Livestock husbandry and snow leopard conservation

Snow Leopards

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CHAPTER

18

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SUBCHAPTER

18.1

Corral improvements

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Introduction

Livestock depredation and retaliatory killing in response to such events are some of the key sources of snow leopard mortality across their range (SLN, 2014). Livestock depredation rates due to snow leopards and other carnivores, such as wolves, vary widely from under 1% in parts of Mongolia and China (Schaller, 1998; Schaller et al., 1994) to over 12% of livestock holdings in some parts in Nepal and India (Jackson et al., 1996; Bhatnagar et al., 1999; Mishra, 1997), but they generally average 3%–5% (Mallon, 1991; Oli et al., 1994; Namgail et al., 2007; Maheshwari et al., 2010; Wegge et al., 2012; SLN, 2014; Mijiddorj et al., 2018; Samelius et al., 2021). However, the amount of livestock predation by snow leopards alone, as reported in the literature, ranges between 0.3% and 4% with an average of 2.1% of the livestock holding across the range. Snow leopards sometimes break into livestock corrals, often as a result of poor maintenance and design, killing many domestic goats and sheep during the attack and thereby inflicting substantial economic damage and emotional trauma to the livestock owners (Jackson and Wangchuk, 2004). People often respond to these attacks by killing the snow leopard and sometimes selling their body parts. Improvements to livestock corrals have increased livestock protection by reducing depredation by snow leopards (Bhatnagar et al., 1999; Jackson and Wangchuk, 2001, 2004; Samelius et al., 2021).

Many corrals seen in snow leopard habitats do not have a proper roof and have gaps in the walls allowing snow leopards and other carnivores to easily climb in. At other times, poor maintenance and local people's lack of material and financial resources to make improvements have led to some roofs and walls to collapse, leaving the livestock vulnerable to predation.

This is where corral improvements have emerged as a very important conflict mitigation tool across many of the snow leopard range countries, including Afghanistan, India, Kyrgyzstan,

Nepal, Mongolia, Pakistan, and Tajikistan. Corral improvements, or predator proofing of corrals, may seek to eliminate livestock losses in corrals, although 100% predator-proof corrals are expensive and difficult to construct. Proofing of corrals typically involve securing the corral to prevent entry by snow leopards and other large predators. Corrals can come in different sizes and forms, depending on how large the herds are, the needs of the families, and the materials available. Communal corrals may be larger and accommodate as many as 700 sheep and goats.

FIG. 18.1.1 Roof of a family corral in the Wakhan, Afghanistan. *Photo courtesy Zalmai Moheb.*

Design of corrals across the snow leopard range: Examples from Afghanistan, India, Kyrgyzstan, Mongolia, Pakistan, and Tajikistan

In the Wakhan National Park of Afghanistan, snow leopards and wolves frequently predate on livestock, causing significant loss of income and threatening food security. Wolves are responsible for over 90% of livestock predation in the area (Simms et al., 2011); however, snow leopard predation, although relatively low, often results in more livestock killed when it happens inside corrals. In retaliation for these incidents, snow leopards and wolves are killed. The predation problem attributed to snow leopards stems largely from the livestock corrals in Wakhan. The traditional corrals either used communally or privately by families in Wakhan are often low-walled structures with no roof (for summer use) or lose roof coverage (in winter) that offers very limited protection against predators and which the predators can very easily gain access. When inside and surrounded by terrified livestock, snow leopards often kill multiple animals (Simms et al., 2011). The Wildlife Conservation Society (WCS) and the Wakhan-Pamir Association (WPA) have been addressing this problem through corral improvements and construction of "predator-proof corrals" (Simms et al., 2011) (Fig. 18.1.1).

Since 2010, 39 predator-proof communal corrals have been built that all the community members in those areas can use and access. In addition, 1079 traditional personal corrals within 34 villages along the Wakhan Valley have been predator-proofed in snow leopard predation hotspots. The corrals have successfully reduced livestock losses and consequent retaliatory killing in the area. On one occasion, however, a snow leopard intruded into an improved household corral where it killed 22 sheep and goats and injured another eight in 2018, but later investigation showed that the roof of that corral had collapsed and was repaired poorly with a layer of dry vegetation. Demand for more corrals is very high among the communities in the Wakhan National Park and its surrounding buffer areas, i.e., Ishkashim and Zibak. The corrals have thick, high stone walls, and a wire mesh roof, which prevent snow leopards and wolves from gaining access.

The corrals are approximately 15 m (9–21 m) long, 8 m (5–12 m) wide, with 2–3 m high walls. The size of the predator-proof corral depends on the number of livestock owned by the communities. Herders in Pamir region, where livestock is the only source of livelihood, and

people have relatively higher number of livestock, ask for larger corrals (at least 10 m × 20 m) to accommodate their livestock.

Predator-proof corrals are built from local materials—stone, timber, and wire—and they are able to house over 500 sheep and goats. Based on the corral project experience in Wakhan, it is important to plaster, with local material (a mixture of dirt and straw), the corral walls on both sides. This will strengthen the corral walls, enabling them to stay firm for a longer period, and also protect against humidity in those high altitudes.

