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Population assessment of Himalayan lynx (*Lynx lynx isabellinus*) and conflict with humans in the Hindu Kush mountain range of District Chitral, Pakistan

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Abstract

This paper is the first-ever attempt to outline the interaction of Himalayan lynx (*Lynx lynx isabellinus*) with humans and its abundance measured through motion triggered camera traps in Hindu Kush Mountain Range of District Chitral, Pakistan. The study was undertaken in December-January, 2011 for a period of 35 days with a total trap days of 770 resulting the corroboration of the sporadic occurrence of lynx with a minimum population estimate of 6 individuals. High capture rate of human and livestock (90% of the total photos) exposes the immense human induced pressure on this fragile mountain ecosystem and ascribable to the dwindling population of the species in the region. Majority of the respondents (n=166: 90%) reckoned lynx as the rare species. Human acceptance of lynx was lower owing to the predation on livestock and thus was taken more dangerous with perceived danger per respondent of 35.77%. Although protected areas provide suitable habitat for the conservation of species but the non-capture of lynx in the buffer zone highly suggestive that sound conservation measures are required to inflate the survival of the species outside the protected areas in the longer run.

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Introduction

Himalayan lynx (*Lynx lynx isabellinus)* is one of the nine subspecies of the Eurasian lynx (*Lynx lynx*) distributed widely across the central and south Asia. Remaining eight subspecies are distributed from Western Europe through the boreal forests of Russia (Sunquist and Sunquist, 2002). Populations in the south and southwest of its range (Europe and southwest Asia) are generally small and isolated, whereas the bulk of its historic range from Scandinavia through Russia and Central Asia is largely intact (Breitenmoser *et al*., 2008). Lynx is a forest associated species in Europe and Siberia, but in Asia it occurs in more open, thin wooded and alpine habitats (Nowell and Jackson, 1996). Lynx in Central and South Asia is believed to occur throughout the northern slopes of the Himalaya (Nowell and Jackson, 1996) and most parts of the Hindu Kush (Din and Nawaz, 2010). In Central Asia, lynx is native to the Chinese provinces of Gansu, Qinghai, Sichuan and Shaanxi, as well as to Mongolia, Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan, Tajikistan and Northern Pakistan (Roberts, 1997).

In Pakistan, anecdotal reports of lynx occurrence come from Chitral, Gilgit-Baltistan, and Azad Jamu and Kashmir, respectively. Based on these reports the species was listed as least concern (Sheikh and Molur, 2004). However, this assessment is based on sparse information leading Sheikh and Molur (2004) to conclude that proper and robust scientific studies should be initiated to update the red list status of Pakistan's mammals in the longer run. The only published data on Himalayan lynx available so far from Pakistan is the study undertaken by Din and Ali (2010) in District Chitral in 2010. Besides debating on the human-lynx conflict, the study revealed the occurrence of lynx in different parts of the district and recommended for further robust studies to reckon the status of the species based on population estimation. This study was aimed to serve two major objectives including assessment of the population of Himalayan lynx through questionnaire surveys and then confirmation of the data through systematic camera trapping study and secondly reckon intensity of the of human-lynx conflict in the study site. Following the guidelines developed by Breitenmoser *et al.* (2006), we firstly collected chance observations (sightings, tracks, killed wildlife and livestock) and assessed potential conflicts with lynx through questionnaire survey. Secondly, we conducted a pilot camera trapping study (Sliver, 2004; Jackson *et al*., 2005) in the most promising areas driven from the results of the questionnaire surveys to assess the population of Himalayan lynx and test the suitability of the technology for conducting similar studies covering larger landscape in future.

