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Snow Leopard Reports encourages exchange amongst snow leopard practitioners and researchers. The journal aims to collate and make available the latest information on snow leopard biology and conservation through contributions that capture the ecological and conservation status of the species and its wider habitat.

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Editorial

Connected for Better Snow Leopard Conservation

Two weeks ago, the fifth plenary meeting of the China Snow Leopard Conservation Network was held in Chengdu, Sichuan Province. There were 120 representatives from protected areas, NGOs, research institutions and local governments of snow leopard habitats across the country attended the meeting, and more than 3,000 people watched it online.

China's Snow Leopard Network was established in 2015. It was formed in a spontaneous manner, among individual and groups working on snow leopard monitoring and researches in the wild. There were less than a dozen members in the beginning, but now the number has multiplied several times. This means more people are interested and engaged in snow leopard conservation, more snow leopard habitats and populations are covered by monitoring and conservation – more attention has been paid to the species.

At the same time, our understanding and knowledge toward the snow leopard are increasing. In the past few years, occurrence of snow leopards has been reported in places where they have not been found before and far away from current populations: the Wanglang Nature Reserve in Sichuan, and even in Liaoning Province in northeast China. Snow leopards have been rediscovered in the Helan Mountain in Inner Mongolia after having disappeared for more than 60 years. Is the snow leopard's range expanding? Long term monitoring is required. If snow leopard populations are indeed dispersing over long distances – we're talking about hundreds of kilometers in distances – corridors are critical. In any case, it's a good sign.

Obviously, the expansion of knowledge also resulted in new conservation issues. New tools and technologies may help. Infrared cameras, which were new fifteen years ago, have become a widely applied monitoring tool. GPS collars, DNA and AI technology are playing increasingly important roles.

For conservation, effective protected areas are critical. Whether it is inside or outside the protected area, the community that lives in the same area as the snow leopard actually plays a leading role in protecting the snow leopard. At the same time, how to benefit local communities through snow leopard conservation remains challenging.

Source: ShanShui Conservation Center

Fortunately, there are already inspiring pilot projects presenting positive impacts of snow leopard conservation on community livelihoods, which, in return, attracted more community involvements in conservation.

What have been done is far from enough. We are still answering the question of where and how many snow leopards there are, what threats they face – ranging from intensified development activities in the context of economic downturn to increased climate impacts – and what we should do. And China's snow leopard habitat covered by monitoring is still less than 10%.

Sichuan Province responded positively. The province plans to spend three years supporting all protected areas in the snow leopard range to survey their populations and establish a standardized monitoring system. Sichuan is the eastern edge of the distribution of snow leopards. In addition to being famous for pandas, more and more protected areas have captured snow leopards in their infrared cameras in recent years. These protected areas proudly claimed a dual-flagship-species strategy.

The two flagships are functional. Research shows that the best protected regions for endangered species in China are the Southwest Mountains and the Qinghai-Tibet Plateau – the ranges of pandas and snow leopards. They are also global biodiversity hotspots and priority ecoregion. In addition to the panda and the snow leopard, the two adjacent areas are home to 8 other large carnivores, including the Bengal tiger, the leopard, the clouded leopard, the lynx, the gray wolf, the dhole, the brown bear and the black bear, the place with the most variety of large carnivores in the world.

This is applausable especially when we are in the battle of reversing the decline of global biodiversity by 2030. This battle is ultimately relying on the people who are willing and taking actions for such a change. And each of us could be one of those.

Snow Leopard Reports, the Snow Leopard Network's new journal, is set to make a significant contribution in bringing people together for better snow leopard conservation. I eagerly anticipate reading the articles it will publish, encompassing both research and conservation-focused content.

Lu Zhi
Peking University Center for Nature and Society
Shan Shui Conservation Center

Conservation News

Empowering local champions from across Mongolia's snow leopard landscape

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The Snow Leopard Conservation Foundation (SLCF) collaborates with over 30 local communities that manage 'Community Responsible Areas', which encompass over 12,000 square kilometers of snow leopard habitat. These communities participate in various conservation programs, such as a women-led handicraft program, Livestock Insurance Schemes, and Predator proofing of corrals. Each community elects its own leaders, who are respected individuals actively involved in local affairs. The community leaders are responsible for coordinating the management of designated 'Community Responsible Areas' approved by local authorities.

