2018
中国雪豹调查与保护现状

SNOW LEOPARD SURVEY AND CONSERVATION STATUS IN CHINA 2018

中国雪豹保护网络
http://www.snowleopardchina.org/

Snow Leopard China is a network of research institutions, non-government organizations, and nature reserves dedicated to sharing and promoting snow leopard research and conservation in China through various means, such as reporting and website presentation, online and land-based communication, technical support, training, and forum-based exchange.

This report is jointly prepared by the members of Snow Leopard China with respect to snow leopards in China.

Contributors hereto are listed as follows (in no particular order):

Guangzhou Yuanwang Wildlife Conservation Services; WWF; Wild Xinjiang; Chinese Felid Conservation Alliance (CFCA); Qinghai Yuan Shang Cao Conservation Center; Sichuan Green River Environmental Protection Initiative; Beijing Qiaonyu Foundation; Sanjiangyuan (Three-River-Source) National Park Administration; Wolong National Nature Reserve; Gongga Mountain National Nature Reserve; the government of Sojia Town, Zhidoi County (Tongtian Snow Leopard Group); Peking University Center for Nature and Society; Peking University Wildlife Ecology and Conservation Research Group; Chinese Academy of Sciences Northwest Institute of Plateau Biology; Chinese Academy of Forestry Institute of Forest Ecology and Conservation; Beijing Forestry University Wildlife Institute; Eco-Bridge Continental; Shanshui Conservation Center (SCC).

Cover design: a snow leopard in Namse Town of Yushu Prefecture, Qinghai, courtesy of French photographer Frédéric Larrey.

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Acknowledgements

Looking back, we find that snow leopard research and conservation in China has been given greater attention for the past twenty years, particularly over the last decade. Most surprisingly, we also see an increasing amount of non-government effort behind all that concerns the species. These social forces include the general public, NGOs, research institutions, and local communities. With strong governmental support, it has been a promising endeavor undertaken all over the country. Therein lies a message about what yet needs to be done: Wildlife conservation requires greater effort, coverage, and flexibility over such expansive a land with diverse ecosystems as China. With its ecological civilization program underway, we have a valid reason to expect more in the future.

Huge expanses of territory, as well as socioeconomic complexities near snow leopard habitat, greatly challenge the conservation of the species. The reporting team, a group of young front-line researchers and conservationists, has done their best to comb through what was made available to them at the time of writing this report by a standardized and participatory approach. Should anything be found amiss or inappropriate herein, we offer our sincere apologies and hope to make improvements at a later, opportune time.

Last but not least, the finalization of this report is attributed to efforts from a multitude of agencies, organizations, and individuals committed to snow leopard research and conservation. Behind them is long and continued support by governments, foundations, and corporations. We would like to thank the National Forestry and Grassland Administration and competent authorities at all levels for their input and support, which are vital for snow leopard conservation in China. We feel deeply indebted to Beijing Forestry University Professor Shi Kun who took the time to review and provide invaluable feedback to our work.

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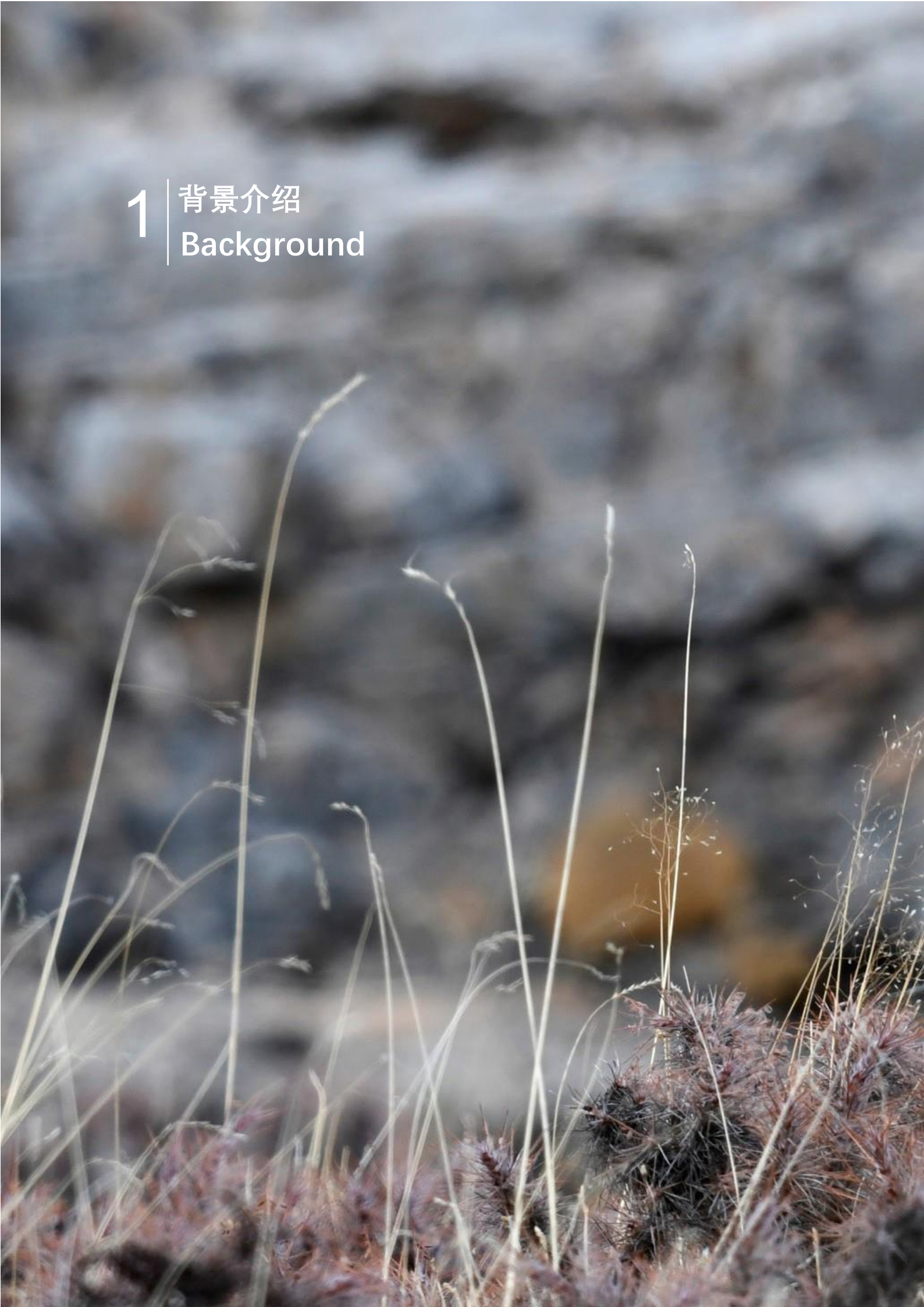

1 背景介绍 Background

Photo by Frédéric Larry in Namse Town, Yushu Autonomous Prefecture, Qinghai

1.1 Introduction

The snow leopard (*Panthera uncia*) is a member of the subfamily *Pantherinae* within the family Felidae. Adult males weigh about 37-55 kg and females 35-42 kg, with a shoulder height of approximately 60 cm, body length of 1-1.3 m and a tail length of 0.8-1 m (Hemmer 1972, Johansson *et al*. 2013). The snow leopard cannot roar like other large felids due to the absence of an elastic ligament in the larynx. Therefore, it was initially classified in the monotypic genus *Uncia* (Pocock 1916a; Hemmer 1972; Peters 1980; Sunquist & Sunquist 2002). Phylogenetically, it was recently placed in the genus *Panthera* and is most genetically related to *Panthera tigris*. Branching began about two million years ago (Johnson *et al*. 2006). The proposal by Janecka *et al*. (2017) to divide the snow leopard into three subspecies remains controversial.

1.1.1 Evolution

The evolution of the Felidae around the world is but a grand epic ever known to mankind. Their ancestors started from Asia and roamed back and forth across all the five continents before they diverged into 37 feline species of various forms and sizes, from big as tigers and lions to small as a pet cat curling up in your living room. About 10.8 Mya, *Panthera* was the first to branch out of this family and then evolved into five large felids that would be prowling at the top of the food chain: the tiger and lion (*Panthera leo*), the leopard (*Panthera pardus*), the panther (*Panthera once*) and snow leopard (*Panthera uncia*), and two clouded leopard species – *Neofelis nebulosa* and *Neofelis diardi*. These big cats dispersed along land bridges dominating the top level of local ecosystems and then eventually settled into the following pattern of locality: The tiger settled on the Asian Continent; the snow leopard, in the Himalayas and other major mountain ranges in Asia; the leopard, all over the Asian and African Continents; the lion and panther first lived in North America and then moved to Africa and South America respectively, which helped them survive the Pleistocene extinctions in North America (Johnson *et al*. 2006).

The evolution of these five large felids began with branching between the tiger and the snow leopard (much earlier than branching between the panther and the leopard/lion). As estimated with the DNA of the existing feline species, this branching occurred 2.7 to 3.7 Mya (Christiansen 2007). However, archaeological fossil studies further pushed the time earlier to somewhere between 4.86 and 5.13 Mya (Tseng *et al*. 2014). On August 7, 2010, an incomplete snow leopard skull fossil was found in the Zanda Basin, Tibet. Subsequent morphological and molecular genetic studies showed that it should originate from what would later be known as *Panthera blytheae*, the closest relative of the snow leopard. This finding not only confirmed the hypothesis that the ancestors of large felids originated in Asia and thus set the time of evolution earlier; it also attached ever-greater importance to the Tibetan Plateau in the context of the evolution of feline animals. Archaeologists continued to propose the "Out of Tibet" hypothesis. The fossils of ancestral snow leopard, argali, and blue sheep found in the Zanda Basin indicated that the elevation of the Tibetan Plateau was critical to the evolution of fauna around the Arctic Circle. These Mammalia very much likely treated the Tibetan Plateau as a training ground, took shelter there at certain times, and, in glacial epochs, dispersed to various continents around the Arctic Circle (Deng *et al*. 2011). This hypothesis has yet to be verified and validated, but the correspondence between snow leopard evolution and the Tibetan Plateau has been largely acknowledged in the academic community.

Fig. 1.1.1 Reconstruction of ancestral snow leopard *Panthera blytheae* and its habitat, courtesy of Deng Tao with Sciencenet.cn.

The snow leopard has evolved a suite of adaptations to alpine climate while living on the cold Tibetan Plateau. It has the densest and longest pelage of all large felids (belly hair can grow 12 cm in winter, Hemmer 1972) that may effectively keep it warm. A camouflage of light gray or creamy yellow, with loosely flecked patterns, easily blends with the surrounding bare rocks as it looks very similar to lichen on rocks. The skull is broad and short, with the top protruding, and the nasal cavity is inflated to help warm and humidify the dry cold alpine air while increasing oxygen intake per breath (Haltenorth 1937; Pocock 1916; Torregrosa *et al.* 2010). Like the majority of montane species, the snow leopard is able to absorb oxygen more effectively at higher altitude because of a large concentration of small red blood cells. It has round (not flat) canines that may act great forces (Christiansen 2007) from every direction to help catch prey on steep rocky terrain. Its jaw may gape open at over 70 degrees and therefore may effectively clamp the broad necks of montane ungulates such as blue sheep and Siberian ibex (Christiansen & Adolfsen 2005). It has a special structure of muscles and bones helpful for it to accelerate, turn, leap, and jump from high on steep terrain (Gonyea 1976; Rieger 1984; Ognev 1962). The snow leopard can use its tail, which is about as long as its body, to maintain balance and also keep warm by circling around the body (Hemmer 1972; Rieger 1984).

