Snow Leopard Conservation Grants,
Snow Leopard Network

FINAL REPORTS FOR 2013 PROJECTS

DUE: 15 FEBRUARY 2014

TITLE: Complementing a nation wide evaluation with a local assessments of human activities and attitudes of snow leopard conservation relevance in the Qilianshan National Nature Reserve

1. Executive Summary: No more than 750 words. Please describe the original goals and the final results of your project. This may be used in press releases and other publicity material about the Grants Program, so please write it for the general public who may not have scientific background.

China contains the greatest proportion of snow leopards and the global snow leopard range. However, in light of the geographic scale, national efforts to conserve snow leopards remain in the early phases of development and urgently require better understanding of the ecological and social issues underpinning human-snow leopard conflicts. Studies in other range states have highlighted the interrelationships between wild ungulates, snow leopards, domestic livestock and the people that herd them. Increased competition between domestic and wild ungulates can reduce wild prey available to snow leopards. This potentially creates a dependence on domestic livestock for sustenance and triggers the risk of retribution killings in light of economic losses.

This study begins the process of investigating these complex interactions between changing herding practices, attitudes towards snow leopards, competition between domestic and wild ungulates and livestock depredation. The project provides regional data by means of a questionnaire survey among the communities living within and on the periphery of QNNR. The survey focused on five issues of importance to conservation: development activities within park boundaries, influence of development activities on local household socio-economic status, trends in herding practices within park boundaries, community attitudes towards snow leopards and other carnivores and a wider scale understanding of large carnivore occurrence.

The study results suggest that development activities have made little impact on livestock herding practices and wildlife in the region. However households expressed concerns about negative impacts on herding and wildlife related to informal mining activities in three of the seven study villages. A large proportion of the herder population reported livestock depredation, which was described as a major economic burden. The perceived severity of livestock depredation did not differ across villages, gender and educational level. In common with other studies, snow leopards were reported to be responsible for a relatively low percentage of livestock losses. Herders and household members generally had positive attitudes towards snow leopards. On the other hand, the Eurasian lynx and the grey wolf were reported to be the most important predator of livestock, in terms of

livestock losses and proportion of households affected. Herders also voiced strong negative views concerning these two species. The results suggest that if in the future snow leopards were to depredate higher numbers of livestock, attitudes towards them might change, resulting in retaliatory killing.

From this studies preliminary assessment, it appears that a combination of measures, including a reassessment of the current grazing ban, carefully designed financial compensation measures, improved husbandry practices and education activities may be useful to reduce livestock losses and the associated economic burden on local communities and improve attitudes towards wildlife. Providing QNNR with locally relevant information concerning the potential impacts of development activities, livestock depredation and local attitudes towards carnivores enable management recommendations to be formulated from a robust evidence base. We anticipate that the results from this study, in concert with additional working being carried out by BFU-WI and University of Oxford, will assist Chinese Government with the development of effective protection strategies for snow leopard across their range.

2. Objectives: What was the purpose of the project? How was it expected to contribute to the knowledge or conservation of snow leopards, their prey, or habitat?

The project aims to directly address high priority research needs for the HIMLY region as stated in the Snow Leopard Survival Strategy (Mccarthy & Chapron, 2003).
R.1 Snow leopard distribution
R.12 Wild ungulate – livestock interactions
R.18 Grazing pressure and range conditions
R.27 Socio-economic profiling of herder communities
R.29 Livestock and human population status and trends
R.31 Human attitudes to snow leopards
The following medium level research priorities are also targeted:
R.6 Agents of habitat degradation and relative impacts
R.16 Livestock depredation rates
R.17 Livestock depredation causes
R.24 Snow Leopard relationships to other predators

Specifically the project aims to:
1) Generate data on the type, location, extent, seasonality and trends of development activities likely to impact snow leopard presence or habitat use within QNNR.
2) Determine how development activities are influencing local peoples socioeconomic status and relationships with the natural world
3) Assess how changing lifestyles impact the occurrence and perceived severity of livestock depredation.
4) Quantify local attitudes towards snow leopards, isolating their drivers.
5) Generate presence and distribution of snow leopards and sympatric carnivores using local interview data
6) Train Chinese researchers on the design, implementation and utilization of social surveys
7) Contribute to substantiating the extent data collected at the November meeting can contribute towards the Chinese snow leopard action plan.

3. Methods: Describe the methods you used in detail, so that someone else could repeat the work, or, avoid the problems that you encountered.

Key informant interviews with regular collaborators within QNNR reserve staff identified communities within which surveys took place, illustrated relevant regional policies and laws (R.30) and highlighted changes to the human population composition within QNNR (R.29). During community focus groups participatory mapping and timeline exercises were carried out to identify and describe local changes in herding styles, grazing pressure, range conditions livestock populations and development activities (R.29, R.12, R.18). Focus groups also assisted finalizing two semi-structured questionnaire survey instruments for household surveys.
The first questionnaire survey targeted all herders living within sampled villages. Snowball sampling enabled interviewing the maximum number herders within each target village. The herding practices and the socio-economic profile of herders (R.27) was assessed alongside factors relating to the drivers and rates of livestock depredation (R.16, R.17). Herder's detection/non-detection of snow leopard and sympatric carnivores was associated with the areas of QNNR surveyed during the previous year(R1, R24). Questionnaire 2 was distributed to all occupied households across survey villages to assess local perceptions of, and involvement with, development activities within park boundaries (R.6, R.27, R.29) and community attitudes towards snow leopards (R.31) and other carnivores. Interviews were undertaken between June – July 2013 by the Beijing Forestry University team, in collaboration with national reserve staff.

Development activities were described and compared between sampled villages (R.6). Attitudes towards development activities, impacts of development activities on community socio-economic opportunities, herding practices, and wildlife were compared (R.18, R.27, R.29). A Generalized linear mixed model (GLMM) was used to assess whether there were significant differences in attitude responses between villages. The importance of livestock herding as a livelihood strategy and perceived past and future changes in livestock was assessed (R.27, R.29). The status, causes of livestock losses, and measure to prevent future depredation in each village were evaluated and compared (R.16, R.17). Herder profiles were then utilized to assess relationships between reported occurrences of livestock depredation and underlying herder characteristics.
These data also form key explanatory variables in Generalized Linear Mixed Models to determine the drivers of attitudes towards snow leopards and other carnivores (R.31). Established methods for quantifying attitudes towards large carnivores were adapted for the target species.

Responses from herder interviews were transformed into direct and indirect detections for each carnivore species of interest. Originally data was to be analyzed using a multi-species occupancy model (R.1, R.24) using the software PRESENCE. However given the small sample size of villages surveyed, the number of carnivores detected within the last twelve months and associated detection characteristics were reported.
Comparing locally gathered data with that collected at the November 2012 meeting is in progress and will contribute to ground truthing the national level data enabling its accuracy and suitability for inclusion in the Chinese snow leopard action planning process to be determined.

4. Results: Please describe in detail the results of your project. Please illustrate clearly how your stated goals and objectives could be met. You may wish to include tables or graphs in this section if appropriate. This section will be very important to explain the value of these grants to funders of the Snow Leopard Conservation Grant Program. Please be clear, concise, and thorough.

Section 1

1. **Development activities identified**

In the villages surveyed, four types of development activity were known about and reported to be taking place in the vicinity: road building, building of a canal, mining and small-scale tourism (Table 1.1). Road building, canal building and tourism were all reported in the village of Hong Shan, while mining was reported in three other villages. No development activities were identified in the villages of Gan Ba Kou, Hung Cao Ba and Qi Lin.

Table 1.1: Identified activities by respondents at household level (n=60). The table shows the villages surveyed, with the number of households included in brackets, and the number of households with respondents identifying an activity.

Village	Road	Mining	Canal	Tourism	No activities
Hong Shan (20)	19		11	1	1
Guan Shan (1)		1		1	
Qing Ke Di (11)		10			1
Ci Yao Kou (5)		4			1
Gan Ba Kou (8)					8
Hung Cao Ba (7)					7
Qi Lin (8)					8

Not all of the sampled households in each village were aware of or reported development activities. In Hong Shan the majority of household-level respondents (19/20) reported that road building was under way, however only a subset of them mentioned canal building and tourism. Respondents in one household did not identify any activities taking place within and around the village. Similarly in both Qing Ke Di and Ci Yao Kou, the majority of household-level respondents reported mining taking place, but no activities were identified by at least one household in each village.

The timescale over which activities were stated as taking place varied but often seasonal. Road building in Hong Shan was reported as having recently started in July 2013, with building activity said to only occur during the summer months. The work on building of a canal had only recently started in 2013 and was expected to continue throughout the year. In Qing Ke Di and Ci Yao Kou mining was reported to have been taking place for the last 30 years but only during the summer months.

Section 2

2. Attitudes towards development activities

The majority of household-level respondents (71%) stated that there had been no change in work opportunities within their community within the last five years. In addition no household members were engaged in any of the development activities taking place.

Diverse views were expressed about the benefits of the development activities at village level. The majority of households that reported road-building activities (16/19, all in Hong Shan) stated that the building of roads was beneficial for the community (Figure 2.1). In contrast, among the 15 households that reported mining, the majority (9/15) disagreed that it was beneficial to the community. Most households felt that it had a negative impact on livestock grazing (11/15) and wildlife (10/15) in the area (Figure 2.2 & 2.3). Canal building was not generally perceived as bringing benefits to the community but was not considered by most (8/11) to negatively impact local wildlife. Attitudes towards tourism activities were not so clear given the small sample size (2 household-level respondents).

Respondents identified specific benefits associated with ongoing development activities. For example in Hong Shan the building of roads was described (in all 19 households) as providing an important service, by improving access to spaces for herding livestock. The building of the canal in Hong Shan was considered (in 7/11 households) to provide a service, by increasing opportunities for the irrigation of crops. On the other hand, mining was not so favourably considered. None of the household respondents interviewed in Qing Ke Di and Ci Yao Kou indicated that mining activities had brought them any benefits. In Guan Shan the single respondent who mentioned mining observed that it had increased road access to areas used for grazing livestock.

A subset of households (34/60) was asked whether it was a good thing to invest in protecting the environment. The majority of these households (68%) did not think that it was.

A Generalized linear mixed model (GLMM) with a binary response was carried out to assess whether there were significant differences in attitude response between villages.
Attitudes towards development activities were defined as a binomial response (where "agree" and "strongely agree" was defined as 1 and "neutral", "disagree" and "strongly disagree" was defined as 0). Individual household respondent IDs were included as a random effect. Village and question posed were considered as fixed effects within the model. No significant difference in attitude was observed between villages. Unsurprisingly the GLMM showed a significant association between some of the questions asked (Table 2.1). Village was not associated with attitudes towards development activities ($p>0.1$).

Table 2.1. The model of the effect of the different predictor variables on attitudes at the individual respondent level, significance at p<0.05.

Predictor Variable	Level	Estimate±SE	p
Question	Benefit	0	
	Livestock	-0.44±0.42	0.30
	Invest	-1.27±0.44	p<0.001**
	Wildlife	-1.17±0.44	p<0.001**
Village	Ci Yao Kou	0	
	Gan Ba Kou	-0.27± 1.16	0.82
	Guan Shan	0.28± 0.92	0.76
	Hong Shan	-0.72±0.55	0.19
	Qing Ke Di	-0.63±0.63	0.32
	Huang Caoba	NA	NA
	Qi Lin	NA	NA

Questions:
Benefit: I think that the development project has brought about benefits for the community.
Livestock: The development project has had a negative impact on livestock grazing in this area.
Invest: I think it is a good thing to invest in protecting the environment.
Wildlife: The development project has had a negative impact on wildlife in this area.

