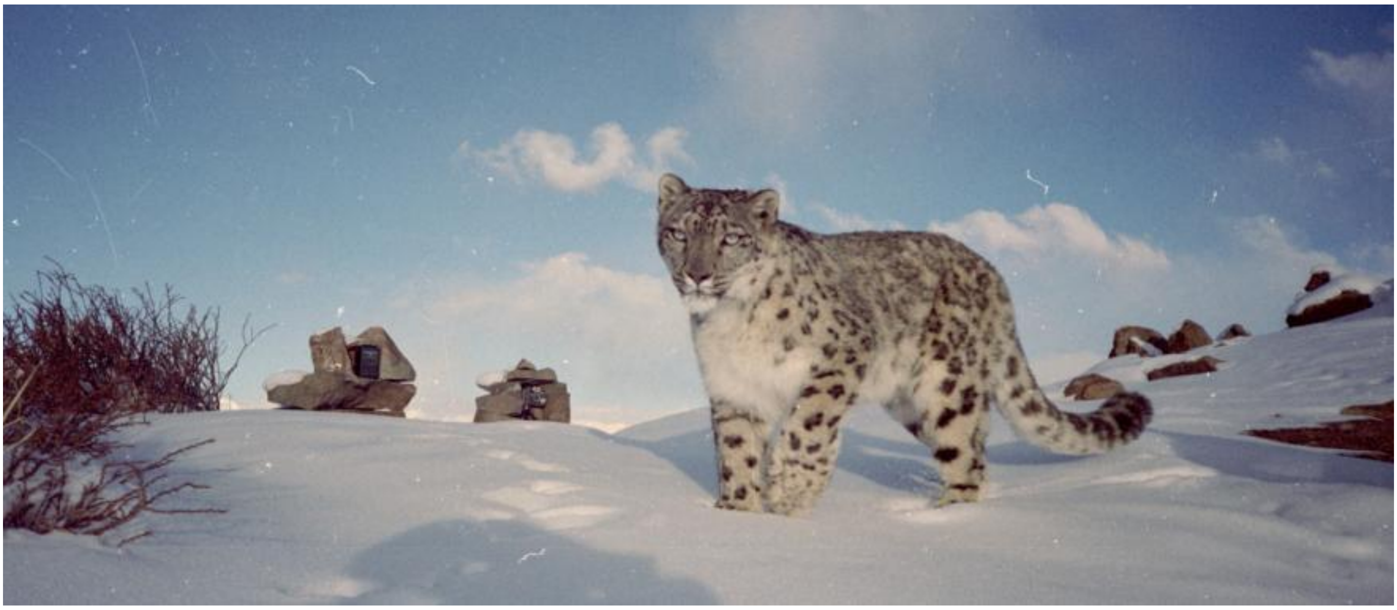
Snow Leopard Survival Strategy

Revised Version 2014.1



Snow Leopard Network

The designation of geographical entities in this book, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of the Snow Leopard Network concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Citation: Snow Leopard Network (2014). Snow Leopard Survival Strategy. Revised 2014 Version Snow Leopard Network, Seattle, Washington, USA.

Website: http://www.snowleopardnetwork.org/

The Snow Leopard Network is a worldwide organization dedicated to facilitating the exchange of information between individuals around the world for the purpose of snow leopard conservation. Our membership includes leading snow leopard experts in the public, private, and non-profit sectors.

The main goal of this organization is to implement the Snow Leopard Survival Strategy (SLSS) which offers a comprehensive analysis of the issues facing snow leopard conservation today.

Cover photo: Camera-trapped snow leopard. © Snow Leopard Conservancy / Snow Leopard Conservancy India Trust.

Snow Leopard Survival Strategy
Revised Version 2014.1

Compiled by: Rodney Jackson, David Mallon, Charudutt Mishra, Sibylle Noras, Rishi Sharma, Kulbhushansingh Suryawanshi.

Contributors:

Som Ale, Yash Veer Bhatnagar, Paul Buzzard, Mukesh Chalise, Jaffer Ud Din, Katalina Engel, John Farrington, Darla Hillard, Don Hunter, Rodney Jackson, Li Juan, Kubanych Jumabay, Ashiq Ahmed Khan, Oleg Loginov, Tom McCarthy, Tessa McGregor, Aishwarya Maheshwari, Ma Ming, Stefan Michel, Tatjana Rosen Michel, Ranjini Murali, Wali Modaqiq, Tsewang Namgail, Muhammad Ali Nawaz, Mikhail Paltsyn, Upendra Mani Pradhan, Philip Riordan, S Sathyakumar, George Schaller, Karan Shah, Koustubh Sharma, Rinjan Shrestha, Anthony Simms, Navinder Singh, Kamal Thapa, Pranav Trivedi, Pauline Verheij, Dajun Wang, Per Wegge, Lingyun Xiao, Peter Zahler.

Copy editing: Sibylle Noras.

Technology and communications: Rana Bayrakcismith, Jeff Brown, Heather Hemmingmoore, Sibylle Noras, Anush Shetty.

Table of Contents

Chapter 1: Introduction

1.1. The Snow Leopard *Panthera uncia*

The iconic snow leopard is the least known of the 'big cats' due to its elusive nature, secretive habits and the remote and challenging terrain it inhabits. As an apex predator, its survival depends on healthy populations of mountain ungulates, the major prey; these in turn are dependent on the availability of good-quality rangeland minimally degraded by concurrent use from livestock and humans. The snow leopard has a large home range size, so viable populations can only be secured across large landscapes. The snow leopard therefore represents the ideal flagship and umbrella species for the mountain ecosystems of Asia.

Snow leopards share their range with pastoral communities who also require healthy rangelands to sustain their livestock and livelihoods. Moreover, these high altitude mountains and plateaus provide invaluable ecosystem services through carbon storage in peat lands and grasslands, and serve as Asia's 'water towers', providing fresh water for hundreds of millions of people living downstream in Central, East and South Asia.

1.2. The Snow Leopard Survival Strategy (SLSS)

SLSSS was developed to summarize current knowledge on the distribution, status and biology of the snow leopard, to consolidate the knowledge of snow leopard researchers and conservationists worldwide, to identify the key threats to their survival, review the existing state of research and conservation programs, and identify priorities for action.

The specific goals of SLSS are to:

- Assess and prioritize threats to snow leopard across their range.
- Define and prioritize appropriate conservation, education, and policy measures to alleviate threats.
- Prioritize topics for snow leopard research and identify viable and preferred research methods.

The Snow Leopard Trust initiated the SLSS process in February 2001 with a survey of specialists. The survey results were made available on a website and discussed via an email group. This stage was followed by the Snow Leopard Survival Summit, held in Seattle, USA, 21-26 May 2002, and attended by 58 specialists, including representatives from the range states, to discuss and refine the Strategy. The end product was the original version of SLSS (McCarthy & Chapron 2003). The Summit also established the Snow Leopard Network (SLN) a global alliance of more than 500 professionals and nearly 50 institutions involved in snow leopard conservation. SLN later produced a summary and partially revised version (Mallon 2007) in English, Chinese, Mongolian and Russian. All earlier versions are available on the SLN website (www.snowleopardnetwork.org).

Since then, many conservation programs have been initiated, field surveys have expanded across snow leopard range, new protected areas have been established, and major advances in research technology have occurred. Among these are great improvements in camera trap technology, GPS satellite collars, and vastly more refined techniques of genetic analysis that allow the identification of individual snow leopards from fecal DNA. These have generated a large amount of new information and have facilitated research as well as conservation and management. However, the conservation of the snow leopard, its prey and habitat is contingent upon the degree to which such information is shared, reviewed or constructively evaluated and advanced, along with sufficient human and financial resources for advancing our understanding of the species' ecology and conservation priorities.

At the same time, the pace of rural development has increased, opening up previously remote parts of snow leopard range; livestock grazing has expanded and intensified, and new factors have emerged that may threaten the future of snow leopards and their habitat, notably increased resource exploitation and climate change – all of which have created new challenges for snow leopard conservation.

This was therefore deemed the appropriate time for SLN to update SLSS. The period of updating coincided with the Global Snow Leopard & Ecosystem Protection Program (GSLEP), a new initiative launched in 2012 by President Alamazbek Atambaev and the government of the Kyrgyz Republic and modelled on the Global Tiger Initiative. The GSLEP seeks to bring together governments of snow leopard range countries to collectively recognize the threats to snow leopards and commit to coordinated national and international action. The GSLEP's Goal is to identify and secure 20 snow leopard landscapes by the year 2020. The foundation of the process is a set of 12 National Snow Leopard and Ecosystem Priorities (NSLEP) developed by each range country government. For further details, including access to the global and national plans released at the Summit Workshop in Bishkek in October 2013, see http://en.akilibirs.com.

The GSLEP and revised SLSS have been developed in parallel and the two products are intended to be complementary, with GSLEP organized around a policy-level and government-focused agenda and SLSS a wider, more technical document targeting researchers, conservationists and wildlife or protected area managers in the government and public sectors. There is naturally some overlap in thematic content, since several individual and institutional members of SLN also contributed to the development of the GSLEP along with providing input and initial reviews of the country-based NSLEPs.

SLSS must remain on top of all the rapid developments so that the conservation community is equipped with the information it needs to respond to ongoing changes in a manner that assures the continued conservation of snow leopards, their prey and habitat. The large volume of new information available and speed with which it is distributed on new media soon render any static document outdated and waiting for 10-year updates is impractical.

It is with this critical need in mind that the 2014 version of SLSS is presented as an online resource and as a "living" document so that sections or chapters can be updated quickly in response to new information and syntheses, ensuring that it remains relevant and a valued resource.

Chapter 2: Review of Current Status

2.1.1. Introduction

2.1.1 Taxonomy

The snow leopard *Panthera uncia* Schreber (1776) is a member of the family Felidae, subfamily Pantherinae (Nowak and Paradiso 1983). The snow leopard's vocal fold lacks a thick pad of fibro-elastic tissue so it cannot 'roar' like the other big cats and was formerly placed alone in a separate genus *Uncia* (Pocock 1917, Hemmer 1972, Peters 1980, Sunquist and Sunquist 2002). Recent phylogenetic analyses place the snow leopard within the genus *Panthera*, being most closely related to the tiger (*Panthera tigris*) with the divergence time estimated to be 2 million years (Johnson et al. 2006). Two subspecies were described by Stroganov (1962) but are not generally recognized. Ongoing genetic analysis may clarify whether significant intraspecific variation in snow leopards is present.

As in other Pantherinae, the diploid chromosome number in snow leopards is 38 and the fundamental number is 36. There are 17 metacentric and 2 acrocentric chromosomes (Soderlund et al. 1980). The karyotypic banding pattern is almost identical to that of other Pantherinae (Gripenberg et al. 1982). There is virtually no fossil record of snow leopards, the only positive identifications being upper Pleistocene remains from Altai caves (Hemmer 1972).

2.1.2 Common names

Snow leopard, *ounce* (English); *léopard des neiges* (French); *Schneeleopard*, (German); *pantera de las nieves* (Spanish); *snezhniy bars* (Russian); *xue bao* (Chinese); *palang-i-barfy* (Dari); *bharal he*, *barfani chita* (Hindi, Urdu); *shan* (Ladakhi); *hi un chituwa* (Nepali); *ilbirs*, *akilbirs* (Kyrgyz) *irbis* (Kazakh), *irvis* (Mongolian); *sah*, *sarken* (Tibetan); *chen* (Bhutanese), *pes* (Wakhi), *palang* (Pamiri), *babri barfi* (Tajik).

2.1.2 Description

Adult male snow leopards weigh 37–55 kg and females 35–42 kg; they have a shoulder height of c. 60 cm, head-body length of 1-1.3 m, and tail 0.8-1 m (Hemmer 1972, Johansson et al. 2013). With its smoky-grey pelage tinged with yellow and patterned with dark grey, open rosettes and black spots, the snow leopard is especially well camouflaged for life among bare rocks or patchy snow. It has a well-developed chest, short forelimbs with sizeable paws, strong hind limbs, all adaptations for traversing steep terrain. Adaptations for cold include an enlarged nasal cavity, long body hair with dense, woolly under-fur (belly fur up to 12 cm in length). The long, thick tail aids balance and can be wrapped around the body for added warmth (Sunquist and Sunquist 2002). Snow leopards are well known for the ability to leap significant linear or vertical distances.

2.1.3. IUCN Red List Status

Snow leopards have been classified as Endangered in the IUCN Red List of Threatened Species since 1988, with the most recent assessment in 2008 (Jackson et al. 2008). The species is currently being reassessed for the next period (2015-2020).

2.2. Distribution

The range of the snow leopard extends from the Himalaya in the south, across the Qinghai-Tibet Plateau and the mountains of Central Asia to the mountains of southern Siberia in the north. It occurs in the Altay, Sayan, Tien Shan, Kunlun, Pamir, Hindu Kush, Karakoram, and Himalayan ranges and in smaller isolated mountains in the Gobi region. It occurs in 12 countries: Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russia, Tajikistan and Uzbekistan. A small area of potential range occurs in northern Myanmar but recent snow leopard presence has not been confirmed.

Figure 2.1 Range Map

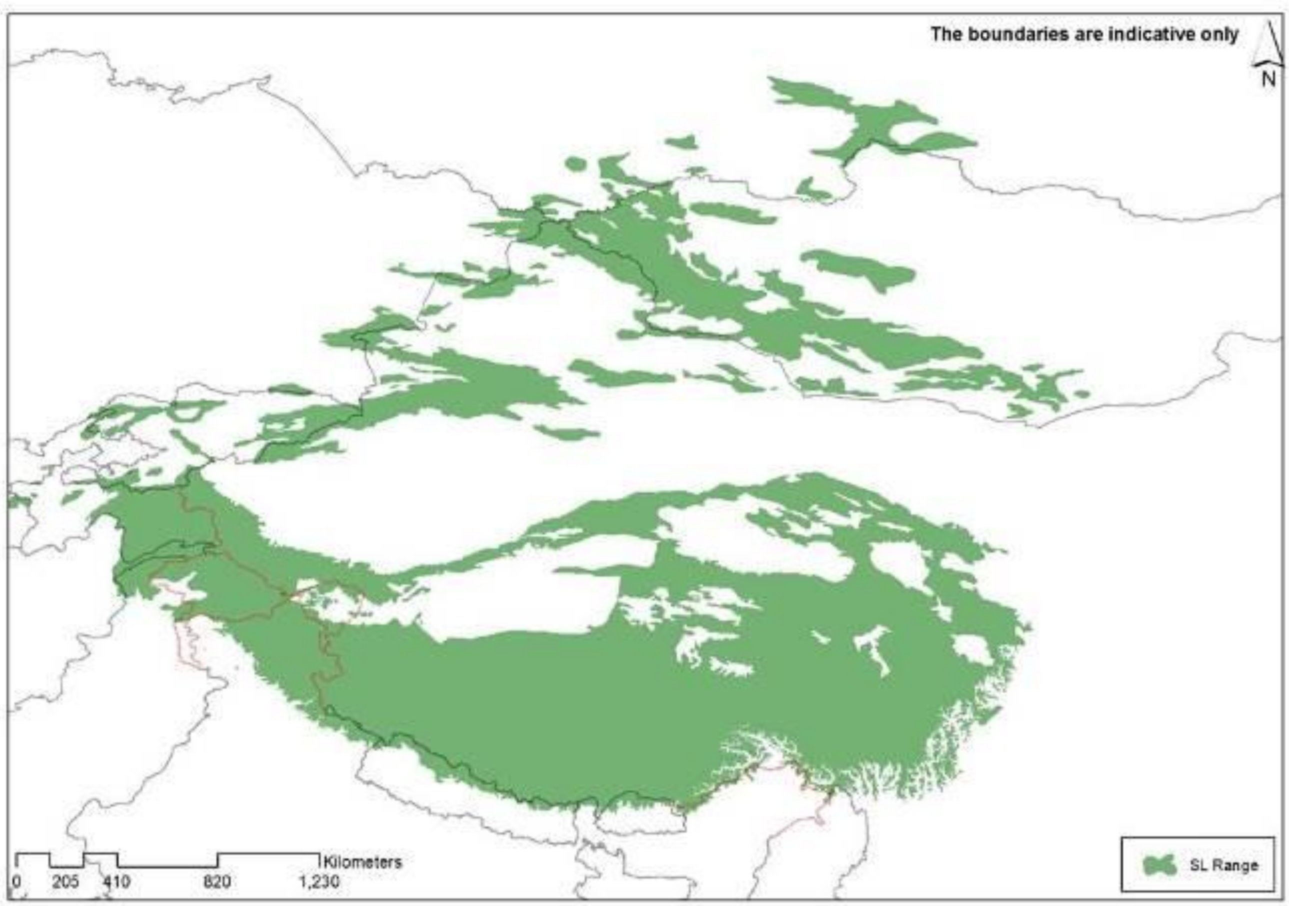


Figure 2.1 The potential range of the snow leopard. The range depicted includes some areas of less habitat (notably across the Qinghai-Tibet Plateau where much terrain is level or undulating). In some places, snow leopards may have been extirpated, while other sites may not have been surveyed due to their inaccessibility. In others, long intervals may have passed since surveys were undertaken in the 1980s and 1990s. In addition, much of the snow leopard's distribution is located along contentious international borders, adding to the difficulty of reliably establishing the species' current status and distribution. Depicting the current distribution of the snow leopard at a fine scale is therefore not straightforward. These factors partly explain the wide range in estimates of global range size, varying from 1.2 million to over 3 million km^2 (Table 2.1).

Modeling of snow leopard distribution as has been done in the Sanjiangyuan region of China (Li et. al. 2013) using field data and predictive distribution mapping based on remotely-sensed data along with relatively large scale environmental parameters (e.g. using digital terrain models to derive landform ruggedness indices) is needed across the snow leopard's range.

Table 2.1. Estimates of snow leopard range size

Estimate (km^2)	Source
1,230,000	Fox (1989)
1,835,000	Fox (1994)
3,024,728	Hunter & Jackson (1997
Confirmed: 1,003,608	Beijing (2008)
Probable: 219,489	Beijing (2008)
Possible: 1,535,116	Beijing (2008)
Total: 2,758,213	Beijing (2008)
1,200,000-1,600,000	Jackson et al. (2010)
1,776,000	GSLEP (2013)

2.3 Population

The global population of the snow leopard was estimated at 4080–6590 in the 2003 version of SLSS, between 3920–6390 by GSLEP (2013), and is suggested to lie between 4500–7500 by Jackson et al. (2010) who noted that current knowledge was inadequate to generate a reliable figure. There are several difficulties to overcome in making reliable estimates of snow leopard population size. The species' secretive nature, generally low density, and remote terrain result in low detection rates and small sample sizes which make extrapolations problematic.

Many population estimates have been produced for specific sites, regions or countries, Many of these are derived from field sign encounter rates, such as the number of tracks, feces or scrapes found, or based on 'expert opinion' or general intuition. Thus, most of these estimates contain a high degree of subjectivity and the methodologies applied are unsuited to producing reliable figures and should be regarded as 'guesstimates' at best.

Improved technology and analytical techniques (e.g. camera trapping, GPS collaring, fecal DNA analysis, and occupancy modelling) are beginning to address this problem. For further details see Chapter 12 Estimating Snow Leopard and Prey Populations and Monitoring Trends. Recent and ongoing studies using these techniques have produced density estimates varying from 0.15 to 8.49/100 km^2 (Appendix 1). However, most of the studies so far have been conducted over rather small areas, sometimes smaller than the home range of a single snow leopard, rendering the information inadequate to make population and density inferences over larger areas. In addition, estimates derived from modeling such as Habitat Suitability Index (HSI) remain speculative, with an urgent need for field studies correlating indices like HSI and occupancy, with areas of known snow leopard density derived from intensive telemetry, remote camera surveys and fecal genotyping studies.

2.4. Country summaries

The following are summarized from the information provided in each country's National Snow Leopard and Ecosystems Priorities (NSLEP) profile compiled for the GSLEP in 2013, to ensure that the two documents are aligned, and supplemented with recent reports where available. Only the most recent population estimates have been included. Full details of earlier site estimates are provided in the 2003 version of SLSS – available online http://www.snowleopard.org/downloads/snow_leopard_survival_strategy.pdf

A full list of protected areas (PAs) harboring snow leopards is in Appendix 3.

2.4.1 Afghanistan

Snow leopards occur in Badakhshan Province in the north-east and there are local reports from Nuristan and Laghman provinces (Habibi 2004). Earlier reports of occurrence in the Central Hindu Kush have not been confirmed. Most of the recent information comes from Wakhan District of Badakhshan. Since 2009, the National Environmental Protection Agency and Wildlife Conservation Society have obtained over 1300 camera trap images at 20 locations in Wakhan (Simms et al. 2011) and in 2012, three snow leopards were equipped with satellite collars (Simms et al. 2013). The whole of Wakhan District was declared a National Park in April 2014, covering an area of more than 10,000 km^2, and encompassing the Big Pamir Wildlife Reserve (576 km^2) and Teggermansu (Little Pamir) Wildlife Reserve (248 km^2).

2.4.2 Bhutan

There is an estimated c. 10,000 km^2 of potential range, mainly across the north of the country and a small area of the east. Snow leopard presence has been confirmed in Toorsa Strict Nature Reserve, Jigme Dorje National Park, and Wangchuk Centennial Park. Protected areas with potential habitat are Sakten Wildlife Sanctuary, Jigme Singye Wangchuk National Park and Bumdeling Wildlife Sanctuary. Based on camera trapping, the total snow leopard population is estimated at 100-200. Shrestha et al. (2013) reported a density of 2.39 snow leopards per 100 km^2 (95% CI 2.24-2.49) in 797 km^2 of the upper Chamkar Chu region (27°51'N, 90°39′E) of Wangchuk Centennial Park.

2.4.3 China

Snow leopards occur in provinces or autonomous regions (Qinghai, Tibet, and Xinjiang, but also in Gansu, Inner Mongolia, Sichuan, and Yunnan. They occur in the mountains chains of Pamir, Kunlun, Altun, Tien Shan, Altai and Qilian and on the Qinghai-Tibet Plateau. Their range in China covers c. 1.1

million km^2, over 60% of the global total and the population is estimated at 2000-2500. China has established 26 nature reserves in snow leopard range, covering about 600,000 km^2, more than half of the total area.

A very large network of protected areas (covering in excess of 478,000 km^2) is located on the Qinghai-Tibetan Plateau: this consists of Chang Tang Reserve, including the Memar addition, (300,000 km^2) in Tibet; Sanjiangyuan Nature Reserve (152,000 km^2), and Kekexili Nature Reserve (45,500 km^2) in Qinghai; and Arjin Shan Reserve (45,000 km^2) in Xinjiang, with an addition of 23,000 km^2 along the central Kun Lun Range, as well as Xinjiang and Siling Reserve in Tibet's Xainza County. However, these reserves, with the exception of Sanjiangyuan, have been reported to harbor relatively few snow leopards, because of unfavorable terrain, sporadic and generally low blue sheep numbers, or the presence of habitat rendered marginal by the high base altitude of the northwestern portions of the Tibetan Plateau (Schaller 1998). Li et al. (2013) reported up to 89,602 km^2 of suitable snow leopard habitat in the Sanjiangyuan region.

Gansu Province: Present in the Qilian Shan range along the border with Qinghai and in the Die Shan along the border with Sichuan. Snow leopards have been extirpated from the Mazong Shan and the other outlying ranges along the Gansu-Inner Mongolia boundary (Wang and Schaller 1996). The Qilian Shan National Nature Reserve, (>20,000 km^2) is thought to have shown a recovery in the population of blue sheep and snow leopards. Yanchiwan Reserve (5,000 km^2) also contains a population of snow leopards (Schaller et al. 1988b).

Inner Mongolia Autonomous Region: According to Schaller (1998), snow leopards once occupied most of the large desert ranges on the Inner Mongolia-Ningxia border, including the Dongda Shan, Yabrai Shan, Ulan Shan, Daqing Shan, Helan Shan, and Longshou Shan on the Inner Mongolia-Gansu border. By the late 1990s, the species was believed to be on the verge of extinction in Inner Mongolia, except for a few animals that may persist in the Arqitu area of the Lang Shan, and transients are occasionally killed along the border with Mongolia (Wang and Schaller 1996). A snow leopard was photographed in the border area in January 2013. These mountain ranges likely served as one of several important linkages connecting southern and northern (Mongolia-Russian) snow leopard populations.

Qinghai Province: Schaller et al. (1988b) estimated the total population at about 650 snow leopards within an occupied range of some 65,000 km^2 which amounts to about 9% of the total area of Qinghai. Their range includes the Arjin Shan (bordering Xinjiang), the Danghe Nanshan, Shule Nanshan, and Qilian Shan on the border with Gansu Province, and the Kunlun Shan which bisects Qinghai and terminates in the Anyemaqen Shan, along with a series of small massifs on the Qinghai-Tibet Plateau. Within the latter area Schaller et al. (1998) identified three "hotspots" (North Zadoi, South Zadoi, and Yushu), where density was estimated at about one snow leopard per 25-35 km^2. Abundant sign was also noted in parts of eastern Anyemaqen and the Shule Nanshan. The core areas of Sanjiangyuan Reserve include an estimated 7,674 km^2 of snow leopard habitat, while an additional 8,342 km^2 is estimated to be protected by the region's Buddhist Monasteries (Li et al. 2013). Li (2012) reported a population density of 3.1 snow leopards per 100 km^2 in Suojia region of Sanjiangyuan Nature Reserve.

Sichuan Province: Liao and Tan (1988) listed 10 counties where snow leopard have been reported, including Yaan, Baoxing, Jinchaun, Xiaojin, along with Aba, Garze, Dege and Batang. Its presence has been confirmed in select Giant Panda Reserves such as in Wolong and it is present in low numbers in various areas above the timberline (Schaller 1998). Distribution and status in Sichuan Province are poorly understood, and field surveys are needed to establish the current distribution.

Tibet Autonomous Region (TAR): Snow leopards occur sporadically across the entire TAR, with more or less continuous distribution along the northern slopes of the Himalaya and the larger mountain ranges which bisect the Tibetan Plateau, and also sporadically on smaller mountains. Surveys by Schaller (1998) indicated that snow leopards were scarce in the Gandise and Nyainqentangla ranges, and rare and localized in the vast Chang Tang Reserve, which he attributed to a paucity of blue sheep as well as the absence of suitable habitats. Despite wide-ranging surveys across much of north-western Tibet, Schaller rarely encountered snow leopard signs. A survey of over 40,000 km^2 area south of Lhasa along the Bhutan border indicated that snow leopards had been virtually exterminated in the previous decade. There are high populations of blue sheep, the main prey species, in the southern parts of Chang Tang, including Shenzha, Southern Nyima, and Southern Tsonyi counties, which also have limestone cliff habitats. Extensive snow leopard sign was recorded in the limestone hills both north and south of Seling Lake, suggesting a potential improvement in conservation status as a result of greater compliance with wildlife laws (John Farrington, unpubl. data).

Jackson (1994a) reported up to 100 snow leopards in the Qomolangma National Nature Reserve 33,910 km^2 area along the main Himalaya and Nepalese border and centered on Mt. Everest. Snow leopard status and habitat in Tibet urgently needs to be delineated. Areas with the highest priority for status surveys are the Nayainqentanglha, Taniantaweng and Ningjing Shan mountains in eastern and south-eastern Tibet, and along with western Nepal, the mountains bordering Uttarakhand in India, and the Nganlang Kangri mountains bordering Ladakh.

Xinjiang Autonomous Region: Schaller et al. (1988a) estimated that there were about 750 snow leopards in 170,000 km^2 of suitable habitat in Xinjiang. Snow leopards are found in the Tien Shan mountains close to the Mongolian border (Nan Shan and Karlik Shan); along the Mongolian-China border in the Altay, Baytik and Khavtag Shan complexes, in the Jungarian Alatau (along the Kazakhstan border), the Arjin Shan and Kun Lun range along the northern edge of the Tibetan Plateau, the Pamirs along the Tajikistan-Afghanistan border, and the Karakorum mountains along the Pakistan border. Twenty protected areas in Xinjiang have snow leopards (Ma et al. 2013). These include Taxkorgan Reserve (14,000 km^2) Aerjin Shan or Arjin Mountains (45,120 km^2), and Tumor Feng Reserve (100 km^2).

Yunnan Province: Potential habitat is limited to a small area in the Hengduan Shan in north-west Yunnan near the borders with the Tibet Autonomous Region, Sichuan and Myanmar. Snow leopard was reported there by Ji (1999). Details of status and distribution are lacking, and field surveys are needed to confirm their current presence.

2.4.4 India

Snow leopards occur in the Himalayan and Trans-Himalayan areas of five states in northern India. The total range is estimated to cover 126,842 km^2, in two landscapes lying west and east of Nepal, respectively. In the west in Jammu & Kashmir (76,601 km^2), Himachal Pradesh (28,843 km^2), Uttarakhand (14,271 km^2); and in the east, Sikkim (2,390 km^2) and Arunachal Pradesh (4,736 km^2). They are found principally in the subalpine and alpine zones above c. 3,200 m in the west and c. 4,200 m in the east. The Trans-Himalayan areas of Ladakh and Spiti contain extensive areas of contiguous habitat, healthy prey populations and many confirmed records snow leopard presence have been obtained.

A coarse estimate of the population size is 400-700 snow leopards. Snow leopards occur in around 20 protected areas but range all across the landscape. Jackson et al. (2006) reported densities of 8.49/100 km^2 and 4.45/100 km^2 in the Rumbak area of Hemis NP in 2003 and 2004 respectively, a difference they attributed to variances in camera-trap placement and density. Suryawanshi (2013) reported densities ranging from one 0.5/100km^2 to 3.4/100km^2 for five different areas in the Spiti Valley of Himachal Pradesh. Sharma et al. (unpub. data) suggest an overall density of 0.77/100 km^2 for the entire Upper Spiti Valley. Sathyakumar et al (unpubl. data) suggest an overall density of 3.88 ± 0.4 individuals/ 100 km^2 in Khangchendzonga National Park – Prek Chu Catchment.

2.4.5 Kyrgyz Republic

Widespread in the Tien Shan system (West Tien Shan, Talass Alatau, Kyrgyz range, Central Tien Shan, Inner Tien Shan) and the Pamir-Alai (Alai, Trans-Alai and Turkestan ranges) as well as the Fergana range. The total range is estimated at 54,000 km^2. In 2000, Koshkarev and Vyrypaev estimated the number of snow leopards for the whole Kyrgyzstan to be 150-200 individuals, attributing the decline from the earlier estimate of ca 650 to widespread poaching in the 1990s. More recent population estimates are closer to 300-350 individuals for the whole country. Snow leopards occur in eight nature reserves and two national parks: Besh-Aral State Reserve (632 km^2), Kara-Bura SR (114 km^2), Karatal-Japyryk SR (364 km^2), Padyshat SR (305 km^2), Kulun-ata SR (274 km^2), Naryn SR (910 km^2), Sarychat-Ertash SR (720 km^2), Sary Chelek Biosphere Reserve (238 km^2), Ala Archa NP (194 km^2) and Kara-Shoroo NP (120 km^2). Densities of snow leopards have been reported to range between 0.8-4.7 per 100 km^2, averaging 2.35 animals per 100 km^2.

2.4.6 Kazakhstan

Snow leopards occur in the mountains along the southern and eastern borders: in the West Tien Shan (Talass Alatau, Sairam, Ugam and Karzhantau ridges) and the Kyrgyz Alatau (along the border with Kyrgyzstan); the Borohoro, Junggar Alatau, Saur, and Tarbagatai (on the border with China); and Altai (on the border with Mongolia, Russia and China). The range in Kazakhstan is estimated to make up 2.7% of global range and 18,673 km^2 lies within protected areas. Zhiryakov & Baidavletov (2002) estimated total numbers at 100-110, including 30-35 in Almaty State Reserve (915 km^2). Snow leopards also occur in the Aksu Zhabagly State Reserve (744 km^2).

2.4.7. Mongolia

Distributed widely in the west and center in the Mongolian Altai and Gobi Altai (east to about 103^0E; Schaller et al. 1994), Harhiraa, Han Hohey and Turgen mountains of the north-west; lower mountains and hills in the Trans-Altai Gobi; and the southern end of the Sayan mountains around Lake Hovsgol. Snow leopard range is estimated at 103,000 km^2 and the population at 1000 animals.

McCarthy (2000) provided a detailed range map and assessment of snow leopard status and distribution in Mongolia, based on 328 sign transects across the snow leopard's entire range. Its presence is reported or suspected from up to 10 aimags. The highest densities are said to occur in the South Gobi, Central Transaltai Gobi, and Northern Altai, with remnant populations in Khangai and possibly Khovsgol. These surveys indicated that snow leopards cross 20-65 km of open steppe in traveling between isolated massifs, more recently confirmed through radio-collaring studies in South Gobi. Bold and Dorzhzunduy (1976) estimated a total snow leopard population of 500-900. They further estimated that there were 190-250 snow leopards in a 6,600 km^2 area in the South Gobi Province, and calculated a density of 4.4/100 km^2 in a 1,000 km^2 area encompassing the Tost Uul Range. Using camera-traps and referring to a 'known' population of radio-collared snow leopards within the study area encompassing ca. 1,684 km^2, Sharma et al. (2014) estimated the adult snow leopard population at 12-14 individuals over a 4-year period (2009 – 2012). Schaller et al. (1994) found signs suspected to be of at least 10 animals within a 200 km^2 area of the Burhan Buudai in the Central Altay, an estimated density substantially more than that existing elsewhere.

At least 10 Protected Areas harbor snow leopards (McCarthy 2000), totaling about 20% of the snow leopard's range within Mongolia. The PAs include the Transaltay Gobi Strictly PA or SPA (consisting of Great Gobi 'A' 44,190 km^2 and 'B' 8,810 km^2), Khokh Serkh SPA, Otgontenger SPA, Tsagaan Shuvuut SPA, Turgen Uul SPA, Gobi Gurvansaikhan National Conservation Park or NCP - a 12,716 km^2 area in South Gobi (Reading 1995), Altai Tavaan Bogd NCP, Burhan Buudai Nature Reserve, Alag Khairkhan Nature Reserve and Eej Uul National Monuments, in all totalling 1,110 km^2 within the snow leopard's range in the central Transaltai Gobi. Snow leopard sign has not been observed in the 723 km^2 Khokh Serkh SPA. Gurvan Saikhan and Altai Tavaan Bogd are the two largest PAs totalling roughly 28,080 km^2. More recently, a Local Protected Area has been established in the Tost Mountains of South Gobi, encompassing snow leopards subject to a long-term study (McCarthy et.al 2010; Sharma et al. 2014).

2.4.8. Nepal

Snow leopards are found along the northern region of the country and the Himalaya range. There are three main complexes: The largest is located in western Nepal, from Tscharka Pass in Shey-Phoksundo National Park to the Api-Nampa Conservation Area (CA) along the Indian border; a central complex, including the Annapurna Conservation Area and Manaslu CA; and a smaller, eastern complex from the Kangchenjunga CA on the India (Sikkim) border through Sagarmatha and Makalu-Barun NP's to the Gaurishankar CA and Langtang NP. The national Snow Leopard Conservation Action Plan estimates a total habitat of 13,000 km^2 in Nepal. The population is estimated at 195-416 individuals, based on the relationship between scrape encounter rates and individuals, extrapolated over suitable habitat and cross-verified with predator-prey relationships (Government of Nepal 2012). Population density is estimated at 1.5–3.2 animals/100 km².

The largest populations occur in the west (Mustang, Mugu, Dolpo and Humla districts) of Nepal (Jackson 1979). Based on radio-telemetry, Jackson and Ahlborn (1989) reported a density of at least 5-10 snow leopards per 100 km² in the remote, uninhabited Langu Valley of west Nepal. These are slightly higher than estimates from Manang (north of the Annapurna Range) in the Annapurna Conservation Area (Oli 1995), where blue sheep and livestock biomass was reported to exceed 1,200 kg per km² (Jackson et al. 1994b). Ale et al. (2014) reported a minimum of 3 snow leopards camera-trapped within an area of ca 75 km^2.

Snow leopard presence has been confirmed in the following Protected Areas: Langtang National Park, Api Nampa Conservation Area, Gaurishankar Conservation Area, Rara National Park, Khaptad National Park, the Shey-Phoksundo National Park (3,555 km²), Dhorpatan Hunting Reserve (1,325 km²), Annapurna Conservation Area (7,629 km, including the Manang, Nar Phu and Mustang sectors each offering good to excellent snow leopard habitat), Sagarmatha National Park (1,148 km²), Kangchenjunga Conservation Area (2,035 km²), Manaslu Conservation Area (1,663 km², and possibly elevated portions of the 2,233 km² Makalu-Barun National Park and Conservation Area.

The Qomolangma Nature Reserve in Tibet, China, provides a corridor linking the Makalu-Barun, Sagarmatha, Langtang, Manaslu and Annapurna conservation areas, thus offering a potentially vast trans-frontier Protected Area (Singh and Jackson 1999). Based upon a habitat model, Jackson and Ahlborn (1990) concluded that 65% of Nepal’s snow leopard population was located outside of the PA network. Populations of 50 or more individuals might be expected in three Reserves (Shey-Phoksundo, Langtang and Annapurna), but no PA is expected to contain more than 180 animals even assuming mean densities as high as 5 snow leopards per 100 km² as suggested from sign surveys (Jackson and Ahlborn 1989; Fox and Jackson, 2002).

2.4.9. Pakistan

Snow leopards occur in the Hindu Kush, Karakoram and Pamir mountains of Khyber-Pakhtunkhwa province (Chitral District and northern parts of Swat District); Gilgit-Baltistan province (all seven districts but major strongholds in Hunza-Nagar, Gilgit and Skardu) and Azad Kashmir (presence limited to Neelam District, particularly in Shontar and Gurez valleys). The total area of habitat available is about 80,000 km^2 and the population is estimated at 200-300. Over 60% of the range is in Gilgit-Baltistan, mainly in two adjoining PAs: Khunjerab NP and Central Karakoram NP. With the notification of Broghil National Park and Qurumber National Park and other protected areas, the total area under protection rises to over 37,000 km^2. With the exception of Khunjerab and Central Karakoram NPs, most reserves are too small to protect more than a very few animals.

Through sign-based occupancy and intensive camera trappings since 2011, the Snow Leopard Foundation has confirmed presence of the species over large landscapes, starting from Gahriat Gol and Chitral Gol in the west to the Karakoram ranges in the east, including Torkho, Laspur, Mastuj and Broghil valleys in Chitral District, and Qurumber, Misgar, Chuparson, Phandar, Khunjerab, Shimshal, Shigar, and Astore valleys and in peripheral valleys of Deosai in Gilgit Baltistan. Though the densities in these areas have not yet been estimated, the highest photo-capture rate of the species was in Shimshal, Khunjerab, and Misgar valleys, where good populations were also reported by Wegge (1988) based on snow leopard signs.

2.4.10. Russian Federation

Russia lies at the northern edge of snow leopard range. They are distributed in the Altai, Tannu-Ola and Sayan mountains. The total area of potential habitat is c. 60,000 km^2 but the areas regularly used (relatively less snow cover in winter and adequate prey populations) total only 20,000-30,000 km^2, and harbor an estimated 70-90 snow leopards. Five areas harbor a stable population covering 12,000 km^2 in total and 50-65 snow leopards. These are: (i) Chikhachev Ridge; (ii) Tsagan-Shibetu ridge, southern Shapshal Range and western Tannu Ola range; (iii) Sayano-Sushensky Biosphere Reserve and its buffer zone; (iv) Sengelen ridge and (v) the Okinsky and Tunkinsky ridges.

Paltsyn et al. (2012) reported that in the Altai, potential snow leopard habitat is located in central, southeastern, and eastern Altai and includes the following mountains and ridges: Terektinsky (eastern), Katunsky, Northern and Southern Chuisky, Aygulaksky, Kuraysky, Abakansky, Kurkure, Chulyshman, Shapshalsky, Chikhachev, Sailyugem, and Tabyn-Bogdo-Ola. The population in Sayano-Sushensky Biosphere Reserve, where camera trapping was started in 2007, has recently been reported by SLN members to have declined due to poaching (A. Subbotin pers. comm.).

2.4.11. Tajikistan

The total habitat of the snow leopard in Tajikistan is reported to be about 85,700 km^2, which represents 60% of the total territory of the country. Distribution covers the Western and Eastern Pamir, Darvaz, Academy of Sciences, Peter the Great, Vanj, Yazgulem, Rushan, Shakhdara, Pshart, Muzkul, Sarykol, South Alichur, North Alichur, Wakhan and Alay ranges. Snow leopards are also known to occur in the Turkestan, Zeravshan, Hissar, Karategin, Hazratishoh and Vakhsh ranges. They occur in Tajik National Park (26,116 km^2), Zorkul State Reserve (SR) (877 km^2), Romit SR (161 km^2), Dashtijum SR (534 km^2), two Natural Parks (Shirkent, Sarikhosor), and eight reserves with regulated natural resource use. Further snow leopards occur in at least five areas managed by local conservancies with a total size of about 2300 km^2 as well as in several private hunting concessions.

2.4.12. Uzbekistan

Uzbekistan is situated at the western end of the species' range. Snow leopards occur in two areas, separated by the Fergana Valley: the Ugam, Pskem and Chatakal ranges (part of the Western Tien Shan system) and the Gissar, Turkestan, and Zeravshan Ranges in the Pamir-Alai system. The total area is estimated at 10,000 km^2 and snow leopard numbers at 10-15 and 20-30 respectively based on sign and sightings. The first camera trapped snow leopards were reported in 2014 in Gissar State Reserve (T. Rosen Michel pers. comm. 2014). The first camera trapped snow leopard was reported recently in 2014. Snow leopards occur in Chatkal State Reserve (two areas 111 km^2 and 242 km^2, separated by a distance of 20 km), Gissar State Reserve (875 km^2), Ugam-Chatkal National Park (6683 km^2), and Zaamin State Reserve (106 km^2). These protected areas cover about 65% of snow leopard range in Uzbekistan.

