



Snow leopard – human conflict as a conservation challenge—a review

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Human wildlife conflict, conflict domains, mitigation schemes, *Panthera uncia*

Abstract

Human conflict with large carnivores continues to be a great conservation challenge, and conflict with snow leopards (*Panthera uncia*) has been studied to understand causes and propose mitigation schemes. While the nature of snow leopard-human conflict is similar in most cases, reported studies have been case- and area-specific with mitigation strategies not necessarily based on a synthesis of relevant literature. We reviewed snow leopard literature published from 1970-2020 to identify the main drivers of human-snow leopard conflict (HSLC) and describe conservation and conflict mitigation strategies commonly employed. Based on 47 relevant peer-reviewed articles, review papers, book chapters, project reports, and other grey literature, we identified four major conflict domains: livestock management-related, socio-economic/

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human-related, ecological, and policy-related. Most articles suggested more than one conflict mitigation scheme. Three conflict mitigation domains – preventive, supportive, and compensatory – were widely reflected in the snow leopard-human conflict literature. The most commonly reported mitigation schemes included: 1) building or predator-proofing corrals; 2) training shepherds and improving livestock guarding; 3) livestock insurance schemes; 4) compensation for livestock predation; 5) capacity building, education, and awareness programs; and 6) improved breeding and use of guard dogs. Future management efforts need to tailor their approach depending on cultural, economic, and ecological circumstances.

Introduction

Coexistence of humans and large carnivores has been among the greatest conservation challenges (Lamb et al. 2020). Human-snow leopard (*Panthera uncia*) conflict (HSLC) is a continuing conservation challenge across the snow leopard's global range (Young et al. 2010, Redpath et al. 2013), and includes ecological, socio-economic, cultural, and commercial dimensions. The ecological aspects of HSLC include abundance and distribution of wild prey species, snow leopard abundance and distribution, its rugged and remote habitat, and the presence of sympatric large carnivores (Robinson and Weckworth 2016). Among the socio-economic and cultural aspects of HSLC are excessive numbers of livestock, livestock predation with devastating economic loss for people, socio-economically and culturally diverse communities with different poverty levels, and negative perception of local communities about carnivore species (Moheb et al. 2012, Kansky et al. 2014). In addition, some wildlife management programs might also have roots in HSLC in some parts of snow leopard range

(Hussain 2003, Kachel et al. 2017, Rashid et al. 2020); for example Hussain (2003) reported that snow leopard and other predator species in Northern Pakistan where trophy hunting happens for ibex are killed not only to protect livestock but also to protect the wild ungulate subject to trophy hunting.

Here we aim to describe human-snow leopard conflict circumstances at the range-wide level, conflict assessment methods, and provide recommendations on best mitigation strategies based on documented scientific research across the species range. We assess conflicts across snow leopard range and compile the best conflict mitigation practices reported in snow leopard-human conflict literature. We review predation and conflict related articles published since the 1970s that have reported snow leopard and other sympatric predators' conflicts with livestock. Our main focus was to understand the circumstances of livestock predation, the retaliatory killing of predator species, and conflict mitigation schemes applied throughout the entire range of snow leopards.

Methods

We assessed snow leopard and human conflict literature, published in English from 1970-2020, by retrieving peer-reviewed snow leopard conflict-related articles online using the PRISMA (Preferred Reporting of Items for Systematic Review and Meta-Analysis) review method (Moher et al. 2009). We used the Web of Science and Google Scholar databases, and also reference-mined where we searched for snow leopard conflict-related article titles within relevant scientific publications (Fig. 1). We used the word combinations of either “snow leopard” or “*Panthera uncia*” with any of the following

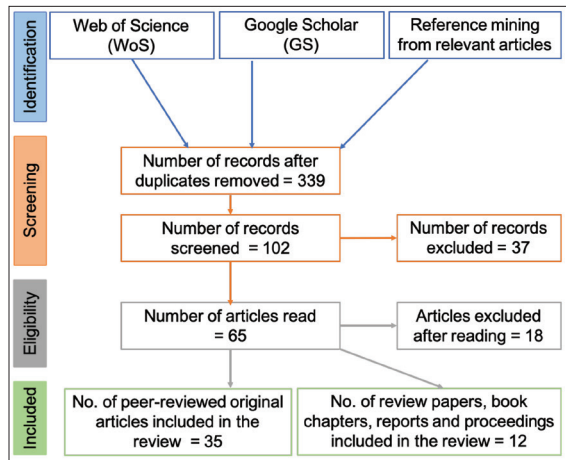


Fig. 1. Various steps of systematic review from searching through the inclusion of the human-snow leopard conflict relevant articles in the review.

