pradesh, India

Team: Kulbhushansingh Suryawanshi, Rishi Kumar Sharma, Vaibhav Chaturvedi

Institution involved:
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Aim: To examine the landscape scale correlates of human-snow leopard conflicts

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Section 1:
Summary

Livestock depredation by large carnivores is an important conservation and economic concern and conservation management would benefit from a better understanding of spatial variation and underlying causes of depredation events. Focusing on the endangered snow leopard *Panthera uncia*, we identified the ecological factors that predispose areas within a landscape to livestock depredation. We also examined the potential mismatch between reality and human perceptions of livestock depredation by the snow leopard whose survival is threatened due to persecution by pastoralists.

We assessed the distribution of the snow leopard and wild ungulate prey through field surveys in the Upper Spiti Landscape of Trans-Himalayan India. We interviewed local people to assess the distribution of livestock and peoples' perceptions of the risk to livestock from the snow leopard. We monitored village-level livestock mortality to assess the actual level of livestock depredation. We quantified several potential determinant variables that together captured variation in topography, carnivore abundance and abundance and other attributes of livestock. We identified the key determinants of livestock depredation using multiple logistic regressions and hierarchical partitioning. Based on the findings of the project we have set up a long-term monitoring of snow leopard prey populations and the extent and distribution of livestock depredation by this carnivore.

Introduction

Livestock depredation by large carnivores and their retaliatory or preventive killing is a worldwide conservation concern (Madhusudan & Mishra 2003; Woodroffe, Thirgood & Rabinowitz 2005; Treves *et al.* 2006). Persecution of carnivores over livestock depredation, and the desire to conserve them, leads to situations referred to as human-carnivore conflict (Woodroffe, Thirgood & Rabinowitz 2005). The conflict arises because farmers' interests are compromised, as are conservation goals.

Conservation and the management of human-wildlife conflict would benefit from a better understanding of the extent, causes and correlates of actual livestock damage caused by wild carnivores, and the threat of damage that affected people perceive. While actual levels of livestock depredation are likely to be determined by the behavioural ecology of the carnivore and livestock rearing practices, the perceived threat is likely to be determined by a suit of individual, socio-economic and cultural factors such as the cultural and economic value of the livestock killed, the cultural significance of the carnivore, general awareness of the local communities, presence of good conservation models (unlike livelihood threatening exclusionary conservation actions), and the physical and behavioural characteristics of the carnivore.

The endangered snow leopard *Panthera uncia* occur across the mountain ranges of Central Asia where they live alongside large numbers of livestock (Mishra *et al.* 2003). Persecution of these

carnivores by pastoralists over livestock depredation threatens their survival across their range (Mishra 1997; Mishra *et al.* 2003; Namgail, Bhatnagar & Fox 2007). Studies report 3-12 % annual losses of the livestock holdings to snow leopards and wolves in high conflict areas (Mishra 1997; Mishra *et al*. 2003; Hussain 2000; Jackson and Wangchuk 2004; Namgail, Bhatnagar & Fox 2007). High losses sometimes create such levels of intolerance that local communities view complete extermination as the only solution (Oli, Taylor & Roger 1994). Resolving human-carnivore conflict is of utmost priority for the continued survival of the snow leopard in Central Asia (McCarthy and Chapron 2003).

Research on human-carnivore conflicts in Central Asia has focused on documenting the extent of livestock depredation and peoples' attitudes in target villages (Oli, Taylor & Roger 1994; Mishra 1997; Hussain 2003; Ikeda 2004; Namgail, Bhatnagar and Fox 2007, Jackson *et al.* 2010). They have recognized the existence of conflict 'hotspots' or sites predisposed to livestock depredation, but they have not explored the ecological causes or correlates of livestock depredation or conflict hotspots. These studies have relied on interviews of affected people to understand patterns in livestock depredation. Interviews are likely to reflect peoples' perceptions of the conflict, which may be at variance with the reality of actual livestock depredation. This potential dichotomy between human perceptions and the actual levels of livestock depredation has not been explored. The purpose of the project was to assess the spatio-temporal distribution of human-snow leopard conflict in the Upper Spiti Valley, Himachal Pradesh India.

