

*Snow Leopard Survey of Taxkurgan Nature Reserve 2009*  
**Report to Snow Leopard Conservation Grants Program**

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## 1. Summary

Snow leopards occur in vanishingly low numbers in the mountains of Central Asia. Much of their existing and probable former range lies within China. Of the estimated total population of approximately 6,000 individuals, more than half are likely to occur in China. The importance of China for the conservation of this endangered big cat is therefore paramount.

The scale and pace of economic development in China during recent decades is unprecedented. Amidst this change, biodiversity conservation efforts have often foundered. Despite a rapid rise in the number of protected areas in China, there is inadequate capacity to effectively monitor and manage these areas. For many threatened species, such as snow leopard, current population estimates are based on outdated surveys, which urgently need revision. In this project we have resurveyed the Taxkurgan nature reserve in the far west of Xinjiang Uygur Autonomous Region, where the population has not been assessed for approaching 25 years. In addition, we carried out surveys in the southern part of the reserve, near the Shaksgam Valley at the foot of K2. Wildlife populations in this area have not been assessed since the cursory observations made during expeditions in the early 1900s.

In previous earlier summer surveys carried out by our team in the vicinity of Mariang, we found evidence of snow leopard, though none was recent. We hypothesised that snow leopard were only able to use these part of their range during winter, when livestock were brought down to the communities from the high elevation areas (Shi, Fude et al. 2009). Summer livestock pressure also appeared to move wildlife prey species to higher areas, providing a potential mechanism influencing snow leopard, in addition to direct human interference.

Our winter surveys presented here appear to confirm our hypotheses, and we were able to obtain direct photographic evidence of snow leopard around Mariang using remote camera traps. Furthermore, recent snow leopard sign were also found at higher density, compared with summer.

Our surveys in the more remote southern part of Taxkurgan Reserve did not reveal conclusive evidence of snow leopard presence. This was despite apparently healthy wild ungulate populations and very low livestock intensity and low levels of human activity in general. In the south of the reserve there was sign of other mammalian predators, particularly wolf, with sign occurrence rates being relatively high. Local communities also consistently reported wolf predation as the principal cause of livestock loss to wildlife, with predation by snow leopard not being raised as a concern.

In addition to field surveys, we also provided training for local wildlife support staff within the reserve and identified and trained members of local communities to act as parabiologists within the region. We were delighted with progress on this front and have two parabiologists from this project working in the reserve, observing and recording basic wildlife information. We are also pleased with the development of the reserve staff and their dedication. The key staff are now better able to collate and assess the information being collected from the field. We still see further opportunities to develop the capacity within the reserve, but we regard this as a good start. As a result of these capacity building activities and our broader involvement with the communities within Taxkurgan, we are delighted to have secured funding from the UK Government Darwin Initiative. This three-year project will develop a network for cat conservation in China to provide training to protected area staff throughout China to build capacity for cat monitoring and conservation. Xinjiang will remain a significant centre within this project and we will seek to further develop our approach in this region and elsewhere.

Our next steps in Xinjiang are to develop further permanent transects across to establish a robust baseline from which future trends can be assessed. This will be in close collaboration with the local reserve team and communities and we see their development as vital to maintaining and improving biodiversity conservation in this region. More widely, we are assessing snow leopard populations in other marginal regions of China, such as the eastern Qinghai-Tibetan Plateau to determine range status and enable action on any evidence of shrinkage. We will continue to liaise closely and develop partnerships with other organisations concerned with snow leopard in China and in other range countries.

## 2. Introduction and Objectives

China holds possibly the greatest proportion of the world's snow leopard population of any single country. This endangered species (IUCN 2008), occupies the mountains of Central Asia, occurring within 12 countries. The area of good quality suitable habitat for snow leopards in China is estimated at nearly 300,000km<sup>2</sup> (McCarthy and Chapron 2003), more than half that available across their entire range. The scale and diversity of the country's ecosystems and human infrastructure present great challenges and also potential opportunities to engage the Chinese public with conservation issues at a critical time in the country's development.

The Pamir Mountains range across Tajikistan, Kyrgyzstan, Afghanistan, Pakistan and China, forming a hub with the Karakorum Mountains connecting the remaining major mountain ranges of Central Asia. The connectivity of these mountain ranges may be critical for the long-term survival of snow leopards. In China, these mountains are situated in the province of Xinjiang in the northwest of the country. The Taxkurgan Reserve was established in 1984 in west Xinjiang and lies along the border with Afghanistan and Pakistan. On the Pakistan border the reserve is positioned adjacent to the Karakorum National Park and there is a long term goal to promote transboundary conservation in this area for the benefit of endangered species such as snow leopard and Marco Polo sheep (Schaller and Kang 2008). The importance of this region is further highlighted by its position at the junction of two designated biodiversity hotspot areas: the Mountains of Central Asian and the Himalaya (Conservation International 2007). In both hotspot areas the significance of these high mountain environments for biodiversity conservation and their fragility are common themes.

Taxkurgan Nature Reserve was surveyed for snow leopard in the 1980s, at which point few snow leopard sign were apparent across the wider area. The exception was the area in the vicinity of the Mariang community, where the population of snow leopards was estimated to be between 50 and 75 (Schaller, Li et al. 1987). In more than two decades since these initial surveys, social and economic situation within China has changed markedly (Brandt and Rawski 2008) and the status of snow leopards in this area has remained uncertain amidst this change. We therefore deem it essential, for the development of conservation for this region, that evidence be gathered urgently to determine if former potential snow leopard hotspots are still viable. Here our objective is to follow up surveys carried out in 2008 by the Wildlife Conservation Research Unit (WildCRU) at the University of Oxford, the Wildlife Institute at Beijing Forestry University and the Xinjiang Forestry Administration (Shi, Fude et al. 2009; Riordan, Shi et al. submitted). Evidence from these surveys indicated that snow leopards might still occur in the vicinity of Mariang and other communities in Taxkurgan NR after a period of 23 years, although their distributions may be seasonally skewed by human activity, principally grazing. Other wildlife surveys have been carried out in Taxkurgan NR, including Marco Polo sheep (*Ovis ammon polii*) (Schaller and Kang 2008). Snow leopard surveys have been carried out in the neighbouring areas of Pakistan along with surveys for other wildlife (Gaines 2001; Hussain 2003; Dagleish, Ali et al. 2007).

In addition, we aim to determine the current status of snow leopards in formerly unsurveyed areas in the south of Taxkurgan NR. The northern and western regions of Taxkurgan have had human connections for centuries, along the former Silk Road. The southern part of the reserve however remains relatively inaccessible, with few survey attempts since the early 1900s (Younghusband 1904; Shipton, Auden et al. 1938) and much of it remaining unsurveyed for wildlife.

Conservation action for snow leopard in China is of vital importance and legal protections exist through the Endangered Species Legislative Act (2001). Population assessments of snow leopard in China have been made on the basis of the area of suitable habitat and estimates of population density from other parts of the species range (McCarthy and Chapron 2003). Surveys such as ours and others (Xu, Jiang et al. 2008) are a critical step towards devising conservation planning for the snow leopard in China.

