Chapter 15
Fostering Community-Based Stewardship of Wildlife in Central Asia: Transforming Snow Leopards from Pests into Valued Assets

Rodney Jackson

Abstract Addressing human–wildlife conflict is an important requisite to managing rangelands for livestock and wildlife. Despite high altitudes, aridity, and relatively low primary productivity, the rangelands of Central Asia support a rich and diverse biodiversity—including the endangered snow leopard that many herders perceive as a predator to be eliminated. Conserving this and other wildlife species requires carefully crafted interventions aimed at curbing depredation losses and/or reducing competition for forage, along with offering locally sustainable, environmentally friendly income-generating activities for supplementing pastoral household livelihoods. This is best achieved through a combination of incentives designed to foster sound rangeland and wildlife stewardship, along penalties or disincentives targeting herders who violate mutually agreed rules and regulations (including grazing norms and wildlife disturbance or poaching).

When working toward the harmonious coexistence of people and wildlife, conservationists and rangeland practitioners need to seek the cooperation and build goodwill among herders and other stakeholders, including local government and private industry (especially the livestock production, mining, and tourism sectors).

Keywords Gurvan Saikhan National Park • Annapurna National Park • Nepal • Pakistan • India • Mongolia • China • Tibet • Mining • Poaching • PRA • Holistic • Community engagement • Fuel • Habitat fragmentation

R. Jackson (✉)
Snow Leopard Conservancy, 18030 Comstock Ave, Sonoma, CA 95476, USA
e-mail: rodjackson@mountain.org

V. Squires (ed.), *Rangeland Stewardship in Central Asia: Balancing Improved Livelihoods, Biodiversity Conservation and Land Protection*,
DOI 10.1007/978-94-007-5367-9_15, © Springer Science+Business Media Dordrecht 2012

Key Points

- The demise of the Soviet Union in the late 1980s and early 1990s precipitated profound changes to the formerly collectivized livestock and rangeland systems found across large expanses of Central Asia, in tandem with widespread and often catastrophic poaching of wildlife. The collapse of employment in the collectives, state-owned farms, and state-managed factories led to a surge in rural migration and the emergence of new herding households. For example, today, almost every small valley in southern and western Mongolia has a resident family, and this pattern is being repeated throughout Central Asia. These events were accompanied by substantial shifts in livestock spatial distribution patterns following the collapse of the relatively sophisticated, centralized support system which had created and maintained widely spaced groundwater wells and made supplementary feed available during prolonged periods of drought or heavy snowfall. A combination of failing management interventions and the introduction of a free market economy has led to rapid declines in the ecological condition and stability of rangeland resources.
- Central Asia's wildlife are well adapted to living at high elevations, tolerating climatic extremes, dealing with prolonged aridity and severe winters, while sharing scarce resources and minimizing competition through niche specialization, seasonal migrations, and habitat separation. The real long-term challenge lies with moving pastoral communities beyond their harsh and often insecure subsistence livelihood into more economically viable and environmentally friendly activities. Ultimately, local people must be encouraged to perceive snow leopards and other large carnivores as being worth "more alive than dead." They must also assume greater responsibility for protecting their flocks or herds from predators if we are to attain an enduring coexistence between predators and humans in the Central Asian rangelands.
- The real long-term challenge lies with moving pastoral communities beyond their harsh and often insecure subsistence livelihood into more economically viable and environmentally friendly activities. Ultimately, local people must be encouraged to perceive snow leopards and other large carnivores as being worth "more alive than dead." They must also assume greater responsibility for protecting their flocks or herds from predators if we are to attain an enduring coexistence between predators and humans in the Central Asian rangelands.

1 Introduction

The mountains and plateaus of Central Asia are remarkably rich in terms of its wildlife and diversity of habitats. The Chang Tang of Tibet and Mongolia constitutes the last strongholds of Central Asia's hoofed wildlife that includes Tibetan gazelle (*Procapra picticaudata*), Mongolian gazelle (*Procapra gutturosa*), chiru or Tibetan antelope (*Pantholops hodgsonii*), wild yak (*Bos grunniens*), kiang (*Equus kiang*), Asiatic wild ass (*E. hemionus*), Argali sheep (*Ovis ammon*), blue sheep

(*Pseudois nayaur*), ibex (*Capra sibirica*), saiga (*Saiga tatarica*), red deer (*Cervus elaphus*), white-lipped deer (*C. albirostris*), and musk deer (*Moschus* spp.). Carnivores include snow leopard (*Panthera uncia*), lynx (*Lynx lynx*), wolf (*Canis lupus*), dhole (*Cuon alpinus*), and several fox species (*Vulpe*s spp.). Of special note are Mongolia's white-tailed gazelle migratory herds which until recently were said to rival the annual ungulate migrations of Africa's Serengeti plains (Mallon and Jiang 2009). The Tibetan antelope migrates across a vast landscape at elevations exceeding 4,500 m and sparsely populated by humans (Schaller 1998).

Central Asia's wildlife are well adapted to living at high elevations, tolerating climatic extremes, dealing with prolonged aridity and severe winters, while sharing scarce resources and minimizing competition through niche specialization, seasonal migrations, and habitat separation (Schaller 1998). Mountain areas support argali sheep, blue sheep, ibex, and snow leopards, while along the northern and western perimeters of Mongolia, one finds red deer, roe deer (*Capreolus capreolus*), and wild boar (*Sus scrofa*). The desert expanses in China, Kazakhstan, or Mongolia harbor the endangered wild camel (*Camelus bactrianus*), Gobi bears (*Ursus arctos*), wild ass, and Saiga antelope. There is a diverse array of small- or medium-sized rodents ranging from voles (*Microtus* and *Alticola* spp.) to jeboas (*Allactaga* spp.), gerbils (*Meriones* spp.), ground squirrels (*Spermophilus* spp.), and marmots (*Marmota* spp.), while hares (*Lepus* spp.) and pikas (*Ochotona* spp.) may constitute important prey items for medium-sized rangeland carnivores such as the red fox (*Vulpes vulpes*), Tibetan fox (*V. ferrilata*), corsac fox (*V. corsac*), Pallas' cat (*Otocolobus manul*), and lynx.

For centuries, humans have coexisted with wildlife practicing nomadic or semi-nomadic pastoralism herding sheep and goat flocks, cattle, horses, yaks, and camels. For example, Mongolia is among the world's leading pastoral nation, with rangelands covering 83% of the country's 1.29 million km^2 (Scharf et al. 2010). Thanks in large measure to the low sparsely distributed human population and their relative economic isolation, Mongolia and Tibet represent the last stronghold in Central Asia for many species of ungulates and carnivores considered rare, endangered, or declining elsewhere in their ranges.

The demise of the Soviet Union in the late 1980s and early 1990s precipitated profound changes to the formerly collectivized livestock and rangeland systems found across large expanses of Central Asia, in tandem with widespread and often catastrophic poaching of wildlife. The collapse of employment in the collectives, state-owned farms, and state-managed factories led to a surge in rural migration and the emergence of new herding households. For example, today, almost every small valley in southern and western Mongolia has a resident family, and the trend is being repeated throughout the uplands of the Central Asian region.

These were accompanied by substantial shifts in livestock spatial distribution patterns following the collapse of the relatively sophisticated, centralized support system which had created and maintained widely spaced groundwater wells and made supplementary feed available during prolonged periods of drought or heavy snowfall. A combination of failing management interventions and the introduction of a free market economy has led to rapid declines in the ecological condition and

stability of rangeland resources, especially in Mongolia's southern desert steppes (Behnke 2006). Neglected water sources encouraged herders to concentrate livestock around the few remaining functioning wells and to stay longer than previously at a particular site. Seasonal mobility thus suffered, and many pastures have become notably degraded, including those near administrative centers. As noted by Schmidt (2006), a reversed rural-to-urban migration followed several years of severe winters (known as *dzud*) with a resulting catastrophic loss of livestock. However, the herds are now rapidly rebounding, with Mongolia recording a doubling of its livestock population to some 36 million animals (including sizeable increases in sheep and goats).

Revisions in pasture management laws invested in local political units (*soum* and *bag*), along with ill-defined or contested property rights, economic inequities, and a scarcity of water and winter forage, have all produced mixed results. The poorer households have been marginalized and communal respect for seasonal grazing restrictions and long-held pasture rest-rotational practices severely compromised (Fernandez-Gimenez 1999; Fernández-Giménez and Batbuyan 2004; Scharf et al. 2010). These changes, along with more restricted seasonable movements, are resulting in widespread overuse of fragile pastures due to extensive overstocking that in turn is leading to spreading desertification.