Project members

Project Leader: Kulbhushansingh Suryawanshi, age 27, has recently completed his PhD and is currently working as a Regional Ecologist with the Snow Leopard Trust, Seattle (SLT). He maintains an affiliation with The Nature Conservation Foundation, Mysore (NCF) and is based out of NCF, Bangalore, India. With the new position at the SLT, Kulbhushan has been working in other snow leopard habitats especially in the South Gobi region of Mongolia. It has allowed him to get a wider global perspective on the conservation needs of the snow leopard. Kulbhushan was involved in the designing, executing, analyzing and writing up of the project. Kulbhushan now has almost 5 years of experience working in the Himalaya on issues related to Snow Leopard Conservation.

Rishi Kumar Sharma, age 33, is working with Nature Conservation Foundation as a Research Scholar. Rishi anchored the field component and conducted the ecological surveys. Rishi was also involved with the analysis and writing up of the project. Rishi is currently also pursuing his PhD on 'Spatial Ecology of the Snow Leopard in the Upper Spiti Landscape'. Rishi brought in a diversity of perspective using his experience of working on tigers and other large carnivores from other ecosystems in India.

Vaibhav Chaturvedi, age 27, has completed a Masters in Environmental Science. Vaibhav currently works with WWF-India. Vaibhav helped with the interview and ecological surveys. He also contributed in preparing maps of the landscape and with the analysis. Vaibhav also added to the project with his experience from working in the Central Indian tiger landscapes.

Section 2:
Aim and objectives (max 200 words)

1. Assess the spatio-temporal distribution of livestock depredation by the snow leopard.
2. Identify the determinants and predictors of human-snow leopard conflict such that these variables can be used for preliminary prediction of conflict in other similar areas.
3. The local people being the primary stake holders in this conflict we propose to assess local human perception and understanding of conflict
4. We propose to set up local monitoring of human-snow leopard conflict at all the important sites of conflict.

Methodology (max 500 words)

1. Identify the villages affected by livestock depredation by the snow leopard

An interview survey was conducted in all the villages of the Upper Spiti Valley. We interviewed the village head man (locally called the Lambardar), the Panchayat pradhan and the village livestock herder. We used a semi structured interview focusing on examining the extent of livestock damage by snow leopard in that village. Through these interviews with the village head man we also record data on other important variables such as the livestock holding, land holding, education level, total population, primary occupation and age-sex-caste distribution of the population. During our visit to each village we also recorded information on ecological variables such as altitude, slope aspect and GPS location of the village. The GPS location of the village will be used to derive other variables such as ruggedness and NDVI from the Digital elevation model and satellite imagery of the region. The map of the distribution of conflict were prepared using the GPS location of the village, the digital elevation model of the region and the NDVI imagery of the region. The map include location of villages affected by livestock depredation by snow leopard and the seasonal trends in damage, if any.

2. Identify the determinants and predictors of human-snow leopard conflict

The data recorded on socio-economic and ecological variables through the interview and ecological surveys were used in a multiple regression frame work to identify the determinants and predictors of human-snow leopard conflict. We used AIC score for model selection. The response of the village headman, herder and panchayat pradhan was used as the response variable and other ecological and socio-economic variables was used as predictor variables.

3. Assess human perception and understanding of human-snow leopard conflict

We conducted a second tier of interviews in the villages where the interviews with headman, panchayat pradhan and herders suggest a significant level of livestock depredation by snow leopards. In the second tier we interviewed at least 30% of the villages households with equal representation of all caste, sex, age and education level. These interviews focus on assessing the attitudes local people the snow leopard.

4. Set up local monitoring of human-snow leopard conflict

During our visit to each village, we worked closely with the village herder. We have had a long term engagement with many of them since year 2009. We first assessed their ecological knowledge of identifying snow leopard signs. Wherever needed we trained them in identifying snow leopard signs from wolf and dog signs. Herder from 42 villages are now trained to keep a basic record of the livestock mortalities from various causes including predation by snow leopard.