Arising from this background, the principal aims of our study were:

- To establish the presence of snow leopard, other carnivores and key prey species in south Taxkurgan Reserve, Xinjiang Province, China

- To derive initial estimates of snow leopard relative population abundance and that of key prey species in Mariang during winter
- To determine winter habitat and physical conditions predicting species presence (and abundance where possible) and the position of territorial marking by snow leopard and other carnivores in this region
- To provide training to local wildlife support teams in survey techniques, data collection and storage, and basic practical data analyses for effective reserve management
- To initiate a monitoring network for snow leopard and other wildlife in Taxkurgan using people we will train from within local communities (“parabiologists”)

### 3. Methods

This survey was focused in two areas in the Taxkurgan region (fig. 1): Mariang community (75° 43'E 37° 21'N), within the Taxkurgan Nature Reserve, where we conducted preliminary surveys in 2008 (Shi, Fude et al. 2009; Riordan, Shi et al. submitted); and Shaksgam Valley region in the south of Taxkurgan NR, where no surveys have taken place. Surveys in the Shaksgam area were limited due to the proximity to the international border. Our surveys were ultimately based near to the community of Mazar (77° 01'E 36° 27'N), in the southeast of Taxkurgan NR and Kude community (76° 59'E 36° 49'N) outside of the reserve. It should be noted that the position of the Mazar community we report on here differs to that of Schaller et al (1988), where they surveyed in the vicinity of a “breeding farm” named Mazar.

Snow leopard and other species presence were determined based on sign surveys and direct counts, where possible. Transects were established for ungulates and other snow leopard prey species. Distance sampling techniques (Buckland 1993; Buckland 2007) were used to estimate initial population densities. Ungulate population parameters were collected from sighting of each species, including group size, sex ratios and age structures. Sign and sighting positions were incorporated into a spatial database using GIS, along with physical and habitat parameters for analysis.

In conjunction with sign surveys, passive infra-red (PIR) triggered digital camera traps (Reconyx RM45) were used to determine snow leopard and other species presence and provide preliminary estimates of relative abundance. A total of 22 cameras were placed in pairs (11 camera trap stations) in the Mariang study site for 28 days during February and March 2009. Camera trap stations were positioned on snow leopard travel routes with relatively high visitation rates determined from sign (footprints, scrapes, scent sprays and faeces). Sites with restricted movement options, where snow leopards are constrained to a particular narrow route were prioritised and cameras were placed on both sides of the anticipated travel path, to capture simultaneous photographs of either side of each animal. Individual identity of snow leopards was assessed from captured photographs and footprints at each camera traps station by analysis of unique features (Riordan 1998; Jackson, Roe et al. 2006). Camera trap locations, were determined initially based on our previous surveys (Shi, Fude et al. 2009; Riordan, Shi et al. in press). During the camera placement period, we also provided initial field-based training for the local Mariang parabiologists and reserve staff from Taxkurgan as well as team members from the Kashi office of the Forestry Administration.

The southern part of Taxkurgan NR, in the vicinity of the Shaksgam Valley region was surveyed from 21<sup>st</sup> Feb to 3<sup>rd</sup> March 2009. Camera traps were not deployed, as this was a primary snow leopard survey over a large area, carried out on foot along narrow valleys. Prey animal surveys in Shaksgam were carried out both on foot and from vehicles. Permanent transects were established within the survey area, which continue to be monitored by local members of the team.

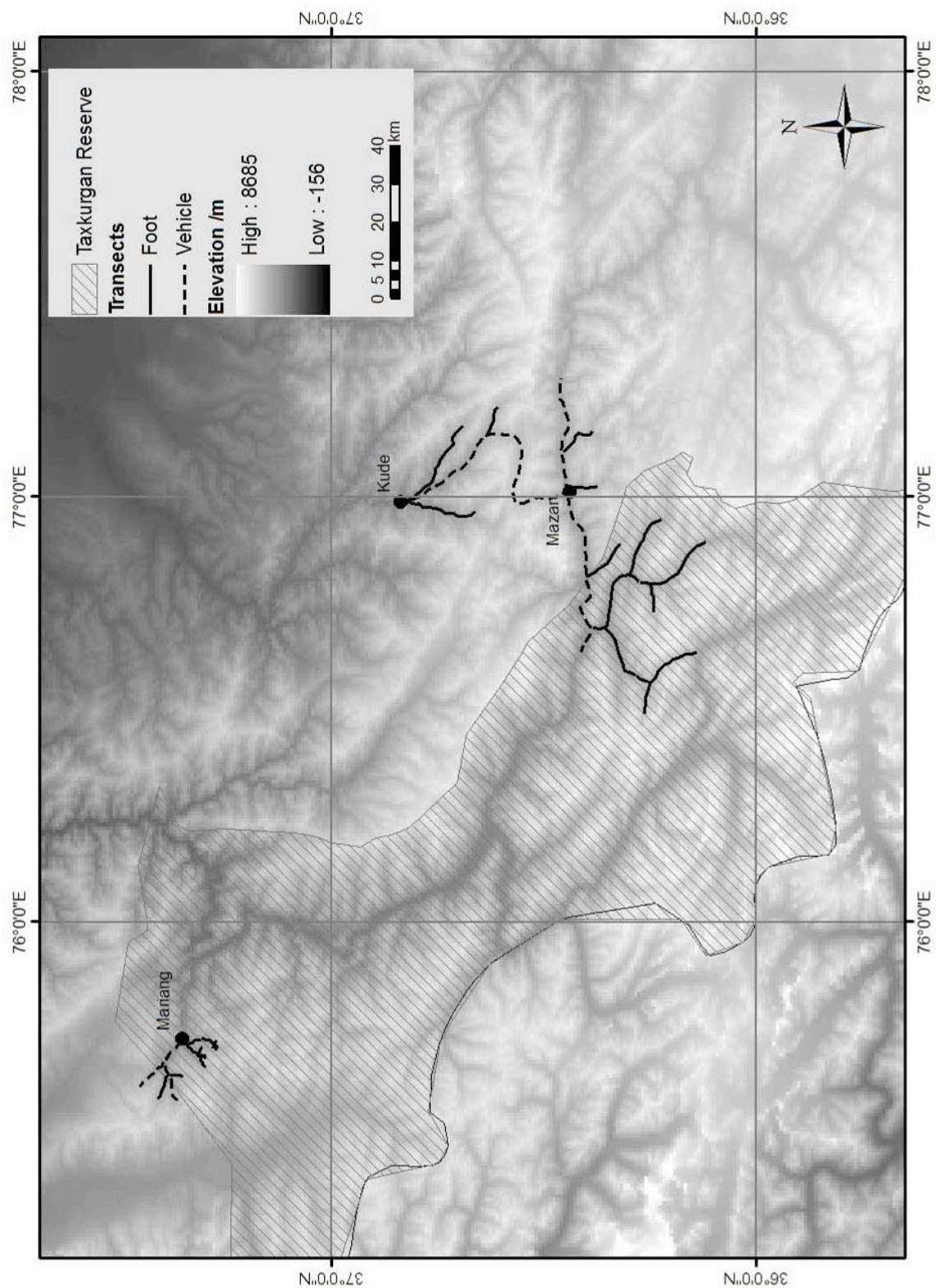


Figure 1. Transect survey positions during winter/spring 2009 within and in the vicinity of Taxkurgan Nature Reserve, Xinjiang Autonomous Region, China. Transects are shown as either from vehicles or on foot.