Materials and methods

Study Area

Chitral is Pakistan's northern-most district, situated just across the border from Afghanistan. It is surrounded by some of the tallest mountains in the world. On the north-west it is bounded by the Hindu Kush, on the north-east by the Pamir and on the south by the Hindu Raj Mountain Range. With more than 40 peaks over 6,100 m packed in an area of 14,850 km^2, altitudes in this rugged terrain range from 1,094 m at Arandu to 7,726 m at Tirichmir. Land access beyond the valley is restricted to a few passes, all situated above 3,500 m. The percentage area covered by glacier, snow-clad mountains, bare rock and barren ground is 28.5%, pastures with sparse vegetation covered 62% and dry temperate forest 4.7% of the district surface of which 35.7% are suitable for commercial harvesting (NWFP and IUCN Pakistan, 2004).

Since, Chitral is surrounded by mountains; it does not receive the monsoon rains. Mean rainfall in Drosh and Chitral towns is approximately 650 mm and 500 mm, respectively, occurring mainly in the spring and winter. Summer and autumn are dry, with the area receiving barely 10–25 mm of rain per month. In high latitude valleys, annual precipitation is as low as 200 mm, received mostly as snow (NWFP and IUCN Pakistan, 2004).

Despite widespread conservation issues, the remote mountain valleys of Chitral are home to a wide variety of wildlife (NWFP and IUCN Pakistan, 2004). Fauna of Chitral has affinities to Palearctic Faunal Region with only a slight oriental mix from the south. Dry and arid temperate climate has been compensated for its species richness by great altitudinal variation. The migratory corridor status of the valley has contributed further to seasonally rich biodiversity of the district.

People are generally poor and the major sources of income include livestock rearing and subsistence farming. The boulder strewn meadows are used as grazing lands. Thus the socio-economic factor coupled with ethnical, cultural, traditional, and religious factors have a direct bearing on the mountain ecology (Din and Nawaz, 2010).

Having reviewed the conflict survey data i.e. recent reports of lynx occurrence based on sightings, predation (livestock killed by lynx, wild prey remains), and tracks, respectively, we opted for a study area of about 1,272 km² covering significant portion of the protected area (PA) network of the District Chitral to conduct our pilot camera-trapping study for subsequent lynx population size estimate by means of capture-recapture analyses. Our study area fall in the protected area network including Chitral Gol National Park and its buffer zone, Tooshi Game Reserve and its surrounding community managed conservation area, Golain Game Reserve, periphery of Arkari Game Reserve, and Murdan community managed conservation area and its surroundings, respectively. The national park and the two game reserve areas fall in subalpine zones with mix forest dominated by Oak (*Quercus ilex*), pine (*Pinus spp.*), deodar (*Cedrus deodara*), and juniper (*Juniperus macrapoda*), while the rest of the study area consist mostly of alpine zone and meadows (Fig. 1).