Outputs and Results

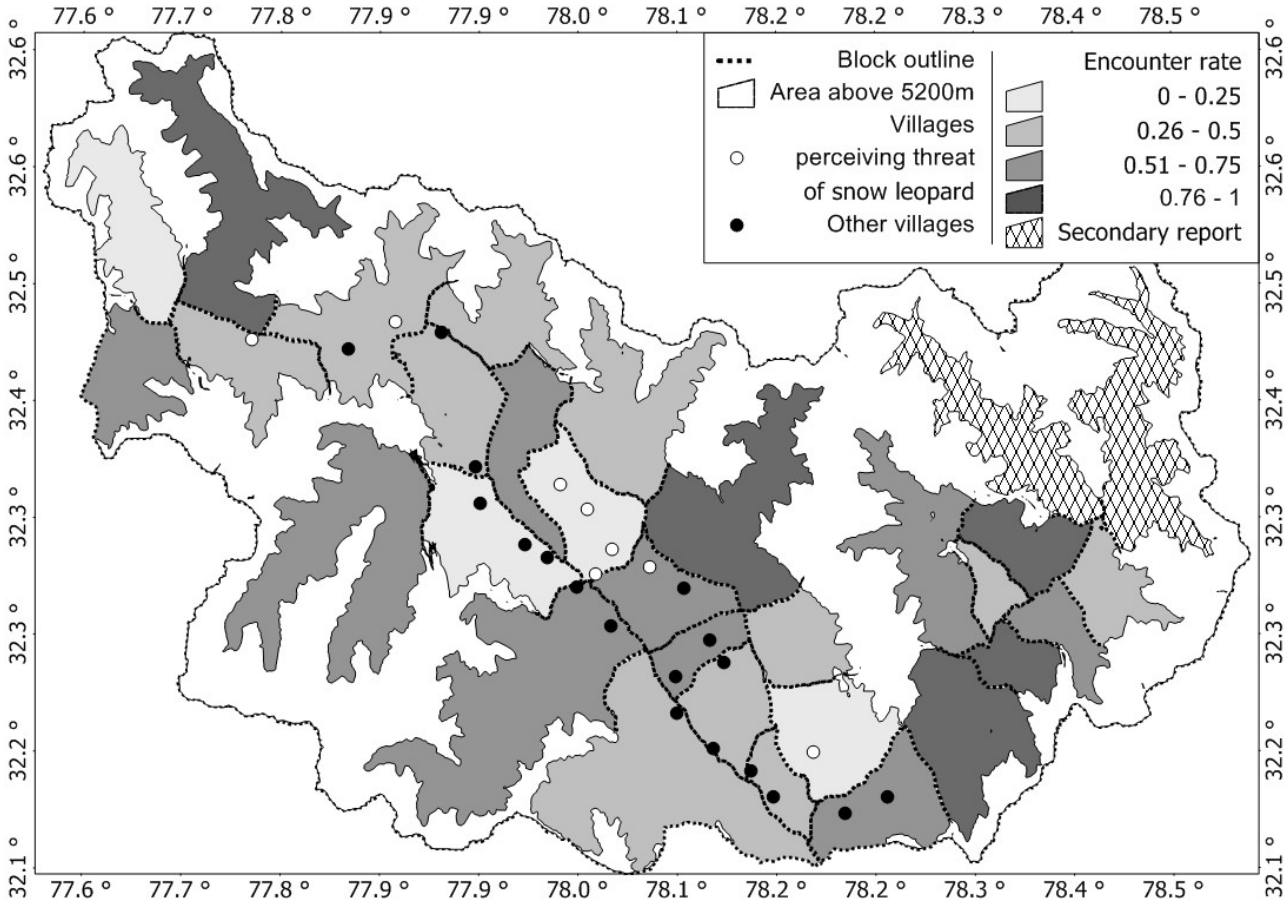

Figure 1: Distribution and encounter rate of snow leopard *Panthera uncia*, and villages where they were perceived as a threat to livestock (open circles) in the Upper Spiti Landscape, India. Encounter rate of snow leopard signs was calculated as the proportion of transect sections in which snow leopard signs were recorded.