In India, more than 200 predator-proof livestock corrals have been built in Ladakh and Spiti, by Snow Leopard Conservancy—India Trust and Nature Conservation Foundation, benefiting more than 120 communities. Herders report that in the past, they used to sleep outside the corrals to fend off potential snow leopard attacks, but this is no longer necessary as snow leopard attacks do not occur where the corrals have been predator-proofed. The work involved in reinforcing corrals ranges from fixing metal grills on open windows and replacing old doors, to enclosing the open roof with a meshed frame, to reconstructing the entire corral in some cases. The size of corrals varies from 4.5 m long, 3 m wide, and 1.5 m high, where herders own up to 30 sheep and goats, to 9 m long, 14 m wide, and 1.2 m high, with meshed frames where individual livestock holdings may reach 500. Parts of these structures, especially the meshed frames, are prone to damage from harsh weather and hence require routine maintenance to remain effective (Fig. 18.1.2).

In Kyrgyzstan and Mongolia, the Snow Leopard Trust, Snow Leopard Conservation Foundation, and Snow Leopard Foundation have supported the construction of tall fences to improve nighttime corrals for large herds of goat and sheep (with mean livestock holding of about 400 sheep and goats in Mongolia and about 350 in Kyrgyzstan). The fences are 2 m tall and consist of wire-mesh nets supported by metal poles (see Samelius et al., 2021). The fences in Mongolia are about 18 × 18 m and in Kyrgyzstan about

FIG. 18.1.2 A family corral in Spiti valley, India. *Photo courtesy Tanzin Thinley, Nature Conservation Foundation.*

15 × 15 m. The fences in Mongolia are built around existing stone corrals when possible, to provide shelter from the wind, and the fences in Kyrgyzstan are supported with a wire mesh roof to prevent predators from jumping in. The fences have succeeded in reducing livestock losses (see Samelius et al., 2021) but are not as strong as small buildings or other structures made from stone or heavy wood and thus require regular maintenance such as adding soil or rocks to places where the soil and goat dung had washed away under the fence. The herders also suggested complementing the fences with some type of wind break, which would require more support poles if attached to the fence. We suggest supplementing the fences with guard dogs when using open-top fences to deter predators from approaching or attempting to dig under fences (Fig. 18.1.3).

In north-eastern Pakistan, the Baltistan Wildlife Conservation and Development Organization (BWCDO) has constructed more than 60 improved and predator-proof corrals. The average size of the corrals is 15 × 6 m, and they accommodate 300 sheep and goats. Most of the corrals are constructed by the local communities on a cost-sharing basis. Like in Tajikistan, India, and Afghanistan, there have been no reports of snow leopard attacks on livestock in the predator-proof corrals in Pakistan. Prior to the construction of the predator-proof corrals, there were many attacks on livestock. In one instance in 2004, in the village of Hushe in the Ganche valley, a snow leopard attacked an unprotected corral and killed 18 sheep and goats. Despite the loss, the community released the snow leopard. In 2011, in Manthal, near Skardu, a snow leopard that had attacked livestock was

FIG. 18.1.3 A traditional corral in southern Mongolia with a tall fence built around it to reduce nighttime losses. The purpose of the traditional corrals is not to keep predators out but to keep the herd together and to provide shelter from the wind. *Photo courtesy Gustaf Samelius.*

FIG. 18.1.4 A communal corral in Basho Sultanabad, Gilgit-Baltistan, Pakistan. *Photo courtesy Ghulam Mohammad.*

heavily beaten by the community and later died. On another occasion, in 2019, a snow leopard found its way into a makeshift corral built by the people of village Mendi in Skardu district. Fifty-six livestock were killed inflicting huge financial losses for the community. The community demanded compensation in the form of a new corral, which BWCDO constructed for them on an emergency basis setting an example of tolerance for other villages (Fig. 18.1.4).

In Tajikistan, the international conservation organization Panthera, the Aga Khan Foundation (AKF), and the Association of Nature Conservation Organizations of Tajikistan (ANCOT) have supported the improvement and predator proofing of more than 120 corrals to date. Most of them are small and meet the needs of single families, although some of them are larger and used communally and may keep as many as 700 sheep and goats. The gaps in the wire mesh used to cover the roof are wide to let the snow fall through, preventing accumulation and possible collapse of the roof. The first corrals were built in 2013, and since then, no livestock depredation events have been recorded.

Measuring the success of corral improvements and documenting problems

Currently, there is still limited empirical evidence to demonstrate the impact of systematic measures to improve livestock husbandry, such as corral improvements, on depredation rates and the retaliatory killing of snow leopards. To begin with, formalized records of improved corrals are largely lacking (but see Samelius et al., 2021), despite the fact that many structures have already been predator-proofed. As described above, none of the improved or predator-proofed corrals have experienced depredation—while in some cases, in the same villages, the nonimproved corrals and poorly maintained improved corrals have experienced livestock losses. While the design is different, there are some interesting parallels between corral improvements and improvements to bomas (Swahili name for traditional livestock enclosures) in East Africa to deter lion predation on livestock (Lichtenfeld et al., 2015); these authors provide an evidence-based account of the significant impact boma improvements have on reducing livestock depredation and the

retaliatory killing of lions and leopards. Over a period of 10 years, there were only two recorded depredations, in both cases because the gate of the fortified boma was not properly constructed, and a leopard was able to enter and kill sheep and goats.