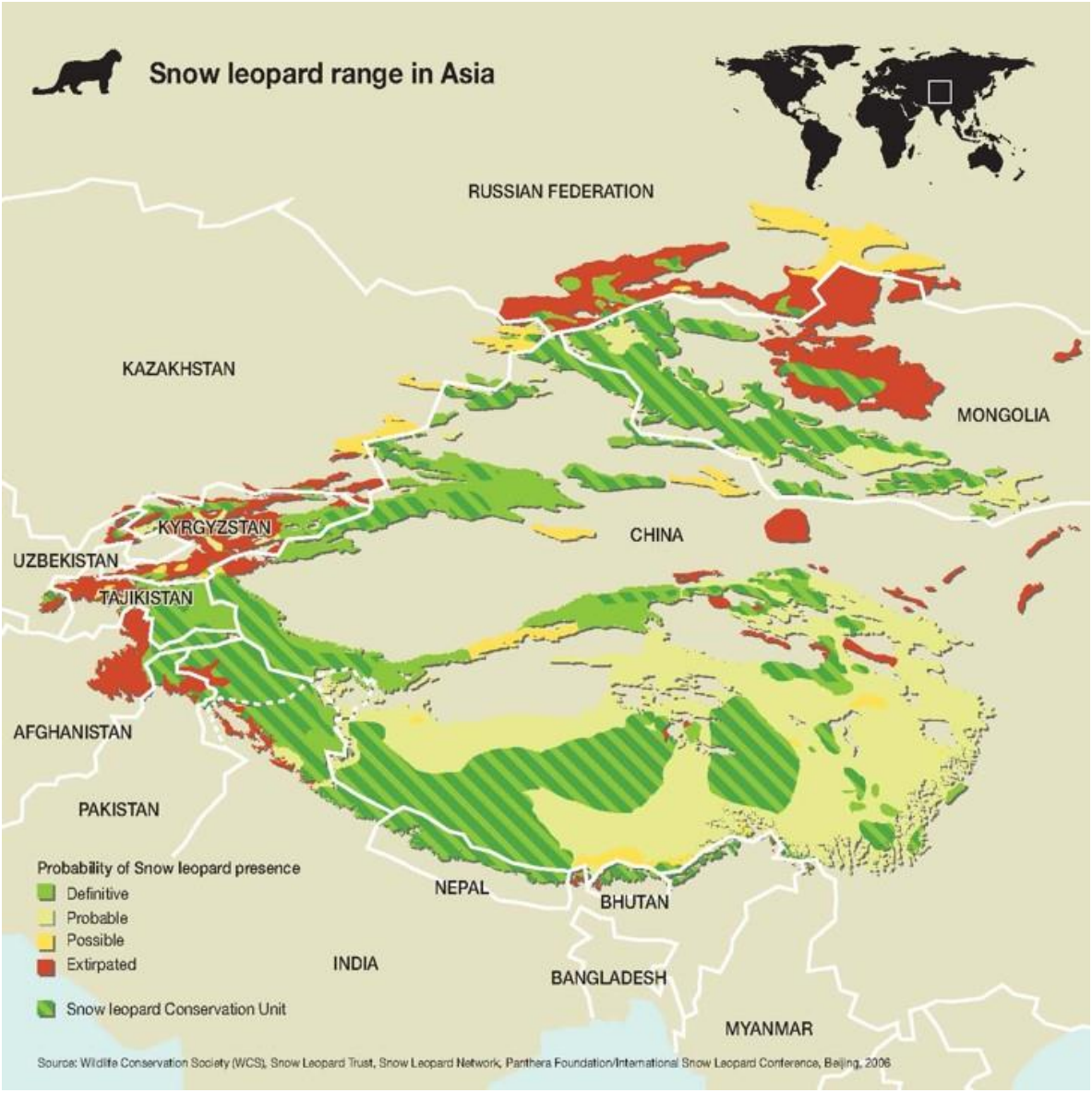

Fig. 1.1.2 The snow leopard range map (courtesy of the Global Workshop for Snow Leopard Survival Strategy Beijing 2008)

1.1.2 Habitat and Distribution

The home range of larger Felidae is extensive with low density, high energy demand, and great mobility. Snow leopards originating from the Tibetan Plateau were distributed over a larger area as their number rose, occupying various kinds of habitat.

Most snow leopard habitats were alpine regions and subalpine zones above the timberline. The presence of snow leopards might occur in the open areas of coniferous or birch forest in the Sajan Mountains of Russia and parts of the Tianshan Mountains. They usually occurred at 3,000-4,500 m above the sea level, the highest being 5,800 m above the sea level where they are distributed in the Himalayas and on the Tibetan Plateau, but the elevations at which they were distributed in the north and in the Gobi Desert are much lower (900-1,500 m). In most of these regions snow leopards tended to inhabit mountain terrain of crags and bare rocks and very much preferred steep and fractured landforms for daily activity, such as

mountain ridges, cliffs, and gorges. It might migrate to lower elevations in winter to avoid thick snow and to follow prey.

At present, snow leopard distribution begins from the Himalayas in the south and on through the Tibetan Plateau and the mountains of Central Asia until it reaches southern Siberia in the north. Snow leopard presence is known in the Altai, Sajan, Tianshan, Kunlun, Hindu Kush, Karakoram ranges, as well as the Pamir Plateau and many smaller hills and mountains in the Gobi Desert region. The snow leopard is distributed in the following 12 countries: Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russia, Tajikistan, and Uzbekistan. A small area of potential distribution may be present in northern Myanmar, but recently there has been no record of snow leopard presence known therein. The snow leopard population density has remained low because of the most deprived environment that they live in. Population genetic studies found the genetic diversity of the snow leopard and the population size estimated thereby are considerably lower than that of other large felids (Cho *et al.* 2013).

Most snow leopard habitats are more or less connected. Few obstructions may come in the way of snow leopards as they disperse, other than large rivers, grazing fences, railways, and major expressways. Riordan *et al.* (2015) hold that the snow leopard may be identified as having south and north regional populations. They also mapped potential key connected areas. Jenecka *et al.* (2017) believe that within the range, roughly three units may be identified with the division of the Junggar and Tarim Basins and high mountains in the Trans-Himalaya:

(1) North Unit: Russia, Mongolian Gobi to Altai mountain areas;

(2) Central Unit: The core range areas of the Tibetan Plateau and the Himalayas (Nepal, Bhutan);

(3) West Unit: The Tianshan Range (Xinjiang, Kyrgyzstan, Uzbekistan, Kazakhstan), the Pamirs (Tajikistan, Afghanistan), the Trans-Himalaya (India, Pakistan).

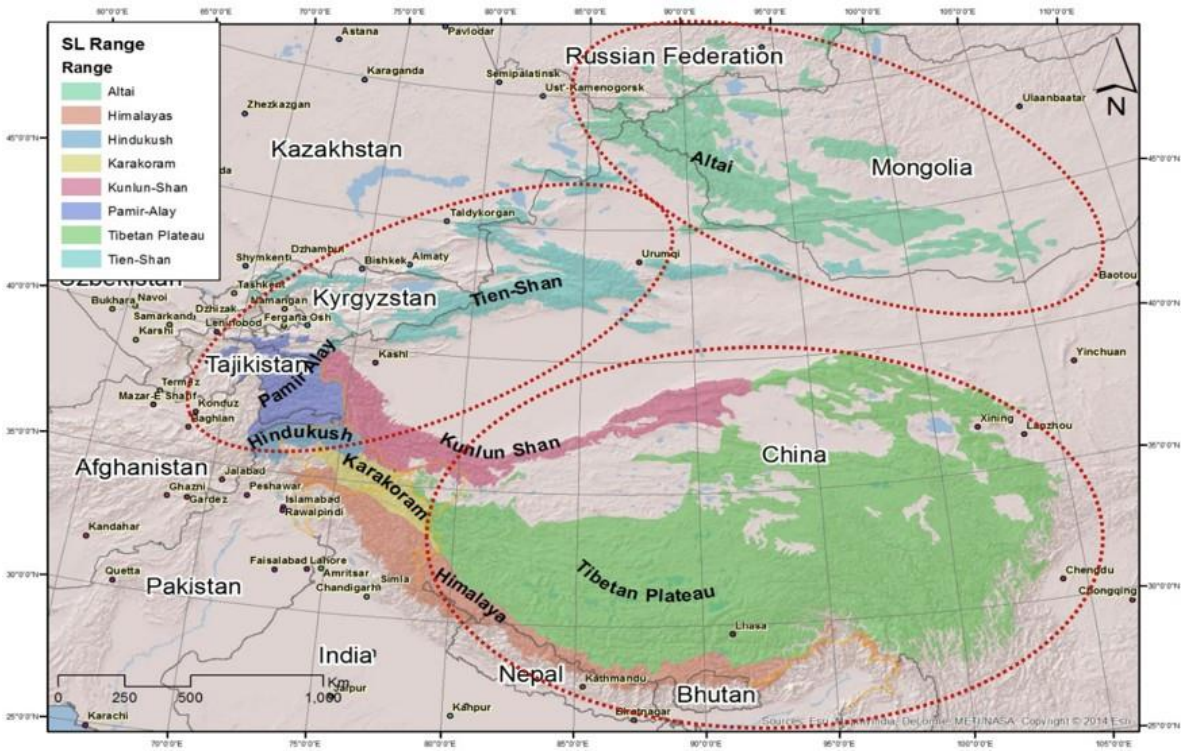

Fig. 1.1.3 SL range proposed by Jenecka et al.

1.1.3 Life Cycle

Adult snow leopards are generally solitary, although in the mating season or at a time when females are with their cubs, a group of 2 to 5 snow leopards may also be present (Fox *et al*. 1988; Jackson & Ahlborn 1988; McCarthy *et al*. 2005; Schaller 1977). Earlier studies used a small number of radio collars to track snow leopards and mistakenly concluded that this animal had a rather weak territoriality (Jackson & Ahlborn 1988; McCarthy *et al*. 2005). By tracking 16 GPS-collared snow leopards in Mongolia, Johansson *et al*. found strong within-sex territoriality, home range being larger for males than for females and great overlaps of home range present for snow leopards of the opposite sex, where potential heterosexual mating happens (Johansson *et al*. 2016). Early radio collar based studies found that snow leopard home range varied greatly, from 12-39 km^2 ((Jackson & Ahlborn 1989) in Nepal to 4,500 km^2 in Mongolia (McCarthy *et al*. 2005). The Mongolian GPS tracking studies found that the home range of males averaged 207 km^2 and of females, 124 km^2 (Johansson *et al*. 2016).

Mating usually happens in January to mid March, during which the snow leopard marks and vocalizes more frequently (Ahlborn & Jackson 1988). In the mating season, the home range of the male will be reduced while the home ranges of both the male and the female overlap more. In addition, the home range of one female will overlap with the home ranges of several males, implying that the mating mechanism for snow leopards may be one in which the female dominates over the male (Johansson *et al*. 2018).

After a 93-110 day pregnancy, the female gives birth in June or July to 1-5 cubs, usually 2 or 3 cubs. The maximum number of cubs born in one single pregnancy on record to date is 7 cubs. Sexual maturation is at 2 to 3 years of age (Sunquist & Sunquist 2002). At 19-22 months, young snow leopards will leave their mother and may stay together for a short while prior to dispersion (Jackson 1996). Penned snow leopards may live up to 21 years of age (Wharton & Freeman 1988) and the oldest wild individual on record is only 15 years old (McCarthy *et al.* 2005).

1.1.4 Prey

Siberian ibex (*Capra sibirica*) and blue sheep (*Pseudois nayaur*), two species of the wild goat that share similar characteristics, provide food base for the snow leopard. Their distribution areas mostly are supplementary to one other and only overlap in extremely small areas (see Figure 1.1.5). Siberian ibex basically covers the north and west snow leopard range units whereas blue sheep covers the central unit (see Section 1.1.2).

Markhor (*Capra falconeri*) and Himalayan tahr (*Hemitragus jemlahicus*) are two other relatives of the goat. Though distributed in small areas, they may also be of great significance to the snow leopard depending on their locations (see Fig. 2.5.2). In Chitral and Gilgit, Pakistan, markhor is a major prey species for the snow leopard (Roberts 1977; Schaller 1977) In Qomolangma National Park, Nepal, Himalayan tahr is the most important food source for the snow leopard and was once almost wiped out locally by one snow leopard family (Ferretti *et al*. 2014; Lovari *et al.* 2009).