The ever-growing human and livestock population has also affected Central Asia's wildlife populations. The former coexistence between herders and wildlife is on the decline, accelerated by commercialization and increasing hunting pressure in response for rising demands for wildlife products, especially from China (Wingard and Zahler 2006). During the Soviet era, herding and grazing collectives or *negdels*, along with hunting brigades, held sole responsibility for rangeland and wildlife management. In Mongolia, a network of hunting brigades held exclusive rights to harvest wildlife and guarded against illegal hunters. Like the *negdels*, they were administered by local government and were outfitted with vehicles for conducting regular patrols.

Twenty-five thousand people participated nationwide, hunting a variety of furbearing species for export to the Soviet Union and other socialist states. With the shift to a market economy in the early 1990s, the hunting brigades quickly disintegrated from lack of state support. A combination of economic hardship and market access encouraged urban and rural dwellers to trade wildlife as an alternative income sources. For example, the price of marmot skins surged starting in 1995, the same year Mongolia relaxed its gun control laws (Scharf et al. 2010). These authors reported markets in provincial centers were swelled with guns, bullets, traps, furs, meat, antlers, and organs used for medicinal purposes. Wingard and Zahler (2006) estimated that up to 250,000 Mongolians were hunting wildlife for subsistence and the commercial market, with the value of wildlife trade (mostly illegal) estimated at US$l00 million. In Mongolia's eastern steppes, Olson et al. (2011) noted the presence of herding households had a negative impact on Mongolian gazelle densities, concluding conservation largely depended on the ability of gazelles to make long-distance, unimpeded nomadic movements, as well as protection from harmful human activities.

In Tajikistan, a civil war followed the Soviet Union's collapse, leading to widespread strife and poverty. Doctors and engineers were forced into subsistence livelihoods, including animal husbandry (Bliss 2006). Along with collective workers, the Kyrgyz of the Pamirs were particularly hard hit, suffering severe winter livestock mortality following the withdrawal of supplementary feed from neighboring Kyrgyzstan. Populations of the famed Marco Polo sheep (*Ovis ammon polii*) plummeted due to widespread poaching, including use of automatic firearms by border guards who were no longer being sufficiently provided for by the state (Jackson, personal communication, 2003). Koshkarev and Vyrypaev (2000) noted widespread poaching of snow leopards in several Central Asia states following the breakup of the USSR.

China's skyrocketing economic growth is also leading to substantial changes across the high mountains and expansive basins of the Tibet Plateau, which is a noted habitat for large migratory herds of wild antelope, gazelle, and bovids. Such socioeconomic changes are fueling a fundamental shift from nomadic or seminomadic pastoralism to a more sedentary rangeland and livestock husbandry practice, in which land privatization and open-range fencing are becoming more prevalent. Besides disrupting wildlife's seasonal movements and its long-distance migratory patterns, such changes are leading to the collapse and replacement of traditional, communally managed, and ecologically adapted grazing management systems (Fox et al. 2009; Richard et al. 2006).

It is against this background that I present the example of the snow leopard, an endangered carnivore widely perceived as a menace to be eliminated by herders. This chapter discusses community-based conservation approaches that have been applied in India, Nepal, and Mongolia which are designed to transform local people's perception of snow leopards from a pest to a species valued more alive than dead.

2 The Setting

Central Asia—the Roof of the World—is characterized by high elevations; a harsh climate with extreme seasonal shifts of temperature, humidity, and precipitation; poor rocky soils; and steep slopes (Maselli, Chap. 1). It is among the world's most inhospitable landscapes where only the hardiest and enterprising of humans are able to survive. There are few roads, the lines of communication are primitive, and most households live in relative isolation for much of the year, making only short visits to nearby administration centers or more distant urban capitals.

It is also a home to the endangered snow leopard, perhaps the world's most elusive and charismatic large felid, that is sparsely distributed across 1.2–1.6 million km^2 of habitat in 12 countries of South and Central Asia, namely, Afghanistan, Bhutan, China, India, Kyrgyzstan, Kazakhstan, Nepal, Mongolia, Pakistan, Russia, Tajikistan, and Uzbekistan (Nowell and Jackson 1996). With an estimated total wild population of 4,500–7,500, snow leopards inhabit mountainous rangelands at elevations of 3,000 to over 5,000 m in the Himalayan and Tibetan Plateau, but as low as 600 m in Russia and Mongolia (Sunquist and Sunquist 2002). This species' habitat is among

the least productive of the world's rangelands due to low temperatures, high aridity, extreme seasonal conditions, and a harsh climate. The average peak graminoid biomass has been estimated at 170 kg ha^{-1} (asymmetric 95% CI 128–228 kg ha^{-1} (Mishra 2001)). Consequently, prey population densities are also relatively low, ranging from 6.6 to 10.2 blue sheep per km^2 in productive habitat in Nepal (Oli 1994) to 0.9 ibex per km^2 in marginal habitat of Mongolia (McCarthy et al. 2005). Supplemental prey items include marmots, pikas and other small rodents, and game birds. As noted later, livestock can be an important component of the snow leopards' diet.

Besides its naturally low density, the primary challenges for conservationists are its elusive and cryptic behavior, large home range (in excess of 650 km^2 in Mongolia, unpub. data), and dependence upon ungulate prey populations that are mostly declining due to widespread poaching (Jackson and Ahlborn 1989). With the depletion of its prey, snow leopards may resort to feeding on killing livestock, in turn encouraging herders to resort to retributive killing of predators (Jackson et al. 2010).

The predominant land uses and source of local livelihoods in most of the snow leopard's habitat revolve around traditional pastoralism, with agro-pastoralism at lower elevations, especially in the Himalayan region. According to Mishra et al. (2003), 7 of the 12 range countries contain over 25% of land area in permanent pasture, with 50% or more of the human population engaged in agro-pastoralism. Over 40% of people live below national poverty levels with an average per capita annual income of US$250–400. While relatively few humans reside in snow leopard habitat, their use of the landscape is pervasive, leading to generally escalating levels of human–wildlife conflict, especially within or adjacent to protected areas where resources are more strictly controlled. Perhaps as much as 50–60% of the snow leopard population and sympatric wildlife inhabit areas outside of protected areas, albeit at lower densities (Jackson and Ahlborn 1990). These populations, however, are critical to sustaining genetically viable metapopulations (unpublished data). Since few, if any, of the approximately 100 existing protected areas situated within snow leopard range are free of human influence (Green and Zhimbiev 1997), its survival hinges upon uneasy coexistence with subsistence pastoralists and farmers trying to eke out a living under the same harsh environmental conditions. Thus, innovative and decidedly participatory approaches for engaging pastoralists in snow leopard and biodiversity conservation are needed to ensure the species' long-term survival. This is especially relevant where mountain ranges are more fragmented and habitat less productive, as in Mongolia's South Gobi region (this author, unpublished data).

This brings us to the vexing problem of how best to empower communities and decision-makers to respond effectively and fairly in light of the continually shifting socioeconomic conditions brought about by powerful political and economic changes sweeping the region (Kurbanova, Chap. 7). Of special note are the far-reaching social, economic, and environmental changes associated with the dissolution of the Soviet Union and specially the states of Tajikistan, Uzbekistan, Kyrgyzstan, Kazakhstan, and Mongolia (and even Russia itself) as they emerged in the 1990s from decades of centrally controlled socialism to the open and highly competitive global economic marketplace. The examples of the Pamirs in Tajikistan

and steppes of Mongolia have been the focus of a number of academic studies (e.g., Bliss 2006; Kreutzmann 2012).

3 The Conflicts

In order to better understand how communities could become effective custodians of land in a rapidly changing environment, we need to examine the sources and root cause(s) of human-habitat–wildlife conflict (Treves et al. 2006). Here, we are using the example of the endangered snow leopard as a flagship species for how rangeland managers and conservationists could work with pastoral communities to ensure a more harmonious future for wildlife of Central Asia.

3.1 Competition for Forage and Habitat Disturbance

Recent studies suggest the density and diversity of wild herbivores in the cold deserts of the Trans-Himalaya may be depleted through resource limitations imposed by competition with domestic livestock, especially where dietary overlap is extensive (a condition perhaps exacerbated by the low productivity and plant species diversity characteristic of this part of the world).