2.4.13. Myanmar

About 4,730 km^2 of potential habitat occurs on the northern border (Hunter and Jackson 1997), most of it within Hkakabo Razi NP (3,885 km^2). Snow leopard tracks were reported in the area in the 1930s (Mallon 2003). Blue sheep occur there and local hunters reported sighting and killing of snow leopards (Rabinowitz 2001); they have a local name for it, *kangzik*, [= snow-leopard in Tibetan]. The presence of snow leopards is deemed unlikely (A. Rabinowitz pers. comm).

2.5. Biology

This section has been summarized from information in a wide range of sources (Hemmer 1972, Schaller 1977, Jackson 1989, Fox 1989, 1994, Heptner & Sludskii 1992, Sunquist and Sunquist 2002, McCarthy & Chapron 2003, Jackson et al. 2010).

2.5.1. Habitat

Snow leopards are closely associated with the alpine and subalpine zones above the tree line. In the Sayan Mountains of Russia and parts of the Tien Shan they may frequent open coniferous or birch (*Betula* sp.) forest. They generally occur between elevations of 3,000–4,500 m, but are found at lower elevations (900–1,500 m) in northern parts of the range and in the Gobi desert, and may range up to 5,800m in the Himalaya and Qinghai-Tibetan Plateau region. However, in nearly all parts of their range, snow leopards favor steep, rugged terrain, well broken by cliffs, ridges, gullies, and rocky outcrops. They show a strong preference for irregular slopes in excess of 40° and well–defined landform edges, such as ridgelines, bluffs and ravines, along which to travel about their home range. They may migrate to lower elevations during the winter to avoid deep snow and follow movements of their primary prey species.

2.5.2. Prey

Snow leopards are capable of killing prey up to three times their own weight, so that only adult wild camel (*Camelus ferus*), kiang (*Equus kiang*), and wild yak (*Bos mutus*) are herbivores occurring in their range that are excluded as potential prey (Schaller 1998). The main prey consist of medium-sized mountain ungulates, especially bharal or blue sheep (*Pseudois nayaur*), Himalayan or Siberian ibex (*Capra sibirica*), markhor (*Capra falconeri*), and Himalayan tahr (*Hemitragus jemlahicus*). Snow leopard distribution coincides closely with the distribution of the first two species, which have mean weights of 55 and 76 kg, respectively. They also reportedly prey on argali (*O. ammon*), urial (*Ovis orientalis or O. vignei*), red deer (*Cervus elaphus*), roe deer (*Capreolus pygargus*) and musk deer (*Moschus* spp.). Supplementary prey includes marmots (*Marmota* spp.), pikas (*Ochotona* spp.), hares (*Lepus* spp.), small rodents, and game birds. On one occasion, a snow leopard killed and partially ate a 2-year old brown bear (*Ursus arctos*) (Heptner & Sludskiy 1972). Several studies have reported snow leopard consuming vegetation and finding scats composed entirely of twigs (Schaller 1977; Mallon 1991; Chundawat & Rawat 1994).

Wild ungulates have been reported to contribute more than 45% and up to 98% of the snow leopard's diet, with livestock providing as much as 40–70%, though generally more in the order of 15–30% (Schaller et al. 1988a; Oli et al. 1993; Chundawat and Rawat 1994; Jackson 1996; Bagchi and Mishra 2006; Anwar et al. 2011; Shezad et al. 2012; Wegge et al. 2012; Suryawanshi 2013).

Lyngdoh et al. (2014) reviewed the literature on prey preferences across snow leopard range; they identified four distinct physiographic and prey type zones, using cluster analysis that had unique prey assemblages and characteristics. Levin's index showed the snow leopard had a specialized dietary niche breadth. The main prey consisted of Siberian ibex (*Capra sibirica*), blue sheep (*Pseudois nayaur*), Himalayan tahr (*Hemitragus jemlahicus*), argali (*Ovis ammon*) and marmots (*Marmota* spp.). The preferred prey species of snow leopard weighed 55-65 kg.

Diet has traditionally been assessed through microscopic analysis of hair and other remains in feces. However, recent research has shown that visual identification of snow leopard (and other carnivore) scats is unreliable, with 41-59% of scats misidentified (McCarthy et al. 2008; Janecka et al. 2011) and that DNA analysis is needed to confirm the species identification. This may cast doubt on the accuracy of aspects of some earlier studies on diet composition.

Some recent studies have used molecular tools to confirm scat identification. For example, Anwar et al. (2011) found the diet at their study site in Baltistan (Pakistan) to consist of 70% livestock, 28% wild ungulates, and less than 2% small mammals and birds. Shehzad et al. (2012) also reported that 98% of snow leopard scats consisted of ungulate prey, and less than 2% smaller mammals and birds. Similarly, Suryawanshi (2013) reported the snow leopard diet to consist mainly of wild and domestic ungulates (92-94%) with small mammals and birds comprising less than 3.5% in six study sites in India and one in Mongolia. Jumabay-Uulu et al. (2013) and Maheshwari et al. (2010) recorded marmots in 8-9% of the snow leopard scats analyzed from Sarychat-Ertash Reserve, Kyrgyzstan, and the Kargil area, India, respectively. Annual prey requirements are estimated at 20–30 adult ungulates, with radio-tracking indicating a large kill every 10–15 days (Jackson and Ahlborn 1984; Jackson 1996). Unless disturbed, a snow leopard may remain on its kill for up to a week (Fox and Chundawat 1988).

2.5.3. Marking

Snow leopards mark their home ranges mainly with scrapes on the ground and scent marks on overhanging cliffs and boulders (Schaller 1977; Jackson and Ahlborn 1988). It is widely assumed that such marking represents a set of visual olfactory signals to communicate information on the presence of individual snow leopards and, since the frequency of marking intensifies during the mating season, reproductive condition. Favored locations are along ridgelines, beside prominent objects, valley bottoms, cliff bases, gorges, and stream junctions (Mallon 1991; Jackson and Ahlborn 1988). These marks are easily recognized and have been widely used on field surveys, in conjunction with tracks (pugmarks), as evidence of snow leopard presence (see Chapter 14 Estimating Snow Leopard and Prey Populations and Monitoring Trends). However, the prevalence of field signs varies according to locality and they are less frequently encountered in some areas, such as habitats in Bhutan where substrate and sign longevity are adversely affected by high annual rainfall. Li et al. (2014) described a communal sign post used by snow leopards and other species at a site in China, and suggested it's possible role in inter-species communication and temporal segregation.

2.5.4. Reproduction

Mating occurs between January and mid-March, which is a period of intensified social marking and vocalization (Ahlborn and Jackson 1988). In captivity, oestrous lasts for 2–12 days, with a cycle of 15–39 days (Nowell and Jackson 1996). One to five cubs are born after a gestation period of 93 to 110 days, generally in June or July. Litter size is usually two to three. The largest litter size as yet recorded was seven. Sexual maturity is reached at 2–3 years (Sunquist and Sunquist 2002). Dispersal of young animals is said to occur at 18–22 months of age, and sibling groups may remain together briefly at independence (Jackson 1996). This may explain reported sightings of as many as five snow leopards in a group (Hemmer 1972). There is no information on longevity in the wild, but captive snow leopards are known to have survived until 21 years old (Wharton & Freeman 1988).

2.5.5. Home range

Home range size has been reported to vary from 12 to 39 km² in productive habitat in Nepal (Jackson and Ahlborn 1989, based on ground-based radio-tracking) to 500 km² or more in Mongolia with its open terrain and lower ungulate density (McCarthy et al. 2005 in the central Altai range; McCarthy et al. 2010 in Tost Uul mountain; and Munkhtsog and Jackson, unpubl. GPS radio-tracked snow leopard in Baga Bogd mountain). The four telemetry studies to date reveal largely overlapping male and female home ranges, but use of a particular area is usually separated temporally.

In Nepal, 42–60% of the home range locations of four individuals radio-collared occurred within 14–23% of their respective home areas: these commonly used 'core areas' intersected the most favorable local topography, habitat, and prey base (Jackson and Ahlborn 1989). Solitary and typically crepuscular, snow leopards remain within a small area for about a week before shifting to another part of their home area. Mountain ridges, cliff edges, and well-defined drainage lines serve as common travel routes and sites for the deposition of signs, including scrapes, scats, and scent marks (Ahlborn and Jackson 1988). Core areas are often used by more than one snow leopard and are marked significantly more frequently than non-core sites, suggesting that such marking may help space individuals and thereby facilitate more efficient use of sparse resources (Jackson and Ahlborn 1989). In Nepal's rugged habitat, snow leopards moved up to 7 km daily (straight-line distances), but averaged c. 1 km (Jackson and Ahlborn 1989), whereas in Mongolia, their daily movements were considerably greater (about 12 km), with one female covering 28 km in a single day (McCarthy et al. 2005).

Spatial and temporal overlap in snow leopard home ranges was first reported from Nepal (Jackson and Ahlborn 1989), a pattern subsequently confirmed by studies in Mongolia (McCarthy 2000; McCarthy et al. 2010). The level of overlap may vary according to age, sex, reproductive status and relatedness between overlapping individuals. Preliminary results from South Gobi suggest that in case of young males, their ranges seem to overlap with each other and it is likely that they manage to survive within the home ranges of more dominant males for considerable periods (McCarthy et al. 2010). Female ranges, on the other hand, show a high variability though there have also been reports of overlap between individuals.

2.5.6. Demography

There is very little published information on the demography and reproduction of the wild population, with the first results of the ongoing long-term ecological study in Mongolia (Sharma et al. 2014). Based on four years of camera trapping in conjunction with satellite telemetry of 20 individuals, these investigators offer initial information on sex ratios, litter size, inter-birth interval, survivorship, and emigration within a relatively isolated snow leopard population over a four-year period. While seemingly stable, adult sex ratios shifted from being male-biased to female-biased (1.67 to 0.38 males per female) during the study. Adult survival probability was 0.82 (SE+20.08) and that of young was 0.83 (SE+20.15) and 0.77 (SE +20.2) respectively, before and after the age of 2 years. Young snow leopards showed a high probability of temporary emigration and immigration (0.6, SE +20.19 and 0.68, SE +20.32 before and after the age of 2 years) though this was not apparent for the adults (0.02 E+20.07). They concluded that, while the current female-bias in the population and number of cubs born each year appeared adequate to keep this population safe, the vigorous dynamics suggests the situation may change quickly. However, the study site is located at the end of a mountain chain in the semiarid Gobi, and similar long-term studies are needed in other representative habitats to capture variation across snow leopard range.

2.6. Gaps in understanding and research priorities

It is clear from the above that despite many promising recent advances in technology, there remain significant gaps in our understanding of snow leopard biology and ecology.

Obtaining reliable estimates of global, national and local population sizes is the most urgent priority in order to assess population trends and inform conservation actions. Accurate, fine-scale information on current presence is also needed, along with habitat modelling to map distribution. Home range size is another vital parameter and is crucial in determining the optimal size of a landscape to be protected.

Dispersal is essential for preserving the connectivity among snow leopard populations and an important time in a species' life history: in most felids this is when maximum mortality takes place. New information from satellite-collaring and landscape genetics is expected to lead to better understanding of dispersal distances and patterns and thus highlight key movement corridors.

The importance of different wild prey and livestock in the diet needs further investigation and the interactions between the wild-herbivores livestock is another important topic for research. Attacks by snow leopards on livestock can lead to negative attitudes among local communities. Understanding the biotic and landscape correlates of conflict hotspots is critical for effective management of conflicts between herders and carnivores. For instance, a recent paper by Suryawanshi et al. (2013) questions the assumption that increasing wild prey will necessarily lead to reduced livestock depredation.

Research on identifying livestock depredation causes, socio-economic profiling of herder communities and people's attitude towards snow leopards are important, and need to be carried out across a cross-section of the ecological and cultural landscapes. It is important to understand the linkage between economic, socio-cultural and ecological factors (such as wild prey-livestock ratios), their role in driving conflict and also how these factors interact in determining the severity of conflict.

Equally important is to develop an understanding of the correlates of human tolerance of snow leopards and other predators, especially the sympatric wolf. There is also emerging conflict over the perceived consumption of forage by wild ungulates, which may be considered detrimental to livestock production, even though surveys show that in most sites currently, livestock consume over 95% of the forage, and wild ungulates consume 5% or less (Berger et al. 2013).

The extent, pattern and factors influencing these interactions between livestock and wild prey populations also need to be better understood. Table 2.3 lists the main research needs identified by SLSS in 2003 and in this update.

Table 2.2: A comparison of the information needs described in the SLSS 2003 with the current SLSS update. The green indicates the research needs that are considered important even now. Yellow indicates the research needs that have not been discussed or highlighted in the current SLSS update.

S No	Research or Information Needs	SLSS 2003	SLSS 2014	Research priority for the next five years
1	Snow leopard migration and dispersal routes	Yes	Yes	Yes
2	Snow leopard population size	Yes	Yes	Yes
3	Snow leopard population trends and factors involved	Yes	Yes	Yes
4	Agents of habitat degradation and relative impacts	Yes	Yes	Yes
5	Economic valuation of snow leopards	Yes	Yes	Yes
6	Snow leopard –prey relationships	Yes	Yes	Yes
7	Livestock depredation rates	Yes	Yes	Yes
8	Livestock depredation causes	Yes	Yes	Yes
9	Snow leopard home range size and habitat use	Yes	Yes	Yes
10	Snow leopard social structure and behavior	Yes	Yes	Yes
11	Snow leopard population	Yes	Yes	Yes

	genetics			
12	Snow leopard food habits	Yes	Yes	No
13	Snow Leopard monitoring techniques development	Yes	Yes	Yes
14	Socio-economic profiling of herder communities	Yes	Yes	Yes
15	Human attitudes to snow leopards	Yes	Yes	Yes
16	Snow leopard distribution and “hot spots”	Yes	Yes	No
17	Prey species distribution and “hot spots”	Yes	Yes	No
18	Prey population baseline and trends	Yes	Yes	Yes
19	Wild ungulate—livestock interactions (competition)	Yes	Yes	No
20	Ungulate disease	Yes	Yes	Yes
21	Snow leopard poaching levels	Yes	Yes	Yes
22	Snow leopard disease	Yes	Yes	Yes
23	Snow Leopard relationships to other predators	Yes	Yes	No
24	Effects of climate change	No	Yes	Yes
25	Livestock and human population status and trends	Yes	Yes	Yes
26	Methods to alleviate impacts of war	Yes	No	No
27	Analysis of existing policies and laws	Yes	No	No
28	PA coverage—extent, presentation of habitats	Yes	No	No

Note: for more recent information and comments on the importance of these topics country-wise, consult the NSLEP documents prepared by the range country governments.

References

Ahlborn, G. G., and Jackson, R. (1988). Observations on the ecology of snow leopard in west Nepal. Pages 65-87 In: H. Freeman, (Ed). *Proceedings of the Fifth International Snow Leopard Symposium*. International Snow Leopard Trust and Wildlife Institute of India, Seattle.

Ale, S.B, Shrestha, B. & Jackson, R. (2014). On the status of Snow Leopard *Panthera uncia* (Schreber, 1775) in Annapurna, Nepal. *Journal of Threatened Taxa*, 6, 5534–5543

Alidodov, M. and Karimov Kh. (2012). Report on the results of the camera-trap survey in the community conservancy “Ravmeddara”. Project “Community-based conservation and management of mountain ungulates in Tajikistan”.

Alidodov, M. and Rosen Michel, T. (2013). Results of camera trap survey carried out in the framework of the GEF Small Grants Project “Conservation of Snow Leopards in the Wakhan and Addressing Threats Faced by Them” (TJK/SGP/OP5/Y5/BD/CORE/2013/07).

Anwar M.B., Jackson R., Nadeem M.S., Janecka J.E., Hussain S., Beg M.A., Muhammad G., Qayyum M. (2011). Food habits of the snow leopard (*Panthera uncia),* (Schreber 1775) in Baltistan, Northern Pakistan. *European Journal of Wildlife Research*, 57, 1077-1083

Bagchi, S., and Mishra, C. (2006). Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology*, 268(3), 217-224.

Berger, J., Buuveibaatar, B., & Mishra, C. (2013). Globalization of the Cashmere Market and the Decline of Large Mammals in Central Asia. *Conservation Biology*, 27(4), 679-689.

Bold, A. and Dorzhunduy, S. (1976). *Report on snow leopards in the southern spurs of the Gobi Altai*. Proc. Institute of General and Experimental Biology, Ulaanbaatar 11:27-43 (in Mongolian).

Chundawat, R.S. and Rawat, R.S. (1994). Food habits of snow leopard in Ladakh, India. Pages 127-132 in: J. L., Fox and Du Jizeng (Eds). *Proceedings of the Seventh International Snow Leopard Symposium* (Xining, Qinghai, China, July 25-30, 1992). International Snow Leopard Trust, Seattle, Washington.

Fox, J.L. (1989). A review of the status and ecology of the snow leopard (*Panthera uncia*). Unpublished Report. International Snow Leopard Trust, Seattle, Washington, 40 pages.

Fox, J.L. (1994). Snow leopard conservation in the wild - a comprehensive perspective on a low density and highly fragmented population. Pages 3-15 in: J. L., Fox and Du Jizeng (Eds). *Proceedings of the Seventh International Snow Leopard Symposium*. International Snow Leopard Trust, Seattle.

Fox, J.L. and Jackson, R. (2002). Blue sheep and snow leopards in Bhutan and trans-Himalayan Nepal: recent status evaluation and their application to research and conservation Page 64 in T. M. McCarthy and J. Weltzin, (Eds) *Contributed Papers to the Snow Leopard Survival Strategy Summit*. International Snow Leopard Trust, Seattle, Washington, USA. Available at http://www.snowleopard.org/sln/

Fox, J.L. and Chundawat, R.S. (1988). Observations of snow leopard stalking, killing, and feeding behavior. *Mammalia*, 52(1), 137-140.

Government of Nepal. (2012). Snow Leopard Conservation Action Plan for Nepal (2005-2015 (Revised 2012). 17 pages, Kathmandu, Nepal.

Gripenberg, U., Soderlund, V., Wahlberg, C. and Blomqvist, L. (1982). Comparison of chromosome banding patterns in the snow leopard (*Panthera uncia*) and in other felids. *International Pedigree Book of Snow Leopards,* 3, 135-138.

Habibi, K. (2004). *Mammals of Afghanistan*. Zoo Outreach Organization, Coimbatore, India.

Hemmer, H. (1972). *Uncia uncia*. *Mammalian Species*, 22, 1-5.

Heptner, V. and Sludskii, A.A. (1992). *Mammals of the Soviet Union, Volume II, Part 2 Carnivora (Hyaenas and Cats*). Smithsonian Institution Libraries and National Science Foundation, Washington DC.

Hunter, D.O. and Jackson, R. (1997). A range-wide model of potential snow leopard habitat. Pages 51-56 in: R. Jackson and A. Ahmad (Eds). *Proceedings of the 8th International Snow Leopard Symposium, Islamabad, November 1995*. International Snow Leopard Trust, Seattle and WWF-Pakistan, Lahore.

Jackson, R., Wang Zhongyi, Lu Xuedong and Chen Yun. (1994a). Snow leopards in the Qomolangma Nature Preserve of the Tibet Autonomous Region. Pages 85-95 In: Fox, J.L. and Du Jizeng (Eds.). *Proc. 7th Int. Snow Leopard Symp.* Xining, China 1992. International Snow Leopard Trust, Seattle and Northwest Plateau Institute of Biology. 331 pages.

Jackson, R.M., Mishra, C., McCarthy, T.M. and Ale, S.B. (2010). Snow Leopards: Conflict and Conservation. Chapter 18, pages 417-430: *Biology and Conservation of Wild Felids* (D.W. Macdonald and A.J. Loveridge, (Eds), Oxford University Press, UK.

Jackson, R. M. (1996). Home range, movements and habitat use of snow leopard (*Uncia uncia*) in Nepal (Doctoral dissertation, University of London).

Jackson, R. (1979). Snow leopards in Nepal. *Oryx* , 15, 191-195.

Jackson, R., Ahlborn, G.G., Ale, S.B., Gurung, D., Gurung, M. and Yadav, U.R. (1994b). *Reducing Livestock Depredation in the Nepalese Himalaya: Case of the Annapurna Conservation Area.* Prepared for U.S. Agency for International Development, King Mahendra Trust for Nature Conservation, and BioSystems Analysis.

Jackson, R. and Ahlborn, G.G. (1984). Preliminary habitat suitability model for the snow leopard Panthera uncia in west Nepal. *International Pedigree Book of Snow Leopards,* 4, 43-52.

Jackson, R. and Ahlborn G.G. (1989). Snow leopards (*Panthera uncia*) in Nepal: home range and movements. *National Geographic Research,* 5(2), 161-175.

Janečka, J. E., Jackson, R., Yuguang, Z., Diqiang, L., Munkhtsog,B., Buckley-Beason, V. and Murphy, W.J. (2008). Population monitoring of snow leopards using noninvasive collection of scat samples: a pilot study. *Animal Conservation,* 11(5), 401-411.

Ji, W. (1999). *Wildlife in Yunnan*. China Forestry Publishing House, Beijing.

Johnson, W. E., Eizirik, E., Pecon-Slattery, J., Murphy, W.J., Antunes, A., Teeling, E. and O'Brien, S.J. (2006). The Late Miocene Radiation of Modern Felidae: A Genetic Assessment. *Science,* 311, 73-77.

Johansson, Ö., Malmsten, J., Mishra, C., Lkhagvajav, P. and McCarthy, T.M. (2013). Reversible immobilization of free-ranging snow leopards (*Panthera uncia*) using a combination of Medetomidine and Tiletamine Zolazepam. *Journal of Wildlife Diseases* DOI: 10.7589/2012-02-049

Kachel, S. (2014) Evaluating the efficacy of wild ungulate trophy hunting as a tool for snow leopard conservation in the Pamir Mountains of Tajikistan. Master of Science Thesis. University of Delaware. 98pp.

Karimov, Kh. and Amirov, Z. (2014). *Progress Report "On the heels of the Snow leopard in the Hissar Range"*. Institute of Zoology and Parasitology of the Academy of Sciences of the Republic of Tajikistan.

Koshkarev, E.P. and Vyrypaev, V. (2000). The snow leopard after the break-up of the Soviet Union. *Cat News* 32: 9-11.

Li, J., Yin, H., Wang, D., Jiagong, Z., and Lu, Z. (2013). Human-snow leopard conflicts in the Sanjiangyuan Region of the Tibetan Plateau. *Biological Conservation*, 166, 118–123

Li, J. and Lu, Zh. (2014). Snow leopard poaching and trade in China 2000–2013. *Biological Conservation,* 176, 207–211.

Liao, Y. and Tan, B. (1988). A preliminary study of the geographic distribution of snow leopards in China. Pp. 51-63 in H. Freeman, (Ed). *Proceedings of the Fifth International Snow Leopard Symposium*. International Snow Leopard Trust and Wildlife Institute of India, Seattle.

Lyngdoh, S., Shrotriya, S., Goyal, S.P., Clements, H., Hayward, M.H. and Habib, B. (2014). Prey preferences of the snow leopard (*Panthera uncia*): Regional diet specificity holds global significance for conservation. *PLOSONE* 9(2):): e88349. doi:10.1371/journal.pone.0088349

McCarthy, T.M. (2000) Ecology and Conservation of Snow Leopards, Gobi Brown Bears, and Wild Bactrian Camels in Mongolia. PhD thesis. University of Massachusetts.
McCarthy, T, M., Murray, K., Sharma, K. and Johannson, O. (2010). Preliminary results of a long-term study of snow leopards in South Gobi, Mongolia. *Cat News*, 53, 15-18.

McCarthy, T.M. and Chapron, G. (2003) *Snow Leopard Survival Strategy*. ISLT and SLN, Seattle, USA.

McCarthy, T. M., Fuller, T. K., and Munkhtsog, B. (2005). Movements and activities of snow leopards in Southwestern Mongolia. *Biological Conservation*, 124(4), 527-537.

McCarthy, K.P., Fuller, T. K., Ming, M., McCarthy, T.M., Waits, L. and Jumabaev, K. (2008). Assessing Estimators of Snow Leopard Abundance. *Journal of Wildlife Management*, 72(8), 1826–1833.

Ma, M., Cheng, F., Mai, Y. Dan, T., Er, T. and Lei, G. (2013) *Snow leopards in Xinjiang* (Chinese Edition), Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences.

Maheshwari,A., Takpa, J., Kujur, S. and Shawl, T. (2010). *An investigation of carnivore-human conflicts in Kargil and Drass areas Of Jammu and Kashmir*, India. Report submitted to Rufford Small Grant, WWF India, 30 pages.

Mallon, D. P. (1984). The snow leopard in Ladakh. *International Pedigree Book of Snow Leopards*. 4, 23-37.

Mallon, D.P. (1991). Status and conservation of large mammals in Ladakh. *Biological Conservation*, 56, 101-119.

Mallon, D.P. (2003). An early record of snow leopard in Myanmar. *Cat News*, 39, 24-25.

Mallon, D. and Diment, A. (2014). *Biodiversity Survey of Zorkul Nature Reserve – Summer 2011*. Fauna and Flora International and State Strict Nature Reserve Zorkul.

Nowell, K. and Jackson, P. (1996). *Wild Cats: Status Survey and Conservation Action Plan*. IUCN, Gland, Switzerland.

Oli, M. K. (1994). Snow leopards and blue sheep in Nepal: densities and predator: prey ratio. *Journal of Mammalogy*, 75, 998-1004

Paltsyn, M.Y., Spitsyn, S.V., Kuksin, A.N., Istomov, S.V. (2012). Snow Leopard Conservation in Russia: Data for Conservation Strategy for Snow Leopard in Russia 2012-2020. WWF- Russia, Krasnoyarsk, 100 pages.

Peters, G. (1980). The vocal repertoire of the snow leopard (*Uncia uncia*, Schreber 1775). *International Pedigree Book of Snow Leopards*, 2, 137-158.

Pocock, R.I. (1917). The classification of existing Felidae. *Annals and Magazine of Natural History* Ser. 8, 20, 329-350.

Rabinowitz, A. (2001). *Beyond the Last Village*. Island Press, Washington.

Schaller, G.B. (1977). *Mountain Monarchs: Wild Sheep and Goats of the Himalaya*. University Chicago Press, Chicago.

Schaller, G.B. (1998). *Wildlife of the Tibetan Steppe*. University Chicago Press, Chicago.

Schaller, G.B., Li Hong, Talipu, Junrang Ren, and Mingjiang Qiu. (1988a). The snow leopard in Xinjiang. *Oryx*, 22(4), 197-204.

Schaller, G.B., Ren Junrang, and Qiu Mingjiang. 1988b. Status of snow leopard (*Panthera uncia*) in Qinghai and Gansu provinces, China. *Biological Conservation*, 45, 179-194.

Schaller, G.B., Tserendeleg, J. and Amarsanaa, G. (1994). Pages 33-42 in: J. L., Fox and Du Jizeng (Eds). *Proceedings of the Seventh International Snow Leopard Symposium*. International Snow Leopard Trust, Seattle.

Sharma, K., Bayrakcismith, R., Tumursukh, L., Johansson, O., Sevger, P., McCarthy, T.M. and Mishra, C. (2014). Vigorous Dynamics Underlie a Stable Population of the Endangered Snow Leopard Panthera uncia in Tost Mountains, South Gobi, Mongolia. PlosOne July 2014 | Volume 9 | Issue 7 | e101319

Shehzad W, McCarthy T.M, Pompanon F, Purevjav L, Coissac E, et al. (2012). Prey Preference of Snow Leopard (*Panthera uncia*) in South Gobi, Mongolia. PLoS ONE 7(2): e32104. doi:10.1371/journal.pone.0032104

Simms, A., Moheb, Z., Salahudin, Ali, H., Ali, I. and Wood, T. (2011). Saving threatened species in Afghanistan: snow leopards in the Wakhan Corridor. *International Journal of Environmental Studies* 68. DOI: 10.1080/00207233.2011.577147

Simms, A., Ostrowski, S., Ali, H., Rajabi, A., Noori, H., and Ismaili, S. (2013). First radio-telemetry study of snow leopards in Afghanistan. *Cat News*, 58, 29-31.

Singh, J. J. and Jackson, R. (1999). Transfrontier Conservation Areas: creating opportunities for conservation, peace and the snow leopard in Central Asia. *International Journal of Wilderness*, 5(2),7-12.

Soderlund, V., U. Gripenberg, C. Wahlberg, and L.Blomqvist. (1980). Chromosome studies in the snow
leopard (*Panthera uncia*): preliminary report. *International Pedigree Book of Snow Leopards*, 2, 168-182.

Stroganov, S.U. (1962). *Carnivorous mammals of Siberia*. Biol. Inst., Acad. Sci. USSR, Siberian Branch. (Eng. Transl., 1969, Israel Program for Scientific Translations).

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

Suryawanshi, K.R., Bhatnagar, YV., Redpath, S. and Mishra, C. (2013) People, predators and perceptions: patterns of livestock depredation by snow leopards and wolves. *Journal of Applied Ecology*. doi: 10.1111/1365-2664.12061.

Wang, X. and Schaller, G.B. (1996). Status of large mammals in western Inner Mongolia, China. *Journal of East China Normal University, Natural Science (Special Issue of Zoology)* 12, 93-104.

Wegge, P. (1988). Assessment of Khunjerab National Park and environs, Pakistan. Unpub. Report, IUCN, Gland. 25 pages + appendices.

Wegge, P., Shrestha, R. and Flagstad, O.(2012). Snow leopard *Panthera uncia* predation on livestock and wild prey in a mountain valley in northern Nepal: implications for conservation management. *Wildlife Biology,* 18(2), 131-141.

Wharton, D. and Freeman, H. (1988). The snow leopard (*Panthera uncia*): A captive population under the Species Survival Plan. *International Zoo Yearbook*, 27, 85-98.

Chapter 3: Threats to Snow Leopards, their Prey and Ecosystems

3.1. Introduction

A sound understanding of the threats affecting the persistence of snow leopard, its prey and habitat is critical to achieving conservation success. The original SLSS threat analysis was updated first by reviewing and revising the original list of threats, resulting in a list of 32 threats and constraints. These were then grouped into four categories (Habitat and Prey; Direct Killing; Policy and Awareness; and Other Issues).

In tandem with the Global Snow Leopard Forum (GSLF) and Global Snow Leopard Ecosystem Protection Program (GSLEP), each threat was assessed and prioritized in each of the 12 snow leopard range countries, according to a modified version of the Threats Reduction Assessment (TRA) protocol of Salafsky and Margoluis (1999). One SLN member and one expert from each country were identified to lead the ranking process, in consultation with other country experts. Each of the 32 listed threats was evaluated for three factors (Area, Intensity and Urgency), using a scale of 1-5, where 1 indicates no/low threat and 5 a severe threat).

Area indicates how widespread the threat is across snow leopard range within a country (a value of 1 indicates an extremely limited areal extent, while a value of 5 denotes that the threat occurs across most or all of snow leopard range within the country).

Intensity is a measure of the severity of impact or destruction caused by a particular threat. Within the overall area, will it completely destroy the habitat(s) or will it cause only minor change? Threats with the least negative impacts are given a value of 1, while those judged most destructive are given a value of 5.

Urgency assesses the immediacy of each threat. Thus, those that may imminently arise or are already occurring (i.e. they are very time sensitive) are given a high ranking compared to threats not presently considered serious or which might arise at some time in the future. The latter are given a low value since implementing remedial measures are less urgent.

Total scores were categorized as Low (1-5); Medium (6-10); and High (11-15). The assessment results by country, along with a mean rangewide score, are shown in Appendix 2.

It is clear from this that there is considerable variation in the impact of individual threats among countries, reflecting different circumstances. Even within a single country, threat levels may vary, often widely, between different regions. This is especially the case in in large countries like China or Mongolia where snow leopard habitat is extensive and split across different regions.

It is also difficult to reflect a full national consensus in this type of assessment exercise unless a wide range of opinion is consulted, reviewed and discussed. Such an extensive consultation was not practical during the preparation phase of the GSLEP and some individual threat scores shown in the table are open to debate and are not all aligned with the national documents (NSLEP) that were prepared later as part of the same process. It is especially difficult to reach sufficient consensus for ranking threats in range states with diverse habitats or variable socio-economic conditions.

A review of the 12 NSLEPs, the results shown in the threats table, and the threat assessment from the original (2003) version of SLSS indicates clearly that the main ongoing threats fall into three broad areas: 1) competition with livestock, habitat degradation and declines in prey; 2) depredation by snow leopards on livestock and retaliatory killing; 3) illegal trade. Two major new threats have emerged since 2003: climate change and mining, large scale infrastructure and barriers such as roads or fenced railway lines. All five of these issues are discussed in more detail in Chapters 4-8, respectively.

A further set of threats regarded as less severe at range-wide level, or more localized, are described below.

3.2. Lack of awareness among local people and policymakers

Lack of awareness was ranked as High in 6 countries and Medium in 6 for local people and as High in 7 countries for policy makers. There is a significant lack of awareness and understanding of the plight of the snow leopard; the value of snow leopards, prey, and habitat; and the local and regional consequences of the on-going degradation of its ecosystems. This is true at all levels of society within and outside the snow leopard range countries, from local people to leaders of governments and from the private sector to the general public. Globally, snow leopards are less well-known than other charismatic species, such as tigers and elephants; as a result, less funding has been available for snow leopard conservation.

3.3. Lack of institutional capacity

Rated as High or Medium in 11 out of 12 countries. All of the snow leopard range countries report they have insufficient numbers of trained conservation practitioners at all levels, from frontline PA staff to game managers and wildlife law enforcement personnel to research scientists. Moreover, and even where conservation staff levels may be adequate, such as in some scientific institutions, low funding limits their effectiveness. In particular, range countries lack people trained to address the needs of communities and develop community programs. In many range countries, conservation-related laws, policies, and institutions are weak as well. In large part, this is due to insufficient country budgets for snow leopard conservation and for conservation in general, given most range countries area developing nations and some are extremely poor. Donor funding is generally time-limited and insufficient to scale-up successful practices. Most of the range countries need greater financial and technical support from the international community for successful snow leopard conservation.

3.4. Secondary trapping and poisoning:

Rated High in Russia and Medium overall. Steel traps set for wolves *Canis lupus* and snares (set e.g. for musk deer *Moschus* spp.) may also catch snow leopards, even if these are not the intended targets.

3.5. Disease

Rated Low overall, Medium in China and India, High in Pakistan, and absent in Russia. Extremely few cases of wild snow leopard mortality due to disease have been reported in the literature and it is difficult to evaluate the potential significance of this threat. Zoo animals are reported to have been affected by common feline viruses (FIV or Immunodeficiency Virus Infection and Papillomaviruses) and congenital abnormalities, including multiple ocular coloboma and neurodegenerative disorders. In 2011, four snow leopards, were found dead in the South Gobi, and mortality was recorded as possibly due to disease, but this has not been confirmed. In India and Pakistan, outbreaks of scabies mange caused by mites in blue sheep and other prey have been reported, in some cases resulting in significant local mortality (Dagleish et al. 2007). Severe outbreaks of scabies, foot-and-mouth, or other diseases among major prey species could impact locally on snow leopard populations.

3.6. Feral dogs attacking Snow Leopards and prey

This was a low threat overall. There are very few, if any, documented cases of feral dogs killing snow leopards, but this may be a localized problem for some prey populations. However, increasing feral dog populations are a potential human health hazard, economic hazard due to livestock depredation, and a potential threat for biodiversity.

3.7. Other threats

War and related military activities: A Low threat overall but, rated Medium in five countries. Although direct effects on snow leopards have not been demonstrated, but it is assumed that the increase in high-powered weapons coupled with the collapse of both government and local community management systems, leads to increases in many of the other threats to snow leopards (e.g. direct poaching, loss of prey species).

Potential legal hunting of Snow Leopards: A proposal to allow limited trophy hunting of snow leopards in Mongolia to raise funds for conservation was made at the 5th International Snow Leopard Symposium (O'Gara 1988). The subject was further discussed by Shackleton (2001) and Jackson (2004) when members of a hunting conservancy in Pakistan argued that it would raise a large sum for conservation and simultaneously reduce predation on markhor (a high-value trophy species) and livestock. A trophy hunting fee up to $150,000 was suggested. More recently, a proposal was put forward in Mongolia to allow hunting of a small number of snow leopards 'for scientific purposes' that was widely regarded as a possible back-door to sale of licences for hunting. This proposal was rejected by the government of Mongolia following interventions from national and international NGOs, including SLN and SLT. In order to carry any such initiative forward, an exemption from CITES would be needed to export/import a snow leopard skin and this would likely be difficult to obtain. Any proposed legal hunting of snow leopards would be no doubt be highly controversial. As Shackleton (2001) observed: "*..allowing even one hunt for a snow leopard would be strongly rejected by some members of the international conservation community, despite the fact that illegal killing of snow leopards will continue*".

Traditional hunting and collection for zoos and museums: Both factors were rated low and are no longer relevant due to legal restrictions.

References

Dagleish et al. (2007). Fatal Sarcoptes scabiei infection of blue sheep (*Pseudois nayaur*) in Pakistan. *Journal of Wildlife Diseases,* 43(3), 512-7.

Jackson, R. (2004). *Pakistan's Community-based trophy hunting programs and their relationship to Snow Leopard conservation*. Snow Leopard Conservancy, Sonoma, CA. 8 pp.

O'Gara, B.W. (1988). Snow leopards and sport hunting in the Mongolian People's Republic. Pp.215-226 in H. Freeman, (Ed). *Proceedings of the Fifth International Snow Leopard Symposium.* International Snow Leopard Trust, Seattle, and Wildlife Trust of India, Dehra Dun.

Shackleton, D.M. (2001). *A review of community-based trophy hunting programs in Pakistan.* Report prepared for Mountain Areas Conservancy Project, IUCN-Pakistan and National Council for the Conservation of Wildlife, Ministry of Environment, Local Government and Rural Development, Pakistan. 59 pp. (Available from: http://www.macp-pk.org/docs/trophyhunting_review.pdf)

Chapter 4: Competition with livestock, rangeland degradation and prey declines

Although human population density in snow leopard landscapes is relatively low, its habitats are heavily used by people whose livelihoods depend on traditional livestock herding. With growing human populations, livestock herds are growing too and in some places exceed the capacity of the land to support them. The resulting overgrazing leads to degradation of rangeland and may result in soil erosion. Competition for food with large and growing domestic livestock populations also reduces wild prey numbers, which already live at relatively low densities due to the low productivity of the habitat.

With agro-pastoralism extensively practiced across snow leopard range, there is great potential for competition for grazing resources between domestic livestock and the wild herbivores that make up the main prey of the snow leopard.

4.1. Livestock competition and overgrazing

Pastoralism and agro-pastoralism are the predominant land uses and sources of local livelihood within snow leopard range, with seven range countries having over 25% of land area under permanent pasture, > 50% of their human population involved in agro-pastoralism, > 40% living below national poverty levels, and average per capita annual incomes of US$250-400 (Mishra *et al.* 2003). For centuries humans have co-existed with wildlife practicing nomadic or semi-nomadic pastoralism herding sheep and goats flocks, cattle, horses, yaks and camels. Although relatively few humans live in snow leopard habitat, their use of the land is becoming increasingly pervasive, resulting in escalating conflicts between conservation and livestock production even within protected areas (Jackson et al 2010).

For example, Mongolia is among the world's leading pastoral nations, with rangelands covering 83% of the country's 1.29 million km^2 (Scharf et al. 2010). During the past few decades, the number of livestock has increased to 36 million animals, with sheep and goats doubling in response to the emerging global market for cashmere (Berger et al. 2013). A combination of failing management interventions and introduction of free market economies has contributed to the rapid decline in ecological condition and stability of rangeland resources, especially in Mongolia's southern desert-steppes (Bedunah and Schmidt 2004; Behnke 2006). Communal respect for seasonal grazing restrictions and long-held pasture rest-rotational practices have been severely compromised in many areas, notably Mongolia, portions of the Qinghai-Tibet Plateau, and many high altitude rangelands in the Himalaya. 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.

Traditional rotational grazing and seasonal use of different pastures has increasingly been eroded by changes in grazing practices, land ownership and official policies that promote sedentarization and settlement of herders in centers (see e.g. Harris 2008 for western China). A combination of failing management interventions and introduction of free market economies has contributed to the rapid decline in ecological condition and stability of rangeland resources in Mongolia's southern desert-steppes (Bedunah and Schmidt 2004; Behnke 2006).

Supplementary winter feeding leads to overstocking especially during the critical winter season. These changes, along with more restricted seasonable movements are resulting in widespread overuse of fragile pastures and associated long-term problems with soil erosion and desertification. High-elevation pastures may also be damaged by collection of shrubs for use as fuel: this is a particular problem with teresken (*Eurotia ceratoides*) in the Pamir of Tajikistan (Breckle & Wucherer 2006).

Overgrazing reduces the quantity and quality of rangeland resources for the principal prey species of the snow leopard, while the presence of livestock, and especially shepherds and dogs displaces them to other areas, often sub-optimal.

Suryawanshi et al. (2009) reported that the blue sheep's winter diet is primarily governed by graminoid availability in rangelands; since livestock grazing reduces such availability, they recommended the creation of livestock-free areas with community support in parts of the pasture land for the conservation of this and similar grazing species in the Trans-Himalaya. 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. Mishra et al. (2004) showed competitive depletion of blue sheep in areas of high livestock density, while Bagchi et al. (2004) found that sheep and goat compete with ibex for forage, often excluding ibex from using pastures if flocks are 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). However, Shrestha et al. (2006) found little competition between blue sheep, argali and domestic livestock in Nepal, concluding that competitive pressures between livestock and wild ungulates tend to be site specific.

Other factors that have led to ecosystem-level disruption include 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 point to changes in traditional pastoral practices and overstocking as the root cause for rangeland degradation, including desertification.

