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Human–bear conflict and community perceptions of risk in the Zanskar region, northern India

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Abstract: The Himalayan brown bear (*Ursus arctos isabellinus*) is an endangered subspecies of brown bear (*U. a.* spp.) and is found throughout the Himalayan region of south and central Asia. We describe the type of and the current level of human–bear conflict (HBC) with Himalayan brown bears in the Zanskar region of northern India and suggest potential mitigation methods. Between July and September 2018, we interviewed 218 households across the Zanskar region, all of whom had experienced HBC. Participants reported increasing numbers of HBC events in the last 4 years. The most common form of HBC was damage to granaries where food is stored (50%). As a result of HBC, most participants said they feared bears (95%) and did not like them (73%). However, 95% of participants thought that the Himalayan brown bear should be conserved. We conclude that local people are receptive to bear conservation, but the current measures are insufficient to protect property and livestock. We encourage community involvement in bear monitoring as well as installation of bear-resistant food containers, solar lights, and electric fences to reduce incidences of HBC and foster tolerance of bears in Zanskar, India.

Key words: community survey, Himalayan brown bear, human–wildlife conflict, India, Trans-Himalaya, *Ursus arctos isabellinus*, Zanskar

Direct and indirect competition between humans and wildlife for natural resources has contributed to global increases in human–wildlife conflicts (HWCs; Messmer 2000). Human–wildlife conflict encompasses crop damage, livestock depredation, disease transmission, and predatory attacks on humans (Messmer 2000, Woodroffe et al. 2009, Mattson et al. 2011). In areas of the world with higher levels of biodiversity and dependence on forest ecosystems such as south and southeast Asia, increased overlap of resource use between humans and wildlife contributes to increased HWCs (Treves et al. 2006).

In the Trans-Himalayan region of northern India, where communities practice agropastoralism by cultivating crops in the fertile river valleys and concurrently grazing their livestock on the surrounding rangelands (Namgail et al. 2007, Aryal et al. 2012), there is a risk of livestock depredation by wild predators (McCarthy and Chapron 2003). Previous studies in this region have documented livestock depredation by snow leopards (*Panthera uncia*) and wolves (*Canis lupus*; Jackson and Hunter 1996, Hussain 2003, Namgail et al. 2007), and mitigation methods are already in place to reduce livestock losses to these species (Jackson 2015, Mohammad et al. 2016, Namgail et al. 2016, Watts et al. 2019). Responses to our survey indicate that incidences of property damage and livestock depredation by Himalayan brown bears (*Ursus arctos isabellinus*) have increased in recent years; they were previously rare or absent. Despite this perceived increase, conflict with Himalayan brown bears has received little attention in India (Chauhan 2003, Maheshwari et al. 2012, Anand and Radhakrishna 2017).

The Himalayan brown bear (Figure 1) is an endangered subspecies of brown bear (*U. a.* spp.), and there are estimated to be <200 wild bears in Pakistan and India (Bellemain et al. 2007, Abbas et al. 2015, McLellan et al. 2017). In India, Himalayan brown bears have been reported in low densities in the Union Territories of Jammu and Kashmir, Ladakh, Himachal Pradesh, and Uttarakhand (McLellan et al. 2017, Sharief et al.

Figure 1. Himalayan brown bear (*Ursus arctos isabellinus*) near Photoksar in the Zanskar valley, northern India (*photo courtesy of J. Dadul*).

2020). Himalayan brown bears occur at elevations of 3,000–5,000 m above sea level, where they predominantly graze in alpine meadows (Sathyakumar 2001). Their diet is varied and versatile, consisting of approximately one-third animal matter and a variety of plants (Nawaz et al. 2019). Evidence of crops, garbage, and domestic livestock consumption has also been found in Himalayan brown bear scats in Pakistan (Nawaz et al. 2019).