There have been similar instances, in Hushe, Baltistan, in Pakistan, and Wakhan National Park in Afghanistan. In Hushe of Pakistan, a door to a regular corral was not properly secured and the sheep and goats ran out and were killed by snow leopards and wolves. In a similar case, a snow leopard intruded through a poorly repaired part of a previously improved personal corral and killed 22 sheep and goats in Wakhan of Afghanistan. Therefore, poor oversight or poor maintenance could compromise the effectiveness of corral improvements.

How to improve corrals sustainably to enable more widespread use in the future?

Significant funds and human resources are necessary to improve livestock corrals across the greater part of the snow leopard range. The key is to ensure that corral improvements benefit high-risk depredation sites and high-density snow leopard areas. There are situations when conservationists respond to the request to build a predator-proof corral without concrete proof that a snow leopard was responsible for the alleged depredation. Assessment of which species of predator was responsible for the depredation can be achieved through a combination of interviews with livestock owners, depredation records (including images of livestock injured or killed), diet assessment, and camera trap surveys.

Preference for the types of predator-proof corral (i.e., communal, or personal corrals) differs by location and the socioeconomic situation of herder communities. In some places, community corrals are mostly used by wealthy families, with more livestock, while herders with a smaller number of livestock become marginalized. In addition, in villages with scattered houses, communal corrals are likely to be used more often by the nearby households especially during winter. Families who either have a smaller number of livestock or live away from the communal corrals do not use them as frequently. In areas with scattered houses in a village, it might be useful to build several small personal or communal corrals in different parts of the village instead of a single large communal corral.

While local labor can be provided for free and materials such as rocks and wood can be sourced locally at little or no cost, the expense of purchasing and transporting wire mesh and cement, often from China or Iran, remains high and beyond the budgets of many small mountain communities. Another challenge is maintenance of the corrals over time. As predator-proof corrals age, and parts such as doors, require replacement, neglect in performing repairs eventually causes the corrals to cease being predator-proof, exposing the livestock to predation. It is therefore crucial to stress the importance of proper maintenance to the owners of the corrals and ensure that responsibility for maintenance is clearly stated in an agreement between the conservation organization and the corral owners. Corral maintenance should be the responsibility of the owners although it is important that conservation organizations help with advice and support as well as ensure that corral owners understand the importance of proper maintenance. In fact, maintenance and sustainability of corrals remain a challenge for poor and remote communities. Finally, the success of corral improvements in reducing conflict, while undoubtedly important across snow leopard range, still remains difficult to fully evaluate, including measuring the proportion of reduced predation resulting from improved corrals versus nonimproved corrals. This will continue to require further monitoring and research.

SUBCHAPTER

18.2

The role of village reserves in revitalizing the natural prey base of the snow leopard

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Introduction

Ungulates play important roles as drivers of ecosystem functions and as prey of large carnivores (Mishra et al., 2016). Wild mountain ungulates such as the bharal or blue sheep (*Pseudois nayaur*), Siberian ibex (*Capra sibirica*), argali (*Ovis ammon*), and Himalayan tahr (*Hemitragus jemlahicus*) form the main prey of the endangered snow leopard, which specializes in feeding on ungulates (Jackson et al., 2010; Johansson et al., 2015). The abundance of wild ungulates in any area is the key determinant of snow leopard abundance (Suryawanshi, 2013).

The primary productivity of the dry and cold landscapes in which snow leopards occur is in general low compared to tropical and temperate rangeland systems (Jackson et al., 2010; Mishra et al., 2010; Namgail et al., 2012), and they support relatively low densities of wild ungulate prey, typically ranging from <1 to about 5 per km^2 (Mishra et al., 2004; Suryawanshi et al., 2012; Tumursukh et al., 2016). Many mountain ungulate species occurring here are wild relatives of livestock, representing an important genetic resource. Most of their populations are in decline, and the conservation status of species such as markhor (*Capra falconeri*) (Near Threatened; IUCN Red List), tahr, and argali (Near Threatened) is a matter of immediate concern (see Chapter 4). Thus, conserving wild ungulates and enhancing their abundance are of conservation value by itself and are also an important aspect of snow leopard conservation.

Snow leopards occur in multiple-use landscapes that are used extensively and often pervasively used for livestock grazing (Jackson et al., 2010). Overstocking of rangelands with livestock can lead to competition for forage and for space with wild ungulate prey of the snow leopard (Mishra et al., 2001, 2004). Decline in populations of wild ungulates due to competition from livestock is a matter of concern in all snow leopard range countries. It is considered to be a serious threat to snow leopards in 6 of the 12 range countries and a medium intensity threat in the other six (Snow Leopard Network, 2014).

In areas where wild ungulate populations are resource-limited due to excessive livestock grazing in their habitats, reducing livestock grazing

pressures can potentially assist in their population recovery. However, the strong livelihood dependence of local human communities on snow leopard habitats for grazing makes it difficult to reduce livestock populations. How does one manage multiple-use snow leopard landscapes to improve the abundance of wild ungulate prey? One proven method is village reserves, which are grazing set asides created in partnership with local communities with the idea of facilitating the recovery of wild ungulate populations.