4.2. *Cordyceps* collection

Cordyceps sinensis is a parasitic fungus that parasitizes on the larvae of the ghost moth *Thitarodes* sp. and this fungus-caterpillar combination is highly valued for traditional medicinal purposes. Demand has increased significantly in recent years and the price rose by 8 times between 1998 and 2008 and the product now sells for $8000 per kilogram (highest quality can retail for up to $100,000/kg). As a result, *Cordyceps* has become the most important source of cash income for many rural households in parts of the Qinghai-Tibet Plateau (Winkler 2008). County governments in Tibet operate a licensing system, but the high value of the product has also begun to attract large numbers of outsiders in Nepal and elsewhere. Digging in search of *Cordyceps* damages the rangeland surface and this damage can be very severe in sites where a high density of collectors is present. The physical damage to mountain pastures presumably reduces the quality of grazing for livestock and wild herbivores, while the presence of so many people increases the factor of disturbance. So far there has been no quantified assessment of an impact on snow leopards, but the potential of this emerging threat requires careful monitoring

4.3. Prey declines

Declining prey numbers due to illegal hunting were rated as a high threat to snow leopards in nine of 12 range countries (Chapter 6 Illegal Trade). Poaching of mountain ungulates takes place mainly for meat but occasionally for trophies or 'sport', even within some protected areas. A contributory factor is weak enforcement of existing laws and chronic under-resourcing of protected areas that leaves staff with inadequate means to carry out regular and effective patrols. There can be no doubt that a shrinking prey base will impact negatively on snow leopards and other predators, although at present quantitative evidence is lacking.

4.4. Recommendations

Pasture and Grazing Management

Research required prior to taking action:

- Determine wild ungulate range and identify key sites (e.g. birthing; rutting, important pasture)
- Determine human land use patterns and underlying socio-economic drivers for livestock selection, herd size, land-tenure and local governance systems
- Collect baseline data on pasture quality, numbers of wild and domestic ungulates
- Estimate carrying capacity of grazing areas, with emphasis on identifying areas where overstocking is causing adverse ecological damage, and negatively impacting range and herd productivity
- Identify ways to sustain pastoral livelihoods with minimal impact to rangelands, including incorporating appropriate traditional knowledge and grazing management governance systems

Table 4.1: Grazing & Pasture Management – Suggested Action Guidelines

	Policy – Government level	Community level
Steps	• Review legal and traditional land tenure systems • Garner official support for community- generated & managed grazing plans, including technical advice	• Identify all stakeholders • Create livestock-free conservation areas • Collaboratively develop grazing plan, including grazing land set-asides where possible • Monitor and adjust grazing plan
Potential Stakeholders:	• Government: local, national • PA Administration Conservation/Development NGOs	• Community livestock owners & user groups • Users of plant resources (medicinal, food) • Agriculturalists
Potential Pitfalls:	• Determining grazing patterns may be a subject of contention, especially in where economy is in transition • Grazing management may need to include reduction of livestock numbers, yet address traditional strategies for accommodating severe drought or winters (*dzud* in Mongolia) • Prescriptive grazing plans without community consultation will likely fail	

<table>
<tr><td>Monitoring Protocols / Success Indicators</td><td colspan="2">Defined collaboratively. May include:
Measuring pasture quality, including relative abundance of palatable or preferred forage species, degree of livestock trailing or erosion;
Indicators developed by local herders based on traditional knowledge and site-specific importance
Numbers, health and productivity of wild ungulates and domestic livestock;
Level of compliance with grazing plan and mutually agreed rules & regulations
Degree of overlap or co-existence between herders and wildlife</td></tr>
<tr><td>Public Awareness</td><td>Raise awareness of legal grazing limitations especially where PA regulations apply</td><td>Display map of natural resource use, key wild ungulate areas and grazing restrictions
Disseminate grazing plan to the community
Ensure monitoring using locally-defined but sufficient indicators</td></tr>
</table>

Improved Livestock Husbandry

Research required prior to taking action:

- Identify target area where wildlife and livestock conflicts exist.
- Determine extent of overgrazing; forage competition and disease prevalence
- Determine baseline data in terms of livestock health and financial impact of disease
- Determine baseline data on livestock numbers and financial returns

Table 4.2: Improved Livestock Husbandry - Suggested Action Guidelines

	Policy level	Community level
Steps	• Review livestock health policies and practices at local and national level • Engage departments of agriculture and/or livestock in identifying nature of the problem and developing appropriate strategies • Support the development of disease surveillance and monitoring systems in livestock and wildlife	• Using PRA methodology, collaboratively determine appropriate strategies for alleviating the problem, including: ◦ Improved livestock nutrition (e.g., stall-feeding) ◦ Improved breeds and breeding management ◦ Improved grazing management (e.g., rest-rotation) ◦ Supplying basic vaccination services ◦ Training/capacity building of community veterinary workers ◦ Basic prophylactic measures e.g. vaccination, dusting for internal and external parasites ◦ Training/capacity building of community livestock health and husbandry workers • Develop strategies to benefit wildlife (e.g., grazing land set-asides or avoidance of breeding sites during lambing period) • Determine resources, skills and training required (local and external) • Identify funding sources • Determine or establish community structure for managing the program • Develop funding and business plan
Stakeholders:	• Government livestock, veterinary and wildlife departments • NGOs • Micro-credit services	• Herders/livestock owners • Village association (e.g., women's or herder's group) • Veterinary and animal husbandry workers • NGOs and rural aid agency workers

References

Bagchi, S. and Mishra, C . (2006). Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology,* 268, 217-224.

Bagchi, S., Mishra, C. and Bhatnagar, Y.V. (2004). Conflicts between traditional pastoralism and conservation of Himalayan ibex (*Capra sibirica*) in the Trans-Himalayan Mountains. *Animal Conservation,* 7, 121–128.

Bedunah, D.J. and Schmidt.S.M. (2004). Pastoralism and protected area management in Mongolia's Gobi Gurvan Saikhan National Park. *Development and Change,* 351, 167-191.

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

Berger, J., Buuveibaatar, B. and Mishra, C. (2013). Globalization of the cashmere market and the decline of large mammals in Central Asia. *Conservation Biology,* 27, 679-689.

Breckle, S.W. and Wucherer, W. (2006). Vegetation of the Pamir (Tajikistan): land use and desertification problems. Pp. 225-237 in E.M. Spehn, M. Liberman and C. Korner, eds. *Land use change and mountain biodiversity*. London, Taylor & Francis.

Harris, R.B. (2008). *Wildlife Conservation in China: preserving the habitat of China's Wild West*. M.E. Sharpe, Armonk, New York.

Jackson, R.M., Mishra, C., McCarthy, T.M. and Ale, S.B. (2010). Snow Leopards: conflict and conservation. Chapter 18, pages 417-430: *Biology and Conservation of Wild Felids* (D.W. Macdonald and A.J. Loveridge, (Eds) Oxford University Press, UK, 762 pages.

Mishra, C., Allen, P., McCarthy, T., Madhusudan, M.D., Bayarjargal, A. and Prins, H.H. T. (2003). The role of incentive programs in conserving the snow leopard. *Conservation Biology,* 17, 1512–1520.

Mishra C, Prins H.H.T and van Wieren, S.E. (2001). Overstocking in the trans-Himalayan rangelands of India. *Environmental Conservation,* 28, 279-283.

Retzer, V. (2006). Forage competition between livestock and Mongolian Pika *(Ochotona pallasi*) in Southern Mongolian mountain steppes. *Basic and Applied Ecology,* 147–157.

Scharf, K. M., Fernández-Giménez, M.E., Batbuyan, B. and Enhkbold, S. (2010). Herders and hunters in a transitional economy: the challenge of wildlife and rangeland management in post-socialist Mongolia. Pages 312-339 In: *Wild Rangelands: Conserving Wildlife While Maintaining Livestock in Semi-Arid Ecosystems*. (Eds.). J.T. du Toit, R. Kock and J.C. Deutsch, John Wiley & Sons, Inc., London.

Smith, A.T. and Foggin, J.M. (1999). The Plateau Pika (*Ochotona curzoniae*) is a keystone species for biodiversity on the Tibetan plateau. *Animal Conservation,* 2, 235-240.

Suryawanshi K.R., Bhatnagar, YV. and Mishra, C. (2009). Why should a grazer browse? Livestock impact on winter resource use by bharal (*Pseudois nayaur)*. *Oecologia* DOI 10.1007/s00442-009-1467-x.

Winkler, D. (2008). The mushrooming fungi market in Tibet exemplified by *Cordyceps sinensis* and *Trichloloma matsutake*. *Journal of the Association for Tibetan Studies,* 4, 1-47.

Chapter 5: Depredation on Livestock and Retaliatory Killing

5.1. Introduction

Depredation rates due to snow leopards and sympatric predators, especially the wolf, vary widely from under 1% in parts of Mongolia or China (Schaller *et al*. 1994; Schaller 1998) to over 12% of livestock holdings in hotspots in Nepal (Jackson et al. 1996) or India (Bhatnagar *et al.* 1999; Mishra 1997), but they typically average 1-3% (Mallon 1991; Oli et al. 1994; Hussain 2003; Namgail et al. 2007; Maheshwari et al. 2010, 2013; Wegge et al. 2012: Li et al. 2013).

Herders are especially angered by events of surplus killing when a snow leopard enters a corral and up to 50 or more of the confined sheep and goats are killed in a single instance (Jackson and Wangchuk 2001); in the Hemis National Park, India, such events (14% of all incidents) accounted for 38% of all livestock lost (Bhatnagar *et al.* 1999) and probably led to most retributive action against snow leopards.

Annual economic losses associated with depredation events range from about $50 to over $600 per household, or as much as 56% of the local average per capita income (Oli et al. 1994; Jackson et al. 1996; Mishra 1997; Ikeda 2004; Namgail 2007; Li et al. 2013).

Depredation tends to be highly site specific, with losses varying greatly between successive years and even between nearby settlements (Jackson et al. 2010, Suryawanshi et al. 2013). Typically less than 10% of households suffer disproportionate loss, usually from corralled sheep and goat kills, or when unguarded, but high-value yaks and horses are killed on the open range (Jackson *et al.* 1996; Ikeda 2004; Li et al. 2013). Complacent guarding, poorly constructed night-time pens, favorable stalking cover and insufficient wild prey are cited as the primary factors contributing to livestock depredation.

Large depredation losses may create such levels of anger towards snow leopards, wolves and other large predators that local communities lose any tolerance and view predator extermination as the only solution to the conflict (Oli et al. 1994). Therefore, understanding and managing conflicts over livestock depredation represents an important goal for effective snow leopard conservation action.

Conflicts involve two important dimensions – the reality of damage caused by snow leopards to livestock, and the resulting perceptions and attitudes of humans impacted by such economic loss (Suryawanshi et al. 2013). People's attitudes and tolerance for snow leopard varies, depending upon their religious beliefs, income status, educational level, perception of threat that snow leopards pose to their livelihood, and the extent of livestock losses they and their community have suffered (Mishra 1997; Jackson and Wangchuk 2004; Suryawanshi et al. 2013, 2014). Li et al. (2013) reported that only 10% of livestock losses in one area of Qinghai, China, were attributed to snow leopards, compared to 45% to wolves and 42% to disease. Livestock losses attributed to snow leopards may be exaggerated, either mistakenly or deliberately. Nonetheless, perceptions can have strong emotional and political consequences, ultimately leading to the persecution of snow leopards or other carnivores. As suggested above, the actual extent of livestock depredation hinges on many interacting factors including wild prey availability, livestock herding and guarding practices, livestock species composition, and habitat characteristics of the rangelands (Suryawanshi et al. 2013).

A review of the literature (including unpublished or gray material) indicates that livestock usually comprises between 20% and 70% of snow leopard scat prey remains, averaging around 30%, while livestock depredation is most severe in winter and early spring (e.g., Mallon 1984; Anwar et al 2011; Devkota et al. 2013) but can be as low as 0% (Tajikistan, Hunting concession “Murghab”, Panthera unpubl. data 2012). Although herders may act to reduce their risk and losses to depredation (Mishra et al. 2003b), these are often insufficient to prevent livestock losses. Besides possessing poorly developed anti-predator abilities, livestock numbers and biomass are often an order of magnitude higher than wild ungulate abundance and/or availability. In Nepal, for example, livestock biomass reaches 1,700 kg per km^2 (Jackson et al. 1996) compared to 330 kg per km^2 or less for the snow leopard’s main prey, the blue sheep (*Pseudois nayaur*), in the same season (Oli 1994). Bagchi and Mishra (2006) reported higher livestock (58%) in snow leopard diet in an area with more livestock (29.7 head km^{-2}) and fewer wild ungulates (2.1-3.1 bharal km^{-2}) in comparison to an adjoining area with less livestock (13.9 km^{-2}) but more wild ungulates (4.5-7.8 Siberian ibex *Capra sibirica* km^{-2}) where livestock formed 40% of its diet. These data highlight the importance of livestock as prey for some snow leopard populations (Anwar et al. 2011), and the potential role that local communities may unintentionally play in sustaining them opens a potential avenue for conservation action (see Chapter 9).

Studies assessing human tolerance of carnivores have shown cultural beliefs and social identity to be important determinants of the way people respond to livestock depredation events (Naughton-Treves et al. 2003; Treves and Morales 2006; Li et al. 2013). The presence of community-based conservation and incentive schemes and a lower role of livestock in the economy tend to positively influence peoples’ tolerance towards snow leopards (Jackson and Wangchuk 2004; Bagchi and Mishra 2006; Suryawanshi et al. 2014). Herders who receive compensation for their “lost” livestock are also likely to have positive attitudes towards snow leopards (Ikeda 2004; Gurung et al 2012), but the proportion of herders receiving compensation is typically very small (e.g. 28 of 131 depredation cases over a period of 18 months; Mishra 1997). For these and other reasons, mitigation measures should combine preventive elements (e.g. improved guarding of livestock; construction of predator-proof night-time pens or corrals) with economic incentives (e.g. income generation from ecotourism or the sale of handicrafts) (Mishra et al. 2003; Jackson and Wangchuk 2004) embedded in target-based contractual agreements that can be monitored for compliance at several levels (see Chapter 14 Estimating Snow Leopard and Prey Populations and Monitoring Trends).

5.2. Mitigation measures

There is an urgent need to reduce the negative economic impacts of livestock predation through (a) livestock management procedures that reduce depredation and (b) to offset losses through insurance, compensation or other incentive schemes. The following paragraphs focus on ways of reducing livestock loss to predators. Table 4.1 summarizes human-wildlife conflicts and mitigation measures currently being applied or proposed across the snow leopard range states (World Bank 2013).

Community-based conservation/incentive schemes have been relatively successful in a few places in establishing a locally managed system for monetary compensation and insurance for those herders losing livestock (Hussain 2000, Mishra et al. 2003, Jackson and Wangchuk 2004; Gurung et al. 2012; Jackson 2012, Rosen et al. 2012). Where carefully designed and implemented, these initiatives were instrumental in also facilitating project ownership by the community, thereby empowering them and leading to largely positive attitudes that better enable long-term co-existence with carnivores. Ultimately, conservation success rests on how tolerant a community is towards predators and to what extent such tolerance can be strengthened through collaboration and educational outreach. A comprehensive understanding of human perceptions, attitudes and tolerance is critical in predicting human response in a conflict situation; however, this is also conditional upon community participation in conservation and conflict management planning process from inception through monitoring and evaluation.

Predator proofing of livestock corrals has been one of the main measures for improving livestock protection (Bhatnagar et al. 1999; Jackson and Wangchuk 2004). Better herding practices and a reward system for effective anti-predatory livestock herding (i.e. fewer kills) have also been encouraged by conservationists, especially where livestock depredation occurs in pastures rather than from corrals (Mishra et al. 2003). Some herders often keep dogs to guard against predators; while presumably relatively effective, however, this can also lead to other conservation problems if the dogs are not properly cared for or should they become feral.

In the Spiti valley in India and parts of Nepal snow leopard predation upon horses is reported to be disproportionately high (Jackson et al. 1996; Mishra 1997). Due to their high economic value, killing of a horse prompts immediate and far greater hostility from the herder community (Oli 1994). Typically, horses and yaks free-range for large parts of the year, and are thus difficult to protect since it is often not economically feasible for livestock owners to guard them constantly (a practice more common for vulnerable small-bodied stock like sheep and goats).

Improving wild-prey availability has been proposed as a solution to reducing livestock damage by the snow leopard (Mishra et al. 2003). While increased prey availability should benefit snow leopard conservation, the effectiveness of this measure in reducing livestock depredation is uncertain (Suryawanshi et al. 2013). There is some evidence that increasing wild ungulate prey availability may lead to increased snow leopard abundance which is likely to increase the extent of livestock depredation, at least initially. Thus, measures to better protect livestock from depredation by snow leopard through effective barriers and deterrents are sorely needed to reduce the extent of livestock damage by this large-felid. Communal guarding is one option, along with the mapping and subsequent avoidance of depredation hotspots (typically more rugged terrain with an abundance of cover and limited human presence).

Lastly, there are important gaps in availability of published information on the scope and extent of livestock depredation by snow leopards and their persecution in snow leopard range countries like Tajikistan, Kyrgyzstan, Uzbekistan, Kazakhstan, Afghanistan, Bhutan, parts of western Mongolia and

Russia (Table 5.1). These areas need to be prioritized for exploratory surveys to understand the extent of human-snow leopard conflict.

Table 5.1: Status of livestock depredation and mitigation measures across the 12 snow leopard range countries.

Country	**Conflict over livestock depredation**	**Retaliatory killing**	**Important livestock**	**Livestock species killed by snow leopard**	**Existing mitigation measures**	**References**
Afghanistan	Yes	Yes	Cattle, Yak, Sheep, Goats	Sheep, Goats, Yak	Corral predator-proofing	Habib (2008) NSLEP (World Bank 2013)
Bhutan	Yes	Yes	Cattle, Horse, Sheep, Yak	Horse, Yak	Propose compensation insurance program	Sangay & Vernes (2008); NSLEP (World Bank 2013)
China	Yes	Yes	Yak, Horse, Sheep, Goats	Yak, Sheep, Goats	Insurance program	Li et al. (2013)
Gansu, Sichuan	Yes	Yes	Yak, Sheep, Goat, Camel	Yak, Sheep, Goat	Proposed pilot compensation scheme; education; enforcement	SLN mailback review
Qinghai	Yes	Yes	Yak, Sheep, Goat, Horse	Yak, Sheep, Goat	Compensation; insurance; veterinary care recommended	Li et al. 2013
Tibet	Yes	Yes	Sheep, Yak, Goat	Sheep and Yak	Trial human-wildlife conflict compensation schemes; trial use of bear-proof fences; education; law enforcement	SLN mailback review Dawa Tsering and JD Farrington pers comm. 2007.
Xinjiang	Yes	Yes	Sheep, goats, cows, yaks, horses, camels, donkeys	Sheep, goats, cows, yaks, horses	Education; law enforcement	SLN mailback review
India	Yes	Yes	Sheep, Goat, Horse, Yak, Cattle, Cow-yak hybrid, Donkey	Yak, Horse, Sheep, Goat	Corral improvement; livestock insurance; ecotourism; grazing free-reserves; conservation education	Jackson and Wangchuk (2001; 2004), Bagchi and Mishra (2006), Namgail et al. (2007), Suryawanshi et al. (2013), SLN
Kazakhstan	?	?	Not specified	Not specified	Compensation & corral predator proofing proposed	NSLEP (World Bank 2013)
Kyrgyzstan	Yes	Yes	Sheep, Goat, Horse, Yak, Cow	Sheep, Goat, Horse	No existing measures	NSLEP (World Bank 2013); SLN mailback review

Mongolia	Yes	Yes	Sheep, Goat, Camel, Horse	Horse, sheep, goats	Improved corrals; Livestock insurance; Snow Leopard Enterprises (handicrafts)	Shehzad et al. (2012), NSLEP (World Bank 2013); SLN mailback review
Nepal	Yes	Yes	Cow, Yak, Cow-yak Hybrid, Horse, Mule	Yak, Horse Mule	Compensation for loss; predator-proofing corrals; community income enterprise	Jackson et al. 1996; Ikeda (2004), Gurung et al. 2012; Devkota et al. 2013; SLN mailback review
Pakistan	Yes	Yes	Goat, Sheep, Cattle & Yak	Goat, Sheep, cattle	Corral predator-proofing; livestock vaccination; livestock insurance; prey species trophy hunting	Anwar et al. (2011), Hussain 2000, 2003, Rosen et al. 2012, NSLEP (World Bank 2013); SLN mailback review
Russia	Yes	Yes	Sheep, Goat, Cattle, Horse, Cow-Yak hybrid	Horse, Cow Yak-Hybrid, sheep, goats	Corral predator-proofing; anti-poaching patrol; education	NSLEP (World Bank 2013); SLN mailback review
Tajikistan	Yes	Yes	Sheep, goats, yak	Sheep, goats, yak	Predator-proof corrals, livestock guard dogs	NSLEP (World Bank 2013)
Uzbekistan	Yes	?	Cow, sheep, goat	?	Compensation	NSLEP (World Bank 2013)

5.3. Recommendations

Research required prior to taking action:

- Determine the location, patterns, nature and extent of the depredation problem and identify hotspots
- Determine trends in depredation using historic and current documentation

Table 5.2: Livestock Depredation - Suggested Action Guidelines

<table>
<tr><td></td><td>Policy level</td><td>Community level</td></tr>
<tr><td>Steps</td><td>Establish livestock depredation monitoring methods for all predators
Establish systematic database for storing records of depredation</td><td>Identify depredation problems and hotspots
Determine appropriate strategies for alleviating conflict. Options include community-managed insurance – compensation scheme, improved livestock husbandry and guarding practices, predator-proofing corrals or livestock pens
Usually, a combination of initiatives is more effective in such conflict management than stand-alone measures.
Identify sources for necessary human resources – materials (community / government / NGOs)
Establish community management structure
Integrate with income generation schemes like wildlife tourism, cottage industry or trophy hunting to provide sustainable revenue stream</td></tr>
<tr><td>Stakeholders:</td><td>PA Authorities
Wildlife departments
Local government
Livestock or Veterinary department
Agricultural research and training institutions
National planning agency</td><td>Livestock herders/owners
Village livestock association
NGOs, rural aid organizations</td></tr>
<tr><td>Potential Pitfalls:</td><td colspan="2">Cost and long term sustainability of resources required to construct or maintain predator proof pens
Difficult to separate scavenging from actual predation
Guard dog breeding programs need rigorous management or their use may be culturally inappropriate (e.g. northern Pakistan)
Livestock insurance usually requires external seed funding & technical assistance over medium to long-term
Logistic difficulties and delays validating claims, especially if payment is made under government managed scheme
Insurance- compensation schemes do not address root causes of depredation (e.g., poor guarding, grazing in prime snow leopard habitat, depletion of natural prey base)
Lack of sufficient labor (at household or community-level) to guard vulnerable livestock</td></tr>
<tr><td>Monitoring Protocols/Success Indicators</td><td colspan="2">Numbers of animals lost to predators (as opposed to other sources of mortality like disease)
Number of incidences of depredation (within enclosures and on open range, seasonal pattern)</td></tr>
<tr><td>Education/Public Awareness:</td><td colspan="2">Publicize best practice examples of livestock depredation reduction strategies among policy makers and communities with similar concerns</td></tr>
</table>

References

Anwar, M.B., Jackson R., Nadeem, M.S., Janecka J.E., Hussain S., Beg M.A., Muhammad G., Qayyum M. (2011). Food habits of the snow leopard (*Panthera uncia*) (Schreber 1775) in Baltistan, Northern Pakistan. European *Journal of Wildlife Research*, 57, 1077-1083.

Bagchi, S. and Mishra, C . (2006). Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology,* 268, 217-224.

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

Devkota, B.P., Silwal, T. and Kolejka, J. (2013). Prey density and diet of snow leopard (*Uncia uncia*) in Shey Phoksundo National Park, Nepal. *Applied Ecology and Environmental Sciences,* 1, 55-60.

Gurung, G.S., Thapa, K., Kunkel, K., Thapa, G.J., Kollmar, M. and Mueller Boeker, U. (2011). Enhancing herders' livelihood and conserving the snow leopard in Nepal. *Cat News,* 55, 17-21.

Habib, B. (2008). *Status of mammals in Wakhan Afghanistan*. Afghanistan Wildlife Survey Program, WCS unpublished report.

Hussain, S. (2000). Protecting the snow leopard and enhancing farmers' livelihoods: a pilot insurance scheme in Baltistan. *Mountain Research and Development,* 20, 216-231.

Hussain, S. (2003). The status of the snow leopard in Pakistan and its conflict with local farmers. *Oryx*, 37, 26-33.

Ikeda, N. (2004). Economic impacts of livestock depredation by snow leopard (*Uncia uncia*) in the Kanchenjunga Conservation Area, Nepal Himalaya. *Environmental Conservation*, 31, 322-330.

Jackson, R.M., Mishra, C., McCarthy, T.M. and Ale, S.B. (2010). Snow Leopards: conflict and conservation. Chapter 18, pages 417-430: *Biology and Conservation of Wild Felids* (D.W. Macdonald and A.J. Loveridge, (Eds) Oxford University Press, UK, 762 pages.

Jackson, R. M. and Wangchuk, R. (2004). A community-based approach to mitigating livestock depredation by snow leopards. *Human Dimensions of Wildlife,* 9, 307-315.

Jackson, R. M. and 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, 138-141.

Jackson R., Ahlborn G., Gurung M. and Ale S.B. (1996). Reducing livestock depredation losses in the Nepalese Himalaya. In Timm, R.M. and Crabb, A.C. (Eds.) Proceedings of the 17th Vertebrate Pest Conference, pp. 241-247. University of California, Davis, CA, USA.

Li, J., Hang Yin, Dajun Wang, Zhala Jiagong, Zhi Lu. (2013). Human-snow leopard conflicts in the Sanjiangyuan Region of the Tibetan Plateau. *Biological Conservation,* 166, 118-123.

Maheshwari,A., Takpa, J., Kujur, S. and Shawl, T. (2010). *An investigation of carnivore-human conflicts in Kargil and Drass areas Of Jammu and Kashmir*, India. Report submitted to Rufford Small Grant, WWF India, 30 pages.

Mallon, D.P. (1984). The snow leopard in Ladakh. *International Pedigree Book of Snow Leopards*, 4, 23-37.

Mallon, D. P. (1991). Status and conservation of large mammals in Ladakh. *Biological Conservation*, 56, 101-119.

Mishra, C. (1997). Livestock depredation by large carnivores in the Indian Trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation*, 24, 338-343.

Namgail, T., Fox, J. L., and Bhatnagar, YV. (2007). Carnivore-caused livestock mortality in Trans-Himalaya. *Environmental Management*, 39, 490-496.

Naughton-Treves L., Grossberg, R. and Treves, A. (2003). Paying for tolerance: rural citizens' attitudes toward wolf depredation and compensation. *Conservation Biology*, 17, 1500-1511.

Oli, M.K. (1994). Snow leopards and blue sheep in Nepal: densities and predator: prey ratio. *Journal of Mammalogy*, 75, 998-1004.

Oli, M. K., Taylor, I. R., and Rogers, M. E. (1994). Snow leopard (*Panthera uncia*) predation of livestock: An assessment of local perceptions in the Annapurna Conservation Area, Nepal. *Biological Conservation*, 68, 63-68.

Rosen, T., Hussain, S., Mohammad, G., Jackson, R., Janecka, J. E., & Michel, S. (2012). Reconciling sustainable development of mountain communities with large carnivore conservation: Lessons from Pakistan. Mountain Research and Development 32: 286-293.

Sangay, T., Vernes, K. (2008). Human–wildlife conflict in the Kingdom of Bhutan: Patterns of livestock predation by large mammalian carnivores. *Biological Conservation*, 141, 1272-1282.

Shehzad W., McCarthy T.M., Pompanon, F., Purevjav L, Coissac E, et al. (2012). Prey preference of Snow Leopard (*Panthera uncia*) in South Gobi, Mongolia. *PLoS ONE* 7(2): e32104. doi:10.1371/journal.pone.0032104

Treves A. and Morales, A. (2006). Co-managing human-wildlife conflicts: a review. *Human Dimensions of Wildlife*, 11, 383-396.

Suryawanshi, K.R., Bhatnagar, YV., Redpath, S. and Mishra, C. (2013). People, predators and perceptions: patterns of livestock depredation by snow leopards and wolves. *Journal of Applied Ecology* doi: 10.1111/1365-2664.12061.

Suryawanshi, K.R., Bhatia, S., Bhatnagar, YV., Redpath, S. and Mishra, C. (2014). Thinking about predators: multi-scale factors influencing human attitudes towards snow leopards and wolves. *Conservation Biology* DOI: 10.1111/cobi.12320

Wegge, P., Shrestha, R. and Flagstad, O. (2012). Snow leopard (*Panthera uncia)* predation on livestock and wild prey in a mountain valley in northern Nepal: implications for conservation management. *Wildlife Biology*, 18, 131-141.

World Bank (2013). Global snow leopard and ecosystem protection program: Conference Document for Endorsement (71 pages) and Annex Document of Complete National Programs (234 pages). Washington DC.

Chapter 6: Illegal Trade

6.1. Introduction

Snow leopards are killed and traded for their fur and other body parts. Although snow leopards have full legal protection in all range countries and have been listed in Appendix 1 of CITES since 1975, illegal trade in snow leopards poses a serious continuing threat to the species that persists in all range countries.

Demand for snow leopard products exists at national and international levels. A report by TRAFFIC International reviewed the snow leopard trade in detail (Theile 2003) and an update to this report is currently underway (A. Maheshwari, pers. comm.). The Environmental Investigation Agency also summarized the results of its research into the illegal wildlife trade in Asia since 2005 (EIA 2012). Snow leopard fur is used for clothing, hats, and furnishings and one instance of snow leopard meat available in a restaurant has been reported (Theile 2003). Recent evidence indicates that trade is now moving towards rugs, luxury décor and taxidermy (EIA 2012).

Until relatively recently, snow leopard skins could be seen on sale in markets and fur shops in several places, but the open market has declined over the last 10-15 years and the trade has become more clandestine almost everywhere, with some exceptions. Pelts have been traditionally used as decorative wall mountings in Kazakhstan, Kyrgyzstan, Mongolia and Xinjiang in China (NABU 2002). This practice is less evident currently since it is illegal, although skins obtained before national legislation was enacted may be exempt. Linxia in Gansu Province, China, has long been a centre for the animal skin trade, with more than 80 000 people engaged in the business, mainly trading sheepskin and cow leather, as well as skins from fox and otter. Although very few traders engage openly in tiger and leopard trade, the rare animal skin business is many times more lucrative than sheepskin and leather (Xu and Compton 2008). Traders stated that Asian big cat skins for sale were sourced from Afghanistan, Burma, China, India, Mongolia, Pakistan, Russia and Vietnam (EIA 2008). They did not appear to know, or be willing to discuss, the original source of the skins or whether the sources indicated were in fact transit / trading points. In Linxia, the buyer demographic appears to have diversified, with buyers coming from all over China, according to traders and the skins are marketed as ready-made rugs for home décor or taxidermy specimens (EIA 2008). The government of China is taking steps to address this trade as part of a strategic crackdown on illegal wildlife trade: for example, around 200 kg of ivory products were seized in April 2013 in Beijing's markets (TRAFFIC e-Newsletter, 17/05/2013).

Domestic markets have created a second trade chain, one step removed from the first (Wingard & Zahler 2006). Instead of supplying consumers directly, hunters bring wildlife products that require little or no processing (fish, unprocessed skins, meat, and animal parts) to small local markets and restaurants for resale to local consumers. This second chain has an international component where some products (such as furs from wolf, lynx, fox, snow leopard, horns from ibex and argali) are marketed to international visitors who then transport them across borders as souvenirs (Mishra and Fitzherbert 2004; Wingard & Zahler 2006).

In Afghanistan it was estimated that 50-80 skins were sold annually in the 1970s (Rodenburg 1977) and relatively recent visits to fur markets of Kabul indicate that snow leopard pelts are still available, with foreigners, aid workers and members of the international military forces reportedly among the main buyers (Mishra and Fitzherbert 2004, Manati 2008). In response, the Wildlife Conservation Society (WCS) has mounted awareness programs targeting these consumer groups. The National Environmental Protection Agency (NEPA) in cooperation with Wildlife Conservation Society (WCS) have developed a trade monitoring system in 2008 for the International Security Assistance Force (ISAF) that regularly inspects bazaars and military bases for snow leopard products (Kretser *et al.* 2012). The US Department of Defense has also supported production of a film for military personnel on the dangers of trade in snow leopards and other threatened species and the development of a mobile app for use by military personnel in identifying snow leopard and other illegal wildlife products (Kretser *et al.* 2014).

A study by TRAFFIC (2008) reviewed the economic and social drivers of wildlife trade and emphasized the need to (i) improve available data and knowledge of wildlife trade (ii) design wildlife trade interventions taking into account the broader conditions and trends that drive illegal wildlife trade (iii) implement and enforce laws and regulations (iv) address wider issues of governance v) make better use of non-regulatory approaches e.g. market based interventions and support for improvements in resource management (vi) target the specific audience for awareness and evaluating its impact and vii) increase policy action and attention to address the illegal trade on priority.

Interestingly the study also found that efforts to reduce poverty, increase income and diversify livelihoods amongst rural communities were believed to have relatively low impact on participation in harvesting wildlife. People involved in the trade were not necessarily poor and the poor who were involved did not necessarily drive the trade, whereas rising affluence and increasing disposable incomes in consumer countries were major drivers of demand and trade (TRAFFIC 2008). Political upheavals can also trigger poaching, e.g. trade in snow leopards increased following the breakup of the former USSR and associated economic crisis in the early 1990s (Koshkarev 1994; Loginov 1995).

The true volume of the illegal trade is hard to assess due to difficulties in monitoring a secretive activity. It is often estimated that customs seizures represent only about 10% of the actual trade in a species, suggesting that as many as 1000 snow leopards may have been illegally traded in the last 12 years (EIA 2012). However, there is no central database containing official data on seizures, trade or killing of snow leopards and the available information is patchy.

In Mongolia, customs authorities confiscated 67 skins over the 10 years 1993–2002. Since 2005, over 100 skins were found on sale in western China, especially in the city of Linxia (EIA 2012). Since the year 2000, 151 skins have been confiscated across the 12 range states. Li and Lu (2014) collected all reported cases of snow leopard poaching and trade in China 2000–2013. These investigators found that snow leopard parts were mainly traded in the major cities within their range provinces, but also began to emerge in a few coastal cities after 2010. They reported 43 cases during 2000-2013, involving at least 98 snow leopards, nine of which were imported from Mongolia Household interviews in the Sanjiangyuan Nature Reserve in Qinghai Province showed a minimum of 25 snow leopards since 2000 and estimated that 11 animals may be killed each year, accounting for about 1.2% of the estimated local snow leopard population. They found that while earlier, snow leopard products were mainly traded in the cities within the range provinces, since 2010, the market appears to have expanded to the wealthy coastal cities of China.

Secondary killing of snow leopards ('by-catch') also occurs. For example, snares set for musk deer in the Argut River basin of Russia's Altai Republic to procure highly valued musk for trading across nearby borders also pose a severe threat to the area's significantly depleted snow leopard population. In the last two years, field researchers have seized hundreds of snares laid densely along narrow ridges and migration routes, leaving snow leopards and other species few chances of escape (M. Paltsyn, in litt. 2013). In South Gobi in Mongolia, a radio-collared snow leopard was captured and killed by a herder in a snare supposedly set out for is wolves. In China, there are several cases of local herders using poison or traps to kill wolves, but unintentionally also killed snow leopards (Li et al. 2013).

Lack of enforcement and underfunding of the wildlife sector are chronic problems across snow leopard range. Some anti-poaching efforts have been supported by NGOs, for example NABU's 'Gruppa Bars' in Kyrgyzstan and the community-based Irbis-1 and Ibis-2 anti-poaching teams supported by WWF and UNDP/GEF in Western Mongolia. These teams have uncovered 12 cases of illegal snow leopard hunting and trade since 2001, including confiscation of 4 snow leopard skins at one time, and seizure of 15 snow leopard skins illegally transported to Russia. Between 1997 and 2012, 18 cases of illegal snow leopard hunting and trade were uncovered, resulting in several successful prosecutions. In Tajikistan, a snow leopard skin was confiscated in the spring of the 2013 (the animal was killed as a result of a depredation attack and the affected herder tried to sell the skin for the equivalent of USD 800); shortly before a snow leopard skin was also found in a shop in Dushanbe offered for USD 15,000.

6.2. Trade regulation

At the global level, international trade in threatened wildlife species wildlife is regulated by CITES. Addressing and curbing the illegal snow leopard trade requires a series of actions taken at international, regional, and national levels. Fully implementing Resolutions and Decisions adopted by the Conference of the Parties to CITES in this regard is essential. All range countries except Tajikistan are parties to CITES though some do not implement the convention fully. The following CITES Resolutions and Decisions are relevant for compliance and enforcement issues related to snow leopards:

- Resolution Conf. 8.4 (Rev. CoP15) on National laws for implementation of the Convention
- Resolution Conf. 11.3 (Rev. CoP16) on Compliance and enforcement.
- Resolution Conf. 12.5 (Rev. CoP16) on Conservation of and trade in tigers and other Appendix-I Asian big cat species
- Decisions 16.33 to 16.35 on National laws for implementation of the Convention
- Decision 16. 68 to 16.70 on Asian big cats

Under CITES Resolution Conf. 12.5 on Asian big cats, signatory countries are obliged to report on illegal trade issues concerning snow leopards, but none has yet done so. Lack of enforcement and underfunding of the wildlife sector are chronic problems across snow leopard range. There is also an inconsistent approach to investigation and enforcement of wildlife-related crime and the recognition of the connection between wildlife crime and international security. This is exacerbated by the fact that information currently collected is inadequate to conduct intelligence analysis and intelligence-led targeting or to identify tangible links between wildlife crime and other crime types.

In addition, INTERPOL has adopted a Resolution AG-2010-RES-03 on Sustainable Environmental Crime Programme and the UN Commission on Crime Prevention and Criminal Justice (CCPCJ) has adopted a revised draft resolution (E/CN.15/2013/L.20/Rev) on Crime prevention and criminal justice responses to illicit trafficking in protected species of wild fauna and flora. The draft resolution was adopted by the United Nations Economic and Social Council (ECOSOC) on 25 July 2013.

Interpol's Environmental Compliance and Enforcement Committee (ECEC) is working to design and develop strategies to enhance the effectiveness and efficiency of its national and international responses to environmental compliance and enforcement, including liaising with its Wildlife Crime Working Group. The key objectives are to explore mechanisms to expedite the exchange and maximize the storage of data, information and intelligence for the benefit of the global law enforcement community; to consider issues associated with communication and networking between governments, non-governmental organizations and the private sector; and to enhance collaboration surrounding transnational investigations and operational actions. The Interpol Wildlife Crime Working Group initiates and leads a number of projects to combat the poaching, trafficking, or possession of legally protected flora and fauna. Enhancing their outreach for curbing illegal trade in the big cats would increase the effectiveness of CITES on the ground.

Wildlife is being increasingly traded illegally by criminal networks that are often also linked with drug and weapons syndicates, and supported by corrupt officials and porous borders, according to a report recently issued by IFAW (2013). The report offers the following recommendations to government, multilateral institutions, intergovernmental agencies and NGOs:

- Elevate wildlife crime to the level of other serious international organized crimes (an effort to do so is already underway at high government levels in the US)
- Strengthen policies and legal frameworks, increase law enforcement capacity and develop effective judicial systems to better combat wildlife crime locally, nationally and internationally
- Develop and implement regional wildlife enforcements strategies and networks
- Address growing demand for and availability of wildlife products through targeted consumer awareness and demand-reduction initiatives in key consumer states.

The largest markets for illegal wildlife products, in order, are said to be China, the European Union and the USA (IFAW 2013). On May 1, 2013 The United Nations Commission on Crime Prevention and Criminal Justice agreed to a resolution calling on nations to "recognize wildlife and forest crimes as a serious form of organize crime and strengthen penalties against criminal syndicates and networks profiting from such illegal trade".

6.3. Recommendations

CITES and related international action

- Encourage Tajikistan to join the Convention as soon as possible
- All snow leopard range states should report regularly to CITES under Resolution Conf. 12.5 (Rev COP.15) *Conservation of and trade in tigers and other Appendix-I Asian big cat species* including enforcement activities, either by Inf. Doc or verbal reports.
- Reports to CITES should include information on snow leopard poaching and trade, including estimates of:
  - Numbers of snow leopards poached and entering trade, and the nature of the trade
  - The number of cases which investigated to, from source to destination
  - The number of arrests, seizures and convictions for snow leopard trade
  - Penalties imposed
- All snow leopard range states submit information on the international illegal snow leopard trade to their INTERPOL National Central Bureaus.
- Snow leopard range states use the Wildlife and Forest Crime Analytic Toolkit produced by the International Consortium on Combating Wildlife Crime (ICCWC) to produce a road map to combat illegal trade in snow leopard skins and parts and produce a strategic enforcement action plan.
- Develop the work of the INTERPOL Wildlife Crime Working Group further to combat snow leopard trade

Strengthening national legislation

- Range States address gaps in legislation, to ensure that snow leopards are fully protected by law, including CITES-implementing legislation (with assistance from the CITES Secretariat).
- Legislation should specifically outlaw hunting, possession, sale and trade of snow leopards, including all their parts, derivatives and products
- Snow leopard range states ensure that penalties are high enough to act as a deterrent. As a minimum, fines should be comparable to the retail value of snow leopards on international markets.
- Governments of snow leopard range states should adopt clear policies regarding the disposal of seized snow leopard products to ensure that these do not re-enter trade. Seized specimens should be marked and registered and kept in safe storage, used for educational and/or scientific purposes, or destroyed.

Strengthening enforcement

- Carry out regular monitoring of major markets and known trade centres, [notably reported markets and tourist shops in Linxia, Kashi, and Xining in China; Namak-Mandi and Kissa-Khawani markets in Peshawar, Pakistan; fur shops in Kabul, Afghanistan; some hotel shops in Kathmandu, Nepal; and the Dharchula border crossing between Nepal and China].