keywords or phrases: human-wildlife conflict; livestock predation; depredation; coexistence; attack; killing; wildlife hunting; predator-prey relationship; food habit; retaliatory killing; conflict management; livestock insurance; poaching; compensation; prey preference; attitude; conflict hotspots; and surplus killings. We also added, one by one, the name of all 12 range countries with the combination of the aforementioned key words to obtain any HSLC related peer-reviewed journal articles for all the snow leopard range states.

We screened relevant articles and extracted information on: 1) data collection methods, 2) study region, 3) livestock, wild prey, and predator densities, 4) predation rates of snow leopards and other predators, 5) contributing factors to livestock predation, 6) suggested conflict mitigation schemes and best practices, and 7) whether or not any of the suggested mitigation schemes were tested for their efficacy. We tested the overall snow leopard contribution to livestock predation versus wolf and lynx predation using t-tests. While compiling the

literature, we identified four major conflict factor domains: livestock management related factors, ecological factors, socio-economic or human related factors, and policy related factors. A variety of factors were identified within each domain.

The data collection methods used in the reviewed articles were coded as:

1. Social science method that includes interview, questionnaire, and focused group discussion data.
2. Ecological method that includes camera trap data, diet study, and scat analysis.
3. Compensatory and supportive record methods that include the compensation records, insurance programs and other project/status reports.
4. Combined methods that include articles that have used a combination of the above-mentioned data collection methods, and
5. Review method covering the review data.

Results

We found 35 peer-reviewed journal articles, 4 review papers, 4 book chapters, 2 proceedings, and 2 reports (total = 47) related to snow leopard-human conflict from eight of the 12 snow leopard range countries (Fig. 2). No peer-reviewed English articles were identified for Kazakhstan,

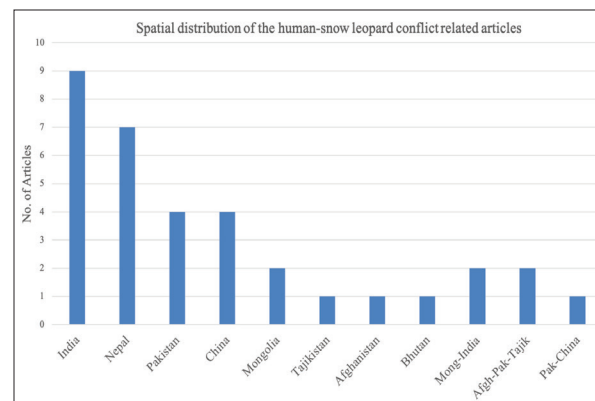


Fig. 2. Number of human-snow leopard conflict related articles identified for each of the snow leopard range countries.

Kyrgyzstan, Russia, and Uzbekistan (Appendix 1).

Data collection methods used by most of the articles were based on social science methods (49%, $n = 23$) (e.g., questionnaires, interviews, and focus group discussions), followed by research based on scat analysis (9%, $n = 4$), compensation records kept by the government or other organizations responsible for compensation (6%, $n = 3$), mix of interview, scat analysis and camera trap surveys (6%, $n = 3$), camera trap data (2%, $n = 1$), and GPS telemetry (2%, $n = 1$). Another 26% ($n = 12$) consisted of review papers and of project reports that were mainly general overview papers which had not used any data collection methods.

Some articles (17%, $n = 8$) that appeared in the search considered wild prey density in evaluation of the snow leopard human conflict, while only 15% ($n = 7$) and 6% ($n = 3$) used or mentioned livestock and snow leopard densities, respectively. The papers that had included predator and prey (wild or domestic) densities only represented the southern part of the snow leopard range (Table 1).