Bagchi et al. (2004), for example, found that sheep and goat compete with ibex for forage, often excluding ibex from using pastures if flocks were accompanied by shepherds and/or their dogs. These investigators estimated that livestock such as sheep, goat, horse, cattle, and yak removed large amounts of forage from pastures (up to 250 kg of dry matter per day by certain species). Mishra et al. (2001) concluded that most rangelands in Spiti (northern India) were overstocked with domestic herbivores that amounted up to 10 times the biomass of wild herbivores. Livestock herding was possibly implicated in the local extinction of four wild ungulate species: ibex, free-ranging horses, and sheep and goats utilized the same habitat and shared a common diet, thus lacking in forage differentiation necessary for unimpeded coexistence. Supplementary winter feeding helped to elevate livestock numbers, leading to overstocking especially during the critical winter season.

Retzer (2006) confirmed forage competition between livestock and the Mongolian pika (*Ochotona pallasi*), which he concluded was able to harvest forage more closely than domestic stock. Bagchi et al. (2006), working in the Trans-Himalaya, found that small mammalian herbivores served as mediators of plant community dynamics in high-altitude arid rangelands. The policy of eradicating pikas and voles in China may compromise ecosystem functioning and species diversity (Smith and Foggin 1999). However, these authors like others also place blame on changes in traditional pastoral practices and overstocking as the root cause for rangeland degradation, including desertification. Thus, conservation interventions should seek ways for fostering coexistence between humans and livestock (Mishra et al. 2009; du Toit et al. 2009).

3.2 Livestock Depredation

Given the prevalence of subsistence agro-pastoralism across most snow leopard range, conflict between herders and cats (including other predators like the wolf) should come as no surprise (Jackson and Nowell 1996). Depredation rates, however, vary widely from under 1% in parts of Mongolia and western China (Schaller et al. 1987, 1994) to over 12% of livestock holdings in hot spots in Nepal (Jackson et al. 1996) and India (Mishra 1997; Bhatnagar et al. 2006), but they typically average 1–3% (Oli et al. 1994; Schaller et al. 1988; Namgail et al. 2007; Bhatnagar et al. 1999). These studies also suggest that depredation tends to be highly site specific, with loss rates varying greatly between successive years and even among nearby settlements over the same time frame. Herders are particularly angered by "surplus killing," or incidents associated where a snow leopard enters a poorly constructed night-time corral and then kills 10–50 (or more) of the sheep and/or goats confined within its walls (Jackson and Wangchuk 2001). In Hemis National Park, India, for example, such incidents amounted to only 14% of all depredation events but accounted for 38% of all livestock lost (Bhatnagar et al. 2006). Such incidents appear to be closely associated with most herder retribution toward the snow leopards (e.g., Jackson and Wangchuk 2001; Hussain 2003), which are perceived as being responsible for wiping the herder's entire "bank account."

Studies to date indicate that the annual economic losses associated with depredation events have ranged from about US$50 to nearly US$300 per household, a significant sum relative to the per capita annual household income of US$250–400 (Oli et al. 1994; Jackson et al. 1996; Mishra 1997; Bhatnagar et al. 2006; Ikeda 2004; Namgail et al. 2007). Typically less than 10% of households suffer disproportionate loss, usually from corralled sheep and goat kills, or when unguarded, but high-valued yaks and horses are killed on the open range (Jackson et al. 1996). Complacent guarding, poorly constructed night-time pens, favorable stalking cover, and insufficient wild prey are cited as the primary factors contributing to livestock depredation.

Snow leopards are capable of killing nearly all types of domestic animals, and while herders typically take measures to reduce the risk of depredation, these are often insufficient. As a result of wildlife poaching and overstocking, both livestock numbers and biomass are usually an order of magnitude greater than that of wild ungulates. In Nepal, for example, livestock biomass may reach 1,700 kg km^2 (Jackson et al. 1996) compared to 330 kg km^2 for blue sheep in the same season (Oli 1994), so the probability of a snow leopard encountering a domestic animal is often high. Bagchi and Mishra (2006) reported higher livestock (58%) proportions in snow leopard diet in an area with more livestock (29.7 heads km^2) and fewer wild ungulates (2.1–3.1 blue sheep km^2) in comparison to an adjoining area stock with less livestock (13.9 km^2) but containing more wild ungulates (4.5–7.8 ibex km^2) and where livestock constituted 40% of the leopard's diet. A more recent food habit study drawing upon genetically confirmed scats indicated that livestock provided up to 70% of the diet of snow leopards in northern Pakistan (Anwar et al. 2011).

These data highlight the importance of livestock as prey, at least for some snow leopard populations. It also confirms the potential role pastoralists could or indeed are unwittingly playing in helping to sustain this highly endangered species by allowing some depredation losses.

The relative abundance of livestock and wild ungulate prey is considered a reasonable predictor of livestock depredation risk (Bagchi and Mishra 2006). Other indicators include the distance to snow leopard travel lanes (e.g., ridges and cliffs) and broken terrain ("depredation hot spots"), along with lax guarding by herders, in part resulting from insufficient manpower or funds for hiring communal shepherds (Jackson et al. 1996). Although losses herders attribute to wild predators are often exaggerated (compared to other sources of mortality like disease and large scale die-offs due to occasional severe winters), it is likely the *perceived* level of depredation mostly drives negative attitudes and subsequent reactions toward wild predators (Oli et al. 1994; Mishra 1997; Jackson and Wangchuk 2001). As shown by Bagchi and Mishra (2006), negative attitudes may have a strong economic basis even in culturally similar areas; thus, communities with more access to alternative income were found to display greater tolerance toward snow leopards, despite losing on average 1.1 heads of livestock per family annually. A nearby community heavily dependent upon animal husbandry, however, held more negative feelings despite losing fewer livestock (0.6 animals). As noted earlier, the snow leopard's habitat tends to be overstocked with livestock, in some cases with herd densities compromising animal production itself (Mishra et al. 2001). The resultant competition for limited forage, along with human disturbance and poaching, is often cited as a cause for natural prey population declines. As livestock numbers increase, so natural prey populations tend to decrease, as illustrated in one study where blue sheep density was 63% lower (2.6 blue sheep per km^2) in a rangeland supporting 30% more livestock than an otherwise comparable area sustaining 7.1 blue sheep per km^2 (Mishra et al. 2004). Range-wide, declining prey populations are a serious and chronic threat to snow leopards, along with the cascading effect of escalating livestock depredation rates leading to intensified herder retribution.

There are a number of other issues which contribute to pastoralist–wildlife conflict and are worth mentioning briefly (with detailed discussion beyond the scope of this chapter):

- Wildlife–livestock disease transmission: governments are particularly concerned about outbreaks of foot and mouth disease, since these can have a major influence on livestock populations as well as marketing opportunities for livestock products. However, it is a little-studied topic, although a number of studies are currently underway in Central Asia (Christine Budke, personal communication).
- The current understanding of snow leopard distribution patterns, abundance, and feeding ecology is quite limited. This is attributed to the technical, demanding logistical, and high financial costs of studying a rare, cryptic carnivore that inhabits some of the most remote and rugged habitat on earth (Jackson and Fox 1997). Hopefully, useful information will be forthcoming from the long-term study currently underway in the South Gobi of Mongolia, although this study site

is rather atypical with respect to habitat productivity, prey abundance and utilization, and genetics and meta-population dynamics at a landscape level. On the other hand, conservationists can ill-afford to delay action, given the rapidity with which wildlife is disappearing across vast swaths of Central Asia, notably in the Pamir Mountains and steppes of southern, western, and eastern Mongolia (Wingard and Zahler 2006; Scharf et al. 2010). Rather, rangeland and wildlife managers need to make prudent decisions based on the best practices and the available information, implementing these under a framework which includes regularized monitoring and adaptive management.

- The remoteness of most areas from consumer markets, along with high transportation cost and daunting logistics, means that those herders located close to administrative centers have distinct competitive advantages over herders living in more remote areas (and which are more likely to constitute core snow leopard habitat).
- Mineral and oil exploration reaches far into formerly remote areas, as governments and the private industry respond to the rapidly growing national and international demand for energy and mineral resources like coal, copper, uranium, and rare earth minerals. While the rapidly expanding network of roads and even railroads facilitates economic development, improved access also allows more outsiders to poach wildlife.
- As noted above, urgent issues relating to land tenure and resource rights need to be addressed (Robinson, Chap. 11, Halimova, Chap. 13, and Leake, Chap. 18).