Village reserves in operation

Our first village reserve was established in Spiti Valley in 1998, and it continues to be protected by the local community to this day. Research had shown that wild ungulate abundance in Spiti Valley was reduced due to overstocking of rangelands with livestock (Mishra et al., 2001, 2004). In 1998, we started working with the local community to establish a grazing set aside in the rangelands of the village Kibber (Mishra et al., 2003). After several rounds of discussions and trust building, we conducted joint surveys with the community to select the land where a village reserve could be established. An agreement was signed with the village council whereby they agreed to stop grazing livestock in the designated area (a valley of around 500 ha at about 4500 m altitude) in exchange for compensation for lost grazing. The local communities in the region have a history of leasing out parts of their grazing land to migratory herders from other parts of the Himalayas, and we used those rates as objective standards to negotiate the extent of compensation (agreed upon at c. USD 0.425 annually for Kibber according to current exchange rate of USD 1 equaling approximately 60 INR). The compensation amount goes to the village council, and it is used for community work. Additionally, two guards were appointed locally to ensure that free-ranging livestock did not enter the reserve area. The agreement was for a period of 5 years and has been renewed each time it expired. The initial size of the village reserve included around 500 ha of grazing land, which was subsequently increased in 2004 to c. 2000 ha with the compensation being increased threefold.

Protection from grazing by livestock and other forms of resource extraction (grass, dung, etc.) was accompanied by a significant increase in bharal abundance in the grazing set-aside and surrounding pastures of Kibber region, perhaps due to an initial aggregational response, and what appears to have been a subsequent numerical response (Fig. 18.2.1). The response of bharal became evident by 2002 and showed a monotonic increase till 2008 after which the population has fluctuated at the higher end (Fig. 18.2.1). The abundance of bharal in the village reserve and surrounding pastures of Kibber is around five times greater today compared to the period before and up to 2 years after the establishment of the village reserve. We have continued to also monitor the livestock population of the surrounding pastures, which has remained stable since 1998 (when the village reserve was established).

How would such a local increase in wild ungulate abundance impact snow leopards? The village reserve is too small in area to meaningfully estimate snow leopard abundance. We also do not have information on relative use of the area by snow leopards over the years, given that reliable techniques and equipment (such as camera traps) for field monitoring had not become available when we started this program. However, it is reasonable to speculate that the Kibber village reserve may have elicited a response from snow leopards. In a recent study, we assessed relative habitat use of snow leopards using camera traps in Spiti Valley (Sharma et al., 2015). We sampled snow leopards photographically in 10 study sites within Spiti (average area 70 km^2), placing 10 cameras in each site for a period of 60 days. We found that snow leopard habitat use was most

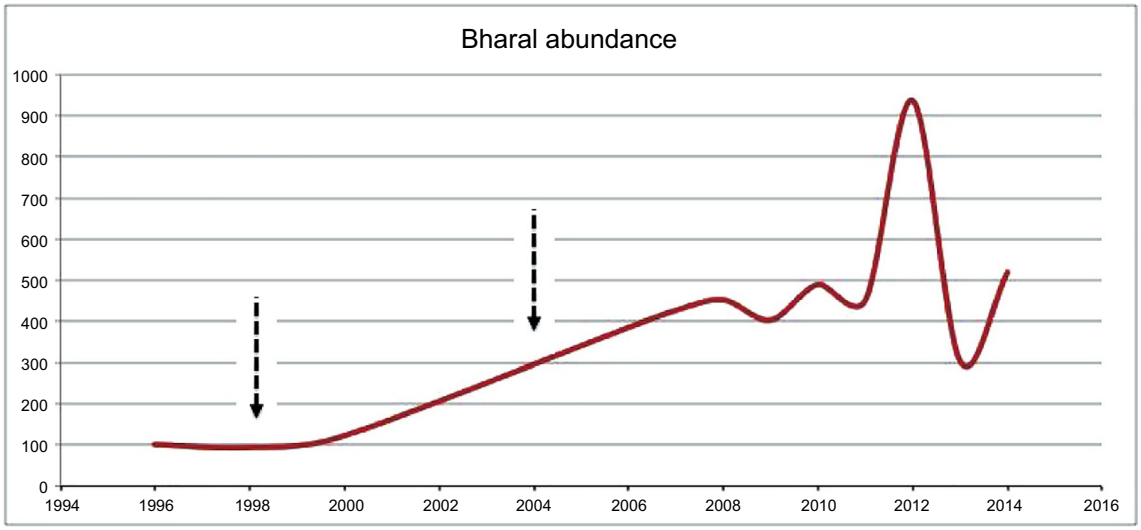

FIG. 18.2.1 Trends in abundance of bharal *(Pseudois nayaur)* in the Kibber region, Spiti Valley, India. The population was monitored one to several times each year during spring and autumn, periods when herds are congregated. Figures presented are maximum counts for a given year. *Dashed arrow* on the left indicates the establishment of a 500 ha village reserve or grazing set aside in the area, which was then expanded to 2000 ha in 2004 (*arrow* on the right) to cover about 20% of the total grazing land of the village. The spike in bharal population seen in 2012 was possibly caused by the temporary movement of a few herds into the area from an adjoining region (separated from the Kibber region by a deep gorge and stream).

influenced (positively) by the local abundance of wild ungulates. Among all 10 study sites, the site that included the Kibber village reserve (and another smaller reserve of c. 4.3 km^2 established in 2004 in the adjoining village of Chichim) recorded the highest intensity of habitat use as well as the number of snow leopards (adults) captured in camera traps.