Across their wide Holarctic distribution, brown bears generally are known to consume anthropogenic food (e.g., Bojarska and Selva 2013) and pose a physical threat to people (e.g., Herrero and Higgins 2003, Kudrenko et al. 2020). Thus far, reported conflict with Himalayan brown bears in India and Pakistan has predominantly been restricted to livestock depredation (Chauhan 2003, Aryal et al. 2012, Maheshwari et al. 2012). However, anecdotal reports of property damage by Himalayan brown bears in the Zanskar Valley of the Union Territory of Ladakh have recently increased (T. Dorjey, headman of Abran village, personal communication) and warrant further investigation. Similar studies have been carried out on Tibetan brown bear (*U. a. pruinosus*) in Sanjiangyuan National Nature Reserve, China (Worthy and Foggin 2008, Dai et al. 2020).

The people living alongside Himalayan brown bears in the Zanskar region are predominantly Buddhists who abhor taking life in any form (Fox et al. 1994). However, there are recent reports of retaliatory killings of bears in neighboring regions, largely in response to suspected livestock depredation (M. Hussain, wildlife tour guide in Kargil, Ladakh, India, personal communication). There are also reports of retaliatory killing of Tibetan brown bears in Nepal (Aryal et al. 2012). From both sources, we suggest that retaliatory killing has the potential to become a conservation issue if the perceived risk or economic loss from Himalayan brown bears become too great.

The goal of our study was to describe the current level of human–bear conflict (HBC) in the Zanskar valley of the Union Territory of Ladakh, India, as reported by local people, and suggest ways to reduce HBC for the benefit of humans and Himalayan brown bears. Specifically, we describe the trend in HBC in recent years, the types of HBC, people's perceptions of brown bears, and discuss possible causes of HBC and the management implications in the region.

Our study was carried out in an area of political instability, which makes it particularly vulnerable, as research and conservation initiatives do not take priority and it is more useful to foster a community approach to conservation as opposed to a top-down approach. The long-term conservation of Himalayan brown bears in this area depends on reducing both habitat degradation and preventing retaliatory killing (Sathyakumar 2001).

Study area

Our study took place in the Zanskar region (Figure 2), in the northern Indian Union Territory of Ladakh. The region extends over approximately 7,000 km2 of rugged, mountainous terrain in the Indian Trans-Himalaya, with elevations ranging from 3,500–7,000 m above sea level. The Zanskar region is a high-altitude cold-desert with an average annual precipitation of <200 mm and mid-winter snow depths of only about 10 cm (Jackson and Ahlborn 1988). Vegetation is a combination of steppe and shrubland (Rawat and Adhikari 2005). Wildlife abundance is low in the area due to low primary productivity and habitat loss caused by excessive livestock grazing (Rawat 2007). In addition to Himalayan brown bears, there are 2 other predators in the region, the snow leopard and the Tibetan wolf (*C. l. chanku*), that play an important role in maintaining the health of the ecosystem by making biomass available for scavengers