### Data Analysis

Distance sampling methods were used to estimate population densities of ungulates and other snow leopard prey. These methods have been successfully used in mountainous areas of China, surveying species such as blue sheep and have substantially improved on direct enumeration techniques (Liu, Wang et al. 2008). Optimum model selection was based on maximum likelihood fitting using Akaike's information criterion (AIC). Where detection functions did not permit adequate model specification, or where sampling rates were too low, direct enumeration was used. Analyses of ungulate densities were carried out using Distance software (Distance version 5: <http://www.distance.org>).

Low camera capture rates precluded the use of coat pattern analysis distinguish individual snow leopard identities from photographs. Similarly, capture rates were too low to permit population estimation using mark-recapture techniques (Carbone, Christie et al. 2001; Jackson, Roe et al. 2006).

Additive generalized linear models (GLM) were used to assess habitat predictors of species distribution and to account for difference in sign characteristics. We used the Information Theoretic (IT) approach (Burnham and Anderson 2002; Richards 2005) to compare alternative and biologically plausible models. This IT approach aspires to find the best of a suite of models, with the fewest parameters absolutely necessary (Johnson and Omland 2004; Boyce, Rushton et al. 2007). Akaike's Information Criterion, AIC (Akaike 1974), corrected for small sample sizes (AICc), was used to determine Akaike's weights of evidence for each model given the other models considered. To allow for count data, either Poisson or quasi-Poisson error terms were used in models. Predictor variables were log-transformed prior to analysis, reducing potential errors from non-normal terms. Model formation and analyses were performed using the GLM and LMER procedures in the R statistical package (R version 2.10, <http://www.r-project.org/>).

## 4. Results

A total of 24 transects (Table 1) were repeatedly surveyed for snow leopard sign and ungulate species at three locations: Mariang, Kude and Mazar (fig. 1).

Table 1. Total lengths of foot and vehicle based transects in study areas in Taxkurgan

<i>Transect Type</i>	<i>Site</i>	<i>Length (km)</i>
Foot	Kude	56.50
	Mariang	46.66
	Mazar	69.17
Vehicle	Kude	31.47
	Mariang	19.30
	Mazar	98.56

Snow leopard sign (e.g. fig 2) were encountered in both Mariang and Mazar study areas, but were absent from transects in Kude (Table 2). In total, 23 sign locations (including multiple sign at the same location) were identified in Mariang and seven in Mazar (fig. 3). Recent sign, estimated to be less than one week old, were only encountered in Mariang. All sign encounters in Mazar were estimated to have been at least several weeks old, though precise age was difficult to determine. All sign were encountered whilst on foot and the standardised number of snow leopard sign per meter along transect was significantly greater in Mariang (GLM with a quasi-Poisson error term:  $\beta = 1.51e^{-03}$ ; SE =  $5.44e^{-04}$ ;  $t = 2.78$ ;  $p = 0.014$ ).



Table 2. Frequency of snow leopard sign encounters along transects in each study location. \*9 Ibex; 1 BS

<i>Sign</i>	<i>Mariang</i>	<i>Kude</i>	<i>Mazar</i>
Faeces	17	0	1
Hair	2	0	0
Kill	10*	0	0
Prints	12	0	6
Scrape	12	0	1
Urine	3	0	0

Most transects included multiple habitats, including river valleys, rolling areas and ridgelines. River valleys were the predominant habitat type, based on distance travelled (68%), with rolling (14%) and ridgeline (18%) being approximately equal. Adjusting for relative survey effort, the positions of sign were associated with transect searches along river valleys, rather than rolling habitats or ridgelines. Along transects on which they occurred, snow leopard sign were negatively distributed with respect to human habitation in Mariang ( $t = -11.56$ ,  $df = 64$ ,  $p < 0.001$ ). Scrapes tended to be found in association with rocky outcrops or overhangs, around which fresh urine marking was encountered on three occasions. Kills made by snow leopard were exclusively found adjacent to rivers at the base of narrow scree, or talus, slopes with adjacent rock or scrub cover.



Figure 2. Snow leopard footprints left on compacted snow in the Mariang study area.

Photograph taken by Shi Kun.

Definitively attributing faecal marking to snow leopards is difficult, due to the potential likelihood of species misidentification. Of the 17 suspected snow leopard faecal samples taken, confidence in five was higher due to collocation with other more definite sign, such as footprints and scrapes. All suitable samples are being subjected to genetic analysis, which will enable definitive species identification, although the results are not available at time of writing.



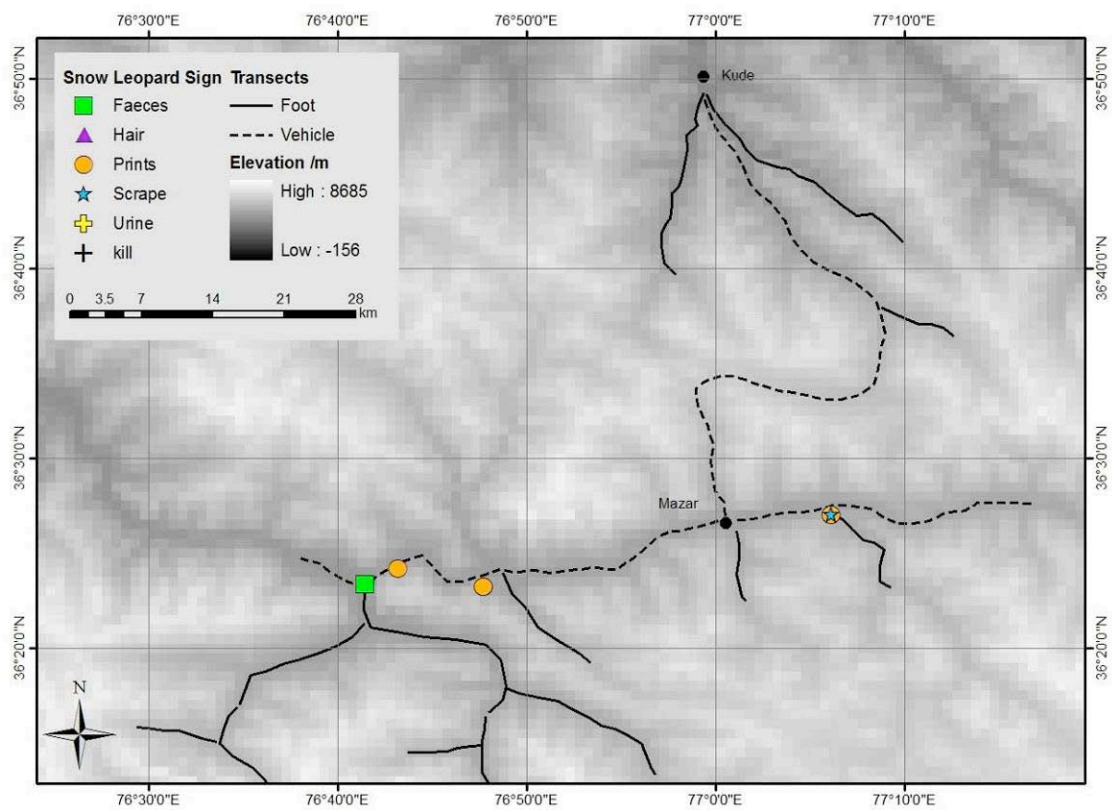


Figure 3a. Snow leopard sign locations in Kude and Mazar study areas.