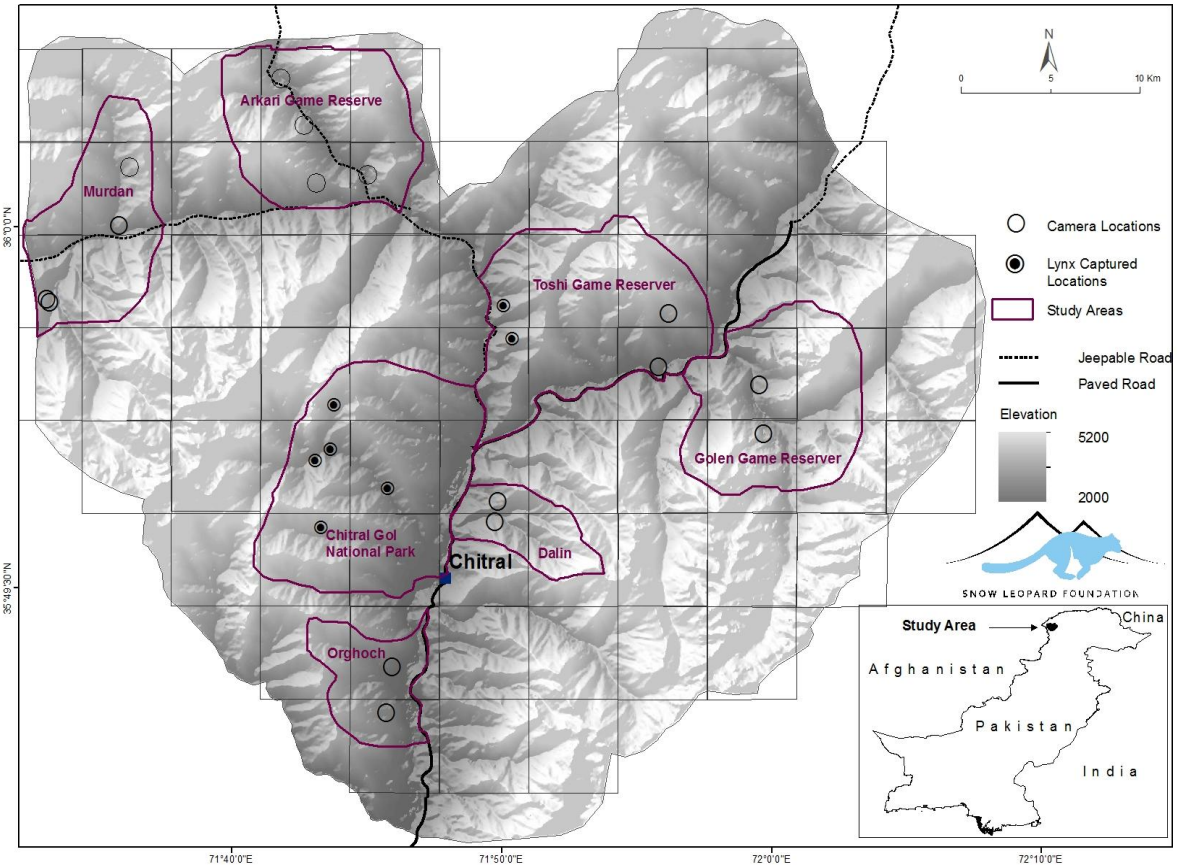

Fig. 1. Map of the study site showing camera locations (white dots) and lynx detections (white dots with black dots).

Methods

Assessment of Human-Lynx Interaction

We tried to link local wisdom with science for information extraction on the status of Himalayan lynx, its interaction with humans, and identification of potential sites for camera trapping through questionnaire surveys. Questionnaires are useful for reckoning human behavior, for example perceptions, attitudes and or level of tolerance towards wildlife management tools and strategies (Jim and Xu, 2002; Obiri and Lawes, 2002; Bouton and Frederick, 2003; White *et al.*, 2003). A very carefully designed questionnaire covering the required aspects of the study i.e. household demographics, source of livelihoods, pastoralism practices, predation, perceived problem animals, economic losses, attitude, and tolerance towards predators was used. The potential informants addressed included herders, hunters, village/valley conservation committee members, and wildlife guards, respectively. One adult person from each household was interviewed and overall about10% of the total households in each locality was accessed. Utmost care was taken to avoid assigning depredation cases mistakenly either to snow leopard, wolf, or lynx (Bagchi and Mishra, 2006; Namgail *et al.*, 2007). However, to minimize the likelihood of receiving inaccurate information, relevant Protected Area staffs, agriculture and livestock department officials were inquired about the key statistics.