The amount of livestock predation by snow leopards reported in the literature ranged from 0.3% to 7.6% of total livestock holdings, with an average loss of 2.5% across its range (Fig. 3). Studies of snow leopard predation on livestock have also included a range of other sympatric predators, including brown bear (*Ursus arctos*), black bear (*Ursus thibetanus*), leopard (*Panthera pardus*), tiger (*Panthera tigris*), red fox (*Vulpes vulpes*), and dhole (*Cuon alpinus*); however, wolf (39%) and lynx (*Lynx lynx*, 17%) appeared most often in snow leopard predation-related articles. The overall snow leopard contribution to livestock predation when multiple predators were assessed (range = 0-89%, mean 40%, median 38%) was not statistically different ($P = 0.90$) than what was

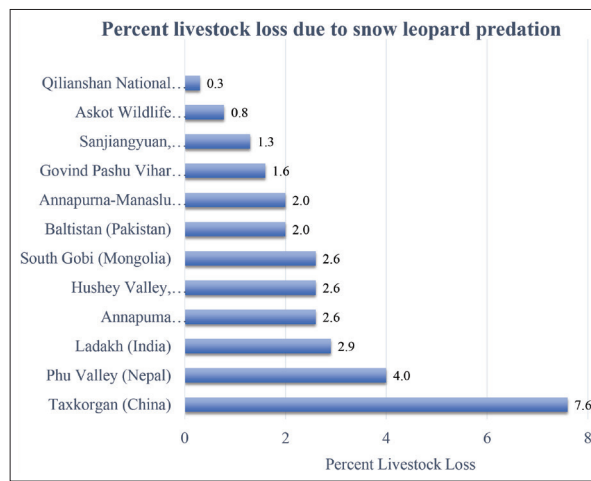


Fig. 3. Percent livestock loss due to snow leopard predation in different areas across the species range.

reported for wolf (range = 8-100% mean 39%, and median 36%) (Table 2). However, the amount of predation by lynx (range = 0.1-34.6%, mean 9%, median 2%) was different than for snow leopard ($P = 0.005$) and wolf ($P = 0.007$).

The literature compilation resulted in identification of four major conflict factor domains: livestock management related factors (59% of the literature), ecological factors (30%), socio-economic or human related (9%), and policy related (2%). A variety of factors were identified within each domain (Table 3).

A range of conflict mitigation schemes have been reported in snow leopard-human conflict literature (Table 4). Most of the articles either reported or suggested more than one conflict mitigation scheme. Over 21% ($n = 10$) of the reviewed articles have evaluated the effectiveness of the conflict mitigation schemes by either monitoring over time the amount of livestock loss, monitoring people's action in favor of conservation, people's tolerance towards the predator, and assessments of snow leopard retaliatory killings. Three conflict mitigation

Table 1
Peer-reviewed articles that considered livestock and wild prey in their analysis.

DENSITY ¹				
SNOW LEOPARD	LIVESTOCK	WILD PREY	LOCATION	REFERENCE
-	27.5	-	Big Pamir, Afghanistan	Karimov et al. 2018
-	1500	-	Trans-Himalaya, India	Mishra 1997
-	-	4.0	Spiti Valley, India	Mishra et al. 2003
-	29.7-13.9	2.6-6.1	Pin Valley NP/Kibber WS, India	Bagchi & Mishra 2006
0.46-3.3	1.9-19.5	0.1-3.1	Various sites ² , India/Mongolia	Suryawanshi et al. 2017
-	-	0.3	Ladakh, India	Namgail et al. 2007
-	57.23	0.05-3.9	Spiti Valley, India	Sharma et al. 2015
-	1,500	-	Hemis NP, India	Jamwal et al. 2019
-	-	8.4	Phu Valley, Nepal	Wegge et al. 2012
-	35.74	-	Annapurna-Manaslu L, Nepal	Chetri et al. 2017
0.4-4	-	0.5	Baltistan, Pakistan	Husain 2003
0.24	-	0.41	Torkhow Valley, Pakistan	Din & Nawaz 2011

1 No./100 km² for snow leopards, No./km² for livestock and wild prey.
2 = Spiti Valley, Jammu and Kashmir in India, and Tost in Mongolia

Table 2
Percent snow leopard wolf and lynx predation on livestock loss reported in human-snow leopard conflict literature.