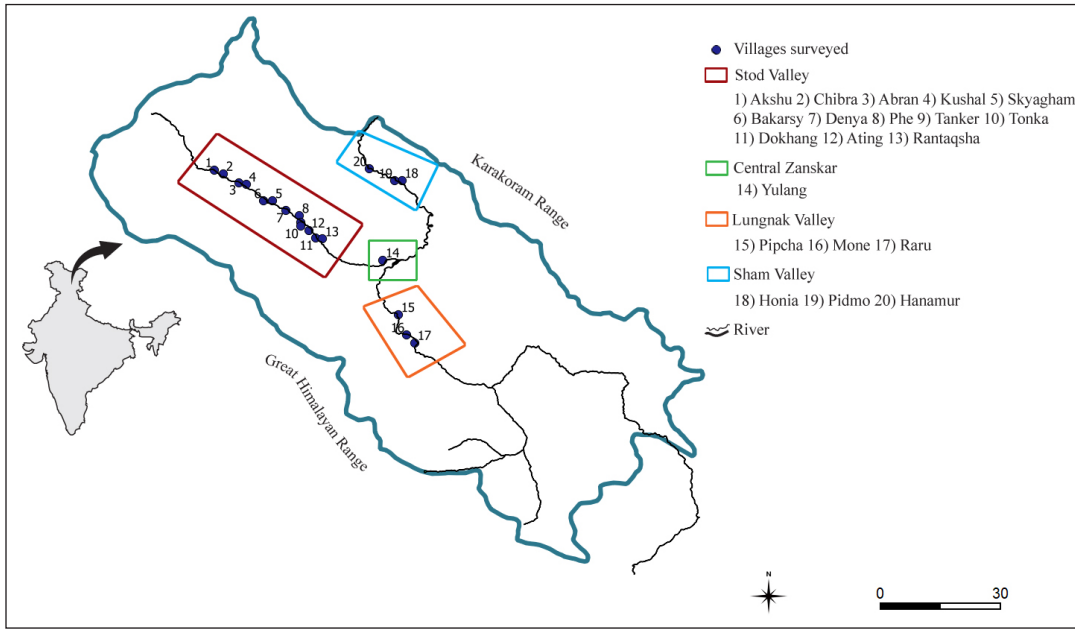

Figure 2. Locations of the 20 villages in the Zanskar valley, northern India, included our 2018 survey on human–Himalayan brown bear (*Ursus arctos isabellinus*) conflicts.

(Wilmers et al. 2003, Kusi et al. 2020).

People in the Zanskar valley practice agro-pastoralism by integrating crop production with livestock production. They rear a variety of livestock including goats (*Capra aegagrus hircus*), sheep (*Ovis aries*), cows (*Bos taurus*), yaks (*B. grunniens*), horses (*Equus caballus*), donkeys (*E. asinus*), and a form of cattle called dzo (male) and dzomo (female) that is a hybrid between a yak and a domestic cow (*B. grunniens* x *B. taurus*). The main crops grown in the area are barley (*Hordeum vulgare*), wheat (*Triticum* spp.), pea (*Pisum sativum*), and potato (*Solanum tuberosum*).

For the purposes of questionnaire survey, the Zanskar region (Figure 2) was divided into 4 areas: (1) Stod valley, (2) Zhungkhor, (3) Sham valley, and (4) Lungnak valley.

Methods

Between July 28 and September 18, 2018, we held meetings with the headman and members of the village administration in the 4 areas of Zanskar to identify households that had experienced HBC. We then conducted semi-structured interviews (Appendix 1) with the most senior members of 218 households that were affected, across 20 villages of the Zanskar valley. Each household was considered a single sampling unit, and the interviews were restricted to 1 participant per household.

A researcher and an accompanying interpreter conducted interviews in Ladakhi (the primary language in the Zanskar region). The study was explained to participants prior to interviewing, and participation was voluntary. Verbal consent was obtained in Ladakhi before starting the interview, and all data were anonymized before analysis. The survey was primarily designed to capture information from the most recent HBC incident and provide further information on perceptions of Himalayan brown bears in the region.

We asked participants to describe the details of their most recent HBC event. To maintain accuracy of the results, we only further analysed HBC events when the participant could recall the month and year of the event. We then separated the events according to location (e.g., granary store, house, livestock). When participants recalled granary or livestock as the most recent HBC location, additional questions were asked regarding grain storage and livestock husbandry practices. In some cases, the granary and livestock were both affected during the same HBC event. When applicable, we verified reports of Himalayan brown bear break-ins by checking for bear signs such as claw marks on walls and windows and scats and footprints

Figure 3. Himalayan brown bear (*Ursus arctos isabellinus*) claw marks on the façade of a house in the Zanskar valley, northern India (*photo courtesy of K. Chavan*).