- Range states consider the development of “whistle blower” or “informant network” programs that provide incentives to report illegal activities, such as the killing, possession or trade in protected animals such as snow leopards.
- Maintain strong links between anti-poaching teams and all relevant agencies responsible for enforcing wildlife protection laws to facilitate the exchange of intelligence, increase the understanding of trade routes and dynamics and avoid duplication of efforts.
- Establish and/or strengthen regional and international links and co-operation, in particular between neighbouring countries where smuggling of snow leopard products has been reported. Where appropriate, undercover investigations should be considered as a means of successful enforcement and collection of intelligence.
- Establish specialised anti-poaching teams to counter the illegal killing of and trade in snow leopards. These should be well trained and effectively equipped and should work with local communities, establishing contacts and keeping them informed of the team’s role and activities.
- Ensure these teams work closely with other wildlife enforcement units or consider the creation of multi-agency anti-poaching and enforcement teams (e.g. border guards, customs, PA staff, police) as different agencies have different mandates and legal responsibilities related to investigation, confiscation of materials, or apprehending suspects.
- Governments should consider training and hiring former wildlife poachers as rangers to provide them with an alternative income and to access their knowledge on wildlife, hunting and trade routes.
- Develop, where appropriate with the assistance of NGOs, practical identification manuals to aid enforcement personnel in the detection and accurate identification of snow leopard body parts.

Awareness raising

- Initiate targeted public awareness campaigns to reduce demand for snow leopard parts and derivatives in all range states among the public, and government officials, especially those responsible for law enforcement. Develop awareness-raising and education materials to inform potential consumers about the conservation status of snow leopards, the threats faced by the species and relevant legislation for their protection. Targeted information, such as “buyer-beware” brochures (transport of snow leopard pelts can break multiple laws, in both country of origin and country of destination), leaflets, posters and web-based information should be provided to potential consumers of snow leopard products, including tourists, sport hunters, business travellers, military personnel and international aid personnel working in snow leopard range states. Information should be made available through the general media, specialized magazines and the internet. Co-operation from bodies as a whole should be sought, for example from the armed forces and those engaged in the legal fur trade.

International cooperation

- Compliance with national reporting requirements on illegal trade (CITES/TRAFFIC)

- Recording of information on illegal snow leopard trade to INTERPOL National Central Bureaus (INTERPOL)

- Use of the Wildlife and Forest Crime Analytic Toolkit produced by the International Consortium on Combating Wildlife Crime (ICCWC) to develop a road map to combat illegal trade in snow leopard skins and parts and produce a strategic enforcement action plan (INTERPOL / ICCWC)

- Reviewing and strengthening national legislation on wildlife protection and trade (IUCN Commission on Environmental Law)

- Multilateral cooperation on illegal cross-border trade and customs training (INTERPOL, SEAWEN and other wildlife enforcement networks).

References

EIA (2008). *Skin Deep: The need for effective enforcement to combat the Asian Big Cat skin trade*. Briefing for the 57th Meeting of the CITES Standing Committee FIC Europe. Brussels, Belgium.

EIA (2012) *Briefing on snow leopards in illegal trade – Asia's forgotten cats*. EIA International.

IFAW (2013). *Criminal nature: the global security implications of the illegal wildlife trade*. International Fund for Animal Welfare, 32 pages.

Koshkarev, E. (1994). *Poaching in Kyrgyzstan*. Original title: Snow Leopard in Kyrgyzstan. Ecological News from Central Asia. Vol. 2/Number 8. http://lynx.uio.no./jon/lynx/alertkgz.htm

Kretser H., Johnson, M., Hickey, L.M., Zahler P., and Bennett, E. (2012). Wildlife trade products available to U.S. military personnel serving abroad. *Biodiversity and Conservation,* 21, 967-980**.**

Kretser, H., Wong, R., Roberton, S., Pershyn C., Huang J. M ., Sun, F., Kang, A. and Zahler P. (2014). Mobile decision-tree tool technology as a means to detect wildlife crimes and build enforcement networks. *Biological Conservation.* In press.

Li, J. and Lu, Zh. (2014). Snow leopard poaching and trade in China 2000–2013. *Biological Conservation*, 176, 207–211.

Loginov, O. (1995). Status and Conservation of Snow Leopard in Kazakhstan. In: R. Jackson and A. Ahmed (Eds.). *Proceedings of the Eighth International Snow Leopard Symposium*. ISLT and WWF-Pakistan.

Manati, A.R. (2008) *Der Handel mit Fellen von Großkatzen und die Abklärung der Unterartenfrage beim Leoparden in Afghanistan* [The trade in big cat skins and clarification of the subspecies of leopards in Afghanistan]. PhD Dissertation, University of Cologne. (In German).

Menon, V. and Kumar, A. (1998) *Wildlife crime: an enforcement guide*. Wildlife Protection Society of India, New Delhi.

Mishra, C. and Fitzherbert, A. (2004) War and wildlife: a post-conflict assessment of Afghanistan's Wakhan Corridor. *Oryx,* 38, 102-105.

Norbu, U.P. (1995) Status and conservation of snow leopard in Bhutan. In: R. Jackson and A. Ahmad (Eds.). *Proceedings of the Eighth International Snow Leopard Symposium*. ISLT and WWF-Pakistan.

Rodenburg, W.F. (1977). *The trade in wild animal furs in Afghanistan*. UNDP/FAO Project AFG/74/016. Field Document.

Theile, S. (2003) *Fading* f*ootprints: the killing and trade of snow leopards*. Cambridge, UK: TRAFFIC International.

Wingard J.R. and Zahler, P. (2006) *Silent steppe: the illegal wildlife trade crisis in Mongolia*. Mongolia Discussion Papers, East Asia and Pacific Environment and Social Development Department. Washington DC: World Bank.

Xu, H. and Compton, J. (Eds) (2008). *The state of wildlife trade in China*. TRAFFIC East Asia.

Chapter 7: Climate Change

7.1. Introduction

Broad trends in global climatic patterns including a rise in mean temperatures and changes in the level of precipitation are clear. The mountains of Asia are likely to be subject to more extreme and more variable weather as a result of a changing climate according to the assessment by the Intergovernmental Panel on Climate Change (IPCC 2007). In mountain areas, increased intensity and frequency of severe or extreme weather events are also among the expected consequences (ICIMOD 2009). In general, precipitation in snow leopard landscapes appears to have become less predictable – whether floods or droughts.

Reported, possible and future consequences of climate change in the greater Himalayan region, and on the glaciers, permafrost, and the implications for water resources and ecosystems, were reported by Xu et al. (2007). Glaciers in the Himalaya-Hindu Kush region have been mapped using satellite imagery and digital elevation models (Bajracharya & Shrestha 2011) so that changes in extent can be tracked.

However, the lack of basic data and potential interactions between many factors mean that the fine-scale effects of climate change at specific sites and on individual species are less easy to predict with accuracy. In fact, lack of information is the biggest current challenge in understanding the effects of climate change in mountain areas (e.g. ICIMOD 2009 for the Eastern Himalaya; Zoi Environmental Network 2009 for Central Asia).

Computer models provide a valuable resource, but are unlikely to predict future conditions adequately. Therefore, climate change planning for snow leopards should include a range of plausible future scenarios in a flexible adaptive management framework. Potential landscape scale effects of warmer increased temperatures and precipitation include melting permafrost, longer growing seasons, upward shifts in tree lines and other ecological zones, while lower precipitation is expected to lead to aridification and retreat of glaciers.

Increases in precipitation may be restricted to certain seasons; e.g. winter precipitation is very likely to increase on the Qinghai-Tibet Plateau (IPCC AR4 2007). Research suggests a transition towards a warm-wet regime in north-west China as temperatures rise, as opposed to a warm dry one, given the increased rates of evaporation with rising temperatures and increasing size of closed basin lakes as they refill with glacial meltwater (Shi et al. 2002, 2007; Zhang and Chu, 2009; Zhu et al. 2009). Avalanches and glacial lake outburst floods (GLOF) are existing hazards in higher mountain habitats and climate change-related storms are likely to exacerbate these events as well as landslides, debris flow and flash floods (Rai & Gurung 2005; Bajracharya et al. 2007; Nyaupane & Chhetri 2009).

Climate and socioeconomic change are already affecting the livelihoods of mountain communities and some these are developing a set of response strategies (Macchi et al. 2011). Climate change will have a direct impact on patterns of livestock grazing and human land use, thus indirectly influencing snow leopards and their prey, but again, the effects are currently difficult to assess. If changing conditions result in greater pasture productivity, stocking densities can be expected to increase, while lower precipitation leading to reduced productivity and/or availability of fresh water may result in fewer livestock or abandonment of some mountain pastures. Earlier onset of spring as a result of climate change, along with increased summer precipitation, especially in arid regions like the Gobi Desert of Mongolia, might benefit herders by increasing green biomass productivity. However, such potential may be countered by periodic years of extreme summer droughts or prolonged winter snowfall (Batima et al. 2005; Marin 2010).

On the Qinghai-Tibet Plateau, increasing rainfall may be contributing to decreasing pasture productivity, possibly due to increasing cloud cover and soil saturation, flooding of high productivity lakeshore pastures, and increased erosion due to higher intensity of rainfall. A further effect of higher temperatures is degradation of permafrost and falling groundwater levels that in turn negatively impact pasture productivity through conversion of meadows to steppe-type grasslands, often regardless of rainfall increases (e.g. Wang et al. 2006; Zhao and Li 2009).

A recent preliminary study assessing the vulnerability of snow leopard habitat in the Himalayas estimated a 30% reduction in its habitat in the higher Himalayas due to an upward shift in tree line and consequent shrinkage of the alpine zone over the next century (Forrest et al. 2012). However, advances in tree growth may be slowed or prevented by browsing livestock and cutting by local people to maintain their pastures.

A recent review of existing studies across China since 2008 shows both complex direct and indirect impacts of climate change on snow leopard populations (Riordan et al. 2012). Livestock grazing pressure has tended to increase in its intensity and spatial extent in response to land opportunities and expansion of optimal sowing season due to climate change. This pattern appears now to be altering in response to policy interventions, though not uniformly. Snow leopard natural prey populations, principally blue sheep (*Pseudois nayaur*) in this study, responded negatively to environmental degradation from increased livestock grazing pressure. This in turns appears to negatively affect snow leopard populations (Riordan et al. 2012). However, in parts of Qinghai at least, some people have shifted their main source of livelihood from livestock to *Cordyceps* collection for the time being, presumably reducing the grazing pressures (J. Farrington, unpub. data). The vulnerability of ecosystems and communities to climate change across the high mountains of Asia has been recently assessed by Smith (2013).

According to the ICPP report, global warming raises the threat of extinction for 20-30% of species. As the top predator of the central Asia's high mountains, the snow leopard may be an indicator of climate change. Given the extreme difficulty and expense of snow leopard research, it is urgent that long-term studies get underway to monitor the snow leopard as an indicator of the rate and scope of climate change. Studies are needed that correlate seasonal changes with snow leopard movement, home range changes, migration, and deviations from established life history parameters.

Maintaining habitat connectivity is a key strategy for addressing climate change and for ensuring viable populations of snow leopard and their high-altitude prey – especially as protected area boundaries cannot be easily shifted as regional climates change under global warming. Besides, natural ecosystem processes extend well beyond PA boundaries, so that strategies of adaptive ecosystem management are needed to facilitate range shifts driven by the forces of climate change. Governments and national research institutions need to take this leads in promoting such studies, drawing upon both empirical field studies and office-driven GIS modeling exercises. Ensuring corridors in fact meet basic functional requirements will mean placing greater emphasis on delineating genetically effective population units, and in turn on implementing a framework for systematically sampling genetic makers across snow leopard range that allows for the identification of management units (Palsbøll 2006).

In extreme cases, it may become necessary to relocate individual snow leopards or their prey to the nearest, less threatened meta-population, but such operations would be extremely expensive, logistically challenging and fraught with risks.

7.2. Recommendations

A growing literature addressing climate change in Asia's high mountains is emerging (e.g. ICIMOD has published widely on climate change impacts and adaptation in the Himalaya-Hindu Kush region). It is important that governments, NGOs and other institutions act to address threats locally, nationally, internationally and globally, which fall into two major categories:

- Strengthen climate change policies nationally and internationally, including capacity building; regional watershed management and collaboration; and disaster risk management.
- Work with local communities in snow leopard range to assess climate change vulnerability and adaptive capacity
- Share specific actions that local communities could take to adapt to climate change, ranging from community education (including drawing on traditional knowledge); natural resource and rangeland management and restoration to erosion control, desertification and water-resources conservation, etc.

Further specific recommendations relevant to snow leopards and their high mountain ecosystems will be posted on the SLN website as these become available.

References

Bajracharya, S.R. and Shrestha, B. (2011). *The status of glaciers in the Hindu Kush-Himalayan Region*. International Centre for Integrated Mountain Development (ICIMOD): Kathmandu.

Bajracharya, S.R., Mool, P.K. and Shrestha, B.R. (2007). *Impact of climate change on Himalayan glaciers and glacial lakes: case studies on GLOF and associated hazards in Nepal and Bhutan*. International Centre for Integrated Mountain Development (ICIMOD): Kathmandu.

Batima P., Natsagdorj L., Gombluudev P., and Erdenetsetseg B. (2005). *Observed Climate Change in Mongolia*. AIACC Working Paper No.12 (Accessed 09/14/2012): http://www.aiaccproject.org/working_papers/Working%20Papers/AIACC_WP_No013.pdf)

Forrest, J.L., Wikramanayake, E., Shrestha, R., Areendran, G., Gyeltshen, K., Maheshwari, A., et al. (2012). Conservation and climate change: Assessing the vulnerability of snow leopard habitat to tree line shift in the Himalaya. *Biological Conservation,* 150, 129–135.

Macchi, M., Gurung, A.M., Hoermann, B. and Choudhary, D. (2011). *Climate variability and change in the Himalayas: community perceptions and responses*. International Centre for Integrated Mountain Development (ICIMOD): Kathmandu.

Marin, A. (2010). Riders under storms: contributions of nomadic herders' observations to analyzing climate change in Mongolia. *Global Environmental Change*, 20(1), 162–176.

Nyaupane, G.P. & Chhetri, N. (2009) Vulnerability to climate change of nature-based tourism in the Nepalese Himalayas. *Tourism Geographies,* 11, 95–119.

Palsbøll, P.J., Berube, M. & Allendorf, F.W. (2006). Identification of management units using population genetic data. *Trends in Ecology and Evolution,* 22, 11-16.

Rai, S.C. & Gurung, A. (2005) Raising Awareness of the Impacts of Climate Change: Initial Steps in Shaping Policy in Nepal. *Mountain Research and Development,* 25, 316–320.

Riordan P, Shi K, Wang, J, Hughes J and Wang (2012). International conference on managing protected areas under climate change (IMPACT). Dresden, Germany. 24-26 September 2012 http://ww.habit-change.eu/index.php?id=200

Shi, Y.F., Shen, Y.P. and Hu, R.J. (2002). Preliminary study on signal, impact and foreground of climatic shift from warm-dry to warm-humid in northwest China. *Journal of Glaciology and Geocryology,* 24:,219–226. (In Chinese.)

Shi, Y.F., Shen, Y.P., Kang, E.S., Li, D.L., Ding, Y.J., Zhang, G.W. and Hu, R.J. (2007). Recent and future climate change in northwest China. *Climatic Change,* 80, 379-393.

Smith, T. (2013) *Assessing community and ecosystem vulnerability to climate change and glacier melt in Asia's high mountains*. WWF-USA, Washington DC, unpublished report.

Wang, G.X., Li, Y.S., Wu, Q.B. and Wang, Y.B. (2006) Impacts of permafrost changes on alpine ecosystem in Qinghai-Tibet Plateau. Science in China, Series D: *Earth Sciences,* 49, 1156–1169.

Xu, J.C., Shrestha, A., Vaidya, R., Eriksson, M. and Hewitt, K. (2007).*The melting Himalayas: regional challenges and local impacts of climate change on mountain ecosystems and livelihood*s. International Centre for Integrated Mountain Development (ICIMOD): Kathmandu. ICIMOD Technical Paper.

Zhang, X. and Chu, Z. (2009) *Climate change on the Qinghai-Tibet Plateau*. In: Impacts of climate change on the Yangtze source region and adjacent areas. J. D. Farrington, (Ed). Beijing: China Meteorological Press.

Zhao, L. and Li, R. (2009) *Changes in permafrost along the Qinghai-Tibet highway in the Yangtze Source Region*. In: Impacts of climate change on the Yangtze source region and adjacent areas. J. D. Farrington, (Ed). Beijing: China Meteorological Press.

Zhu, L., Wang, J. and Farrington, J.D. (2009). The response of Qinghai-Tibet Plateau lakes and wetlands to climate change and human activities and the implications for biodiversity. In Impacts of climate change on the

Yangtze source region and adjacent areas. J. D. Farrington, (Ed). Beijing: China Meteorological Press.

Zoï Environment Network (2009). Climate Change in Central Asia: A visual synthesis. Produced in close cooperation with Governments of Switzerland, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. International Affairs Division, Swiss Federal Office for the Environment. 80 pages, available from: http://www.preventionweb.net/english/professional/publications/v.php?id=12033

Chapter 8: Large-scale Infrastructure, Mining, and Linear Barriers

8.1. Introduction

Major infrastructural developments are either planned or under construction in different parts of the snow leopard's range, particularly in those countries undergoing rapid economic growth like India, China, Russia and Kazakhstan. These include mineral exploration and extraction, new gas and oil pipelines, new road and rail transportation networks, and hydro-electric power facilities associated with large or medium-sized dams.

As water shortages increase in the densely populated lowlands of South and East Asia, so the need for upstream water-storage facilities are expected to grow significantly. As economic development of the region proceeds, so it becomes increasingly important for range countries to put into place, or act upon, existing regulations in order to minimize negative environmental impacts through careful planning, appropriate mitigation measures and related "Best Practices." Addressing this sector will comprise an important component of both GLSEP and NSLEP action toward securing 20 snow leopard populations range-wide by the year 2020.

8.2. Mining

This sector is considered a key engine of economic development by many countries, and may contribute greatly to GDP. However, there are not insignificant risks that such mining operations will also result in negative socio-economic and environmental impacts. Attention to social and environmental considerations and government commitment to good governance and transparency is thus important (The World Bank, 2005; 2006; http://www.worldbank.org/en/results/2013/04/14/mining-results-profile).

Snow leopard range countries such as China, Mongolia, Kyrgyzstan, Russia and Tajikistan are rich in minerals and other extractive resources like natural gas and oil (Baker et al. online from US Geological Survey 2010). A network of major roads and railroads is being planned to transport the products southward to China, potentially bisecting wildlife habitat and migration routes in the South Gobi region (Heiner et al. 2013, Ito 2013).

Afghanistan also harbors large untapped energy and mineral resources like chromium, copper, gold and semiprecious stones. Small-scale gold mining occurs in Mongolia's South Gobi, in isolated but widespread places on the Tibet-Qinghai Plateau and other parts of snow leopard range. The impact of mining, and associated indirect threats such as poaching of prey and opening up new areas and disturbance, are considered serious (Wingard and Zahler, 2006).

Proposed liquid gas and petroleum pipelines bisect known or potential snow leopard habitats in the Tien Shan Mountains. These include gas pipelines (labeled as G19, G31, G10) in the Kazakhstan-China border area to Urumqi and Lanzhou, along with proposed routes into the Tarim Basin which separates the northern and southern populations of snow leopards. In addition, one proposed pipeline routes from Russia traverses the Altai Republic's sacred Ukok Plateau, though a more northerly route may be selected instead.

8.3. Electric power

The huge glaciers of the Himalaya and parts of the Tibet-Qinghai Plateau have been designated as the "Water Towers of Asia". Hydroelectric power generation and dam construction are considered major growth industries for Bhutan, Nepal and India, as their governments seek to meet the massive power and water demands from neighboring, densely populated lowland of India, Bangladesh and Pakistan. Pandit and Grumbine (2012) projected the effects of 292 existing or proposed dams on terrestrial ecosystems under different scenarios of land-cover loss. They concluded that dams affect almost 90% of India's Himalayan valleys with the greatest impact occurring in areas of dense forests (i.e. a habitat type not utilized by snow leopards). Smaller hydroelectric plants have been constructed (e.g. Spiti Valley, Kinnaur in India) in higher areas with snow leopard habitat. The potential for constructing large dams within core habitat areas is unclear, although the presence of deep, mountain gorges appears to offer numerous potential dam sites, some with an apparently massive water-pool storage capacity. For example, a suggested site on the Yarlung Tsangpo River of China along the border with India has the reputed potential to be three times the size of the Three Gorges dam, currently the largest such structure in the world. If constructed, it would draw from the headwaters of the Brahmaputra, one of India's most important waterways, and according to some reports, direct water towards China's Yellow River.

8.4. Railroads and highways

Transport links are being extended and developed throughout Asia. In China, in particular, paved highways (including high-speed two-lane freeways) have been constructed through previously remote landscapes to link distant population centers. Even in rugged mountain areas of, roads are being constructed to service previously isolated settlements in an effort to develop their marginal economy and provide a better life for the rural population. However such roads may present an indirect threat by opening up remote areas to poachers. Where railroads are fenced, they may represent significant barriers to the free movement of wildlife. The Golmud-Lhasa railroad, completed in 2006, bisects the Qinghai-Tibetan plateau, but those sections subject to risk of permafrost melting have been elevated, thus allowing for the passage by plains ungulates.

8.5. Fences

Fences along international borders – which often follow mountain ridgelines – present another barrier to wildlife movement, especially prey species. Short stretches of border between Tajikistan and Afghanistan have been fenced, as well as most of the border between Tajikistan and China in the Pamir, although fence posts have been cut for firewood along the southern 50 km, so animals can cross (Schaller and Kang 2008). Border fences also exist along. A barbed wire border fence between the Russian Federation and Mongolia, built in the year 2000 runs for about 50 km along the Mongun-Taiga. China's Grassland Privatization Policy and other policies encourage fencing of formerly open rangelands. These too can impede animal movements, but so far these fences are confined to the plains and have not yet encroached on snow leopard habitat.

8.7. Other developments

Tourist and recreational facilities are also becoming more prevalent in the mountains. For example, the recent proposal to establish a ski resort in Ile-Alatau National Park in Kazakhstan within habitat known to be used by snow leopards.

8.8. Mitigating impacts of large-scale development projects

The three basic steps involved consist of identifying critical sites for snow leopard and prey populations; conducting credible environmental impact assessments; and taking specific actions to avoid, minimize or mitigate any environmentally damaging effects.

An Environmental and Social Impact Assessment (ESIA) is a statutory requirement at the planning stage of major developments in most snow leopard range countries, but these are not always carried out rigorously or transparently. Ensuring that ESIA's are conducted according to the highest professional and international standards is an important step in minimizing adverse effects on snow leopards, their prey and habitat, as well as other critical elements of biodiversity. Where finance for development projects is provided by major multilateral donors or lenders, such as the World Bank, European Bank for Reconstruction and Development (EBRD) or the Asian Development Bank (ADB), adherence to the International Finance Corporation's Performance Standard 6 covering biodiversity is required and provides a further safeguard. SLN and its members collectively possess technical expertise for assisting governments, companies and local communities assess the impacts of large-scale projects – in order to identify detrimental impacts and develop reasonable mitigation measures based on careful environmental and economic planning as summarized below. Large-scale infrastructural development projects represent both a challenge and an opportunity for better ensuring the long-term conservation of biodiversity, including the potential for win-win outputs. For example, Quintero and Mathur (2011)suggested opportunities for such collaboration, while the Global Tiger Initiative produced a "Smart-Green Infrastructure" handbook for ameliorating direct and indirect impacts to tigers, many of which also apply to snow leopards (Quintero et al. 2011).

Biodiversity offsets may provide another mechanism for maintaining or enhancing environmental values in situations where development is sought despite detrimental environmental impacts. An emerging approach seeks to ensure that unavoidable negative environmental impacts of development are balanced by environmental gains, with the overall (and ideal) aim of achieving a net neutral or positive outcome (Kieseker et al. 2009, Heiner et al. 2011).

8.9. No Net Loss policy

Businesses, governments, and financial institutions are increasingly adopting a policy of no net loss of biodiversity for development activities. This goal is intended to help relieve tension between conservation and development by enabling economic gains to be achieved without concomitant biodiversity losses. Biodiversity offsets represent a necessary component of a much broader mitigation strategy for achieving no net loss following prior application of avoidance, minimization, and remediation measures. However, defining suitable offsets and the associated conditions under which the array of species, habitat and ecosystems can be ensured is not straight forward: they need to be comparable in type and amount, additional in terms of enrichment and offer lasting gains. Gardner et al. (2013) describe a framework designed to strengthen the potential for offsets to provide an ecologically defensible mechanism that can help reconcile conservation and development.

For example, while Mongolia's rich oil and mineral deposits are attracting developers and fueling the country's burgeoning economy, they could also irreparably harm Mongolia's unparalleled temperate grasslands and arid ecosystems. To address this, The Nature Conservancy is working with the Mongolian government under its *Development by Design* approach to find a model that gives equal weight to the needs of conservationists, herders and developers through a mapping biodiversity values in order to identify potential areas where impacts could be offset for minimal mean loss to the country's overall biodiversity portfolio. Initial signs are promising with sustainable outcomes being possible in places previously lacking sophisticated environmental information generated through remote sensing and GIS tools, and validated by ground-truthing.

References

Baker, M.S., Elias, N., Guzmán, E. and Soto-Viruet, Y. (2010).*Mineral Facilities of Asia and the Pacific*. Accessed 09/11/2012 at http://pubs.usgs.gov/of/2010/1254/

Gardner, T.A et al. (2013). Biodiversity offsets and the challenge of achieving no net loss. *Conservation Biology*, 27 (6), 1254–1264.

Heiner, M. et al. (2013). *Identifying conservation priorities in the face of future development: applying development by design in the Mongolian Gobi*. The Nature Conservancy, Ulaanbaatar, Mongolia, 126 pages. Available for download from: http://s3.amazonaws.com/DevByDesign-Web/DataDissemination/data/gobi/Gobi_ERA_report_20130827_ENG.pdf

Heiner, M. et al. (2011). *Identifying conservation priorities in the face of future development: applying development by design in the grasslands of Mongolia*. The Nature Conservancy, 56 pages.

Ito T.Y. et al. (2013). Fragmentation of the habitat of wild ungulates by anthropogenic barriers in Mongolia. PLoS ONE 8(2): e56995. doi:10.1371/journal.pone.0056995

Kashkarov, E.P., Vyrypaev V.A., Skorobogach, A.V., Nolfin G. B., Gribkov A.B., Barashkova A.N., Ishchenko I. V. (2008). Argali Ovis ammon ammon Linnaeus, 1758: The role of marginal populations in the strategy for conservation of the subspecies. *Journal Ritm* 2: 255-291.

Kiesecker, J.M, et al. (2009). A framework for implementing biodiversity offsets: selecting sites and determining scale. *BioScience*, 59 (1), 77-84.

Pandit, M.K and Grumbine, R.E. (2012). Potential effects of ongoing and proposed hydropower development on terrestrial biological diversity in the Indian Himalaya. *Conservation Biology*, 26(6), 1061–1071.

Quintero, J.D. and Mathur, A. (2011), Biodiversity offsets and Infrastructure. *Conservation Biology*, 25(6), 1121-1123.

Quintero J., Roca R., Morgan A.J. and Mathur A. (2011). Smart Green Infrastructure in Tiger Range Countries: A Multi-Level Approach. GTI-SGI Working Group, World Bank, Washington DC. 24 pages + appendices.

Schaller, G.B. and Kang, A.L. (2008). Status of Marco Polo sheep *Ovis ammon polii* in China and adjacent countries: conservation of a vulnerable subspecies. *Oryx*, 42, 100-106.

Singh, N.J. (2008). Animal - Habitat relationships in high altitude rangelands. PhD Dissertation. University of Tromso, Norway.

US Geological Survey. (2010). Minerals Year Book. Accessed September 10, 2012: http://minerals.usgs.gov/minerals/pubs/country/2010/myb3-2010-ch.pdf

Wingard J.R and 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 and Washington DC.

World Bank (2005). *Community development toolkit*. ESMAP Formal Report Series, Report No. 310/05. (This toolkit supports government, industry, and community efforts to realize more sustainable community development around mining and mineral processing operations.)

World Bank (2006). A review of environmental and social impacts in the mining sector. Discussion Paper, East Asia & Pacific Region, Washington DC., 33 pages.

Chapter 9: Conservation Actions

9.1. Introduction

Since the first version of SLSS appeared in 2003, millions of dollars and hundreds of thousands of person-hours of effort are likely to have been invested in conserving of snow leopards, their prey and their habitats.

This conservation response takes many forms: international agreements aimed at protecting the snow leopard and other biodiversity, legal protection at national level, new and enlarged protected areas, scientific research, field conservation projects, capacity building, alternative livelihood support, ecotourism programs, socio-economic surveys, awareness-raising and others.

The charismatic nature of the snow leopard confers an immediate advantage in terms of public appeal and the species is widely used as a flagship for ecosystems and projects. This iconic quality is shared with a very small number of other mammals – mainly big cats and great apes.

Two international NGOs are entirely dedicated to snow leopard conservation: the Snow Leopard Conservancy (SLC) and Snow Leopard Trust (SLT), while a third, Panthera, has snow leopards as one of its core programs. Other INGOs engaged in snow leopard conservation include Fauna & Flora International (FFI), Nature and Biodiversity Conservation Union Germany (NABU), Wildlife Conservation Society (WCS), World Wide Fund for Nature or WWF (including the US-based World Wildlife Fund), and numerous other smaller international and national NGOs.

Several successful community-based conservation models are being implemented across the snow leopard distribution range by various organizations. The extent of success of this diverse range of conservation efforts may vary but there is little published information on their performance. Such research would be highly useful in designing and adapting conservation programs. Larger international NGOs have developed monitoring frameworks to evaluate their conservation programs, but it would be useful if a cooperative, standardized monitoring framework were put in place.

An inventory of ongoing conservation and education awareness programs across range countries has yet to be undertaken, although some information is available from the National Action Plans (NSLEPs) submitted in support of the Global Snow Leopard Environment Protection Plan (GSLEP). SLN should consider establishing a database for partner organizations (government, NGOs, INGOs etc) to share projects and lessons learned. Mishra et al. (2003) and Jackson et al. (2010) summarized economic and incentive-based programs for snow leopard conservation

9.2. Handicrafts

The Snow Leopard Enterprises handicrafts initiative (SLE) was established in Mongolia about 10 years ago (Snow Leopard Trust, unpublished data, Mishra et al. 2003). Currently it also operates in Pakistan, Kyrgyzstan and northern India, involving some 250 producers. To date the program has generated nearly 1 million dollars in sales with herder families increasing their household income by nearly 40%.

Artisans receive training and simple tools to develop culturally appropriate woollen products that are marketed overseas in the USA and Europe by the Snow Leopard Trust. In exchange, each community signs a conservation contract stipulating a moratorium on snow leopard and wild ungulate poaching. Full compliance with the contract brings the herders a 20% bonus over the agreed price of their products; this bonus is split between the artisans and a community conservation fund. A single contract violation loses the entire community's bonus. The resultant peer pressure results in collaboration to stop or significantly reduce poaching by both locals and outsiders with compliance being monitored by protected area rangers, law enforcement agencies and the SLE.

9.3. Savings and credit programs

S&C Programs tie snow leopard conservation to livelihood promotion under a community-managed savings and loan arrangement. For example, the Snow Leopard Conservancy provided $8,000 in seed funding to over 200 community members in four communities in the Mt. Everest National Park in Nepal. Loans at competitive interest rates are provided to eligible members to support entrepreneurial income-generating activities, with the community augmenting the fund from cultural shows targeting foreign tourists. Within a 3-year period these S&C members almost quadrupled the fund amount, of which 15% (approximately $700) supported community-led conservation initiatives ranging from partially compensating herders for livestock losses incurred to predators and for habitat monitoring. An additional 10% was provided to village schools for biodiversity awareness programs including World Environment Day (June 5). The program is being expanded to other settlements, as well as the Annapurna Conservation Area.

9.4. Corral improvements

Predator-proofing corrals and night-time livestock shelters significantly reduces depredation on livestock by snow leopards, in particular multiple kills and has achieved positive effects in Hemis National Park, Ladakh (Jackson and Wangchuk 2001). While formalized records of improved corrals are currently lacking, to date many dozens of structures have already been predator-proofed in snow leopard areas in Afghanistan, northern India, Nepal, Pakistan and Tajikistan by the government and conservation organizations. However, substantial funds and human resources would be required to improve livestock pens over significant portions of snow leopard range, since each livestock-owning household could have 2-3 or more village- and/or pasture-based facilities. Thus, conservationists need to ensure corral improvements target high risk depredation sites and high density snow leopard areas, drawing on a combination of interviews of livestock owners, depredation records, diet assessments, snow leopard habitat mapping and predator status abundance surveys. depredation records, diet assessments, snow leopard habitat mapping and predator status abundance surveys. The improvement or construction of community corrals used jointly by several families increases the coverage and cost efficiency of this approach.

9.5. Livestock insurance

Locally-managed livestock insurance programs are operating in at least five range countries. The first was established in Pakistan's Baltistan region Hussain (2000). The scheme which is managed by the participating local communities and financed through premiums contributed by participating families along with contributions from the sponsoring NGO, was rapidly embraced by the three settlements and 151 families. Thirteen years later the project had expanded into ten villages in three different valleys (Rosen et al. 2012). Such insurance schemes have led to greater tolerance of snow leopards amongst local communities. With local management by village-level committees and family-paid premiums, local ownership is strengthened, as is internal peer pressure against corruption or false claims. On the other hand, capitalizing insurance funds can present a special challenge: for example, in eastern Nepal, almost $60,000 in capital funds were required to fund a program covering less than 50 households. Another program in India's Spiti Valley is supported with conservation funds (60% over 5 years) in addition to premiums contributed by the participating families (remaining 40%) with the goal of becoming financially self-sustaining within 5 years. Obviously, the higher the depredation losses, the larger the fund balance required, especially where payments accrue from the interest revenue stream.

9.6. Veterinary assistance

Conservationists are also tackling issues related to animal health, since livestock losses to disease (up to 50% or more) usually far exceed losses to snow leopards. For example in Pakistan, a pilot livestock vaccination program vaccinates livestock against common diseases in exchange for herder's tolerating depredation. Participants agreed to cease snow leopard persecution, reduce their livestock holdings, and improve fodder handling methods to increase forage availability for wild herbivores. Programs like this create economic incentives by increasing livestock survival and productivity, with sales of excess animals bringing each family some $400 per annum (Snow Leopard Trust, unpublished data).

9.7. Ecotourism

The *Himalayan Homestays* initiative is a good example of a tourism program in which local people directly benefit from protecting snow leopards and other wildlife through household managed "bed and breakfasts" operations active over extensive areas in Ladakh, Jammu & Kashmir State, India. The first traditional homestays were established in Hemis National Park, India's premier snow leopard protected area. Well over 100 families in more than 20 communities in Ladakh, Zanskar and Spiti currently participate with homestay operators located in prime snow leopard habitat earning $100–1,500 during the brief 4-month tourist season (Snow Leopard Conservancy, unpublished data). Approximately 10-15% of homestay profits go 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 hodgsoni*). Efforts are underway to initiate similar ecotourism programs in Bhutan, Mongolia and Russia.

9.8. Education and awareness-raising

Initiatives have been, or are being, implemented in virtually all range countries; these range from the production of educational tool-kits for teachers, children and the general public (e.g. books and posters) to specific classroom and outdoor activities aimed at sensitizing urban and rural school children to conservation issues, including biodiversity and sustainable development. For example, in Nepal and India, a series of reading booklets about snow leopards and their role in the environment have been produced in both English and local languages including Tibetan Braille. Youth clubs have been formed to help teachers implement educational and awareness activities. In Nepal's Annapurna Conservation Area Project, youths known as Snow Leopard Scouts work with local herders to assist biologists deploy remote trail cameras for monitoring snow leopards.

9.9. Capacity building

Significant funding has been expended on this by donor governments, multilateral agencies, and several international NGOs, with the primary recipients governmental and NGO workers and protected areas. NGOs in particular have invested heavily in training of personnel, protected area management planning, and provision of vehicles, horses and essential equipment for protected area staff in many range countries from Afghanistan to Tajikistan. Training has covered community development and livelihoods enhancement, human-wildlife conflict resolution, field survey techniques, monitoring, camera-trapping, among other activities. However, community members have often been overlooked at the governmental policy level when it comes to community empowerment and replacing top-down dictates with participatory capacity building and planning The Global Snow Leopard & Ecosystem Protection Plan prepared by the World Bank, NGO's, other partner organizations and range state governments places local communities as key stewards for implementing many of the recommended actions (see the individual National Snow Leopard Ecosystem Priorities or NSLEP documents and the Global Snow Leopard Ecosystem Protection Program (GSLEP: http://www.akilbirs.com/files/final_gslep_web_11_%2014_%2013.pdf).

9.10. The challenge

Scaling-up these and related actions is the most important challenge facing snow leopard conservationists. Initiatives to date have been heavily subsidized, limited to relatively small areas, and supported over the short-term. Project transaction costs and human resources are high, since developing the necessary skills for undertaking relatively complex, competitive market-based enterprises like handicrafts production, traditional homestays, and nature guiding is time-consuming. Creating a self-sustaining market for such goods or services, and implementing monitoring activities for ensuring compliance with species or general biodiversity conservation goals adds to costs. Finally donors often 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 (Jackson et al. 2010).

At the October 2013 Global Snow Leopard Forum in Bishkek, Kyrgyzstan, all 12 snow leopard states agreed, with support from interested organizations, to work together to identify and secure at least 20 snow leopard landscapes across snow leopard range by the Year 2020. The success of GSLEP implementation will depend upon scaling up known and tested key actions and good practices, which will require incremental domestic and external financing of about $150-250 million over the first 7 years of the program, subject to additional cost harmonization. In turn, this hinges upon the ability of the World Bank, major multilateral partners like GEF and UNDP, and NGOs and governments to bring in, allocate and/or leverage enabling funding. Undoubtedly, the range country governments have high expectations that external funding will be made available.

As the GSLEP notes (page viii), "*Good practices that have proven successful in one or more range countries are being scaled-up in those countries or emulated in others. For example, programs to increase community participation in conservation, improve livelihoods, and address human-wildlife conflict have been tested in China, Nepal, India, Pakistan, and Russia with very promising results including reductions in poaching of snow leopards and increased willingness to co-exist with the predators. Creation of anti-poaching teams and stiff penalties for poaching have also proven effective in Kyrgyz Republic, Russia, Kazakhstan, and Mongolia. Establishment of PAs has brought significant areas under protection in Bhutan, China, Tajikistan, India, and many countries plan to create new PAs or strengthen their existing PA system. Effective scientific monitoring programs are being conducted in Afghanistan, China, Kazakhstan, Mongolia, Kyrgyz Republic, and Russia and their methods can be applied, with adaptation as necessary. In other areas, such as engaging industry, capacity building and policy enhancement, and building awareness, successful models are available from other parts of developing and developed world*."

9.11. Legal status

Snow leopards have been included in Appendix I of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) since 1975, and hence all international commercial trade in the species, its parts and derivatives is prohibited. Kyrgyzstan became a Party to CITES in 2007 leaving Tajikistan as the only range state not currently a party to CITES but with discussions underway to complete the process (see Table 13.1). In general, implementation and enforcement of the Convention's provision varies in the different countries and is, in many cases, insufficient. In fact, none of the countries have been reporting illegal trade issues concerning snow leopards as they are obliged to do under CITES Resolution Conf. 12.5 on Asian Cats.

The species has been listed in Appendix I of the Convention on Migratory Species of Wild Animals (CMS) since 1985. Six of the twelve snow leopard range states are party to CMS (Table 13.1). With regard to species listed in Appendix I, Parties to the Convention are requested to i) conserve and restore the habitat of the species, ii) prevent, remove, compensate or minimize adverse effects of activities or obstacles that seriously impede their migration, and iii) prevent, reduce or control factors that are endangering or are likely to further endanger the species. In addition, the Convention requests Parties to prohibit the harvest or taking of animals belonging to such species. At the 7th Conference of the Parties to CMS the snow leopard attained the status of a 'concerted action species', for which cooperative activities such as the development of a CMS Agreement must be carried out between the concerned Parties (CMS 2002). The CMS Central Asian Mammals Initiative (CAMI) addresses the conservation of 15 species including snow leopard and one of its prey species, argali. A CAMI program of work will be proposed for adoption at the 11th CMS Conference of the Parties in November 2014.

<u>National Level</u>:

Snow leopards are legally protected in all range countries. However, legislation may not always be fully effective for several reasons, such as penalties being too low to function as deterrents, weak enforcement, or because laws and legal procedures contain significant loopholes. The economic and political situations present in many of the snow leopard range countries also negatively affect law enforcement activities to varying degrees. Wildlife rangers and enforcement personnel are often poorly equipped and live on extremely low wages. In addition, corruption appears to be a common factor in a number of snow leopard range states and plays a considerable role in the inability of some range states to tackle wildlife crime effectively (Anon. 2003).

Table 9.1: Snow Leopard range countries states and participation in Multilateral Environmental Agreements.

Country	CITES	Date of entry into force	NLP category	CMS	Date of entry into force
Afghanistan	Yes	Jan 1986	3	No	
Bhutan	Yes	Nov 2002		No	
China	Yes	Apr 1981	2	No	
India	Yes	Oct 1976	2	Yes	Nov 1983
Kazakhstan	Yes	Jan 2000		Yes	May 2006
Kyrgyzstan	Yes	Sep 2007		Yes	May 2014
Mongolia	Yes	Apr 1996	3	Yes	Nov 1999
Nepal	Yes	Sep 1975	3	No	
Pakistan	Yes	Jul 1976	3	Yes	Dec 1987
Russia	Yes	Jan 1992	2	No	
Tajikistan	No	-		Yes	Feb 2001
Uzbekistan	Yes	Oct 1997	3	Yes	Sep 1998

Afghanistan

In 2009, Afghanistan declared its list of protected species (NEPA 2012), which includes the snow leopard, banning all hunting or harvest of the species. The list is to be reviewed every five years by a panel of experts.

Bhutan

Hunting of snow leopards is prohibited through the Forest and Nature Conservation Act 1995. Killing of a snow leopard can result in a fine of BTN 15,000 (approx. USD 309), which is among the highest fines for killing an animal in Bhutan and approximately twice the annual income of a wildlife warden).