Today, seven more villages in Spiti Valley and Ladakh are running village reserves in partnership with us. They are aimed at facilitating the recovery of various ungulate species, including bharal, urial (*O. vignei*), argali, ibex, and Tibetan gazelle (*Procapra picticaudata*). The reserves range in size from 1 to 400 km^2. The selection of any reserve area is usually based on a combination of its ecological potential (quality habitat for wild ungulates), topographical (for determining reserve boundaries), and administrative characteristics. The terms of agreement with the communities are variable; some involve similar compensation for lost grazing as in Kibber, others have involved provisioning of desired amenities (e.g., solar lanterns) or employment in the form of village reserve guards. In the case of the wide ranging argali, we are experimenting with a "floating reserve" for the past 3 years, where livestock grazing is not curtailed, but the herders refrain from taking livestock to pastures where argali have been sighted recently. So far, we have not recorded an increase in ungulate abundance in any of the aforesaid reserves, though none of them have showed a decline either. Most of these village reserves are relatively recently established. In the case of the Tibetan gazelle, the reserve was set up in 2005, but recovery may have been prevented either due to the small size (1 km^2) of the reserve, due to other forms of disturbance, or due to demographic or Allee effects, as this is a very small population on the brink of local extinction (Bhatnagar et al., 2007).

Snow leopards require large areas, with individual home ranges typically varying from a hundred to even over a 1000 km^2 (McCarthy et al., 2005; O. Johansson et al., unpublished data). It is often not feasible to create protected areas or desirable to exclude humans and livestock from areas that are large enough to support even a number as small as 20 adult snow leopards. Village reserves provide a potential alternative; they represent voluntarily created "core" areas with local community support in landscapes that are otherwise used by people. If planned at a landscape level (Appendix), a series of village reserves could actually help facilitate an increase in the abundance of snow leopards through recovery of their wild prey. While we have developed the village reserve model to reduce competitive pressures on wild ungulates, the model could also be adapted for enabling ungulate recovery in areas where their populations are limited by hunting rather than livestock. We suggest that village reserves should be a part of a repertoire of conservation initiatives with local communities that are necessary for snow leopard conservation.

Acknowledgment

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Appendix

Suggested principle for landscape-level planning of village reserves (Mishra et al., 2010).

Within a multiple-use landscape matrix, it is desirable to have as many village reserves as possible. The guiding principle for recovery and management of wild ungulate population can be as follows:

(i) In village reserves, the aim is to facilitate and maintain wild ungulate populations (N_v) at highest potential abundance (K) and enable conditions where birth rates (b_v) exceed mortality rates (m_v), and rates of emigration (e_v) are considerably higher than immigration rates (i_v) to enable spill-over effects, i.e., Eq. (A.1):

$$N_v \approx K, b_v > m_v, \text{and } e_v \gg i_v \quad \text{(A.1)}$$

(ii) For the intervening landscape units between any two village reserves, it is conceptually useful to estimate the desirable wild ungulate population size (N_m)—which will be a function of the trade-off between conservation and rangeland use objectives—and ensure that populations are maintained around that level (Eq. A.2):

$$N_m = K - f(A), \text{and } b_m + i_m \geq m_m + e_m \quad \text{(A.2)}$$

where $f(A)$ is a function by which the wild ungulate population size is reduced below carrying capacity as a result of an acceptable level of anthropogenic pressure.

The size and number of village reserves should be large and adequately interspersed within a matrix of multiple-use landscape units to enable the conservation of viable wildlife populations. At a minimum, the coupled landscape-level guiding principle for village reserves and multiple-use landscape units should be to aim for the total spillover from village reserves to at least offset the net individuals lost from multiple-use units due to mortality and emigration, i.e., Eq. (A.3):

$$\sum N_v \, (e_v - i_v) \geq \sum N_m \, (b_m - m_m - e_m) \quad \text{(A.3)}$$

This assumes that as the livestock grazing intensity in a multiple-use landscape unit increases, one can expect a decline in the density of wild ungulates. It will need to be counter-balanced by establishing a suitable village reserve in the proximity such that the inequality condition above continues to hold.

SUBCHAPTER

18.3

The Ecosystem Health Program: A tool to promote the coexistence of livestock owners and snow leopards

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Introduction

Livelihood systems throughout the snow leopard's (*Panthera uncia*) range are predominantly agro-pastoral where livestock plays a central role. The mean livestock holding per household is 40 animals in northern Pakistan, including goats = 11.64, sheep = 12.3, cattle = 13.33, and yaks = 3.44. Livestock serves as the main source of cash income in such communities besides providing milk, milk products, and meat. Families sell an average of 4.4 animals each year, which constitutes some 13% of their holdings. Animals sold are usually replaced by births. However, disease and predation, which often operate in parallel, cause considerable livestock loss, affecting the local economy. The annual loss to disease in northern Pakistan ranges between 0% and 54% across different valleys, averaging 1.56% of livestock holdings. Highest mortality occurs in the first year of vaccination and gradually drops by 59% in later years.