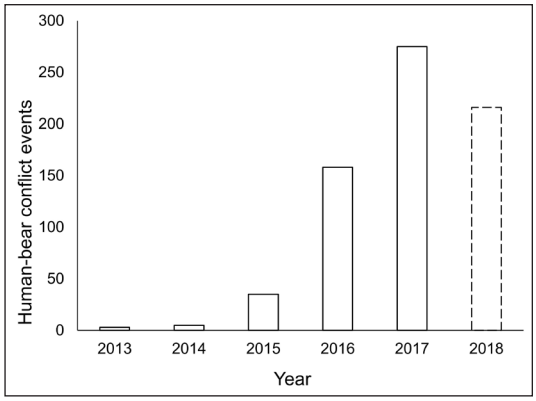

Figure 4. Total number of conflict events each year between humans and Himalayan brown bears (*Ursus arctos isabellinus*), 2013–2018, Zanskar valley, northern India, as recalled by the participants. Data for 2018 are incomplete (depicted with a dashed line), as the last interviews were carried out in September 2018.

around the buildings (Figure 3).

All participants were asked about the methods they used to scare Himalayan brown bears away, their opinions about bears, and why they thought bears entered the villages. Data handling and descriptive analyses were carried out in Microsoft Excel™.

Results

Most participants recalled first seeing Himalayan brown bears in the villages in the last few years before the survey (mode = 3 years), although some recalled seeing bears up to 20 years before the survey (median = 10.5 years). The earliest recalled HBC events were in 2013, and since this time HBC has increased each year (Figure 4).

Over half of the participants (n = 218, 56%) listed autumn (September to November) as the season during which most HBC events occurred, followed by spring (March to May, 37%) and summer (June to August, 30%). Most participants (86%) also listed autumn as the season during which HBC events were most severe.

When asked to recall the details of the most recent HBC event, 199 participants (91%) were able to recall the month and year of the events. Most of these occurred during 2018 (70%), 25% occurred in 2017, and the remaining 5% occurred between 2014 and 2016. Of the most recent HBC events (where month could be recalled), granary break-ins were the most frequent form of HBC reported (50%), followed by house break-ins (33%) and livestock depredation (28%). In some cases, multiple locations were damaged during the HBC event (e.g., granary and house break-in), and therefore percentages exceed 100%. None of the participants recalled bear damage to crops in the field as the most recent HBC event.

Of the granary break-ins (n = 100), the bears primarily caused damage to the windows (82%) and/or the doors (12%) while attempting to enter the building. Participants recalled that these events mostly occurred late at night (84%). The granaries and storerooms of houses contain a range of products including sugar, rice (*Oryza sativa*), barley, wheat, butter, churpey (a type of sweetened dried cheese), curd, meat, oil, lentils (*Lens culinaris*), and peas. Jute sacks were the most common storage method in granaries (68%), followed by plastic containers (49%), animal skins (35%), small steel tins (18%), and aluminum drums (3%). None of these storage methods are suitable for protecting food from bears.

Of the livestock depredation events (n = 56), depredation most frequently took place late at night (93%), with only 1 attack occurring early in the morning. Three participants did

Table 1. Livestock holding and loss to Himalayan brown bears (*Ursus arctos isabellinus*) by farmers in the Zanskar valley, northern India (n = 56). Surveys were carried out in Zanskar in 2018. Figures in parentheses are the percentages of participants reporting.

Livestock type	Participants who kept this livestock	Participants who lost this livestock to bears
Sheep (*Ovis aries*) and goat (*Capra aegagrus hircus*)	53 (95)	35 (63)
Cow (*Bos taurus*)	52 (93)	26 (46)
Dzo/dzomo (*B. grunniens* x *B. taurus*)	53 (95)	4 (7)
Yak (*B. grunniens*)	51 (91)	2 (4)
Donkey (*Equus asinus*)	33 (59)	8 (14)
Horse (*E. caballus*)	37 (66)	0 (0)

Table 2. The reasons participants believed Himalayan brown bears (*Ursus arctos isabellinus*) approached human areas for food. More than 1 reason was accepted from each respondent; therefore, figures in parentheses are percentages of respondents reporting (n = 218) and exceed 100%. Surveys took place in the Zanskar valley, northern India in 2018.