Within snow leopard range are also two relatives of sheep, argali (*Ovis ammon*) and urial (*Ovis orientalis*). They both have majestic horns and long legs. As good runners, not climbers, they prefer gentle slopes and open terrain. Therefore, there is little overlap with snow leopard habitat. Argali are present in almost all the snow leopard range areas,

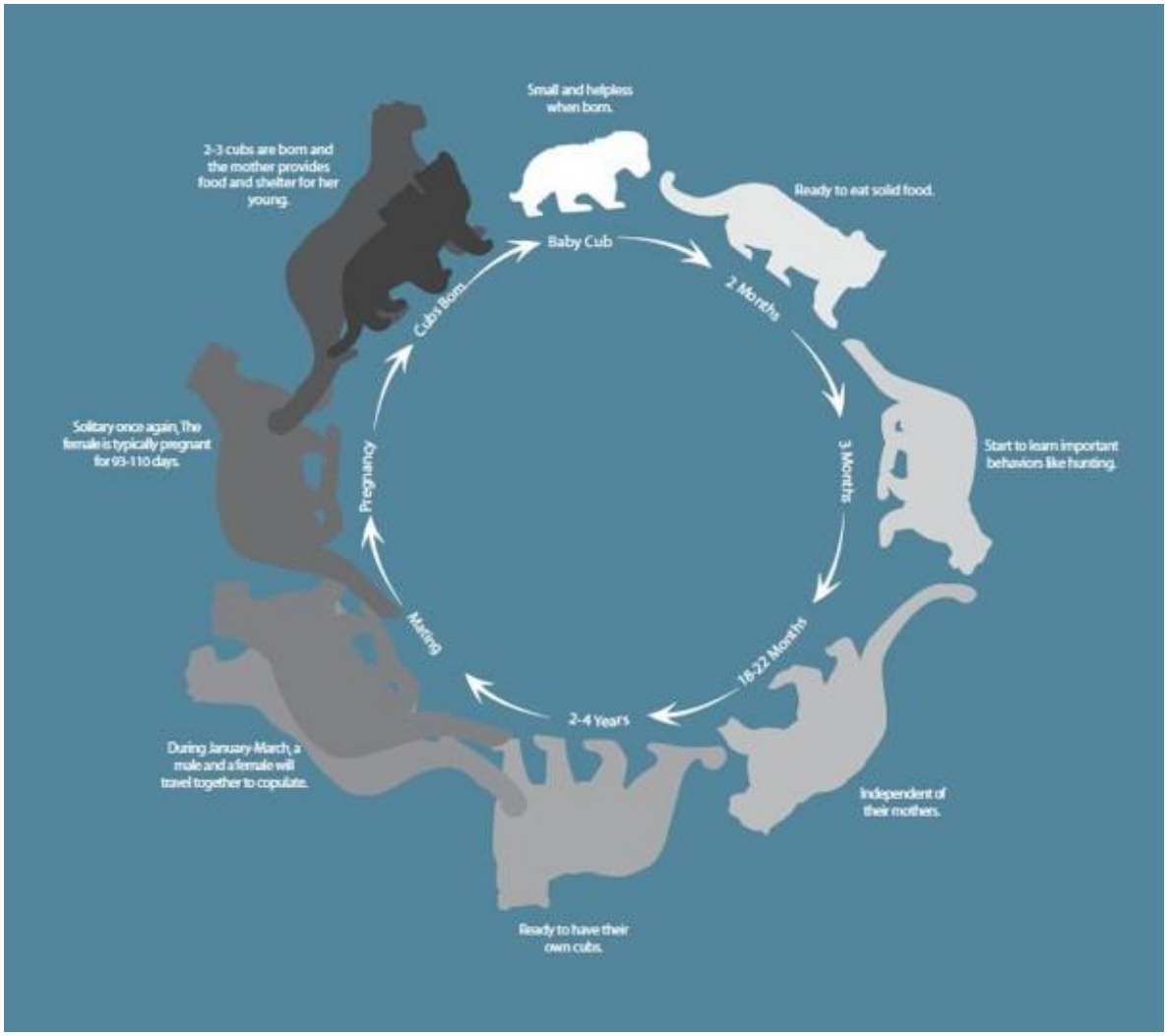

Fig. 1.1.4 Life cycle of the snow leopard (Snow Leopard Trust)

although they rarely appear in the snow leopard diet.

In addition to various species of the wild goat and sheep, the snow leopard di*et al*so includes red deer, white-lipped deer, musk deer, Siberian roe deer, Tibetan wild ass, wild boar, gazelle, antelope, Sumatran serow, goitered gazelle, wild camel, etc. Also included are marmots, hares, pikas, voles, and other small mammals, as well as birds and even other carnivores.

Fig. 1.1.5 Several of the major prey species for the snow leopard are relatives of the goat. Up left: Siberian ibex; up right: blue sheep; down left: markhor; down right: Himalayan tahr (online sources)

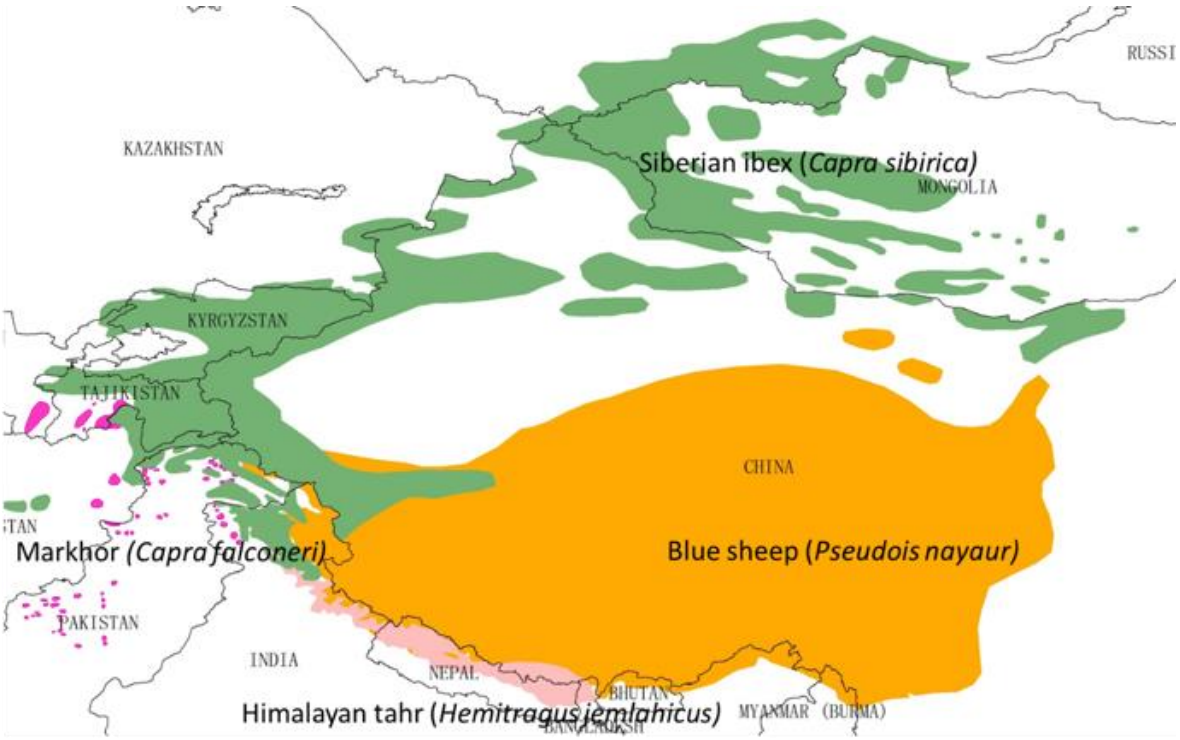

Fig. 1.1.6 Distribution of major prey species (Siberian ibex) for the snow leopard (Data source: IUCN, 2013)

1.2 Global Snow Leopard Population Sizes and Dynamics

1.2.1 Global Population Estimates

Up to now there has been no precise data of the world's snow leopard population. Only made available to date are rough estimates: 4,080-6,500 (McCarthy & Chapron 2003), 4,500-7,500 (Jackson *et al.* 2010), and 3,920-6,390 (Snow Leopard Working Secretariat 2013). Furtive behavior, low population density, sporadic distribution, and low detectability are challenges to the reliable estimation of the snow leopard population. Moreover, much of the existing field work has limited coverage; some even failed to cover the home range of a single individual; still, some other studies did not mention the studied area, making it all the more difficult to assess the results. Fortunately, these problems are being addressed by applying more reliable methods (Shrestha *et al.* 2013; Thinley *et al.* 2014; Alexander *et al.* 2015) and studying larger areas.

McCarthy and Mallon (2016) concluded that there were about 7,367-7,884 snow leopards around the world and that if added up with the Bhutan data of 2014-2016 (79-112: Thinley *et al.* 2016), the global population should range between 7,446 and 7,996. Based on these estimates, the IUCN decided to lower the snow leopard endangerment level from EN to VU in 2017.

However, Mishra and Ale (2018) published a letter on Science proposing against the IUCN's decision, thinking that the reference based on which the IUCN made the estimation was derived from the best 2% of the snow leopard habitat and therefore cannot represent the true status of the world's snow leopard population.

1.2.2 Population Dynamics

Reportedly, snow leopard population changes vary from area to area. In some areas, the population is

on the rise; in some, it remains status quo; and in others, it may be declining. With the exception of a few areas, at present we cannot accurately describe snow leopard population dynamics due to the long lack of surveys and research. This information gap needs to be filled.

It is estimated that the snow leopard population in Central Asia declined by 40-75% after the Soviet Union collapsed in the 1990s. But no evidence suggests that the decline continued towards the end of the 1990s (McCarthy *et al.* 2017).

Recent studies in Pakistan show that snow leopard populations in some areas may be lower than previously estimated (Snow Leopard Foundation, unpublished reports, Nawaz and Hameed 2015) and may continue to decline. Mining in and around the snow leopard range is an increasing threat, and climate change may also have an impact on the snow leopard population. Increasing livestock populations in some countries have led to decreases in wild prey and may further reduce the snow leopard population (McCarthy *et al.* 2017).

1.3 Snow Leopard Conservation in China

Sixty percent of the world's snow leopard habitat is located in China. Given the remote, most inaccessible locations of these habitats, as well as China's increasingly fueled effort for conservation over the last 20 years, the conservation of this large felid most likely will be successful in the country and make a case for China to construct its identity as a responsible global power.

In October 2013, with reference to the Global Tiger Initiative (GTI), the President of Kyrgyzstan Atam Bayev launched a Global Snow Leopard & Ecosystem Protection Program (GSLEP). The GSLEP focuses on the government of each snow leopard range state, recognizes threats to the species, and promises to coordinate domestic and international conservation efforts. Its goal is to identify and protect 20 landscapes for snow leopard survival by 2020.

Back in 2008, the Global Workshop for Snow Leopard Survival Strategy was held in Beijing. It marked the beginning of snow leopard research and conservation in China. Ten years have passed. In 2018, as the government authority of one of the snow leopard range states under the GSLEP, the China National Forestry and Grassland Administration hosted the International Conference for Snow Leopard Conservation in Shenzhen. In this event, China issued a positive signal to the international community as executives and professionals from the Chinese government, research institutions, and non-governmental environmental organizations, together with representatives from various countries, released the Shenzhen Consensus on Global Snow Leopard Conservation and expressed China ' s firm commitment to the cause.

In ten years from 2008 to 2018, an increasing number of research institutions and NGOs were engaged in snow leopard research and conservation. In 2008, Beijing Forestry University partnered with Oxford University to offer capacity training for local conservation facilities in Xinjiang, Gansu, and Inner Mongolia. In 2009, supported by Panthera and the Snow Leopard Trust, a group of scholars from Peking University and Shanshui Conservation Center (SCC) began snow leopard research and conservation in the Sanjiangyuan area of Qinghai.

As snow leopard conservation was gaining more attention, several other organizations joined in with their own distinct modalities. In 2012, the west section of the Qilian Mountains was subjected to snow leopard surveys and conservation. In 2014, Wild Xinjiang extended such work to the East Tianshan of Xinjiang with support from the East Tianshan Forestry Bureau. Around the same year, Green River partnered with the CAS Institute of Plateau Biology to initiate snow leopard surveying

and conservation in the Yangtze River head area. Also, Peking University joined efforts from national nature reserves, *inter alia* Wolong, to conduct snow leopard surveys in the Qionglai mountain range. In 2015, the Wildlife Conservation Society (WCS), in partnership with the Changtang and Serling Tso National Nature Reserves of Tibet, began snow leopard surveying and conservation in the said areas. The Chinese Felid Conservation Alliance (CFCA) began to carry out similar missions with Sichuan's Xinlong and Luoxu Nature Reserves in the Ganzi Prefecture. With the support of Vanke Foundation, Mt. Qomolangma Snow Leopard Conservation Center was established to conduct snow leopard surveys and conservation in collaboration with the Mt. Qomolangma Nature Reserve. In 2016, World Wildlife Fund (WWF) began to implement snow leopard conservation projects in Xinjiang, Gansu, and Qinghai. Likewise, Yuan Shang Cao Conservation Center started to take on both surveying and conservation responsibilities in Amne Machin. Qilian Mountains National Park also launched a systematic set of snow leopard surveys in collaboration with Beijing Forestry University.

In addition, the research institutions and NGOs involved have also held multiple meetings to discuss snow leopard conservation strategies. In July 2015, PKU and SCC, as one team, held the first International Snow Leopard Forum where homegrown snow leopard conservation groups sat down together in Yushu to discuss what could be done to protect the species. This event also led to the establishment of a Chinese snow leopard conservation network in collaboration with the sponsors. One year later in September 2016, the members attended the second Snow Leopard Forum, this time in Urumqi, Xinjiang, held by the East Tianshan Forestry Bureau in collaboration with Wild Xinjiang, and released a Snow Leopard Survey Handbook, hoping to help consolidate surveying methods and make it easier for newcomers to learn the know-how and join the network. In November 2017, what is officially known as "Hengduan Mountain Snow Leopard Conservation Workshop," an assembly of workers the executives of Wolong Nature Reserve summoned from all nature reserves of Sichuan, was held in Dujiangyan to discuss the methodology and planning of snow leopard surveys in the province.