Predation by snow leopards and other large carnivores is another major threat to livestock and a key cause of retaliatory killings. However, the disease death toll is estimated to be 1.5–5 times greater than that by predation. In fact, it was found that herders were more inclined to tolerate occasional losses to predation if losses to disease were reduced or controlled. It is this set of facts that motivated a conservation-based incentive program for local communities, the "Snow Ecosystem Health Program" (EHP), which is administrated by the Snow Leopard Foundation (SLF), an independent Pakistan conservation NGO.

The EHP promotes the peaceful coexistence of livestock owners and snow leopards through indirect compensation for livestock predation and by improving overall ecosystem health. The program is a conflict mitigation and management tool that increases both incomes and tolerance toward snow leopards by reducing disease-based livestock mortality.

The EHP is named as such because the risks associated with livestock health cannot be isolated from wildlife or people. Thus, an ecosystem approach to health issues is being increasingly recognized and touted as it examines animal and human health issues holistically. According to Osofsky et al. (2005), "the state of health of an ecosystem can be judged by criteria very similar to those used for evaluating the health of a person or animal, namely, homeostasis (having a balance between system components), absence of disease, diversity and complexity, stability and resiliency, and vigor and scope for growth."

Program implementation mechanism

The EHP makes vaccines available to rural communities, empowering them economically. In return, the communities agree to limit their herd sizes—accounting for reproduction—to ensure that there is no increase in competition with wild prey. Communities are also required to refrain from poaching snow leopards and their primary wild prey. The program is implemented in seven steps:

Site selection

Site selection is based on the presence of snow leopards and prey species, depredation pressure, and livestock movement in the area as determined by snow leopard and prey surveys and herder interviews.

Social mobilization

Program orientation is provided through meetings with concerned communities. A *Conservation Agreement* is signed if the community agrees to the program. This specifies the responsibilities of the parties (Table 18.3.1).

Training

Trainees are selected from communities in consultation with local community organizations. Centrally located and conducted by relevant experts, the trainings enhance understanding of livestock diseases, while teaching trainees how to vaccinate animals according to vaccination calendars. Trained vaccinators are referred to as *Ecosystem Health Workers (EHWs)*.

Vaccine delivery

The EHW's role is an important one. The vaccine delivery system involves determining vaccine quantity and type in consultation with vaccination calendars and local officials of the Livestock Department. Vaccines are then purchased from the production source by SLF to ensure quality and validity and given to the EHWs along with registration forms. The completed forms are later returned to the implementing agency. Considered self-employed, the vaccinators receive a small payment from each household for their services.

Conservation fund

A fund is created in each community and serves two purposes. First, it encourages farmers to pay for vaccines and formalizes the system of payment, procurement, and vaccination. Second, it provides a small financial buffer against minor emergencies such as unexpected disease outbreaks or increases in vaccine costs.

Cost sharing

The concerned conservation agency, in this case SLF, bears the full cost of vaccines in the first year while participants begin contributing to the vaccination fund. In the second year, the

TABLE 18.3.1 Key points in Conservation Agreements with local communities.

Local community	Implementing agency
• Select persons for vaccine-administration training • Pay the community share of vaccine costs • Maintain constant herd sizes by selling animals • Record and report snow leopard and wild ungulate sightings, and report predation • Protect snow leopards and wild ungulates	• Arrange for community members to receive training in administering vaccines • Develop vaccination calendars • Provide vaccines at subsidized rates • Monitor the program and its environmental impacts

conservation agency covers 75% of the cost of vaccines and provides the remaining 25% to strengthen the vaccination fund. The unpaid portion of the year's vaccination cost is borne by the participants. In the third year, half the cost of vaccines is provided by the conservation agency, and the remaining 50% goes into the vaccination fund. Again, the unpaid portion of the year's vaccination is covered by the participants. Finally, in the 4th year, the participants pay for their vaccinations themselves while the agency's contribution goes into the vaccination fund. Cost sharing stops at this point.

In some communities, SLF bears the full cost for the 5 years for vaccines, transportation, and the CLEW's payment. The community organization deposit PKR 25,000–50,000 each year into to the vaccination fund. The community organization involves the maximum farmers in the vaccination program. At maturity, farmers pay 50 PKRs/household/vaccination campaign to keep the program running.

Monitoring

The program is monitored biannually and involves implementing agency staff, the Wildlife Department, and the community organization. Monitoring entails reviewing vaccine administration, examining its impacts on livestock health and community well-being, and looking for signs of snow leopard poaching. In addition, the impact of the Conservation Agreements is assessed through periodic specialized snow leopard surveys that assess the occurrence and abundance of snow leopards.

Program success in resolving conflicts

The EHP was initiated in Kuju village in district Chitral, Pakistan, in 2003. It has been replicated to a larger landscape. By 2022, vaccination program is operational in 11 districts of snow leopard range, including 22 valleys in Gilgit-Baltistan, 15 valleys in Chitral (Khyber Pakhtunkhwa), and 4 valleys in Azad Jammu and Kashmir (Fig. 18.3.1). The program involves 81,000 households and has vaccinated 1.5 million livestock in the past 15 years.