Image 1: *Community leaders participating in group exercises to identify the roles and responsibilities of their community members and develop strategies to effectively engage them.*

To enhance the capacity of community leaders, in January 2023, we conducted a workshop for 37 community leaders from across the snow leopard habitat. The workshop utilized the Partners Principles toolkit developed by the PARTNERS Conservation Alliance. Of the participants, 28 were women leaders and 9 were men leaders actively participating in the training. Many of these leaders had not met each other in nine years, given the vast distances across the snow leopard habitats in Mongolia. This training provided them with the opportunity to reconnect as a team and share their experiences.

We learned that the community leaders face various challenges in managing and engaging with their community members and other local stakeholders. These challenges include lack of confidence, team building skills, and skills in sharing their work with authorities/stakeholders and community members. The workshop aimed to provide the community leaders with organizational and management skills that translate into their roles as conservation leaders at the local and regional level. After the two-day workshop, they reported gaining skills in communication, negotiation, and human-wildlife conflict management. They also felt more confident as leaders and discovered new ways to bring their teams together.

> *"This training allows us to reflect where we [our community] are in terms of all conservation communities. I learnt many things from this training including communication skills, team bonding and ways to gain trust from different stakeholders"*
> (Uvs Saaltikhuren Oyunbileg)

Based on the training, we are developing a handbook for local champions to use as a reference in the future. We are grateful for the financial supporters of the workshop, including

Image 2. *Thirty seven community leaders from across Mongolia reunite after 9 years.*

Tencent Foundation, Shan Shui Conservation Center, and the Amity Foundation. Together, we are empowering 37 community leaders in the Mongolian snow leopard landscape.

A school student photographed rare snow leopard in the Nyinba Valley of Humla district, Nepal

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On January 24th, 2023, at 17:00, students from Manasarovar High School in the Humla district of Nepal had a peculiar encounter with an unknown animal that was chasing a horse. They had no idea what kind of animal it was until the first author recognized it as a snow leopard. The students, Nurbu Gyaljan Lama and three other friends from Burunse village, were searching for their livestock in the Laparsing pasture area at an elevation of around 3650m (Fig. 1), when they spotted a large cat's tail chasing a horse. Nurbu Lama, who is a grade

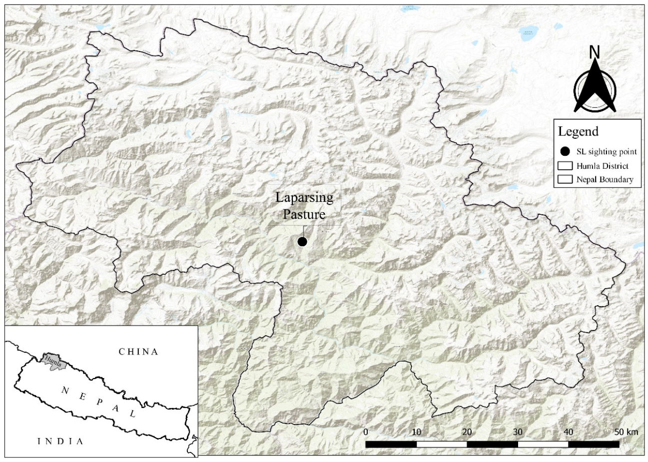

Figure 1: *Snow leopard sighting area in Nyinba valley, Humla*

10 student, mentioned that they were frightened by the animal and shouted loudly to scare it away. He quickly managed to take a photograph of it with his mobile phone (Image 1) and shared it with us

Image 1*: Snow leopard photographed in Nyinba valley, Humla Photo credit: Nurbu Gyaljan Lama*

for identification. This was the first time a snow leopard had been photographed in the Nyinba valley of Humla. Snow leopards are distributed throughout northern part of Humla, bordering the Tibet Autonomous Region of China. They are locally threatened due to conflicts with herders and the decline of their prey base from subsistence hunting (Lama et al. 2018). Snow leopards are classified as Endangered in the National Red List of Nepal and are listed as a protected species under the National Parks and Wildlife Conservation Act 1973 of the Government of Nepal.