Lynx camera-trapping pilot study

Since its development in the early 1980s, the use of camera traps to study population size of species with distinctive natural marks has become an important tool for monitoring rare and cryptic species in a wide range of environments (Karanth and Nichols, 1998; Carbone *et al.*, 2001).This methodology has been applied to a range of species such as Striped Hyena (Gupta *et al.*, 2009), manned wolf (Jacomo *et al*, 2004), arboreal mammals (Oliveira-Santos *et al.*, 2008),and, in particular, large cats with individual distinctive coat patterns (Jackson *et al.*, 2006; Karanth and Nichols, 1998; Larrucea *et al.*, 2007). For Eurasian lynx it has been successfully applied to estimate abundance and densities of central European (Blanc *et al.*, 2012; Pesenti and Zimmermann, 2013; Weingarth *et al.*, 2012; Zimmermann *et al.*, 2013) and southwest Asia (Avgan *et al.* in press) lynx populations. However this methodology aimed to assess the status of Himalayan lynx has not been applied in very remote, rough and though terrain such as the Hindu Kush Mountain range. As factors, such as location of the travel paths, orientation of the camera-traps with respect to lynx's travel path, settings of the camera-trap, necessary resources to complete the survey, capture success rates could vary compared to those in the central European studies; a pilot camera-trapping study was conducted to get prepared for a future camera-trap survey. In parallel, this survey would enable to assess the minimum number of lynx present in the study area.

Having assessed the findings of questionnaire survey such as recent lynx reports including sightings, signs, and predation cases, we were able to sieve an area of about 1,272 km² covering significant portion of the protected area (PA) network of the District Chitral for a systematic camera trapping study. A 5x5-km grid was overlaid on the study area resulting in 66 cells (Fig. 1). Adequate camera-trap sites were chosen in the 17 cells that contained at least one chance observation (sighting, predation and other signs of presence such as tracks) resulting from the questionnaire surveys. Within these cells one to two camera-trap sites with one camera-trap per station were set by keeping a minimum distance of 500 meters in between the sites resulting in 22 camera-trap sites.

We used 22 motion-triggered camera traps including 7 Reconyx TM HC500 Hyperfire™ and 15 Reconyx TM PC900 Hyperfire™ in our study. All cameras were set to take 3 consecutive images (1-sec picture interval) each time they were triggered without delay.

Cameras were mounted on a metal pole about 40-60 cm above the ground. Cameras generally faced towards the north or south to avoid erroneous pictures caused by direct sunlight. The camera

sensors were placed in such a position that there was no vegetation in the foreground that could trigger the camera (Jackson *et al.* 2006) or hide important body parts of the target species. To remedy the use of single camera-trap at each site, two different commercial attractants (castor-based and skunk-based scent lure) were used (Guil *et al.*, 2010; Din *et al.*, 2013). Burst of images in rapid sequence of Reconyx camera-traps increases the chances to get photographs of the same individual from different angles especially if it stays for a while in front of the camera-trap. Besides easing the individual recognition it would increase the detection probability.

We run each of the 22 stations for 35 days from December 15, 2011 to January 19, 2012 and revisited each station once in between the setting and take down period to change the SD cards, change batteries, and re-bait the stations.

Lynx were identified from photographs by comparing their distinct pelage patterns as every individual feline has unique fur pattern (Sunquist and Sunquist, 2002). Independent dispersers (sub-adults) cannot be distinguished from resident animals (adults) using pictures, and hence the estimated minimum number of lynx refers to "independent lynx" (Zimmermann *et al.*, 2013).

Results

Questionnaire survey

Information from 238 respondents was acquired. Herders, shepherds, hunters, and farmers (summed under occupation agriculture), constitute 71.8% of the total respondents, followed by employees with 18.9%, students/teachers with 6.7%, and wildlife department staff with 2.5%. The average age of the informants was 46 years (range: 17–80 years).

Status of lynx

We recorded 238 lynx chance observations mostly sightings in the wild in total (average report/ respondent/year=0.09) from the six valleys in five years (2007-11) period (Fig. 2). Highest number of observations (n=80) came from Arkari Valley, while lowest (n=4) was reckoned from Drosh and Orghoch Valleys. When respondents were asked about the status of the lynx, 6.3% believed that lynx is a common species, while 87.8% professed that lynx is rare, and 5.9% declared it absent across the study sites.