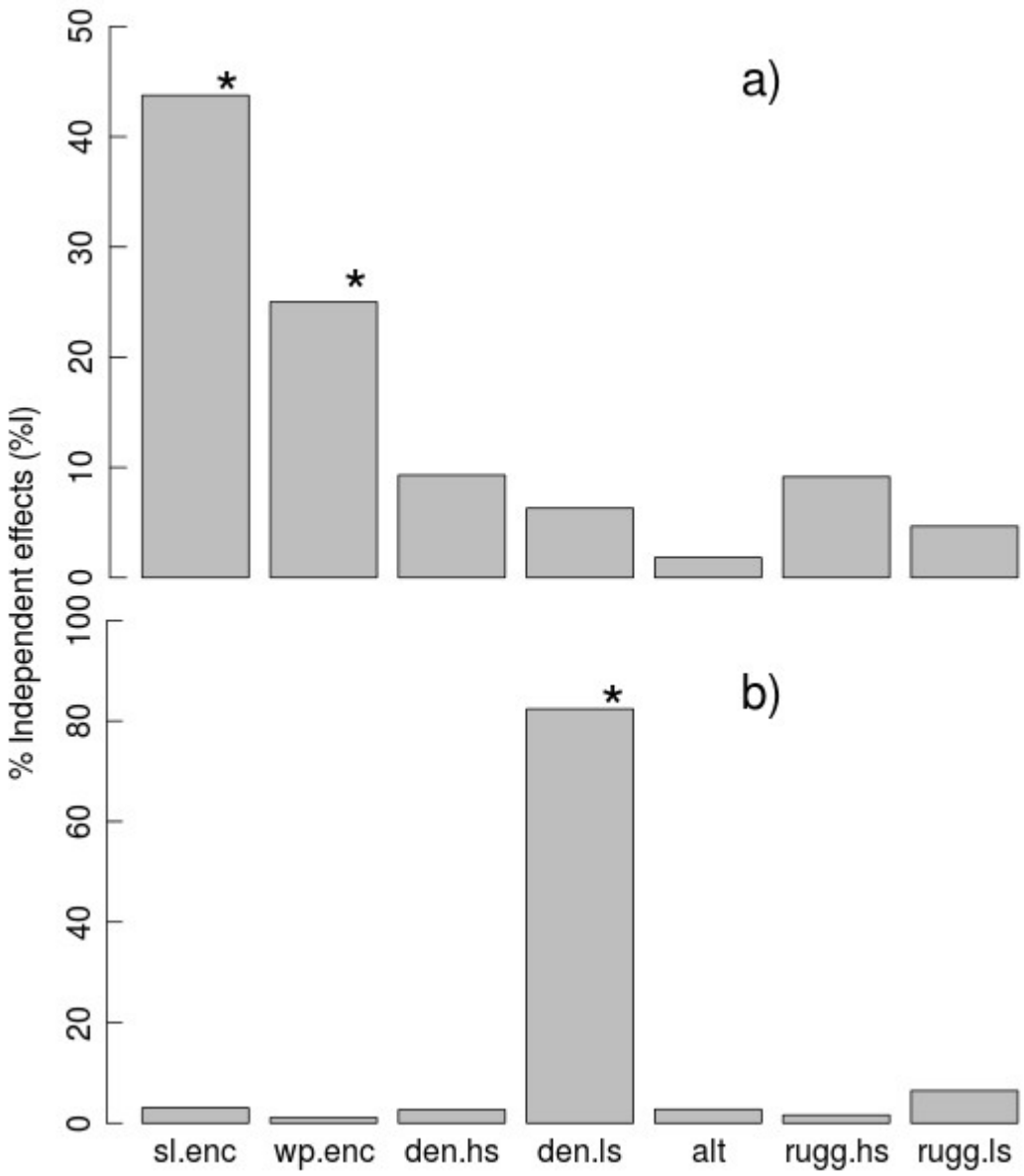

Figure 2: Independent contribution of the seven explanatory variables to a) actual livestock damage by snow leopard, and, b) villages where people perceived a threat to livestock from the snow leopard, determined by hierarchical partitioning. Asterisk denotes statistical significance. Abbreviations indicate snow leopard encounter rate (sl.enc), wild-prey encounter rate (wp.enc), density of herded stock (den.hs), density of large stock (den.ls), altitude (alt), ruggedness of herded stock pasture (rugg.hs), ruggedness of large stock pasture (rugg.ls). Variables are defined in Appendix 1.