The program has trained 66 persons in Gilgit-Baltistan, 38 in Chitral, and 17 in AJ&K over the last 18 years, as ecosystem health workers. As a result, there are at least three active EHWs at each program site, who have successfully vaccinated 114,879 heads of livestock in Chitral, 109,425 in GB, and 31,578 in AJ&K during the year 2021. The EHP was assessed through household structured interviews in 2016 and 2019 and focused on program effectiveness and its impact on livestock health and productivity, herders' incomes, and changes in attitudes toward snow leopard conservation. Both reviews concluded that the EHP had been a positive experience for the communities as it had reduced livestock mortality and improved livelihoods. These measures contributed significantly to reducing retaliatory killings of snow leopards, as evidenced by zero poaching in program communities.

Reduction in disease-caused mortality and impacts on community well-being

Livestock production and productivity were affected by the widespread occurrence of vectors and diseases prior to the EHP. The program improved both productivity and household incomes. Review results showed that livestock losses to disease varied significantly across the program area. However, mortality reduced significantly with the age of the program, and we observed a negative correlation (r −0.96) between disease-caused mortality and years of vaccination. Communities were losing 2.6% of their holding at the onset of the program, which reduced to 0.5% after 3 years of vaccination. This 80% reduction in mortality is significant in economic terms.

Economic loss due to disease-related mortality for an average household was PKR 56,497

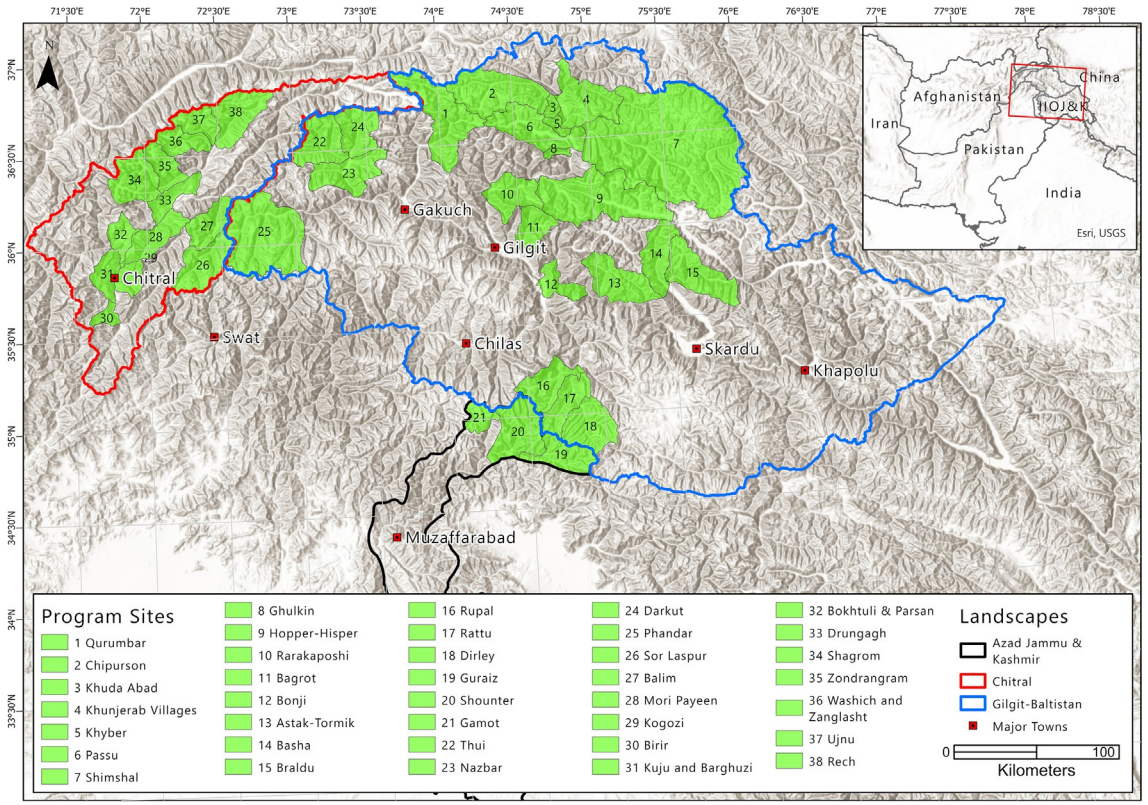

FIG. 18.3.1 Ecosystem Health Program operations in 2022.

(US$ 297). Comparing this figure to the average annual household cash income of PKR 96,000 (US$ 960) in program villages, the loss from disease-related mortality was equivalent to 1.75 months of household income. Mortality reductions can be regarded as savings. The financial gain per household from animals sold was estimated at PKR 11,604 (US$ 116). Income gained through vaccination programs therefore enables a general improvement in standards of living.

Healthy livestock are a principal source of animal protein, a basic requirement for body growth and maintenance (FAO, 1996). A major direct effect of animal diseases on human beings is the loss of protein and milk. The latter is particularly important for children. Animal products also supply other nutrients, minerals, and vitamins (Hush-Ashmore and Curry, 1992). The review found increases in both livestock and local consumption, an overall positive impact of vaccination services on livestock health and productivity and human well-being.