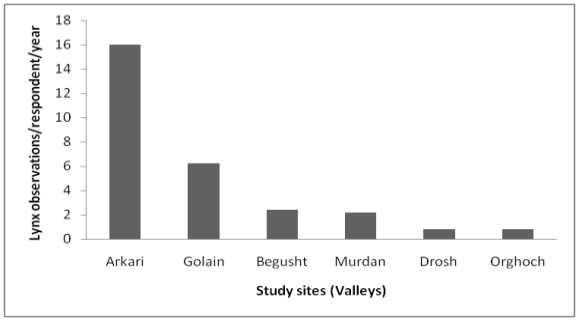

Fig. 2. Lynx observations per respondent per year across the study sites.

Depredation on livestock

Himalayan lynx was linked with livestock depredation in four valleys and 80 losses of livestock consisting of 53 goats and 27 sheep were reported in this study during the last five years (2007-11). The majority of losses (n=44) were reported from Golain Valley followed by Arkari Valley (n=19). We did not get any predation information from Drosh and Beghust Valleys. Furthermore, all the victims were young animals of the age of 1-2 years. Livestock predation cases were noticed almost around the year with the exception of the month of January were no losses were reported. The greatest number of losses were recorded duing the month of May (36.3%) followed by November (22.5%) (Fig. 3).

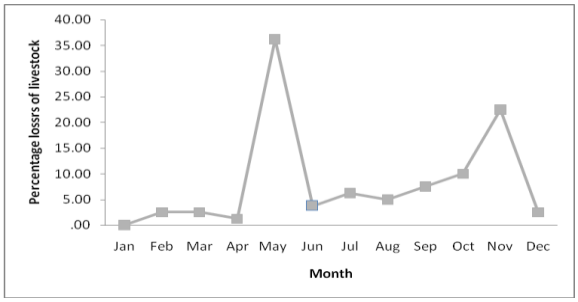

Fig. 3. Monthly lynx predation rate on livestock across the study sites.

Public tolerance and acceptance of lynx

Himalayan lynx were not unanimously accepted and tolerated by the local communities. More than eleven percent (11.34%) of the respondents reckoned lynx as most dangerous for livestock, 63.03% considered the species as moderately dangerous, while 25.6% took lynx as least dangerous as far as the predation on livestock was concerned. Likewise, 16% of the respondents were found to be in favor of an increase of the lynx population, 33.6% wished to maintain the current status, 10.5% wanted the number of lynx to be reduced, and 39.9% opined to eliminate lynx from their respective pastures (Fig. 4).

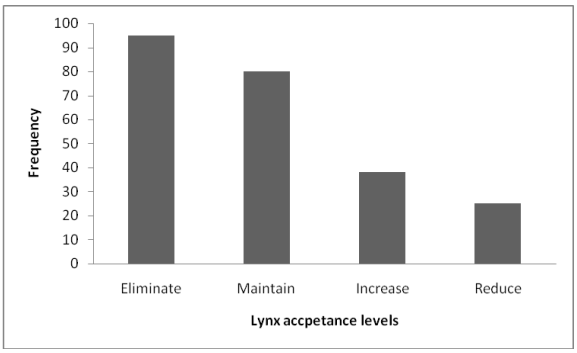

Fig. 4. Public tolerance and acceptance of lynx across the study sites.

Lynx camera-trapping pilot study

Each of the 22 camera station was operational for 35 days, corresponding to a potential of 770 trap days. We got 28,296 (excluding 4,201falsely triggered or unidentified pictures) photographs including 4,969 photos of carnivores (lynx, wolf, jackal, and fox) with overall carnivore capture rate of 564.66 per 100 trap days. Other included 7,233 (capture rate of 821.9) photos of livestock and 15,332 (capture rate of 1,742.) of human. Human and livestock together constitute 79.7% of the total photos taken, while birds and other small mammals constituted 2.69% of the total captures. Out of 22 trap stations, Himalayan lynx was captured at 5 stations with 706 photos in total which corresponded to 12 independent detections. Three lynx captured sites fall in Chitral Gol National Park and two in Tooshi Game Reserve (Fig. 1). A minimum number of six independent lynx were identified in the whole study area: two individuals in Tooshi Game Reserve and four in Chitral Gol National Park.