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Research Note

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Body measurements of free-ranging snow leopards across their range

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Abstract

We provide body measurements of snow leopards collected from 55 individuals sampled in five of the major mountain ranges within the species distribution range; the Altai, Hindu Kush, Himalayas, Pamirs and Tien Shan mountains. Snow leopards appear to be similarly sized across their distribution range with mean body masses of 36 kg and 42 kg for adult females and adult males, respectively. In contrast to other large felids, we found little variation in body size and body mass between the sexes; adult males were on average 5% longer and 15% heavier than adult females.

Introduction

The snow leopard's (*Panthera uncia*) elusive behaviour combined with remote and often inaccessible habitat provide great challenges for scientific studies. As a consequence, much of the research around the species relies upon remotely collected data and few records of accurate morphological measurement have been published. Available information suggests a large variation in body measurements such as body mass ranging between 25 and 75 kg having been reported, perhaps inaccurately (Hemmer 1972). Scientists commonly collect standard body measurements and tissue samples, such as hair and blood, during the course of handling anesthetised animals for telemetry-based research and monitoring. These measurements can be used to describe a species morphology, help distinguish taxonomic distinctions of possible subspecies (e.g. Haig et al. 2006) and ultimately develop a better understanding of the species. To provide a more precise description of snow leopard morphology, assess the extent of sexual dimorphism and investigate for possible variation across the species distribution range, we have collated measurements from snow leopards measured in five of the 12 snow leopard range countries.

Methods

Data were collected from 47 snow leopards in the Pamirs (Afghanistan; n=7), Tien Shan (Kyrgyzstan; n=7), Hindu Kush (Pakistan; n=1), and the Altai (Mongolia; n=32) in 2006-2019 (Fig 1). Four of the snow leopards in Afghanistan were measured during captures, the remaining three were found

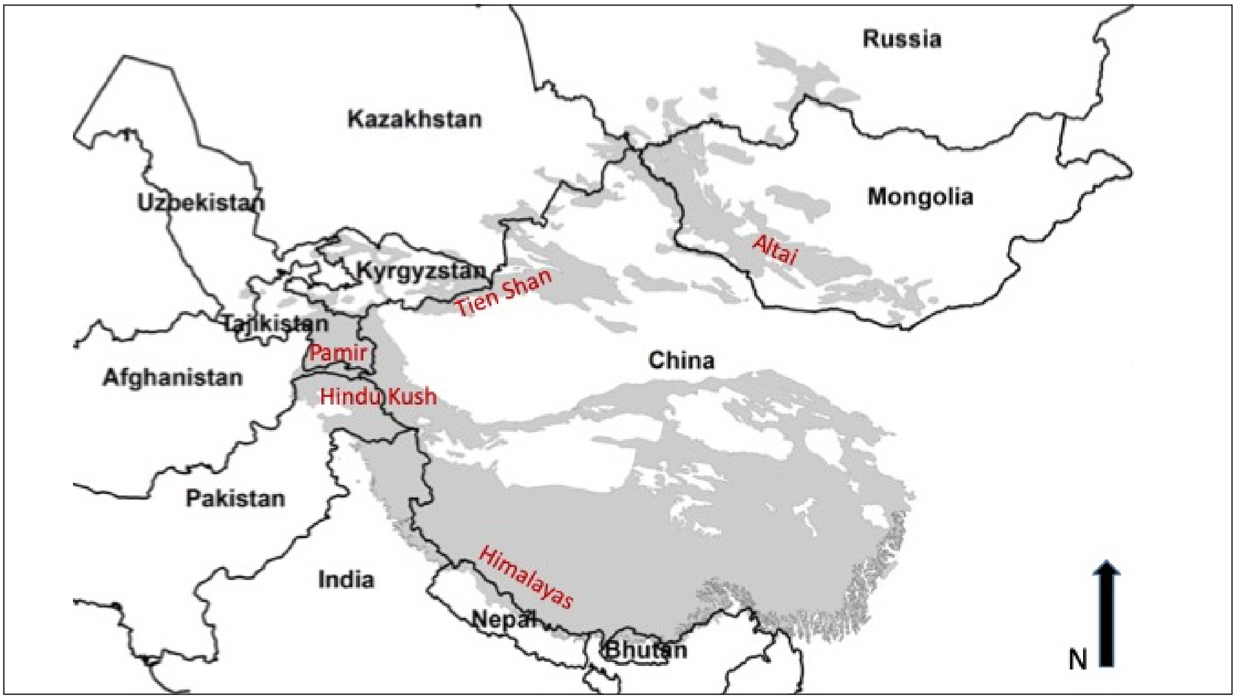

Fig. 1. *Map of the snow leopard distribution range (shaded grey) and the locations of the study areas (mountain ranges in red): Pamir – Hindu Kush; Wakhan Corridor, Afghanistan and Chitral Gol, Pakistan, Tien Shan; Sarychat, Kyrgyzstan, Himalayas; Langu valley, Nepal and Kanchenjunga Nepal, Altai; Tost Mountains, Mongolia.*