China

The Wildlife Animal Protection Law (WAPL) of the People’s Republic of China (1989) and the Enforcement Regulations for the Protection of Terrestrial Wildlife of the People’s Republic of China (1992) are the two principal laws providing full protection to snow leopard in China. Snow leopard is listed as Class I protected species under WAPL, which means hunting and trade in their products are criminal offences, although permits may be granted for special purposes such as scientific research, domestication, breeding, or exhibition (O’Connell-Rodwell and Parry-Jones, 2002). The Criminal Law, last amended in 1997, provides severe penalties for unlawful taking, killing transporting, purchase or sale of State protected animal species including the snow leopard. Provinces can adopt their own protection regulations which can be more stringent (but not less) than the national legislation.

India

Protected in India under the National Wildlife (Protection) Act of 1972 as well as under the Jammu and Kashmir Wildlife (Protection) Act of 1978, and is listed in Schedule I of both Acts. In 1986, the National Wildlife (Protection) Act was amended through the inclusion of a new chapter that prohibited the trade in all Scheduled species. After this amendment the maximum penalty for offences against animals listed in Schedule I of this Act is seven years imprisonment and a fine of INR 25,000 (approx. USD 408.83 as of current exchange rate, August 5, 2014). However, as the Jammu and Kashmir Wildlife (Protection) Act was not amended until 2002, the punishment under the latter remained as maximum imprisonment of six years and a maximum fine of INR 2,000 (approx. USD 32.71). Trade in snow leopard skins continued in Jammu and Kashmir until the end of the 1990s, due to loopholes in the legislation and a long pending court case in the Supreme Court of India against the general ban on trade in any part derived from protected Scheduled species (Panjwani, 1997). Following the most recent amendment of the Wildlife Protection Act of Jammu and Kashmir in 2002, similar to the national Act, all trade in parts of scheduled (Schedule 1,2,3) animals is considered illegal and the maximum penalties are the same as under the national Wildlife Protection Act.

Kazakhstan

Protected under the Law on Protection, Reproduction and Use of the Animal World of July 2004 wherein hunting, possession and sale of species listed as rare and endangered are prohibited.

Kyrgyzstan

Hunting, possession and trade of snow leopard are prohibited in Kyrgyzstan through the Law on the Animal World (1999). Hunting of snow leopards has been prohibited since 1948, and the species was listed in the national Red Data Book of the Kyrgyz SSR since 1985. The snow leopard is listed as “critically endangered” in the second edition of the Red Book of the Kyrgyz Republic (2006). Species listed in the Red Book are generally protected, but can be taken from nature based on special decisions by the government.

Mongolia

In 1972, the snow leopard was listed in the Mongolian Red Data Book as ‘very rare’ and hunting is prohibited since then. However, sport hunting of the species was legal until 1992. The new Hunting Law of 1995 prohibits the hunting, trapping, or selling of snow leopard hides and any other part. However, until April 2000 there was no legal restriction on purchasing, owning, or possessing of snow leopard parts. After strong lobbying activities by several national conservation NGOs, the Hunting Law of 1995 was revised and a new Law of Fauna (2000) was enacted. This law specifically prohibits the sale or purchase of any snow leopard part. In addition, the law includes provisions to provide ‘whistle-blowers’ with 15% of the total fines paid by the offender. The government of Mongolia passed a resolution (# 23) in 2011 to update the ecological-economic value of wildlife. The snow leopard was valued at MNT 11,200,000 (USD 7,466) for a male and 13,000,000 (USD 8,666) for a female. Amongst prey species, the ibex was valued MNT 2,700,000 (USD 1,800) for male, and MNT 3,100,000 (USD 2,066) for females, while argali at MNT 11,000,000 (USD 7,333) for male and

12,000,000 (USD 8,000) for females. The penalty for killing these species is twice the economic value of the species. Special permission to kill endangered species including the snow leopard can be granted for the purpose of scientific research. An attempt to exploit this provision was made in 2010 to initiate a hunting program, but permission was subsequently cancelled by the government following objections by Mongolian conservationists and the Snow Leopard Network.

Nepal

Fully protected in Nepal under the National Parks and Wildlife Conservation (NPWC) Act 2029 since 1973. Under the Fourth Amendment of the Act it is illegal to hunt, acquire, buy or sell snow leopard parts such as its skin, and the penalties for persons convicted of such offences can be up to NRS 100,000 (approx. USD 1,300), or 5-15 years in prison. Nepal has also established 'whistle-blower' regulations.

Pakistan

The snow leopard is protected in Pakistan, where wildlife management and protection are provincial subjects, and therefore, federal level wildlife legislation is not deemed necessary. However, the restrictions and obligations under CITES are managed by the federal government. Snow leopard is legally protected in Khyber Pakhtunkhwa (KPK), Gilgit Baltistan (GB) and Azad Jammu and Kashmir (AJK) through provincial wildlife legislation. The NWFP (former name of KPK) Wildlife (Protection, Preservation, Conservation and Management) Act, 1975, for example, prohibits the hunting, capturing and killing of any 'protected animal'. Section 14 of the Act specifically refers to trade and prohibits the trade and/or sale in snow leopard, their trophies and meat (Khan, 2002). The maximum fine for violation of the Act is two years of imprisonment and/or a fine of one thousand PKR (approx. USD 10). The Azad Jammu and Kashmir, Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 2012, includes snow leopard in its Third Schedule (Protected Animals; i.e. animals which shall not be hunted, killed or captured). In Gilgit-Baltistan, snow leopards are protected through the Northern Areas (former name of GB) Wildlife Conservation Act, 1975. However, there is a provision under section 22 of the Act that sanctions the eradication of so-called "problem animals". Under this provision a designated official of the wildlife department or a private individual can eradicate an animal that threatens private property or human life. In cases where an animal inflicts damage to property, however, such as by killing of livestock, there is no mechanism for compensation to the affected individual (Hussain, 2003).

Russia

At the federal level three main laws apply to snow leopard protection: the Law of Environment Conservation, the Law on the Animal World (Fauna) No 52 of March 1995 and the Law on Specially Protected Natural Areas No 33 of 14 March 1995. The snow leopard is also included in the Red List of the Russian Federation and the Law of the Animal World makes special reference to species listed in the Red Data Book. The maximum penalty that can be imposed for the killing, illegal possession, or trade under paragraph 258 of the Criminal Code is up to 2 years of imprisonment. However, enforcement of this legislation is limited.

Tajikistan

Listed in the Red Book of the Tajik SSR in 1988. Species listed in the Red Book are protected under the Law on Environmental Protection (2011) and the Law on the Animal World (2008). The maximum fine for the illegal killing of a snow leopard is ten months of the minimum wage.

Uzbekistan

The snow leopard is protected in Uzbekistan under the Law on Nature Protection of January 1993 and its hunting, possession and sale are prohibited. It is also included in the Red Data Book of Uzbekistan. The maximum fine for violations of the Law on Nature Protection is 50 times the minimum wage of the offender or 2 years imprisonment.

9.12. Country Strategies and Action Plans

Nine range countries have developed official Snow Leopard Action Plans or Strategies. Some of these plans have been officially approved, while are still awaiting formal endorsement. These country-specific plans are available in the online library of the Snow Leopard Network.

In 2012-2013, in the run-up to the Global Snow Leopard Forum in Bishkek, all range countries followed a standard format to develop their respective National Snow Leopard Ecosystem Protection Priorities (NSLEP) in a coordinated exercise. These are summarized in the Global Snow Leopard Ecosystem Protection Priorities (GSLEP) document (reference above).

India

The National planning process was initiated in 2005 by the Nature Conservation Foundation and Snow Leopard Trust, and the final strategy, called Project Snow Leopard, was approved by the government in 2009. (http://www.snowleopardnetwork.org/actionplans/India_PSL.pdf)

Kazakhstan

The national plan drafting was assisted by the Snow Leopard Fund, Kazakhstan, and was completed in 2011. It has been approved by the Scientific Technical Council of the Forest and Hunting Committee of the Ministry of Agriculture.
http://www.snowleopardnetwork.org/actionplans/Kazakhstan_SLAP_2013.pdf)

Kyrgyzstan

The drafting process was initiated in 2012, assisted by FFI. The final version of the national plan was approved by the Prime Minister in August 2013 but has not yet been published.

Mongolia

The Mongolian Snow Leopard Conservation Plan was developed in 1999. The National Snow leopard Policy was approved by Mongolian Parliament in 2005. In 2008, snow leopard experts who participated in Beijing conference on “Range-wide Conservation Planning for Snow Leopards” suggested “10 year action plan for Mongolia” to the Government of Mongolia to build on previously approved plan of National Snow Leopard Policy. Although accepted and signed by all partners, the plan must be discussed and approved at the National Endangered Species Commission before it can be recognized as official policy.

Nepal

A Snow Leopard Conservation Action Plan was drafted for the Department of National Parks and Wildlife Conservation – Ministry of Forests and Soil Conservation of the Government of Nepal, in collaboration with WWF Nepal Program and King Mahendra Trust for Nature Conservation. It was submitted to the Government and is awaiting endorsement. (http://www.snowleopardnetwork.org/actionplans/Nepal_SLAP_2013.pdf)

Pakistan

Government agencies, conservation NGOs, and other stakeholders met in spring 2001 to develop a Strategic Plan for the Conservation of Snow Leopards in Pakistan. The planning process was led by WWF- Pakistan. The strategic plan was endorsed by the Federal Ministry of Environment in 2008. However, its recommendations were not implemented, and it has been recently revised and updated in the form of the country's NSLEP for the Global Snow Leopard Forum, through a process facilitated by the Climate Change Division, Government of Pakistan. (http://www.snowleopardnetwork.org/actionplans/pakistan.pdf)

Russia

A Strategy for Conservation of the Snow Leopard in the Russian Federation was developed by a working group comprising representatives of the Ministry of Natural Resources of the Russian Federation, representatives of state and environmental authorities of the republics Altai, Khakasia, Tyva, Krasnoyarsk region, Commission on Large Carnivores of the Theriological Society of the Russian Academy of Sciences and WWF Russia. The strategy was approved by the Conservation of Biodiversity Section of the Scientific Technical Council of the Ministry of Natural Resources of the Russian Federation. It was also approved by the Ministry of Natural Resources of the Russian Federation in December 2001. The strategy was updated in 2012. (http://www.snowleopardnetwork.org/sln/ActionPlans.php)

Tajikistan

The National snow leopard planning process, led by the Institute of Zoology and Parasitology of the Academy of Sciences of Tajikistan, aided by FFI and Panthera was initiated in 2010. The draft plan is awaiting final approval by the government.

Uzbekistan A National Action Plan for the period 2005–2010 was developed in 2004 and approved jointly at a roundtable attended by the State Committee of Nature Protection of the Uzbekistan Republic, Ministry of Agriculture and Water Management of Uzbekistan Republic, Uzbekistan Zoological Society, Institute of Zoology of Academy of Science of Uzbekistan Republic, National University, Chatkal Biosphere, Hissar Nature Reserves, Ugam-Chatkal National Park, and others. (http://www.snowleopardnetwork.org/actionplans/uzbekistan.pdf)

9.13. Implementing conservation measures

The effectiveness of conservation measures depends in large part upon correctly identifying the main underlying threats, then designing and implementing tightly targeted interventions that are most likely to reduce threat severity, including bringing about fundamental changes in human attitudes and behavior toward this large predator. The following paragraphs outline the main elements for adopting, refining and implementing conservation measures, based upon the collective experience of SLN members working across snow leopard range over the past few decades.

While many conservation actions require significant investment of resources and time to have the desired effect, the most successful and self-sustaining projects are those which:

- Empower local people to adopt responsible actions supporting sustainable livelihood development while also protecting the environment, particularly snow leopards, their prey and habitat
- Focus people's attention on finding positive solutions rather than concentrating on problems or past failures
- Ensure full and equitable participation of all major stakeholders (from the beginning through each stage of project planning, implementation, monitoring and evaluation). Identify and establish local mechanisms (financial and governance) for helping implement interventions and activities that are agreed upon
- Clearly and transparently articulate the roles, obligations and responsibilities expected of each stakeholder group (local people, government, NGOs etc.)
- Encourage leadership by entrepreneurial individuals and create or strengthen village associations responsible for implementation
- Provide a balanced set of incentives and disincentives which target the major threat(s) to snow leopards, their prey and habitat
- Establish pilot projects and grassroots initiatives which serve as examples for other stakeholders and communities to adopt (a process that can be facilitated through community-to-community, NGO and government practitioner workshops, and exchanges or field study tours)
- Provide the desired level of government and/or donor support over the medium or long-term rather than only for the short-term (3 years or less)
- Recognize that "one solution does not fit all." Rather, interventions must be crafted to fit the particular conditions at hand

Attitudes, interests and motivations vary widely, as do livelihood opportunities, economic conditions, and access to markets or natural resources. Gender and age have a major influence on labor allocation and responsibilities. Therefore, efforts at biodiversity conservation must target each gender strategically if the primary objective involves catalyzing long-term change in behavior and resource harvesting practices.

There are several different strategies for engaging communities in conservation and development initiatives. Appreciative Participatory Planning and Action (APPA) has proven to be among the more effective in some social economic, cultural and political contexts. APPA combines the framework of Appreciative Inquiry with tools from Participatory Learning and Action arena. APPA was pioneered by The Mountain Institute (www.mountain.org/tmi/appa.cfm) and its partners. Participatory Rural Appraisal/Assessment (PRA) and Rapid Rural Assessment (RRA) are very similar, and include a range of participatory techniques and tools that enable stakeholders to analyze their problems and then plan, implement and evaluate agreed-upon solutions. Analyses by outside agents should be balanced with participatory input by the main players from within the targeted community.

Li et al. (2013) point to the importance of Tibetan Buddhism among local people over much of snow leopard range, and highlight the potential role of the Buddhist Monasteries as partners in implementing snow leopard conservation strategies.

9.14. Importance of project monitoring

The selection of suitable indicators for monitoring is crucial in achieving successful and sustained conservation outputs. Indicators need to be:

- Time-bound and meaningful for the spatial and temporal scales under consideration
- Measurable and specific with the values varying proportionately in response to change from the baseline conditions
- Verifiable and consistently applied by different persons over the life of the project
- Appropriate in terms of scale, available resources, and cultural context
- Logistically and economically feasible

Process indicators include e.g. example number of families involved, extent of livelihood degeneration, and the extent of threats reduction.

Monitoring should be undertaken by the project's beneficiaries as well as its sponsors (government, NGOs, INGOs etc.) in the interest of cementing project ownership and encouraging the sharing of information and new knowledge. The lessons learned are a vital component of Adaptive Project Management which enables communities and their conservation practitioners to periodically make necessary changes leading to more effective and efficient project outputs.

9.15. Resources

The manual titled "*Measures of Success*" by Richard Margolius and Nick Salafsky (1998) offers a useful guide to designing, managing and implementing conservation and development projects based on the threat-alleviation model. For information on Participatory Rural Appraisal (PRA) and using their related tools, we suggest the following handbooks (though there are many other handbook, numerous scientific and popular articles on the subject, as any internet search will show):

Ashford, G. and Patkar, S. (2001). *The Positive Path: Using Appreciative Inquiry in Rural Indian Communities* (International Institute for Sustainable Development / Myrada, Winnipeg, Canada). http://myrada.org/myrada/docs/ai_the_postive_path.pdf

Margoluis, R. and Salafsky, N. (1998). *Measures of Success*: designing, managing, and monitoring conservation and development projects. Island Press, Washington DC. 362 pages.

Pretty, J.N., Guijt, I., Scoones, I. and Thompson, J. (1995). *A Trainer's Guide for Participatory Learning and Action*. IIED Participatory Methodology Series, International Institute for Environment and Development, London, 267 pages.

9.16. Recommendations

Table 9.2 summarizes conservation interventions and activities, comparing them with respect to their relative cost, technical and logistical complexity, potential pitfalls and monitoring needs (from Jackson et al. 2010). Recommended actions on ecotourism, handicrafts and education / awareness are detailed in Tables 9.3. to 9.5 below. Actions to address other threats are included in preceding chapters. Actions should all be implemented in conjunction with other planning documents endorsed by range states including the respective National Environmental Protection Plans (NSLEPs) and the overarching Global Snow Leopard Environmental Protection Plan (GSLEP).

Table 9.2: Summary of Conservation Interventions: guidelines and comparisons (Source: Jackson et al. 2010)

Conservation Action	Key Activities	Cost, Technical & Logistical Factors	Potential Pitfalls	Monitoring Needs
Grazing Management	Promote grazing practices that reduce impacts on wildlife	Low cost (excluding set-aside payments); Moderate technical requirement	• Determining existing grazing patterns or land tenure disputes • Grazing plans designed without input from community likely to fail	• Pasture quality & indicators developed by local herders • Numbers & productivity of wild & domestic ungulates for grazing plan compliance
Wildlife-based ecotourism	Establish tourism that provides financial benefits to local people & creates incentives to protect natural resources	Moderate – high (may require substantial skills training & infrastructure development; marketing critical)	• Political instability, security & health issues of importance to clientele • Viewable wildlife often wary of humans • Short season & leakage of revenue • Financial benefits not equitably distributed • Maintenance of prices & servicing standards may be difficult to achieve	• Numbers & trends of wildlife • Quality of tourist attractions • Level of economic benefit of eco-tourism to local people • Local attitudes toward wildlife & tourists • Strong incentives for compliance
Cottage industry	Provide income to residents of snow leopard habitat through handicraft sales linked with wildlife conservation	Moderate to high cost (getting products to high value markets, skills training, maintaining standards & marketing outreach)	• Semi-skilled artisans (products may not consistently meet market standards) • Strong international competition • Inconsistent participation after training investment • Market saturation requires continued new or unique product development	• Numbers & trends of wildlife for anti-poaching compliance • Other indicators determined collaboratively by community (compliance incentives) • Number of participants benefiting • Financial impact at household & community levels • Public attitudes to snow leopards
Community managed prey species trophy hunting	Establish sustainable trophy hunting to provide return to local people as an incentive to protect ungulates & snow leopards	Moderate (externally-driven planning & decision-making; high technical demands)	• Corruption at national & local level • Lack of awareness of law among foreign outfitters / clientele • Insufficient hunting fee revenues reach local level (lack of incentive to protect) • Poor monitoring of trophy species • Perverse incentive to persecute snow leopards	• Numbers & trends of wildlife • Harvest statistics (hunting effort, trophy size, etc.) • Numbers of local people or communities gaining benefit • Financial impact at household / community levels

Animal husbandry	Provide training in animal husbandry & veterinary care to improve monetary return at lower stock levels or to offset depredation costs	Low to moderate (linked with government veterinary extension capacity)	• Long-term commitment of community, government or NGO may be difficult to maintain • Low skill level for effective veterinary training program • Limited acceptance of fewer high-quality animals versus large unproductive herds	• Numbers of livestock & financial returns • Livestock health, incidences disease & other mortality • Stocking density & carrying capacity of pastures • Attitudes toward depredation / predators
Livestock insurance	Establish locally managed subscription-based insurance scheme to off-set depredation economic losses	Moderate over long-term but potential high start-up costs	• Initial investment into capital fund can be high • Validation of claims can be difficult & contentious • Fails to address root cause of depredation	• Numbers of livestock & financial returns • Livestock health, incidences of depredation. • Attitudes toward depredation & targeted predator species
Education outreach	Raise public awareness for snow leopard conservation	Low to moderate (hinges on collaboration with local school teachers & education departments)	• Low levels of education and literacy • Linguistic, cultural or ethnicity barriers • Limited capacity of education system • Dissemination in remote areas difficult	• Baseline surveys to determine current levels of awareness • Monitoring to evaluate program effectiveness
Applied Research	Investigate snow leopard & prey ecology, behavior, etc., including ecosystem & landscape dynamics	Moderate to high (dependent upon outside researchers & institutions)	• Research topics often not of interest to PA managers • Tendency to exclude communities from research (i.e. information “mining” only)	• Ensure project targets priority topics & management issues • Dissemination to general public & decision-makers

Table 9.3. Wildlife tourism – Suggested Action Guidelines

	Policy – Government level	Community level
Steps	• Educate decision makers about benefits & pitfalls of ecotourism • Integrate with national or international responsible tourism campaigns • Seek funding for rural tourism development • Explore "wildlife valuation" funding mechanisms	• Determine stakeholder groups • Assess local capacity to provide services such as guiding, pack animal rental, campsites, homestays, teahouses, handicrafts sales, etc. • Determine training needs and sources • Develop wildlife tourism plan and marketing strategy which allows for equitable & transparent benefit distribution, and is market-sensitive • Identify actions to be taken to benefit wildlife, local environment & community (e.g., conservation fund, grazing land set-
Stakeholders:	• Local, regional, national government agencies, including national planning & finance • NGOs, INGOs	• Local communities • Tour operators and travel agencies • NGOs, CBOs (community-based organizations)
Potential Pitfalls:	• Relatively low abundance and visibility of wildlife (compared to e.g. East Africa) • Remoteness & logistical constraints & costs • Market saturation & competition with easier-to-see species – all of snow leopard range cannot be a tourist destination • Inequitable distribution of financial benefits of tourism may lead to resentment & internal friction in communities • Failure to implicitly link conservation and business objectives • May expose remote snow leopard area to international poachers	
Monitoring Protocols/Success Indicators	Biological: • Numbers, trends and productivity of wild ungulates • Minimum number snow leopards, frequency of sightings, sign density • Quality of pastures & wildlife habitat Socio-economic: • Level of economic benefit to local people • Local attitudes toward wildlife and tourists by community • Involvement and co-financing provided by travel agents & other providers • Tourist awareness of local conservation & cultural issues • Visitor satisfaction surveys	
Education/Public Awareness:	• Publicize examples of best practice conservation linked wildlife-tourism at the level of policy	• Publicize examples of best practice • Promote ecofriendly business partners • Publicize successes, biological and economic

Resources:

Berkes F, Colding J., and Folke , C. (2000). Rediscovery of traditional knowledge as adaptive management. *Ecological Applications*, 10, 1251-1262.

Dickman, A.J., Macdonald, E.A. and Macdonald, D.W. (2011). A review of financial instruments to pay for predator conservation and encourage human–carnivore coexistence. *PNAS* , 108 (34), 13937-13944.

Eagles, PJ., McCool, S.F. and Haynes, C.D. (2002). Sustainable tourism in PAs: guidelines for planning and management. Best Practices PA Guidelines Series No 8, A. Phillips, Series Editor. IUCN-The World Conservation Union, 183 pages.

Jain, N and Triraganon, R. (2003). Community-based tourism for conservation and development: a training manual. The Mountain Institute, RECOFTC, 188 pages.

Lama, W.B., Jackson, R and Wangchuk, R. (2012. Snow Leopards and Himalayan Homestays: catalysts for community-based conservation in Ladakh. In: *Mountain Biodiversity Conservation and Management*: selected examples of good practices and lessons learned from the Hindu Kush Himalayan Region.

Chettri, N., Sherchan, U., Chaudhary, S. and Shakya , B. (Eds). Working Paper 2012/2. International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Lindberg, K., and Hawkins, D.E. (Eds). (1999). *Ecotourism: a guide for planners and managers* (2 volumes). The Ecotourism Society, Washington DC.

Mishra, C., Bagchi, S., Namgail, T and Bhatnagar, YV. (2009). Multiple use of Trans-Himalayan rangelands: reconciling human livelihoods with wildlife conservation. Pages. 291-311 In: *Wild rangelands: Conserving wildlife while maintaining livestock in semi-arid ecosystems*. (Eds.) J. du Toit, R. Kock, and J. Deutsch. Blackwell Publishing, London.

Sandbrook, C.G. (2010). Local economic impact of different forms of nature-based tourism. *Conservation Letters*, 3(1), 21–28.

Tresilian, D. (2006). *Poverty alleviation and community-based tourism: Experiences from Central and South Asia.* UNESCO, Paris, 100 pages.

Websites:

The International Ecotourism Society (TIES): NGO dedicated to promoting ecotourism, through annual conferences and support for guidelines and standards, training, technical assistance, and educational resources. TIES' global network of ecotourism professionals and travelers is leading the efforts to make tourism a viable tool for conservation, protection of bio-cultural diversity, and sustainable community development. http://www.ecotourism.org/

World Tourism Organization (UNWTO): the United Nations agency responsible for promoting responsible, sustainable and universally accessible tourism. Provides information on tourism policy, practical sources of know-how and marketing information. UNWTO is committed to the United Nations Millennium Development Goals (MDGs) and helping reducing poverty and foster sustainable development. http://www2.unwto.org/

Cottage handicrafts

Research required prior to taking action:

- Assess the nature and extent of the conservation threat and actions required
- Assess target community income generation needs and opportunities
- Conduct biological baseline survey to enable impact monitoring
- Incentives, bonus payments and contractual arrangements for compliance, including willingness of community to deter members or non-members who break compliance agreement and wildlife protection rules

Table 9.4. Cottage Industry - Suggested Action Guidelines

	Policy- Government level	Community level
Steps	• Gain government recognition of need and importance of community generated conservation contracts • Gain local governments and/or PA administration support in development of conservation contracts • Establish communications channel for reporting contract violations • Foster government – community collaboration in monitoring compliance & project outcomes • Help secure technical assistance, including NGO support for product development, skills training, marketing & snow leopard friendly product endorsement • Conduct ongoing independent scientific monitoring for relevant biological indicators and to ensure contract compliance	Contract – Compliance development: • Identify stakeholders (especially entrepreneurial individuals) • Define conservation actions the community will commit to in exchange for livelihood skills training with income generation opportunities • Prepare conservation contract with explicit conservation and business commitments • Establish incentive structure (e.g., bonus payment) • Develop monitoring and success indicators Handicraft Products Development: • Evaluate skills, capacity, and training needs • Determine demand, profit potential, development & management / accounting needs • Develop business plan and product distribution strategy
Stakeholders:	• PA administration and wildlife conservation agencies • National planning & finance departments • NGOs, private business sector • Micro-credit agencies	• Local communities particularly in buffer zones of Pas • Local businesses and traders

Potential Pitfalls:	• High logistical costs due to remoteness and difficulty of access • High development and transaction costs for internationally marketed products (demand for new products and designs) • Time constraints imposed by climate and production cycles • Consistently meeting quality expectations of broad market; shortage of skilled artisans • Pressure on natural resources if materials used are in short supply or are overharvested • Failure to implicitly and explicitly link conservation and business objectives
Monitoring Protocols/Success Indicator	Biological: • Numbers, trends and productivity of wild ungulates if appropriate • Minimum number snow leopards, frequency of sightings, sign density • Other indicators as determined by community and conservationists Socio-economic • Numbers of local people gaining benefit • Financial impact at household and community levels • Public attitudes to snow leopards
Education/Public Awareness:	• Publicize examples of best practice conservation linked income generation • Publicize success indicators, both biological and socio-economic • Promote snow leopard friendly community livelihoods and enterprises

Resources:

Cattermoul, B., Townsley, P., and Campbell, J. (2008). Sustainable livelihoods enhancement and diversification (SLED): a manual for practitioners. IUCN and IMM. Ltd., 85 pages. Available for download from: http://www.icran.org/pdf/SLED%20Manual%20Final%20-%20Low%20Res.pdf

Koontz, A. (2008). *The Conservation marketing equation: a manual for conservation and development professionals*. USAID & EnterpriseWorks/VITA, 35 pages.

Mishra C., Allen P., McCarthy T.M., Madhusudan, M.D., Bayarjargal , A. and Prins H.H.T. (2003). The role of incentive programs in conserving the snow leopard (*Uncia uncia*.) *Conservation Biology*, 17, 1512-1523

SNV (Nepal). (2004). Developing sustainable communities: a toolkit for development practitioners. Kathmandu, Nepal, 209 pages. Available from: http://www.icimod.org/publications/index.php/search/publication/51

WebSites: IFAD's Sustainable Livelihoods Approach webpage: http://www.ifad.org/sla/index.htm

- International Institute for Sustainable Development (Community Adaptation and Sustainable Livelihoods): http://www.iisd.org/casl/CASLGuide/MethodsMenu.htm

• ELAN -Ecosystems and Livelihoods Adaptation Network

http://www.elanadapt.net/ecosystems-and-livelihoods-adaptation

Conservation Education and Awareness

Research required prior to taking action:

- Current attitudes or level of understanding of specific issue among the target audience
- Level of education, literacy, cultural factors influencing the choice of appropriate media

Table 9.5: Conservation Education and Awareness – Suggested Action Guidelines

	Policy level	Community level
Steps	• Integrate conservation education into national curriculum • Prepare education campaign for law enforcement officers • Integrate departments into awareness campaigns	• Identify local “coordinators” of conservation education, provide training • Identify key issues in target area • Identify target audience(s) and establish awareness baseline • Determine the message to be delivered and most appropriate media for conveying the message • Develop and disseminate educational materials • Conduct monitoring assessments (before and after)
Stakeholders & Potential Audiences:	• Government officials • Law enforcement officials • PA staff • Development agency staff • Policy makers & public media	• Livestock herders • Hunters and poachers • Women and young people • Community elders and school teachers
Potential Pitfalls:	• Low levels of education and literacy • Rigid school curricula, often lacking in relevant or up-to-date materials • Lack of, or insufficient teachers skilled in teaching participatory techniques • Linguistic and cultural barriers between different groups • Limited capacity & infrastructure of education systems (logistical constraints in remote sites) • Financial sustainability of any education campaign is difficult to maintain	
Success indicators	• Change in attitudes and behavior • Level of knowledge of wildlife in target audience	
Education/public awareness	• Disseminate lessons learned regarding successful strategies • Promote hands-on education, such as nature clubs	

Resources:

Braus, J.A .and Wood, D. (1993). *Environmental education in the schools – creating a program that works!* Peace Corps Information Collection and Exchange, North American Association for Environmental Education.

Hart, R.A. (1997). *Children's participation: the theory and practice of involving young citizens in community development and environmental care*. UNICEF and EarthScan, London. 208 pages

Jacob, S. and Skelton, L. (2009). *Engaging students in conservation: protecting the endangered snow leopard*. Available from Facing the Future and Snow Leopard Trust, Seattle, Washington (targets Grades 5-8 in US schools).

Jacobson, S.K., McDuff, M.D. and Monroe, M.C. (2006). *Conservation education and outreach techniques*. Oxford University Press, Techniques in Ecology and Conservation Series, Oxford. 480 pages.

Websites

North American Association for Environmental Education *(NAAEE):* Advocates excellence in environmental education, targeting professionals, students, and a global networked membership. http://www.naaee.net/

References

Hussain, S. (2000). Protecting the Snow Leopard and Enhancing Farmers' Livelihoods: a Pilot Insurance Scheme in Baltistan. *Mountain Research and Development*, 20, 226-231.

Jackson, R. and 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, R.M., Mishra, C., McCarthy, T.M. and Ale, S.B. (2010). Snow leopards: conflict and conservation. Chapter 18, pages 417-430: *Biology and Conservation of Wild Felids* (D.W. Macdonald and A.J. Loveridge, (Eds), Oxford University Press, UK, 762 pages.

Jackson, R. (2012). Fostering community-based stewardship of wildlife in Central Asia: transforming snow leopards from pests into valued assets, pages 357-380 In: Victor Squires (Ed.*), Rangeland Stewardship in Central Asia: Balancing Improved Livelihoods, Biodiversity Conservation and Land Protection.* DOI 10.1007/978-94-007-5367-915, Springer Science and Business Media, Dordrecht.

Margoluis, R. and Salafsky, N. (1998). *Measures of Success: designing, managing, and monitoring conservation and development projects*. Island Press, Washington DC. 362 pages.

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

Margoluis, R. and Salafsky, N. (undated). *Is Our Project Succeeding? A guide to threat reduction assessment for conservation.* Biodiversity Support Project, Washington DC. 52 pages. Available for download from: www.rmportal.net/library/content/tools/biodiversity-support-program/tra.pdf/download

Ale, S.B, Shrestha, B. and Jackson, R. (2014). On the status of Snow Leopard (*Panthera uncia*) (Schreber, 1775) in Annapurna, Nepal. *Journal of Threatened Tax*, 6, 5534–5543

Lyngdoh, S., Shrotriya, S., Goyal, S.P., Clements, H., Hayward, M.H. and Habib, B. (2014). Prey preferences of the snow leopard (*Panthera uncia*): Regional diet specificity holds global significance for conservation. *PLOSone* 9(2): e88349. doi:10.1371/journal.pone.0088349

McCarthy, T, M., Murray, M., Sharma, K. and Johannson, O. (2010). Preliminary results of a long-term study of snow leopards in South Gobi, Mongolia. *Cat News*, 53, 15-18.

Paltsyn, M.Y., Spitsyn, S.V., Kuksin, A.N., Istomov, S.V. (2012). *Snow leopard conservation in Russia: data for conservation strategy for snow leopard in Russia 2012-2020*. WWF-Russia, Krasnoyarsk, 100 pages.

Rosen, T., Hussain, S., Mohammad, G., Jackson, R., Janecka, J. E., & Michel, S. (2012). Reconciling sustainable development of mountain communities with large carnivore conservation: Lessons from Pakistan. *Mountain Research and Development*, 32(3), 286-293.

Chapter 10: Protected Areas

Protected areas (PAs) are widely regarded as a crucial component of biodiversity conservation and have been shown to harbor higher levels of biodiversity than areas that are unprotected (Millennium Ecosystem Assessment 2005, Gaston *et al*. 2008). Protected areas are defined by IUCN as: *"A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values* (Dudley 2008). IUCN has also been developed a set of categories for PAs, based on their management objectives (see box below).

> IUCN protected area management categories and governance types (Dudley 2008)
>
> *1a Strict nature reserve:* Strictly protected areas set aside for biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values.
>
> *1b Wilderness area:* Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.
>
> *II National park:* Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which also have environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.
>
> *III Natural monument or feature*: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.
>
> *IV Habitat/species management area:* Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category.
>
> *V Protected landscape or seascape:* Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.
>
> *VI Protected areas with sustainable use of natural resources: Areas* which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims

In practice the legal protection given to individual sites and controls on human activities may not be fully enforced and many PAs within Snow Leopard range suffer from a severe lack of resources – human and financial – so legal protection does always not imply effective protection on the ground.

PAs also vary greatly in size and only the largest ones can harbor populations of Snow Leopards and their prey that are viable over the long-term. Nevertheless, protected areas play an essential role in conservation of Snow Leopards and their prey. Outside official networks of legally designated PAs, other types of site are relevant to Snow Leopard conservation, including community-managed areas, conservancies and hunting concessions. The World Database on Protected Areas (WDPA; www.protectedplanet.net) records all officially designated PAs as reported by national governments, together with their IUCN category, if this has been assigned. A number of PAs important for Snow Leopards were mentioned in the country accounts in Chapter2. A full list of all PAs listed on WDPA that are known to harbor Snow Leopards, as well as other sites, such as community reserves and community managed areas is given in Appendix 3. Site names and details follow the official designations on WDPA in most cases.

References

Dudley, N. (Ed.) (2008). *Guidelines for applying IUCN Protected Area Categories*. Gland, Switzerland: IUCN

Gaston, K.J., Jackson, S.F., Cantú-Salazar, L. and Cruz-Piñón, G. (2008) The ecological performance of protected areas. *Annual Review of Ecology, Evolution and Systematics* 39: 93–113.

Millennium Ecosystem Assessment (2005). *Ecosystems and human well-being*. Vol. 5. Washington, DC: Island Press.

Chapter 11: Transboundary Cooperation

11.1. Introduction

Snow leopards are top predators that live in environments with relatively low productivity and have large home range sizes (See Chapter 2 Review of Current Status). Single sites, including most Protected Areas (PAs), are too small to harbour significant snow leopard populations. It is, therefore, essential to design and implement conservation strategies at landscape scales to ensure the long-term persistence of viable populations of snow leopards and their prey (Jackson et al. 2010; see Chapter 1 Introduction). Larger populations are inherently more likely to persist, retain greater genetic variation, and are less vulnerable to the stochastic factors influencing population size and dynamics. Landscape scale planning for intact meta-populations safeguards dispersal corridors between core populations, maintains genetic variation and enhances resilience to climate change.

Political borders rarely coincide with entire ecosystems, and this is particularly true of mountain regions where national boundaries commonly follow ridgelines, where snow leopards and mountain ungulates range on both sides. Indeed, large parts of snow leopard habitat globally lie along international borders. It has been estimated that up to a third of the snow leopard's known or potential range is located on or less than 50-100 km from the international borders of the 12 range countries (Jackson, unpub. data). The need for transboundary cooperation in these cases, and in wider ecosystem initiatives, has always been clear. However, political considerations may inhibit or prevent cooperation from being realized in specific cases.

Delegates to international snow leopard conferences held over the past two decades have advocated transboundary collaboration, including the establishment of transboundary Protected Areas (see Proceedings of Snow Leopard Symposia available online at: http://www.snowleopardnetwork.org/sln/SLBiblio.php). For example, at the 2008 meeting held in Beijing, the delegates called upon range countries to "develop mechanisms (e.g. Memoranda of Understanding) for promoting transboundary cooperation on matters such as trade, research and management relevant to snow leopard conservation that include, *inter alia*, the impacts of climate change on distribution and long-term survival of snow leopards, and where it is possible to incorporate positive actions within conservation programs (e.g. carbon neutral projects)".

Range states endorsed the importance of transboundary collaboration and identified specific measures for implementation through Year 2020 under the country-specific NSLEPs or National Snow Leopard Ecosystem Priority Protection plans presented at the October 2013 Global Snow Leopard Forum held in Bishkek and sponsored by the World Bank (2013) to which readers are referred for details. These documents can be downloaded from: http://en.akilbirs.com/

The World Commission on Protected Areas (2001) published a "Best Practices" manual on PA collaboration. The Transboundary Conservation Specialist Group of the IUCN World Commission on PAs is a potential source of information and advice.

Singh and Jackson (1999) examined the role of transboundary PAs for creating opportunities for conservation and peace using the snow leopard as a flagship species. Transboundary cooperation can be realized in a variety of ways and at different levels: formal international accords (such as CITES and CMS); bilateral or multilateral agreements focused on snow leopards or on ecosystem projects encompassing snow leopards among other species; cooperation and information-sharing among NGOs, scientists, researchers, agencies or PA staff. Transboundary collaboration involving an iconic species like the snow leopard offers a number of advantages to the host countries (IUCN 2001, WCS 2007):

Primary Objectives for Transboundary Collaboration

- Support long-term cooperative conservation of biodiversity, ecosystem services, and natural and cultural values across boundaries
- Promote landscape-level ecosystem management and bio-regional land-use planning
- Build trust, understanding, reconciliation and cooperation between and among countries, communities, agencies and other stakeholders
- Share knowledge on biodiversity and cultural resources, skills and experience, including cooperative research and information management
- Encourage multinational or regional training and surveys

Benefits of Transboundary Collaboration

- Larger, contiguous areas offer safeguards for biodiversity by better protecting more habitats, providing for maintenance of minimum viable populations of many species, and to allow movement and migration, particularly of large carnivores and ungulates
- Where populations of flora or fauna cross a political or administrative boundary, transboundary cooperation promotes ecosystem or bioregional management
- Reintroduction or natural re-colonization of large-ranging species can be facilitated by transboundary cooperation
- Pest species (pathogens, insects) or alien invasive that adversely affect native biodiversity are more easily managed if joint control is exercised
- Poaching and illegal trade across boundaries are better controlled by transboundary cooperation, including joint patrols and border inspections for illegal wildlife
- Improved capacity of government agencies to deliver benefits and provide ecosystem services to local residents as well as downstream populations
- Environmental security, enhanced political and economic collaboration
- Consistency of methodology in monitoring promoted

11.2. Recent Transboundary Initiatives and Current Status of Transboundary PAs:

Several ecosystem-level projects within snow leopard range have been initiated.

The GEF West Tien Shan project (2005-2009) aimed to improve and increase cooperation between five PAs, all of which hold snow leopards: Chatkal State Reserve (Uzbekistan), Sary-Chelek and Besh-Aral SRs (Kyrgyzstan) and Aksu-Djabagly SR (Kazakhstan). The objectives also include strengthening institutional capacity and national policies, supporting regional cooperation, and enhancing income generation within the PAs.

The Tien Shan Ecosystem Development Project, also funded by GEF, was launched in 2009 to support management of PAs and sustainable development in Kazakhstan and Kyrgyzstan. The Pamir-Alai Transboundary Conservation Area project (PATCA) was funded by the EU and examined the option of creating a transboundary PA across the border between Kyrgyzstan and Tajikistan and a biological database was assembled, but no further action was taken, though proposals to establish a PA still exist.

The “Mountains of Northern Tien Shan” project has been developed for the period 2013-2016 with the assistance of the government of the Federal Republic of Germany (FRG) and the German Society for Nature Conservation (NABU). Within the framework of this project it is planned to organize a transboundary PA at the junction of three existing PAs: Chon-Kemin (Kyrgyzstan), Chu-Or NP and Almaty SR (Kazakhstan).

In Kyrgyzstan, the Issyk-Kul Oblast State Administration decided to establish Khan Tengri Natural Park (more than 1870 km^2), in order to implement a Decision of the Parliamentary Committee of the Kyrgyz Republic. This proposed site directly borders the Kazakhstan and the People's Republic of China and links Naryn, Sarychat-Ertash State Reserves and Karakol NP in Kyrgyzstan with Tomur Reserve in Xinjiang, China.

The Altai Sayan Ecoregion Project, which began in 2007, aimed to enhance cooperation on biodiversity conservation between NW Mongolia and Russia in that Ecoregion and snow leopard was one of the focal species. Subsequently, the governments of Russia and Mongolia and Russia and Kazakhstan prepared and signed agreements to establish the Uvs-Nuur and Altai Transboundary Nature Reserves, respectively, in 2011-2012, with WWF-Russia, WWF-Mongolia and the UNDP-GEF Project “Biodiversity Conservation in Altai-Sayan Ecoregion providing a coordinating role. The Altai Transboundary complex consists of the Katunskiy Biosphere Reserve (Zapovednik) (1,516.4 km^2) in the Altai Republic, Russia, and the Katon-Karagaysky National Park (6,435 km^2) in the Eastern Kazakhstan Region. The Uvs-Nuur complex includes the Ubsunurskay Kotlovina Biosphere Reserve (Zapovednik) (3,232 km^2) of the Tuva Republic of Russia and 8 PAs in Mongolia (Tsagaan Shuvuut Uul Strict PA, Uvs Nuur Strict PA, Tesiin gol Nature Reserve, Altan Els Strict PA, Khankhokhii National Park, Khyargas Nuur National Park and Turgen Uul Strict PA) totalling some 14,000 km^2 in Uvs Aimag. A threats assessment was completed in 2012, along with the drafting of the Altai-Sayan Ecoregion Conservation Strategy (WWF, 2012).