Table 1. Summarized attitude scores of local people towards snow leopards and wolves, and extent of livestock depredation across six clusters of villages in Spiti Valley, India. Means estimated from the hierarchical linear models with study site as fixed effect and village as random effect. Figures in parentheses indicate one standard error.

Study site	Mean attitude to snow leopard	Mean attitude to wolf	Large stock damage by snow leopard	Large stock damage by wolf	Herded-stock damage by snow leopard	Herded-stock damage by wolf
Kibber	3.06 (0.49)	1.92 (0.56)	42	42	17	35
Langza	-0.97 (0.67)	-1.84 (0.75)	36	36	19	109
Lingti	0.36 (0.64)	0.3 (0.79)	3	3	7	3
Lossar	2.25 (0.69)	1.24 (0.74)	6	6	12	54
Pin	1.85 (0.65)	1.55 (0.79)	39	39	38	11
Tabo	2.45 (0.66)	1.96 (0.78)	4	4	228	7

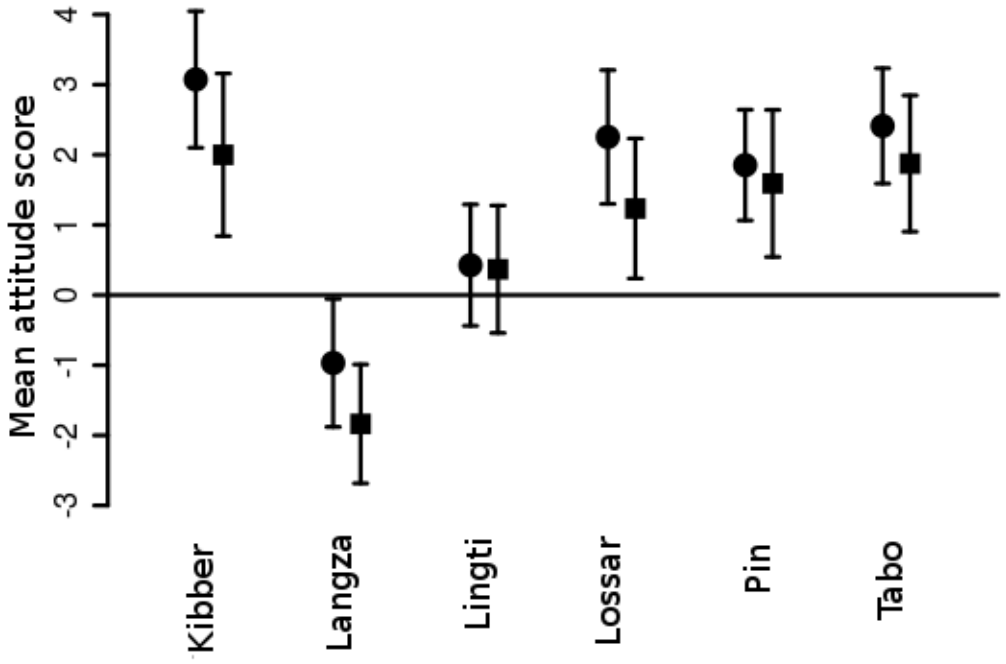

Figure 3: Mean attitudes score of local people towards large carnivores in six study sites in the Spiti Valley, India, estimated from the hierarchical linear model with study site as fixed and village as random effect. The shaded area indicates the site with a long-term conservation program. Higher values indicate positive attitudes. Error bars represent 95% CI. Circles and squares represent attitudes towards snow leopards and wolves, respectively.