1.4 Reporting Purpose and Content

In active response to the Shenzhen Consensus on Global Snow Leopard Conservation, the members of Snow Leopard China agree that it is necessary to review the Chinese efforts and progress in snow leopard research and conservation over the past ten years, summarize experiences and lessons, and promote future missions throughout the country. Therefore, we jointly released the Snow Leopard Survey and Conservation Status in China, a comprehensive report that

1) reviews the past and present realities of snow leopard research in China and identifies the gaps that need to be addressed;

2) identifies major threats to snow leopards in China and prioritizes these threats by province;

3) summarizes China's snow leopard conservation efforts and proposes actions to take in each province based on the ranking of the threats identified; and

4) identifies gaps in national snow leopard conservation policies and strategies and gives suggestions for snow leopard conservation in the next five years.

The first chapter of this report briefly introduces the ecology of the snow leopard and summarizes the background, purpose and content hereof. Chapter Two gives a summary of Chinese snow leopard research literature published since 1980, and briefly describes the results of these studies. Chapter Three, based on literature and interviews with key informants, summarizes the results of distribution

and population surveys on the snow leopard and prey in various provinces and autonomous regions (including findings at different phases of a project), and identifies areas where information gaps need to be filled. Chapter Four lists major threats to snow leopards in China, ranks specific threats in various provinces and autonomous regions, and summarizes the conservation actions to date. Then, it compares the threat ratings and the existing conservation efforts and analyzes gaps therein. Chapter Five is about vision and prospect. Based on the analyses mentioned earlier, it tries to put forward the objectives and suggestions for snow leopard conservation in China.

This report is the first attempt to synthesize findings and suggestions from various sources in a standardized and quantifiable manner and to conduct as comprehensive a review as possible of how the snow leopard has been studied and protected in China. Given the limited capacity and time involved in such a complex topic, we are bound to overlook certain issues that otherwise are too important to ignore. You will find such inadequacies in the data and results we present hereinafter. Your insights would be deeply appreciated.

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2 研究综述：1980-2018 年间的中国雪豹研究

Literature Review: Published Snow Leopard Research in 1980-2018, China

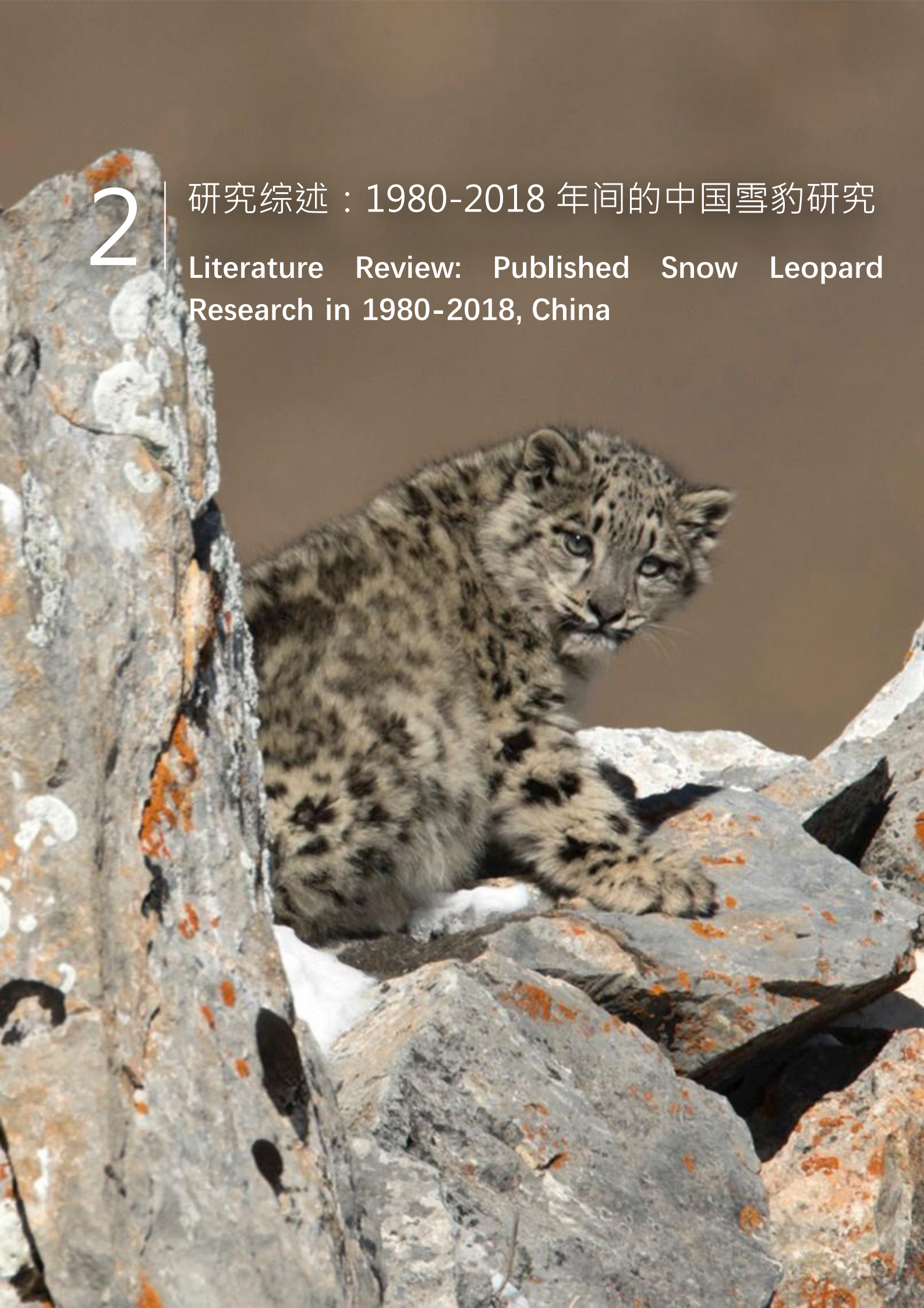

Photo by Frédéric Larry in Namse Town, Yushu Autonomous Prefecture, Qinghai

2.1 Background

The snow leopard (*Panthera uncia*) is distributed in 12 countries. The fact that most of its habitats are located in elevated, remote areas, coupled with its stealthy behavior and low population density, poses persistent challenges to researchers around the world. Despite these difficulties, an increasing volume of studies has been published, including fundamental ecological studies, dissertations on human-wildlife conflict, and surveys of local attitudes towards the snow leopard (Fox *et al*. 1991; Ale *et al*. 2014; Sharma *et al*. 2014; Johansson *et al*. 2015).

The nature and extent of threats to the species and their impact on its behavior and existence in general vary from area to area (Snow Leopard Network 2014). Where these threats might occur, what impact they might have, and which threats may be mitigated, still largely remain unidentifiable. Snow leopard conservation policies and practices should be based on rigorous and strong evidence (GSLEP Secretariat 2013). However, the existing data is very limited, particularly so when it involves snow leopard populations, key threats, and the human-snow leopard relationship.

It is estimated that China has 60% of suitable habitat for the snow leopard (McCarthy & Chapron 2003). From this perspective, it can be said that the country is central to snow leopard conservation. Its performance is of great significance to the international conservation effort as a whole. While China experiences an unprecedented economic growth, an increasing amount of pressure is bearing down on its ecosystems on one hand, but on the other, more resources are being made available for conservation actions in the country.

In this chapter, we will review snow leopard research in China with reference to the Chinese and English literature published in 1980 to 2018 on snow leopard ecology and conservation biology within the national territory. This chapter draws on *A Spotlight on Snow Leopard Conservation in China* (Alexander *et al*. 2016b), a review of the literature on snow leopard conservation between 1980 and 2014. It is necessary to mention that a multitude of studies in both Chinese and English languages have yet to be published and are useful for us to bridge the knowledge gaps and learn more about snow leopards in China. In several chapters that follow, we will review these unpublished works.

2.2 Methodology

Alexander *et al*. (2016b) reviewed the literature published in 1990 to 2014. We used the same methodology and added hereto the published works of 2015-2018.

We searched with the keywords "snow leopard," “uncia," and "Panthera uncia" plus "China" in Google Scholar (Google 2015). In the meantime, the keywords “snow leopard", "uncia” and "Panthera uncia" were used in the CNKI search engine (http://www.cnki.net/) to identify relevant Chinese and English citations from 2015 to 2018. These results were then compiled into the original sheets. Unpublished works, conference papers, and popular articles were excluded.

We thus identified 24 pieces of literature published in 2015 to 2018 with an explicit focus on snow leopards in China (the name of the species mentioned in the title and/or copious research on the subject matter). From the literature published in 1990 to 2014, Alexander *et al*. (2016b) retrieved 33 pieces.

2.3 Results

2.3.1 Overview

A total of 57 research papers were retrieved concerning snow leopard ecology and conservation (Table 2.1, n = 33, 1980-2014; n = 24, 2015-2018) (n = 57).

The earliest works were written by Liao Yanfa (1985)

and George Schaller *et al*. (Schaller *et al*. 1988a, b). These studies covered various snow leopard habitats in Xinjiang, Qinghai and Gansu. Our search results yielded no snow leopard related works throughout the 1990s and up to 2000. From 2000 to 2014, a number of studies were published discussing snow leopard habitat utilization, populations, and distribution (n = 21), addressing human-snow leopard conflict (n = 6) or the status of prey (n = 7, Table 2.1), and comparing the Chinese and foreign studies of the snow leopard (Wang *et al*. 2012a, b). No works on policy assessment were published until 2014.

Between 2015 and 2018, the volume of snow leopard research literature increased sharply, accounting for 42% of all published works. Most of these studies concern snow leopard habitat utilization, populations, and distribution (n = 21), while a few look into human-snow leopard conflict (n = 5), genetics (n = 3), prey (n = 1), illegal wildlife trade (n = 1) and climate change (n = 1). Among them are two general reviews of snow leopard conservation in China ((Alexander *et al*. 2016a; Li *et al*. 2016b). Fifty-seven papers are based on snow leopard studies conducted in Xinjiang (n = 22), Qinghai (n = 15), and Gansu (n = 10). Since 2015, there have been some new works on snow leopards in Tibet. Overall, only a few of the studies have been done in Sichuan (n = 4) and Tibet (n = 4).

The first study of snow leopards in Yunnan was published in 2017. No concrete study has been found of snow leopards in Inner Mongolia. However, according to Alexander *et al*. (2016), there have been sightings of the species in those areas (Zhao & Feng 1985; Zhao 1984; Yang 1988; Wang & Schaller 1996).

Janefika *et al*. (2008) identified a male individual using the fecal genetic method during a two-day survey in Qinghai. Similarly, Zhou *et al*. (2014) identified 48 individuals from Tibet, Qinghai, and Gansu by genetic testing.

In recent years, camera trapping has been extensively used in snow leopard range. In Mt. Qomolangma National Nature Reserve of Tibet, seven snow leopards were found this way. By dividing this number by the studied area, the researchers estimated that the local snow leopard population density was 1.8-2.5 per 100 km^2 (Chen *et al*. 2016b). In Bortala Mongolian Autonomous Prefecture, Xinjiang, 13-14 infrared cameras were installed in 2012 and 2013, covering an area of 192 km^2, and 11-15 adults and 2 sub-adults (Pan *et al*. 2016) were identified thereby. Similarly, camera traps were also set up at four monitoring sites located in the eastern, central, and western parts of the Tianshan Mountains, each of which captured images of 2-3 adults (Buzzard *et al*. 2017b). In Yunnan, the camera traps Buzzard *et al*. (2017) set up at four observation points in the Three Parallel Rivers area, one of the World Heritage Sites, have failed to catch any snow leopard. However, through interviews with local pastoralists and nature reserve staff, they believe that snow leopards do exist in this area. In Wolong, the species was effectively discovered 43 times with 20 cameras installed between 2013 and 2016 (Tang *et al*. 2017). McCarthy *et al*. (2008) estimated the snow leopard population density in the Tianshan Mountains to be about 20.74 per 100 km using the mark and recapture method. A recent study in Gansu using the spatial mark and recapture method estimated that the snow leopard population was somewhere between 1.40 (0.36 SD) and 3.29 (1.10 SD) per 100 km^2 (Alexander *et al*. 2015b, 2016b).

Unfortunately, different research methods adopted in these surveys make it difficult to compare the absolute snow leopard population sizes or population densities in different areas.