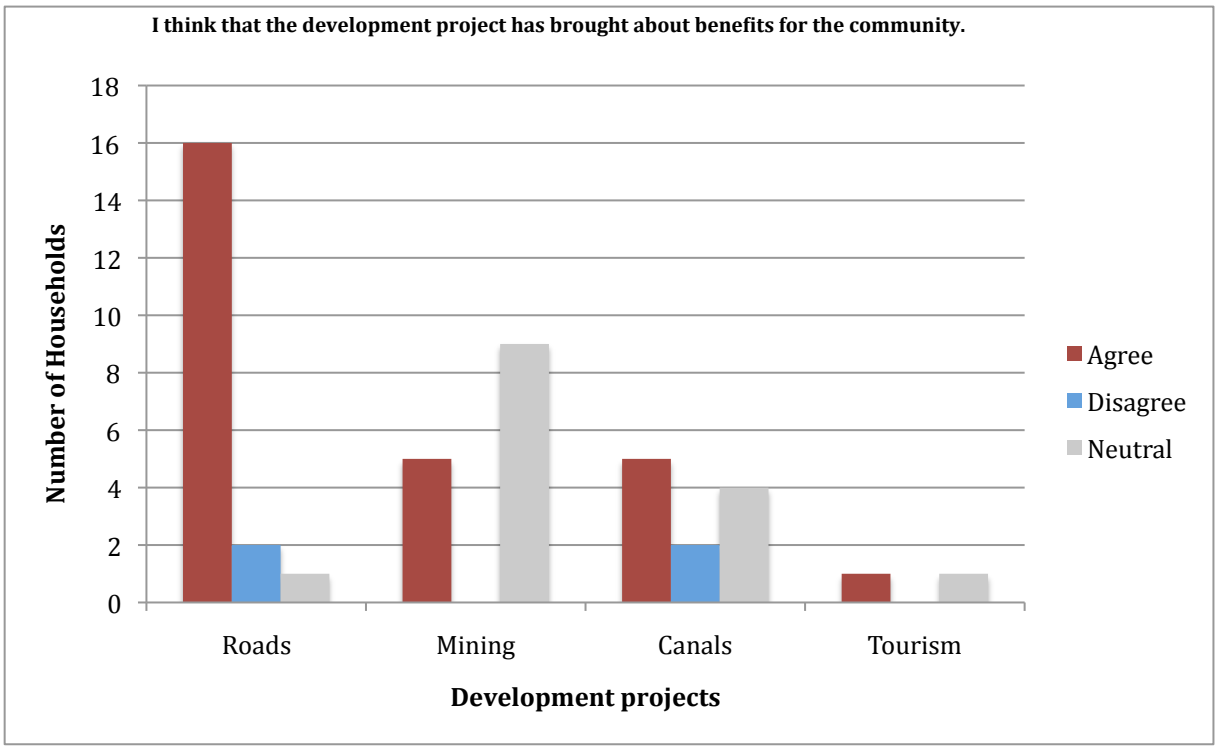

Figure 2.1: **Household-level attitudes about the benefits for the community brought about by development activities (n=46).**

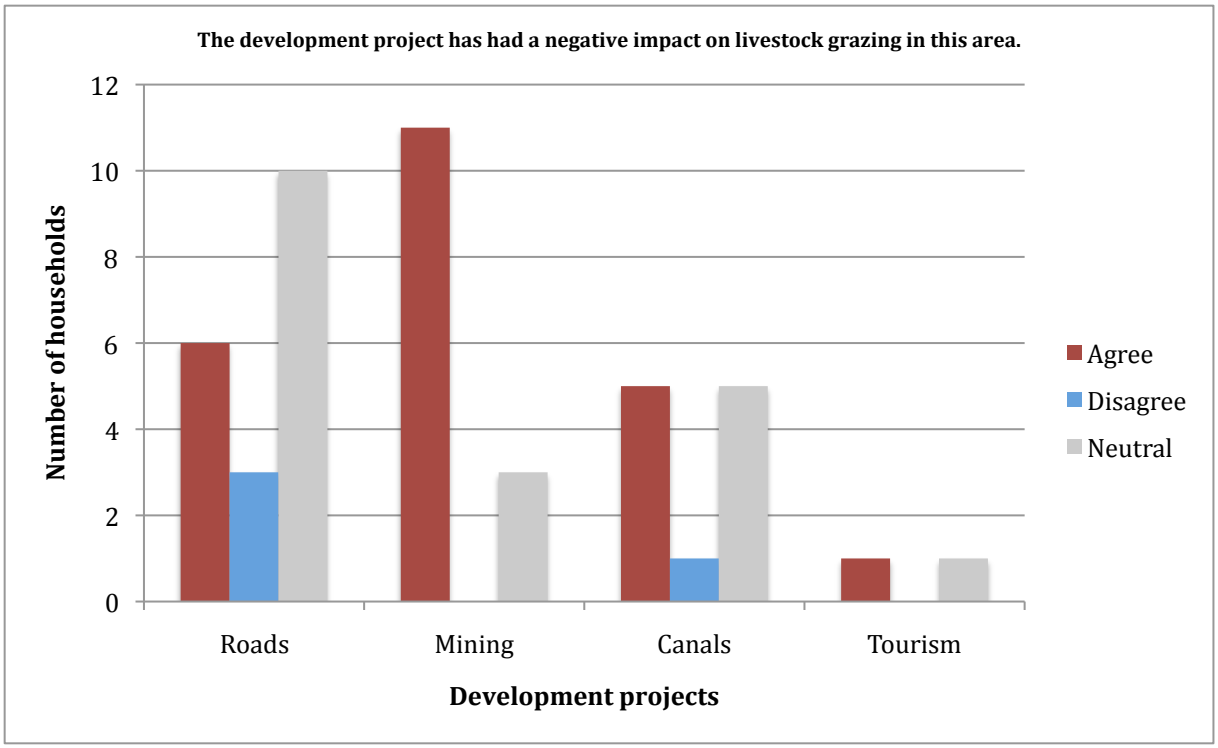

Figure 2.2: Household-level attitudes about whether development activities negatively impact livestock grazing in the area. (n=46).

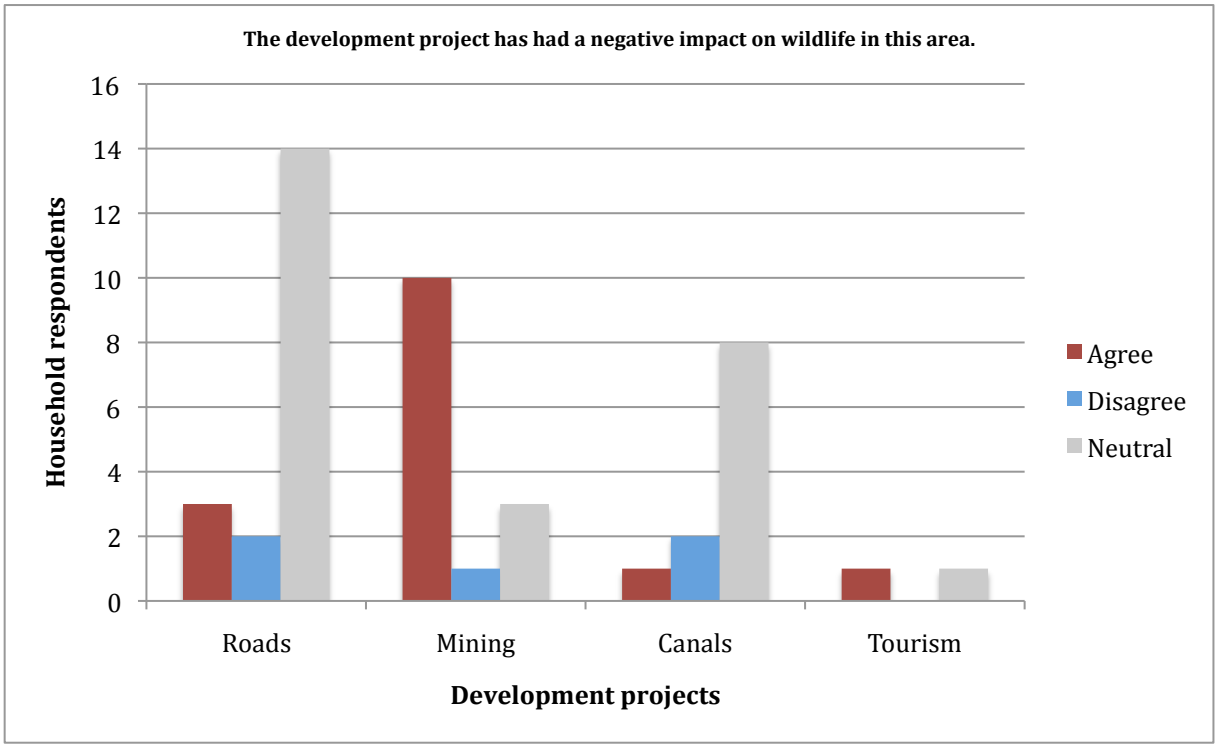

Figure 2.3: Household-level attitudes about whether development activities negatively impact wildlife in the area. (n=46).

Section 3

3. Impact of lifestyles on livestock depredation.

a. Livestock herding as a livelihood strategy

A total of 60 households were interviewed in 7 villages, with many households having more than one livelihood activity. Herding was the most common livelihood activity among households in all villages, involving 92% of all households (Figure 3.1). The second most frequent livelihood activity consisted of arable farming, involving 48% of all households. Migrant labor, consisting of people going to a nearby city for a variety of different occupations, was also frequently reported (in 22% of all households). Other reported livelihood activities included those of doctor, teacher, village officer, secretary, oil worker, government worker and veterinarian. Livelihood activities were not significantly different between villages (Chi-squared = 29.3112, df = 21, p = 0.106).

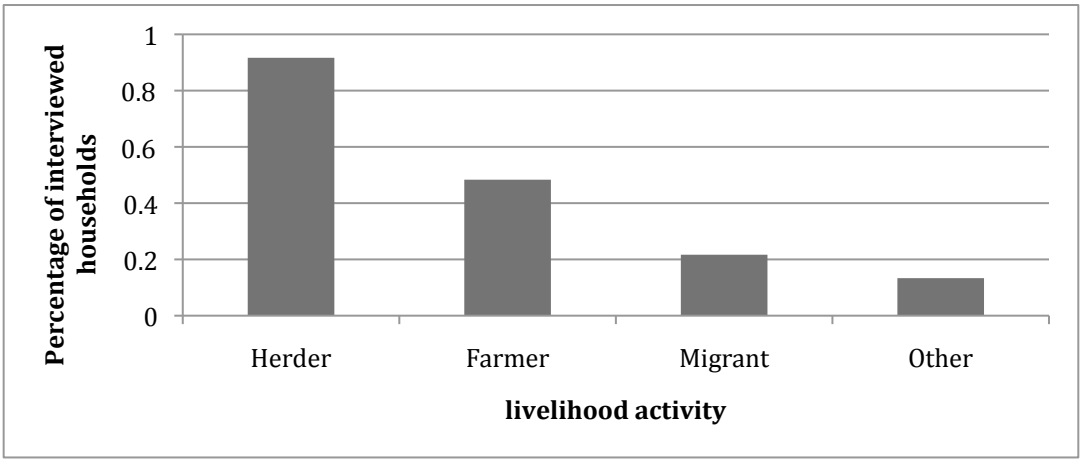

Figure 3.1: Percentage of households involved in each livelihood activity (n=60).

Table 3.1. Sampled Characteristics of Surveyed Herders

	Households surveyed		Herders surveyed
	No. of Households surveyed	Percentage of Households herding	
Qi Lin	**8**	**100%**	**3**
Guan Shan	**1**	**100%**	**4**
Hong Shan	**20**	**95%**	**13**
Qing Ke Di	**11**	**100%**	**9**
Ci Yao Kou	**5**	**100%**	**7**
Gan Ba Kou	**8**	**100%**	**10**
Hung Cao Ba	**7**	**43%**	**3**
Total	**60**	**92%**	**49**

A total of 49 targeted herder interviews were conducted (Table 3.1). Many animals were involved: yak, sheep, goats, horses, mules and donkeys. The majority of herders (94%) reported herding small stock (goats or sheep) with 22% also herding yak and 25% owning horses. Individual herds were large with the average small stock herd size being 210.0 (sd = 127.0) and an average yak herd of 68.0 (sd = 47.0) (Table 3.2). Horses and mules/donkeys were kept in small numbers with an average of 1.0 (sd= 0.5) and 1.0 (sd = 0.6) respectively.

The reported herding patterns varied according to the season and type of livestock. During the summer months (May-Oct) all livestock tend to be herded in high, mountainous areas. In other months small stock are either sold or kept in corrals in the villages, while yak continue to be herded in high or low mountain areas.

Table 3.2: Average number of livestock per herder household in each village

	Yak (SD)	Small Stock (SD)	Horse (SD)	Mule/donkey (SD)
Qi Lin	110.0 (0.0)	145.0 (21.0)	0.0 (0.0)	0.0 (0.0)
Guan Shan	0.0 (0.0)	393.0 (122.0)	1.0 (0.0)	2.0 (0.0)
Hong Shan	47.0 (24.6)	164.0 (76.0)	2.0 (0.6)	0.0 (0.0)
Qing Ke Di	140.0 (0.0)	159.0 (76.0)	0.0 (0.0)	0.0 (0.0)
Ci Yao Kou	78.0 (74.2)	188.0 (138.0)	1.0 (0.0)	1.0 (0.6)
Gan Ba Kou	50.0 (42.4)	218.0 (157.0)	1.0 (0.4)	1.0 (0.0)
Hung Cao Ba	0.0 (0.0)	319.0 (53.5)	0.0 (0.0)	0.0 (0.0)
Total	68.0 (47.0)	210.0 (127.0)	1.3 (0.5)	1.4 (0.6)

b. Perceived past and future changes in livestock herding

In five of the villages a recent policy has been instigated, limiting herding activity in the mountains with the aim of improving the alpine vegetation. Accordingly, livestock grazing has been completely banned in particular zones of the mountains, for the next five years.

Across all seven villages, the majority of herders (57%) reported that the number of livestock had decreased in the last 10 years. The reduction in livestock was attributed to the impending implementation of recent policies on grazing in the areas, but also the degradation of the vegetation. The 37% of herders who reported an increase in livestock attributed it to herders' rising incomes given the economic growth in the area, allowing herder households to afford larger livestock herds. The majority of herders (59%) indicated that the number of households had decreased in the last 10 years (Figure 3.2). This was attributed to migration of young people to cities in search for other job opportunities. No differences were observed between villages with and without the policy limiting herding activity (change in livestock: Chi-squared = 2.75, df = 2, p = 0.25; change in number of households: Chi-squared = 1.41, df = 2, p = 0.49).

Herders from all seven villages predicted that in the next five years the number of livestock was going to reduce even further. This was attributed due to the grazing ban even in villages where the ban was not being implemented, with people selling livestock rather than altering their summer grazing ranges to areas outside the ban zones. The five herders who predicted an increase in livestock numbers again attributed it to rising incomes from herding from economic growth.