Reason	Number of respondents
Attracted to livestock	1 (1)
Bear population increased	5 (2)
Bears conditioned to human food	40 (18)
Food habits of bears have changed	4 (2)
Bears are hungry	5 (2)
Lack of natural food for bears	119 (55)
Karma	12 (6)
Not sure	44 (20)

not know what time livestock were attacked. Livestock were depredated inside the corrals in 70% of cases, out in the open in 28% of cases, and only 2 participants (4%) did not know where depredation occurred. When livestock depredation occurred inside the corrals (n = 39), bears mostly broke the door (49%) or the window (28%) of the corrals to gain entry. In 15% of cases, bears climbed over the wall, and in 5% of cases they broke the roof. Only 1 participant (2%) was unsure how the bear entered the corral. Sheep, goats, and cows were most vulnerable to depredation by bears, while horses and yaks were least vulnerable (Table 1).

Most of the participants (91%) recalled scaring the bears away after HBC events. Shouting was the most frequently used method (80%), followed by shining a torch light (62%), banging tins/pans (21%), and throwing stones (19%). Less common methods included chasing off with pet dogs (*Canis lupus familiaris*; 3%) and vehicles (3%). When these methods were grouped by type, methods that made noise were most common (52%), followed by light (33%) and then chasing (15%). Participants were unaware of any traditional methods to scare away bears.

When the participants were asked why bears enter villages (Table 2), the most common reasons reported were lack of natural food in the mountains (55%) and human-food conditioning (18%). When asked about their opinions on bears, most participants (n = 218, 95%) said they feared bears and 73% said they did not like them. However, 95% of participants thought the Himalayan brown bear should be conserved.

Discussion

Conflict between humans and Himalayan brown bears has been reported since the early

2000s in northern India (Chauhan 2003, Aryal et al. 2012, Maheshwari et al. 2012). Nonetheless, it has received little attention from conservationists and wildlife managers. In this study, we have presented evidence that the occurrence of HBC has increased in the last 5 years across the Zanskar region (Figure 4) compared to being rare or absent in the past.

Based on our study, HBC events in India are similar to events in other parts of the Himalayan brown bear range. The most reported HBC events in Zanskar were house or granary break-ins, where bears damaged property to gain access to stored food products such as sugar, butter, and oil. This was also the primary form of HBC associated with Tibetan brown bears in China (Dai et al. 2020). Livestock depredation was a form of HBC for farmers in Zanskar as it was in Pakistan where livestock were found to make up 7% of Himalayan brown bear diet (Nawaz et al. 2019). Similarly, Tibetan brown bear diet in Nepal contained up to 10% livestock (Aryal et al. 2012). Sheep, goats, and cows were the most frequently predated species in Zanskar, a trend that has also been reported in Tibetan brown bears in China (Dai et al. 2020). Although we received anecdotal reports from local people in other parts of northern India that suggest that Himalayan brown bears consume crops (M. Raza, Snow Leopard Conservancy India Trust, personal communication), this was not reflected in our survey data from Zanskar. This could be because crops such as corn (*Zea mays*) and fruits such as apples (*Malus domestica*), which could be preferred by the bears, are not cultivated in our study area.

Generally, all these types of anthropogenic food, including livestock and products stored in houses, are unprotected and have a high energy-content; hence, they are likely to be an energy efficient food source for bears compared to hunting or foraging. Based on the increased frequency of bears entering villages in search of food, particularly bears entering people's houses, we suggest that the Himalayan brown bears in the Zanskar region might be human food-conditioned. This has been documented in other brown bear subspecies across their Holarctic range (e.g., Herrero and Higgins 2003, Rauer et al. 2003, Hopkins et al. 2012) and can have negative consequences for individual animals.