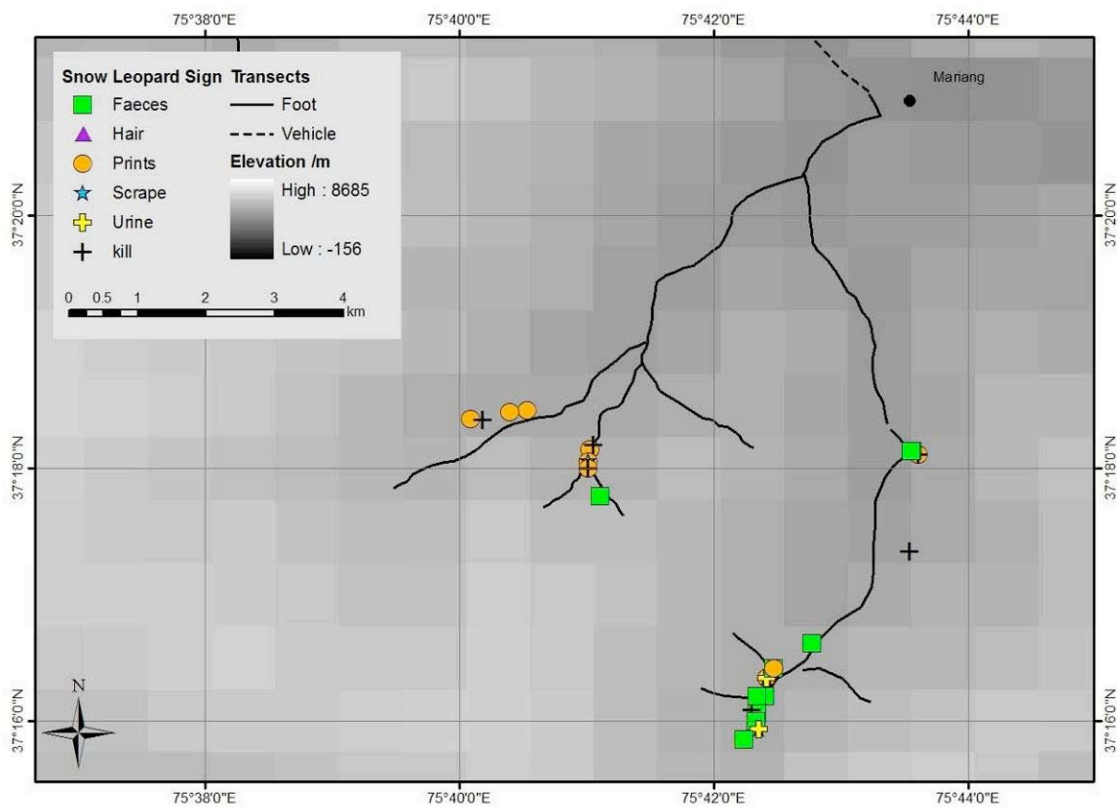


Figure 3b. Snow leopard sign locations in the Mariang study areas.

### Camera Trapping

Camera trapping stations were positioned at 14 locations across the Mariang study area. Initial positions of three camera stations were deemed suboptimal following further surveys and these were moved after a period of 10 days. Photographs of a single snow leopard (e.g. fig. 4) were captured on a one camera at station 10, which was set by one of our local parabiologists, Kometti Taklashur. The camera station was positioned at an elevation of 3,794m ( $\pm$  10.4m) along a narrow ridgeline. The animal was consistently captured face-on, on only one of the pair of cameras at the station. The photographs were taken at 03:35 hours. No further photographs of snow leopard were taken during this survey; however images of wolf, red fox and ibex were captured.



Figure 4. Snow leopard captured on camera trap set in the Mariang study area (37.272N 75.733E, elevation 3,794m). This camera station was installed by one of our parabiologists from the Mariang community, Mr Kometti Taklashur.

### Ungulate Surveys

The northeast extent of the blue sheep global range lies across Taxkurgan Nature Reserve (IUCN data). In our surveys, live blue sheep (fig 5) were only encountered in Kude and Mazar (fig. 6). Despite Mariang lying just north of the recorded range for the species, numerous blue sheep carcasses were found adjacent to rivers and one snow leopard kill was also found (Table 2). This region has been under recent observation for disease outbreaks among blue sheep, particularly following the occurrence of fatal sarcoptic mange in the neighbouring population in Pakistan (Dagleish, Ali et al. 2007).



Figure 5. Male blue sheep (*Pseudois nayaur*) in the vicinity of Kude, east of Taxkurgan Nature Reserve.

Photograph taken by Philip Riordan.