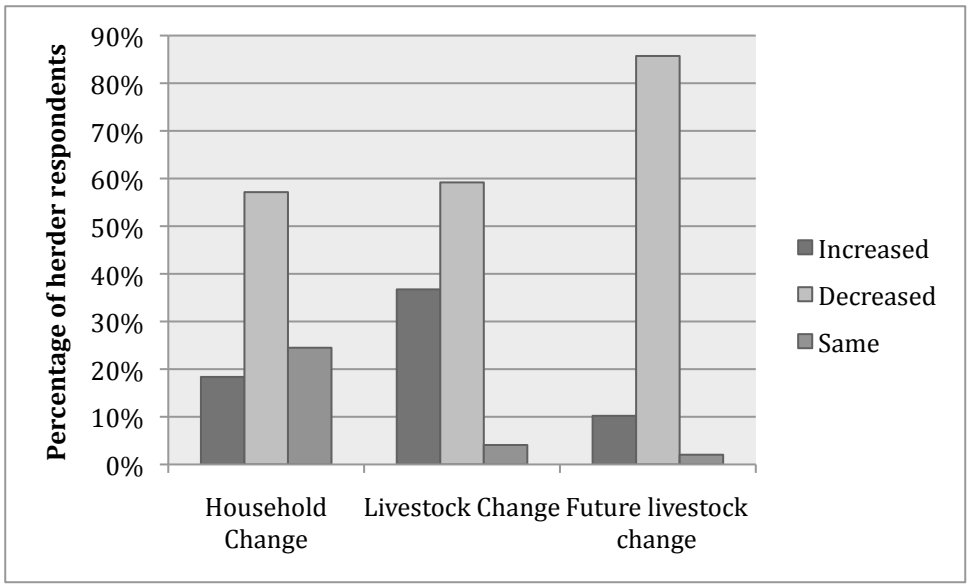

Figure 3.2: Reported changes in the total number of households and livestock surrounding each village in the last 10 years and perceived future changes in the total number of livestock surrounding each village.

c. Livestock Depredation

From June 2012 to May 2013 a total of 115 yaks and 1174 sheep and goats were reported to be lost from the combination of natural disasters (for example drought, avalanches and floods), disease and depredation (Table 3.3). A total of 76% of interviewed herders suffered livestock losses from depredation, while 65% and 63% suffered livestock losses from disease or natural disasters respectively. 20% of all herder respondents reported no losses whatsoever. Herders reported having lost livestock to the four large carnivores known to be present in the area: snow leopards, grey wolves, Eurasian lynx and brown bears. While depredation was reported by a larger number of households, it was not identified as the principal cause of most livestock losses. Natural disasters were responsible for 39% of all livestock losses, while disease and depredation were both responsible for 32% and 29% respectively (Figure 3.4a). Livestock depredation by snow leopards was reported to be responsible for 2% of all livestock losses (8% of all depredation events attributed to snow leopards, Figure 3.4b), while Eurasian lynx and wolves contribute 16% and 8% respectively. A large majority of depredation events were reported to have occurred when livestock were grazing (98%), with only one event reported to have occurred at a corral. A majority of depredation events also occurred when livestock were guarded (68%) compared to 23% unguarded. Guarding of livestock was described as being

carried out by a wide range of different methods including directly watching over livestock continuously or at periodic intervals and the presence of a nearby feral dog. The majority of livestock loss by snow leopard, Eurasian lynx and grey wolf occurred during the summer months, May to August. There were also a number of reports of losses in the autumn from October to December.

Snow leopards were reported to kill a similar number of juvenile yaks and goats or sheep. All the 15 yaks reportedly killed by snow leopards were juveniles. By contrast Eurasian lynx and grey wolves were reported killing a larger number of goat or sheep compared to yak. Eurasian lynx were only reported to have killed one juvenile yak.

There was a significant difference between villages on which carnivore species as reported to be responsible for the losses (Chi-squared = 41.90, df = 24, p = 0.01, Figure 3.5). All villages reported loss of livestock by lynx, however the villages Hong Shan and Gan Ba Kou in particular reported a much large number.

Only one of the 49 surveyed herders reported receiving compensation from the local government for their loss of livestock. The most commonly proposed measure to prevent future depredation of livestock was the use of a physical barrier to prevent depredation (Figure 3.6). Removing predators by shooting, trapping or poison was the next most common suggestions.

Table 3.3: Status of livestock losses in all villages (n=49)

					Livestock losses					
					Yak		Goat/sheep		Horse	
Cause	Species	Number of Herder Households	Percentage of total herder respondents (%)	Number of events reported	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Depredation	Snow leopard	5	10	5	0	15	12	2	0	0
	Eurasian Lynx	25	51	34	0	1	154	44	0	0
	Grey wolf	12	24	14	0	18	40	24	0	0
	Brown bear	1	2	1	0	0	12	8	0	0
	Unknown	4	8	5	0	18	13	13	0	0
	Total	**37**	**76**	**57**	**0**	**52**	**231**	**91**	**0**	**0**
Disease		**32**	**65**	**35**	**6**	**11**	**175**	**224**	**0**	**0**
Disaster		**31**	**63**	**36**	**25**	**21**	**245**	**208**	**0**	**0**
Total		100		128	31	84	651	523	0	0

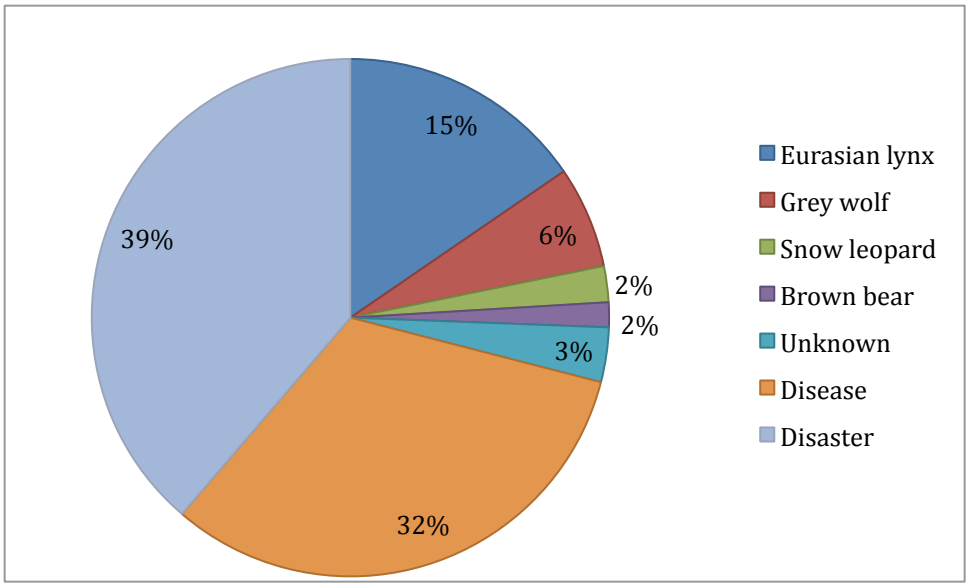

Figure 3.4a: Livestock losses composition ratio. Snow leopards took 2% of the reported responsibility.

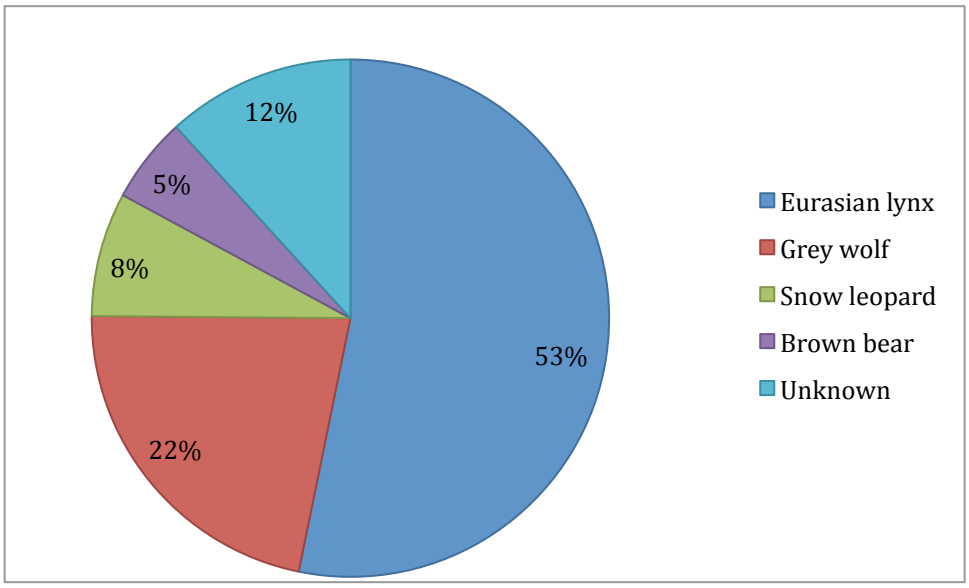

Figure 3.4b: Livestock losses composition ratio attributed to depredation. Snow leopards were responsible in 8% of cases.

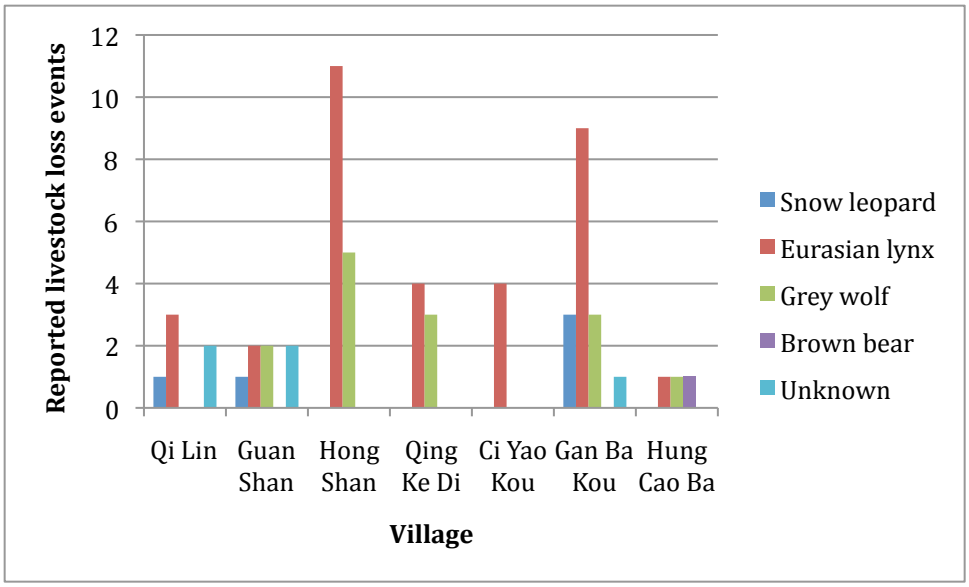

Figure 3.5: Livestock loss events attributed to species for each village (n=57 livestock loss events).

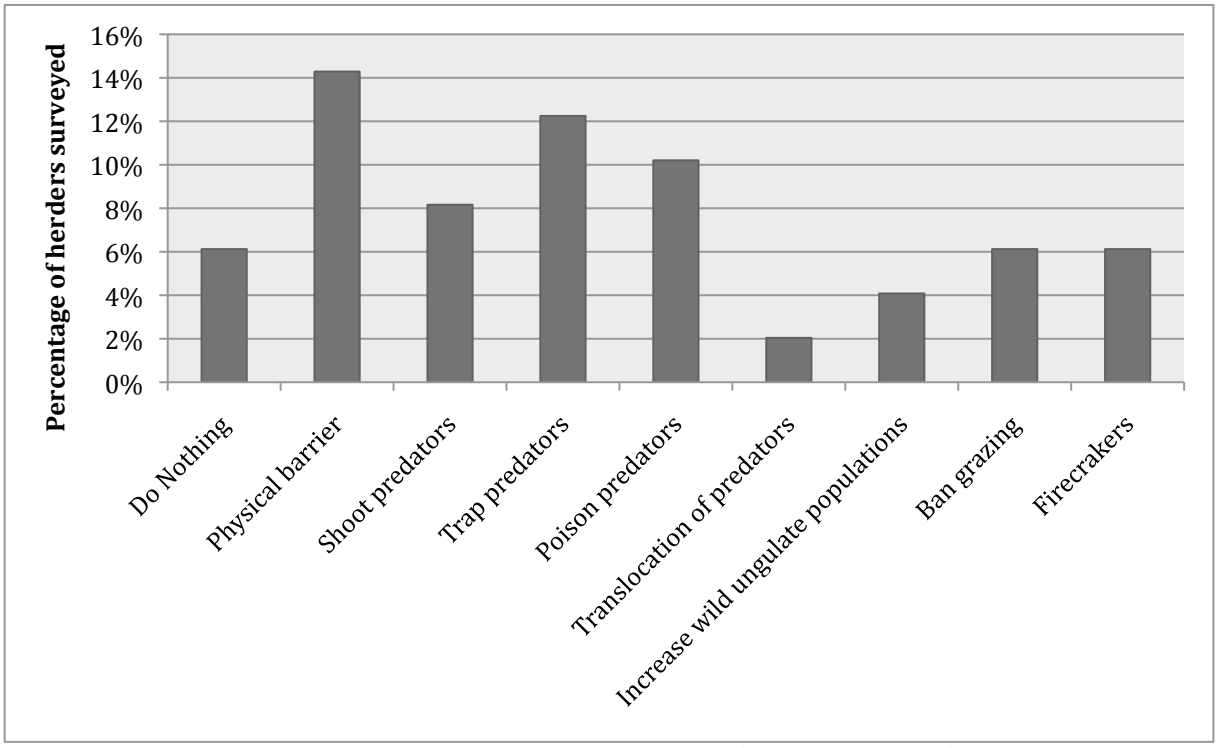

Figure 3.6: Herder suggestions on how to minimize depredation for all villages (n=49).

d. Lifestyle impact on perceived occurrence of depredation

There were few clear relationships between reported occurrences of livestock depredation and underlying herder characteristics (Table 3.3). There was a relationship with age class

of herders (Test: $F_{3,17.12} = 4.39$, $p = 0.02$) and reported livestock depredation, in which herders aged >60 years old tended to report fewer livestock depredation incidence (Figure 3.7).