A Pamir International PA has been proposed by the Wildlife Conservation Society (WCS) in the eastern Pamirs where the borders of Afghanistan, Pakistan, Tajikistan and China meet (Schaller, 2005; WCS, 2007). This would encompass 8 existing or proposed Reserves, including one in China, two in Pakistan, two in Tajikistan and three in Afghanistan, totalling 35,165 km². The most significant PAs containing snow leopards are Zorkul SR (870 km²) in Tajikistan, Wakhan NP (11,457 km²) in Afghanistan, Taxkorgan NR (15,863 km²) in China, and Khunjerab NP (6,150 km²) in Pakistan.

Nepal has signed agreements with China and India to facilitate biodiversity and forest management, encompassing six border PAs under the initiative known as the Sacred Himalayan Landscape. This effort covers about 39,021 km² in the eastern and central Himalaya, with 74% located in Nepal, 24% in Sikkim and Darjeeling areas of India, and the remaining 2% in Bhutan (HMGN/MFSC, 2006). The large Qomolangma Nature Reserve (34,000 km²) is located on the Chinese side.

The Kailash Sacred Landscape (KSL) Conservation Initiative is a collaborative effort of ICIMOD (International Centre for Integrated Mountain Development), UNEP (United Nations Environment Program) and regional partners from China, India and Nepal. It represents a sacred landscape that is significant to hundreds of millions of people in Asia and around the globe, as well as the source of four large rivers (Indus, Brahmaputra, Karnali, and Sutlej), which serve as lifelines for large parts of Asia and the Indian subcontinent (for further information, see http://www.icimod.org/?q=1856).

Bilateral initiatives exist in the Kangchendzonga landscape between Bhutan and Nepal and India and Nepal. Potential for transboundary cooperation also exists in the Central and Inner Tien Shan, where Naryn and Sarychat-Ertash NRs in Kyrgyzstan could be connected to Tomur Reserve in China if the proposed Sary-Jaz conservation area in eastern Kyrgyzstan is realized.

One example of cross-border cooperation on the ground is represented by a joint survey of the Kyrgyz Range on the border between Kazakhstan and Kyrgyzstan by scientists from both counties (FFI 2007). Asia-Irbis functioned for several years as a network connecting snow leopard researchers and conservationists in the four countries of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan) and a workshop to foster cooperation on snow leopards within the same region was held in Bishkek in 2006 (FFI 2007). A meeting in Bhutan in 2005 fulfilled a similar function for South Asia (WWF 2005).

The Snow Leopard Network itself was established after the Snow Leopard Survival Summit in 2002 as a means of coordinating and exchanging information between range countries and international experts. For information and a detailed bibliography on snow leopards, visit the SLN website: http://www.snowleopardnetwork.org/sln/Homepage_En.php

Appendix 4 lists PAs for all range countries that are located within approximately 10-30 km of an international boundary. These areas, as well as all other documented non-transboundary PAs are shown in figure 11.1. This information was compiled from the World Database on Protected Areas (WDPA) (www.unep-wcmc.org) and the National Snow Leopard Environmental Protection Plans (NSLEPs), supplemented by listings published by country PA agencies, NGOs and INGOs. Experts were contacted where information was known to be contradictory, out-of-date or lacked recently proposed or established PAs (e.g. Afghanistan, Kazakhstan, and Russia). In any event, there is an urgent need to both validate and update the database on PAs within snow leopard range on a country-by-country basis.

References

FFI (2007). Central Asia snow leopard workshop, Bishkek 19-21 June 2006. Meeting Report. Fauna & Flora International, Cambridge, UK.

IUCN-WCPA (2001). *Transboundary Protected Areas for peace and cooperation*. A. Best Practice Protected Areas Guideline Series # 7, IUCN-World Conservation Union, Gland. 111 pages. Available for download from: https://www.iucn.org/about/work/programmes/gpap_home/gpap_capacity2/gpap_bpg/?2176/Transboundary-Protected-Areas-for-Peace-and-Cooperation

Jackson, R., Mishra, C., McCarthy, T.M. and Ale, S.B. (2010). *Snow Leopards: conflict and conservation*. Chapter 18, pages 417-430: Biology and Conservation of Wild Felids (D.W. Macdonald and A.J. Loveridge, (Eds). Oxford University Press, UK, 762 pages.

Schaller G.B. (2005). A winter survey of Marco Polo sheep in the southern Pamir Mountains of Tajikistan. Report to Wildlife Conservation Society, New York.

Singh, J.J. and Jackson, R. (1999). Transfrontier Conservation Areas: creating opportunities for conservation, peace and the snow leopard in Central Asia. *International Journal of Wilderness*, 5(2), 7-12.

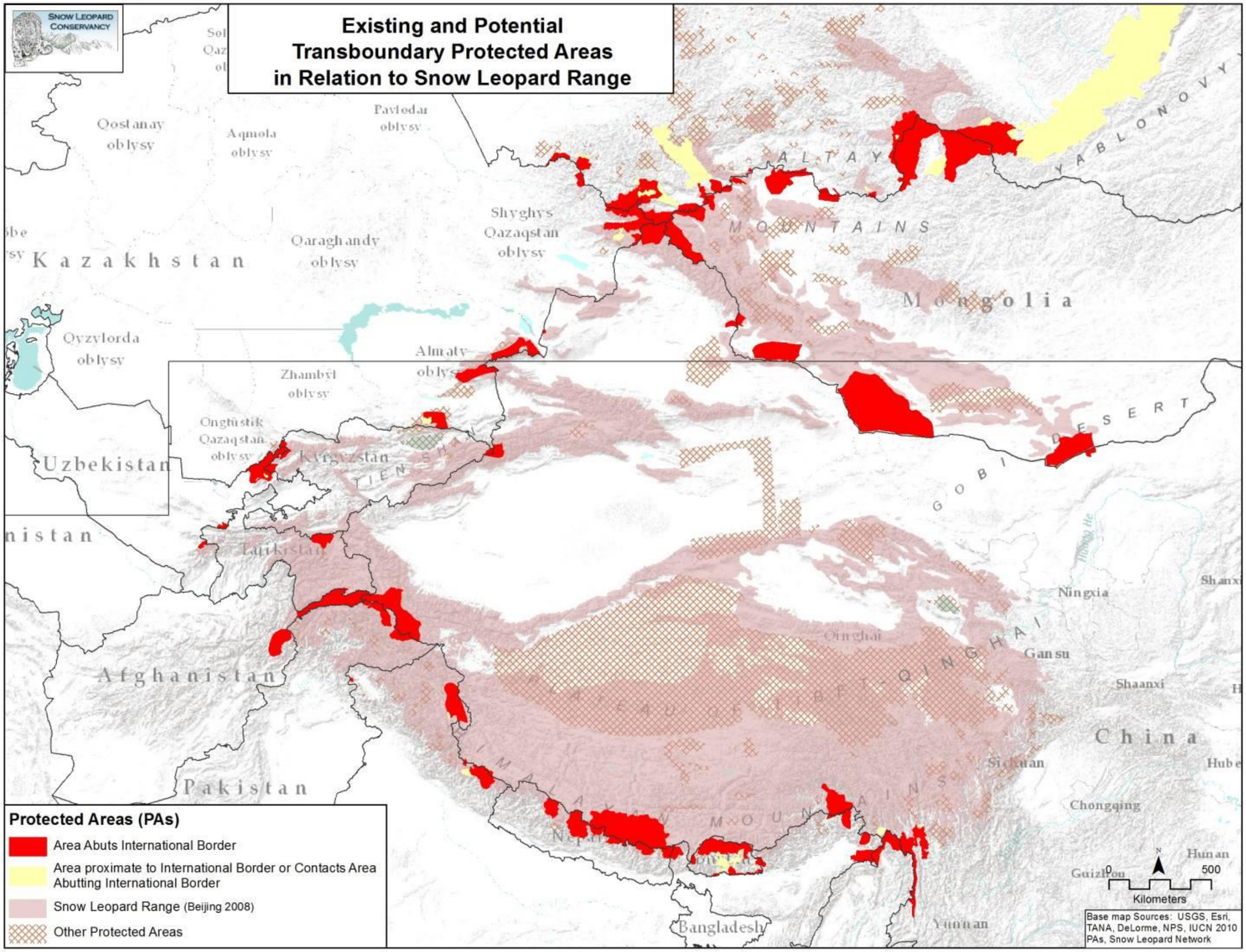
WCS (2007). The Pamirs Transboundary Protected Area: A report on the 2006 International workshop on wildlife and habitat conservation in the Pamirs. Wildlife Conservation Society, Unpub. Report prepared by Wildlife Conservation Society in partnership with USAID, and the Governments of Tajikistan, Pakistan, Afghanistan and China.

World Bank (2013). Global Snow Leopard & Ecosystem Protection Program: Conference Document for Endorsement (71 pages) and Annex Document of Complete National Programs (234 pages). Washington DC. Available for download from: http://en.akilbirs.com/

WWF (2005). Proceedings of the WWF South Asian Regional Consultative Workshop for Snow Leopard Conservation, Paro, Bhutan. Report compiled by E. Wikramanayake and V. Moktan, WWF-Bhutan Program, Thimphu. 81 pages.

WWF (2012). Report on Altai-Sayan Ecoregion Conservation Strategy, draft dated 29 June.

Figure 11.1: PAs located within approximately 10-30 km of an international boundary. These areas, as well as all other documented non-transboundary PAs are shown. GIS dataset, supplemented by listings published by country PA agencies, NGOs and INGOs. (Map prepared by the Snow Leopard Conservancy).


Existing and Potential Transboundary Protected Areas in Relation to Snow Leopard Range
Snow Leopard Conservancy
Protected Areas (PAs)
Area Abuts International Border
Area proximate to International Border or Contacts Area Abutting International Border
Snow Leopard Range (Beijing 2008)
Other Protected Areas
Base map Sources: USGS, Esri, TANA, DeLorme, NPS, IUCN 2010 PAs, Snow Leopard Network
Kilometers
0
500
Kazakhstan
Qostanay oblysy
Aqmola oblysy
Pavlodar oblysy
Qaraghandy oblysy
Shyghys Qazaqstan oblysy
Qyzylorda oblysy
Zhambyl oblysy
Almaty oblysy
Ongtüstik Qazaqstan oblysy
Uzbekistan
Kyrgyzstan
Tajikistan
Afghanistan
Pakistan
Nepal
Bangladesh
Mongolia
China
Qinghai
Ningxia
Gansu
Shaanxi
Shanxi
Sichuan
Chongqing
Guizhou
Hunan
Hubei
Yunnan
ALTAY MOUNTAINS
YABLONOVY
GOBI DESERT
TIEN SHAN
PLATEAU OF TIBET
QINGHAI
HIMALAYAN MOUNTAINS

Chapter 12: Ecosystem Services and Economic Valuation of Snow Leopards and their Mountain Ecosystem

12.1. Introduction

Mountains and other high elevation areas occupied by snow leopards provide direct and indirect benefits to people that depend on healthy and functioning ecosystems. These can be categorized as: provisioning services (food, fibre, and water), regulatory services (climate regulation, water regulation, soil preservation), cultural services (cultural diversity, spiritual and religious values), and supporting services (soil production, soil retention, oxygen production) (MEA 2005).

12.2. Hydrological services

The snow leopard's high mountain habitat acts a gigantic water storage tower on which hundreds of millions of people living downstream in South, Central, and East Asia depend for drinking, irrigation and industry. For instance, the Qinghai-Tibetan Plateau is the origin of six of the major rivers of Asia: the Hwang He, Yangtze, Mekong that are estimated to impact 40% of the world's population (Foggin, 2008) and the Indus, Ganges and Tsangpo-Brahmaputra that support more than 1 billion people in Bangladesh, India, and Pakistan (Thenkabail 2005). The Hindu-Kush range provides fresh water for more than 200 million people living in the region and about 1.3 billion people downstream (Rasul 2011). The Altai and Sayan mountains stretch across Russia, Mongolia, Kazakhstan, and China, comprising the watershed between Central Asia and the Arctic Ocean (Kokorin 2001). Hydrological services support about 13 million people in Central Asia, over an area of 343,100 km², most notably in the Syr Darya and Amu Darya river basins. Land uses like grazing and road-building reduce infiltration of rainfall or snowmelt while increasing runoff rates (Braumann 2007). Dam construction for electricity and irrigation may also have unanticipated negative effects on watersheds and water cycle regimes at both local and regional levels (Pandit and Grumbine 2012).

12.3. Regulatory and support services

These services are vital to human existence but are often overlooked as they appear not to have a direct utilitarian value nor do they have an explicit market value. A study on the Qinghai-Tibetan Plateau estimated the economic value of non-degraded grassland for primary production (above ground biomass) at USD 308.9/ha, carbon sequestration was valued at USD 33.07x 10^4/ha, nitrogen sequestration at USD 64.58 x 10^4/ha and biodiversity maintenance at USD 400/ha (Wen 2013).

Surprisingly little is known about the regulatory and supporting service values provided by mountain habitats and thus studies are urgently needed to determine how different land-uses affect them. Although we have a reasonable understanding of prevailing land-uses in snow leopard habitat, we remain ignorant of other essential services for well-being offered by such habitats. In maximizing ecosystem provisioning services, humans tend to trade-off crucial regulatory and supporting services: it is thus important to understand which ecosystem or regulatory services are being compromised and the future effects on regional and global systems. There is an urgent need for undertaking ecosystem service assessments and for understanding the primary drivers of change within snow leopard habitat, nationally and regionally.

12.4. Agro-pastoralism

Pastoralism is the primary land use within snow leopard habitat. The Mongolian economy, for instance, is heavily dependent on this livelihood with some 8.19 million livestock grazed within snow leopard habitat (FAO, 2013), and in India, it numbers approximately 2.5 million (GOI, 2007). In Kyrgyzstan where more than half the country is potential snow leopard habitat, about 44% of the land area (around 89,000 km²) is used as pastures for livestock (Undeland, 2005). In 2005, an estimated 30 million sheep and goat and 12 million yaks were using the Qinghai-Tibetan plateau, which embraces a significant proportion of China’s snow leopard habitat (Miller, 2005).

Due to harsh climatic conditions, especially extreme temperatures and a shortened growing season, high elevations and in some places the scarcity of water, very little crop production takes place in most snow leopard areas. The principal crops grown are barley, wheat, buckwheat and pea. Livestock production is almost completely dependent upon natural forage produced in rangelands, along with the water stored in glaciers and snowfields.

However, intensive livestock production often has a detrimental effect on other ecosystem services, causing land degradation and affecting nutrient resource cycles in several ways. As ruminants, livestock may affect nitrogen and carbon cycles (Steinfeld 2007). Overgrazing in alpine areas may result in soil and pasture degradation and the resultant decrease in their regenerative capacity, along with a reduction in vegetation production and biomass, lowered amination, nitrification (nitrogen fixation) and soil fertility (Steinfeld 2007). On the Qinghai-Tibetan Plateau, excessive livestock grazing is reported to have caused vegetation degradation and created barren soils over some 70,319 km² (Shang 2007). The economic loss up to 2008 due to overgrazing has been estimated at $2.44 billion for primary production, $84.85 billion for carbon emission, $69.39 billion for nitrogen loss and $2.02 billion for loss in plant diversity (Wen 2013). This economic valuation does not account for other ecosystem services such as the value of gross primary production (GPP), recreation values or the potential synergy of this high altitude ecosystem (Wen 2013).

12.5. Biodiversity values

The protection of biodiversity is another important ecosystem service. In India for example, snow leopard habitat covering an estimated 89,271 km² supports 350 documented species of mammals, 1,200 species of birds, 635 species of amphibians and reptiles (Anonymous 2011). The Altai mountain ranges of Russia, Mongolia, Kazakhstan and China support 3,726 known species of vascular plants, 143 species of mammals, 77 fish species, and 425 bird species (Kokorin 2001; MEA 2005). The Tien Shan region represents a center of endemism for fruit trees and numerous other economically important plants. Overall, the snow leopard's range covers 50 Ecoregions as designated under the WWF Biome and Ecoregion program. http://worldwildlife.org/pages/conservation-science-data-and-tools

12.6. Cultural values

Snow leopard habitats in South, Central and East Asia harbour immense cultural values and diversity. There are numerous important religious sites that attract people from all over the world who come to pay homage (for example, the sacred Kailas Mountain in the Tibet Autonomous Region, China and the national cultural sites of the Altai or Golden Mountains of Russia, Mongolia and Kazakhstan) or simply to view and enjoy mountain landscapes.

The large number of tourists visiting snow leopard habitat annually contributes to the local and national economy. In Kazakhstan, tourism revenues comprised 5.0% of the GDP in 2011 which amounted to 8.4 billion US dollars (Ruggles-Brise 2012). In 2012 tourism contributed 9.4% to Nepal's GDP which totalled 1.68 billion USD (Turner 2013a). In Mongolia, tourism contributed to 5.7% of the country's GDP, approximately 0.57 billion USD in 2012 (Turner 2013b). While an important source of revenue, tourism often places undue pressure on the environment and may thus compromise other ecosystem services. Snow leopard habitat is relatively fragile, so that added pressures from tourists and associated servicing can affect the environment negatively unless regulated and well managed. In areas of water shortages, tourism limits the availability of this essential resource to local residents.

12.7. Applying economic incentives toward the conservation of Snow Leopards and their habitats

The risk of carnivore extirpation is probably best minimized by enabling local people to benefit from carefully targeted incentives for sustained co-existence with snow leopards and other predators, and by capitalizing on opportunity costs and cultural values that underpin community-based conservation action(s).

Sustained investment in social capital is an important element to encourage effective, genuine and equitable resource management. This, in turn, may require financial and technical inputs from external agents who may also need to assume some of the cost of long-term monitoring. In effect, local people need to both receive and perceive tangible benefits from their willingness to co-exist amicably with snow leopards and other wildlife.

One strategic framework for fostering sustained co-existence entails positively valuing large predators by providing cash or in-kind rewards to communities demonstrating a sustained snow leopard population within their geographic area (Dinerstein et al. 2012). These financial instruments, termed "payments to encourage coexistence" (Dickman et al. 2011) appear to meet key criteria applied to *Payments for Ecological Services* or PES (Wunder 2005; Pagiola and Platais 2007; Ferraro 2011; Rasul et al. 2011). PES is a market-driven approach to conservation based on the twin principles that those who benefit from environmental services (e.g., downstream users of clean water) should pay for them, and those who generate such services (upstream watershed communities) should be compensated for providing them. Dinerstein et al. (2012) advocate the use of a *Wildlife Premium Mechanism*, whereby premiums are embedded in carbon payments, linked to a related carbon payment (but as independent and legally separate transactions) or otherwise provided to designated communities acting as agents for conserving targeted species, habitats and related ecosystem services.

Under conventional PES mechanisms, service providers receive regular payments conditional on their providing the desired environmental services (or adopting a practice considered necessary to supporting or generating those services). In the case of snow leopards, communities could be vested with authority to manage and protect snow leopards, prey and habitat according to prescribed protocols, with payments being linked to the verified persistence of a given number of snow leopards and large prey animals over time. Typically, participation in PES is voluntary, but requiring extensive community management because programs are designed to occur on lands where local people hold the title or contract to long-term lease user rights and responsibilities from the government. The monitoring, reporting and verification required to make premium payments credible to investors include transparent methods for collecting data on key indices by trained community members along with verification by an independent biologist or organization (see Chapter 14 Estimating Snow Leopard and Prey Populations and Monitoring Trends).

Incentives and performance payments for conservation are receiving increased attention from both conservation and development practitioners (Ferraro 2011). While the theory underlying PES is relatively simple, studies verifying the efficacy of PES are lacking. Nor is there information on the valuation of snow leopards or their alpine ecosystem. Reasons for this include poor beneficiary targeting and participation, unforeseen changes in land-use and failure of participants to comply with contractual obligations. Options for ecosystem services related to water provision appear limited unless linked with payments from hydro-power generation since water is considered an open-access commodity within snow leopard range.

Cost-effective targeting of land through the use of discriminative conservation payments can substantially improve the efficiency of investments in the Grain-to-Green program and other payment for ecosystem services programs (Chen et al. 2010). Dinerstein et al. (2013) offer examples for incentivizing local communities to protect wildlife through premium payment mechanisms such as REDD (carbon sequestration).

Accounting for economic benefits arising from conservation and reducing potential policy conflicts with alternative plans for development can provide opportunities for successful strategies that combine conservation and sustainable development and facilitate conservation action.

The PES approach may generate new financing which would not otherwise be available for conservation; it can be sustainable, as it depends upon mutual self-interest of service users and providers and not upon the whims of donor funding. It is judged efficient if it generates services whose benefits exceed the cost of providing them. Spatially-based cost-benefit analyses provide a basis for more equitable distribution of cost-sharing through management initiatives that offer herders incentives, as well as drawing upon traditional knowledge to create more sustainable rangeland management protocols (Ferraro 2011; Zabel and Rowe 2009). Rasul et al. (2011) suggest a framework for valuing ecosystem services in the Himalayan region.

Conservationists have debated how best to link ecosystem service payments to biodiversity conservation. Gibbons et al. (2011) suggest that PES payments should target actions where there is a clear intervention which clearly and directly benefits biodiversity and that is relatively easy to measure and monitor over time. In degraded habitats or where it is not clear what action or set of actions will produce the desired result, it may be preferable to incentivize activities for results (i.e. a given number of snow leopards and large prey animals). A *Payment by Results* system will allow individual managers to optimize their level of action, especially if they have special knowledge about the species or the habitat being protected and managed. However, a key consideration in determining which incentive system might work most effectively involves the costs of compliance and population monitoring, as well as the ability to robustly and reliably detect changes in number over time (a statistic which may be surprising difficult to determine). Further research is required to determine circumstances and policies under which direct payment schemes for restoring or maintaining intact ecosystems provide consistent results. These need to be species and site specific, and supported through reliable protocols such as camera-trapping and non-invasive scat genotyping, along with prey species and habitat condition surveys.

References

Anonymous (2011). *Management plan for the Upper Spiti landscape including the Kibber Wildlife Sanctuary.* Wildlife Wing, Himachal Pradesh Forest Department & Nature Conservation Foundation, Mysore.

Brauman, K. A., Daily, G. C., Duarte, T. K. E., and Mooney, H. A. (2007). The nature and value of ecosystem services: an overview highlighting hydrologic services. *Annual Review of Environment and Resources*, 32, 67-98.

Chen, X., Lupi, F., Viña, A., He, G., and Jianguo Liu. (2010). Using cost-effective targeting to enhance the efficiency of conservation investments in payments for ecosystem services. *Conservation Biology*, 24(6), 1469–1478.

Di Minin, E., Macmillan, D.C., Goodman, P.S., Escott, B., Slotow, R. and Moilanen, A. (2013). Conservation businesses and conservation planning in a biological diversity hotspot. *Conservation Biology*, 27(4), 808–820.

Dickman, A. J., Macdonald, A.E. and Macdonald, D.W. (2011). *A review of financial instruments to pay for predator conservation and encourage human-carnivore coexistence*. Proceedings of the National Academy of Science of the United States of America 108:13937-13944.

Dinerstein, E., Varma, K., Wikramanayake, E., Powell, G., Lumpkin, S. Naidoo. R., Korchinsky, M., Del Valle, C., Lohani, S., Seidensticker, J., Joldersma, D., Lovejoy, T. and Kushlin. A. (2012). Enhancing conservation, ecosystem services, and local livelihoods through a wildlife premium mechanism. *Conservation Biology*, 27(1), 14–23.

Ferraro, P.J. (2011). The Future of Payments for Environmental Services. *Conservation Biology*, 25(6), 1134-1138.

Foggin, J.M. (2008). Depopulating the Tibetan grasslands: national policies and perspectives for the future of Tibetan herders in Qinghai Province. *China. Mountain Research and Development*, 28(1), 26-31.
Gibbons, J., Nicholson, E., Milner-Gulland, E., & Jones, J. (2011). Should payments for biodiversity conservation be based on action or results? *Journal of Applied Ecology* DOI: 10.1111/j.1365-2664.2011.02022.x.

Government of India (GoI) (2007). 18th Livestock Census.

Jackson, R.M., Mishra, C., McCarthy, T.M. and Ale, S.B. (2010). Snow leopards: conflict and conservation. Chapter 18, pages 417-430: *Biology and Conservation of Wild Felids* (Macdonald, D.W. and Loveridge, A.J., (Eds), Oxford University Press, UK, 762 pages.

Kokorin, A.O., Kozharinov, A.V., Minin, A.A. (2001). *Ecoregional climate change and biodiversity decline.* Issue 1, Altai Sayan Ecoregion. WWF, Moscow, Russia.

Li, J., Wang, D., Yin, H., Zhaxi, D. Zhala Jiagong, Schaller, G.B., Mishra, C., McCarthy, T.M., Wang, H., Wu,L., Xiao, L., Basang, L., Zhang, Y., Zhou,Y. and Zhi Lu. (2014). Role of Tibetan Buddhist monasteries in snow leopard conservation. *Conservation Biology, 28*(1), 87-94.

Millennium Ecosystem Assessment (2005). *Ecosystems and human well-being*. Vol. 5. Washington, DC: Island Press.

Miller, D.J., (2005). The Tibetan steppe. Plant Production and Protection Series No. 34.In: Suttie, J.M., Reynolds, S.G. and Batello, C. (Eds.), *Grasslands of the World*. UN Food and Agriculture Organization, Rome, pp. 305–342.

Pagiola, S. and Platais, G. (2007). *Payments for environmental services; from theory to practice*. World Bank, Washington, DC.

Pandit, M.K. and Grumbine, R.E. (2012). Potential effects of ongoing and proposed hydropower development on terrestrial biological diversity in the Indian Himalaya. *Conservation Biology,* 26(6), 1061–1071.

Rastogi, A., P. Shengji and D. Amatya. (1997). *Regional consultation on conservation of the Kanchenjunga Mountain Ecosystem*. ICIMOD and WWF-Nepal Programme, Kathmandu,

Rasul, G., Chettri, N. and Sharma, E. (2011). *Framework for valuing ecosystem services in the Himalayas*. International Centre for Integrated Mountain Development ICIMOD, Kathmandu, Nepal

Ruggles-Brise, O. (2012). Travel and tourism economic impact 2012 Kazakhstan. World Travel and Tourism Council. Accessed on 14/5/2013:

http://www.wttc.org/site_media/uploads/downloads/kazakhstan2012_2.pdf

Shang, Z., & Long, R. (2007). Formation causes and recovery of the “Black Soil Type” degraded alpine grassland in Qinghai-Tibetan Plateau. *Frontiers of Agriculture in China*, 1(2), 197-202.

Steinfeld, H., & Wassenaar, T. (2007). The role of livestock production in carbon and nitrogen cycles. *Annual Review of Environment and Resources,* 32, 271-294.

Thenkabail, P. S., Schull, M., & Turral, H. (2005). Ganges and Indus river basin land use/land cover (LULC) and irrigated area mapping using continuous streams of MODIS data. *Remote Sensing of Environment*, 95(3), 317-341.

Turner, R. (2013a). *Travel and tourism economic impact 2013 Nepal*. World Travel and Tourism Council. Accessed on 14/5/2013: http://www.wttc.org/site_media/uploads/downloads/nepal2013_2.pdf

Turner, R. (2013b). *Travel and tourism economic impact 2013 Mongolia*. World Travel and Tourism Council. Accessed on 14/5/2013: http://www.wttc.org/site_media/uploads/downloads/mongolia2013_2.pdf

Undeland, A. (2005) *Kyrgyz livestock study: pasture management and use*. World Bank, Bishkek.

Wen, L., Dong, S., Li, Y., Li, X., Shi, J., Wang, Y., and Ma, Y. (2013). Effect of degradation intensity on grassland ecosystem services in the Alpine Region of Qinghai-Tibetan Plateau, China. PloS one 8(3): e58432.

World Bank (2013). Global snow leopard and ecosystem protection program: Conference Document for Endorsement (71 pages) and Annex Document of Complete National Programs (234 pages). Washington DC.

Wunder, S. (2005). *Payments for environmental services: some nuts and bolts*. Centre for International Forestry Research, Bogor Barat, Indonesia.

Zabel, A. and Roe, B. (2009). Optimal design of pro-conservation incentives. *Ecological Economics*, 69, 126–134.

Chapter 13: Snow Leopard Conservation through Hunting of Prey Species

13.1. Introduction

A key threat to the survival of snow leopard involves widespread declines in the availability of its main prey species, including reductions in their range extent. Thus the conservation of the prey species is of utmost relevance to snow leopard conservation. The primary large prey species like Asiatic ibex, blue sheep, argali, markhor, and urial are threatened by poaching or unsustainable hunting, forage competition due to an increasing livestock population, habitat degradation and in some cases, by transmission of infectious diseases from livestock (McCarthy and Chapron 2003; Mishra et al. 2004; Ostrowski et al. 2012; Berger et al. 2013).

PAs, where hunting is prohibited, cover only a small part of the range of the snow leopard; those without livestock grazing are even smaller. The establishment of new large-scale strict PAs (no-take zones) which would provide effective protection for the ungulate species and their habitats is becoming increasingly difficult and in most cases meets strong political resistance. Many PAs with formally regulated land-use rarely restrict livestock grazing effectively. In both, strict PAs as well as regulated use areas, the enforcement of rules is weakened by the lack of financial and human resources and/or insufficient political support. With growing human and livestock populations, even existing strict PAs are increasingly challenged by pressures to convert these areas into other forms of land-use.

Total or partial hunting bans have been enacted in some snow leopard range states including Bhutan, India and more recently, China. In other range states ungulates not listed in the Red Data Book (in particular Asiatic ibex) may be hunted based on quotas determined by the state agencies in charge. Elsewhere, species classified as endangered, such as argali and markhor, are also legally hunted within the framework of strict quotas. Enforcement of hunting bans or hunting limitations is often difficult for the same reasons as the enforcement of PA regulations. In some areas, especially in remote border zones, the problem is exacerbated by the involvement of military, border guards and police in poaching activities. Thus, hunting bans do not necessarily protect local ungulate populations from serious decline and extinction.

For example, in the Wakhan valley in south-east Tajikistan the local urial population was extirpated by poachers around 2005 despite the species being legally protected at least since 1988. The ibex populations declined significantly though very few hunting permits were being issued annually. In contrast, argali numbers in the Tajik Pamirs have remained high, despite, or because of commercial trophy hunting (Schaller 2005; Michel and Muratov 2010). Similarly, in the Afghan part of the Wakhan valley, traditional systems of hunting regulations seem to have survived until recently. In each village a few designated hunters took a limited number of ungulates from defined areas based on self-imposed restrictions. In 2011, the Wildlife Conservation Society (WCS) recorded more than 400 urial and 2000 ibex in such traditionally regulated areas (Moheb et al. 2012). This dichotomy suggests that outright bans on hunting may not always produce the desired effect, and conversely, that well managed hunting can have a positive influence on ungulate numbers.

Given the considerations outlined above, combined with the large home ranges of individual snow leopards, an approach for the conservation of snow leopards that relies only on strengthening PA systems and enforcing hunting bans of the prey species has obvious limitations. Snow leopard conservation therefore must look beyond PA boundaries. In certain sites where it is culturally acceptable and where ungulate populations have been scientifically determined to be able to support some level of harvest, consideration is warranted, on a site specific basis, for developing well-regulated, sustainable prey hunting programs which may contribute to the conservation of mountain ungulates and indirectly to that of the snow leopard. Sustainable use approaches are widely recognized internationally as conservation tools (Hutton and Leader-Williams 2003).

The Convention on Biological Diversity (CBD) has developed several statements of principles relevant for the management of hunting. Most importantly, the 7th Conference of Parties to the CBD (Kuala Lumpur, February 2004) adopted the Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity (AAPG). The AAPG are based on the assumption that it is possible to use biodiversity in a manner in which ecological processes, species, and genetic variability remain above the thresholds needed for long term viability, and that all resource managers and users have the responsibility to ensure that such use does not exceed these limits (http://www.cbd.int/sustainable/addis.shtml).

IUCN's "Policy Statement on Sustainable Use of Wild Living Resources", adopted as Resolution 2.29 at the IUCN World Conservation Congress in Amman in October 2000, affirms that use of wildlife, if sustainable, can be consistent with and contribute to biodiversity conservation. IUCN recognizes that where an economic value can be attached to a wild living resource, perverse incentives removed, and costs and benefits internalized, favorable conditions can be created for investment in the conservation and the sustainable use of the resource, thus reducing the risk of resource degradation, depletion, and habitat conversion (http://www.iucn.org/about/work/programmes/species/publications/iucn_guidelines_and__policy__statements/)

Further, the IUCN SSC Caprinae Specialist Group adopted a formal position statement in December, 2000, recognizing that hunting, and in particular trophy hunting, can form a major component in conservation programs for wild sheep and goats. This statement noted that "Trophy hunting usually generates substantial funds that could be used for conservation activities such as habitat protection, population monitoring, law enforcement, research, or management programs. Equally importantly, the revenues from trophy hunting can provide a strong incentive for conservation or habitat protection" http://pages.usherbrooke.ca/mfesta/thunt.htm).

In 2012, the IUCN Species Survival Commission published the IUCN SSC Guiding Principles on Trophy Hunting as a tool for creating conservation incentives. In particular for trophy hunting these guiding principles are of relevance for the ungulate prey species of the snow leopard. This document explicitly states that although a wide variety of species (many of which are both common and secure) are hunted for trophies; some species that are rare or threatened may be included in trophy hunting as part of site-specific conservation strategies (IUCN SSC 2012). Examples include markhor in Pakistan, which is a snow leopard prey species, listed on Appendix I of CITES: https://cmsdata.iucn.org/downloads/iucn_ssc_guiding_principles_on_trophy_hunting_ver1_09aug2012.pdf).

13.2. Trophy hunting in Snow Leopard range – current status and benefits

Wild ungulates share landscapes with people, and may compete with other forms of economically productive land uses upon which people's livelihoods depend: they may thus be perceived negatively when damaging crops, competing with livestock for forage, or transmitting infectious diseases to livestock. Trophy hunting is one of the ways of making the ungulates more valuable than, and/or complementary to, other forms of land use (Rosen 2012).

Trophy hunts are usually conducted by hunters ready to pay substantial amounts of money for the opportunity. Trophy hunting generally involves taking small numbers of individual animals and requires relatively limited infrastructure, and is thus high in value but low in impact if properly managed. Trophy hunting on mountain ungulates can return benefits to local people (preferably through effective involvement in their management or through benefit sharing schemes supporting local communities as well as through income opportunities), encouraging their support for wildlife, and motivating investment at the community, private, and government level for research, monitoring, habitat protection, and enforcement against illegal use. Trophy hunting, if well managed, is often a higher value, lower impact land use than existing alternatives such as agriculture.

Trophy hunting takes place in several range states: on Asiatic ibex in Mongolia, Kazakhstan, Kyrgyzstan, Pakistan, Russia, Tajikistan and Uzbekistan; on argali in Mongolia, Kyrgyzstan and Tajikistan; on markhor, blue sheep and urial (on the latter only outside snow leopard range) in Pakistan; on Himalayan tahr and blue sheep in Nepal. Some species are excluded from trophy hunting in countries where such activity is generally allowed (e.g. until 2013 markhor in Tajikistan, argali in Russia and Kazakhstan). In Afghanistan, Bhutan, China and India no trophy hunting is permitted. China stopped issuing trophy hunting permits in 2006.

Impacts of trophy hunting on the populations of the target species and indirectly on snow leopard are heavily contended. In Kyrgyzstan, for instance, some conservation organizations see trophy hunting on the prey species as a major threat for the snow leopard, while the state agency in charge of hunting management, scientists from the National Academy of Sciences and other stakeholders consider it an effective incentive for preventing poaching of prey species (at least in some areas), and thus indirectly benefiting the snow leopard (Davletbakov and Musaev 2012). In Tajikistan, trophy hunting has locally benefited argali, ibex and (in expectation of future hunting options) markhor protection (Michel et al. in press), while monitoring has indicated the presence of snow leopards in some hunting management areas in higher numbers than in areas without hunting management (Panthera, unpubl. data, Kachel

2014). From Pakistan, positive impacts of trophy hunting programs on numbers of ibex, markhor and urial have been reported (Johnson 1997; Shackleton 2001; Woodford et al. 2004; Frisina and Tareen 2009).

Poorly managed trophy hunting, however, may result in negative ecological impacts such as altered age/sex structures, social disruption, deleterious genetic effects, and in extreme cases, population declines. Where trophy hunting fails to involve local people, who are perhaps in the best position to support or to impede conservation, or when it does not provide substantial benefits to the local community, or when it fails to reinvest in species and habitat conservation, the conservation benefits may be lost. This type of trophy hunting may encourage poaching by those feeling alienated from using wildlife they perceive as their natural right to access. Thus, trophy hunting beyond the take of few trophy males can indirectly cause much higher mortality among populations of the ungulate species hunted.

13.3. Best practices

To avoid negative consequences, trophy hunting should be designed and implemented to maintain wild populations of indigenous species with adaptive gene pools and in natural ecosystems that are home to native biodiversity. This will require that:

- Quotas be set conservatively (a significant number of old males should die by natural factors), thereby ensuring that the hunting off-take produces only minor alterations to naturally occurring demographic structure and that significant evolutionary impacts of selective hunts on large mature males as described by Coltman et al. (2003) are avoided. A quota of up to 1% of the population size recorded during the previous survey and of up to 20% of males of an estimated age of eight years or older are considered sustainable under most circumstances (Harris 1993; Wegge 1997).
- Unethical hunting practices by guides and hunting concession owners (e.g., switching small trophies taken by a client for larger ones which may have been bought from poachers, or manipulation of trophies using spare horns to artificially increase horn length or repair broken horns) need to be prevented through self-control and regulation by the hunting sector and law enforcement. Because old males of maximum trophy size are the hunter's primary target, trophy hunting of wild sheep and goats usually has little impact on the population size and reproduction of these polygamous species (Mysterud 2012; Frisina and Frisina 2012; Harris et al. 2013). Areas where offtake is excessive and trophy sized males are disproportionately taken, are likely to lose attractiveness for trophy hunters and reduce economic return to the hunting concession owner (Harris et al. 2013; pers. statements to Michel by hunting guides operating in Kyrgyzstan and Tajikistan).
- Trophy hunting should take place only in officially approved hunting management areas based on permits bound to the specific geographic area. These areas should be assigned to legal entities on a long-term basis to ensure an interest in the sustainability of the hunting

opportunities over many years. When hunting permits are not area-bound or where hunting areas are assigned on a short term basis, there is increased likelihood of excessive, opportunistic harvesting of large trophy males without commensurate investment in conservation, monitoring and benefit sharing with local communities. The entities receiving the rights to such hunt areas should also have the capacity and interest to manage and invest in trophy hunting programs over the long-term.

- Hunting management should not substantially manipulate or modify ecosystems or their natural components in ways that are incompatible with the objective of supporting the full range of native biodiversity. Relocation (with the exception of reintroduction in areas where a species went extinct), restocking and breeding of ungulates in enclosures, as well as the reduction of predators in the interest of increasing trophy animals are, therefore, not acceptable practices. Income from trophy hunting should support conservation of all wildlife and biodiversity, and not just high populations of the trophy hunting animals.
- Revenue from hunting fees, especially where it is substantial, should be invested in the protection, monitoring and management of target ungulate populations and their habitats and also in the development and other incentives which benefit the local communities where the hunting is taking place. Where possible, community members and/or community-based organizations should be allowed to manage, or at a minimum assist in managing, hunting areas for the benefit of their communities. Private hunting concessions should employ local community members whenever possible, in particular traditional hunters, as well as investing in the prevention of poaching through outreach, community development and patrolling activities.

13.4. Subsistence and other forms of hunting

While the international trophy hunting market is limited, for more common and widely available species like Asiatic ibex, the supply of hunt opportunities can easily exceed demand and keep prices low. For species like markhor and argali some countries keep the quota low to retain a high price, which also limits the opportunities to develop trophy hunting on a much larger scale. Therefore in some cases other forms of hunting may be considered as an alternative or complementary option. Compared to trophy hunting, usually by foreign clients, hunting by local people does not provide very high economic returns, the primary benefit being meat for one's family or a modest compensation by other villagers for meat.

The implementation of alternative forms of hunting management might be considered where trophy hunting would be hindered by factors such as the lack of access to international markets and legal restrictions. In such cases poaching can still be curtailed by putting sustainable hunting management practices into place. In some countries, residents, especially from the cities, are interested in having hunting opportunities in the countryside. This may provide an additional market: if targeted at the wealthy elite and where offering good services, substantial fee revenue for hunting agencies and incomes for local communities may be possible. Further, local people traditionally hunt for meat and a well-managed population of mountain ungulates can provide a higher sustainable annual harvest than an overhunted population. From the perspective of snow leopard conservation it is crucial that harvest rates are set that ensure adequate prey numbers remain to sustain populations of large predators. Thus, as a result of balanced hunting management, the population of the large prey should be greater.

Where other hunting is combined with trophy hunting only females older than one year should be hunted along with trophy males. In stable populations with natural predation, between 2% and 5% of all females >1 year old could be hunted. In populations not used for trophy hunting all sex and age classes may be hunted. In stable populations with natural population the annual quota should not exceed 5% of the total population with most harvested animals being males and young of both sexes. (Wegge 1997).