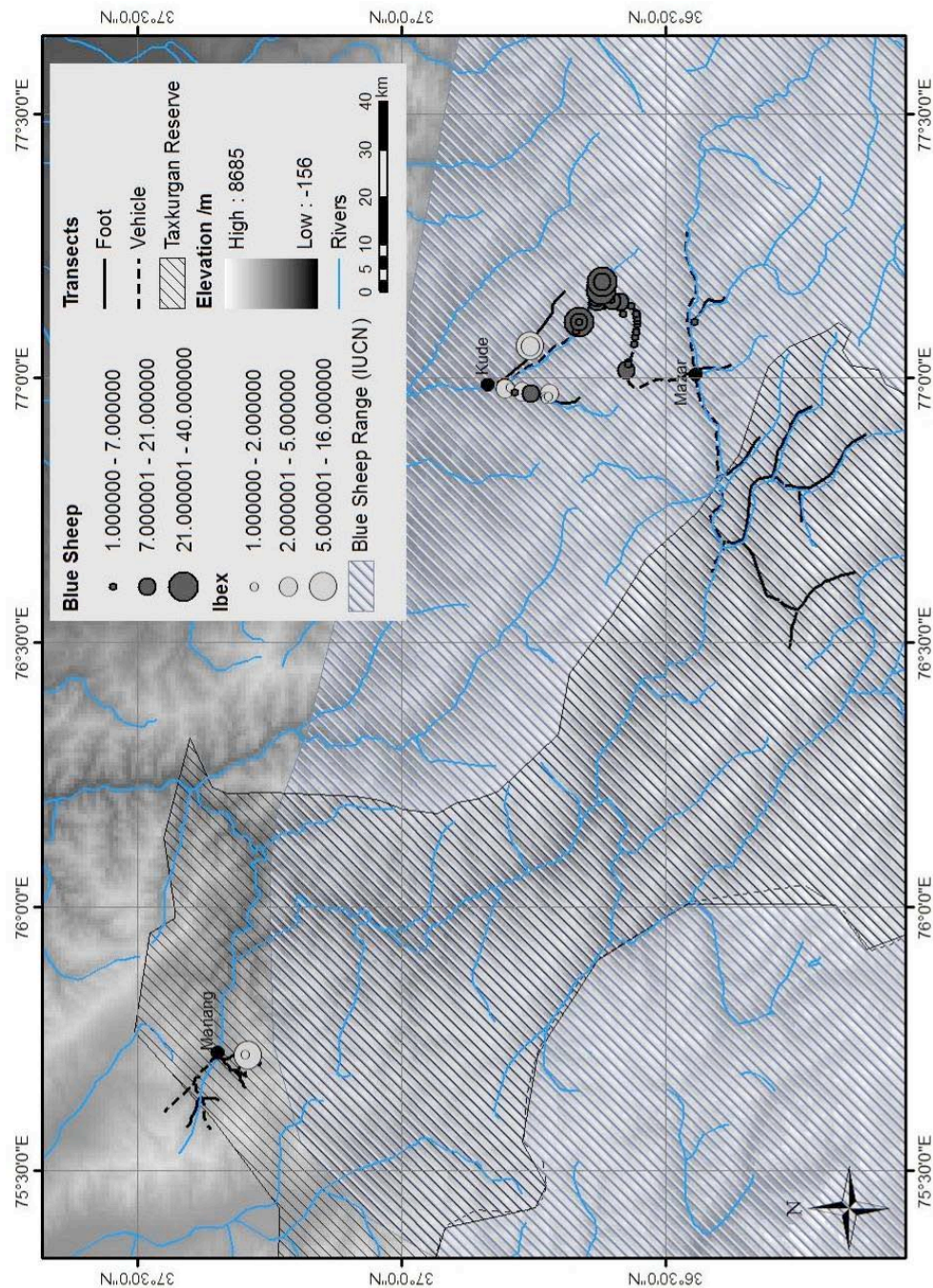


Figure 6. Sighting locations of blue sheep and ibex in Taxkurgan Nature Reserve during February and March 2009

Both the number of herds encountered and herd sizes were greater for blue sheep than for ibex (Table 3). The greatest numbers of ibex from this samples were from Kude transects, with only two herds being counted in Mariang, one of which only consisted of two animals.

Table 3. Herd counts and sizes for ungulate species encountered along transect surveys in Taxkurgan during winter 2009.

Species	Area	Total Individuals	Number of Herds	Herd Size Mean	Herd Size SD	Herd Size Range
Blue sheep	Kude	212	17	12.47	11.83	40
	Mazar	185	47	3.94	3.34	14
Ibex	Kude	32	9	3.56	2.70	10
	Mariang	17	2	8.50	10.61	16

Encounter rates for ibex were too low to generalise population density models using Distance. Detection functions derived for blue sheep differed between Kude and Mazar (fig. 7), reflecting differences in transect topographies and lower observation rates in Kude. The effective detection distances in Kude and Mazar were 1,000m and 194m respectively.

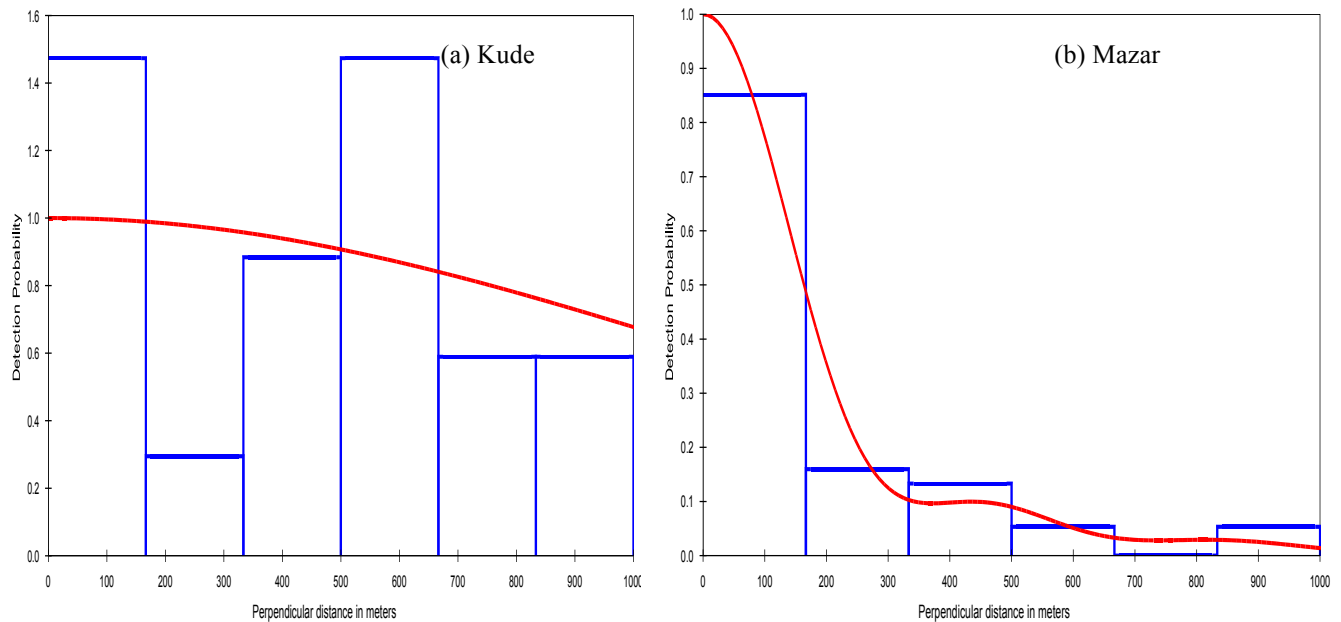


Figure 7. Distance detection functions for blue sheep

Blue sheep herd sizes were significantly greater in Kude, compared with Mazar (GLM:  $\beta_{1,63} = 8.53$ ; SE = 1.89;  $t = 4.53$ ;  $p < 0.001$ ). Herd density was estimated to be significantly greater in Mazar compared with Kude (Table 4). Individual density was also greatest in Mazar, however not significantly, based on the 95% confidence intervals (Table 4).

Table 4. Estimated blue sheep herd and individual densities (herd or animals per km<sup>2</sup>) in Kude and Mazar.

	<i>Site</i>	<i>Estimate</i>	<i>df</i>	<i>95% Confidence Interval</i>	
Herd Density	Kude	0.10	18	0.06	0.17
	Mazar	0.72	42	0.50	1.05
Individual Density	Kude	1.21	17	0.61	2.40
	Mazar	2.84	88	1.83	4.40

Blue sheep adult sex ratios within groups did not differ from unity ( $t = -0.12$ ,  $df = 13$ ,  $p = 0.910$ ), with the majority of groups consisting of both adult males and females. Herd sex ratios did not differ between sites. This contrasts with previous findings during summer, where the majority of herds were exclusively male, with few female only or nursery groups (Namgail, Fox et al. 2004). The mean number of juvenile animals per adult female was 1.3 ( $s = 1.5$ ). No infants were observed at this time of year, and the juveniles were born during 2008. Taken as a proxy for intrinsic growth rate, juvenile numbers suggests population increase rather than decline, although mortality rates are not known. Numbers of young per adult female for these populations were greater than those reported in other areas, such as Nepal (Shrestha and Wegge 2008), where fewer than one young animal was observed per adult female. In other areas, young per female are related to livestock grazing pressure (Mishra, Van Wieren et al. 2004). Our results from Kude and Mazar, where rates of livestock grazing were low, are in line with these previous findings.