Discussion

Linking local wisdom with science (Din and Nawaz, 2010 and 2011; Din *et al*., 2013; Mishra, 2001; Hussain, 2003) helps reckon important aspects of conservation and properly plan in-depth monitoring programs as reported in this study. Himalayan lynx is fairly enigmatic to realistically assess in Pakistan owing to its habitat-spread across the rough and antagonistic terrain of Hindu Kush, Karakorum, and Himalayan Mountain ranges and presence of other sympatric felids like snow leopard and leopard cat. The methodology we opted in this study, which forms the first ever attempt in Pakistan as for as the assessment of Himalayan lynx is concerned is in line with the lynx monitoring protocols developed by KORA, Switzerland (Breitenmoser *et al*., 2006) has proven to be an effective and replicable tool in term of resources and availability of expertise is concerned.

The highest predation rates in the months of May and November may be due to the fact that the large herds of livestock start moving towards the summer pastures during the spring season (March-May) and the young animals are more prone to the attack of opportunistic predators like lynx and in autumn season (October-November) the herds retreat towards winter pastures and again the kids are exposed to predators. Lynx predation on predominately 1-2 years old domestic animal is probably due to the fact the lynx select domestic preys that are within the weight range of the natural preys. Similar pattern was observed in Switzerland where lynx killed predominantly sheep and goats less than one year old (Angst *et al*., 2000). Furthermore, although a small population of lynx was reported in this study yet the communities showed increased hatred towards lynx with almost 40% of the informants were in favor of eliminating lynx suggests dire need of the conservation measures.

The highest capture rate of livestock and human (about 80%) observed mostly in the buffer zone of the protected areas reflects the intensity of habitat degradation and overwhelming pressure on the resources. This status quo has unprecedentedly resulting in the increased predation of carnivores on livestock and alternatively developing adverse attitudes and perceptions about lynx and other sympatric carnivores in the region. However, the overall acceptance of carnivores as compared to the losses of valuable livestock due to predation was not that much discouraging when compared to the poor socio-economic status of the mountain communities.

Systematic camera trapping studies in the Hindu Kush Mountains are enormously hectic especially in winter months owing to the rough terrain and heavy snowfall. We suggest identifying trap sites that remain accessible during the study period, safe from mountain hazards like excessive snowfall and avalanche and have potential for capturing lynx through reconnaissance surveys prior the initiation of camera trapping study.

Himalayan lynx is often subjected as the species that mostly occurred above tree line (Roberts, 1997; Breitenmoser *et al*., 2006; Din and Nawaz, 2010) but this study reveals the association of the species with habitat type dominated by forest. Both the Chitral Gol National Park and Tooshi Game Reserve where lynx was captured in this study constitute the dry temperate mix forests dominated by the Holy Oak (*Quercus spp.*). Another reason could be the high diversity and abundance of prey base including markhor (*Capra falconeri cashmiriances*), hare (*Capes spp.*), game birds (e.g. *Tetragalleous himalayances*, *Alectoris Chukar*, *Lepophorus impeginus*), and other small mammals, respectively in this protected area. It is also evident fact that protected areas play vital role in conserving threatened species and the presence of Himalayan lynx in the core of the two high ranked protected areas of the District in this study augments the implication of such corridors. However, in further north of the Hindu Kush range the species was reported above tree line (Din and Nawaz, 2010).

The confinement of Himalayan lynx only in the core zone of the protected areas coupled with the affirmation of lynx as the most rare species and predation on livestock vividly reveals that this elusive species is declining outside the protected area network of District Chitral and hence, requires urgent conservation measures.

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