Surprisingly herders who thought snow leopards were dangerous to humans reported less livestock losses ($t = -2.67$, $df = 37.18$, $p = 0.01$). In contrast no significant relationship was observed between livestock loss and the agreement of herders that snow leopard, grey wolf, lynx and brown bear were dangerous for livestock and reported livestock loss (snow leopard: $t = -0.68$, $df = 5.63$, $p = 0.52$, grey wolf: $t = -0.05$, $df = 1.15$, $p = 0.97$, Eurasian lynx :$t = -0.23$, $df = 1.10$, p-value = 0.85, brown bear : $t = -1.11$, $df = 4.24$, p-value = 0.32). No significant relationship was observed for herders from different villages ($F = 1.43_{6, 10.20}$, p-value = 0.29), genders ($t = -0.2296$, $df = 19.794$, p-value = 0.8208) and educational level ($F = 2.31_{3, 11.31}$, p-value = 0.13). Multiple linear regressions did not reveal any combinations of variables that could explain more clearly the pattern in reported livestock losses.

Table 3.3: Explanatory variables considered as potential predictors of the perceived occurrence of livestock depredation by carnivores

Explanatory Variables	Detail	Type
Age	4 Age Classes: 20-29, 30-39, 40-49, 50-59, and 60+	Categorical
Gender	Male or Female of respondent	Categorical
Educational level	Education level: none, primary, middle, high, university.	Categorical
Village	Qi Lin, Guan Shan, Hong Shan, Qing Ke Di, Ci Yao Koum Gan Ba Kou, Hung Cao Ba.	Categorical
Number of owned livestock	Summed number of owned livestock (yak, sheep, goat, horse, mule)	Continuous
Carnivore is dangerous to people	Attitude scale; Agree or Disagree	Categorical
Carnivore is dangerous to livestock	Attitude scale; Agree or Disagreed	Categorical

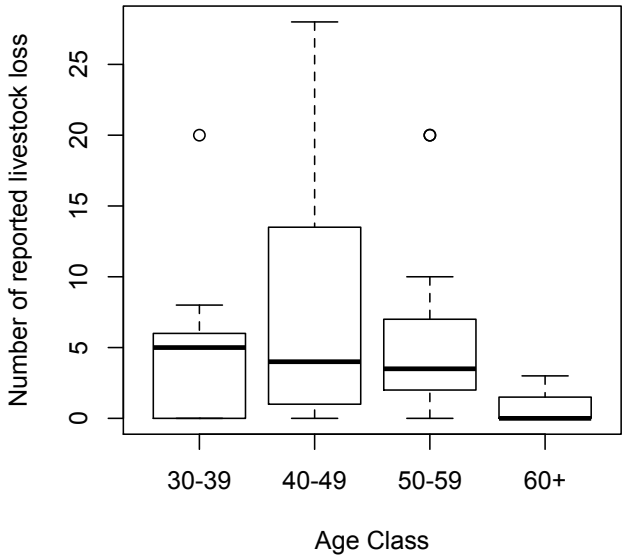

Figure 3.7 Relationship between herder age class and reports of livestock depredation. Open circles in represent outliers. ($F_{3,17.12} = 4.39$, p = 0.02).

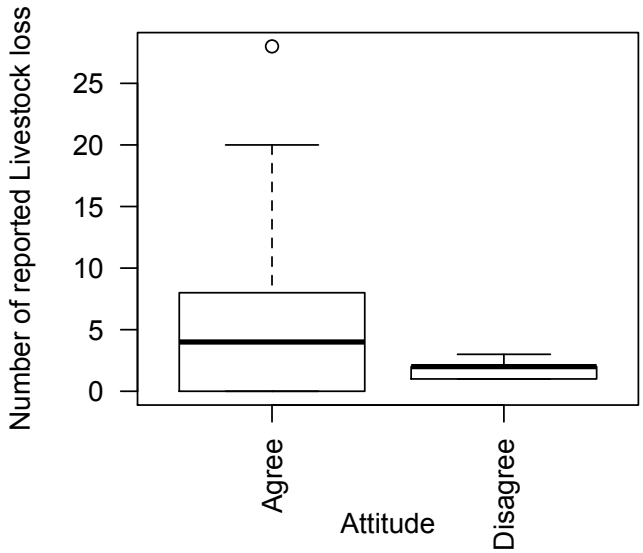

Figure 3.6 Relationship between herder attitude towards snow leopard and reports of livestock depredation. Open circles represent outliers. (t = -2.67, df = 37.18, p-value = 0.01)

Section 4

4. Attitudes towards species

a. Household and herder attitude towards wildlife

Herder and household-level respondents had similar attitudes towards wildlife (Table 4.1). The majority of herder and household respondents stated that they either agreed or strongly agreed that snow leopards and blue sheep should be protected (Herder: 67%-snow leopard, 55%-blue sheep, Household: 72%-snow leopard, 57%-blue sheep) (Appendix: Figure 6.1a & 6.1b). In contrast, fewer respondents agreed or strongly agreed that the grey wolf and Eurasian lynx should be protected (Herder: 22%-grey wolf, 16%-Eurasian lynx, Household: 28%-grey wolf, 25%-Eurasian lynx). Responses regarding the protection of brown bears were less polarized with similar numbers agreeing and disagreeing.

Consistent views were found regarding the presence of various species as a sign of a healthy environment (Appendix: Figure 6.2a & 6.2b). The majority of herder and household-level respondents agreed or strongly agreed that snow leopards and blue sheep were a sign of a healthy environment. On the other hand, fewer respondents agreed that grey wolves and Eurasian lynx were a sign of a healthy environment. Again respondents were less polarized concerning brown bears with similar numbers agreeing and disagreeing.

Brown bears were considered to be a threat to humans by the majority (72%) of household and herder respondents (Appendix: Figure 6.3a & 6.3b). Their presence was reported to prevent people from venturing into the mountains (Appendix: Figure 6.4a & 6.4b). The other carnivore species were in general not considered dangerous to humans and did not prevent people from venturing into the mountains. By contrast all of the carnivores were considered dangerous to livestock, particularly the Eurasian lynx and grey wolf (Appendix: Figure 6.5a & 6.5b). It was thus not surprising that the majority of herders (Eurasian lynx: 86%, grey wolf: 71%) agreed that the presence of these two species should be reduced around their village (Appendix: Figure 6.6a & 6.6b).

Herder attitudes related to the need to protect a species and recognition that a species was a sign of a healthy environment were correlated (r_{sp}=0.56, n = 245, p<0.01, Table 4.2), so that respondents who believed that a species needed to be protected generally agreed the species was a sign of a healthy environment. Similar attitudes for herders were found regarding the danger posed by carnivores to humans, which were correlated with the perceived risk of venturing into the mountains (r_{sp}=0.50, n = 245, p<0.01).

Table 4.1: Mann-Whitney U test between herder and household attitudes at the level of the individual respondent.

	Q1	Q2	Q3	Q4	Q5
Q1	** (P<0.01)	x	x	x	x
Q2	x	** (P<0.01)	x	x	x
Q3	x	x	** (P<0.01)	x	x
Q4	x	x	x	** (P<0.01)	x
Q5	x	x	x	x	** (P<0.01)

Q1: I think the following species are dangerous to humans: (negative question)

Q2: I believe that the following are dangerous for livestock and domestic animals: (negative question)
Q3: The following species prevent me going into the mountains: (negative question)
Q4: The presence of the following species is a sign of a healthy environment: (positive question)
Q5: I believe it is important to protect the following species: (positive question)

Table 4.2: Spearman correlation coefficients (r_{sp}) between the attitude questions at the level of the individual respondent.

	Q1	Q2	Q3	Q4
Q2	0.29 **	x	x	x
Q3	0.50 **	0.30 **	x	x
Q4	-0.11	-0.33 **	-0.17 *	x
Q5	-0.07	-0.36 **	-0.15 *	0.56 **

Where ** = (P<0.01) and * = (P<0.05)
Q1: I think the following species are dangerous to humans: (negative question)
Q2: I believe that the following are dangerous for livestock and domestic animals: (negative question)
Q3: The following species prevent me going into the mountains: (negative question)
Q4: The presence of the following species is a sign of a healthy environment: (positive question)
Q5: I believe it is important to protect the following species: (positive question)

b. An exploration of herder attitudinal drivers

Analysis of the association between attitude responses and various predictor variables was based on a binomial GLMM at the herder respondent level. Attitude was defined as a binomial response ("agree" and "highly agree" defined as 1 and "highly disagree", "disagree" and "neutral" as 0). The model included the predictor variables that may affect attitudes towards carnivores as covariates, such as gender, age class and education level. A mixed model (GLMM) was used by entering individual respondents as a random effect.

First we checked for multi-collinearity between predictor variables at the herder respondent level. Low correlation was found between predictor variables, except between attitudinal questions (Table 4.1) and between species (Table 4.3).

A strong correlation was observed between grey wolf and Eurasian lynx. For example if a respondent agreed that grey wolves were a threat to humans they generally agreed the Eurasian lynxes were also a threat. Moderate correlation was also observed related to the snow leopards and all the other species (r_{sp}>0.41, n=245, p<0.01). Low correlation was observed between the other species (r_{sp}<0.27).

Unsurprisingly the GLMM showed a significant association between attitude responses and questions asked (Table 4.4). The model also showed a significant association between attitudes and all of the different species of concern (p<0.05). Village, Gender, age class and educational level were all not associated with attitudes towards the carnivores (p>0.1).

Table 4.3: Spearman correlation coefficients (r_{sp}) between attitudes to species at the level of the individual respondent.

Species	Snow leopard	Grey wolf	Eurasian lynx	Brown bear
Grey wolf	0.48 **			
Eurasian lynx	0.43 **	0.77 **		
Brown bear	0.44 **	0.42 **	0.27 **	
Blue sheep	0.41 **	0.14 *	0.16 *	0.04

Where ** = (P<0.01) and * = (P<0.05)

Table 4.4. The model of the effect of the different predictor variables on attitudes at the individual respondent level, significance at p<0.05.

Predictor Variable	**Level**	**Estimate±SE**	**p**
Species	Brown bear	0	
	Snow leopard	-0.40±0.19	p<0.05 *
	Grey wolf	-0.72±0.19	p<0.001 ***
	Eurasian lynx	-0.97±0.19	p<0.001 ***
	Blue sheep	-1.53 ±0.20	p<0.001 ***
Question	Danger	0	
	Livestock	-2.29±0.22	p<0.001 ***
	Healthy	0.81±0.20	p<0.001 ***
	Mountain	-0.12±0.21	0.58
	Protect	0.57±0.20	p<0.01 **
Village	Ci Yao Kou	0	
	Gan Ba Kou	-0.52±0.29	p<0.1 .
	Guan Shan	0.27±0.36	0.47
	Hong Shan	-0.12±0.29	0.68
	Huang Caoba	-0.09±0.41	0.83
	Qi Lin	0.20±0.37	0.60
	Qing Ke Di	-0.40±0.28	0.15
Gender	Female	0	
	Male	0.02±0.20	0.90
Age Class	20-29	0	
	30-39	-0.38±0.60	0.53
	40-49	0.65±0.58	0.26
	50-59	-0.75±0.59	0.20
	60+	-0.69±0.67	0.31
Education level	High	0	
	None	-0.12±0.42	0.77
	Primary	-0.09±0.25	0.72
	Middle	-0.20±0.23	0.39

Section 5

5. Detection of species surrounding sampled villages

a. Species detections

Within the last 12 months five carnivore species (snow leopard, Eurasian lynx, grey wolf, red fox and brown bear) were detected directly or indirectly (from signs) by herders surrounding the seven sampled villages. Snow leopards were directly observed on three occasions within three different villages (Table 5.1), while the signs of snow leopard were observed on 14 occasions at least once surrounding each village besides Qing Ke di (Table 5.2). Eurasian Lynx were detected most frequently on 13 and 38 occasions directly and by signs respectively. Brown bears were the carnivore least frequently detected, having only been observed directly only once in Huan Cao Ba.

Table 5.1: Number of direct observations of carnivores reported by herders in each sampled village.

Species	Qi Lin	Guan Shan	Hong Shan	Qing Ke Di	Ci Yao Kou	Gan Ba Kou	Huan cao Ba	**Total**
Snow leopards	0	1	0	0	1	0	1	**3**
Eurasian Lynx	1	1	4	3	1	2	1	**13**
Grey wolf	1	1	2	0	1	3	1	**9**
Red Fox	1	1	7	1	2	5	1	**18**
Brown Bear	0	0	0	0	0	0	1	**1**
Total	**3**	**4**	**13**	**4**	**5**	**10**	**5**	**44**

Table 5.2: Number of carnivore sign detections reported by herders in each sampled village.