### Training Local Wildlife Teams



Figure 8. Dr Philip Riordan providing GIS training in the field to Taxkurgan Reserve management staff. L-R: Dr Philip Riordan (University of Oxford); Mr Wang Qingbo (XWCA); Mr Dai Zhigong (Deputy Director Taxkurgan Nature Reserve); and Mr Xiao Hu (XFA).

Photograph taken by Shi Kun.

Field and classroom training, derived from the Diploma course run by WildCRU and the teaching programmes in Beijing Forestry University, was provided for local reserve staff in Taxkurgan, covering basic survey and monitoring techniques and principles. Class training was directed towards management staff, carried out over three days in Taxkurgan town and Kashi, covering:



- Survey design & bias
- Survey methods (Distance sampling, sign, vegetation, camera trapping)
- Basic field skills (maps, compass, note taking & recording)
- Basic data management and analysis
- Basic GIS skills

Training in the field was directed at reserve field staff and management, covering:

- Basic field skills
  - Map reading & interpretation
  - Compass use
  - GPS
  - Distance estimation
  - Note taking and data recording
- Survey methods
  - Distance sampling
  - Sign surveys
  - Vegetation surveys
  - Camera trapping

Class materials were continuously reviewed and reinforced in the field. Evening sessions were carried out during fieldwork, where training content from each day was reviewed and data were entered into databases on field laptop PCs and explored using basic statistics and GIS (e.g. fig. 8). Excel spreadsheet and ArcGIS software, licensed through BFU, were initially used to demonstrate principles and allow practise, though the high costs of licences for these products may preclude their subsequent use. Open-source software packages are currently being evaluated for this and other projects within China.



Figure 9. Field based training included the use of camera traps, in this instance Reconyx RM45 units. (L-R: Mr Kometti Taklashur; Dr Shi Kun; Mr Arimujan Dushambe; Dr Philip Riordan)

Photograph taken by Wang Jun.

## Socio-economic Surveys

In addition to the schedule of work proposed and funded, we were able to seize the opportunity to undertake socio-economic surveys. Questionnaire surveys and semi-structured interviews were carried out in villages in the southern Taxkurgan region, both inside and outside of the (unmarked) reserve boundary. Straw poll questionnaires of people in an urban area (Urumqi – capital of Xinjiang) were also conducted. In total, 107 people in 20 families were interviewed in and around southern Taxkurgan. Family structures were extended, with principally along the male line, with brothers tending to co-occur with family groups present, whereas sisters were apparently absent. However, in general conversations within the Mariang community marriage between sisters and brothers from different families were apparently common given the remoteness and limited ability to marrying outside of the community. Communities outside of the reserve, around Kude appeared to be more connected, by virtue of perennially passable roads and greater volumes of traffic than Mariang.

## Income

The Chinese government has recently set the annual per-capita income poverty line at 1,300 RMB (approximately US\$190), based on World Bank estimates based on purchasing-power parity (PPP). The UN poverty line of US\$1.25 per day, equates to an annual per capita rate of approximately 3,000 RMB; a rate recently used by Chinese Premier Wen Jibao during the 2009 Copenhagen Climate Summit (Speech to COP, December 18, 2009). Of the 20 rural families interviewed, three had incomes above the national poverty line (and only one reached the UN poverty line) with 86 people (80.4%) in 17 families existing below the poverty line (fig.10). In all but four families the principal form of income was from livestock farming. The mean per capita annual income for this community was RMB 831, which was significantly lower than the national poverty line ( $t_{19} = -3.47$ ,  $p = 0.001$ , 95% CI = RMB 1,039).

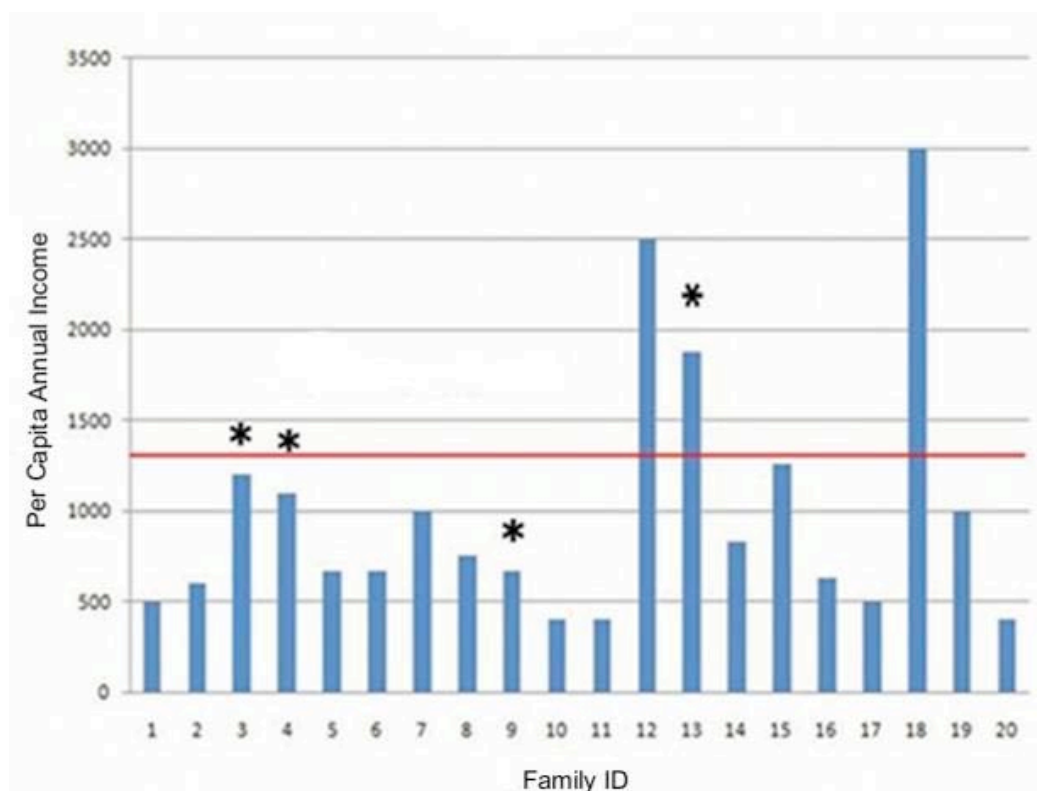


Figure 10. Per capita annual income, in Chinese RMB, for families living in the Kude / Mazar region of southern Taxkurgan. The red line shows the national poverty line (RMB 1,300) and \* indicates families for whom their principal source of income does not come from livestock farming.



### Education

Children from poor rural communities in China have been entitled to non-compulsory state-funded education to the age of 15, since 2003. The highest levels of education attained by individuals that have finished formal education, excluding the 7-15 age class (Table 5) have increased significantly in lower age classes, compared with older generations (GLM:  $\beta = -0.09$ ; SE = 1.89;  $z = -2.44$ ;  $p = 0.015$ ; AICc = 162.53).