13.5. Impact of ungulate hunting on snow leopards

Trophy hunting programs on snow leopard prey – wild ungulates - must ensure conservation of not just the prey but also of the snow leopard. Ungulate trophy hunting programs in snow leopard habitat need to be managed from an ecosystem perspective, and must be designed to improve snow leopard conservation, conserve entire ecosystem function and diversity, rather than focus only on the specific species being hunted or harvested. It is also critical to assist the local communities and others involved to realize these broader objectives. This is necessary to avoid the kind of perverse incentives which accompanied past markhor trophy hunting in the Rondu valley in Baltistan, Pakistan (Jackson 2004). Concerns over snow leopard predation on markhor used to be paramount but it is no longer the case as people now seem to understand better the ecological role of snow leopards. Similar concerns were expressed in Tajikistan as the potential of trophy hunting on markhor became visible. As a result of the high economic value placed on the ungulate by trophy hunting, snow leopards are now perceived as a threat not only to village livestock, but more importantly, as a threat to the economic benefit from trophy hunting.

In fact, these concerns are rarely justified as in areas with healthy ungulate populations and with a conservatively set quota, most often there are enough large males for successful trophy hunts. Further, natural predation, which is less selective in terms of sex and age than trophy hunting, can help reduce the potential evolutionary impacts of selective trophy hunting (Harris et al. 2002). Natural predation by snow leopards and other carnivores fulfills important functions by helping keep populations of prey species healthy, reducing risks of fatal outbreaks of epidemic infectious diseases and contributing to the prevention of overuse of vegetation from excessive numbers of grazing or browsing herbivores. Local stakeholders should be educated and informed on the role of predators in maintaining or balancing ungulate populations.

In conclusion, snow leopard predation on wild ungulates is part of the natural order, and the economic benefit that accrues from ungulate conservation as a result of trophy hunting should be viewed as a reward for ecosystem conservation that ensures sufficient wild prey to sustain this endangered top predator as well. Wise conservation of predators, and in particular snow leopards, should become mandatory for all hunting management areas and as such, be duly embedded in the respective management agreements and instruments. Where non-extractive forms of nature tourism can also be implemented, the presence of snow leopards and wild ungulates offers additional incentives for local communities to accept snow leopards and other predators as an asset.

13.6. Some important research questions and priorities

Research focussing on the relations between snow leopard conservation and trophy hunt management might consider the following questions and priorities:

- How quota setting can ensure that sufficient prey remains available for snow leopards and how predation by snow leopards needs to be taken into consideration while setting hunting quotas?
- What interactions exist between snow leopards and other predators (wolf) in terms of their relative impact on prey populations?
- Will an increase of natural prey lead to increases in snow leopard numbers, and in turn increase depredation on livestock, as suggested by Suryawanshi et al. (2012) or in a reduction in livestock depredation?
- What is the potential of managing wild ungulates as an alternative or complementary land-use to livestock grazing? Can income from wild ungulates offset losses due to restrictions on livestock grazing in snow leopard habitats (trophy hunting and / or other hunting, reduced costs for wildlife management compared to maintenance of livestock, risk of losses under extreme weather conditions, adaptation capacity under climate change scenarios)?

13.7. Monitoring needs

The sustainable use of the snow leopard's prey species through hunting requires targeted monitoring efforts:

- Standard, cost-effective and efficient protocols for monitoring ungulate populations are required. The protocols used in consecutive surveys should allow for the comparison of the data over time. Wider applicability of recently developed double observer technique needs to be explored (Suryawanshi et al. 2012).
- Monitoring of hunting effort and results, both quantitative (numbers harvested, kill per unit effort) and qualitative (trophy quality, age, size, hunter satisfaction), is necessary to detect changes in the hunted population and to adopt quota and other management interventions accordingly.
- The monitoring of snow leopard presence and abundance in hunting management areas using established protocols (see Chapter 12 on Estimating snow leopard populations and monitoring trends) is necessary as it provides an indirect indicator for the monitoring of its prey species.
- Monitoring methods and protocols should be transparent and consistent among range countries, and results shared freely.

References:

Berger, J., Buuveibaatar, B. and Mishra, C. (2013) Globalization of the cashmere market and the decline of large mammals in Central Asia. *Conservation Biology*, 27, 679-689.

Coltman, D.W., O'Donoghue, P., Jorgenson, J.T., Hogg, J.T., Strobeck, C. and Festa-Bianchet, M. (2003). Undesirable evolutionary consequences of trophy hunting. *Nature,* 426, 655-658.

Davletbakov, A.T. and Musaev, A.M. (2012). *Census of argali and ibex*. Department of Hunting of the State Agency on Protection of the Environment and Forest resources. Bishkek. And GIZ. Project on sustainable management of mountain ungulates in Kyrgyz Republic. Report (in Russian).

Frisina, M. and Tareen, S.N. (2009). Exploitation prevents extinction: case study of endangered Himalayan sheep and goats. In: *Recreational Hunting, Conservation and Rural Livelihoods: Science and Practice* (Eds) B. Dickson, J. Hutton and W.M. Adams). Wiley-Blackwell, Oxford, UK. pp. 141-156.

Frisina M. and Frisina R.M. (2012). Influence of trophy harvest on the population age structure of argali (*Ovis ammon)* in Mongolia. *Journal of the Bombay Natural History Society*, 109(3), 173-176.

Harris, R.B. (1993). Dealing with uncertainty in counts of mountain ungulates. Pages 105-111 In: Fox, J.L. and Du Jizeng (Eds). *Proceedings of the 7th International Snow Leopard Symposium.* Held in Xining, China 1992. International Snow Leopard Trust, Seattle and Northwest Plateau Institute of Biology. 331 pages.

Harris, R.B, Cooney, R. and Leader-Williams, N. (2013) Application of the anthropogenic Allee effect model to trophy hunting as a conservation tool. *Conservation Biology*, 27*,* 945-951. doi:10.1111/cobi.12115.

Hutton, J, and Leader-Williams, N. (2003). Sustainable use and incentive-driven conservation: realigning human and conservation interests. *Oryx*, 37, 215-226.

Johnson, K. A. (1997). Status of Suleiman markhor and Afghan urial populations in the Torghar hills, Balochistan Province, Pakistan. In *Biodiversity of Pakistan*, (Eds). S. A. Mufti, C. A. Woods, & S. A. Hasan, pp. 469-483. Pakistan Museum of Natural History, Islamabad, Pakistan.

Kachel, S. (2014). Evaluating the efficacy of wild ungulate trophy hunting as a tool for snow leopard conservation in the Pamir Mountains of Tajikistan. Master of Science Thesis. University of Delaware. 98pp.

McCarthy, T.M. and Chapron, G. (2003). *Snow Leopard Survival Strategy*. International Snow Leopard Trust, Seattle, USA.

Michel, S. and Muratov, R. (2010). *Survey on Marco Polo Sheep and other mammal species in the Eastern Pamir (republic of Tajikistan, GBAO)*. Nature Protection Team, Khorog and Institute of Zoology and Parasitology of the Academy of Sciences of the Republic of Tajikistan. 28 pp.

Mishra, C., van Wieren S., Ketner, P., Heitkonig, I. and Prins, H. H.T. (2004). Competition between domestic livestock and wild bharal (*Pseudois nayaur*) in the Indian Trans-Himalaya. *Journal of Animal Ecology*, 73, 344-354.

Moheb Z., Mostafawi N., Noori H., Rajabi A. M., Ali, H. and Ismaily, S. (2012). *Urial survey in the Hindu Kush Range in the Wakhan Corridor, Badakhshan Province, Afghanistan*. Wildlife Conservation Society. 26 pp.

Mysterud, A. (2012). Trophy hunting with uncertain role for population dynamics and extinction of ungulates. *Animal Conservation*, 15, 14-15.

Ostrowski S, Noori, H. and Rajabi, A M. (2012). Livestock and urial interactions in Wakhan and the risk of disease transmission between them. WCS. 8 pp.

Rosen, T. (2012). Analyzing Gaps and Options for Enhancing Argali Conservation in Central Asia within the Context of the Convention on the Conservation of Migratory Species of Wild Animals. Report prepared for The Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bonn, Germany and the GIZ Regional Program on Sustainable Use of Natural Resources in Central Asia.

Schaller, G.B. (2005). *A winter survey of Marco Polo sheep in the southern Pamir Mountains of Tajikistan*. Report to Wildlife Conservation Society and National Geographic Society, New York, USA.

Shackleton, D.M. (2001). *A review of community-based trophy hunting programs in Pakistan.* Report prepared for Mountain Areas Conservancy Project, IUCN-Pakistan and National Council for the Conservation of Wildlife, Ministry of Environment, Local Government and Rural Development, Pakistan. 59 pp. (Available from: http://www.macp-pk.org/docs/trophyhunting_review.pdf)

Suryawnashi, K.R., Bhatnagar, Y.V. and Mishra, C. (2012). Standardizing the double-observer method for estimating mountain ungulate prey of the endangered snow leopard. *Oecologia* DOI 10.1007/s00442-011-2237-0

Wegge, P. (1997). Appendix 1. Preliminary guidelines for sustainable use of wild caprins. Pp. 365-372 in: D.M. Shackleton, (Ed). *Wild sheep and goats and their relatives. Status survey and action plan for Caprinae*. IUCN, Gland, Switzerland and Cambridge, UK.

Woodford, M.H., Frisina, M.R. & Awan, G.A. (2004). The Torghar Conservation Project: Management of the livestock, Suleiman Markhor (*Capra falconeri*) and Afghan Urial (*Ovis orientalis*) in the Torghar Hills, Pakistan. *Game and Wildlife Science,* 21, 177-187.

Chapter 14: Estimating Snow Leopard and Prey Populations and Monitoring Trends

14.1. Introduction

There are no robust estimates of snow leopard population size range wide or at national level (Jackson et al. 2010) but such estimates are urgently needed in order to detect population trends and inform conservation action.

Throughout the 1970s and 1980s, indirect evidence in the form of field sign (pugmarks, feces, scrapes and other scent markings) served as the primary means for confirming snow leopard presence and mapping its distribution. During the 1990s, systematic recording of field sign along transects under the SLIMS protocol (Jackson and Hunter 1997) was also used in crudely assessing snow leopard populations. SLIMS is a valuable tool for “presence-absence” surveys, and may have some use in assessing relative abundance if (1) restricted to scrapes or well-defined pugmarks, (2) aging criteria can be consistently applied and (3) feces are verified through genetic analysis. However, this technique if widely prone to error and/or bias related to observer-based differences in judging the age of signs, effects of rainfall and snowfall that influence sign detectability by damaging, obliterating or covering sign, and disturbance from livestock or humans (similar results) as well as observer skills at selecting and conducting surveys.

Compared to other large cats like the tiger (*Panthera tigris*), jaguar (*P. onca*), leopard (*P. pardus*) and puma (*Puma concolor*), very few snow leopards have ever been radio-collared, due in large part to the difficult terrain and their land home ranges which together present significant difficulties in obtaining enough fixes. While radio-telemetry may offer precise estimates of home range, such studies are generally too costly or time consuming to apply except in a few cases.

In the last few years, far more robust, sophisticated and reliable techniques have become available in the form of remote camera trapping, non-invasive genetics based on laboratory analysis of feces, and GPS/satellite collars that allow individual animals to be tracked across time and space. These technological innovations have been accompanied by advances in statistical computing that greatly increase the power of analyses.

A major limitation of all monitoring initiatives has been the relatively small study areas (a few hundred km^2), making extrapolations to larger landscapes difficult or problematic unless based on reliable maps of habitat suitability. Much of this is believed to be a direct consequence of logistic challenges of working in snow leopard habitats, and the limited resources at disposal (Janečka et al. 2011).

14.2. Camera-trapping

Modern camera-trapping of wild felids, using individual photo identification coupled with use of the Capture-Recapture (CR) algorithm, began on tigers in the 1990s, Since then, this technique has been applied to many species, including snow leopards. The advent of relatively cheap, reliable, and much more sophisticated digital cameras has led to camera trap surveys being applied widely across all countries of snow leopard range.

Important elements to consider in using camera trapping to generate population density estimates include individual identification, confidence in avoiding false IDs, ensuring adequate sample size and capture probability, proper camera location and spacing, size of study area and ad hoc density estimation from the calculation of an effective trapping area (Foster and Harmsen 2011). Jackson et al. (2006) recommended achieving capture probabilities of about 0.30. A common constraint, imposed by a combination of access and logistics involved in periodically moving traps to new sites, and the availability of cameras, is the size of area that can be surveyed within a time frame that minimizes the likelihood of violating key underlying assumptions of CMR and yet that permits sufficient captures and recaptures upon which to base abundance estimates.

Typically, sampling should be done over relatively large areas sufficient to support a population of at least 20 adults or more, although this may not prove feasible for snow leopards for several reasons: large home range, low densities and rugged terrain with limited access significantly limit the size of area which can be surveyed without danger of violating key assumptions related to population closure (immigration and emigration) and births/deaths (ca. up to 60-80 days). Large samples with adequate numbers of recaptures are necessary to ensure reasonably narrow confidence limits around the population estimates in order to detect changes over time robustly and accurately: thus, this goal may only be possible under special circumstances. Also, continued long-term abundance monitoring aimed at generating valuable additional data on life history parameters like birth rates, mortality, and migration are needed, but are typically costly since such studies hinge upon satellite telemetry and are labor intensive with respect to monitoring trail cameras, changing batteries and retrieving and processing images. The huge volume of photos generated, often including numerous false images, in nearly all surveys presents its own challenge, and represents a research topic for examining the utility of computer-assisted image recognition algorithms.

Another important issue in abundance estimation involves translating abundance values into density estimates. Conventional buffer-based approaches such as Mean Minimum Distance Moved (MMDM), ½ MMDM, and radius of home range (if available) have been used to estimate the effective trapping area and to calculate density (e.g. Karanth & Chundawat, 2004). These approaches have been criticized for underestimating the area and inflating density estimates (Efford 2011; Obbard et al 2010; Sharma et al. 2010; Soisalo & Cavalcanti 2006), with researches recommending combining telemetry and camera-trap studies.

A more feasible approach involves use of Spatially Explicit Capture Recapture (SECR) methods (Efford 2004; Royle & Young 2008; Linkie et al. 2010). These generate more realistic, geographically aligned density estimates, and are also compatible with information from other sources (e.g. DNA, occupancy surveys) as well as allowing for covariate analysis aimed at identifying key environmental correlates of high capture rates.

SECR models do not require estimation of the effective survey area, but instead estimate density directly using maximum likelihood (Borchers and Efford 2008) or hierarchical Bayesian (Royle and Young 2008) approaches. Such models use spatial information (i.e. capture locations) in conjunction with the capture probability of different individuals to estimate the number of sampled individuals likely having activity centers within the sampling area. Additionally, these models are robust to individual capture heterogeneity, and do not require strict geographic closure, a problematic assumption with many other CR models. SECR models have been used in camera-trapping studies (e.g. Royle et al. 2009; Sollmann et al. 2013) as well as in non-invasive genetic studies using hair snares (Obbard et al. 2010; Kery et al. 2011) as described below.

Photo capture–recapture density estimation may be of little value when population sizes are extremely low and individuals are elusive and highly dispersed; here simple photo capture rates may provide more reliable results as an index of relative abundance than capture–recapture density estimation. McCarthy et al (2008) considered photo-rates to provide a legitimate index of snow leopard abundance in their study area based on similarity with genetic individual identification. They noted that this relative index may be suitable when true densities are not needed, although this metric is also affected by multiple factors, from camera placement to spacing densities with regard to prevailing travel patterns of the resident or dispersing snow leopard cohort.

14.3. Fecal genetics

A more promising method of monitoring of snow leopard populations may involve fecal DNA analysis, especially given the generally lower costs and ability to cover large areas of habitat within a relatively short time-frame. However, important issues relating to aging and the relative longevity of genetic material in high elevation arid climates need to be resolved and standard procedures for collecting and analyzing feces put in place.

Schwartz et al. (2006) highlighted the use of genetic monitoring as a tool for conservation and management. Non-invasive fecal genetics is especially applicable to monitoring rare and elusive carnivores like the snow leopard, and may serve as a viable and more cost-effective alternative to intensive techniques such as fitting radio/GPS collars to free-roaming animals. The tendency of snow leopards to use well-defined travel routes (Ahlborn and Jackson 1986; Jackson and Ahlborn 1989) facilitates the collection of feces, especially in mountains with well-defined ridges and drainages. The dry, cold climate helps retard bacterial action and breakdown of nucleic acids that otherwise degrades genetic material, so that amplification success rates tend to be higher than for felids inhabiting tropical climes.

Among the many applications aiding in the conservation of elusive cats are species identification to establish species distribution; habitat requirements and diet, determination of the sex of individuals within a population; and identification of individuals within a population, allowing for estimates of population abundance and breeding rates (Rodgers and Janečka 2012). Fecal DNA enables researchers to investigate evolutionary, population, landscape or conservation genetic hypotheses like the rate of gene flow, metapopulation dynamics, habitat connectivity, genetic diversity and phylogeography. Additionally, species ID from scat can be used to identify those individuals most responsible for livestock related depredation conflicts with humans and to provide data for modeling occupancy across different habitat and study sites (Mackenzie et al. 2002).

Monitoring snow leopard population trends over time using non-invasive genetic methods should enable managers to better identify population declines and threats of local extinction, as well as assessing the effectiveness of conservation actions or the outcome of re-introduction programs. Individual identification can also be used to examine ecological and behavioral parameters such as home range size, spatial overlap between individuals and population turnover, as well as to identify ‘problem animals’ responsible for attacks on livestock or conflict with humans. Finally, individuals must be identified among the scat sampled before population, landscape and conservation genetics analyses can be conducted (Rodgers and Janečka 2012).

Polymorphic microsatellite markers within each population provide the basis for identifying individuals. For any two individuals, the probability that both will share the same allele at a given microsatellite locus is dependent upon the frequency of that allele in the population. As more loci are analyzed, the probability that two individuals will possess the same alleles at all loci decreases multiplicatively. The number of microsatellite loci that should be used to identify individuals is a balance between achieving sufficiently low probability of individual identity, whilst minimizing costs by using the least number of loci necessary. Where different populations are sampled and/ or where large numbers of individuals are being sampled (>100), additional loci may be required since some loci may not be variable across all populations.

Once individuals have been identified, the simplest approach to population estimation is to determine the minimum number of individuals present within the area surveyed. Capture–Recapture approaches comparable to camera trapping can be employed to generate more rigorous estimates of abundance based on sampling over multiple, independent sampling occasions; however, the important issue of aging of feces remains to be resolved.

The other important study design element – still under study --involves how best to delineate and estimate the actual area being sampled, since this suffers from similar biases associated with camera trap studies. The relationship between extraction success and scat age needs to be more thoroughly investigated in order to establish robust temporal limits for genetic surveys. Several population estimation methods are available if samples cannot be collected over sequential and multiple sampling occasions (Rodgers and Janečka 2012). Janečka et al. (2011) recommend that to minimize such bias, non-invasive scat survey transects should be uniformly distributed and oriented to maximize the area surveyed (see Box 2). These investigators also suggest that it may be preferable to sample a greater number of shorter transects, as opposed to a few long transects.

However, fecal genetics has a number of downsides: it is time consuming, and sequencing costs (roughly 5–10 USD/sample for species identification and 10-20 USD/sample for individual and gender identification) may be prohibitive for large-scale studies or for those individuals and agencies that do not have access to the latest, but costly sequencing equipment. Rodgers and Janečka (2012), Janečka et al. (2011) and Lampa et al. (2013) offer guidelines for sample collection, storage and DNA extraction. Rigorous error-detection procedures must be followed, including highly recommended exchange of blind samples between different laboratories. As noted by numerous investigators, the techniques employed must be carefully matched and customized to the task and questions being posed; these are undergoing constant change and improvement as more sophisticated sequencing equipment becomes available and new or more efficient approaches are identified. In addition, because allele sizes can vary, care must be taken when combining samples across different areas, time periods, or studies unless a subset of the same samples is analyzed together in order to calibrate the allele designations and arrive at reliable estimates of the number of individuals present.

Lampa et al. (2013) reviewed potential sources of error associated with non-invasive genetic capture-mark-recapture analysis, including low amplification success rates and genotyping errors that can substantially bias subsequent analysis. In order to attain reliable results and minimize time and costs required for non-invasive microsatellite genotyping, one must carefully choose a species-specific sampling design, methods that maximize the amount of template DNA, and methods that could overcome genotyping errors, especially when using low-quality samples. A key goal involves generating consensus genotypes to minimize errors that lead to overestimated population sizes. The literature includes many other methodological reviews that are beyond the scope of the SLSS document.

Research has indicated that even experienced field researchers mistakenly allocate feces to snow leopards which were deposited by foxes (Janečka et al. 2008). Scat misidentification leading to presumed species presence in an area where it does not occur may waste limited conservation resources. Therefore, genetically-based verification of feces is an essential component of any diet study, since it is impossible to definitively identify all snow leopard scats from that of other carnivores in the field.

In comparing these two methods, camera-trapping and fecal genetics, for surveying and monitoring snow leopards, Janečka et al. (2011) cautioned that estimates from the two approaches may be difficult to compare because of differences in the distribution of observations and because sub-adults are typically excluded from population estimates derived from camera-trapping, whilst differentiating between adults and sub-adults is not possible using non-invasive genetic techniques. However, these investigations concluded that the costs of estimating abundance of snow leopards using non-invasive genetic sampling is lower than for camera-trapping primarily because a much larger area can be covered within a shorter period of field time. Therefore, scat sampling has the potential to enable large-scale (i.e. regional) distribution and abundance surveys of snow leopards at significantly lower costs than camera trap surveys. This assumes equivalent laboratory capabilities between range states and/or that samples can be shared between designated laboratories located in different countries. Important advantages of such information sharing include the ability of different facilities to identify the same individuals (important in transboundary locations), use of standardized methods with increased rigor and robustness of the resulting data and cross-validation of data sets.

In genetic sampling, it is difficult to separate dependents (cubs) from adults, and as noted above the sampling period is also difficult to ascertain, because some collected scats might well be older than the desired sampling period.

However, a major advantage of camera trap and fecal genetics techniques is that all of the above can be done without having to capture or directly observe snow leopards, thus greatly increasing the number of individuals sampled (compared to costly telemetry) and the amount of data that can be collected (compared to camera-trapping). In addition, snow leopard density estimates from various sites are in turn expected to help understand relationships between these estimates and sign-based occupancy estimates, at various scales.

14.4. Occupancy modelling

One issue influencing estimates of population density of snow leopards and other secretive species is that of 'detectability' - the probability of detecting a snow leopard during a survey even if it is present at the site. A new type of statistical modelling technique (occupancy models) was developed to deal with problems created by imperfect detectability (Mackenzie et al. 2006). These models use information from repeated observations and the proportion of sites occupied. The records of whether the species was detected or not detected at each site during each survey are then converted to mathematical statements. Occupancy modelling offers potential in increasing the robustness of density estimates, but is dependent on meeting a set of assumptions to avoid bias. Few if any applications to snow leopards have so far been reported.

14.5. Radio and satellite telemetry

Radio-collaring of snow leopards was pioneered in western Nepal in the 1980s (Jackson and Ahlborn 1989 and generated valuable new information on home ranges, movement patterns and density. Subsequently, similar operations were undertaken in NW India (Chundawat 1990), western Mongolia (McCarthy 2000), Nepal (Oli 1997) and Pakistan (McCarthy et al. 2007). The feasibility of remote telemetry has been dramatically improved with the availability of miniaturized radio collars and GPS satellite technology which allows multiple fixes to be obtained daily and downloaded remotely, thus providing detailed data on movement patterns, habitat use, home range size and dispersal. This technique has been deployed in an ongoing, long-term study in the South Gobi, Mongolia during which 19 snow leopards have been collared. The first results of this study have now been published (Sharma et al. 2014). In other areas, in 2008 one animal was equipped with a satellite collar in Baga Bogd, Mongolia (B.Munkhtsog, pers comm.) and five snow leopards were fitted with these devices in Wakhan, Afghanistan in 2013 (P. Zahler, pers. comm. 2014). Researchers recently collared a male snow leopard in eastern Nepal (WWF-Nepal, pers comm.). Further, a device to automate and enable constant monitoring of trap transmitters while capturing snow leopards has been invented (Johansson et al. 2011).

14.6. Monitoring prey populations

Developing robust methods of estimating prey populations that allow for statistical comparison over time and space are crucial. Singh and Milner-Gulland (2011) explored the pros and cons of various methods available for monitoring snow leopard prey populations. Suryawanshi et al. (2012) propose the use of double observer methods to monitor snow leopard prey. The methods have been implemented at a few sites including India and Mongolia, and the results have been found comparable to predicted prey populations. Although some minor modifications may need to be made in the method to cater to specific issues such as behavioral response of animals in areas where hunting is prevalent, or have highly variable prey group sizes (Tomotsukh (2013), the method can efficiently be used to estimate and monitor prey populations in specific landscapes. For larger landscapes that include an entire range or a province, information on local extinctions and colonisations can be generated using site occupancy framework. This method may not provide abundance estimates, but provides useful probabilistic estimates of local colonization and extinctions taking place for the species of interest. Further testing and development of prey abundance monitoring techniques is warranted.

Attaining robust estimates of the size of mountain ungulate populations is problematic due to a range of factors including broken terrain hindering visibility and clumped distributions and consequent issues with detectability. It is notoriously difficult to meet the assumptions for *Distance Sampling* and a combination of block and point-counts is still widely used, e.g. as developed for censusing argali and ibex in Kyrgyzstan by the IUCN Caprinae Specialist Group and others. Such raw or uncorrected counts are often the best available, but biases cannot be quantified and so the results should be interpreted with care (see e.g. Wingard et al. 2011).

Harris et al. (2010) concluded that fecal DNA analysis of prey species like the argali is too expensive, although this study demonstrated the importance of sex identification and separate sex-based abundance estimates, especially where movement ecology differs by sex.

14.7. Aerial photography

Recent technical advances in aerial photography have greatly improved the counting of ungulates in open terrain and trials should be conducted in mountain habitats to assess their potential, especially in conjunction with lightweight unmanned aerial vehicles (UAVs), commonly termed drones, which are being increasingly deployed as a tool in biodiversity surveys and environmental monitoring.

For larger landscapes that include an entire range or a province, information on local extinctions and colonisations can probably be generated using site occupancy framework, assuming ungulates can be detected using technologies like thermal sensing; feasibility studies in the high mountains have yet to be conducted. Presumably winter, fall or spring represent the best time, when ambient temperatures are low and the animal’s warm-bodied thermal signatures most different from that of the background. Even where this method cannot provide abundance estimates, it might enable useful probabilistic estimates of local colonization and extinctions for the species of interest. Further testing and development of prey abundance monitoring techniques is warranted in order to establish optimal grid dimension and sampling replicates.

We also postulate that the visual or thermal detection of snow leopard by remotely controlled UAVs is probably not possible, except in unusual circumstances, given this species' thick pelage and excellent thermal conservation as well as its preference for seeking protected daytime beds.

We also recommend investigating the option of involving local students and herders as "citizen naturalists or scientists" in helping to document ungulate sightings over time under a standardized occupancy framework managed by a trained biologist. While these individuals would probably not have access to GPS units, their records could be based on the pre-designated watershed and/or livestock pasture polygons or blocks along with use of simple data forms for gathering and tabulating sightings and/or sign.

14.8. Monitoring snow leopards: the need for regional and global monitoring alliances

Monitoring serves as an alarm system alerting managers to possible population declines and for enabling the creation of population baselines against which conservation interventions and targets can be designed, measured and compared between areas or over time. However, it requires a well-implemented monitoring program in order to evaluate snow leopard status and performance of conservation initiatives. Any monitoring program should be structured in order to facilitate adaptive management.

There are two simple but real constraints in monitoring the abundance of snow leopards. First, estimating abundance over the entire habitat, or even in the area of interest, is usually difficult, and in the specific cases of snow leopard, it may not be feasible. Second, while it is usually simpler to detect the presence of the species within a given sampling unit, it is far more challenging to ascertain or confirm its absence (the problem of false absence). Appropriately designed sampling schemes, together with analytical frameworks such as occupancy modeling or capture-recapture analyses can help overcome these challenges.

The key elements in monitoring snow leopards involve tracking population size and trend. At the very least, the presence/absence of snow leopards (based on sign, sightings, reports of local informants etc) within carefully designated sampling units could be monitored, yielding distribution maps and changes in distribution over time. At the level of landscapes, changes in the relative abundance of snow leopards could be monitored, estimated through various indices including snow leopard sign, camera trap capture rates and individual IDs and fecal DNA sampling. Finally, the most desirable -- albeit also the most difficult indicator to monitor --- is the actual population size of snow leopards, and how each population or subpopulation in the general region changes over time, along with the level of functional connectivity between separate entities.

How frequently should the monitoring be carried out? That is no simple answer but snow leopard abundance in the key conservation landscapes using robust mark-recapture or SCER techniques could ideally be estimated annually or once every in three years. Large-scale (country-wide) snow leopard occurrence could be monitored once in 5 years based on occupancy frameworks, and supplemented by more localized camera trapping or fecal DNA surveys.

The importance of coordinating snow leopard landscape identification and population monitoring cannot be over-estimated. SLN therefore recommends the GSLEP sponsors organize a workshop bringing together experts from range state governments, and national and international research institutions and NGOs to address the questions posed above with the objective of generating a Range-Wide Plan for monitoring progress.

References

Ahlborn, G. and Jackson, R. (1988). Marking in free-ranging snow leopards in west Nepal: a preliminary assessment. Pages 25-49 In: H. Freeman (Ed). *Proceedings 5th International Snow Leopard Symposium* International Snow Leopard Trust and Wildlife Institute of India, Seattle, Washington. 269 pages.

Chundawat, R. S., Panwar, H.S and Rawat, G.S. (1990). *The ecological studies of snow leopard and its associated prey species in Hemis High Altitude National Park, Ladakh*. Technical Report No. RR-l, Wildlife Institute of India, Dehra Dun.

Borchers, D.L .and Efford, M.G. (2008). Spatially explicit maximum likelihood methods for capture-recapture studies. *Biometrics,* 64, 377-385.

Efford, M. (2004). Density estimation in live-trapping studies. *Oikos*, 106, 598–610.

Efford, M. G. (2011). Estimation of population density by spatially explicit capture-recapture analysis of data from area searches. *Ecology*, 92, 2202–7.

Efford, M.G., Dawson, D.K and Robbins, C.S. (2004). DENSITY: software for analyzing capture-recapture data from passive detector arrays. *Animal Biodiversity and Conservation*, 27(1), 217-228.

Foster, R.J. and Harmsen, B.J. (2011). A critique of density estimation from camera-trap data. *Journal Wildlife Management*, 76(2), 224–236.

Gopalaswamy, J.M., Royle, J.A., Hines, J.E., Singh, P., Jathanna, D., Kumar, N.S. and Karanth, K.U. (2012). Program SPACECAP: software for estimating animal density using spatially-explicit capture-recapture models. *Methods in Ecology and Evolution,* 3(6), 1067-1072.

Harris, R.B., Winnie, J. Jr., Amish, S.J., Beja-Pereira, A., Godinho, R., Nia Costa, V. and Luikart, G. (2010). Argali abundance in the Afghan Pamir using capture–recapture modeling from fecal DNA. *Journal of Wildlife Management*, 74(4), 668–677.

Jackson, R. and Ahlborn, G. (1989). Snow leopards (*Panthera uncia*) in Nepal: home range and movements. *National Geographic Research*, 5, 161-175.

Jackson, R. and Hunter, D.O. (1996). *Snow leopard survey and conservation handbook.* International Snow Leopard Trust, Seattle, and U.S. Geological Survey, Biological Resources Division, 154 pages + appendices.

Jackson, R., Roe, J.D., Wangchuk, R. and Hunter, D.O. (2006). Estimating snow leopard population abundance using photography and capture–recapture techniques. *Wildlife Society Bulletin*, 34, 772–781.

Jackson, R., Munkhtsog, B., Mallon, D.P., Naranbaatar, G. and Khurlee Gerelmaa, K. (2009). Camera-trapping snow leopards in the Tost Uul region of Mongolia. *Cat News*, 51, 18-21.

Janečka, J.E., Jackson, R., Yuguang, Z., Diqiang, L., Munkhtsog, B., Buckley-Beason, V. and Murphy, W.J. (2008). Population monitoring of snow leopards using noninvasive collection of scat samples: a pilot study. *Animal Conservation*, 11, 401-411.

Janečka, J.E, Munkhtsog, B., Jackson, R., Naranbaatar, G., Mallon D.P., and Murphy, W.J. (2011). Comparison of noninvasive genetic and camera-trapping techniques for surveying snow leopards. *Journal of Mammalogy*, 92, 771–783.

Karanth, K., & Chundawat, R. (2004). Estimation of tiger densities in the tropical dry forests of Panna, Central India, using photographic capture–recapture sampling. *Animal Conservation*, 7, 285–290.

Kéry, M., Gardner, B., Stoeckle, T., Weber, D. and Royle, J.A. (2011). Use of spatial capture-recapture modeling and DNA data to estimate densities of elusive animals. *Conservation Biology*, 25, 356–364.

Lampa, S., Henle, K., Klenke, R., Hoehn, M. and Gruber, B. (2013). How to overcome genotyping errors in non-invasive genetic mark-recapture population size estimation—a review of available methods illustrated by a case study. *Journal of Wildlife Management*, 77(8), 1490–1511.

Li, J., Wang, D., Yin, H., Zhaxi, D., Jiagong, Z., Schaller, G. B., and Lu, Z. (2014). Role of Tibetan Buddhist monasteries in snow leopard conservation. *Conservation Biology*, 28(1), 87-94.

Linkie, M., Guillera-Arroita,G., Smith, J. and Rayan, D.M. (2010). Monitoring tigers with confidence. *Integrative Zoology*, 5, 342-350.

Mackenzie, D. I., Nichols, J.D., Lachman, G.B., Droege, S., Royle, J.A. and Langtimm, C.A. (2002). Estimating site occupancy when detection probabilities are less than one. *Ecology*, 83, 2248–2255.

Mackenzie, D. I., Nichols, J.D., Royle, J.A., Pollock, K.H., Bailey, L.L and Hines, J.E. (2006). *Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence*. Elsevier, Amsterdam.

McCarthy T.M. (2000). *Ecology and conservation of snow leopards, Gobi brown bears and wild Bactrian camels in Mongolia*. University of Massachusetts, Amherst, MA, USA.

McCarthy T.M., Khan J., Ud-Din J. and McCarthy K. (2007). First study of snow leopards using GPS-satellite collars underway in Pakistan. *Cat News*, 46, 22-23.

McCarthy, K. P., Fuller, T. K., Ming, M., McCarthy, T. M., Waits, L., and Jumabaev, K. (2008). Assessing estimators of snow leopard abundance. *Journal of Wildlife Management*, 72, 1826–1833.

Oli M.K. (1997). Winter home range of snow leopards in Nepal. *Mammalia*, 62, 355-360.

Obbard, M. E., Howe, E. J., and Kyle, C. J. (2010). Empirical comparison of density estimators for large carnivores. *Journal of Applied Ecology*, 47(1), 76–84.

Rodgers, T.W. and Janečka, J.E. (2013). Applications and techniques for non-invasive fecal genetics research in felid conservation. *European Journal of Wildlife Research*, 59, 1-16.

Royle, J.A, and Young, K. (2008). A hierarchical model for spatial capture-recapture data. *Ecology*, 92, 526–528.

Royle, J.A, Karanth, K.U., Gopalaswamy,A.M. and Kumar, N.S.S (2009). Bayesian inference in camera trapping studies for a class of spatial capture–recapture models. *Ecology*, 90, 3233–3244

Sharma, R.K., Jhala, Y., Qureshi, Q., Vattakaven, J., Gopal, R., and Nayak, K. (2010). Evaluating capture–recapture population and density estimation of tigers in a population with known parameters, *Animal Conservation*, 13(1), 94-103.

Singh, N.J. and Milner-Gulland, E.J. (2011). Monitoring ungulates in Central Asia: current constraints and future potential. *Oryx*, 45, 38–49.

Soisalo, M.K. and. Cavalcanti, S.M.C. (2006). Estimating the density of a jaguar population in the Brazilian Pantanal using camera-traps and capture-recapture sampling in combination with GPS radio-telemetry. *Biological Conservation,* 129, 487-496.

Sollmann, R.,Tôrres, N.M., Furtado, M.M, Tereza de Almeida, A., Jácomo, F., Palomares, S., Roques, S. and Silveira, L.(2013). Combining camera-trapping and noninvasive genetic data in a spatial capture–recapture framework improves density estimates for the jaguar. *Biological Conservation*, 167, 242-247.

Stanley, T. R. and Burnham, K.P. (1999). A closure test for time-specific capture–recapture data. *Environmental and Ecological Statistics,* 6, 197–209.

Suryawanshi, K.R., Bhatnagar, Y.V. & Mishra, C. (2012) Standardizing the double-observer survey method for estimating mountain ungulate prey of the endangered snow leopard. *Oecologia*, 169, 581–90.

Swartz, M.K., Luikart, G. and Waples, R.S. (2006). Genetic monitoring as a promising tool for conservation and management. *Trends in Ecology and Evolution,* 22(1), 25-33.

Tobler, M.W. and Powell, G.V.N. (2013). Estimating jaguar densities with camera traps: Problems with current designs and recommendations for future studies. *Biological Conservation,* 159, 109–118.

Wingard, G.J., Harris, R.B., Amgalanbaatar, S. and Reading, R.P. (2011). Estimating abundance of mountain ungulates incorporating imperfect detection: argali (*Ovis ammon)* in the Gobi Desert, Mongolia. *Wildlife Biology,* 17, 93-101.

World Bank (2013). Global Snow Leopard & Ecosystem Protection Program: Conference Document for Endorsement (71 pages) and Annex Document of Complete National Programs (234 pages). Washington DC.

Box 1: Specific Recommendations for Camera-trap Surveys of Snow Leopards

Box 2: Specific Recommendations for Non-invasive Fecal Genetic Surveys

BOX 1: Recommended Guidelines for Remote Trail Camera Surveys of Snow Leopard

Camera Trapping, has become a preferred tool for investigating snow leopard abundance and distribution patterns. Nonetheless, we believe more attention should be devoted toward standardizing sampling procedures and minimizing the underlying sources of bias that result from this felid's low numbers, sparse distribution and relatively large home ranges (Jackson et al, 2006, McCarthy et al 2008). The snow leopard's rugged and largely roadless habitat hampers on-the-ground logistics, making the deployment and servicing of cameras both time-consuming and relatively expensive compared with other large cats like jaguar and tiger.

We urge all researchers to consult the literature prior to undertaking their camera survey. Unless carefully planned and then rigorously executed, the resulting survey may end up reporting little more than the "number of photographs taken." Many surveys fail in properly documenting photo-capture rates, or to even list the minimum number of individuals detected -- thus limiting their usefulness for conservation.

Camera reports often only consist of a series of photos disseminated through social media. Unless robust and defensible abundance and/or density estimates are undertaken, snow leopard conservation will suffer and valuable resources may be needlessly squandered.

The key elements and associated questions that need to be addressed during any remote camera survey should include the following:

- Pre-survey planning, including launching a pilot or feasibility study to address the question, "what are the prospects of the survey generating sufficient information on population size and/or occupied range in Area X and Y?"
- Critical parameters for population estimation under the Capture-Recapture (C-R) framework, including a working understanding of the assumptions underlying each model
- Size and configuration of the survey area (how big should an area should be surveyed and how many trail cameras do I need to complete the survey?)
- Spacing of trail cameras (where should I place cameras and how far apart should they be?)
- Duration of the survey, including identifying an optimal sampling period and session interval

- Data analysis and interpretation (Which population estimation model or models are most appropriate for my dataset? How much information will I need to collect to complete the computations?)
- Lessons learned and recommendations (how can future surveys be improved?)
- Dissemination of survey results (Who should I share the results with? What information is most important to share with others?)

Survey Pre-Planning: We urge all investigators to familiarize themselves thoroughly with the available literature, and to consult experts for advice. Further, it is highly recommended that researchers carry out simulation studies in order to test their study design prior to deploying camera traps in the field. These simulations are readily implemented using the SECR package in R (Efford, 2011b) or the software DENSITY (Efford, 2011a). Both packages allow users to use a real camera trap layout and to define realistic parameters as the basis for simulations. By varying parameters like trap density, home range size or encounter rates, one can evaluate the range of conditions under which the proposed study design would be expected to give the best results.

Paying attention to even small details, like minimizing false-triggering, maintaining camera battery life and freeing memory card space, pays major dividends in the long-run through more time-efficient and site-sensitive data collection. In order to estimate population densities robustly, researchers must carefully plan and adopt sampling protocols that are based on a biologically meaningful understanding of snow leopard habitat use and movement patterns in the survey area. This, in turn, will help ensure cameras are well located, thus more likely to generate high capture and recapture rates which are required by most computer-enabled capture-recapture computations.

Demographic and Geographic Closure: Abundance and density estimates depend upon meeting the basic assumptions underlying the C-R framework, namely demographic and geographic closure of the sampled population over the entire sampling period. In addition, one should be familiar with known or potential sources of bias that lead to unequal capture rates between individuals or variations over time – all of which need to be addressed through proper survey design, camera placement etc.

Study Area Size: Camera trap surveys are only useful if they encompass most or all of the home ranges of multiple individuals, preferably for a sample size in excess of 15-20 individuals. While home range sizes varies widely, from around 50-100 km^2 in the Himalaya to as much as 800 km^2 in Mongolia, individual snow leopard home ranges tend to overlap to a large extent, especially between gender. Dominant males occupy home ranges 2 – 4 times greater than those of females, along with exhibiting greater spatial exclusivity. Females with cubs gradually expand their area of use as their litter ages and become more mobile. Therefore, on the basis of home range size and assuming a population in excess of 5-10 individuals, the survey area should total at least 300 km^2 and 1,000 km^2 or more in size. The study area boundaries and configuration should follow the natural local mountain terrain, and may include patches of less suitable habitat like an intervening alluvial plain or high-elevation snowfield.

Camera Placement: Trail cameras should be placed at sites in ways that maximize the detection of a passing snow leopard (i.e. at communal sign sites and along well used travel routes, including well-defined ridgelines, the base of cliffs or along narrow drainages). We recommend striving for capture probabilities of ≥ 0.30. Such capture rates serve to improve the precision of survey estimates and resulting upper and lower population bounds (95% confidence intervals), of course assuming a sufficiently large survey area and optimized camera spacing. Note that camera arrays placed randomly within the landscape have low or very low capture probabilities, resulting in poor if any usable data.