Species	Qi Lin	Guan Shan	Hong Shan	Qing Ke Di	Ci Yao Kou	Gan Ba Kou	Huan cao Ba	**Total**
Snow leopards	1	4	1	0	2	3	3	**14**
Eurasian Lynx	4	2	11	8	5	7	1	**38**
Grey wolf	1	1	15	4	3	4	2	**30**
Red Fox	1	1	7	0	3	3	1	**16**
Brown Bear	0	1	0	0	0	0	1	**2**
Unknown	0	1	0	0	0	0	0	**0**
Total	**7**	**10**	**34**	**12**	**13**	**17**	**8**	**100**

Carnivores were detected in a range of different landscape types, mostly in broken terrain (Figure 5.1, 5.2). The few snow leopard detections were reported to have occurred in broken terrain, while red fox detections, also primarily reported in broken terrain, were also observed in a variety of other landscape types. Reported detections (direct and indirect) occurred primarily in the spring, summer and autumn seasons. The largest

number of detections occurred during the autumn (September to November), and the least in the winter (December to February). This pattern is probably related to herding activity in the mountains. Herders reported primarily herding between July and October (96%) and the majority reported not herding during the winter (73%).

On average direct and indirect detections were observed at 1.5km (sd= 3.1) and 2.7km (sd= 5.1) respectively, however observations ranged from sightings at the village (0 km) to distances up to 24km from the village. In addition a number of direct and indirect detections (34%) were also reported to have occurred at the summer pastures, located large distances away from the villages (reported between 20km to two days' travel on horse back).

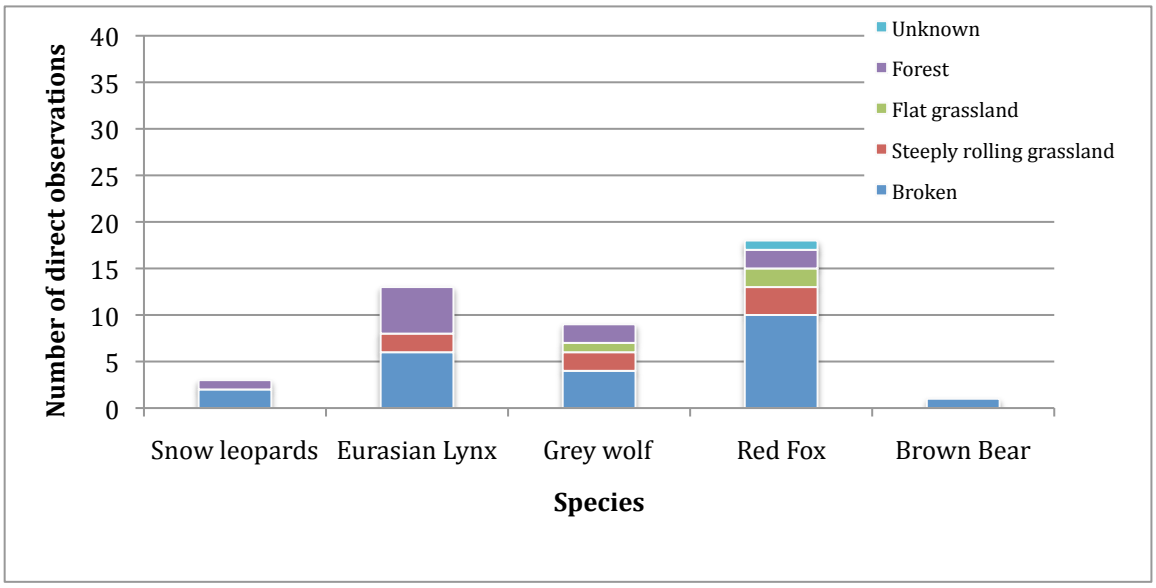

Figure 5.1: Reported landscape-use for carnivores directly observed (n=44)

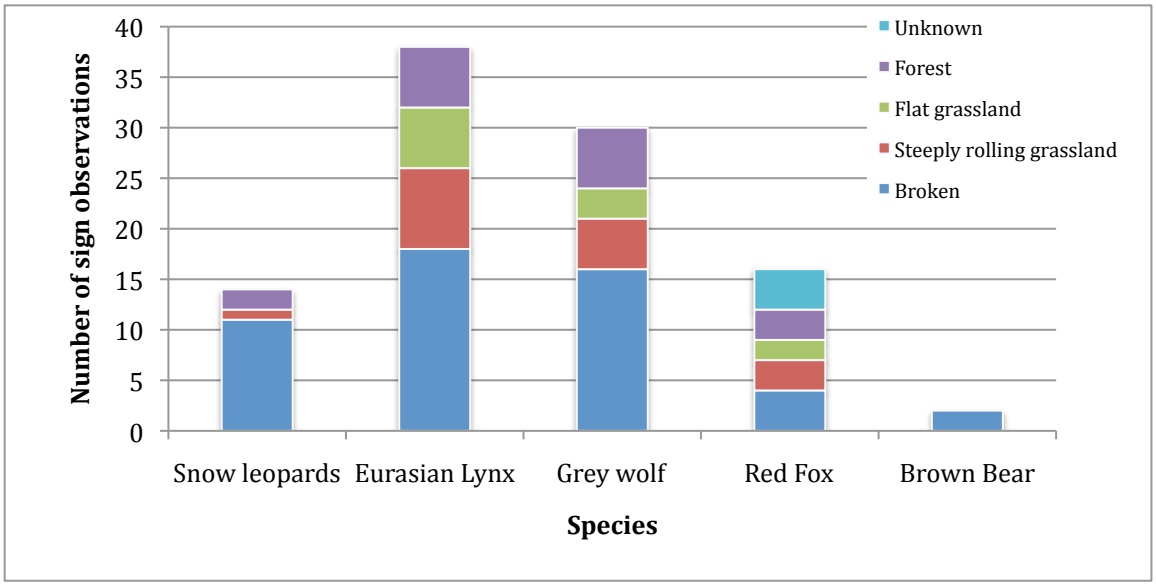

Figure 5.2: Reported landscape-use for carnivore signs observed (n=100)

Section 6: Appendix

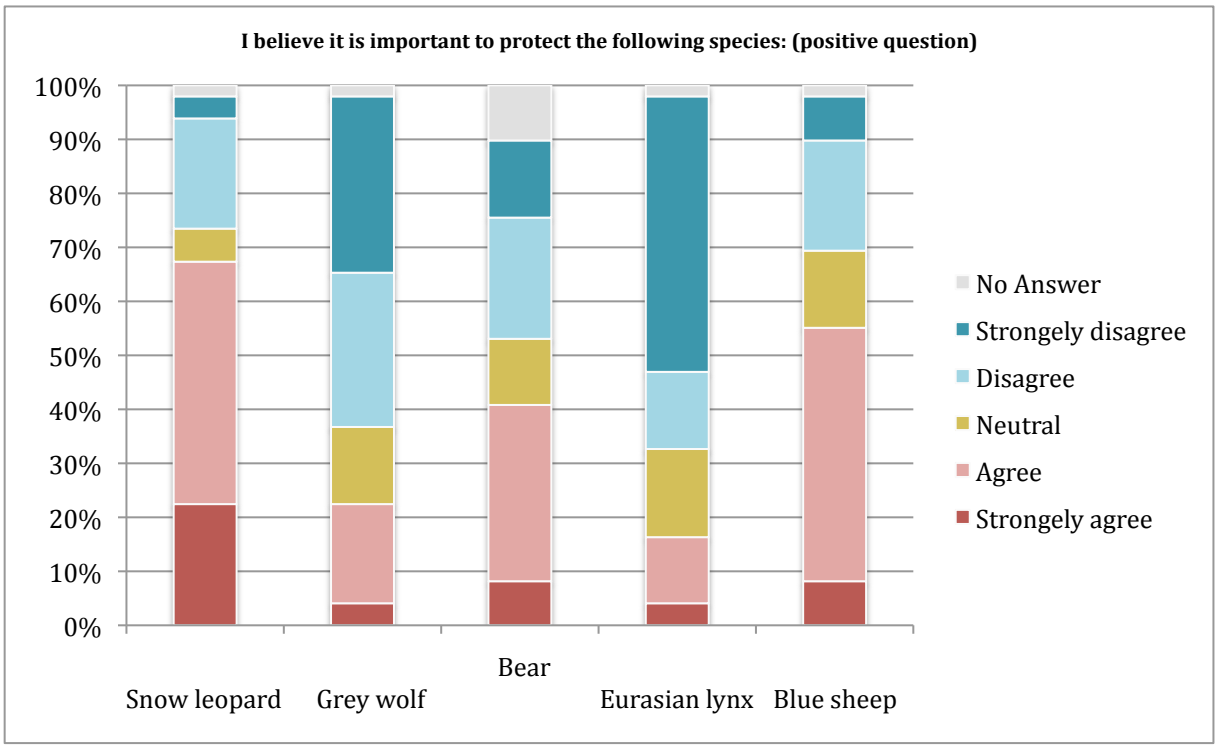

Figure 6.1a: Herder attitudes towards the protection of the selected species (n=49)

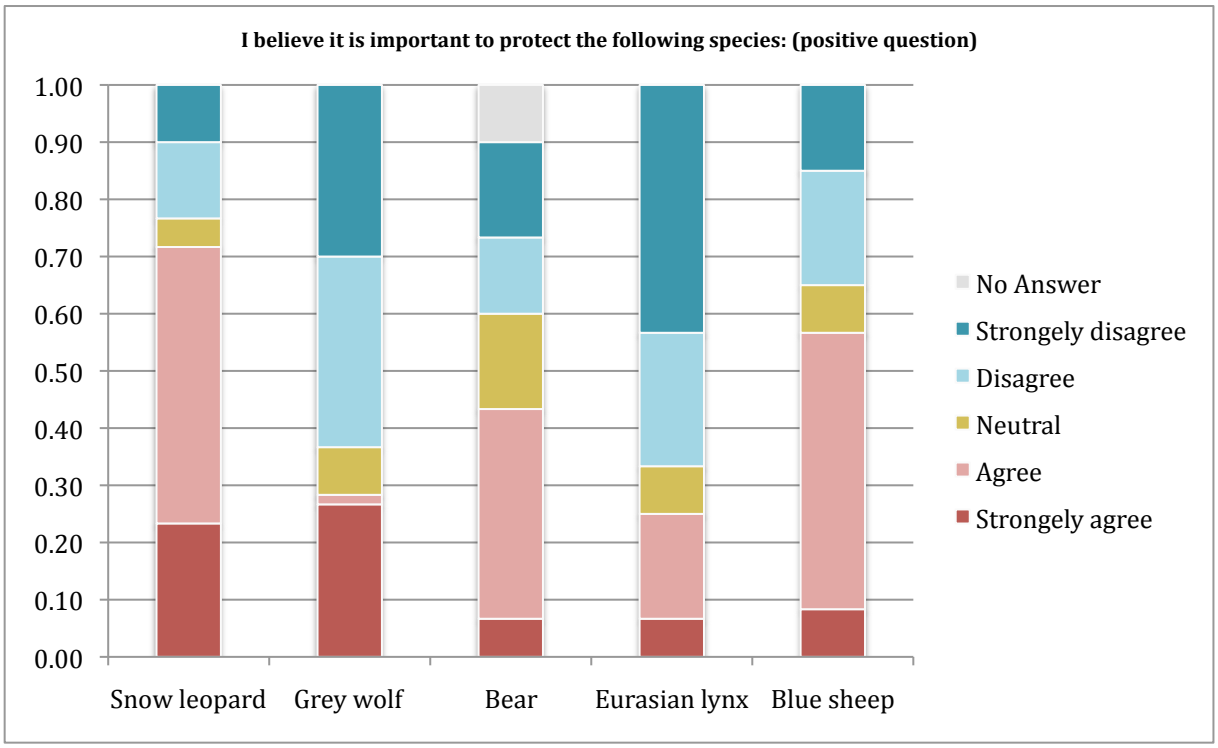

Figure 6.1b: Household attitudes towards the protection of the selected species (n=60)

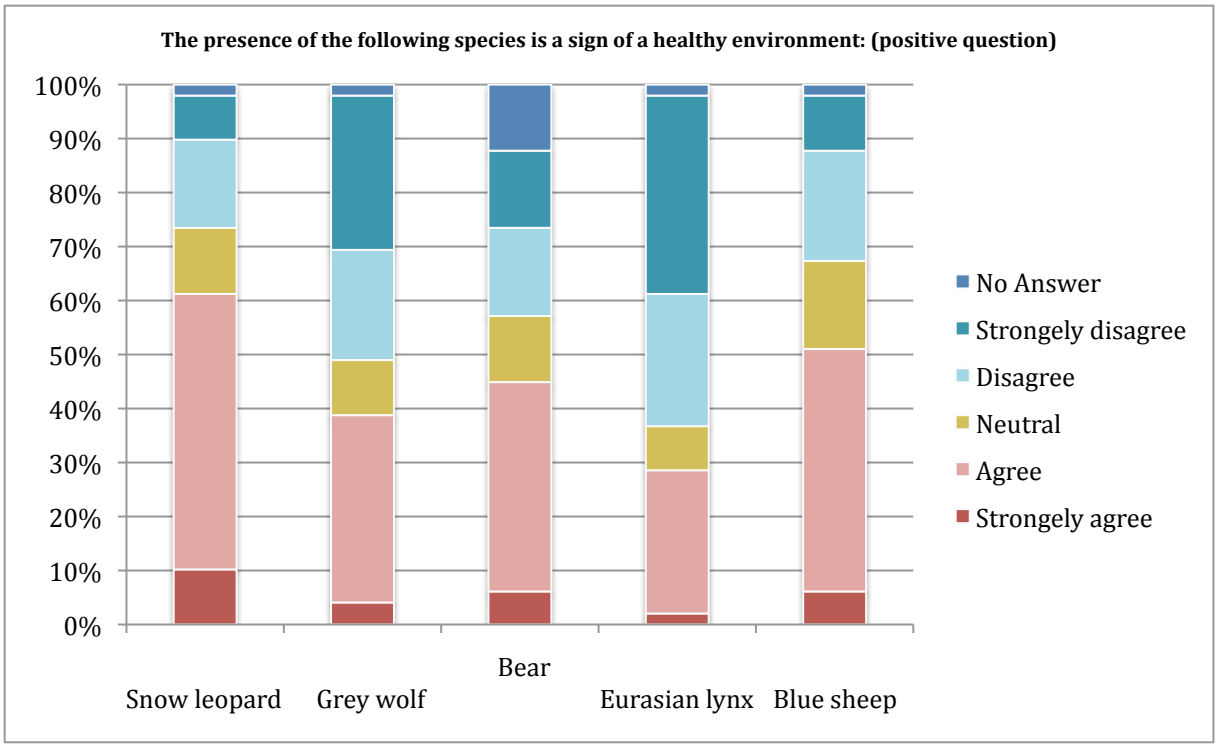

Figure 6.2a: Herder attitude relating towards the species indicating a sign of a healthy environment (n=49)