2.3.2 Distribution / Abundance / Density

As estimated under the GSLEP in 2003, there are 2,000 to 2,500 snow leopards across 1,100,000 km^2 habitat in China.

Suitable habitat for this species is distributed in five provinces and two autonomous regions (ARs) in central and western China (Inner Mongolia, Gansu, Sichuan, Yunnan, Qinghai, Xinjiang and Tibet), covering a number of ethnic and cultural groups (at least 13 different ethnic groups) (Wucherpfennig *et*

al. 2011).

Specifically, Xinjiang, Qinghai, and Tibet have the largest habitat, while habitat in Yunnan and Inner Mongolia is much smaller. The snow leopard distribution, population, or habitat utilization were described in most of the works (n = 35). However, many of the methods used in these studies have not been universally proven or lacking in statistical rigorousness. Two recent studies have used the "spatial mark and recapture method" (Alexander *et al*. 2015b, 2016b). This method is considered the most appropriate for density research (Snow Leopard Network 2014). As to landscape-scale distribution studies, occupancy analysis is being widely recognized, but its application in snow leopard research remains very limited (Taubmann *et al*. 2016; Ghoshal *et al*. 2017).

Early studies of snow leopards in China predicted their population sizes through extensive sign-based surveys (based on dents, feces, and footprints) (Schaller *et al*. 1988a, 1988b). Schaller *et al*. (1988a) estimated that there were no more than 750 individuals across 170,000 km^2 suitable habitat in Xinjiang. In Qinghai, Schaller *et al*. assumed that there might be about 650 snow leopards within a radius of 65,000 km^2 according to their preliminary estimates of snow leopard density, i.e., one snow leopard per 100 km^2 (Schaller *et al*. 1988b). Later, a number of surveys based on systematic tracking and camera trapping in Xinjiang estimated that there were 2-5 snow leopards per 100 km^2, though the mark and recapture method was not used (Ma *et al*. 2006; Xu *et al*. 2011; Ma *et al*. 2011). Wu Guosheng (2009) estimated that there were at least 7 individuals within a radius of 1,900 km^2 in Xinjiang, according to various sign-based and sociological surveys. As estimated by Peng Jitai (2009), 51-78 snow leopard individuals were found in nine nature reserves of Ganzi Tibetan Autonomous Prefecture, Sichuan.

2.3.3 Protected Areas

Over the past 30 years, the number of protected areas (PAs) in China has increased rapidly and reached 2,740 by 2016, covering about 14.83% of China's land area (1.47 million km^2). These PAs, as Alexander *et al*. (2016a) estimated, have covered a large part of snow leopard range in the country. According to the IUCN and Protected Planet reports (Jackson *et al*. 2008, Juffe-Bignoli *et al*. 2014), more than 138 PAs of various sizes and types have been established. Among them, the largest network of PAs is located in the Hoh Xil, Changtang, and Sanjiangyuan Nature Reserves, forming a connected area of 766,000 km^2 across the borders of Tibet and Qinghai (Juffe-Bignoli *et al*. 2014).

Up till now, we have found only one study that focuses on the potential contribution of PAs to snow leopard conservation (Xu *et al*. 2014). The increasing number of nature reserves holds hope for snow leopard conservation, but their actual effectiveness remains controversial (Liu *et al*. 2003; Xu & Melick 2007). Some PAs have only sporadic low-density blue sheep populations, and snow leopard populations probably are also very low (Schaller 1998). Xu *et al*. (2014) pointed out that many of the nature reserves in Xinjiang are faced with pressure. Take Kalamaili Nature Reserve for example. It has undergone five to six boundary changes in the past few years, forcing the core area to move northward and resulting in the fragmentation and degradation of the reserve. Buzzard *et al*. (2017b) further stressed the need for snow leopard conservation in Xinjiang's nature reserves and cited relevant data to call on the Chinese government for the establishment of new PAs.

At present, it seems that no effort has been taken to critically assess the effectiveness of snow leopard conservation in a single PA or across the country. The existing network of PAs is not designed for snow leopard conservation, and there is not much continuity in the distribution of PAs. Moreover, it is not clear whether habitat in between PAs is enough to provide pathways for snow leopard dispersion (Riordan *et al*. 2015). This represents a critical knowledge gap in conservation.

2.3.4 Wild Prey Species

Central Asia and the Tibetan Plateau are home to

12 large herbivorous species, three of which once occurred as megafaunal. Due to excessive hunting and habitat loss, the populations of all these species have decreased, some of which are even close to extinction (Mallon & Jiang 2009). From 1998 to 2015, the Red List Index (RLI) of ungulates on the Tibetan Plateau declined on a continuing basis, indicating that the living conditions of plateau ungulates kept deteriorating (Jiang Zhigang *et al*. 2018). The availability of wild ungulates is a key determining factor of carnivore density (Karanth *et al*. 2004), making it necessary to review more fully the living status of prey animals for the snow leopard. However, estimating montane ungulate populations in a scientific manner still remains quite a challenge (Singh & Milner-Gull and 2011). In this respect, the " double-observer method" has gradually shown good applicability in recent years (Suryawanshi *et al*. 2012; Tumursukh *et al*. 2015).

2.3.5 Human Activities

1. Hunting and trade

We only found 4 research papers on trade in snow leopards. In Sichuan, Peng Jitai (2009) described that the local government bought 20 to 30 snow leopard skins from hunters every year from the 1960s to the 1980s. Based on questionnaires, Ma *et al*. (2012) assumed that the number of snow leopard poaching and trade cases in Xinjiang increased significantly between the 1960s and 2010. Conversely, Li & Lu (2014) believe that illegal trade has declined in recent years based on news reports. From 2000 to 2013, they found nationwide 43 commercial deals that involved 98 snow leopards, principally furs and bones. Among local families in the Sanjiangyuan area of Qinghai, the same authors found no needs for traditional medicine, clothing, or decoration related to the snow leopard (Li & Lu 2014). An evaluation of illegal trade in snow leopards showed that China accounted for 50.6% of the world's trade in snow leopards from 2003 to 2014 (Mahesh Wari & Niraj 2018). They also described two cases of whole snow leopard sales in China and one incident in which about 70 snow leopard paws were sold in Xinjiang. Further, the authors found that the sentencing rate for snow leopard related cases in China reached 47%, or 17 out of 36 cases, eight of which involved imprisonment and fining.

2. Human-wildlife conflict

Human-wildlife conflict is a kind of hostile act between humans and wild animals that adversely affects each other (Redpath *et al*. 2013). Such conflict often occurs in snow leopard range, and a large number of relevant studies are also present (Mishra 1997; Hussain 2003; Bagchi *et al*. 2004; Sangay & Vernes 2008; Li *et al*. 2013c). In many parts of the world, wild animals prey on livestock, causing the local community considerable financial losses. These "criminals" may be avenged and killed, resulting in serious threats to conservation (Bagchi *et al*. 2004).

We have found 11 research papers that evaluated livestock losses inflicted by snow leopard attacks and discussed local attitudes to the snow leopard (Ma *et al*. 2005; Xu *et al*. 2008; Xu *et al*. 2007, 2010; Li *et al*. 2013a, b, 2015; Alexander *et al*. 2015a; Chen *et al*. 2016a, b; Buzzard *et al*. 2017a). Some researchers have found that there seem less chances that snow leopard attacks occur to livestock in Gansu, Qinghai, and Tibet than in other countries where the species is distributed (Xu *et al*. 2008; Li *et al*. 2013b; Alexander *et al*. 2015a; Chen *et al*. 2016a). People in Sanjiangyuan and the Kunlun mountain areas of Qinghai are more tolerant towards the snow leopard (Xu *et al*. 2008; Li *et al*. 2013a, c). For example, pastoralist communities in Sanjiangyuan don't see the snow leopard as a threat to livestock, but they have a strongly hostile attitude towards other carnivores such as brown bears and wolves (Li *et al*. 2013c). Increasingly evident on the Tibetan Plateau might be that the snow leopard is given more tolerance while other predators, such as bears, wolves, and lynx, are being treated with more hostility.

3. Other potential threats

Some works assume that the snow leopard faces many new threats, such as rapid human population growth, natural habitat being reduced to farmland, stray dogs, mining, and hydropower constructions. The GSLEP has also highlighted a number of

potential threats in China, including the lack of proper policies and cross-border cooperation, climate change, cordyceps harvesting activities, etc. (Snow Leopard Working Secretariat 2013).

The threat of climate change is underlined in two studies published recently (Li *et al*. 2016a; Mei *et al*. 2018). Li *et al*. (2016a) analyzed for the first time on a global scale the priority areas of snow leopard conservation. The authors concluded that the Altai and Qilian Mountains and Tianshan-Pamir-Hindu Kush-Karakoram (TPHK) ranges account for about 35% of the current snow leopard range. In the context of climate change, these regions may play a role in providing shelter for snow leopards.

At present, the extent to which these threats affect snow leopards in China remains unclear. These assessments are mainly based on expert opinions and need to be verified in different contexts. Currently, a task of great concern is to synthesize the assessments of snow leopard populations and potential threats nationwide. For instance, at the macroscopic level, it is necessary to document the current and future highway networks that pass through snow leopard range as well as the planning of ongoing or scheduled urban-rural transformation and major development projects. This requires continuous research based on the changing local socioeconomic conditions. Assessment in a micro perspective should include human population and economic data collections, human population predictions, and fundamental livelihood and economic activities. It's also necessary to assess community attitude towards wildlife, reflect its roots in social and cultural history, and find out why that attitude changes (Redpath *et al*. 2013). These efforts need to be taken in a way that fully respects the experience and knowledge of local residents and the staff of local nature reserves.

2.3.6 Policies

In the 1980s, snow leopard range in China, as a whole, went through a revitalization of conservation policies. Although the national list of protected species was not revised until the end of the 1980s, the snow leopard was raised one level higher to the top level of conservation under new regional policies. In 1983, represented by the northwest provinces of Shaanxi, Gansu, Xinjiang, Ningxia, and Qinghai (all being the snow leopard range provinces and the provinces surveyed in the mid-1980s), a wildlife conservation commission was jointly established and hence conducted meetings on a regular basis, in addition to wildlife conservation and management research. As wildlife conservation was being prioritized, the snow leopard was fully placed under the legal framework of Qinghai in 1983 (Lewis & Songster 2016).

2.4 Conclusion

Since 2014, there has been a drastic increase in the number of papers published with respect to the snow leopard, resulting in a total volume of literature almost twice as much as before. This shows that the Chinese research capacity has been greatly uplifted on snow leopard related topics. Most of the early studies targeted Qinghai and Xinjiang. It is reassuring to learn that more recently published studies have included Sichuan, Tibet, Yunnan, and Gansu.

Research techniques and methods for studying other carnivores and international effort to dig deeper into the knowledge of the snow leopard have provided new opportunities for snow leopard research and conservation in China. Non-invasive research methods, such as spatial mark-recapture and occupancy modelling, are of great significance for further studies of the ecology of carnivores (Karanth & Nichols 1998; Karanth *et al*. 2006, 2011; Taubmann *et al*. 2016; Ghoshal *et al*. 2017). Based on these methods, we need to set up standards for methodical large-scale regional surveys as soon as possible. A survey-targeted area should be one that extensively covers each of the snow leopard range areas in China and can be used to analyze large-scale snow leopard occupancy models and corridors. Such surveys will help to further identify key areas for deeper and more longstanding studies on topics like snow leopard densities and dynamics. Rigor in methodology brings robust results. Additionally, the data collected from such long-

term work in snow leopard range areas will also inspire and inform new research ideas.

To make proper conservation plans on both the regional and global scales, it is urgent to understand the impact of human activities on the snow leopard population. Despite the considerable amount of resources China has made available for conservation, what starts out as effective work nevertheless may be postponed or misled without a sound scientific basis. Therefore, it is imperative to align research methods to tasks at hand and build infrastructure for applied research in a way to promote and support further snow leopard research in the country. China's deep and continued engagement is urgently needed for future snow leopard conservation around the globe.