Salafsky and Margolius (1999) described a threat-based model for conceptualizing key underlying threats affecting species, habitats, or ecosystems, establishing desirable conservation targets and conditions, along with necessary interventions for achieving these goals. Figure 19.2 from Jackson et al. (2010) summarizes the key threats and interventions for ensuring a viable population of snow leopards and prey species, including local support and protection from poaching and illegal trade. It is reproduced here as Fig. 15.1.

Clearly, managing human–wildlife conflict is critical, requiring reduction of livestock depredation levels through better animal husbandry and wild prey population and habitat restoration as well as devising sustainable means for offsetting or sharing in the economic cost of coexisting with a large carnivore. Given the snow leopard's endangered and elevated protected status, traditional predator control strategies do not appear an option.

Rather, incentive programs for garnering local community support are imperative; it is largely when tangible economic returns are realized that rural communities are willing, indeed able, to assume their role as conservation partners and become effective stewards of their surrounding environment (Western et al. 1994; Jackson and Wangchuk 2001; Mishra et al 2003).

I will next focus on participatory approaches to community-based stewardship of snow leopard and other wildlife, drawing upon my experience in Tibet's (China) Qomolangma Nature Preserve (Jackson 1998, 2001) and work in the Trans-Himalayan region. Here, I supervised the implementation of a grassroots pilot program in Ladakh (Jackson and Wangchuk 2001) with the goals of (1) reducing livestock loss by

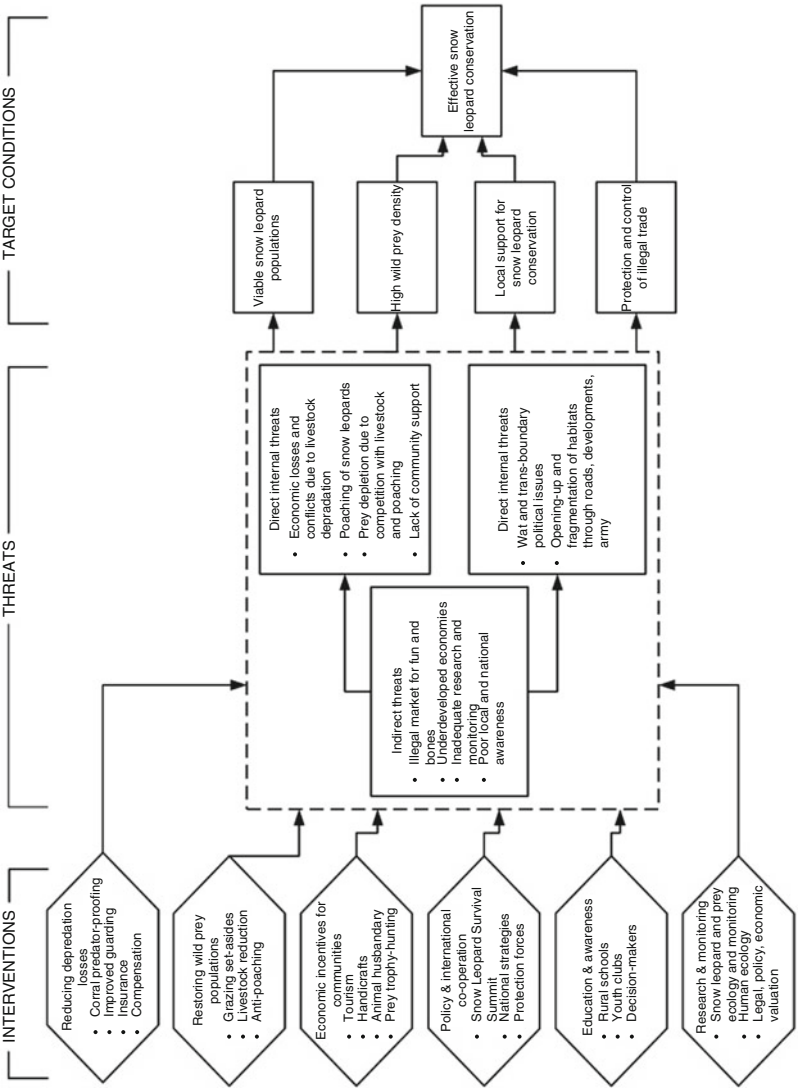

Fig. 15.1 A conceptual threat-based model for snow leopard conservation (Figure 19.2 from Jackson et al. (2010)

predator-proofing night-time pens and improving daytime guarding practices, (2) enhancing rangeland habitat and prey populations through community-based stewardship and sustainable resource management, and (3) increasing household incomes to help offset unavoidable depredation losses.

4 Community Engagement

The process of community engagement and planning is outlined below (see also Kurbanova, Chap. 7 and Hua, Chap. 14 for other examples of community participation).

4.1 APPA: A Holistic Process for Engaging Pastoralists in Rangeland Management and Biodiversity Conservation

Communities were engaged using a highly participatory process pioneered by the Mountain Institute in Tibet and Sikkim in the late 1990s and known as Appreciative Participatory Planning and Action or *APPA* for short (Jackson 1998; Jackson and Wangchuk 2001). *APPA* builds upon the community's interest, motivation, and available resources for improving resource management and enhancing income generation through an integrated set of low-cost, locally appropriate interventions. Using simple Participatory Rural Appraisal or PRA tools, the facilitator "leads" villagers and other stakeholders through a sequential four-step reiterative process termed the *4-D's*, namely, *Discover, Dream, Design*, and *Delivery*. It takes advantage of local people's wealth of traditional knowledge relating to animal husbandry, predator occurrence, habitat conditions, and animal behavior and then blends this with information derived through more structured, rigorous, and tightly focused scientific or "problem-solving" approaches, outlined below:

Step 1 Discovery—Learning About Livestock Herding Practices and Identify the Community's Strengths and Valued Resources

The most effective remedial actions emerge from a sound understanding of the root causes for depredation, which in turn requires knowledge of how people manage their domestic herds and their rationale for adopting favored strategies, including the role played by local institutions and the supporting decision-making procedure(s).

Common participatory rural appraisal or *PRA* tools were deployed to encourage learning from pastoralists for a better understanding of the root cause(s) for livestock depredation, livestock guarding practices, and other driving factors behind the generally negative perception of large predators among herders. These tools, which do not require special educational grounding, enabled planners and villagers to gather and then evaluate diverse information on existing conditions affecting rangeland use, herd productivity, and depredation risk. Table 15.1 provides some

Table 15.1 Examples of *PRA* tools used for appraising livestock depredation and animal husbandry patterns

Map of valued natural resources and village assets
Map of seasonal pastures and depredation "hotspots"
Calendar of seasonal livestock movements and daily herding cycle
Calendar of seasonal depredation losses (shows peak depredation periods)
Pair-wise matrix ranking of major sources of livestock mortality
Pasture ranking with respect to depredation and other losses
Ranking of different guarding measures
Income and livelihood ranking matrix
Semi-structured interviews to assess predation causes and patterns, along with possible remedial actions
Venn diagram showing village institutions affecting livestock production and management
Village or pasturage transects to obtain firsthand understanding of livestock management practices and issues

examples of the type of information generated and that helped forge mutual understanding vital to coming up with remedial measures which livestock owners and the community could implement and manage with minimal outside technical or financial inputs; the reader is referred to the online manual for more information (http://www.snowleopardconservancy.org/pdf/community_engagement_handbook.pdf).

In nearly all cases, these exercises conducted implicated poorly constructed livestock pens and lax daytime guarding practices as the primary cause of depredation. Livestock were allowed to forage, poorly or completely unguarded, in areas with well-broken terrain and cliffs that constitute prime habitat for the snow leopard (e.g., Jackson et al. 1996). Historically, there was better emphasis on daytime guarding, and problem predators were controlled by trapping or other traditional control methods no longer permitted. With children at school and the youths increasingly reluctant to assume animal husbandry, even highly vulnerable small-bodied livestock were left unguarded for extended periods of time.