PERCENT LIVESTOCK LOSS DUE TO					
SNOW LEOPARD	WOLF	LYNX	OTHER PREDATORS	REGION, COUNTRY	REFERENCE
88.7	11.1	0.1	0	KPTB, Pakistan-China	Khan et al. 2014
74.5	8.4	4.0	13.1	Mustang region, Nepal	Aryal et al. 2014
64.9	35.1	0	0	Misgar/Chuparsan, Pakistan	Din et al. 2017
60.0	37.0	0	3.0	Hushey Valley, Pakistan	Khan et al. 2018
58.0	32.0	2.0	8.0	Hemis NP, India	Jackson et al. 2003
38.0	60.0	2.0	0	Ladakh, India	Namgail et al. 2007
30.4	69.6	0	0	Wakhan NP, Afghanistan	Din et al. 2017
27.5	24.5	0	47.9	Spiti Valley, India	Suryawanshi et al. 2013
21.7	37.7	34.6	6.0	Qomolangma NNR, China	Chen et al. 2016
0.0	100.0	0	0	Tajik Pamir, Tajikistan	Din et al. 2017

KPTB = Karakoram Pamir Trans-Border, NP = National Park, CA = Conservation Area, NNR = National Nature Reserve, L = Landscape.

Table 3
Livestock predation factors reported within the snow leopard-human conflict related peer-reviewed and grey literature.

HUMAN-SNOW LEOPARD CONFLICT FACTORS	CONTRIBUTION TO SLHC	NO. OF REFERENCES
Livestock management		
Lax and traditional herding practice ^{2,3,4,5,10,11,16,18,19,20,21,22,23}	ElsP	13
Poorly constructed livestock corrals ^{4,10,17,18,19,20,22}	ElsP	7
Free ranging animals ^{1,12,18,22}	UlsEP	4
Increase in the number of livestock ^{7,18,22,^}	MCE	4
Types of livestock ^{1,12}	SlsPP	2
Livestock herd size ¹	LHMCE	1
Repeated use of pastures where predators are active ²³	ElsP	1
Poor veterinary care ¹⁴	DlsEC	1
Ecological		
Prey depletion ^{2,5,6,10,11,14,15,23}	PAIsS	8
Higher predator density ^{3,6,8,16}	MCE	4
Topography and ground cover help predation ^{*,5,10,18}	ICPA	4
Wild prey abundance ⁸	IP	1
Socio-economic/Human-related		
Negative perception of local communities ^{9,16}	ICPK	2
Increase in human population ¹¹	MCEP	1
Limited external resources and low income ¹³	CAPIs	1
Policy-related		
Conservation measures e.g., wildlife protection laws, creation of protected areas ²³	IP	1

1 Chetri et al. 2019, 2 Khan et al. 2018, ^ Suryawanshi et al. 2017, 3 Chen et al. 2016, 4 Mishra et al. 2016, * Johansson et al. 2015, 5 Khorozyan et al. 2015, 6 Khan et al. 2014, 7 Maheshwari et al. 2013, 8 Suryawanshi et al. 2013, 9 Moheb et al. 2012, 10 Jackson et al. 2010, 11 Qamar et al. 2010, 12 Sangay & Vernes 2008, 13 Ogra 2008, 14 Namgail et al. 2007, 15 Bagchi & Mishra 2006, 16 Wang & Macdonald 2006, 17 Mishra & Fitzherbert 2004, 18 Jackson et al. 2003, 19 Jackson et al. 2002, 20 Jackson & Wangchuk 2001, 21 Linnell et al. 1999, 22 Mishra 1997, 23 Jackson et al. 1996

Contribution to SLHC: ElsP = Expose Livestock (ls) to Predator; UlsEP = Unattended ls Easy Prey; MCE = More Chance of Encounter; SlsPP = Some ls more Prone to Predation than others; LHMCE = Larger Herds More Chance of Encounter; DlsEC = Diseased ls Easy to Catch; PAIsS = Predator Attack ls for Survival; ICPA = Increase the Chance of Predator Ambush; IP = Increase Predators; ICPK = Increase the Chance of Predator Killing; MCEP = More Chance of Encounter with Predator; CAPIs = Can't Afford to Protect Livestock

domains – preventive, supportive, and compensatory – are widely reflected in the snow leopard-human conflict literature (Table 4). Most articles focused on predator-proof corrals (47% of articles), training shepherds and improving livestock guarding (42%), livestock insurance schemes

(36%), and compensation for livestock predation (33%). Capacity building and education (25%), improved breeds of (or just use of) guard dogs (25%), and conservation of wild prey (19%) were also prominent in the literature (Appendix 2).

Table 4
Human-carnivore conflict mitigation measures reported within the literature.