When we explored the seasonality of HBC, we found an increased frequency and severity of HBC in autumn (September to November) that could be attributed to hyperphagia, the need for bears to accumulate fats prior to winter hibernation, gestation, and lactation between December and March (Hilderbrand et al. 1999, López-Alfaro et al. 2013). In a similar study on Tibetan brown bears, Dai et al. (2020) reported that most livestock depredations occurred in autumn. The changing climate may also play a role by extending the potential foraging season; villagers have observed a reduction in the amount of snowfall each year along with a shortening of the winter cold season. Villagers have also seen bears actively looking for food in the middle of winter (headmen from Akshu, Skyagham, and Tungri villages, personal communications), which could also be evidence of human food-conditioning. In central Asia and the Asian Highlands, research suggests that changes in temperature can significantly affect the geographical distribution of brown bears (Su et al. 2018). This may have further contributed to an increase in HBC in Zanskar as the wider Ladakh region shows an overall trend of warming temperatures (Chevuturi et al. 2018) and Himalayan brown bears may be inhabiting areas where they were previously absent.

To our knowledge, there have been no recorded human deaths or injuries caused by Himalayan brown bears in Zanskar. Yet, most participants in our study were still fearful of bears and did not like them as they understand that bears are physically capable of causing injury. Despite this potential physical risk and realized economic losses from livestock depredation and property damage, participants had an overwhelmingly positive attitude toward bear conservation. This may be because they were previously exposed to the conservation and HWC mitigation success story surrounding snow leopards and wolves in the region. The increase in tourism and supplementary or compensatory income had a positive impact on local communities both in terms of economics and perceptions toward predators.

Management implications

To reduce conflict between humans and Himalayan brown bears in the Zanskar region, existing HWC mitigation methods (e.g., livestock corrals)—which were installed for snow leopards and wolves—need to be upgraded.

Himalayan brown bears are extremely capable climbers and diggers, making it easy for them to break into houses and livestock corrals where they can gain access to anthropogenic food sources. The existing livestock corrals are not robust enough to safeguard livestock against bears that can break the wire mesh and doors. Additionally, many households store food products in jute sacks, plastic containers, and animal skins, which are all easily accessible to bears.

Several alternative bear-specific methods have been trialed by the Snow Leopard Conservancy India Trust. For example, solar-powered lights installed on households that previously reported property damage by Himalayan brown bears were considered a successful deterrent to bears (Talbert 2020). These lights are switched on and off automatically by an inbuilt sensor and could easily be installed on houses around the perimeter of villages. Bear-resistant containers, like those used in North America, have also been trialed for storing anthropogenic food and waste. These metal containers are made to withstand repeated attempts to open them by bears, and they utilize a locking mechanism that cannot be operated by bears when used properly. Typically, bear-resistant containers are costly to construct but can be made locally and subsidized and distributed to households by non-governmental organizations.

Other potential mitigation methods are solar-powered electric fences, which could help reduce both crop damage and livestock depredation by bears (Huygens et al. 2001). Livestock guarding dogs such as those commonly used in China and Pakistan (Nawaz et al. 2019, Dai et al. 2020) are also a possible solution. However, there are ongoing problems with feral dogs in the Indian Union Territory of Ladakh that need to be addressed before promoting this option.

To aid success in trials of any of these mitigation measures, community outreach should be promoted, as it helps build a positive attitude toward wildlife (Zajac et al. 2012). This can be done through inducting members of communities as bear-guardians who will receive training in conflict reduction methods. These members of the community may then better understand the issue and be able to help devise locally relevant conservation strategies. The combined effort of HBC mitigation methods and community engagement could have positive benefits for local people and for the long-term survival of Himalayan brown bears.

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