Step 2 The Dream—Envision the Community's Short- and Long-Term Futures Were Necessary Resources Suitably Mobilized and It Acted in Concert

In the second phase, participants envisioned (i.e., visualized) what their settlement could realistically "look like" over the short-term (1–3 years) and long-term (5–10 years) time frames if a majority of its members acted collaboratively to reduce predation loss, protect snow leopards and other wildlife, and successfully enhance household incomes. Collective discussions broadened the framework upon which stakeholders could help devise interventions for achieving the preferred objectives, including harmonious coexistence of people and wildlife. The overwhelming majority of herders agreed that existing corrals were inadequate, having low, flimsy walls that easily allowed snow leopards to enter the structure. The highest ranked interventions included predator proofing of night-time corrals to prevent future multiple attacks, followed by protection of the natural prey base and herder education for improving daytime guarding practices. With predation on the open range being

virtually impossible to eliminate, project sponsors focused on ways of enhancing income generation.

Step 3 Design—Design an Action Plan to Guide the Community's Development and Encourage Nature Protection While Minimizing Long-Term Dependency upon Outside Financial Sources and/or Technical Expertise

Stakeholders were asked to follow "best practices" design guidelines for better ensuring that remedial actions are (1) environmentally responsible, (2) economically sustainable within the local context, (3) socially responsible (i.e., build on tradition and cultural values compatible with the protection of nature), and (4) implemented under a mutually agreeable and communally signed "action plan" that sets forth specific responsibilities, contributions, and obligations of each partner (Jackson and Wangchuk 2001) (Table 15.2).

These guidelines encourage stakeholders to blend traditional knowledge with external expertise and scientific information so that interventions comply with protected area regulations, yet are also integrated with the longstanding pastoral system. Drawings and plans prepared in the field encourage all livestock-owning households to design and then build secure and cost-effective livestock pens, especially known as depredation "hotspots." The typical improved sheep or goat corral measures 6×10–15 m with a 2.5-m stone drywall and 10-×110-cm wire-mesh cover over the roof and supported by wooden cross-poles for preventing a snow leopard from jumping into the enclosure. Each structure is provided with suitably protected (or small) air vents and a well-fitting wooden door which can be securely closed at night. These materials (wire mesh, cable fasteners, poles, door, and door frames) typically cost between $400 and $1,500 (USD) depending upon the dimensions of the structure and transportation to typically remote site via horse or yak. The beneficiary community contributes by providing all mud and stones for drywall construction, along with needed labor for constructing the corral and then maintaining it in good repair.

Stakeholder consensus on setting realistic targets for alleviating conflict is also important. Given limited availability of labor and costs involved with hiring shepherds, there is no easy way to avoid depredation on the open range. Large-bodied stock such as horses, yaks, and cattle crossbreeds must roam widely when foraging and are only rarely tended by a shepherd. These animals are especially prone to snow leopard predation in the winter when they are the weakest due to poor nutrition and when escape can be impeded by deep snow. Herders are offered other incentives, such as training revenue-generating skills to address this type of human–wildlife conflict.

Step 4 Motivating the Participants—To Initiate Improvements Immediately and Largely on Their Own Rather than Waiting Until an Undefined Time in the Future

Exploring how wildlife and biodiversity conservation can directly or indirectly benefit local people is a key objective of the community planning session. Posters which visually illustrate alternative rangeland management and livelihood opportunities, including tourism, help foster debate and build ownership among stakeholders who focus on improving existing activities rather than trying to establish unfamiliar activities or businesses. For example, villagers could be encouraged

Table 15.2 Conditionality and best practices for community-based wildlife conservation interventions

(a) Project conditionality

Projects are most likely to succeed if its sponsor and beneficiary communities endorse and include the following conditionality within the project's implementation and operational framework:

Ensure Tangible Conservation Results and Benefits for People, Rangelands, and Wildlife—Project activities should be implicitly linked with snow leopard and mountain biodiversity conservation (i.e., must have positive impact and not adversely impair species, habitat or rangeland resources). Specific and clearly defined actions are needed to benefit snow leopards, their prey, and habitat as well as helping to improve local people's livelihoods and income-generating opportunities

R*equire Reciprocal Investment by Participating Organizations or Institutions*—Each stakeholder (whether villager, NGO, or government) must make a reciprocal (cofinancing) contribution, within their means, in support of the agreed-to project actions or activities. This may be in the form of cash or in-kind services like materials and labor, which are valued using existing market rates and prices

Full Participation by All Involved Parties—There must be strong commitment to active and equitable participation from each involved stakeholder group throughout the life of the project (from planning to implementation, monitoring, and evaluation and reporting). In addition, project-supported activities should benefit as many households as possible (and especially those that are more marginalized)

Responsibility for Project Facilities—The beneficiary community must be willing to assume all or a significant responsibility for repairing and maintaining any infrastructural improvements (e.g., predator-proofed corral) that may be provided by the project

Monitoring and Compliance Performance—Stakeholders should be willing to employ their own simple but realistic indicators for measuring project performance and impact, according to an approved community monitoring and evaluation plan. Similarly, the project donors or implementing agency will monitor project activities, outputs, and results

(b) Design and operational best practices (Adapted from Jackson 2001)

Biodiversity conservation and livelihood enhancement actions and their associated activities should comply with the following general "best practices" guidelines:

Environmentally sound—Measures should result in no or only very minimal harm to plant or animal species, habitats, or ecosystems and preferably increase the abundance of key or endangered species, restore degraded habitats, and sustain natural ecological and biodiversity-sustaining processes

Economically sustainable—Control actions should be affordable, contain cost-sharing mechanisms, and be capable of being sustained with minimal outside cost and technical input

Socially responsible—Measures should build upon proven traditional customs and good animal husbandry or pastoral practices

Based on good science and adaptive management—Projects should benefit from the blending of modern science and traditional knowledge while being driven by principles of adaptive management

Imbedded with clear responsibilities and a transparent budget—Implemented based upon a signed agreement and *action plan* that clearly sets forth the responsibilities and contributions of each partner, in accordance with a mutually agreed-to work plan and budget. *The work plan should specify details such as where (location), who (responsible party), what (inputs/activities), how much (quantity), when (scheduling), how implemented (method), and how monitored (indicator and process to be used)*

to improve their capacity for capturing more of the revenue from existing tourism activities, but without unduly increasing dependency upon this fickle sector. Improved marketing of livestock products, the production of high-quality cashmere wool, and the production of handicrafts represent other income-generating options that could be explored.

Examples of Community-Based Conservation Actions: In this section, I present examples of community-managed conflict alleviation and incentive conservation programs.

The most important steps toward addressing human–snow leopard conflict involve reducing livestock depredation and offsetting costs (real or perceived) of resulting losses. Better antipredator livestock management represents an important means of reducing livestock depredation by wild carnivores. Predator-proofing corrals have been shown to significantly reduce losses to snow leopards (Jackson and Wangchuk 2001). This simple and effective conservation partnership of providing predator-proofing materials to local virtually eliminates multiple depredation incidents, removes long-held herder animosity toward this large cat, and helped lower livestock in its diet from over 30% to around 11%. To date, no depredation losses have resulted from properly improved livestock pens, although there have been a number of visitations and attempts at entry by snow leopards. The community's sense of ownership and satisfaction with this approach contrasts with outside agencies who built similar pens in Hemis National Park without seeking significant community involvement during site selection or design. One such corral was situated at the base of a cliff where snow leopards could gain easy access, and not surprisingly, this corral remains unused by the community that it was intended to benefit. The importance of engaging communities on equal terms as planners cannot be overemphasized.

Reducing livestock losses on the open range is far more challenging. Vigilant daytime herding by communally hired shepherds is one option, especially if infused with cash rewards for herders demonstrating better shepherding with fewer depredation losses in their pastures. As noted, low wild ungulate and high livestock numbers may lead to increased livestock depredation by snow leopards and sympatric carnivores. Besides antipoaching initiatives, ungulate recovery can be facilitated by establishing grazing set-asides on community-used pastures, where grazing and resource extraction are curtailed seasonally or on a more prolonged basis. This approach enabled the blue sheep population to double in one area in India (Charadutt Mishra, unpublished data) that together with improved herding practices has led to livestock depredation losses declining from 12 to 4% of holdings annually (Mishra 1997).

However, balancing predator–prey populations is not necessarily simple, as indicated by events following the natural reoccupation of Mt. Everest National Park by snow leopards following nearly 30 years of their absence from the ecosystem. Here, researchers observed the number of Himalayan tahr (*Hemitragus jemlahicus*) declined by nearly 70% within a few years of the leopard's return, which was attributed to heavy and sustained kid predation (Lovari et al. 2009). This suggests that elevated snow leopard numbers and/or use of the area follow better nature protection,

leading to intensified predation upon wild prey and possibly eventually followed by increased livestock depredation losses over the long run.