PROPOSED/REPORTED CONFLICT MITIGATION SCHEMES	NO. OF REFERENCES
Preventive	
Building or predator-proofing existing corrals ^{2,4,6,7,8,9,11,12,13,19,22,24,25,26,30,33}	16
Training shepherd and improving livestock guarding ^{2-4,6-8,11,12,19,22-24,30,34,35}	15
Capacity building, education, and awareness programs ^{5,7,8,13,15,16,20,30,35}	9
Improved breeds of or just use of guard dogs ^{3,7,12,19,22,25,27,34}	8
Conservation of wild prey species ^{9,11,14,17,22,26,28}	7
Removal of the carnivore species (suggested either by earlier literature or the interviewees) ^{23,25,30,32,33,35}	6
Avoiding predator hotspots/habitats ^{1,7,11,25,34}	5
Increase in number of shepherds ²²	1
Hire experienced shepherds ³⁴	1
Supportive	
Livestock management ^{1,4,10,30,32,33}	6
Livestock vaccination ^{2,5,7,9,11}	5
Pasture management ^{10,19,24,26,32}	5
Livelihood schemes ^{7,22,26}	3
Community based conservation initiatives ^{*25,29}	3
Compensatory	
Livestock insurance schemes ^{2,5,9,11,13,16,18,19,22,23,24,28,33}	13
Compensation for livestock predation ^{5,9,10,11,14,16,23,24,25,28,30,35}	12

1 Chetri et al. 2019, 2 Din et al. 2019, 3 Khan et al. 2018, 4 Mijiddorj et al. 2018, 5 Din et al. 2017, 6 Alexander et al. 2016, 7 Mishra et al. 2016, 8 Moheb & Paley 2016, 9 Wilman & Wilman 2016, 10 Alexander et al. 2015, 11 Jackson 2015, 12 Li et al. 2015, 13 Aryal et al. 2014, 14 Khan et al. 2014, 15 Maheshwari et al. 2013, 16 Suryawanshi et al. 2013, 17 Moheb et al. 2012, * Din & Nawaz 2011, 18 Gurung et al. 2011, 19 Qamar et al. 2010, 20 Sangay & Vernes 2008, 22 Namgail et al. 2007, 23 Bagchi & Mishra 2006, 24 Wang & Macdonald 2006, 25 Ikeda 2004, 26 Jackson & Wangchuk 2004, 27 Mishra & Fitzherbert 2004, 28 Mishra et al. 2003, 29 Jackson et al. 2002, 30 Jackson & Wangchuk 2001, 32 Linnell et al. 1999, 33 Mishra 1997, 34 Jackson et al. 1996, 35 Oli et al. 1994

Discussion

Snow leopard-human conflict factors are numerous and understanding them is key in conflict mitigation and overall conservation of the species as well as community livelihood. Sangay and Vernis (2008) divided the conflict factors into two main categories: 1) herder-induced factors, such as poor herding and livestock management practices, overgrazing, and bigger herd sizes (Wang and Macdonald 2006, Chetri et al. 2019),

and 2) factors that are out of herders' control; e.g., predator density and behavior, wild prey populations, and predator-prey interactions (Mishra et al. 2001, Sangay and Vernis 2008). Our review, however, not only focuses on those factors but also identified socio-economic and policy related domains. Rashid et al. (2020) recently published a review of snow leopard-human conflict literature, including the spatio-temporal distribution of research articles, data collection

methodologies, conflict mitigation factors, and potential options for snow leopard-human conflict management. Our review, not surprisingly, aligns with the findings of Rashid et al. (2020) to a great extent, although we also investigated: 1) livestock, wild prey, and predator densities; 2) percent snow leopard, wolf and lynx predation within the snow leopard's range; and 3) the contributing factors to livestock predation reflected within the literature.

Understanding livestock, wild prey, and predator densities inform management decisions and conflict mitigation strategies, which eventually help predator species conservation as well as community livelihood. The amount of livestock predation can differ by every predator species in multi-predator landscapes (Moheb 2020), which sometimes result in accusing one predator species more than the others while the reality could be otherwise. While predation strategies differ by predators (Alexander et al. 2015), understanding the scope and amount of predation by every predator species is key for identifying species-specific solutions.

Our literature review reveals that not many of the conflict mitigation schemes are tested for effectiveness in their respective areas. The snow leopard-human conflict literature, in most cases (>78%), only suggest or report conservation and conflict mitigation measures rather than follow-up studies to test the effectiveness of those measures. Some conflict mitigation measures could be area- and species-specific and testing the effectiveness of such programs will help snow leopard and other carnivores throughout their global range.