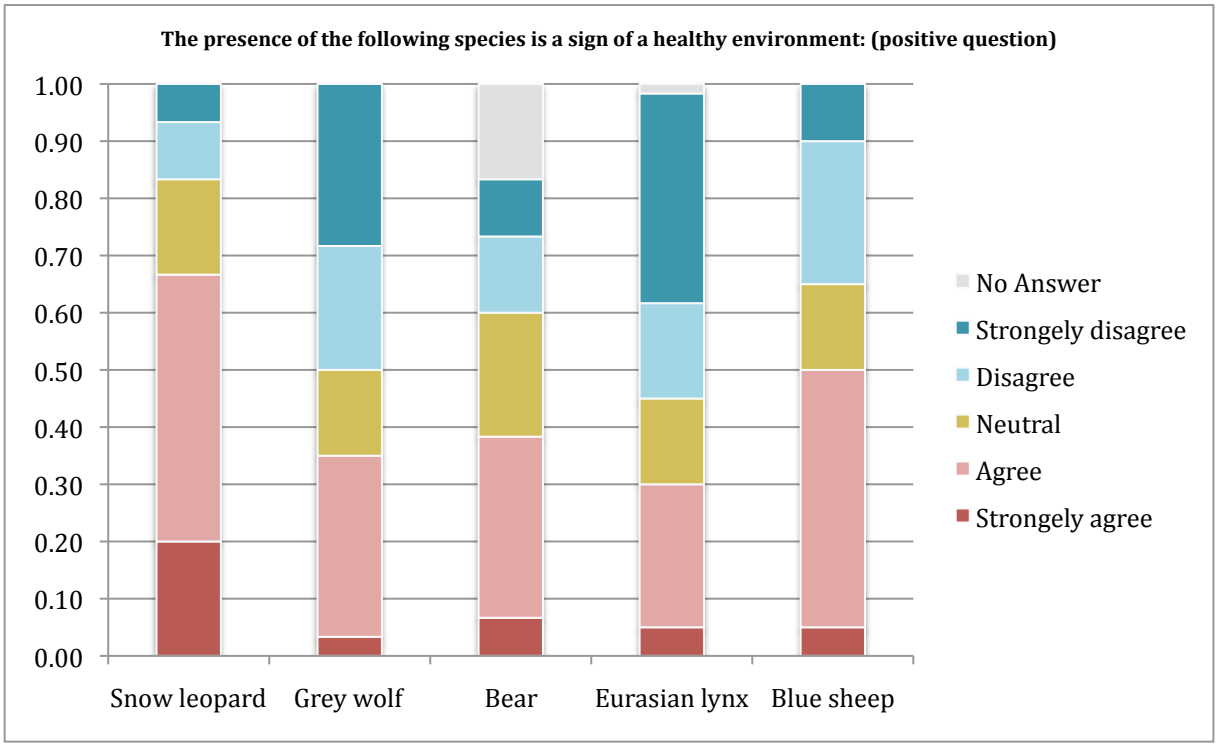

Figure 6.2b: Household attitude relating towards the species indicating a sign of a healthy environment (n=60)

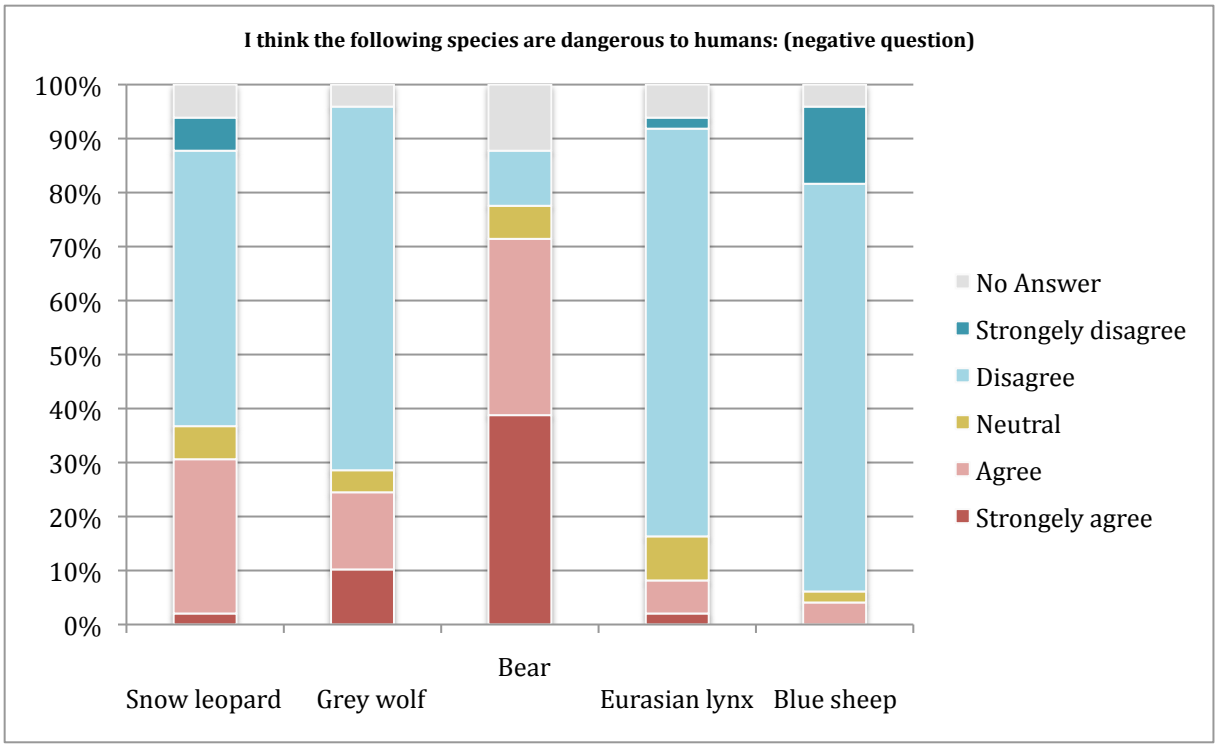

Figure 6.3a: Herder attitude relating to the threat posed to humans by selected species (n=49)

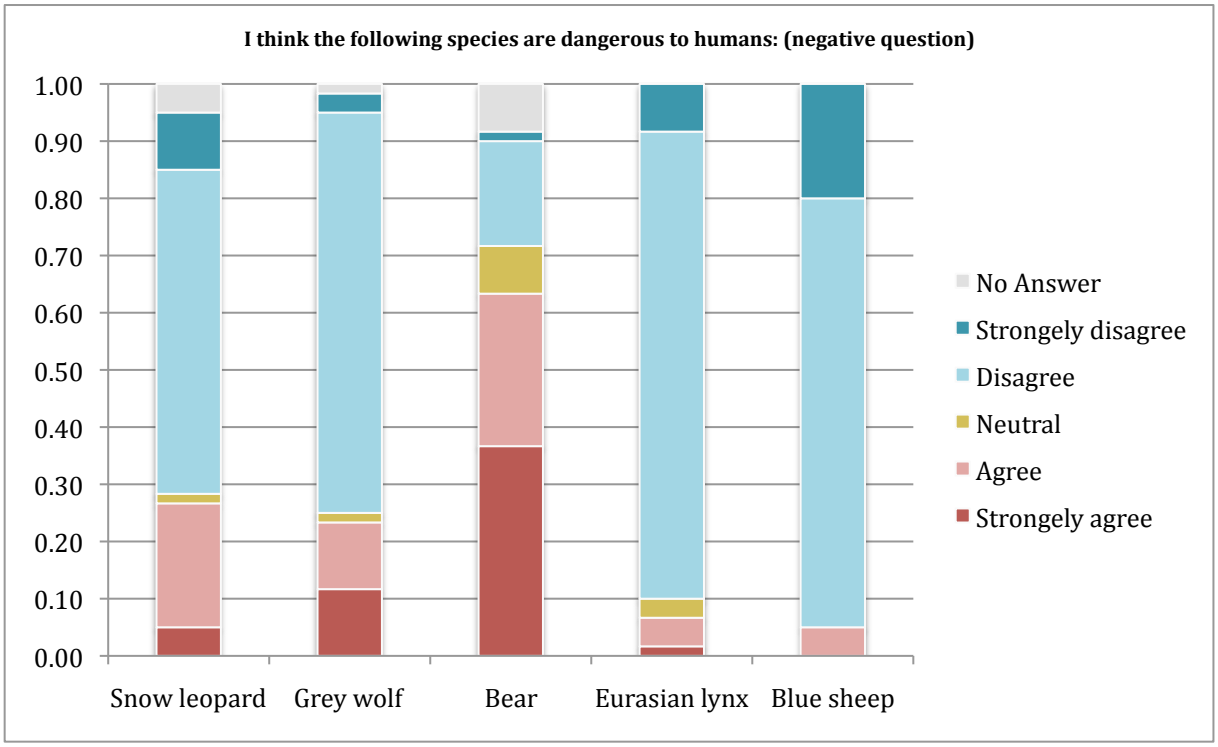

Figure 6.3b: Household attitude relating to the threat posed to humans by selected species (n=60)

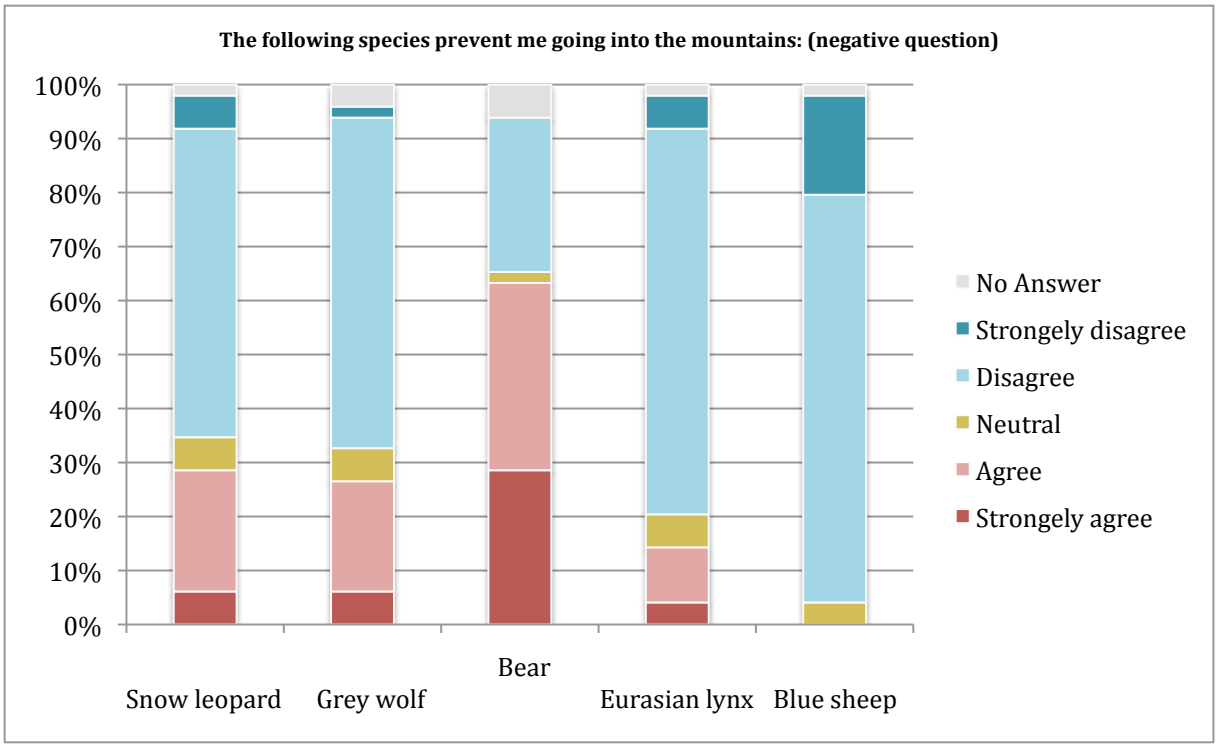

Figure 6.4a: Herder attitude relating to the threat posed by selected species in venturing into the mountains (n=49)