An ungulate trophy hunting program in Pakistan generated substantial economic benefit, with 80% of the US$25,000 trophy fee being distributed to local communities and amounting to as much as US$150 per household. Concurrently, the number of markhor (*Capra falconeri*) increased due to stringent community-imposed curbs on poaching. However, a negative outcome of such protection occurred when one beneficiary community demanded monetary compensation for snow leopards preying "their valuable wild ungulate" (Hussain 2003). These two examples underscore the importance for establishing multipronged conflict management programs along with emphasizing wild prey population recovery should be accompanied by more holistic range management and better livestock protection.

Livestock are inherently vulnerable to depredation given their reduced antipredatory abilities: depredation loss may ensue even given vigilant herding practices and high wild prey densities. Therefore, addressing human–carnivore conflict by offsetting or sharing depredation-related economic impacts may be a more promising long-term strategy. Compensation, an accepted predator conservation strategy in many parts of the world, faces numerous challenges in this remote and heavily rural region. Low compensation amounts (offsetting only 3–35% of the financial losses), false claims, corrupt disbursement officials, difficulty in authenticating claims, and bureaucratic apathy often associated with state-run programs (Mishra 1997; Jackson and Wangchuk 2004) have inadvertently elevated local resentment toward protected areas harboring snow leopards. A variant approach whereby the communities themselves manage funds, verify claims, and disburse payments appears more promising (Hussain 2000; Mishra et al. 2003). With local management by village-level committees and family-paid premiums, ownership is strengthened along with leveraging internal peer pressure against corruption or false claims. Nonetheless, fund capitalization remains the most important obstacle, as exemplified by a conservation organization in Nepal that had to invest $60,000 to establish a livestock insurance-compensation fund to serve some 45 households in a protected area (Gurung et al. 2011).

Livestock losses to disease (often exceeding 50%) typically exceed the loss to snow leopard. In Chitral (Pakistan), for example, depredation loss amounts to less that 0.5% of the average herd, so the Snow Leopard Trust launched a pilot livestock vaccination program in 2003. In exchange for tolerating depredation, some 1,500 livestock were vaccinated against common diseases which declined by 90%. Participants agreed to cease persecution of snow leopards, reduce their livestock holdings, and improve fodder handling methods in order to increase forage availability for wild herbivores. This program hopes to create sufficient economic incentive by increasing livestock survival and productivity in order that sales of excess animals will bring each family US $400 or more income per annum.

The most promising avenues for offsetting the economic burden from livestock depredation rests with providing herder households the necessary resources and skills training to enable them to generate alternative or supplementary income from activities like tourism or sale of handicrafts. A prime example is the largely

self-sustaining *Himalayan Homestays* incentive program in India which builds upon existing tourism and trekking to enhance livelihoods for local people and garner support for snow leopard conservation (Jackson and Wangchuk 2004). This UNESCO-supported initiative provides villagers training in homestays and nature guiding, with bookings facilitated by local travel agents. Individual households, operating through women's groups, accrue revenue from "bed and breakfast" stays by tourists in village homes (rotated among households), catering and handicraft sales at tented cafes on trekking routes, and nature guiding.

The Snow Leopard Conservancy established the first traditional homestays in 2003 in Hemis National Park, premier snow leopard protected area. Currently, some 100 households in 20 communities participate, with those operators situated in prime snow leopard habitat earning US$100–650 (average US$230) during the 4-month tourist season (unpublished data). Tourist visitation increased from 37 in 2001 to >700 by 2006. Client satisfaction exceeded 85% and tourists welcome the cultural interaction. Another US$400 in sales from cafes is shared among 4–8 families. Approximately 10–15% of homestay profit goes into a village conservation fund which has supported tree planting, garbage management, and recently the establishment of a village wildlife reserve for the threatened Tibetan argali (*Ovis ammon hodgsonii*). One community constructed predator-proof corrals, another paid a full-time herder to guard livestock in high summer pastures, and a third insured large-bodied, high-valued livestock like yak through a national livestock insurance program.

Mongolia's Snow Leopard Enterprises program generates income for herder–artisans through handicrafts sales, in exchange for community support of snow leopard conservation (Mishra et al. 2003). Artisans are trained and given simple tools to develop culturally appropriate woolen products which are marketed by an international NGO in the west. In exchange, communities sign conservation contracts stipulating a moratorium on snow leopard and wild ungulate poaching; contract compliance provides herders with a 20% bonus above the agreed price of their products and which is shared between artisans and the community's conservation fund. Violation of this contract results in the entire community losing the bonus. Compliance is monitored by nearby protected area rangers and law enforcement agencies. This program is currently benefiting 29 communities and over 400 herder families across snow leopard range in Mongolia and is being expanded to Kyrgyzstan and Pakistan.

5 Conclusion: The Next Steps

Pastoralism in Central Asia has undergone profound changes in recent decades. Recent attention has been directed at mineral exploration and extraction, driven in large part by China's phenomenal growth. In Mongolia's eastern and central grasslands, the Nature Conservancy (2011) recently evaluated areas of potential conflict between this country's conservation portfolio and the areas leased for mining or petroleum development in order to determine how development impacts to biodiversity

could best be offset. Areas with relative conservation value in the highest 30th percentile were designated as places to avoid development; the remaining conflict areas were removed from the portfolio and replaced with sites of similar biotic composition and ecological condition located outside of existing leases or projected development sites.

Besides this "Development by Design" approach, community stewardship (i.e., custodian responsibility) of wildlife and rangelands should be encouraged across the region. This type of initiatives needs to be designed and implemented within a highly participatory framework that ensures involvement from all stakeholders at the very onset of the project, including incorporating traditional knowledge among the planning tools and process (Berkes et al. 2000; Fernández-Giménez 2000). An open process valuing information exchange and the sharing of ideas and experience is critical to establishing resource norms and management guidelines that will best address local and regional environmental, economic, and social conditions (Schmidt et al. 2002). For example, herder training in the Gurvan Saikhan National Park of Mongolia's South Gobi (Bedunah and Schmidt 2004) where training focused on (1) improving nature conservation, (2) maintaining mobility of herder households, (3) improving skills in collaborating between households and local government, and (4) instilling skills for resolving conflicts, including actions at sharing and strengthening resource governance between herders and local government at the *soum* and *bag* level. Critical pasture management issues included rotational grazing, mutually agreeable moving dates, reservation of winter pastures, negotiating agreements with outside users, collaboration in transportation between seasonal camps, forage and winter risk management, and commitment to alternative fuels and fuel efficiency in order to reduce the pressure upon shrubs.

Strategies aimed at establishing ecologically appropriate rangeland utilization systems may need to include poverty alleviation since a relatively high proportion of herders in Central Asia are poor. Herders in colder climes and capable of producing higher-quality cashmere wool may earn substantial income, with many showing such indicators of wealth as solar-operated TVs, satellite dishes, and 4-wheel vehicles. Access to micro-credit is a crucial step in breaking the cycle of poverty in remote areas. When paying back the loan in the spring, after combing cashmere, traders demand payback in cash if prices are low and in cashmere when prices are high (Schmidt 2006). Recruiting and providing basic financing for volunteer rangers to assist herders in developing pasture protection and management plans is another option meriting further consideration: the designation of *Community Conserved Areas* offers the possibility of extending biodiversity conservation beyond established protected areas, thereby connecting fragmented habitat into more suitable units for the maintenance of viable predator and prey populations.

Facilitating protection of carnivores like snow leopards, which are highly valued globally but viewed negatively by local people, presents a special challenge. A promising avenue may rest with special incentive packages designed to increase household incomes in environmentally friendly and socially acceptable ways and fitting within the framework of "Payments for Ecological Services" or *PES* (Pagiola and Platais 2007). Financial instruments that translate the snow leopard's

global values into tangible local values large enough to drive conservation "on the ground" need to be expanded to meet site-specific conditions and made available for implementation by rangeland managers (Dickman et al. 2011). While these could evolve from the examples provided above and be structured to offer conservation payments, compensation, or insurance mitigation or meet local development needs, the relevant cost, constraints, and capacity requirements (e.g., skills training, product quality control, and marketing) should be taken into account under a cost–benefits framework (e.g., Figure 1, Dickman et al. 2011).