Rashid et al. (2020) listed compensation programs, livestock management strategies, and community interventions as the most common interventions, and they recommended more focus

on “rangeland management” for future HSLC mitigation. However, in terms of intervention practices, we found that predator-proofing of corrals, training shepherds and improving livestock guarding, and livestock insurance were more commonly identified mitigation interventions as compared to compensation programs. Compensation for livestock loss, although widely used as compared to some other conflict-mitigation interventions, has different challenges including an exhaustive case verification process, and in many cases it is unsatisfactory for the impacted herders as the amount of loss is often far higher than the compensation herders receive (Jackson and Wangchuk 2001, Chen et al. 2016, Valentova 2017). Also, compensation for livestock loss frequently struggles with long-term sustainability due to insufficient funding resources.

Snow leopard predation on livestock pose varying amount of economic loss to local communities' dependent on livestock for their livelihood. The average economic loss due to snow leopard predation was up to 23.9%, ranging from 0.6–52% of herders' family per capita income. Supportive and compensatory mitigation measures relate to alleviating the economic hardship for the communities; however, these measures are rarely effective because they rarely match the actual loss, and other restrictions cause communities to remain unhappy with the process. This affects their attitude towards snow leopard and overall conservation programs in their areas. Although less than one third of the reviewed articles (n = 14) have reported the attitudes of local communities towards snow leopard and overall conservation programs, over 57%, 43%, and 7% of the articles reported positive, negative, and neutral attitudes, respectively.

It appears that conservation programs are imbalanced (Samelius et al. 2020) in at least two directions. First and most important, conservation biologists usually focus on the ecological outcome of their mitigation efforts as they aim to see the number of the target species increase (Redpath et al. 2015); this is different than the approach that considers both community livelihood and protection of predator species. Second, most snow leopard conservation programs only focus on the snow leopards and do not involve other relatively common and less threatened predators, although they co-occur in the landscape. For example, wolves and lynx share habitats with snow leopards and they also depredate livestock (Din et al. 2017, Namgail et al. 2007, Chen et al. 2016). Predation by sympatric predators also poses a threat to local community livelihoods, which often exacerbates negative attitudes of herder communities towards all predators (Samelius et al. 2020). However, abundance of other predator species may also decrease snow leopard predation on livestock. Din et al. (2019) have associated relatively limited snow leopard predation with the abundance of wolves in the Pamir region; however, they did not provide a reason or hypothesize why this might be the case.

Because protected areas cover only around 10% of snow leopard global range (Rashid et al. 2020), more than just land conservation designation is needed to ensure long-term sustainability of snow leopard populations. Reducing carnivore predation on livestock is essential for successful carnivore conservation (Linnell et al. 1999), and recent scientific literature has suggested a number of conflict mitigation measures. Future management efforts need to take into account the full range of possibilities,

and then tailor an approach depending on specific cultural, economic, and ecological circumstances.

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Appendix 1. Research articles appeared in the literature search for the snow leopard range countries.