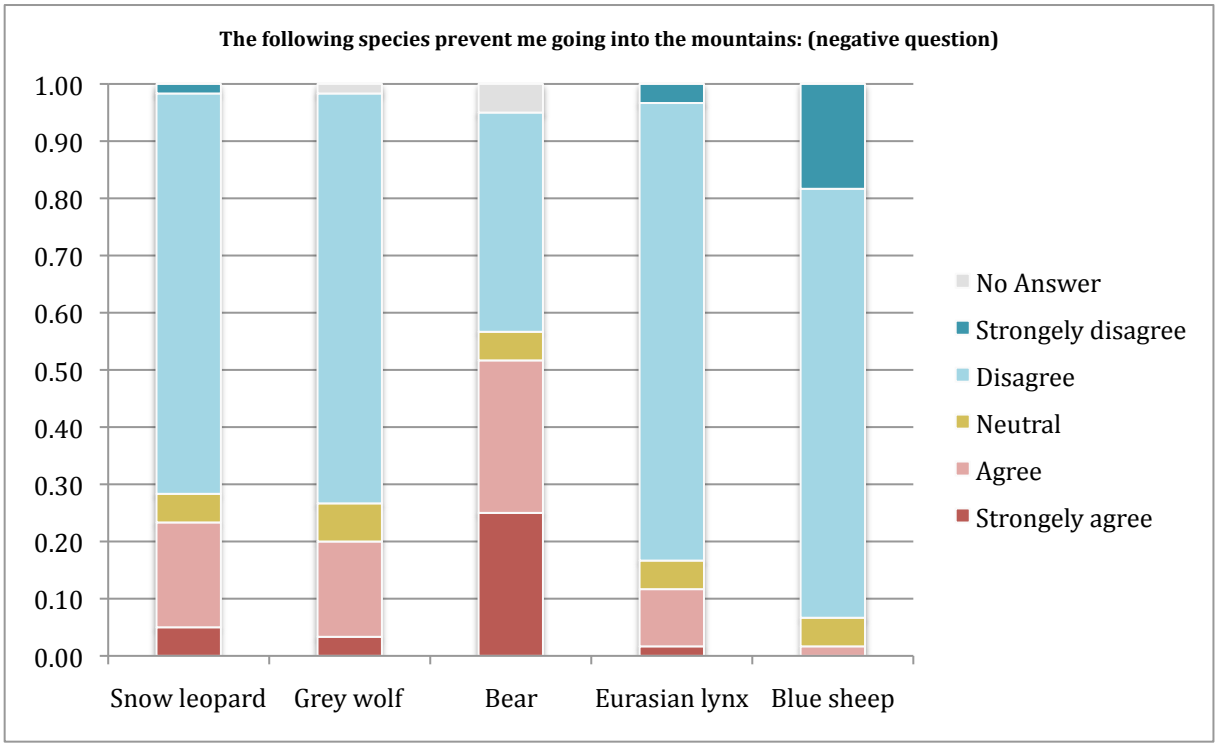

Figure 6.4b: Household attitude relating to the threat posed by selected species in venturing into the mountains (n=60)

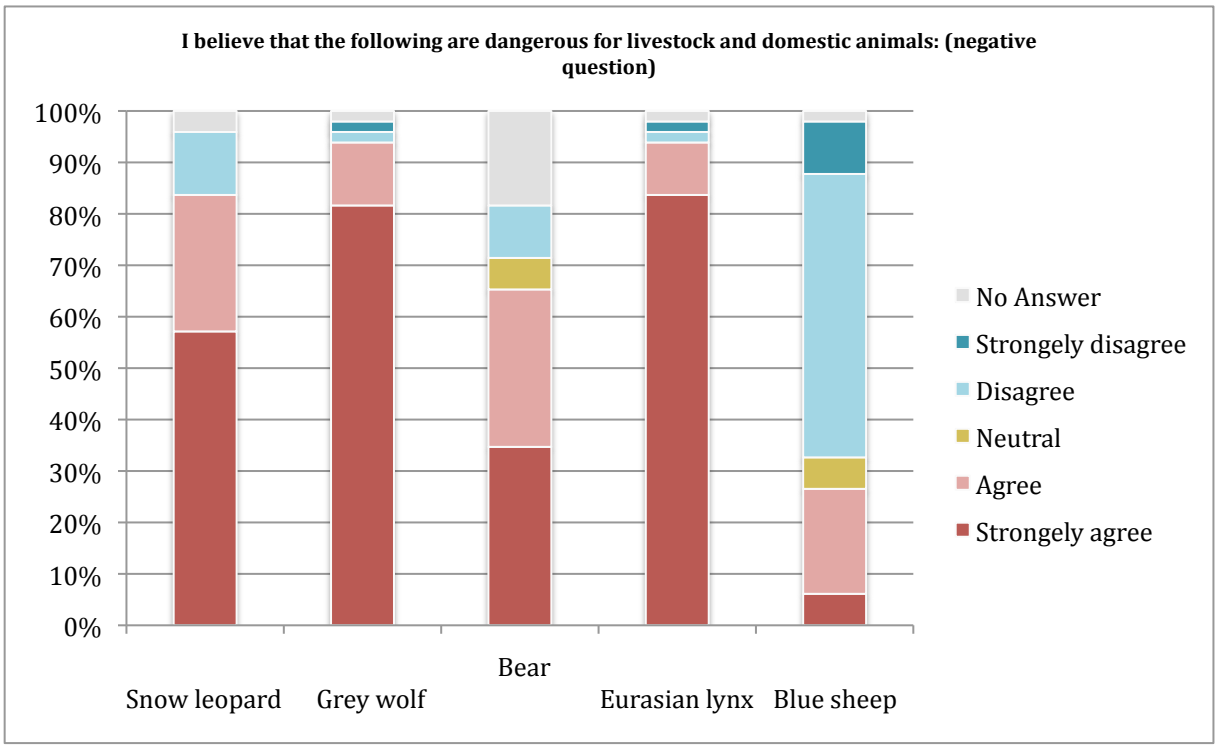

Figure 6.5a: Herder attitude relating to the threat to livestock posed by selected species (n=49)

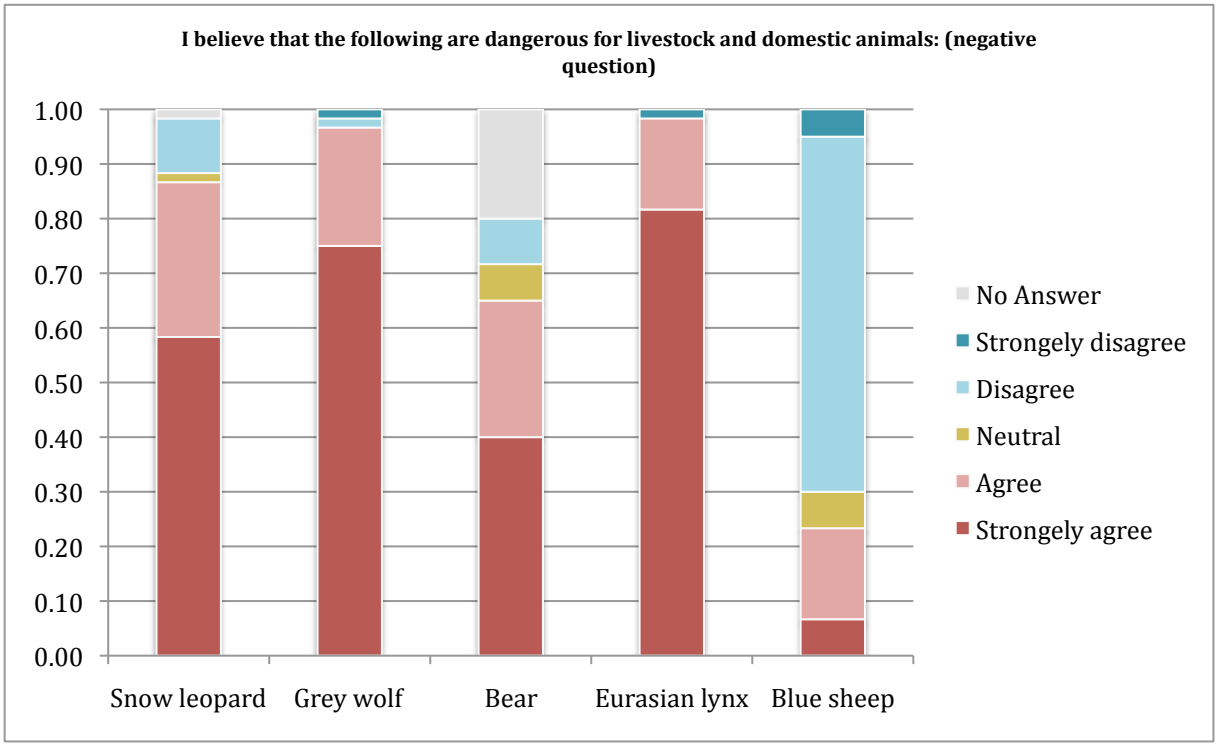

Figure 6.5b: Household attitude relating to the threat to livestock posed by selected species (n=60)

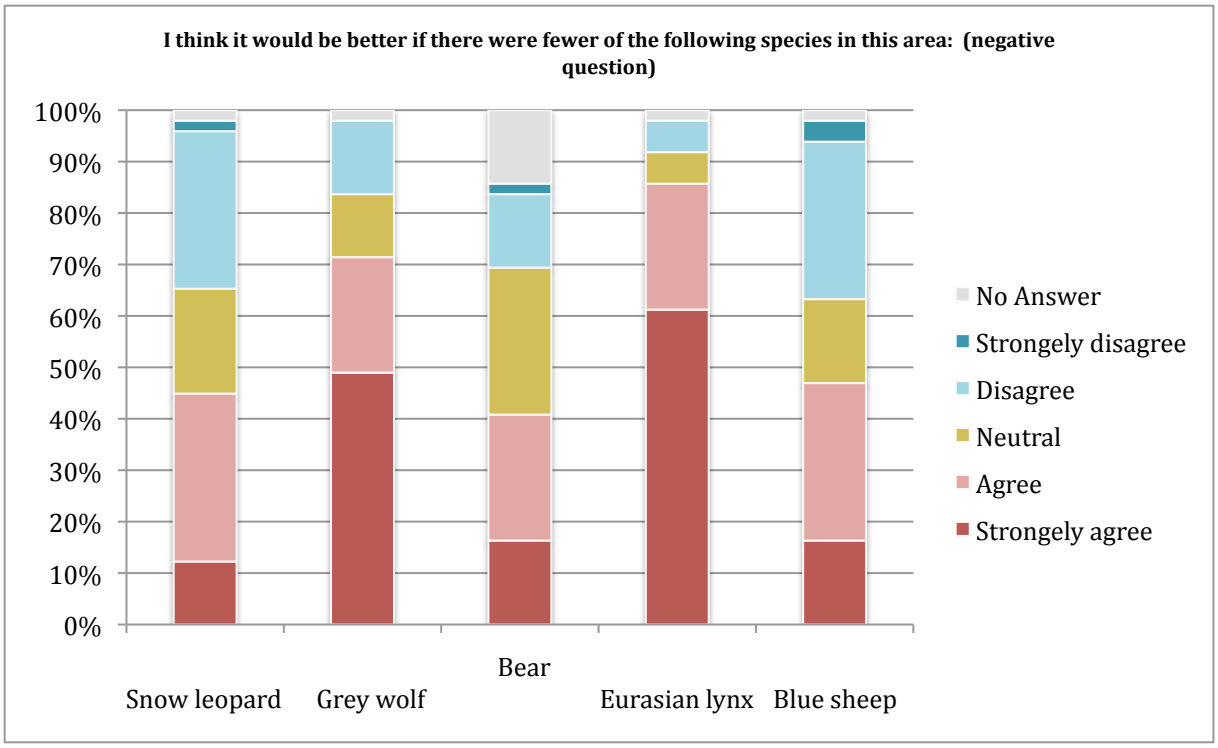

Figure 6.6a: Herder attitude relating to the need to reduce the selected species in their area (n=49)

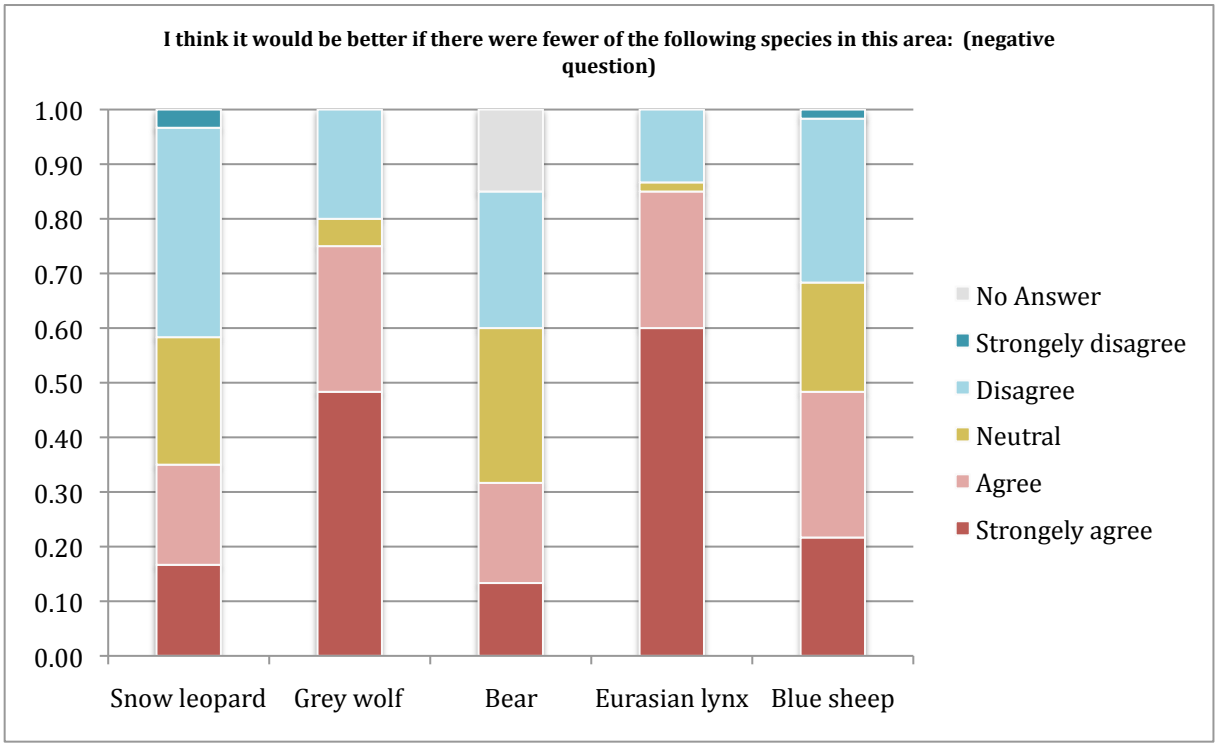

Figure 6.6b: Household attitude relating to the need to reduce the selected species in their area (n=60)

5. Discussion: Please evaluate your own work. What did you learn that could help others wishing to do similar projects? How do you see the results being applied to conservation? What additional work is now needed based on your findings?