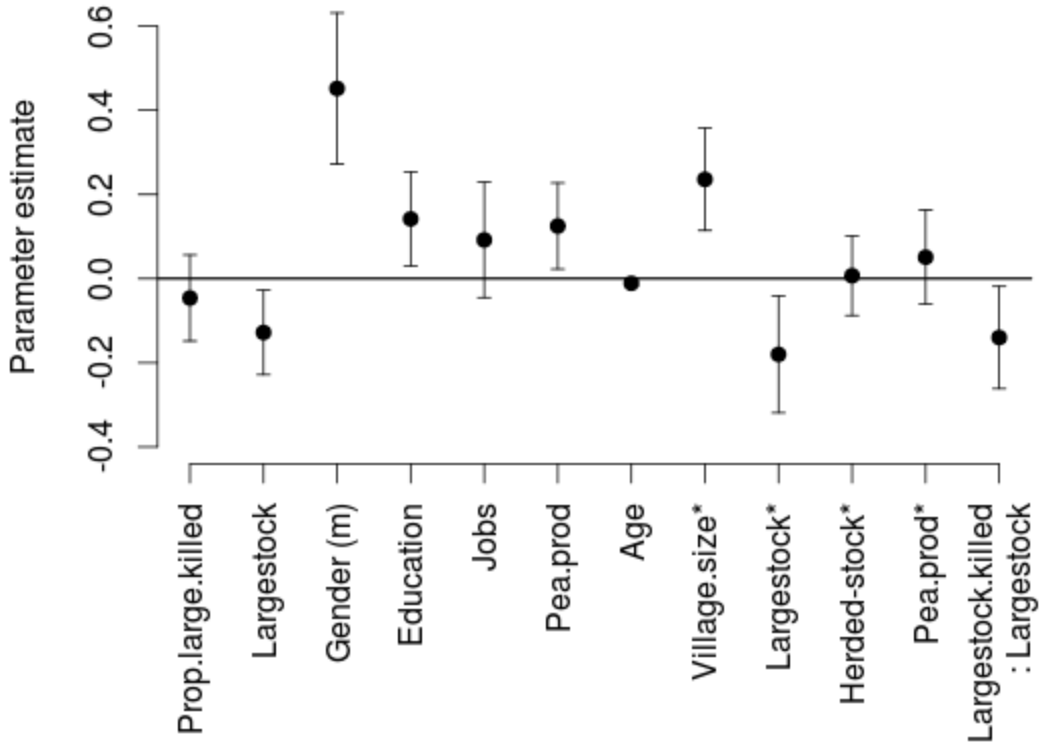

Figure 4: Parameter estimates for all the variables included in the hierarchical linear model explaining human attitudes towards the snow leopard. Error bars indicate 95% CI calculated using the standard error. * indicates variable measured at village scale.

We found that livestock predation by snow leopard across the landscape is clumped and deterministic. We call these as "hot-spots" of conflict (fig 1). Through regression analysis we have identified the correlated of hotspots of perceived and well as estimated conflict (fig. 2). We also found that attitides of people towards the snow leopard varied across the landscape. We sampled a total of 25 villages in six clusters. Although the overall attitude score are positive there were certain villages with very poor attitude scores. Using hierarchical linear regression models we have tried to identify the correlates of local attitudes to snow leopards. The result suggest that an individuals age and possession of yaks and horses led to lower attitude scores while education and income from agriculture led to positive attitudes (fig 4).

Achievements and Impacts

The project succeeded in identifying the key determinants of the two important dimensions of human-carnivore conflicts viz. The perception of conflict and the reality of economic costs. Our preliminary analysis suggests that while the perception of conflict is driven by the economic importance of the livestock and the cultural bias of carnivores the reality of economic loss can be predicted with the abundance of carnivores and their primary wild prey. The project has collected important information on covariates of human-snow leopard conflict. Along with the spatio-temporal determinants of human-snow leopard conflict, the project has also gathered important information on the attitudes and tolerance of local people of wild carnivores. We have interviewed over 350 people across 40 villages to understand the determinants of human attitudes towards wild carnivores at the individual, village and landscape scale. Together we have

addressed both the ecological and the socio-economic and cultural aspects of human-carnivore conflict. The results of this project have already generated interest in the management authorities and the conservation academia. The results were presented at the Society for Conservation Biology-Asia Chapter in Bangalore India. The findings of the project have been published in reputed journals such as Oecologia and Journal of Applied Ecology. We expect two more publications over the next few months.