Table 2.1 A list of 57 research papers stated herein (by chronological order)

ID	Year	Location*	Author(s)	Title	Publication	Language	Area of research
1	1985	QH	(廖炎发， 1985)	青海雪豹地理分布的初步调查	兽类学报	CHN	habitat
2	1988	GS, QH	(Schaller *et al.*1988b)	Status of the Snow Leopard *Panthera uncia* in Qinghai and Gansu Province China	Biological Conservation	ENG	habitat, prey
3	1988	Xinjiang	(Schaller *et al.*1988a)	The snow leopard in Xinjiang China	Oryx	ENG	habitat, prey
4	2003	QH, GS, XJ, SC	(刘楚光等， 2003)	雪豹的食性与食源调查研究	陕西师范大学学报	CHN	prey
5	2005	XJ	(马鸣等， 2005)	新疆雪豹调查中的痕迹分析	动物学杂志	CHN	habitat, prey, HWC
6	2005	XJ	(徐峰等， 2005)	新疆托木尔峰自然保护区雪豹调查初报	四川动物	CHN	habitat
7	2006	XJ	(徐峰等， 2006a)	新疆北塔山雪豹对秋季栖息地的选择	动物学研究	CHN	habitat
8	2006	XJ	(马鸣等， 2006)	利用自动照相技术获得天山雪豹拍摄率与个体数量	动物学报	CHN	habitat, prey
9	2006	XJ	(徐峰等， 2006b)	雪豹栖息地选择研究初报	干旱区研究	CHN	habitat
10	2006	XJ	(马鸣&徐峰， 2006)	利用红外自动照相技术首次拍摄到清晰雪豹照片——新疆木扎特谷雪豹冬季考察简报	干旱区地理	CHN	habitat
11	2007	XJ	(徐峰等， 2007)	新疆北塔山地区雪豹及其食物资源调查初报	干旱区资源与环境	CHN	habitat, prey, HWC
12	2008	XJ	(McCarthy *et al.*2008)	Assessing Estimators of Snow Leopard Abundance	The Journal ofWildlife Management	ENG	habitat
13	2008	QH	(Xu *et al.*2008)	Status and conservation of the snow leopard Panthera uncia in the Gouli Region Kunlun Mountains, China	Oryx	ENG	habitat, prey, HWC
14	2008	QH	(Janecka *et al.*2008)	Population monitoring of snow leopards using non-invasive collection of scat samples: a pilot study	Animal Conservation	ENG	habitat, GNS
15	2008	QH	(张于光等，2008)	基于粪便 DNA 的雪豹种群调查和遗传多样性	动物学报	CHN	GNS
16	2009	SC	(彭基泰，2009)	青藏高原东南横断山脉甘孜地区雪豹资源调查研究	四川林业科技	CHN	habitat, human
17	2009	QH	(张于光等， 2009)	基于粪便 DNA 的青海雪豹种群遗传结构初步研究	兽类学报	CHN	other
18	2009	QH	(吴国生， 2009)	青海省都兰县沟里乡智玉村野生雪豹调查	畜牧兽医杂志	CHN	habitat
19	2010	XJ	(Xu *et al.*2010)	Recovery of Snow Leopard *Uncia uncia* in Tomur National Nature Reserve of Xinjiang	Pakistan Journal of Zoology	ENG	habitat, HWC
20	2011	XJ	(Turghan *et al.*2011)	Status of snow leopard *Uncia uncia* and its conservation in the Tumor Peak Natural Reserve in Xinjiang China	International Journal of Biodiversity and Conservation	ENG	habitat
21	2011	XJ	（徐峰等，2011a)	新疆托木尔峰国家级自然保护区雪豹的种群密度	兽类学报	CHN	habitat, prey

22	2011	XJ	（徐峰等， 2011b)	新疆雪豹种群密度监测方法探讨	生态与农村环境学报	CHN	habitat
23	2012	XJ	(Ma ，2012)	Market prices for the tissues and organs of snow leopards in China	Selevinia	ENG	human
24	2012		（王彦等，2012b)	近 60 年来雪豹 *(Uncia uncia)* 研究的文献分析	生物学杂志	CHN	other
25	2012		（王彦等，2012a)	雪豹*(Uncia uncia)* 研究的文献计量评价	生态学杂志	CHN	other
26	2013	QH	(Li et al. 2013b)	A Communal Sign Post of Snow Leopards *(Panthera uncia)* and Other Species on the Tibetan Plateau China	International Journal of Biodiversity	ENG	other
27	2013	QH	(Li et al. 2013a)	Role of Tibetan Buddhist Monasteries in Snow Leopard Conservation	Conservation biology	ENG	habitat, HWC
28	2013	QH	(Li et al. 2013c)	Human-snow leopard conflicts in the Sanjiangyuan Region of the Tibetan Plateau	Biological Conservation	ENG	HWC
29	2013	XJ	（马鸣等， 2013)	新疆雪豹	科学出版社	CHN	other
30	2014	XJ	(Wang et al. 2014)	Dietary overlap of snow leopard and other carnivores in the Pamirs of Northwestern China	Chinese Science Bulletin	ENG	prey, GNS
31	2014		(Li & Lu 2014)	Snow leopard poaching and trade in China 2000-2013	Biological Conservation	ENG	human
32	2014	XJ	(Xu et al. 2014)	Nature reserve in Xinjiang: a snow leopard paradise or refuge for how long?	Selevinia	ENG	habitat
33	2014	QH, TB, GS	倜芸芸等， 2014)	基于粪便 DNA 的青藏高原雪豹种群调查和遗传多样性分析	兽类学报	CHN	habitat, GNS
34	2015	GS	(Laguardia *et al* 2015)(Alexander *et al* 2015a)	Human wildlife conflict involving large carnivores in Qilianshan, China and the minimal paw-print of snow leopards	Biological conservation	ENG	HWC
35	2015	GS	(Alexander *et al* 2015b)	Conservation of snow leopards: spill over benefits for other carnivores?	Oryx	ENG	other
36	2015	GS	(Alexander *et al* 2015c)	Face value: towards robust estimates of snow leopard densities	PlosOne	ENG	habitat
37	2015	GS	(Alexander *et al* 2015d)	On the high trail: examining determinants of site use by the Endangered snow leopard Panthera uncia in Qilianshan, China	Oryx	ENG	habitat, human
38	2015	XJ	(Laguardia et al. 2015)	Species identification refined by molecular scatology in a community of sympatric carnivores in Xinjiang, China	Zoological Research	ENG	GNS
39	2015	QH	(Li et al. 2015)	Livestock depredations and attitudes of local pastoralists toward carnivores in the Qinghai Lake Region, China	Wildlife Biology	ENG	HWC
40	2015	XJ	(Wu et al. 2015)	Relationship between ibex and snow leopard about food chain and population density in Tianshan	Selevinia	ENG	prey
41	2015	QH, GS	（周芸芸等， 2015)	雪豹的微卫星 DNA 遗传多样性	动物学杂志	CHN	GNS

Table 2.1 (Cont'd)

42	2016	GS	(Alexander *et al.* 2016a)	Patterns of Snow Leopard Site Use in an Increasingly Human-Dominated Landscape	PlosOne	ENG	habitat、human
43	2016	-	(Alexander *et al.* 2016b)	A spotlight on snow leopard conservation in China	Integrative Zoology	ENG	all
44	2016	GS	(Alexander *et al.* 2016c)	A granular view of a snow leopard population using camera traps in Central China	Biological Conservation	ENG	habitat
45	2016	TB	(Chen *et al.* 2016a)	Human-carnivore coexistence in Qomolangma (Mt. Everest) Nature Reserve, China: Patterns and compensation	Biological Conservation	ENG	HWC
46	2016	TB	(Chen *et al.* 2016b)	Status and conservation of the Endangered snow leopard Panthera uncia in Qomolangma National Nature Reserve, Tibet	Oryx	ENG	habitat、HWC
47	2016	XJ	(Pan *et al.* 2016)	Detection of a snow leopard population in northern Bortala, Xinjiang, China	Catnews	ENG	habitat
48	2016	-	(Li *et al.* 2016a)	Climate refugia of snow leopards in High Asia	Biological Conservation	ENG	human
49	2016	-	(Lietal. 2016b)	Challenges of snow leopard conservation in China	Science China Life Sciences	ENG	all
50	2017	YN	(Buzzard *et al.* 2017a)	The status of snow leopards Panthera uncia, and high altitude use by common leopards P. pardus, in north-west Yunnan, China	Oryx	ENG	habitat
	2017	XJ	(Buzzard *et al.* 2017b)	Presence of the snow leopard Panthera uncia confirmed at four sites in the Chinese Tianshan Mountains.	Oryx	ENG	habitat
	2017	-	(Janecka *et al.* 2017)	Range-wide snow leopard phylogeography supports three subspecies	Journal of Heredity	ENG	GNS
53	2017	SC	(唐卓等, 2017)	基于红外相机技术对四川卧龙国家级自然保护区雪豹（ft^tAera ii/Kia)的 研 究	生物多样性	CHN	habitat
	2017	SC	(乔麦菊等.2017)	基于MaxEnt模型的卧龙国家级自然保护区雪豹imcia)适宜栖息地预测	四川林业科技	CHN	habitat
55	2018	TB	(Bai *et al.* 2018)	Assessment of habitat suitability of the snow leopard (Panthera uncia) in Qomolangma National Nature Reserve based on MaxEnt modeling	Zoological Research	ENG	habitat
56	2018	-	(Maheshwari and Niraj 2018)	Monitoring illegal trade in snow leopards: 2003-2014. Global Ecology and Conservation	Global Ecology and Conservation	ENG	human
	2018	QH	(Mei *et al.* 2018)	Common leopard and snow leopard co-existence in Sanjiangyuan,Qinghai, China	Catnews	ENG	habitat

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3 分布与数量：种群现状与调查空缺

Distribution and Abundance: Survey Results and Gap Analyses

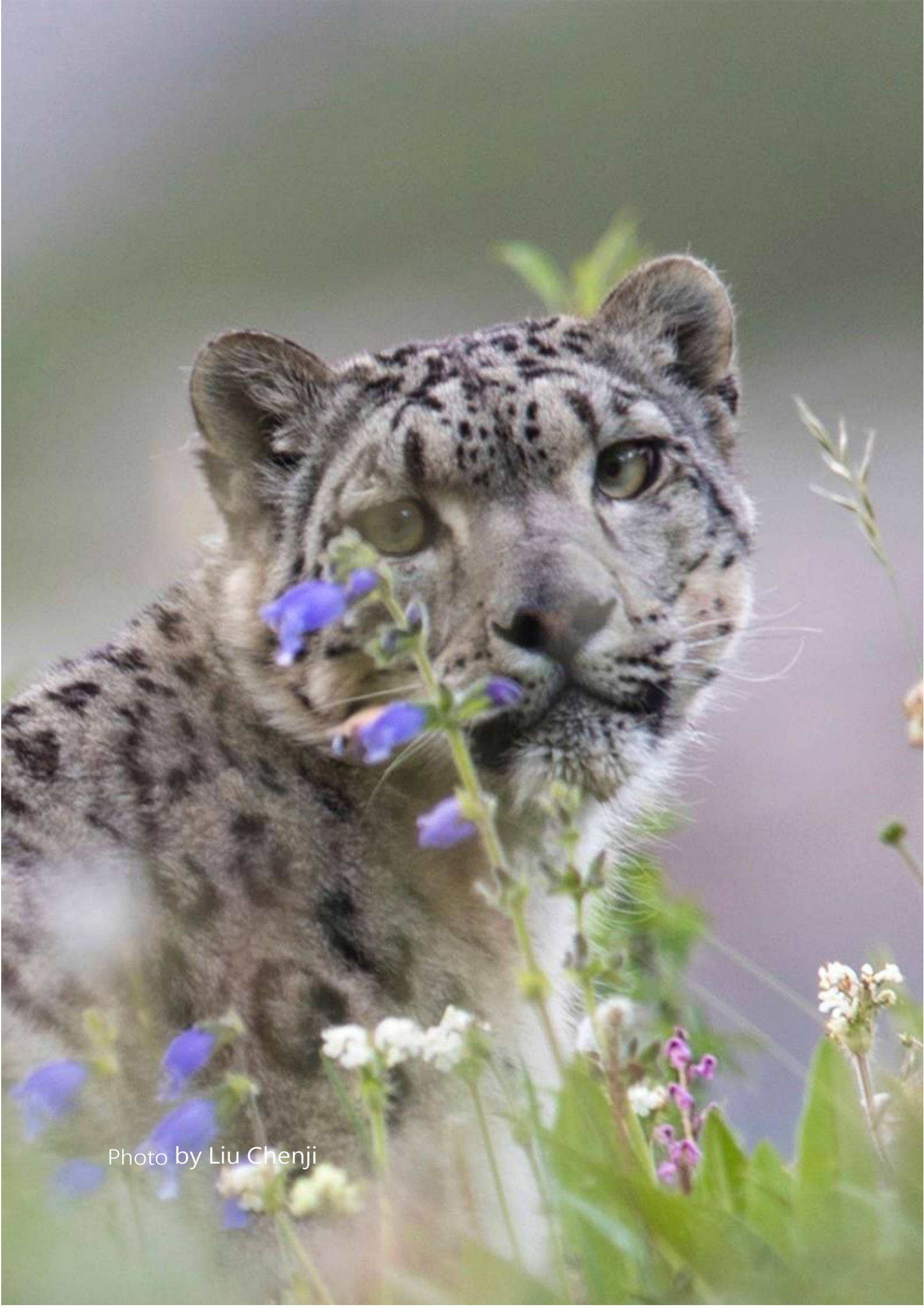
Photo by Liu Chenji

3.1 Introduction

The lack of snow leopard related baseline data is the primary problem faced by almost all the countries where the species is distributed, making it difficult to set up proper conservation targets and plans for goal-orientated and focused actions. The wide distribution of snow leopards in the least accessible mountain areas greatly challenges the possibilities to conduct all-inclusive surveys. To overcome these setbacks, a considerable amount of human, physical, and financial resources is needed both inside and outside the protected areas (PAs). Wildlife conservation volunteers and local communities both can serve as important contributors to the cause.