Stabilizing herd size and avoiding pressure on the environment

Herd size is largely dependent on range resources, which vary considerably with altitude, aspect, season, labor availability, and cropping patterns. Households within snow leopard range

traditionally sell relatively few cattle (1.8 per household). Household consumption is also low at 1.5 animals. The largest share is considered a long-term investment, especially for families possessing no other sources of income. Community Conservation Agreements stipulated that participating communities would *not* increase their livestock holdings. Compliance was evaluated through surveys in Chitral where respondents were questioned about their herds. Some 72% of herders reported stable herd sizes and another 14% felt that herd sizes had decreased. However, the remaining 13% reported increased herd sizes. Though the livestock numbers slightly increased in few households, the average herd size for the participating communities did not increase, hence the agreement was considered to be in compliance.

In addition, communities have not reported any expansion of grazing lands in the last 5 years—herders were reportedly using existing pastures that also support the snow leopard's natural prey species.

Enhanced tolerance toward snow leopards

Mountain communities are generally hostile toward carnivores. For example, a recent survey in Musk Deer National Park in Azad Jammu and Kashmir (AJK), where there are currently no ongoing carnivore conservation efforts, showed that 72%–86% of people wanted to reduce or eliminate populations of snow leopards, brown bears, and wolves (Ahmad, 2015), Similarly 53% of respondents wished to eliminate carnivores in Misgar Valley of Pakistan when there were no conservation interventions in the valley. Attitudes changed after conservation work (trophy hunting, livestock insurance, and vaccination), and currently 49% of respondents in the Misgar Valley believe carnivores are important for maintenance of the ecosystem (Bano et al., 2021), despite serious levels of livestock depredation. In areas where EHP was operation for more than 3 years, 83% respondents expressed a desire to see increased or maintained snow leopard populations in their valleys. Just 6% preferred a population decrease, and 10% wanted complete elimination. These figures probably indicate higher tolerance for snow leopards in our program sites over ecologically similar nonprogram sites. Moreover, there have been no reports of snow leopard or prey species being poached in the area since the program began.

Conclusions and recommended practices

The EHP has been very effective in helping reduce livestock mortality and improving incomes. EHW training has strengthened local capacity and helped poor herders adopt technical management options for improved livestock systems. Herd sizes are stable or declining, despite reductions in mortality, and there have been no expansions of natural pastures. Overall acceptance of snow leopards is apparent, despite the associated economic loss.

The program is cost-effective and lean in terms of staff time and overall budget (approximately US$ 5000 per site for the 4-year cost sharing period). Its low input, low maintenance, and high impact clearly distinguish it from other conservation programs.

The following measures are considered good practices that can strengthen program implementation and increase the chances of success.

Strengthening community organizations

Community organizations must be strong enough to deliver programs. Success in this regard requires effective social mobilization, organization, and engagement. Social mobilization helps idea acceptance and adoption, paving

the way for collective action. People can be brought together to form community organizations that create and spread awareness about the social and economic benefits of organized action. This allows resource pooling and collective planning and management. When required, program interventions can even be revisited.

An ongoing systematic approach is required for effective engagement with community organizations (e.g., monthly meetings). Rights and responsibilities must be clearly defined and in line with overall conservation and development goals. The focus of such exercises is to strengthen community organizations through maximum representation and create an environment of empowerment.

Establishing vaccination funds

Community-level vaccination funds can help program communities attain financial self-sufficiency. Such funds encourage people to pay for their own vaccines and provide savings for minor emergencies. While resource mobilization and savings are not new concepts, regular contact and community meetings are necessary to motivate community members to deposit their monetary shares regularly. The fund also sustains the program after donor support is terminated.

Enhancing EHW capacity

EHW capacity and commitment are important factors in program delivery and sustainability. Selection through community organizations is based on education, experience with livestock, and staying potential. Candidates possessing a high school education—or less—are unable to assimilate training effectively. Conversely, candidates possessing higher education levels were found to have low staying potential as they were likely to leave the community in search of better jobs. It was found that mid-career persons possessing a matriculation qualification performed better and stayed in the community longer. Proper training means that EHWs become committed, cost-effective workers, who make efforts to convince livestock owners of the merits of vaccination. Naturally, EHWs require remuneration to maintain their motivation. This is generally based on the number of animals vaccinated. The EHW role can also be expanded to provide first aid services, manage reproductive disorders, and treat injuries and common diseases. Given suitable professional training, EHWs can become breadwinners for their families, and remote communities can receive cost-effective veterinary services at their doorsteps.

Program monitoring

The entire process demands an effective monitoring system and regular field team visits to community organizations. The following measures are recommended:

- A participatory data monitoring system involving community organizations should be developed. Variables could include livestock population, disease-caused mortality, livestock depredation, sightings of snow leopards, and prey species. Such information could be collected by the field offices on prescribed formats. Random data checks at the household level are also recommended.
- Key performance indicators to meet program requirements need to be developed in collaboration with community organizations. These would make both communities and field teams part of the process and therefore, accountable.

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