COUNTRY AND REGION	MAIN PREDATOR SPECIES BESIDES SNOW LEOPARD	TYPE OF DATA	REFERENCE
Afghanistan (3)			
Wakhan National Park.....	wolf.....	Interview.....	Din et al. 2019
Wakhan National Park.....	wolf.....	Interview.....	Din et al. 2017
Wakhan National Park.....	wolf, lynx.....	Interview, field survey.....	Mishra & Fitzherbert 2004
Bhutan (1)			
Entire country.....	leopard, tiger, black bear.....	Compensation records.....	Sangay & Vernes 2008
China (5)			
Qomolangma National NR.....	wolf, lynx.....	Compensation records.....	Chen et al. 2016
Qilianshan National NR.....	wolf, lynx, brown bear.....	Interview.....	Alexander et al. 2015
Qilianshan National NR.....	wolf, fox, dhole, lynx.....	Camera trap data.....	Alexander et al. 2016
Taxkorgan.....	wolf, lynx, brown bear.....	Interview.....	Khan et al. 2014
Sanjiangyuan, Qinghai.....	wolf, lynx, brown bear.....	Interview.....	Li et al. 2013
India (11)			
Hemis National Park.....	-.....	Compensation records.....	Jamwal et al. 2019
Spiti Valley.....	-.....	Camera trap data.....	Sharma et al. 2015
Uttarakhand.....	-.....	Interview and scat analysis.....	Maheshwari et al. 2013
Spiti Valley.....	wolf.....	Field surveys and interview.....	Suryawanshi et al. 2013
Spiti Valley/Jammu & Kashmir.....	-.....	Surveys, trapping, scat analysis.....	Suryawanshi et al. 2017
Ladakh.....	wolf, lynx.....	Interview.....	Namgail et al. 2007
Pin Valley NP/Kibber Wildl Sanc.....	-.....	Scat analysis.....	Bagchi & Mishra 2006
Hemis National Park.....	-.....	Interview.....	Jackson & Wangchuk 2004
Kibber in Spiti Valley.....	-.....	Project report.....	Mishra et al. 2003
Hemis National Park.....	wolf, lynx.....	Interview.....	Jackson & Wangchuk 2001
Trans-Himalaya.....	wolf.....	Interview and field survey.....	Mishra 1997
Mongolia (4)			
Great Gobi Protected Area.....	-.....	Project report.....	Mishra et al. 2003
Tost and Bayasah, South Gobi.....	wolf.....	Interview.....	Mijiddorj et al. 2018
Tost in South Gobi.....	-.....	Surveys, trapping, scat analysis.....	Suryawanshi et al. 2017
Tost Mountain.....	-.....	GPS Telemetry.....	Johansson et al. 2015
Nepal (7)			
Annapurna-Manaslu landscape.....	wolf.....	Semi-structure questionnaire.....	Chetri et al. 2019
Annapurna-Manaslu landscape.....	wolf.....	Scat analysis-genetics.....	Chetri et al. 2017
Mustang region.....	wolf, fox, jackal, lynx.....	Interview.....	Aryal et al. 2014
Phu Valley.....	-.....	Scat analysis-genetics.....	Wegge et al. 2012
Kangchenjunga Conserv. Area.....	-.....	Interview.....	Gurung et al. 2011
Kanchenjunga Conserv. Area.....	-.....	Interview.....	Ikeda 2004
Annapurna Conserv. Area.....	-.....	Interview.....	Oli et al. 1994
Pakistan (7)			
Misgar, and Chuparsan.....	wolf.....	Interview.....	Din et al. 2019
Misgar, and Chuparsan.....	wolf.....	Interview.....	Din et al. 2017
Hushey Valley.....	wolf.....	Interview.....	Khan et al. 2018
Khunjerab.....	wolf, lynx, brown bear.....	Interview.....	Khan et al. 2014
Torkhow Valley.....	-.....	Sign survey/Questionnaire.....	Din & Nawaz 2011
Baltistan.....	-.....	Interview, field survey.....	Hussain 2003
Baltistan.....	-.....	Project report.....	Hussain 2000
Tajikistan (3)			
Tokhtamish, Shymak, Alichur.....	wolf.....	Interview.....	Din et al. 2019
Zorkul Reserve.....	wolf, bear.....	Scat analysis, Camera trap.....	Karimov et al.2018
Tokhtamish, Shymak, Alichu.....	wolf.....	Interview.....	Din et al. 2017

Note: no peer-reviewed research article appeared in the literature search for Kazakhstan, Kyrgyzstan, Russia, and Uzbekistan.

* = Double observer survey, interview, camera trapping, scat analysis

Appendix 2. Details of the proposed/reported conflict mitigation schemes.