1. **Impact of development activities**

The study results suggest that development activities have not made significant impact on herding livestock practices and wildlife. Small-scale development activities were identified within each village and their surrounding areas. These do not seem to have led to significant changes in the socio-economic status of herders over the last few years. No increased income or influx of migrant workers was reported. Herders indicated that they have derived only indirect benefits from, for example, the construction of roads. Household survey findings highlight the continuing importance of herding as a primary livelihood strategy, even though there are suggestions that herding is less common than before. Local policies regulating livestock use and wider economic factors seem to be the key factors driving changes in herding activities. In particular, outmigration to urban areas to seek alternative income provides an important explanation for the reported decrease in herding activity.

Households expressed concerns about negative impacts on herding and wildlife, related to informal mining activities in three of the seven study villages, where extraction of rare metals and coal was reported. Information remains scarce regarding the impact of such mining activities. In the past few decades deposits of various mineral resources have been discovered throughout the Tibetan Plateau and it is believed that the area still has many untapped resources (Huang, Sillanpää, Gjessing, Peräniemi, & Vogt, 2010; Zheng, Duo-Ji, Cheng, Gao, & Dai, 2007). Mining activities have been associated with severe environmental impacts, largely due to inadequate planning and management practices (Huang, Sillanpää, Gjessing, Peräniemi, & Vogt, 2010). The effects of such development within high altitudes ecosystems on snow leopard populations remains understudied. There is, however, evidence from studies of other carnivores that disturbances such as the construction of roads and the expansion of agricultural areas can modify mortality risk, habitat utilization, and species dispersal (Thurber & al., 1994; Cushman & Lewis, 2010; Kerley et al., 2002).

2. **Livestock depredation**

A large proportion of the herding population reported livestock depredation, which was described as a major economic burden. The perceived severity of livestock depredation did not differ across villages, gender and educational level. Older herders, aged older then 60 years old, however did report less livestock loss. As found in other studies, snow leopards were reported to be responsible for a low percentage of all livestock losses (2%) (See Li, Yin, Wang, Jiagong, & Lu, 2013) and only 10% of herder households reported livestock losses to snow leopards. Snow leopards were said to prey on both yaks and small stock.

The Eurasian lynx was reported to be the most important predator of livestock, in terms of livestock losses and proportion of households affected. By contrast, other studies have reported very low levels of livestock depredation by Eurasian lynx within the snow leopard range. For instance, the Eurasian lynx were responsible for 1% of total livestock

loss in Qinghai Province, China (Li, Yin, Wang, Jiagong, & Lu, 2013)) and 2% in Ladakh, India (Namgail, Fox, Veer, Snow, & Wolf, 2007). Within QNNR Eurasian lynx were said to kill more small stock during each incident and were most frequently detected, both directly and indirectly, by herders in all villages. The detection rate of lynx was more than four times higher than that of snow leopards. Sheep and goats were major victims of predation, probably because the primary predators responsible were lynx.

The grey wolf was also reported to prey on small stock, although it was not given the same importance as the lynx in terms of overall depredation and number of households affected. Wolves may be associated with a smaller impact because of their lower densities in the region, as they were reported to have been largely decimated during the 1980s as a result of hunting activities. However their numbers may be increasing again as hunting activities have been banned since the Wildlife Protection Law was enacted in 1988 and there are current strict limits on personal firearm possession. Research is currently underway in order to assess carnivore distributions and population densities in the region and will be used to assess relative differences between species and changes in predator numbers.

It should be recognized that some predation claims maybe erroneous and are difficult to validate, despite our best efforts to obtain detailed information concerning each depredation event (Mishra, 1997). For example herders may attribute livestock mortality to a predator when death was actually related to another cause such as a disease and the carcass was later scavenged by a predator (Oli, Taylor, & Rogers, 1994). Nonetheless this study highlights the existence of important conflicts between herders and carnivores in the region, even though natural disasters and disease were responsible for the largest proportion of livestock mortality.

3. Community attitudes towards snow leopards

Herders and household members generally had positive attitudes towards snow leopards. This was true across the seven villages and individuals of different genders, ages and educational levels. Snow leopards were considered to be generally discreet and harmless. Such positive attitudes bode well for enlisting the support of local herders in future snow leopard conservation and research efforts. On the other hand, herders voiced strong negative views about Eurasian lynxes and grey wolves. This is probably because these species are more common in the area and reportedly responsible for a higher rate of livestock depredation (Suryawanshi, Bhatnagar, Redpath, & Mishra, 2013). It has also been suggested that the behaviors of wolves, including greater visibility and howling, may heighten the perception of risk they pose and produce greater negative attitudes towards them (Kellert, Black, Rush, & Bath, 1996). It is possible that herders actively persecute wolves and Eurasian lynx through poisoning, trapping or shooting. Our data indicate that herders recommend such measures in order to reduce livestock losses, though we have no direct evidence for such persecution.

The current situation is influenced by many factors and could change rapidly. Even though the majority of respondents supported protection measures for snow leopards, 84% of herders expressed the concern that snow leopards are dangerous for livestock. If in the future snow leopards were to depredate higher numbers of livestock, attitudes

towards them might change, resulting in retaliatory killing. A recent study suggests that increases in wild prey may lead to an increase in livestock uptake by snow leopards (Suryawanshi et al., 2013). This is of particular concern in QNNR as the grazing ban policy already in place will most likely result in an increase in the abundance of wild prey and ultimately lead to an increase in depredation.

Another issue is that herders hold negative attitudes towards blue sheep, the main natural prey of snow leopards in the region. 27% of herders regarded blue sheep as a competitor to livestock and 46% wished that their numbers would come down. This is probably because they consider that blue sheep increase the pressure on vegetation quality in the area.

4. Implications for conservation policies and practices and

Poor understanding of the ecological and social issues underpinning human- carnivore conflicts often constrains the formulation of effective conservation management strategies (Bagchi & Mishra, 2006). Through this project we have initiated the process of investigating the complex interactions between development activities, changing demographics, and attitudes towards snow leopards and livestock depredation in China, to better inform policies and practices. From this preliminary assessment, it appears that a combination of measures, including a reassessment of the current grazing ban, carefully designed financial compensation measures, improved husbandry practices and education activities may be useful to reduce livestock losses and the associated economic burden on local communities and improve attitudes towards wildlife.

The design of the compensation scheme should be underpinned by context-specific information, as could be obtained through the quantification of the economic impact of the predation losses within the area and an assessment of the role of direct payments in relieving this impact (Mishra et al., 2003). Such information is required to estimate the resources required to design and sustain compensation measures. Our preliminary findings suggest that a compensation scheme that involves timely financial replacement of livestock lost may serve to change herder attitudes towards predators and build trust and confidence in wildlife managers.

Improved husbandry practices may also help to reduce the economic burden of livestock losses. For example, as recommended by herders, improved physical barriers between carnivores and livestock may be useful, as brought about by the introduction of sheltered night corrals in grazing areas. In addition more effective guarding of livestock in grazing areas, using feral dogs, may prove effective. These efforts should be complemented by measures to reduce livestock losses to disease and natural disasters.

In parallel with the above, educational programs in support of snow leopard protection should be implemented. Such education programs need to underline the importance of wild prey for snow leopards in order to help improve herder attitudes towards wild ungulates in the area.

Systematic enquiries, such as those used in this project, are helpful not only to check assumptions about community beliefs and attitudes towards wildlife conservation but also to provide evidence to policy makers and inform conservation measures. Our ongoing

ecological research will provide complementary information, including data on wild ungulate abundance and vegetation composition, together with data on the carnivore occurrence, habitat use, distribution and diet in QNNR and elsewhere in China. More targeted research, however, is needed to better understand the impact of development activities and disturbances on snow leopards and their prey. Such research should assess their effects at the landscape scale to inform recommendations that protect snow leopards and provide for the needs of local people. It is important to secure community support for research and conservation initiatives however by working through local authorities and/or trusted members of the community, as sensitive issues are being addressed. In our case, researchers were external to the area, but worked in close collaboration with the local wildlife authorities.

Bibliography

Bagchi, S., & Mishra, C. (2006). Living with large carnivores : predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology*.

Cushman, S. a., & Lewis, J. S. (2010). Movement behavior explains genetic differentiation in American black bears. *Landscape Ecology*, *25*(10), 1613–1625.

Huang, X., Sillanpää, M., Gjessing, E. T., Peräniemi, S., & Vogt, R. D. (2010). Science of the Total Environment Environmental impact of mining activities on the surface water quality in Tibet : Gyama valley. *The Science of the Total Environment*.

Kellert, S. R., Black, M., Rush, C. R., & Bath, A. J. (1996). Human Culture and Large Carnivore Conservation in North America. *Conservation Biology*, *10*(4), 977–990.

Kerley, L. L., Goodrich, J. M., Miquelle, D. G., Smirnov, E. N., Quigley, H. B., & Hornocker, M. G. (2002). Effects of Roads and Human Disturbance on Amur Tigers. *Conservation Biology*, *16*(1), 97–108.

Li, J., Yin, H., Wang, D., Jiagong, Z., & Lu, Z. (2013). Human-snow leopard conflicts in the Sanjiangyuan Region of the Tibetan Plateau. *Biological Conservation*, *166*, 118–123.

Mccarthy, T. M., & Chapron, G. (2003). *Snow leopard survival strategy*. Seattle, Washington, USA: International Snow Leopard Trust and Snow Leopard Network.

Mishra, C. (1997). Livestock depredation by large carnivores in the Indian trans-Himalaya :, *24*(4), 338–343.

Mishra, C., Allen, P., McCarthy, T., Madhusudan, M. D., Bayarjargal, A., & Prins, H. H. T. (2003). The Role of Incentive Programs in Conserving the Snow Leopard. *Conservation Biology*, *17*(6), 1512–1520.

Namgail, T., Fox, Æ. J. L., Veer, Æ. Y., Snow, L. Á., & Wolf, Á. T. Á. (2007). Carnivore-Caused Livestock Mortality in Trans-Himalaya, 490–496.

Oli, M. K., Taylor, I. R., & Rogers, M. E. (1994). Snow leopard Panthera uncia predation of livestock: An assessment of local perceptions in the Annapurna Conservation Area, Nepal. *Biological Conservation*, *68*(1), 63–68.

Suryawanshi, K. R., Bhatnagar, Y. V., Redpath, S., & Mishra, C. (2013). People, predators and perceptions: patterns of livestock depredation by snow leopards and wolves. (N. Pettorelli, Ed.) *Journal of Applied Ecology*, *50*(3), 550–560.

Thurber, J. M., Peterson, R. O., Drummer, T. D., & Thomasma, S. A. (1994). Gray wolf response to refuge boundaries and roads in Alaska. *Wildlife Society Bulletin, 22*, 61–68.

Zheng, Y.Y., Duo-Ji, Cheng, S.B., Gao, S.B., Dai, F.H. (2007). Progress in porphyry copper exploration from the Gangdise belt, Tibet, China. *Front Earth Sci China, 1*(2), 226–32.

6. Photographs: If you have good photographic (preferably digital) images of your project that we could use to advertise the Grants Program, please submit them at this time. Please be sure to include a brief description of the photo and provide the credits for the photographer.

4 digital photos were attached to the email of submission. All Photos were taken by Justine Shanti Alexander.
Photo descriptions:

Photo 1: A yak grazing within QNNR.

Photo 2: A blue sheep within QNNR.

Photo 3: The summer months within QNNR.

Photo 4: Discussions with key informants in QNNR.

If you have any questions on the format or other aspects of your final report, please contact us at grants@snowleopardnetwork.org.

Final reports and digital images should be emailed to grants@snowleopardnetwork.org.