Monitoring of conservation outputs is required whether payments for biodiversity protection are on the project's actions (e.g., predator-proofing corrals, proper guarding of livestock while grazing, antipoaching patrols) or its results (e.g., number of snow leopards and/or prey species present). Fortunately, the emergence of noninvasive genetic sampling from scats provides a means for determining the number of snow leopard present, so tracking populations over time has become easier (Janečka et al. 2008).

The ultimate challenge lies with moving pastoral communities beyond their harsh and often insecure subsistence livelihood into more economically stable and environmentally friendly activities. With sufficient incentives, and by embracing proven pastoral practices like seasonal or rotational grazing and winter forage banking, livestock production could be better sustained on these arid or semiarid rangelands. Transforming herder perceptions of snow leopards from a pest to an asset also depends upon pastoralists assuming greater responsibility for protecting their flocks or herds from predators.

5.1 Take-Home Lessons

Regularly emphasize the rationale for providing such incentives, the benefits they bring, and the community's vested responsibility for protecting snow leopards, its prey, and habitat:

- Clearly articulate each stakeholder's conservation responsibilities, the arrangements for reciprocal financing or in-kind contributions, and provide efficient tools enabling participatory planning and action along with supporting collaborative compliance monitoring and project evaluation.
- Value traditional ecological knowledge and blend it with findings from science-based approaches which address the key threats to wildlife and plant biodiversity as well as rangeland/ecosystem management.
- Incentive-driven, income-generating programs typically require substantial financial and human resource investment in order to sustain competitive market-based enterprises like handicrafts production, traditional homestays, or nature guiding. Many donors fail to appreciate that significant returns on community-based programs may not be forthcoming for 5–10 years, while implementing agencies are hard-pressed to demonstrate tangible results within the typical 2–5-year time frame expected by donors.

- Central Asia's varied topography, climate, biodiversity, economic geography, and cultures demand locally crafted approaches that address the particular set of environmental, social, and political conditions.
- Success is closed tied to the effectiveness with which project sponsors and stakeholders alike manage conflict, alleviate local threats to biodiversity and rangeland productivity, and yet meet fundamental aspirations of the targeted community. This, in turn, requires a well-informed, networked group of beneficiaries and project instigators—a process which is greatly enhanced with equitable participation and empowering decision-making.

References and Further Reading

Anwar MB, Jackson RM, Sajid NM, Janečka JE, Hussain S, Beg MA, Muhammad G, Qayyum M (2011) Food habits of the snow leopard, *Panthera uncia* (Schreber, 1775) in Baltistan, Northern Pakistan. Eur J Wildlife Res 57:1077–1083

Bagchi S, Mishra C, Bhatnagar YV (2004) Conflicts between traditional pastoralism and conservation of Himalayan ibex (*Capra sibirica*) in the Trans-Himalayan mountains. Anim Conserv 7:121–128

Bagchi S and Mishra C (2006) Living with large carnivores: predation by snow leopard Uncia uncia Conservation Biology 17 1q512–1523

Bagchi S and Mishra C (2006). Living with large carnivores: predation on livestock by the snow leopard (Uncia uncia). J Zoo 268:217–224.

Bedunah DJ, Schmidt SM (2004) Pastoralism and protected area management in Mongolia's Gobi Gurvan Saikhan National Park. Dev Chang 35(1):167–191

Behnke R (2006) The socio-economic causes and consequences of desertification in Central Asia. Springer, Bishkek

Berkes F, Colding J and Folke C (2000) Rediscovery of traditional knowledge as adaptive management. Ecol App 10:1251–1262

Bhatnagar YV, Wangchuk R and Jackson R (1999) A survey of depredation and the related human-wildlife conflicts in Hemis National Park, Ladakh, Jammu and Kashmir. International Snow Leopard Trust, WA, USA (Project Report)

Bhatnagar YV, Wangchuk R, Prins HHT, van Wieren SE, Mishra C (2006) Perceived conflicts between pastoralism and conservation of the kiang *Equus kiang* in the Ladakh Trans-Himalaya, India. Environ Manage 38:934–941

Bliss F (2006) Social and economic change in the Pamirs (Gorno-Badakhshan, Tajikistan). Routledge, Taylor and Francis Group, London, 378 pages

Dickman AJ, Macdonald EA, Macdonald DW (2011) A review of financial instruments to pay for predator conservation and encourage human–carnivore coexistence. PNAS 2011 108(34):13937–13944

du Toit J, Kock R, Deutsch JC (eds) (2009) Wild rangelands: conserving wildlife while maintaining livestock in semi-arid ecosystems. Wiley, London

Fernández-Giménez ME (2000) The role of Mongolian nomadic pastoralists' ecological knowledge in rangeland management. Ecol Appl 10:1318–1326

Fernández-Giménez ME, Batbuyan B (2004) Law and disorder: local implementation of Mongolia's land law. Dev Chang 35:141–165

Fox JL, Dhondup K, Dorji T (2009) Tibetan antelope *Pantholops hodgsonii* conservation and new rangeland management policies in the western Chang Tang Nature Reserve, Tibet: is fencing creating an impasse? Oryx 43:183–190

Green MJB, Zhimbiev B (1997) Transboundary protected areas and snow leopard conservation. In: Jackson R, Ahmad A (eds) Proceedings of the eighth international snow leopard symposium. WWF Pakistan and International Snow Leopard Trust, Seattle, pp 194–203

Gurung GS, Thapa K, Kunkel K, Thapa GJ, Kollmar M, Mueller Boeker U (2011) Enhancing herders' livelihood and conserving the snow leopard in Nepal. Cat News 55:17–21

Halimova N (2012) Land tenure reform in Tajikistan: implications for land stewardship and social sustainability: a case study. In: Squires V (ed) Rangeland stewardship in Central Asia. Springer, Dordrecht, pp 305–332 (Chapter 13, this volume)

Hua L and Zhang D (2012) Engaging with land users; the first steps on a long road. In: Squires V (ed) Rangeland stewardship in Central Asia. Springer, Dordrecht, pp 333–356 (Chapter 14, this volume)

Hussain S (2000) Protecting snow leopards and enhancing the farmer's livelihoods: a pilot insurance scheme in Baltistan. Mt Res Dev 20:224–229

Hussain S (2003) The status of the snow leopard in Pakistan and its conflict with local farmer livelihoods. Oryx 37(1):26–33

Ikeda N (2004) Economic impacts of livestock depredation by snow leopard *Uncia uncia* in the Kanchenjunga Conservation Area Nepal Himalaya. Environ Conserv 31:322–330

Jackson R (1998) People-wildlife conflict management in the Qomolangma Nature Preserve, Tibet. In: Ning W, Miller D, Lhu Zhu J (eds) Tibet's biodiversity: conservation and management. Springer, WWF, Washington, DC, pp 40–46

Jackson R (2000) Managing people-wildlife conflict on alpine pastures in the Himalaya. In: Richard C, Basnet K, Shah JP, Raut Y (eds) Proceedings of regional grasslands workshop, volume 3. Technical and status papers on grasslands of protected areas. ICIMOD (International Centre for Integrated Mountain Development), Kathmandu

Jackson R (2001) Managing people-wildlife conflict in Tibet's Qomolangma National Nature Preserve. In: Field R, Warren RJ, Okarma H, Sievert PR (eds) Wildlife, land and people: priorities for the 21st century. Proceedings of the second international wildlife management congress. The Wildlife Society, Bethesda, pp 188–191, 399 pages

Jackson R, Ahlborn G (1989) Snow leopards (*Panthera uncia*) in Nepal: home range and movements. Nat Geogr Res 5(2):161–175

Jackson R, Ahlborn G (1990) The role of protected areas in Nepal in maintaining viable populations of snow leopards. In: Blomqvist L (ed) International pedigree book of snow leopards, volume 6. Helsinki, Finland, pp 51–69

Jackson R, Fox JL (1997) Snow leopard conservation: accomplishments and research priorities. In: Jackson R, Ahmad A (eds) Proceedings of the 8th international snow leopard symposium Islamabad, November 1995. International Snow Leopard Trust, Seattle and WWF-Pakistan, Lahore, pp 128–145

Jackson P, Nowell K (1996) Problems and possible solutions in management of felid predators. J Wildlife Res 1(3):304–314

Jackson R, Wangchuk R (2001) Linking snow leopard conservation and people-wildlife conflict resolution: grassroots measures to protect the endangered snow leopard from herder retribution. Endangered Species UPDATE 18(4):138–141