dead during field work. All measurements were collected for the cats that were found dead except for body mass when it was estimated that the carcass was older than a few days (n=2). We also included published information from the Himalayas (Nepal; n=8) (Jackson 1996; KCA 2019) in the analyses. Body length of the snow leopards in Kanchenjunga, Nepal did not include the head, we removed these measurements to allow for comparisons. All measurements were collected with measuring tape and spring or digital scales. Age was estimated based on tooth wear and colour, body size, presence of facial scars from territorial disputes and nipple coloration (Johansson et al. 2016). Because large felids grow slowly and do not reach full adult size until 4-5 years of age (Sunquist and Sunquist 2002) and snow leopards are unlikely to reproduce before three years age (Johansson et al. 2021), we classified snow leopards less than or 3 years of age as subadults following Johansson et al. (2016). We provide measurements for body

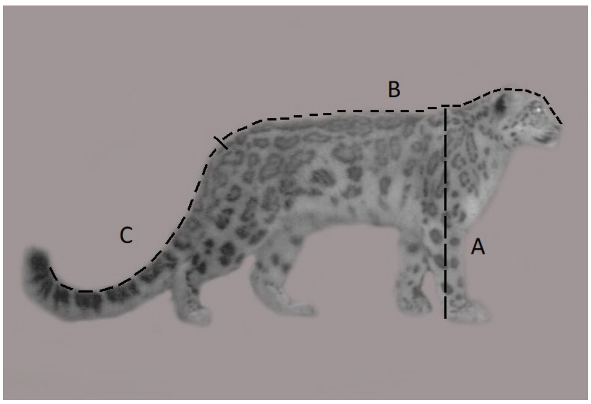

Fig. 2. *Body measurements of snow leopards,*
A: shoulder height measured from the heel of the front paw to top of the shoulder blade
B: body length measured from the tip of the nose to base of the tail, and
C: tail length measured from base of the tail to the tip of the last caudal vertebra.

mass (total weight), body length (tip of the nose to base of the tail), tail length (base of the tail to the tip of the last caudal vertebra) and shoulder height (heel of front paw to top of the shoulder blade), see Fig. 2. For individuals that were captured and measured more than once, we provide the average of all measurements except if the animal transitioned between age classes. For individuals that were measured both as subadults and adults (2 females, 6 males), we provide one measurement for each age class respectively. This yielded a total dataset of up to 63 measurements for 55 individuals (19 adult females, 11 subadult females, 23 adult males and 10 subadult males).

We tested for variation in snow leopard body length, tail length and body mass among mountain ranges (the Altai mountains, Himalayas, Pamir-Hindu Kush, and Tien Shan), between adult males and females, and along a latitudinal gradient using linear models in R (R Development Core Team, 2019). Because the study areas in Pamirs and Hindu Kush were relatively close to each other we combined these samples into one group (Pamir-Hindu Kush). Comparisons could not be made for shoulder height due to low sample size. Only adult individuals were included in the comparisons because the subadults were still growing and we lacked accurate age estimates, preventing meaningful comparisons. Measurements for subadults are included for reference only.

Results

We did not detect any differences among the mountain ranges in body length (Females: $F(9)=3.5$, $p=0.07$. Males: $F(18)=2.8$, $p=0.09$), tail length (Females: $F(9)=1.3$, $p=0.33$. Males: $F(19)=0.10$, $p=0.96$) or body mass (Females: $F(14)=1.7$, $p=0.21$. Males: $F(17)=0.91$, $p=0.46$) for adult snow leopards (Table 1). Adult males

Table 1. Body measurements of adult snow leopards sampled in four mountain ranges across the snow leopard distribution range. Values are given as mean±SD (n).