Despite decades of research, credible snow leopard population estimates are still very limited. The existing results are based on the surveys of the habitat which only accounts for 2% of the total snow leopard range area. Moreover, those areas methodically surveyed as prime habitat have produced results not suitable for extrapolation to the other areas that have not been surveyed. Based on this understanding, the governments of all the snow leopard range states have expressed a strong need for accurate estimation and broad monitoring of the world's snow leopard population. This need is fully represented in the Bishkek Declaration 2017 and the Global Snow Leopard & Ecosystem Protection Program (GSLEP). At the International Snow Leopard Summit and Ecosystem Forum 2017 in Bishkek, a credible estimation of the world's snow Leopard population was set as an objective to achieve. At the summit's official high-level meeting, delegates from the snow leopard range states all resolved to give it the highest priority. The Population Assessment of the World's Snow Leopards (PAWS) was officially launched thereby and will be implemented under the supervision of the GSLEP Executive Committee. A technical panel consisting of international snow leopard experts and statisticians will exercise technical supervision, while training and technical communication will be provided by some of the organizations and institutions that work with the GSLEP Secretariat. This master work plan is expected to be completed in the next five years and will be implemented in the following three steps: 1) to produce credible and true snow leopard distribution and spatial heterogeneous maps through large-scale sign-based surveys and interviews; 2) to take concerted actions in local areas, primarily surveys using camera traps and methods in molecular biology; 3) to estimate the population by identifying individuals and then using spatial mark-recapture models. Technical guidelines for survey design and analysis are being prepared. In September 2018, Beijing Forestry University (BFU) and Peking University (PKU) conducted two training sessions, in which active participation was achieved of many snow leopard conservation agencies.

3.2 Methodology

We extracted from the literature the results of surveys on snow leopard distributions and populations. However, as the species gained popularity in recent years, a large number of organizations have emerged conducting snow leopard surveys and long-term population monitoring projects throughout the country. The results thereof have yet to be released in the form of literature. Through interviews with key informants, we have collected nationwide data from organizations and institutions involved in snow leopard surveys and monitoring; interim results therefrom are enclosed herein (For a list of key informants, see the author(s) of each chapter). This includes survey methods, coverages, and preliminary results.

According to the PAWS's objective, i.e., to survey snow leopard populations in 20% of the snow leopard habitat, we calculated the existing coverage in each province/AR concerned to see how much further we need to go before we reach that goal. In the meantime, an attempt was made to mark all the surveys, including snow leopard distribution and population surveys in the literature and unpublished works, on a predicted distribution map (Li *et al*. unpublished, predicted with the world's 6,252 snow leopard distribution

sites and the MaxEnt model) for an analysis of gaps between snow leopard distribution and population surveys.

3.3 Results

Table 3.3.1 shows that the total area subjected to national snow leopard population surveys accounts for 1.7% of the snow leopard habitat. Though very close to the global means of 2%, it's a far cry from the "20%" goal.

Table 3.3.1 Snow leopard population survey covered areas and percentages of the snow leopard habitat on provincial and national scopes

Scope	Habitat area/km^2	20% SL habitat/km^2	Actual coverage/km^2	% of SL habitat
Xinjiang	476398	95280	2315	0. 49
Inner Mongolia	21762	4352	0	0
Gansu	105815	21163	4300	4. 06
Qinghai	330768	66154	14680	4. 44
Tibet	660798	132160	4503	0. 68
Yunnan	15756	3151	0	0
Sichuan	160366	32073	4578	2. 85
Nation-wide	1771662	354332	29934	1. 69

Specifically, Qinghai has the largest area covered by snow leopard surveys, which accounts for approximately 4.44% of the habitat in the province. Next is Gansu's Snow Leopard National Park, where such surveys conducted account for 4.06% of the habitat. In Sichuan, 2.85% of the habitat has been covered. Xinjiang and Tibet only achieved a coverage of 0.49% and 0.68% respectively due to their vast land areas. No actual coverage or proportion to habitat was calculated for Yunnan as only one survey present in the literature by Buzzard *et al.* (2017) failed to specify the studied area and found no snow leopard using camera traps. In addition, snow leopard habitat in Yunnan and Inner Mongolia is so small and marginalized that the number of surveys ever done in these areas is very close to zero.

3.3.1 Gansu

Published works

There is a relatively small number of studies on snow leopards in Gansu, and only 21 snow leopard distribution sites have been reported in the literature (Figure 3.3.1). Only a small number of snow leopards are distributed along the Qilian mountain range and in Dieshan at the borders. However, Qilian Mountain Nature Reserve (>20,000 km^2) shows signs of rising populations of blue sheep and the snow leopard (Schaller *et al.*, 1988b). Another snow leopard population is present in Yanchiwan Nature Reserve. Distribution used to be around the peripheries of Gansu-Inner Mongolia and in the Mazong Mountain, but now it has disappeared (Wang & Schaller 1996).

In recent years, snow leopard surveys in Gansu have been primarily focused on the Qilian Mountains, where many large carnivorous species inhabit. Snow leopard conservation in this area is very much likely beneficial to the red fox, wolf, Eurasian lynx and the jackal distributed in the same region (Alexander *et al.*, 2015b). In 2013, Alexander *et al.* conducted a large-scale study in Qilian Mountain National Nature Reserve and analyzed snow leopard habitat utilization using the occupancy model. They concluded that snow leopard distribution is mainly associated with

altitude (Alexander *et al.*, 2015d). From January to March of the same year, the team performed a snow leopard population survey using camera traps (Alexander *et al.*, 2016c) and estimated the density in the area to be 3.31/100 km^2. The factors affecting density are prey and grazing. Population density in this area may vary with seasonal fluctuations, ranging from 1.46 to 3.29 per 100 km^2 (Alexander *et al.*, 2016c). The population is mainly concentrated in the southwest corner and is on the edge of the reserve, far away from human settlements (Alexander *et al.*, 2016c).

A greater understanding of the snow leopard population in Gansu has also been achieved by genetic approaches. The research paper published in 2014 described snow leopard samples extracted from Aksai County in the southern mountain area along the Danghe River in Gansu, and the results showed that snow leopards in this area had gene flow with snow leopards in the Sanjiangyuan region (Zhou *et al.*, 2014). Works published in 2015 concluded that three snow leopard populations in Gansu's Aksai County and the counties of Nangqen and Zhidoi inside Qinghai Sanjiangyuan National Nature Reserve share the genetic characteristics of one snow leopard population, indicating an association between genetic distances and geographical locations (Zhou *et al.* 2015).

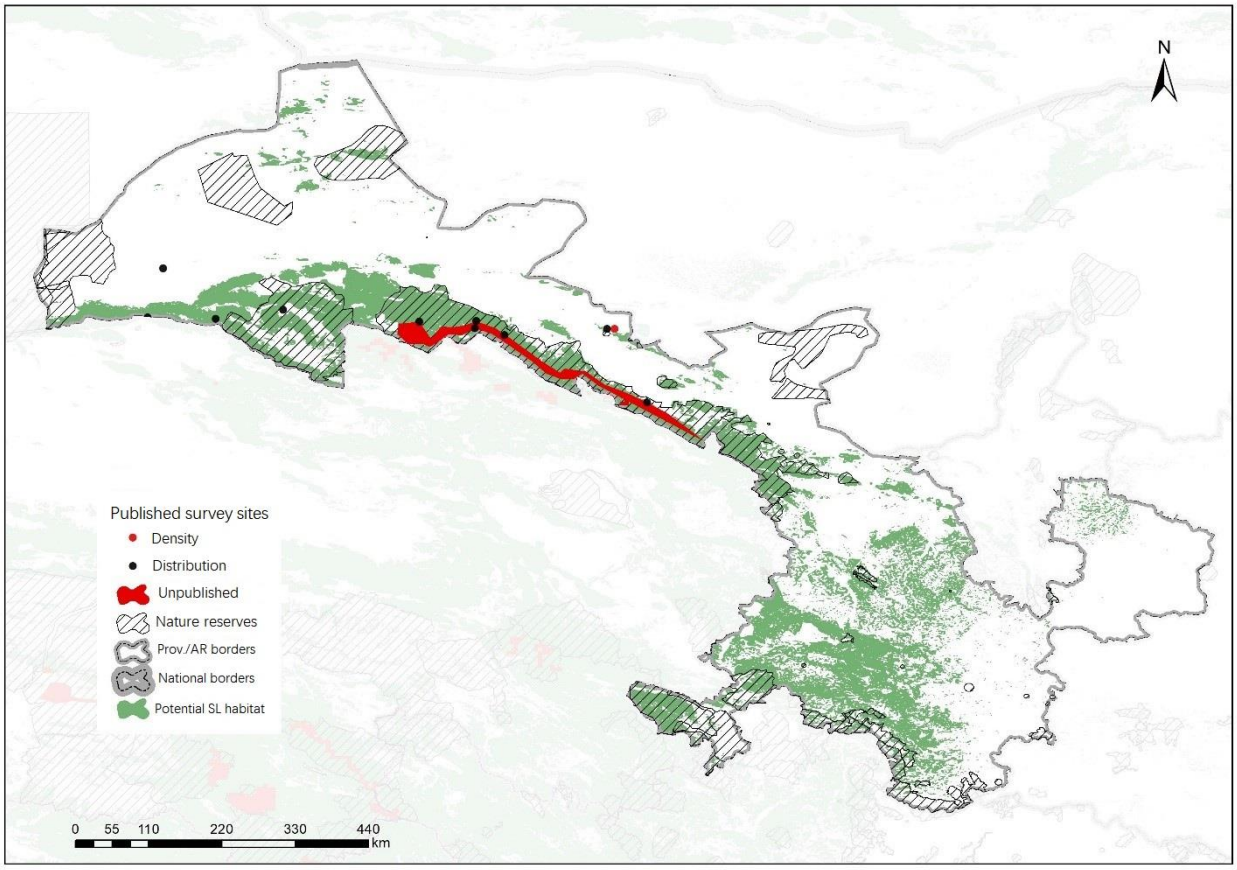

Fig. 3.3.1 Map of SL surveys in Gansu (The surveys that are being conducted in Qilian Mountains National Park can only be represented on a rough sketch map due to the lack of data.)

Unpublished works

The Qilian Mountains (the areas of Gansu)

Since 2011, a research team led by Li Diqiang of the Chinese Academy of Forestry (CAF) has practiced camera-trap-based monitoring in the southern mountain area along the Danghe River, at 6 camera sites identified in two gullies. From 2011 to 2013, animals including snow leopards, brown bears, wolves, red foxes, Pallas's cats, wild yak, blue sheep, marmots and chukar were found. The video footages showed exuberant blue sheep populations in the area, indicating that the local snow leopard population had sufficient food supplies and were doing fine.

In 2013, the BFU team started to practice snow leopard monitoring in partnership with Yanchiwan Nature Reserve and have since been doing so. Since the very first beginning, this project has been granted policy and financial support from the State Forestry Administration and has been brought into partnership with Oxford University. Meanwhile, a "Snow Leopard Habitat Selection and Dynamics" project, undertaken by the BFU team with the support of the National Natural Science Foundation, was also carried out in the Qilian Mountains. In 2016, WWF provided financial support to some of BFU's snow leopard monitoring and conservation efforts. In 2017, large-scale snow leopard monitoring was carried out in Yanchiwan and Qilian Mountain Nature Reserves as a collaborated effort by BFU and the nature reserve's staff. Snow leopard monitoring in Yanchiwan is focused on three areas, 750 km^2 each and 2,250 km^2 total, divided by 5 km x 5 km grids. Monitoring in the Qilian Mountains covers two areas, 1,000 km^2 each and 2,000 km^2 total. For Yanchiwan, 174 infrared cameras were installed and for Qilian, 170. Subsequent data analyses are in progress.