CONFLICT MITIGATION SCHEMES	CITATION
Building predator proof corrals	
Improving corrals	Din et al. 2019
Predator-proof corrals construction	Mijiddorj et al. 2018
Use of predator-proof corrals	Alexander et al. 2016
Building predator-proof corrals	Moheb & Paley 2016
Subsidizing the predator-proof corral construction	Wilman & Wilman 2016
Predator-proofing of high-risk corrals.....	Jackson 2015
Predator-proof corrals	Qamar et al. 2010
Building proper corralling facilities.....	Wang & Macdonald 2006
Predator-proof livestock corrals.....	Ikeda 2004
Building predator-proof corrals	Jackson & Wangchuk 2001
Building predator-proof corrals	Mishra 1997
Compensation for livestock predation	
Self-financed compensation schemes.....	Mishra 1997
Predation compensation programs.....	Din et al. 2017
Compensation schemes.....	Alexander et al. 2015
Compensation for livestock losses.....	Jackson 2015
Compensation schemes for livestock losses.....	Khan et al. 2014
Efficient compensation	Bagchi & Mishra 2006
Financial compensation	Wang & Macdonald 2006
Compensatory programs	Ikeda 2004
Compensation schemes.....	Jackson & Wangchuk 2001
Financial compensation program.....	Oli et al. 1994
Livestock management	
Better husbandry practices.....	Alexander et al. 2016
Improved animal husbandry	Jackson & Wangchuk 2001
Improved animal husbandry practice.....	Oli et al. 1994
Stricter livestock herding practices	Chetri et al. 2019
Livestock management	Mijiddorj et al. 2018
Measures to address other livestock mortalities.....	Alexander et al. 2015
Improving animal husbandry techniques.....	Jackson & Wangchuk 2001
Animal husbandry modifications.....	Linnell et al. 1999
Preventing livestock increase in the future	Mishra 1997
Training shepherds and improving livestock guarding	
Training shepherds.....	Din et al. 2019
Improved livestock guarding.....	Khan et al. 2018
Livestock herding practice	Mijiddorj et al. 2018
Training shepherds how to guard their livestock.....	Moheb & Paley 2016
Improved daytime livestock guarding.....	Jackson 2015
Enhanced livestock guarding	Qamar et al. 2010
Improved livestock herding practice	Bagchi & Mishra 2006
Improving shepherds' herding and guarding practices.....	Wang & MacDonald 2006
Livestock insurance schemes	
Livestock insurance schemes.....	Din et al. 2019
Livestock insurance schemes.....	Din et al. 2017
Livestock insurance schemes.....	Wilman & Wilman 2016
Community-managed livestock insurance schemes	Jackson 2015
Livestock insurance schemes.....	Qamar et al. 2010
Livestock insurance schemes.....	Bagchi & Mishra 2006
Livestock insurance schemes.....	Wang & Macdonald 2006

(cont.) Appendix 2. Details of the proposed/reported conflict mitigation schemes.	
CONFLICT MITIGATION SCHEMES	CITATION
Removal of the carnivore species (either based on previous literature or suggested by the respondents)	
Eradication (30% of respondents suggested in KWS).....	Bagchi & Mishra 2006
Mechanisms to remove animals responsible for predations.....	Ikeda 2004
Removal of carnivores reported in earlier literature.....	Linnell et al. 1999
Elimination of trouble causing animals.....	Mishra 1997
Extermination suggested by most of the respondents.....	Oli et al. 1994
Livelihood schemes	
Wildlife tourism in the area.....	Oli et al. 1994
Handicrafts training, marketing, ecotourism trekking.....	Jackson & Wangchuk 2001
Handicrafts production.....	Jackson 2015
Involve herders in ecotourism activities.....	Ikeda 2004
Capacity building and awareness programs	
Education.....	Din et al. 2017
Capacity building & awareness at local & national levels.....	Moheb & Paley 2016
Educating herders on the importance of protecting natural prey.....	Jackson & Wangchuk 2001
Education program.....	Oli et al. 1994
Conservation of wild prey species	
Leasing pastures for wild prey.....	Wilman & Wilman 2016
Prey species restoration.....	Jackson 2015
Wild prey protection.....	Khan et al. 2014
Conservation of wild prey species.....	Moheb et al. 2012
Livestock vaccination	
Livestock vaccination.....	Din et al. 2019
Livestock disease control.....	Din et al. 2017
Livestock vaccination.....	Wilman & Wilman 2016
Immunization of livestock against diseases.....	Jackson 2015
Avoiding predator habitats	
Avoid predator habitats for grazing.....	Qamar et al. 2010
Land use zoning (avoidance of predator areas).....	Linnell et al. 1999
Avoidance of depredation hotspots.....	Jackson 2015
Guard dogs	
Good breeds of dogs.....	Qamar et al. 2010
Introduction of guard dogs.....	Ikeda 2004
Use of guard dogs.....	Khan et al. 2018
Community based conservation initiatives	
Paying herders for snow leopard conservation.....	Wilman & Wilman 2016
Community perceived ownership of the conservation projects.....	Jackson et al. 2002
Initiation of a community-based conservation program.....	Din & Nawaz 2007
Pasture management	
Adapting grazing restrictions.....	Alexander et al. 2015
Pasture improvement.....	Wang & Macdonald 2006
Other conflict mitigation measures	
Mapping conflict hotspots and investing in those areas.....	Chetri et al. 2019
Wire and stone fencing, flags, fire and scarecrows (reported by herders).....	Mijiddorj et al. 2018
Creation of core areas for snow leopard conservation.....	Ikeda 2004