SEX	AGE CLASS	MOUNTAIN RANGE	BODY LENGTH	TAIL LENGTH	SHOULDER HEIGHT	BODY MASS
Female	**Adult**					
		Pamirs-Hindu Kush	109±1 (4)	93±1 (4)	67±1 (3)	38±3(3)
		Tien Shan	100±3 (4)	91±1 (4)	-	34±4 (4)
		Altai	108±7 (5)	91±4 (5)	56 (1)	36±2 (10)
		Himalaya	-	-	-	39 (1)
		All mountains	*106±6 (13)*	*92±3 (13)*	*64±5 (4)*	*36±3 (18)*
	Subadult					
		Pamirs-Hindu Kush	111 (1)	94 (1)	68 (1)	-
		Tien Shan	-	-	-	-
		Altai	101±7 (4)	86±5 (4)	-	31± (7)
		Himalaya	-	87±9 (2)	60±4 (2)	27±5 (3)
		All mountains	*103±8 (5)*	*87±6 (7)*	*63±5 (3)*	*30±5 (10)*
Male	**Adult**					
		Pamirs-Hindu Kush	112±2 (4)	95±2 (4)	67±1 (4)	39±5 (3)
		Tien Shan	113±3 (3)	95±7 (3)	-	42±3 (3)
		Altai	118±5 (14)	94±5 (14)	61±3 (4)	43±4 (13)
		Himalaya	-	95±3 (2)	65±7 (2)	41±1 (2)
		All mountains	*116±5 (21)*	*95±4 (23)*	*64±4 (10)*	*42±4 (21)*
	Subadult					
		Pamirs-Hindu Kush	-	-	-	-
		Tien Shan		-	-	- -
		Altai	111±7 (7)	90±3 (7)	59 (1)	36±3 (8)
		Himalaya	-	-	-	34±1 (2)
		All mountains	*111±7 (7)*	*90±3 (7)*	*59 (1)*	*35±3 (10)*

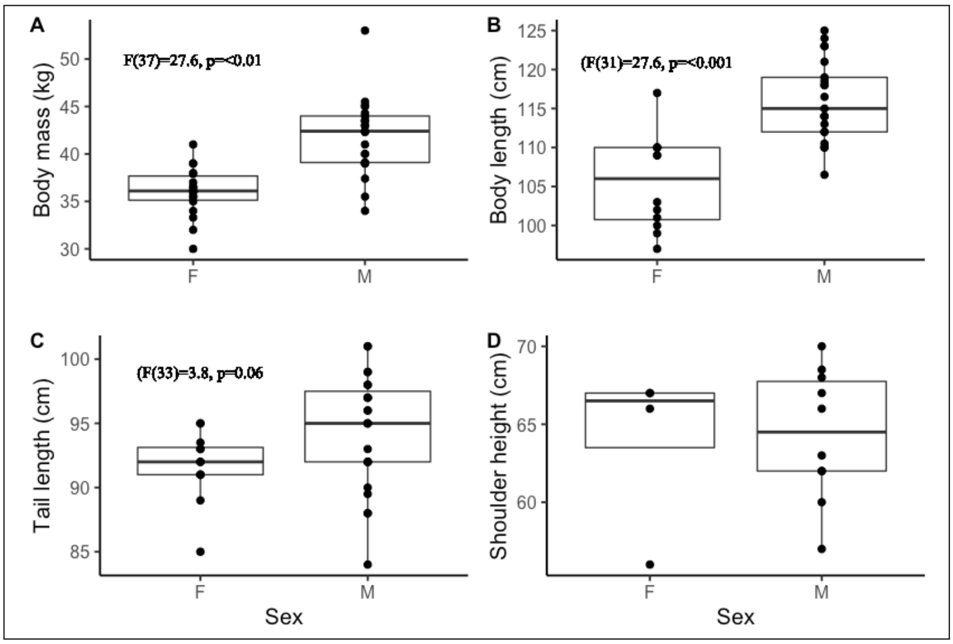

Fig. 3. *Body mass and size of adult snow leopard females and males. The boxes include all values within the 25th and 75th quantile.*

had greater body mass (F(37)=27.6, p=<0.001) and body length (F(31)=27.6, p=<0.001) than adult females whereas tail length did not differ (F(33)=3.8, p=0.06) (Table 1). Adult snow leopard males weighed on average 15% more and had 5% longer bodies than adult females (Table 1). Within the sexes, variation in body mass and size was rather small among adults with 95% of the measurements within ±15% of the mean value (Fig. 3). Mean values (± SD) of the body measurements are presented in Table 1. We did not detect any correlation between body mass and latitude (F(57)=2.2, p=0.14).