Size of Camera Polygon and Camera Spacing: The camera polygon or grid size for a density study should be at least the size of one home range (usually female). However, researchers are still debating whether to use the average size of an adult female or male range, a metric that should not be confused with total extent of habitat covered during the course of an entire camera survey. Extending the survey area helps reduce potential bias, increase sample size, and include greater habitat heterogeneity, thereby making it more representative of the general area and thus better at supporting the extrapolation of density values to a larger regional scale. Tobler and Powell (2013) recommend that when the area that can be covered by a camera polygon is limited, using a more rectangular grid should improve density estimates by SECR models. In that case, the survey area design should attempt to have the long side of the polygon be at least the length of one home range diameter.

<u>Camera Spacing</u>: Jackson et al. (2006) used a camera density of two cameras per 16-32 km^2 for his survey in Ladakh and which relied upon analog trail cameras that require more regular servicing because of the maximum of 36 images per roll of film. Photo capacity is no longer a limitation with the advent of digital trail cameras that are capable of storing many thousands of pictures -- meaning trail cameras can be left unattended longer and dispersed over a wider area. Periodic visit to ensure the units are functioning properly are essential, however.

Tober and Powell (2013) concluded that the maximum distance between cameras depends on the female home range which is generally much smaller than those of males. According to simulations by these investigators, surveys with fewer stations will likely result in biased or at least imprecise results unless capture probabilities are very high. If the number of cameras available is smaller than the total number needed, a blocked design can be used where cameras are periodically moved during the survey to ensure there are no gaps large enough to enable an individual snow leopard to remain undetected during the course of the survey. Procedures for enabling this are well documented in the literature.

Based on this and other surveys, we recommend spacing cameras at least 2-3km apart and preferably at distances of 4-5 km, with a total of at least 20-25 trap stations deployed and concurrently operational in the same area, over a minimum of 30-40 consecutive days.

<u>Survey Duration and Sampling Intervals</u>: Camera trap surveys require a minimum of 40-50 days, although 60-80 days are preferred as long as these do not violate assumptions of population closure. This is best assessed using the program *Closure* (Stanley and Burnham 1999). Sampling intervals can vary from 1 day to 3 or 5 day intervals with aggregated data providing higher capture probabilities. Based on pre-survey trials, investigators need to estimate mean times to first captures, then using this interval as a preferred duration before shifting the camera array to new sites.

<u>Data Analysis and Available Models</u>: C-R models have become far more sophisticated since the original work by White et al. (1982); they are implemented through software programs like *Capture* (Otis et al 1878) and *Mark* (White and Burnham 1999) and more recently R program modules such as *RMark* and *RCapture*. The program *SpaceCap* automates implementation of the Bayesian SECR abundance estimation method (Gopalaswamy et al. 2012). For details consult the original papers as well as the camera trap handbook available for download from the Snow Leopard Conservancy's website: (http://www.snowleopardconservancy.org/pdf/screen111705.pdf)

We recommend using SECR models since these accommodate differences in capture probability between sites, and offer more robust estimation of the area sampled than prior methods that relied on buffering trap arrays (for example, mean maximum distance moved, MMDM or ½ MMDM). Under Mark or RMark, one can examine the influence of predictive site and individual covariates (e.g., habitat type, sex/age cohort etc). Besides altering camera polygon size, another means for increasing sample size entails combining data from multiple surveys where home ranges and habitat are similar. When applying the SECR model, it is straight forward to include the exact number of days each camera was active, thus accounting for camera failure or blocked designs where not all cameras were active at the same time. Not accounting for camera failure can lead to biased density estimates resulting from the underestimation of capture probabilities. Another approach receiving attention recently is the hierarchical Bayesian multi-state mark–recapture model (Calvert et al. 2009) that permits partitioning of complex parameter variation across space or time, as well as simultaneous analysis of multiple data sets. Depending upon data availability, subsampling of environmental covariates greatly improves the utility of population estimates. The assumption of equal detectability rarely holds, so estimating capture probabilities based on sex and/or age should receive high priority.

Like other felids, male and female snow leopards appear to have different home range sizes with varying encounter rates and not accounting for this may lead to biased density estimate. Therefore, try to include sex covariates both for the k0 and the r parameter. While the maximum likelihood implementation of SECR models requires the sex of each individual to be known, the Bayesian implementation allows for such missing data (Sollmann et al., 2011). With the inclusion of covariates, however, the data are divided up into smaller groups and thus larger sample sizes will be needed. SECR models with sex covariates have been run with 10 individuals in jaguars (Sollmann et al., 2011), but a sample size of 30 or more individuals is required for more precise estimates with smaller confidence intervals. Clearly, such a target is difficult or very difficult to achieve in snow leopards, perhaps another reason why genetic means for estimating population merit more attention.

Use of Baits and Attractants: As noted above, generating unbiased sample of populations is not simple: due to behavioral differences between species and individuals, the abundance of photo-captures is being constantly influenced by how each target animal reacts to the remote camera, human activity, the presence (or absence) of roads or trails, and differences in habitat. Therefore, we do not recommend using baits or artificial lures on formalized abundance surveys, since these may result in varying responses (e.g., camera-happy individuals may be attracted while camera-shy individuals deterred by such scent).

Detecting Population Change over Time: The ability to detect population change over time with any degree of confidence represents an unresolved challenge because of typically low detection probabilities, limited sample sizes, and site specific variation and changes in snow leopard social status and structure over the short-term and upon which optimal trap placement may depend to some degree. Linkie et al. (2010) in referring to low density tiger populations (e.g. <1 adult tigers/100 km^2) noted obtaining sufficient precision for state variable estimates from camera trapping represented a major challenge because of insufficient detection probabilities and/or sample sizes. These investigators suggested that occupancy surveys might overcome this problem by redefining the sampling unit (e.g. grid cells and not individual tigers).

BOX 2: Suggested Guidelines for Fecal (Scat) Genetic Surveys

SLSS recommends a collaborative effort to test, evaluate and formulate standard protocols for undertaking non-invasive fecal genetic surveys aimed at quantifying snow leopard presence/absence (occupancy) at regional scales, along with population size estimation based on the number of unique individuals detected over representative time frames. These protocols are needed in support of the Global Snow Leopard Environmental Protection Plan (World Bank 2013) goal of "20 landscape-level populations of snow leopards secured by the year 2020."

We suggest that 2-3 contiguous blocks of habitat which could support >100 breeding snow leopards be selected in each country. Within these blocks a noninvasive genetic survey should be carried out in 3 sites; the core area of the block, representative peripheral area at the edges, and an area of intermediate habitat quality. Field staff would collect recent (fresh) scats along transects in 10 predefined 25 km^2 sampling grids located in each of the 3 areas for a total of 30 grids sampled. Late winter, after the snow cover has melted but before daytime ambient temperatures rise much above about 50 °F represents a prime time for sample collection. Late fall, before the onset of snowfall offers another suitable window. Approximately 30 scats would be collected per grid, for a total of up to 900 scats per survey block.

All samples will be collected using a standardized method, stored and then analyzed at an approved laboratory according to a mutually agreed methodology that includes rigorous quality controls implemented at the country, regional and international levels. Since snow leopard habitat and populations of range countries extend across their national boundary to neighboring states, it is essential that all samples be aligned along a known base pair scale, so that common (i.e. the same) individuals can be identified in locations where (a) snow leopards are known to move between separate populations including international borders, and (b) where young animals (especially males) disperse further from their natal area, and may thus range into a neighboring country or adjacent snow leopard landscape unit.

Detailed information on methodologies for sequencing samples successfully while maintaining high quality control standards is beyond the scope of the SLSS document, but will need to be addressed by both researchers and supporting government agencies.

Appendix 1. List of completed and ongoing studies which have estimated snow leopard populations using camera trapping and fecal genetics[1]

Country	Location	Area (km^2)	Start date	End date	Survey method	Minimum number	Estimate	Density per (km^2)	Reference	Remarks
Bhutan	Upper Chamkar Chu,Wangchuck Centennial Park	797			Camera-trapping	9	9	2.39	Shrestha et al 2013	Not available
China	Qinghai				Genetic analysis	1			Janecka et al. 2008	Peer reviewed
China	Tomur		November	December	Genetic analysis	9			McCarthy et al. 2008	Peer reviewed
China	Tomur	813	23 Oct 2005	20 Dec 2005	Camera trapping	4	6	0.74	McCarthy et al. 2008	Peer reviewed
China (Gansu)	Qilianshan NR	480	Jan 2013	Apr 2013	Camera Trapping	4			Shi et al, in prep	Not yet available
China (Gansu)	Qilianshan NR	67	Jul 2012	Sep 2012	Camera Trapping	3			Shi et al, in prep	Not yet available
China (Gansu)	Qilianshan NR	67	Feb 2012	Apr 2012	Camera Trapping	5			Shi et al, in prep	Not yet available
China (Qinghai)	Akesai	50-75	2009	2009	Genetic analysis	5			Janecka et al. 2009	SLN report
China (Qinghai)	Akesai	125-175	2009	2009	Genetic analysis	14			Janecka et al. 2009	SLN report
China (Qinghai)	Nangqian	25-50	2009	2009	Genetic analysis	3			Janecka et al. 2009	SLN report
China (Qinghai)	Zhiduo	25-50	2009	2009	Genetic analysis	1			Janecka et al. 2009	SLN report

Country	**Location**	**Area (km^2)**	**Start date**	**End date**	**Survey method**	**Minimum number**	**Estim ate**	**Density per (km^2)**	**Reference**	**Remarks**
China (Qinghai)	Zhiduo	25-50	2007	2007	Genetic analysis	2			Janecka et al. 2009	SLN report
China (Qinghai)	Tainjun	25-50	2007	2007	Genetic analysis	3			Janecka et al. 2009	SLN report
China (Qinghai)	Dulan	75-100	2007	2007	Genetic analysis	3			Janecka et al. 2009	SLN report
China (Quighai)	Suojia		10 May 2011	18 Jul 2011	Camera trapping	29	41	3.1	Li, J (2012)	Thesis
China (Sichuan)	Wolong NR	44	Feb 2010	Apr 2010	Camera Trapping	2			Shi et al, in prep	Not yet available
China (Sichuan)	Luoxu NR	86	Mar 2010	Apr 2010	Camera Trapping	1			Shi et al, in prep	Not yet available
China (Tibet)	Shenzha	25-50	2008	2008	Genetic analysis	4			Janecka et al. 2009	SLN report
China (Tibet)	Jiduo	25-50	2008	2008	Genetic analysis	2			Janecka et al. 2009	SLN report
China (Xinjiang)	Taxkurgan NR		01 Feb 2009	01 Mar 2009	Camera trapping	1			Riordan et al. 2010	SLN report
China (Xinjiang)	Taxkurgan NR	117	Feb 2013	Apr 2013	Camera Trapping	4			Shi et al, in prep	Not yet available
China (Xinjiang)	Taxkurgan NR	79	Feb 2012	Apr 2012	Camera Trapping	4			Shi et al, in prep	Not yet available
China (Xinjiang)	Taxkurgan NR	49	Feb 2011	Apr 2011	Camera Trapping	3			Shi et al, in prep	Not yet available
India	Hemis National Park	135	15 Jan 2004	24 Mar 2004	Camera trapping	6	6	4.45	Jackson et al. 2006	Peer reviewed

Country	Location	Area (km²)	Start date	End date	Survey method	Minimum number	Estimate	Density per (km²)	Reference	Remarks
India	Hemis National Park	71	21 Jan 2003	25 Mar 2003	Camera trapping	6	6	8.49	Jackson et al. 2006	Peer reviewed
India	Ladakh				Genetic analysis	4			Janecka et al. 2008	Peer reviewed
India	Spiti valley	686	03 Oct 2011	20 Jan 2012	Camera trapping	15			Sharma et al. in prep	Not available
India	Spiti valley	70	01 Jul 2009	30 Jul 2009	Camera trapping	5		0.68	Sharma et al. 2009	SLN report
India	Khangchendzonga NP– Prek chu Catchment	102			Camera-trapping	4		3.88	Satyakumar et al. (Unpublished results)	Not available
India	Gya	300	01 Jun 2010	01 Dec 2010	Genetic analysis	4	5	1.66	Suryawanshi 2013	Not available
India	Lossar	219	01 Jun 2010	01 Dec 2010	Genetic analysis	1	1	0.45	Suryawanshi 2013	Not available
India	Pin	270	01 Jun 2010	01 Dec 2010	Genetic analysis	2	2	0.74	Suryawanshi 2013	Not available
India	Tabo	341	01 Jun 2010	01 Dec 2010	Genetic analysis	4	4	1.17	Suryawanshi 2013	Not available
India	Kibber	411	01 Jun 2010	01 Dec 2010	Genetic analysis	7	8	1.94	Suryawanshi 2013	SLN report
India	Lingti	240	01 Jun 2010	01 Dec 2010	Genetic analysis	7	8	3.3	Suryawanshi 2013	SLN report
Kyrgyzstan	SaryChat	1340	Jun 2009	Nov 2009	Camera-trapping	18	18	1.38	Jumabay et al. 2013	Not available
Kyrgyzstan	Jangart		August	September	Genetic analysis	5			McCarthy et al. 2008	Peer reviewed

Country	Location	Area (km^2)	Start date	End date	Survey method	Minimum number	Estimate	Density per (km^2)	Reference	Remarks
Kyrgyzstan	SaryChat		May	June	Genetic analysis	3			McCarthy et al. 2008	Peer reviewed
Kyrgyzstan	Jangart	808	03 Aug 2005	20 Sep 2005	Camera trapping	5	7	0.87	McCarthy et al. 2008	Peer reviewed
Kyrgyzstan	SaryChat	655	28 May 2005	15 Jul 2005	Camera trapping	1	1	0.15	McCarthy et al. 2008	Peer reviewed
Mongolia	Tost Uul	264	12 May 2007	16 Jul 2007	Camera trapping	4	4	1.52	Jackson et al. 2009	Peer reviewed
Mongolia	South Gobi	90			Genetic analysis	5			Janecka et al. 2008	Peer reviewed
Mongolia	Noyon	155.5	08 Mar 2007	16 Mar 2007	Genetic analysis	6			Janecka et al. 2011	Peer reviewed
Mongolia	Tost Uul B	59.8	08 Mar 2007	16 Mar 2007	Genetic analysis	4			Janecka et al. 2011	Peer reviewed
Mongolia	Tost Uul A	108	08 Mar 2007	16 Mar 2007	Genetic analysis	5			Janecka et al. 2011	Peer reviewed
Mongolia	Tost Uul	1300	19 Jun 2009	19 Jun 2009	Camera trapping	9	10	0.77	Mccarthy et al. 2010	Peer reviewed
Mongolia	Gurvansaikhan NP, Bogd, Tost, Jargalant, Turgen SPA, Tsagaan Shuvuut SPA	n/a	01 Feb 2010	01 Nov 2010	Genetic analysis	57			Galsandorj et al. 2011	SLN report
Mongolia	Tost Uul	1680	16 Jun 2012	16 Aug 2012	Camera trapping	13	14	0.83	Sharma et al. in prep	Not available

Country	**Location**	**Area (km^2)**	**Start date**	**End date**	**Survey method**	**Minimum number**	**Estimate**	**Density per (km^2)**	**Reference**	**Remarks**
Mongolia	Tost Uul	1680	02 Jul 2011	02 Sep 2011	Camera trapping	11	12	0.71	Sharma et al. in prep	Not available
Mongolia	Tost Uul	1680	27 Jun 2010	27 Aug 2010	Camera trapping	13	14	0.83	Sharma et al. in prep	Not available
Nepal	Rolwaling		2011	2011	Genetic analysis	4			Karmacharya et al. 2012	SLN report
Nepal	Mustang region		2011	2011	Genetic analysis	10			Karmacharya et al. 2012	SLN report
Nepal	Annapurna Conservation Area	105	01 Apr 1990	01 May 1990	Pug-mark and radio collar	5	5-7	4.8-6.7	Oli et al. 1994	Peer reviewed
Nepal	Phu Valley	100	Jan 2004	May 2004	Genetics	6			Wegge et al. 2012	Peer-reviewed
Pakistan	Shigar Valley				Genetics	19			Anwar et. al. 2011	
Tajikistan	Zorkul Strict NR	<200	Jul 2011	Sep 2011	Camera trapping	4	-	-	Mallon and Diment 2014	Report
Tajikistan	Ravmeddara (Bartang valley)	<500	Oct 2011	Apr 2012	Camera trapping	6	-	-	Alidodov and Karimov 2012	Report
Tajikistan	Darshaydara (Wakhan)	<500	May 2013	Aug 2013	Camera trapping	6	-	-	Alidodov and Rosen Michel. 2013	Report

Country	Location	Area (km^2)	Start date	End date	Survey method	Minimum number	Estimate	Density per (km^2)	Reference	Remarks
Tajikistan	Zong (Wakhan)	<500	May 2013	Aug 2013	Camera trapping	1	-	-	Alidodov and Rosen Michel 2013	Report
Tajikistan	Jarty Gumbez (Murghab hunting concession), E Pamirs	1000	Jun 2012	Oct 2012	Camera trapping and genetics	19 23	-	0.87 – 2.85	Kachel 2014	MA thesis
Tajikistan	Pshart and Madiyan valleys, E Pamirs	1000	Jun 2012	Oct 2012	Camera trapping and genetics	6 16	-	0.32 – 1.62	Kachel 2014	MA thesis
Tajikistan	Zighar conservancy, Darvaz Range	40	Jan 2013	Mar 2013	Camera trapping	6	8	-	Rosen Michel pers. comm. 2014	internal data Panthera
Tajikistan	Alichur conservancy	<900	Jul 2014	Sep 2014	Camera trapping	3	-	-	Rosen Michel pers. comm. 2014	internal data Panthera
Tajikistan	Hissar Range	750	Jun 2014	Aug 2014	Camera trapping	3	-	-	Karimov and Amirov 2014	Report
Uzbekistan	Hissar Strict NR	<400	Dec 2013	Aug 2014	Camera trapping	2	-	-	T. Rosen Michel pers. comm. 2014	internal data Panthera & Gosbiocontrol Uzbekistan

[1] With the exception of radio-telemetry and some camera trap surveys, the estimated area surveyed should be treated with due caution, especially in the case of genetic surveys. These are primarily based primarily upon linear transects and which typically lack well-defined sampling periods. Since DNA tends to degrade relatively slowly under the dry, cold conditions prevailing in much of the snow leopard's range, such studies are likely to include samples from individuals that are no longer living or present within the area of collection.

Appendix 2. Threats table compiled as part of the GSLEP process. Key to scores: Low threat=1-5; Medium threat=6-10; High threat=11-15

Threats	Afghanistan	Bhutan	China	India	Mongolia	Nepal	Pakistan	Russia	Kyrgyz Republic	Kazakhstan	Tajikistan	Uzbekistan	Mean Value
Habitat and Prey Related													
Habitat Degradation	11	5	6	10	7	9	11	3	9	6	6	11	8.2
Habitat Fragmentation	10	2	11	6	8	10	10	0	6	9	0	7	6.3
Prey Reduction due to Illegal Hunting	13	5	0	6	11	11	15	11	15	11	14	14	11.0
Prey Reduction due to Competition with Livestock	11	8	6	8	14	9	13	7	14	7	12	14	10.7
Prey Reduction due to Legal Hunting	0	0	11	0	5	3	3	6	10	9	0	0	3.0
Prey Reduction due to Disease	4	5	6	8	6	6	12	0	4	3	7	7	5.7
Fencing that Disrupts Movements/ Migration	3	0	11	8	3	3	3	0	3	3	6	0	3.6
Direct Killing or Removal of Snow Leopards													
In Retribution for Livestock Depredation	13	6	10	8	11	12	14	8	6	12	8	8	9.7
Poaching for Trade in Hides or Bones	9	6	8	6	6	9	12	10	15	11	11	9	9.3
Zoo and Museum Collection of Live Animals	0	0	0	0	0	6	0	0	2	3	3	5	1.1
Traditional Hunting of Snow Leopards	0	3	3	0	4	3	0	0	0	6	1	9	2.4
Secondary Poisoning and Trapping of Snow Leopards	3	7	6	6	7	9	6	14	9	10	4	0	6.7
Diseases of Snow Leopards	1	5	5	8	5	5	11	0	3	3	2	2	4.3

Threats	Afghanistan	Bhutan	China	India	Mongolia	Nepal	Pakistan	Russia	Kyrgyz Republic	Kazakhstan	Tajikistan	Uzbekistan	Mean Value
Potential Legal Hunting of Snow Leopards	0	0	0	0	6	1	5	0	5	0	0	0	1.4
Policy and Awareness													
Lack of Appropriate Policy	13	8	10	10	6	3	9	15	14	3	8	12	9.2
Lack of Effective Enforcement	14	5	12	12	13	7	13	15	15	12	12	12	11.8
Lack of Transboundary Cooperation	9	11	12	8	9	8	9	6	9	7	9	12	9.1
Lack of Institutional Capacity	14	10	10	12	12	9	13	12	12	3	10	12	10.7
Lack of Awareness Among Local People	8	9	9	12	14	10	13	12	13	10	8	12	10.8
Lack of Awareness Among Policy Makers	14	10	10	12	12	3	11	9	13	3	12	12	10.1
Other Issues													
War and Related Military Activities	9	0	8	9	0	6	9	0	4	0	1	0	3.8
Human Population Growth (Rapid) / Poverty	10	5	7	7	6	3	10	0	12	3	10	11	7.0
Feral Dogs Attacking Snow Leopards and Prey	1	10	5	11	3	4	7	0	0	1	2	7	4.2
Poaching and Wildlife Trade by Migrant Workers	3	2	5	10	3	8	11	0	8	9	1	0	5.0
Poaching by Military Personnel	13	6	0	7	3	0	9	6	15	8	11	9	7.2
Emerging Threats													
Climate Change	10	12	10	10	12	12	11	9	4	3	10	15	9.8
Growing Livestock Populations and Intensifying Human-	11	13	12	10	13	9	15	9	13	10	15	15	12.1

Threats	Afghanistan	Bhutan	China	India	Mongolia	Nepal	Pakistan	Russia	Kyrgyz Republic	Kazakhstan	Tajikistan	Uzbekistan	Mean Value
Wildlife Conflict													
Large-scale Development Projects	1	0	12	10	10	11	10	7	5	6	10	0	6.8
Impacts due to Mineral Exploration/Mining (Local)	1	0	12	7	10	5	9	11	12	3	12	0	6.8
Impacts due to Hydroelectric Projects	0	6	7	5	5	12	9	0	3	3	6	0	4.7
Impacts due to Roads or Railroads	0	0	10	11	11	9	9	0	6	9	3	0	5.7
Disturbance Related to *Cordyceps* Collection	0	12	10	7	0	12	0	0	0	0	0	0	3.4

Appendix 3. Protected areas (PA) with confirmed or potential snow leopard occurrence

(NP – National Park; WLS – Wildlife Sanctuary, LPA – Local Protected Area).

PA	Country	Area (km²)	Snow leopard presence
Wakhan National Park	Afghanistan	>10,000	Confirmed
Bumdeling Wildlife Sanctuary	Bhutan	1,520	Potential
Jigme Dorje National Park	Bhutan	4,350	Confirmed
Jigne Singye Wangchuk NP	Bhutan		Potential
Sakten Wildlife Sanctury	Bhutan	755	Potential
Toorsa Strict Nature Reserve	Bhutan	650	Confirmed
Wangchuk Centennial Park	Bhutan	4,914	Confirmed
Aerjin Mountains Nature Reserve	China	45,000	Potential
Altay Mountains Nature Reserve	China	6,759	Potential
Anglarencuo Nature Reserve	China	12,080	Potential
Baimaxueshan Nature Reserve	China	2,816	Potential
Changshagongma Nature Reserve	China	670	Confirmed
Chang Thang Nature Reserve	China	298,000	Confirmed
Gongbu Nature Reserve	China	21,558	Potential
Heishuihe Nature Reserve	China	450	Confirmed
Kanas Nature Reserve	China	2,500	Potential
Kekexili Nature Reserve	China	48,000	Confirmed
Lop Nur Nature Reserve	China	78,000	Potential
Meilixueshan Nature Reserve	China	6,000	Confirmed
Miyaluo Nature Reserve	China	1,659	Potential
Qilian Mountains Nature Reserve	China	26,530	Confirmed
Qomolangma National Nature Preserve	China	30,000	Confirmed
Sanjiangyuan Nature Reserve	China	366,000	Confirmed
Selincuo Nature Reserve	China	1,640	Confirmed
Taxkorgan Reserve	China	14,000	Confirmed
Tumor Feng Nature Reserve	China	2,376	Confirmed
Wolong Nature Reserve	China	2,000	Confirmed

PA	Country	Area (km²)	Snow leopard presence
Yanchiwan Nature Reserve	China	14,126	Confirmed
Zhongkunlun Nature Reserve	China	32,000	Potential
Anzihe Nature Reserve	China	101	Confirmed
Askot Musk Deer WLS	India	599	Confirmed
Changthang Cold Desert WLS	India	4,000	Confirmed
Dachigam NP	India	171	Confirmed
Dhauladhar WLS	India	944	Potential
Gangotri NP	India	2,200	Confirmed
Govind NP	India	472	Confirmed
Govind Pashu Vihar WLS	India	481	Confirmed
Govind Sagar WLS	India	100	Potential
Great Himalayan NP	India	755	Confirmed
Gulmarg WLS	India	139	Confirmed
Hemis NP	India	3,350	Confirmed
Kalatop-Khajjiar WLS	India	69	Potential
Karakoram (Nubra Shyok) WLS	India	5,000	Confirmed
Kedarnath WLS	India	975	Confirmed
Khangchendzonga NP	India	1,784	Confirmed
Kibber WLS	India	1,400	Confirmed
Kugti WLS	India	379	Confirmed
Kyongnosla Alpine WLS	India	31	Confirmed
Lachipora WLS	India	93	Confirmed
Limber WLS	India	43	Confirmed
Lippa Asrang WLS	India	349	Confirmed
Lungnak WLS	India	400	Potential
Maenam WLS	India	35	Confirmed
Manali WLS	India	32	Confirmed
Nanda Devi Biosphere Reserve	India	5,148	Confirmed
Nanda Devi NP	India	624	Confirmed
Overa-Aru WLS	India	511	Confirmed

PA	Country	Area (km²)	Snow leopard presence
Pangolakha WLS	India	128	Confirmed
Pin Valley NP	India	675	Confirmed
Rupi Bhaba WLS	India	738	Confirmed
Sangla (Raksham Chitkul) WLS	India	304	Potential
Sechu Tuan Nala WLS	India	103	Confirmed
Shamsha-Kharboo WLS	India	200	Potential
Shingba (Rhododendron) WLS	India	43	Confirmed
Tirthan WLS	India	61	Confirmed
Valley of Flowers NP	India	87	Confirmed
Ala Archa NP	Kyrgyzstan	194	Confirmed
Besh-Aral SNR	Kyrgyzstan	1,100	Potential
Kara-Buura NP	Kyrgyzstan	590	Confirmed
Karatal-Japyryk SNR	Kyrgyzstan	364	Confirmed
Chon-Kemin NP	Kyrgyzstan	1,236	Confirmed
Kulun-Ata SNR	Kyrgyzstan	277	Confirmed
Naryn SNR	Kyrgyzstan	1,055	Confirmed
Padisha-Ata SNR	Kyrgyzstan	305	Confirmed
Sary-Chelek Biosphere Reserve	Kyrgyzstan	238	Confirmed
Sarychat-Ertash State Reserve	Kyrgyzstan	1,340	Confirmed
Altai Tavan Bogd NP	Mongolia	6,362	Confirmed
Gobi Gurvan Saikhan NP	Mongolia	26,947	Confirmed
Great Gobi A SPA	Mongolia	53,117	Confirmed
Gurvantes LPA	Mongolia	6,689	Confirmed
Ikh Bogd SPA	Mongolia	3,132	Confirmed
Khan Khokhii NP	Mongolia	5,534	Confirmed
Khar Us Nuur NP	Mongolia	8,503	Confirmed
Khasagt Khairkhan Mountain SPA	Mongolia	274	Confirmed
Khokh Serkh SPA	Mongolia	659	Confirmed
Khoridol Saridag SPA	Mongolia	2,256	Confirmed
Mongol Els NP	Mongolia	2,491	Confirmed

PA	Country	Area (km²)	Snow leopard presence
Munkhkhairkhan NP	Mongolia	3,004	Confirmed
Myangan Ugalzat NP	Mongolia	632	Confirmed
Otgontenger SPA	Mongolia	955	Confirmed
Siilkhem "A" NP	Mongolia	1,401	Confirmed
Tarvagatain Nuruu NP	Mongolia	5,254	Confirmed
Tsagaan Shuvuut SPA	Mongolia	230	Confirmed
Tsambagarav NP	Mongolia	1,110	Confirmed
Turgen SPA	Mongolia	1,197	Confirmed
Uvs Nuur SPA	Mongolia	4,320	Confirmed
Annapurna Conservation Area	Nepal	7,600	Confirmed
Api-Nampa Conservation Area	Nepal	1,903	Confirmed
Dhorpatan Hunting Reserve	Nepal	1,325	Potential
Gaurishankar Conservation Area	Nepal	2,179	Confirmed
Kanchenjunga Conservation Area	Nepal	2,000	Confirmed
Langtang National Park	Nepal	1,710	Confirmed
Makalu Barun National Park	Nepal	1,500	Potential
Manslu Conservation Area	Nepal	1,663	Confirmed
Sagarmāthā National Park	Nepal	1,150	Confirmed
Shey Phuk Sundo National Park	Nepal	3,555	Confirmed
Agram Basti Wildlife Sanctuary	Pakistan	299	Confirmed
Askor Nallah Game Reserve	Pakistan	129	Likely
Broghil National Park	Pakistan	1,347	Confirmed
CCHA Bar Valley, Nagar	Pakistan	906	Confirmed
CCHA Bunji DMT and Doyan, Astore	Pakistan	697	Confirmed
CCHA Gorikot/Tarashing, Astore	Pakistan	181	Confirmed
CCHA Gulkin, Gojal	Pakistan	104	Confirmed
CCHA Gulmit-Minapin, Nagar	Pakistan	544	Confirmed
CCHA Hushey, Ghanche	Pakistan	583	Confirmed
CCHA Hussainababd, Gole, Skardu	Pakistan	337	Confirmed
CCHA Hussaini, Gojal	Pakistan	114	Confirmed

PA	Country	Area (km²)	Snow leopard presence
CCHA Ishkoman, Ghizer	Pakistan	298	Confirmed
CCHA Kanday-Saling, Ghanche	Pakistan	272	Confirmed
CCHA Khyber, Gojal	Pakistan	324	Confirmed
CCHA KVO, Gojal	Pakistan	326	Confirmed
CCHA Parishing, Astore	Pakistan	220	Confirmed
CCHA Passu, Gojal	Pakistan	295	Confirmed
CCHA Qurumber, Ghizer	Pakistan	647	Confirmed
CCHA Sher Qilla, Ghizer	Pakistan	168	Confirmed
CCHA Shimshal, Gojal	Pakistan	168	Confirmed
CCHA Shinaki, Hunza	Pakistan	233	Confirmed
CCHA Sikandarabad-Jaffarabad, Nagar	Pakistan	114	Confirmed
CCHA Skoyo-Karbathang-Basingo (SKB), Skardu	Pakistan	1,981	Confirmed
CCHA Sokhterabad, Gojal	Pakistan	324	Confirmed
CCHA Tangir, Diamer	Pakistan	142	Confirmed
CCHA Yasin, Ghizer	Pakistan	427	Confirmed
Central Karakoram National Park	Pakistan	9,738	Confirmed
Chashi/Bowaster Game Reserve	Pakistan	370	Likely
Chitral Gol National Park	Pakistan	78	Confirmed
Community Controlled Hunting Area (CCHA) Sakwar-Jutial-Barmas	Pakistan	194	Confirmed
Community Game Reserve, Arkari	Pakistan	1,000	Confirmed
Community Game Reserve, Begusht	Pakistan	80	Confirmed
Community Game Reserve, Bhan, Sawat	Pakistan	250	Confirmed
Community Game Reserve, Kaigha Nullah, Kohistan	Pakistan	50	Confirmed
Community Game Reserve, Madaklasht	Pakistan	145	Confirmed
Community Game Reserve, Mankial, Sawat	Pakistan	131	Confirmed
Community Game Reserve, Munur	Pakistan	62	Confirmed
Danyor Game Reserve	Pakistan	443	Confirmed
Deosai National Park	Pakistan	3,626	Confirmed (in surrounding valleys)
Drosh Gol Game Reserve	Pakistan	21	Confirmed

PA	Country	Area (km²)	Snow leopard presence
Gehrait Gol Game Reserve	Pakistan	48	Confirmed
Ghamot National Park	Pakistan	273	Potential
Goleen Gol Game Reserve	Pakistan	498	Confirmed
Handarab Shandoor National Park	Pakistan	518	Confirmed
Kargah Community Managed Conservation Area	Pakistan	443	Confirmed
Khunjerab National Park	Pakistan	5,544	Confirmed
Kilik-Mintaka Game Reserve	Pakistan	650	Confirmed
Machiara National Park	Pakistan	135	Potential
Musk deer National Park	Pakistan	528	Confirmed
Naltar Wildlife Sanctuary	Pakistan	272	Confirmed
Nar/Ghoro Nallah Game Reserve	Pakistan	74	Confirmed
Nazbar Nallah Game Reserve	Pakistan	334	Confirmed
Pakora Game Reserve	Pakistan	75	Confirmed
Purit Gol and Chinar Game Reserve	Pakistan	46	Confirmed
Qurumber National Park	Pakistan	741	Confirmed
Satpara Wildlife Sanctuary	Pakistan	311	Confirmed
Tooshi Game Reserve	Pakistan	15	Confirmed
Ak-Cholushpa Nature Park	Russia	1,891	Confirmed
Altaisky Nature Reserve	Russia	8,812	Confirmed
Azas Nature Reserve	Russia	3,003	Potential
Belukha Nature Park	Russia	1,313	Confirmed
Katunsky State Nature Reserve	Russia	1,516	Potential
Khakassky Nature Reserve	Russia	2,465	Potential
Pozarym Wildlife Refuge	Russia	2,537	Potential
Quiet Zone Ukok Plateau Nature Park	Russia	2,542	Confirmed
Sailugemsky National Park	Russia	1,151	Confirmed
Sayano-Shushensky Nature Reserve	Russia	3,904	Confirmed
Shavlinsky Wildlife Refuge	Russia	2,480	Confirmed
Shuyskiy Nature Park	Russia	980	Confirmed
Tunkinsky National Park	Russia	11,837	Confirmed

PA	Country	Area (km²)	Snow leopard presence
Ubsunurskaya kotlovina Nature Reserve	Russia	2,512	Confirmed
Uch-Enmek Nature Park (Argut cluster)	Russia	344	Potential
Dashtijum Sanctuary	Tajikistan		Confirmed
Dashtijum State Reserve	Tajikistan	190	Confirmed
Romit State Reserve	Tajikistan	180	Confirmed
Tajik National Park	Tajikistan	26,000	Confirmed
Zorkul State Nature Reserve	Tajikistan	870	Confirmed
Hissar State Nature Reserve	Uzbekistan	800	Confirmed
Ugam-Chatkal National Park	Uzbekistan	6,680	Confirmed
Zaamin National Park	Uzbekistan	156	Confirmed

Appendix 4. List of Protected Areas (PAs) occurring along international borders:

Codes Used: CA = Conservation Area, NP = National Park, NaP = Nature Park, NR = Nature Reserve; SPA = Strict PA, SR = State Reserve, , WS = Wildlife Sanctuary, WR = Wildlife Reserve

Afghanistan: The whole of Wakhan District was designated Wakhan National Park (c.11,457 km²) in the first part of 2014, encompassing the Big Pamir WR (577 km²) and Teggermansu WR (248 km²)

Bhutan: Four PAs abut the northern border with China. These are Jigme Dorji NP (4,316 km²), Wangchuk Centennial Park (4,914 km²), Bomdeling WS (1,520 km²), and Torsa SNR (609 km²) on border with Sikkim and Tibet. There are no known PAs on the Chinese side.

China: In the east, The Yaluzangbudaxiagu NR (8,982 km²) borders India. The Qomolangma National NR (34,000 km²) is located along the Nepal border; Taxkorgan NR (15,863 km²) along the Pakistan and Afghanistan borders, Tomur (Tuomeurfeng) NR (2,299 km²) at the juncture of the Kazakhstan and Kyrgyzstan border; Kanas (Hamasi) NR (2,500 km²) at the intersection of Kazakhstan, Russia and Mongolia, and the Buersenheli NR (88 km²) situated on the border with Mongolia.

India: Changtang WS (+4,000 Km²) in Ladakh (J&K State) and the Dibang WS (767 km²) with Arunachal Pradesh state in the east. In Sikkim, Khangchendzonga NP (1,794 km²) adjoins Nepal's Conservation Area bearing the same name.

Kazakhstan: In the Altai Mountains: Katon-Karagaj NP (6,434 km²) connects with Russia's Katunsky SRand China's Kanas (Lake) NR (2,500 km²). Further South, the Zhongar-Alatau NP (3,560 km²) is located on the Dzhungar Alatau ridge along the country's border with China. Tarbagatai NP is situated on the Tarbagatai ridge in Kazakhstan.

In the Central Tien Shan region, Ile-Alatau NP (1,993 km²) and Almaty SR (which adjoins Almaty WR) abut Kyrgyzstan's Chon-Kemin NP, located north of Lake Issykul. Kazakhstan's proposed Kolsai-Kolderi

NP (1,610 km²) is located along the same ridge, with its boundary touching Kyrgyzstan's Keng Suu WS (87.12km²). In the Western Tien Shan, Aksu-Zhabagly SR (1,218 km²) boundary touches the border of both Kyrgyzstan and Uzbekistan. Sairam-Ugam NP (1,500 km²) Aksu-Zhabagly NR and Manas WR of Kyrgyzstan are situated along the mountain ridges of Sairam, Ugam and Talass Alatau that define the international border between these countries. Uzbekistan's Ugam-Chatkal NP is adjacent to the Sairam-Ugam NP.

Kyrgyzstan: Besh-Aral SR (632 km²) which is almost contiguous with Uzbekistan's Chatkal SR and Ugam-Chatkal NP (5,746 km²). The Wildlife Sanctuaries of Sandalash and Manas abut Kyrgyzstan's northern border with Kazakhstan. The proposed Khan Tengri NaP (1870 km²) lies close to Tomur NR in China.

Mongolia: Altai-Tavan Bogd NP (6,361 km²) adjoins China's Kanas NR. The Sillkhem Mountain A (781 km²) & B (696 km²) NP's are located along the border with the Altai Republic, as is the Tsagaan Shuvuut Mountain SR (339 km²). Altai-Tavan Bogd NP (6,361 km²) adjoins both the Altai Republic and Chinese borders. The Great Gobi (Gobi A) SPA (53,000 km²) is situated along the Chinese border. Tsagaan Shuvuut Uul SPA (230 km²), Uvs Nuur SPA (4,320 km²), Tesiin Gol NR (1,100 km²), Altan Els SPA (1,533 km²), Khan Khokhii NP (3,357 km²), Khyargas Nuur NP (3,328 km²) and Turgen Uul SPA (1,197 km²) adjoin the Ubsunurskaya Kotlovina NR (2,512 km²) of the Tuva Republic, Russia. The Uuvs Lake SPA (4,423 km²) is located along the border with Tunkinskiy NP in Buryatia, Russia (11,836 km²).

Nepal: Six PAs are contiguous with the border of China (Tibet Autonomous Region): Sagarmatha (Mt. Everest) NP (1,148 km²), Gaurishankar CA (2,179 km²), Langtang NP (1,710 km²), Annapurna CA (7,629 km²), Manaslu CA (1,663 km²) and the Shey-Phoksundo NP (3,555 km²). All but the last area abut China's Qomolangma National NR (34,000 km²), which is itself one of the largest PAs supporting snow leopard populations. In the east, the Kanchenjunga CA (2,035 km²) adjoins the Khangchendzonga NP in Sikkim (India). In the far west the Api Nampa CA (1,903 km²) abuts India and China (Tibet).

Pakistan: The Khunjerab NP (6,150 km²) abuts China's Taxkorgan NR (15,863 km²), as does the Central Karakorum or K2 NP (9,738 km²). The Chitral Gol NP (77 km²) and Agam Besti WS (267 km²) are located close to the Afghanistan border, while the Kilik-Mintaka WS (650 km²) is situated on the China-Afghanistan border.

Russia: In the Altai Republic, the Katunskiy NR (Zapovednik) (1,516.4 km²) abuts Kazakhstan's Katon-Karagajsky NP (6,435 km²). The Katunskiy NR is contiguous with 3 other PAs in the Altai Republic, namely the Belukha NaP (1,313 km²), Argut NaP (205 km²) and the Sailyugem NP (1,184 km²), and the Shavla Refuge (3,288 km²). The Ukok Plateau NaP (2,542 km²) abuts China's Kanas (Lake) NR 4,554 km².

In the Tuva Republic, Ubsunurskaye Kotlovina NR (3,232 km²) adjoins eight PAs in Mongolia (Tsagaan Shuvuut Uul Strict PA, Uvs Nuur Strict PA, Tesiin gol Nature Reserve, Altan Els Strict PA, Khankhokhii National Park, Khyargas Nuur National Park and Turgen Uul Strict PA (total area 14,000 km²). In the Buryatia Republic of Russia, the Tunkinskiy NP (11,836 km²) is contiguous with Mongolia's Khuvsgul Lake NP (11,844 km²).

Tajikistan: Tajik NP and World Heritage Site (26,000 km^2) is situated close to the borders with China and Kyrgyzstan. Zorkul SR (870 km²) is located along the border with Afghanistan and abuts the new Wakhan NP. Shirkent NaP is close to Uzbekistan's Gissar SNR.

Uzbekistan: Ugam-Chatkal NP (5,746 km²) and Chatkal SR are relatively close to Kyrgyzstan's Besh-Aral SR (632 km²).