Table 5. The highest level of school attained by people living in the Kude/Mazar region, given as numbers of people reaching each level.

Age Class (years)	Primary	Junior	High	None	Total
7-15	14	-	-	1	15
16-30	6	33	3	1	43
31-49	2	5	1	10	18
> 49	1	4	0	16	21



Figure 11. Socio-economic surveys were conducted throughout the region, with interviews often being performed ad hoc, particularly for semi-nomadic peoples. Beijing Forestry University student Yi Fang is shown here interviewing local herdsmen with the help of translators in our local team.

Photograph taken by Wang Jun.

### Attitudes to Wildlife

Families were asked to place social and economic issues in ranked order of importance to them on a scale of 1 – 5. The highest scoring concerns among families were access to electrical power and medical facilities (Table 6). Poverty in general and the degradation of grasslands were of secondary importance overall, though both still ranked highly. Poaching of wildlife and the environmental impacts of mining were of least concern. Conflict with wildlife and the depredation of livestock scored at an intermediate level. In general, attitudes towards wildlife conflict were most keenly expressed by families with greater numbers of livestock, with a positive relationship between livestock number and attitudinal score (fig. 12: multinomial GLM regression:  $R^2 = 0.49$ ,  $F_{1,14} = 13.63$ ,  $p = 0.002$ ).

Table 6. Ranked socio-economic concerns based on questionnaire responses. Members of 20 families were asked to score each issues between 1 (least concern) to 5 (most concern).

Rank Order	Socio-Economic Concerns	Mean Score
1	Lack of electricity	4.30
2	Health facilities	3.80
3	Poverty	3.50
4	Grassland degradation	3.47
5	Communication (telephone etc)	3.20
6	Human-animal conflict (e.g. livestock depredation)	2.90
7	Drinking water	2.70
8	Schools	2.65
9	Transport	2.40
10	Overgrazing (as environmental degrader)	2.30
11	Mining issues (as environmental degrader)	1.05
12	Wildlife Poaching (as detriment to wildlife)	0.37

Responses to questions were typically provided by senior men within each family. Responses from women were actively solicited in some families, which tended to be either ignored or dismissed by the men. In this case, the responses in Table 6 could be viewed as the male perspective, though it is not clear to what degree women were influencing male responses. Conversations and discussions were carried out between family members in response to interview questions, with which women were peripherally involved. Local interpreters were often unable to translate the local dialects being used, highlighting the need to improve interpretation in this area, although chains of translation may become long, leading to compounded errors.

Of the reported livestock losses attributed to wildlife between 2005 and 2008, wolf were reported as the responsible wildlife species significantly more than fox or snow leopard (quasi-poisson GLM:  $\beta = 67.76$ ; SE = 4.92;  $z = 13.77$ ;  $p < 0.001$ ). Of the three predators reported, snow leopard were deemed responsible for the fewest livestock losses (quasi-poisson GLM:  $\beta = -11.51$ ; SE = 2.08;  $z = -5.53$ ;  $p < 0.001$ ). This pattern was consistent between years (quasi-poisson GLM:  $\beta = 1.04$ ; SE = 0.67;  $z = 1.54$ ;  $p = 0.124$ ).

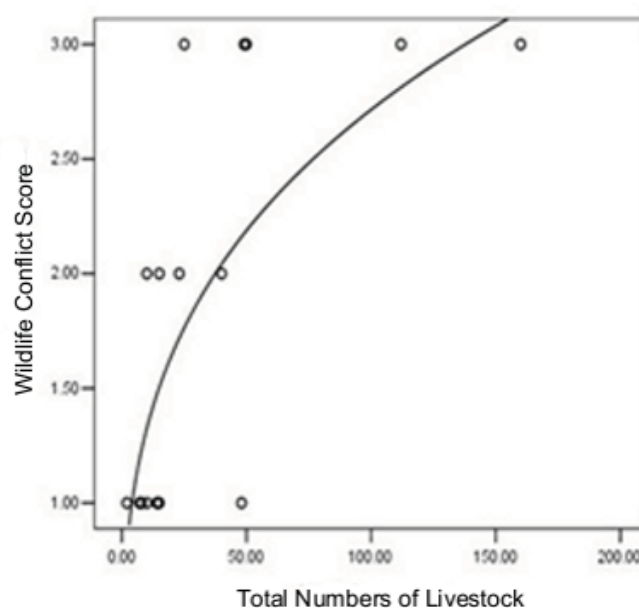


Figure 12. Attitude towards wildlife conflict with livestock against total numbers of livestock kept by 16 herding families in the Kude/Mazar region

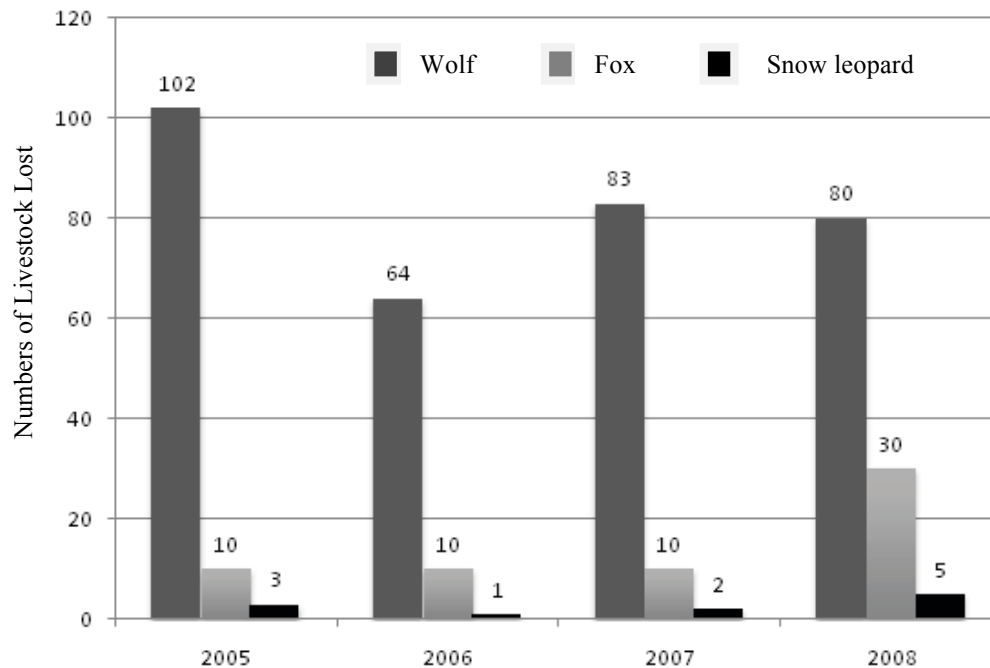


Figure 13. Total numbers of livestock reported to have been depredated by wolf, red fox and snow leopard each year between 2005 and 2008. Numbers above bars indicate the numbers of livestock taken within each case.