Discussion

Snow leopards appear to be similarly sized across their distribution range. This contrasts to the other solitary-living members of the genus *Panthera* (*P. pardus, P. tigris* and *P. onca*) which vary in size geographically by up to two times (e.g. average weights of adult male leopards range from 31 kg in Cape Mountains, South Africa to 66 kg in Iran; Sunquist and Sunquist 2002, Farhadinia et al. 2014, Hunter 2015). Temperatures in the high-altitude habitat used by the snow leopards are likely more affected by altitude than latitude, which would explain the lack of correlation between latitude and body mass (see Bergmann's rule; Bergmann 1847). Sexual dimorphism is common in mammals with polygynous mating systems where males are commonly larger than females because of increased competition for access to breeding females. However, the difference in body mass and size between adult male and female snow leopards was very small compared to jaguars, leopards and tigers where average male body mass range from 1.4 to 1.7 times the body mass of adult females (Sunquist and Sunquist 2002, Wilson and Mittermeyer 2009, Hunter 2015). Snow leopards also show much less sexual dimorphism in craniomandibular and dental size than the other members of Panthera (Christiansen and Harris 2012). Similarly, individual variation in body mass and size within the sexes was rather small for the adult snow leopards compared to e.g. Persian leopards where adult male weights range from 40 to 91 kg (Farhadinia et al. 2014). Janecka et al. (2017) proposed that three subspecies of snow leopards occur based on three genetic clusters (corresponding to Altai, Himalayas and Tien Shan, Hindu Kush and Pamir), our results indicate that the snow leopards across these clusters are similarly sized. Throughout the snow leopard distribution range, the main available prey range in size from 36 to 72 kg (Lyngdoh et al. 2014), perhaps the snow leopards are optimally sized to hunt these prey in the steep slopes and natural selection prevents individuals from becoming much larger or smaller.

A simple, yet fairly precise description of an averagely-sized snow leopard appears to be a body length of 110 cm, tail length of 90 cm, shoulder height of 65 cm, and body mass of 40 kg and that most males are up to 10% larger whereas females are up to 10% smaller. The greater variation in shoulder height compared to body and tail length is likely due to higher intra and interobserver error depending on how much the front leg was extended when conducting the measurement. These morphological values can be used to calculate standard drug doses for immobilization of free-ranging snow leopards and to improve the husbandry and wellbeing of snow leopards in captivity.

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Snow Leopard REPORTS

Field Note

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Risky business: red foxes killed when scavenging from snow leopard kills

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Interspecific killing,
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Panthera uncia,
Vulpes vulpes

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Abstract

Scavenging of foods is a common but potentially dangerous behavior that exposes animals to risk of injury and even death from other animals. Here we report on two observations of red foxes that were killed when scavenging from snow leopard kills that illustrates the risks associated with scavenging for red foxes and other small and medium-sized predators.

Main text

Scavenging is a common behavior among many mammals and birds (De Vault et al. 2003, Iyengar 2008). While the behavior provides easy access to foods, sometimes in large amounts, it is also a dangerous behavior as animals may get injured or even killed by other animals when scavenging (Iyengar 2008, Prugh and Sivy 2020). Red foxes (*Vulpes vulpes*) are opportunistic predators and scavengers that occur throughout a large portion of the northern hemisphere (Larivière and Pasitschniak-Arts 1996). Red foxes have diverse diets with scavenging often being an important source of foods (Larivière and Pasitschniak-Arts 1996). Here we report on two observations of red foxes that were killed when scavenging from snow leopard (*Panthera uncia*) kills in two different parts of the snow leopard range.