Jackson RM, Wangchuk R (2004) A community-based approach to mitigating livestock depredation by snow leopards. Hum Dimens Wildl 9:307–315

Jackson R, Ahlborn GA, Gurung M, Ale S (1996) Reducing livestock depredation losses in the Nepalese Himalaya. In: Timm RM, Crab AC (eds) Proceedings of the 17th vertebrate pest conference. University of California, Davis, pp 241–247

Jackson RM, Mishra C, McCarthy TM, Ale SB (2010) Snow leopards: conflict and conservation, Chapter 18. In: Macdonald DW, Loveridge AJ (eds) Biology and conservation of wild felids. Oxford University Press, Oxford, pp 417–430, 762 pages

Janečka JE, Jackson R, Yuguang Z, Diqiang L, Munkhtsog B, Buckley-Beason V, Murphy WJ (2008) Population monitoring of snow leopards using noninvasive collection of scat samples: a pilot study. Anim Conserv 11(5):401–411

Koshkarev EP, Vyrypaev V (2000) The snow leopard after the break-up of the Soviet Union. Cat News 32:9–11
Kreutzmann H (2012) Pastoral practices in High Asia: Agency of 'development' effected by modernisation, resettlement and transformation. Springer, Dordrecht
Kurbanov B (2012) Constraints and barriers to better land stewardship: analysis of PRAs in Tajikistan, pp 129–164 (Chapter 7, this volume)
Leake JE (2012) Conclusions and a way forward. In: Squires V (ed) Rangeland stewardship in Central Asia. Springer, Dordrecht, pp 431–442 (Chapter 18, this volume)
Lovari S, Boesi R, Minder I, Mucci N, Randi E, Dematteis A, Ale SB (2009) Restoring a keystone predator may endanger a prey species in a human-altered ecosystem: the return of the snow leopard to Sagarmatha National Park. Anim Conserv 12:559–570
Mallon DP, Jiang Z (2009) Grazers on the plains: challenges and prospects for large herbivores in Central Asia. J Appl Ecol 46:516–519
Maselli D, Inam-ur-Rahim (2012) Setting the stage: key features of the present-day Central Asian region. In: Squires V (ed) Rangeland stewardship in Central Asia. Springer, Dordrecht, pp 3–30 (Chapter 1, this volume)
McCarthy TM, Fuller TK, Munkhtsog B (2005) Movements and activities of snow leopards in Southwestern Mongolia. Biol Conserv 124:527–537
Mishra C (1997) Livestock depredation by large carnivores in the Indian trans-Himalaya: conflict perceptions and conservation prospects. Environ Conserv 24:338–343
Mishra C (2001) High altitude survival: conflicts between pastoralism and wildlife in the Trans-Himalaya. PhD thesis, Wageningen University, The Netherlands, 131 pages
Mishra C, Prins HHT, van Wieren SE (2001) Overstocking in the Trans-Himalayan rangelands of India. Environ Conserv 28:279–283
Mishra C, Allen P, McCarthy T, Madhusudan MD, Bayarjargal A, Prins HHT (2003) The role of incentive programs in conserving the snow leopard. Conserv Biol 17:1512–1523
Mishra C, van Wieren SE, Ketner P, Heitkonig IMA, Prins HHT (2004) Competition between livestock and bharal, *Pseudois nayaur* in the Indian Trans-Himalaya. J Appl Ecol 41:344–354
Mishra C, Bagchi S, Namgail T, Bhatnagar YV (2009) Multiple use of Trans-Himalayan rangelands: reconciling human livelihoods with wildlife conservation. In: du Toit J, Kock R, Deutsch J (eds) Wild rangelands: conserving wildlife while maintaining livestock in semi-arid ecosystems. Blackwell Publishing, London, pp 291–311
Namgail T, Fox JL, Bhatnagar YV (2007) Carnivore-caused livestock mortality in Trans-Himalaya. Environ Manage 39:490–496
Nowell K, Jackson P (1996) Wild cats: a status survey and conservation action plan. IUCN, Gland
Oli MK (1994) Snow leopards and blue sheep in Nepal: densities and predator: prey ratio. J Mammal 75:998–1004
Oli MK, Taylor IR, Rogers ME (1994) Snow leopard *Panthera uncia* predation of livestock: an assessment of local perceptions in the Annapurna Conservation Area Nepal. Biol Conserv 68:63–68
Olson KO, Mueller T, Kerby J, Bolortsetseg S, Leimgruber P, Nicholson C, Fuller T (2011) Death by a thousand huts: effects of household presence on density and distribution of Mongolian gazelles. Conserv Lett 4(4):304–312
Pagiola S, Platais G (2007) Payments for environmental services: from theory to practice. The World Bank, Washington, DC
Retzer V (2006) Forage competition between livestock and Mongolian Pika (*Ochotona pallasi*) in Southern Mongolian mountain steppes. Basic Appl Ecol 8:147–157
Richard C, Zhaoli Y, Guozhen D (2006) The paradox of the individual household responsibility system in the grasslands of the Tibetan Plateau, China. In: Bedunah DJ, McArthur ED, Fernandez-Gimenez M (eds) Rangelands of Central Asia: Proceedings of the conference on transformations, issues, and future challenges. 2004 January 27; Salt Lake City, UT. Proceeding RMRS-P-39. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, pp 83–92

Robinson et al. (2012) Pastoral Tenure in Central Asia: theme and variation in the five former Soviet republics In: Squires V (ed) Rangeland Stewardship in Central Asia Springer, Dordrecht, pp 239–274 (Chapter 11, this volume)

Salafsky N, Margoluis R (1999) Threat reduction assessment: a practical and cost-effective approach to evaluating conservation and development projects. Conserv Biol 13:830–841

Schaller GB (1998) Wildlife of the Tibetan Steppe. University of Chicago Press, Chicago, 373 pages

Schaller GB, Li H, Ren JR, Qiu MJ, Wang HB (1987) Status of large mammals in the Taxkorgan Reserve Xinjiang China. Biol Conserv 42:53–71

Schaller GB, Jungang R, Mingjiang Q (1988) Status of snow leopard *Panthera uncia* in Qinghai and Gansu provinces China. Biol Conserv 45:179–194

Schaller GB, Tserendeleg L, Amarasanaa G (1994) Observations on snow leopards in Mongolia. In: Fox JL, Jizeng D (eds) Proceedings of the seventh international snow leopard symposium. Northwest Plateau Institute of Biology and International Snow Leopard Trust, Seattle, pp 33–46

Scharf KM, Fernández-Giménez ME, Batbuyan B, Enhkbold S (2010) Herders and hunters in a transitional economy: the challenge of wildlife and rangeland management in Post-socialist Mongolia. In: du Toit JT, Kock R, Deutsch JC (eds) Wild rangelands: conserving wildlife while maintaining livestock in semi-arid ecosystems. Wiley, London, pp 312–339

Schmidt SM (2006) Pastoral Community Organization, livelihoods and biodiversity conservation in Mongolia's Southern Gobi Region. In: Bedunah DJ, McArthur ED, Fernandez-Gimenez M (eds) Rangelands of Central Asia: Proceedings of the conference on transformations, issues, rangelands of Central Asia: Proceedings of the conference on transformations, issues, and future challenges. 2004 January 27; Salt Lake City, UT. Proceeding RMRS-P-39. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, pp 18–29

Schmidt S, Gongor G, Kar K, Swenson K (2002) Community organizing – a key step towards sustainable livelihoods and co-management of natural resources in Mongolia. Policy Matters September 2002:71–74

Smith AT, Foggin JM (1999) The Plateau Pika (*Ochotona curzoniae*) is a keystone species for biodiversity on the Tibetan plateau. Anim Conserv 2:235–240

Sunquist M, Sunquist F (2002) Wild cats of the world. University of Chicago Press Chicago. IL USA

Treves A, Wallace RB, Naughton-Treves L, Morales A (2006) Co-managing human-wildlife conflicts: a review. Hum Dimens Wildl 11:383–396

Western D, Wright DH, Strum S (1994) Natural connections: perspectives in community-based conservation. Island Press, Washington, DC

Wingard JR, Zahler P (2006) *Silent steppe: the illegal wildlife trade crisis in Mongolia*. Discussion Paper, East Asia and Pacific Environmental and Social Development. Department World Bank, Mongolia/Washington, DC