The biggest contribution of the project has been in directing conservation interventions to the right areas. The Nature Conservation Foundation (NCF) which has been actively involved in snow leopard conservation landscape has benefited from our work in identifying villages where conflict resolution programs could be implemented. Partly informed by our work, NCF has started engagement with 5 new villages for conflict resolution work. Our project has also provided important information for the implementation of the management plan (Under the Project Snow Leopard) in this landscape. We also strongly believe that many of our data will be valuable in the next step of micro planning which is to happen at the scale of individual village. Since our work also targeted the village scale, we see direct relevance of our finding here.

Most importantly, the project has managed to establish a program for long term monitoring of the wild prey population of the snow leopard and monitor the extent and distribution of livestock depredation by the snow leopard. Such long-term information is expected to not only help in human-wildlife conflict management but also serve as an early warning system for large mammal conservation in the region.

Section 3:
Conclusion

Our results show that (i) human perceptions of livestock predation by snow leopards can be at odds with actual patterns of livestock depredation, (ii) increase in wild prey population could intensify livestock depredation by snow leopards, and prey recovery programmes must be accompanied by measures to protect livestock, (iii) compensation or insurance programmes should especially target large-bodied livestock in snow leopard habitats, as holdings of large bodied stock explained the negative perceptions amongst herders. (iv)Scaling-up from the individual to higher levels of social organization can highlight important factors that influence attitudes of people towards wildlife in conflict, or formal conservation efforts in general. (v) Such scale-specific information can help to efficiently target suitable conservation measures at appropriate scales. Our results reiterate the need for conflict management programs to be multi-pronged.

Problems encountered and lessons learnt

Despite heavy flooding and harsh winter the ecological and interview surveys were conducted well and did not suffer from major delay. The teams experience of working in this landscape helped us to minize environment related risk. But, we acknowledge that delays due to weather cannot be eliminated and projects will suffer from them. Our experience of working with the local community here also came in handy in the excution of the project. However, we had originally planned a workshop for all the herder of the Spiti valley region to train them in monitoring snow leopard sign, wild herbivore prey and livestock killing by the snow leopard. We later realized that most of the key herder do not have the time available to attend this workshop. Thus, we had to revisit each village and teach the village herders about recording snow leopard signs, wild herbivore encounter rates and livestock mortality due to various reasons. It was

important for us to realize that all the livestock herders could not be on a study tour at the same time.

In the future

Based on our results, we identified that a regular monitoring of wild herbivore prey of the snow leopard such as the blue sheep (*Pseudois nayaur*) and ibex (*Capra sibirica*) and the extent and distribution of livestock predation by snow leopards was the key information required for effective management of human-snow leopard conflicts. Together with the Nature Conservation Foundation and the Himachal Pradesh Forest Department we have started a long-term monitoring program for both of these parameters.

We have identified five landscape blocks (>300 km^2 each) where we are using the double-observer survey method to monitor the abundance blue sheep and ibex on an annual basis. These five block are representative of the entire landscape of Spiti Valley (>7000 km^2).

We have also identified 42 villages which are situated around conflict hot-spots. We have initiated a long-term monitoring of livestock population and mortalities in these 42 villages. The monitoring of mortalities involve all causes of mortalities including diseases, accidents, predation by snow leopard, wolves and dogs.

The support from Nature Conservation Foundation, an NGO, which is working here for the last 15 years and the government (Himachal Pradesh Forest Department), is crucial for the sustaining these long term monitoring.

Section 4:
Appendices

Appendix A :- Full account of income and expenditure
Appendix B :- Scientific paper published. Suryawanshi et al (2013) People, predators and perceptions: patterns of livestock depredation by snow leopards and wolves. Journal of Applied Ecology. 50: 550-560.
Appendix C: Scientific paper published: Suryawanshi et al (2012) Standardizing the double observer survey method to estimate the mountain ungulate prey of the snow leopard. Oecologia. 169: 581-590.
Appendix D: Manuscript proposed based on project data**:** Suryawanshi et al. Identifying correlates of human attitudes towards large carnivores in conflict at multiple scales.

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Distribution list

A project report has been sent to following organizations:

Himachal pradesh Forest Department
Nature Conservation Foundation
Manipal University

The scientific publications have been circulated widely across people and organizations working towards conservation in Himalayan and Trans-Himalayan region.