The first observation of a red fox killed when scavenging from a snow leopard kill was made in the Sanjiangyuan Region on the Eastern Tibetan Plateau in China (34° N, 94° E) on 24 April 2011. The observation was made when setting up a camera trap at a snow leopard kill inside a narrow valley (see Li et al. 2013 for detail). We spotted a snow leopard climbing a slope as we entered the valley. We judged the snow leopard to be the same female that visited the kill with two cubs the following night based on photos from the camera trap that we set up at the site. We found a bharal (*Pseudois nayaur*) carcass at the bottom of the small valley and a dead red fox lying 5 meters away from the carcass. The fox had a bit of blood dripping from the mouth but no other clear wounds (Fig. 1). We suspect that the blood in the mouth might have been caused by a nape bite or suffocation associated with a throat bite by the snow leopard. We put an infrared camera beside the kill and recorded the snow leopard returning

Fig. 1. *Red fox found dead at the kill site of a snow leopard in Sanjiangyuan Region on the Eastern Tibetan Plateau in April 2011. The fox had a bit of blood dripping out of the mouth but no other clear wounds.*

to the carcass at 16:24 which was approximately one hour after we left the site. The snow leopard fed on the carcass for 15 minutes during which it called occasionally. It left the carcass at 16:38 and returned to the carcass with two cubs at 18:58. The cubs stayed at the kill until 19:40 and fed on the carcass during most of the time. The female snow leopard stayed at the kill until 20:18 and then returned again from 20:47 to 21:47. A Tibetan brown bear (*Ursus arctos pruinosus*) replaced the snow leopards at the kill and was at the carcass from 21:50 to 00:15 and then returned for a short visit at 06:52. Neither the snow leopards or the brown bear touched or showed any interest in the dead fox. We saw snow leopard and fox tracks at the kill site on the first visit to the kill site but no signs from any other carnivores.

The second observation of a red fox killed when scavenging from a snow leopard kill was made in the Tost Mountains in Southern Mongolia (43° N, 100° E) on 7 April 2018. The observation was made at a cluster (an aggregation of positions) from a GPS-collared snow leopard as part of our work on snow leopard predation patterns (see Johansson et al. 2015 for details). Clusters are visited after the snow leopards have left the kills to avoid disturbing the animals. The cluster where we found the dead fox was from an adult male snow leopard that had killed a domestic goat (*Capra aegagrus*). The snow leopard was at the cluster from 15:00 on 27 March to 19:00 on 28 March and then returned to the kill from 04:00 to 19:00 on 31 March and, again, from 00:00 to 01:00 on 1 April. When we visited the cluster on 7 April, we found a dead red fox ca 30 meters from the goat carcass. The fox had a small drop of blood on the right flank but did not show any other signs of outside trauma (Fig. 2). The backbone of the fox was crushed (soft) whereas the skull was hard and did not show any evidence of biting. We saw snow leopard and fox tracks and what we judged to be snow leopard and fox scats at the kill site but no signs of any other carnivores.

Fig. 2. *Red fox found dead at the kill site of a male snow leopard in the Tost Mountains in southern Mongolia in April 2018. The fox had a small drop of blood on the right flank and the backbone was crushed but did not show any other signs of outside trauma.*

The observations reported here are, to our knowledge, the first reports of red foxes killed when scavenging from snow leopard kills and they illustrate the risks associated with scavenging for red foxes and other small and medium-sized predators (De Vault et al. 2003, Iyengar 2008). We could not determine that these foxes were killed by snow leopards as it is possible that they were killed by other large carnivores. However, the only other large carnivores present in these areas were brown bears, wolves (*Canis lupus*), and dogs (*Canis familiaris*) that generally kill by slashing bites or bites and shakes that results in large wounds (Ewer 1973). Felids, on the other hand, generally kill by a strong bite to the throat or back of the prey (Ewer 1973, Leyhausen 1979). The evidence therefore strongly suggest that the foxes were killed by snow leopards because there were no signs of outer trauma on the foxes and we did not see signs of any other large carnivores when finding the dead foxes (the bear that visited the carcass on the Tibetan Plateau visited the site after we found the fox). Red foxes often scavenge foods and we commonly see them and other scavengers and their signs at the snow leopard kills in the studies on the Tibetan Plateau and in southern Mongolia (Li et al. 2013, Johansson et al. 2015). Scavenging animals are often very cautions and vigilant when scavenging (Wikenros et al. 2014) and we sometimes see red foxes leaving the snow leopard kills when visiting them after the snow leopards have left the kills (Snow Leopard Trust, Unpublished data). We therefore suggest that red foxes are generally very cautious when at the kill sites and that the majority of these visits occur when the foxes perceive that the snow leopards have left the kills given the potential risks associated with this behavior.