### Other Activities and Community Relations

During our surveys in the vicinity of Mariang, the community was of vital importance to the success of our endeavours. We are employing Mr Kometti Taklashur as a parabiologists from within the community, having provided him with training in basic wildlife survey techniques and the Deputy Director of Taxkurgan Nature Reserve, Mr Arimujan Deishambe, has been seconded to our project by the Xinjiang Forestry Administration. We employed a total of seven people as our support teams in Mariang (3 people) and Kude/Mazar (4 people), and paid other community members for transportation animals (camels, yaks, donkeys and horses) and for accommodation and subsistence.

Community relations are excellent, aided by having team members within the communities who have been used on subsequent surveys in these areas. One incident occurred where camera trap equipment was stolen from a site. In this event, the local and regional police authority was bought in by our local team immediately. Though no one was found to be guilty nor arrested, the impact of the magnitude of the response resulted in the return of the equipment on the following day. The local police officer in Mariang was satisfied with the outcome (as were we) and assured us that our equipment would be safe from now on (Riordan 2009).



Figure 14. Philip Riordan (centre) assists with the installation of hydro-electric power to Mr Kometti Taklashur's (right) house.

Photograph taken by Shi Kun.

## 5. Discussion

Snow leopard were shown to be present and active during the winter in the northern part of Taxkurgan Reserve, confirming our previous surveys in the area (Shi, Fude et al. 2009; Riordan, Shi et al. in press). In the more remote and less intensively farmed southern part of the reserve, neither recent nor conclusive snow leopard sign were encountered. The absence of snow leopard sign in the southern part of the reserve was not apparently related to prey densities. Blue sheep numbers in southern Taxkurgan were high and the population size appeared to be either stable or increasing. Wolf numbers were high and predation on blue sheep by wolf was observed. As a possibly sympatric large predator in the region, interspecific interactions may occur between wolf and snow leopard, though the magnitude and direction of any relationship is not clear. Interviews with members of local herding communities showed that snow leopard were not regarded as a significant threat to livestock. Wolf were indicated as the principal cause of wildlife conflict, although recorded figures on total livestock losses to wild predators were generally low (Shi, Fude et al. 2009; Riordan, Shi et al. in press). As opportunistic group living predators, it is possible that wolves may have a competitive advantage in areas of low human activity such as Mazar. The main valleys in the area tend to be broad, more suited to wolf hunting behaviours than snow leopards. The apparent absence of snow leopard within the higher, narrower distal valleys, where the terrain is more suited to snow leopard hunting behaviour is less clear and further consideration of connectivity with other populations would need to be taken into account.

In the Mariang region, snow leopard occurrence, as demonstrated by sign, was negatively associated with distance to human habitation. Taken in conjunction with apparent confirmation of our hypothesis regarding seasonal human interference during summer, we suggest human activity in this area is negatively impacting snow leopard numbers. At this stage it is not possible to put a precise number on the snow leopard population size in this area. However, the estimated population of 50-75 snow leopards in the Mariang area during the 1980s (Schaller 1987) has clearly declined.

Previous surveys of the northern areas of Taxkurgan in the late 1980s (Schaller 1987), found ungulate densities of up to 2.5 animals per km<sup>2</sup>. Comparable densities were not found in this study and the blue sheep population in the north of Taxkurgan appears to have collapsed, possibly due to disease. In this study, comparable densities were found only for blue sheep and only in the south of Taxkurgan. No previous estimates exist for this region, however, accounts from an expedition in the mid-1980s in the vicinity of K2 and the Aghil Pass noted only one distant sighting of blue sheep by their “camp cook” (Schaller 1987). If blue sheep occurred in similar numbers to those we found, their camp cook would have presumably noted more sightings, or not reported at all if they were common. Either way, blue sheep numbers in southern Taxkurgan appear to be increasing, offering potential rescue for the northern population if the current mange epidemic passes.

In a similar way, ibex in this area have previously been found at higher densities, whilst in this study, ibex encounter rates were too low to generalise population estimates, suggesting potential declines in this species since the 1980s. The reasons for the discrepancies between these findings and our own remain a matter of unhappy speculation. Hunting pressures prior to its ban in the 1999 may explain some differences and variation in livestock practises also offer possible explanations. Disease outbreaks in livestock and wild ungulates (e.g. foot and mouth, anthrax and sarcoptic mange) may also contribute to local declines and changes in regional distribution. However, without in-depth examination of ungulate demographic processes in relation to livestock farming, conclusive explanations remain unattainable.

We were delighted to be able to provide training to local wildlife support teams, covering aspects of survey techniques, data collection and storage, and basic practical data analyses for effective reserve management. By providing training, we have also initiated a monitoring network for snow leopard and other wildlife in Taxkurgan using people from within the local communities (“parabiologists”). Specifically, we are providing continual support for Mr Arimuja Deishambe in Taxkurgan Nature Reserve and Mr Kometti Taklashur in Mariang to collect wildlife information. These two individuals showed themselves to be both well liked and well connected within the region and we have confidence that they will be able to demonstrate positive approaches to others in the areas and foster further good relations. Quality assurance data are being recorded to assess the success of training for local field staff and their ability to carry out further independent surveys in the Taxkurgan region. We are remaining in continual contact as conditions allow and members of our team visited Xinjiang in August and December 2009 and have scheduled a visit

during April 2010. Recent difficulties in Xinjiang have made communication more problematic, but we are able to maintain effective contact by telephone and fax. We envisage further development of an efficient and mobilized network of parabiologists working within the region's communities, providing monitoring and information on snow leopards and other wildlife and maintaining a positive presence for biodiversity conservation. From our surveys of the communities in this region, we see the needs for economic development as critical for effective and sustainable biodiversity conservation. Wildlife issues and environmental concerns more generally were not ranked highly by local people, whose more immediate economic and social needs are obviously paramount in the face of the poverty in the area. We welcome the efforts by the Chinese Government to provide essential services such as education and will work with the authorities to develop further human well-being improvements that complement rather than damage natural ecosystems.

Stemming from our training and broader community activities within Taxkurgan, we are delighted to have received significant funding from the UK Government Darwin Initiative. This three-year project will develop a network for cat conservation in China to provide training to protected area staff throughout China to build capacity for cat monitoring and conservation. Xinjiang will remain a significant centre within this project and we will seek to further develop our approach in this region and elsewhere.

Our close collaborations with both the Xinjiang Forestry Authority and the State Forestry Authority are ensuring that the results of our surveys are being effectively communicated to high level government officials. Dr Shi and Dr Riordan have numerous high-level government meetings arranged during the early part of 2010 and we will continue to highlight the urgency and needs for snow leopard conservation and the support of local communities. Reports of our surveys have been submitted to Xinjiang government; the Chinese national government. Results of this work will be published in international journals and presented at international symposia.

Our next steps in Xinjiang are to develop further permanent transects across to establish a robust baseline from which future trends can be assessed. This will be in close collaboration with the local reserve team and communities and we see their development as vital to maintaining and improving biodiversity conservation in this region. More widely, we are assessing snow leopard populations in other marginal regions of China, such as the eastern Qinghai-Tibetan Plateau to determine range status and enable action on any evidence of shrinkage. We will continue to liaise closely and develop partnerships with other organisations concerned with snow leopard in China and in other range counties.

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