Interspecific killing among carnivores is relatively common (Palomares and Caro 1999, Donadio and Buskirk 2006) and red foxes have been reported to be killed by wolves and lynx (*Lynx spp.*) (Stephenson et al. 1991, Peterson 1995, Jobin et al. 2000, Helldin et al. 2006). Carnivores may kill other carnivore species to reduce competition, avoid losing foods to scavengers, reduce the risk of infant mortality, for consumption, or a combination thereof where prey availability may affect whether or not the dead animal is consumed (Palomares and Caro 1999). The two foxes reported here were untouched which suggest that they were killed to avoid losing foods to scavengers rather than killed for consumption. Snow leopards have been reported to feed on red foxes occasionally although it was unknown if the foxes in these studies were killed by the snow leopards or scavenged (Lovari et al. 2013, Lyngdoh et al. 2014).

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

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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/

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

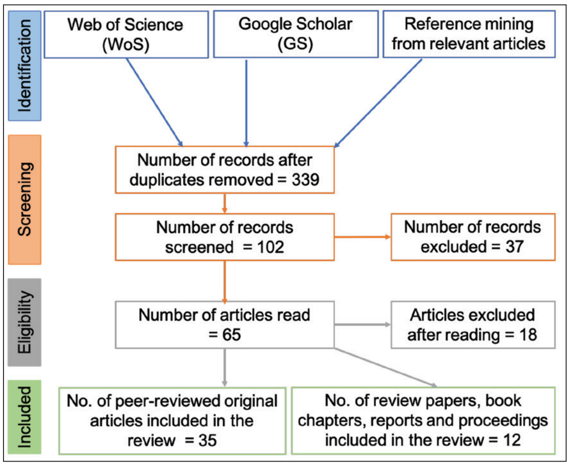

Fig. 1. *Various steps of systematic review from searching through the inclusion of the human-snow leopard conflict relevant articles in the review.*

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,

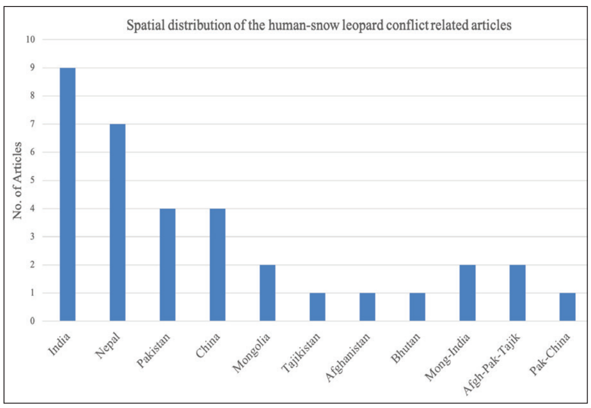

Fig. 2. *Number of human-snow leopard conflict related articles identified for each of the snow leopard range countries.*

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

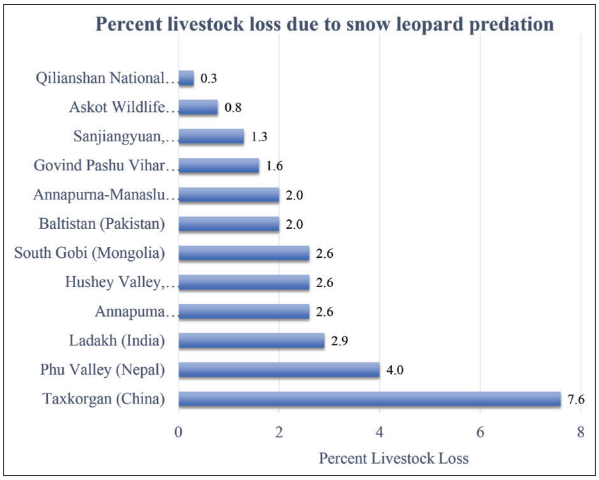

Fig. 3. *Percent livestock loss due to snow leopard predation in different areas across the species range.*

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 km^2 for snow leopards, No./km^2 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]	PAlsS	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]	CAPls	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; PAlsS = 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; CAPls = 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
Annapuma 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

"They are symbols of an environment; if you protect them in their environments you automatically protect thousands of other species of plants and animals… Everything is inter-related in nature… We have plenty of work to do in the decades and centuries to come" – George Schaller

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