Gaps

Snow leopard surveys in Gansu have been mostly conducted within Yanchiwan and Qilian Mountains Nature Reserves. Due to the lack of data, surveys in Qilian Mountain National Park may only be represented on a sketch map as part of Gansu's survey atlas. However, as far as surveyed area is concerned, these surveys account for about 4.06% of the snow leopard habitat in Gansu, which is still a huge gap from the 20% goal. For snow leopard habitat in the southeast corner of Gansu, density surveys are lacking.

3.3.2 Qinghai

Published works

Early snow leopard surveys in Qinghai provided rough descriptions of snow leopard distribution primarily based on signs and door-to-door visits. From 1973 to 1981, Liao Yanfa (1985) traveled deep into snow leopard inhabited areas tracking snow leopard footprints, collecting feces and food debris, visiting local people and livestock purchasing departments, and taking into account 17 years of purchase records of Xining People's Park. He found that snow leopards in Qinghai were mainly distributed in the mountains of Qilian, Tuole, South Tuole, Shule, Bayan Har, Burhan Budai, Amne Machin, and Tanggula in the Kunlun mountain system, spanning over 20 counties and some parts of Da Qaidam in Qinghai. The counties with higher snow leopard distribution are Qilian, Tianjun, Dulan, and Zadoi. This result was cross-verified by the discovery of 72 snow leopard signs in March to May 2016 by Xu *et al.* (2018) along a 440 km transect within a 300 km^2 area of Gouli Town, Dulan County, where 6 functioning camera traps caught images of the species for 8 times. In 2005, Janecka *et al.* (2008) collected and identified three snow leopard feces samples in two days in Dulan County; they were verified to be the progeny of one male snow leopard. Schaller *et al.* also carried out a broad snow leopard survey from 1984 to 1987. After six months of surveying by line-transect, counting ungulates and interviewing local pastoralists, they found snow leopard presence in all major mountain areas and on several hills of Qinghai, believing that the species then was distributed in 9% of the province (approximately 65,000 km^2). Based on the overall density of approximately 1/km^2, it was estimated that there was a population of 650 throughout Qinghai. Further, the prediction by Li Juan *et al.* based on snow leopard signs and MaxEnt models showed that the snow leopard distribution area accounted for 25% of the entirety of the Sanjiangyuan region, exceeding 89,602 km^2, most notably in the mountains of Kunlun, Bayan Har, and Tanggula (Li *et al.* 2013a). The core area included approximately 7,674 km^2 snow leopard habitat, plus 8,342 km^2 habitat protected by Buddhist monasteries, which added strongly to conservation efforts within the protected area (Li *et al.* 2013a). Based on the overall density of approximately 1/km^2, the number of snow leopards in the distribution area of Sanjiangyuan was estimated to be about 900.

More detailed population surveys were mostly carried out on small scales. Schaller *et al.*, by

tracking signs, estimated that there was one snow leopard every 25-35 km^2 in Zaqing and Namse Towns of Zadoi County, as well as in Batang and Amne Machin Towns of Yushu County. The density might be higher in the southern part of the Shule Mountains while it might be considerably low in the other areas because of massive hunting and sales. A rough survey by Wu Guosheng *et al*. (2009) in the area of Zhiyu Village of Guli Town, Dulan County, in the Burhan Budai Mountains, a branch of the Kunlun, using the line-transect and interviewing methods, initially estimated the local snow leopard population at 6.86 minimally with a minimum ungulate population density of 2.88/km^2. Local pastoralists generally thought that the number of snow leopards had decreased significantly compared with 20 years earlier.

Genetics have also contributed to population surveys. From 2006 to 2009, Zhou Yunyun *et al*. (2014) collected and identified 45 samples of snow leopard feces in the counties of Zhidoi, Zadoi, Yushu, Nangqen, and Qumalai in Sanjiangyuan National Nature Reserve. Their further analysis concluded that there were at least 29 snow leopards in the region, particularly no less than 15 in Zhidoi County. Li Juan (2012) reported that the snow leopard population density in Sojia area of Sanjiangyuan Nature Reserve reached 3.1/100km^2, and that Zhidoi County might be the area known for the highest density ever recorded.

Snow leopard populations sympatric with common leopards have also been studied. Meiso Namsto *et al*. set up 42 and 16 cameras in Nyantho Village of Namse Town, Zadoi County, and Yunta Village of Haxiu Town, Yushu County, respectively, and analyzed the data collected thereby from 2015 to 2016. In Nyantho, they successfully identified 5 adult snow leopards, 3 adult leopards, and 1 female leopard with cubs. In Yunta, two snow leopards and one leopard were identified. The number of camera traps set in these areas indicates that it is one of the major areas where snow leopards and leopards coexist (Meiso *et al*. 2018).

In recent years, there has been an increasing number of studies on genetic diversity. The results show that snow leopards in Qinghai are genetically diverse and may be a source population. In years 2005 and 2007, Zhang Yuguang *et al*. (2009) collected and identified 21 samples of snow leopard feces in the towns of Zongjia and Nuomuhong of Dulan County and Sojia Town of Zhidoi County. Subsequent lab tests showed the existence of snow leopards, as well as rich genetic polymorphism, in all three towns where the fecal samples were drawn. In 2014, through a DNA analysis with snow leopard feces collected from Nangqen County, Zhidoi County, and the southern mountain area along the Danghe River in Gansu, Zhou Yunyun *et al*. (2015) concluded that the snow leopard is a species with high polymorphism and genetic diversity. Additionally, given the genetic distance, the researchers assumed that the gene flow across these three areas might be impeded, and that geographical distances, as well as natural and man-made spatial barricades, may be one of the causes. Increasing human disturbances may lead to the fragmentation of snow leopard habitat and cause an even greater impediment to gene flows between snow leopard populations. Therefore, more efforts are needed to build and maintain habitat corridors in between the snow leopard distribution areas.

Unpublished works

1. The entire region of Sanjiangyuan

In 2009, Shanshui Conservation Center (SCC) and the PKU team set out to work throughout the region of Sanjiangyuan in Qinghai. Initial projects were focused on the surveys of snow leopard distribution and threats region-wide. First, satellite imaging was used to draw 15 km x 15 km grids of the entire region and then to sort them into three categories of high, medium, and low density by the size of rocky mountain. From each category a 10% grid matrix was selected for field surveys. Information about camera traps, signs, and feces was collected and distribution points identified. Using the habitat prediction model built thereby, predicated snow leopard distribution in Sanjiangyuan was mapped. Further, these areas were rated by quality to generate a map of potential distribution at the three levels of density as described earlier.

2. The Yellow River head area

The Amne Machin Mountains provides key habitat for many alpine species and, throughout the Tibetan community, is regarded as one of the most revered mountain gods. From January 2017 Yuan Shang Cao Conservation Center started to work with the Chinese Academy of Forestry, Qinghai Forestry Department Wildlife and Nature Reserve Administration, and WWF to install about 100 cameras within a radius of over 2,000 km^2 in the towns of Xiadawu, Xueshan, and Dongqinggou. More than 500 images of snow leopard activity have been captured since. One healthy snow leopard population is present in this area. Subsequent data analyses are underway.

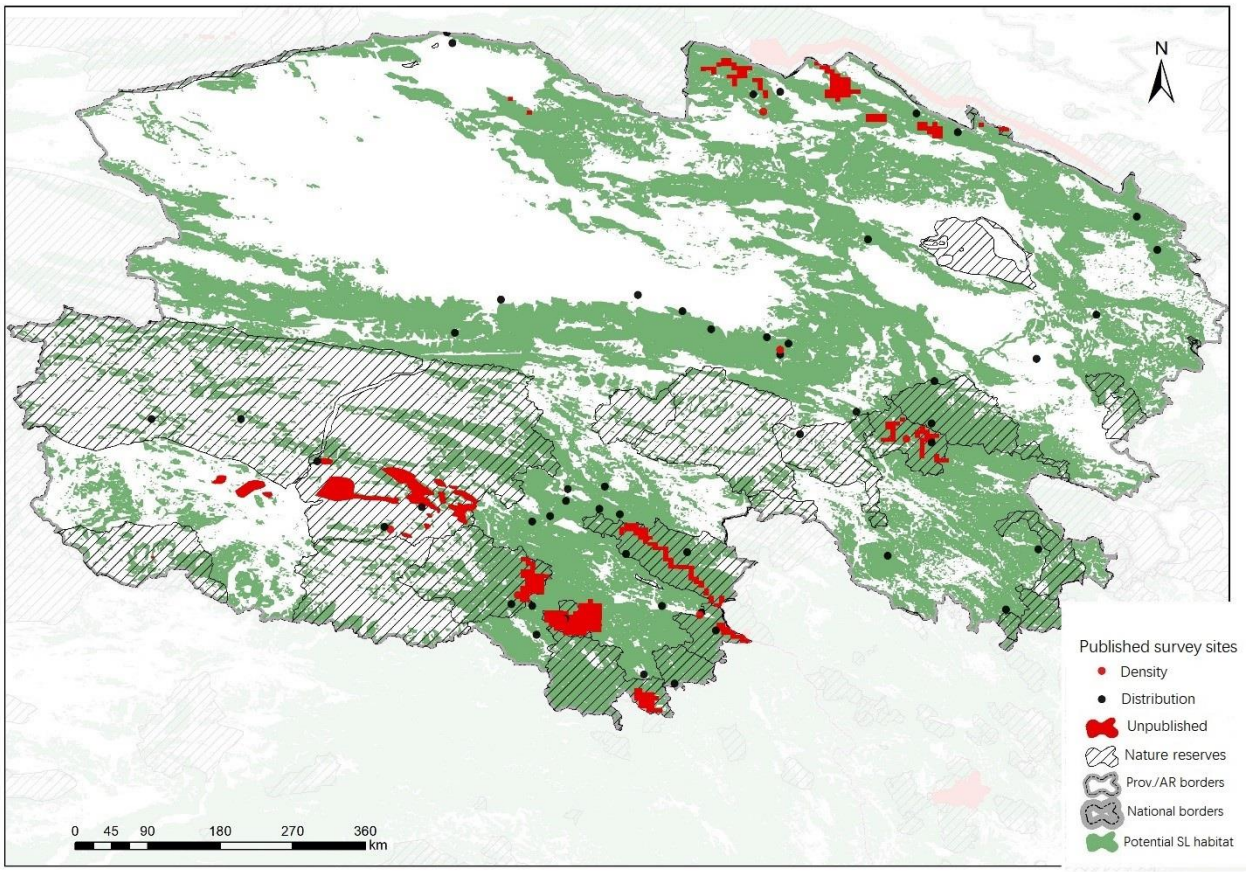

Fig. 3.3.2 Map of SL surveys in Qinghai

3. The Yangtze River head area

In early May 2014, supported by the government of Tsochi Village and the local monastery, Green River recruited more than 60 volunteers to install 6 wireless cameras and 39 infrared cameras within a radius of less than 40 km^2 on both sides of the Yanzhanggua Gorge. The results showed that on the north side of the Tongtian River might live 5-7 snow leopards and on the south side, 3-5 snow leopards. During the survey, the entire section of the Tongtian River in the gorge remained unfrozen and turbulent. Consequently, no crossover occurred among these populations. From this, it can be said that there were 8-12 snow leopards living within a radius of less than 40 km^2 in the Yanzhanggua Gorge. In 2015, Green River extended camera trapping to areas around Cheyerba in the north and installed a total of 54 cameras. Research associate Lian Xinming of the Northwest Institute of Plateau Biology is currently working on data collation and analysis.

In March 2016, with the support of the Qinghai Forestry Department Project Office and the Chinese Academy of Forestry, Xie Ran *et al.* of the Sojia Town government provided training for 24 local pastoralists and installed 60 cameras in the villages of Moqu, Yaqu, and Junqu. Subsequent

data analyses are in progress.

In October 2013, SCC launched a community-based monitoring program with a focus on snow leopards in Yunta Village of Haxiu Town. The community-based monitoring team set up 14 camera traps within ten grid squares, 5 km each, covering an area of 250 km^2. Subsequently, using the mark and recapture model, the local snow leopard density was estimated at 4.7/100 km^2 (SE = 1.1) and the adult snow leopard density 3.1/100 km^2 (SE = 1.1). At the end of 2014, Yunta's monitoring area was expanded to include Axia Village, reaching a total area of 350 km^2. In this village, by the time the mission ceased one year later, 41,838 images had been captured. The community-based monitoring program in Yunta has been going on and has captured 115,873 images.

In 2017, SCC partnered with Dongzhong Forest Farm and Qumalai and Chengdoi Counties to connect Qumalai, Yunta, Chengdoi, and Dongzhong as one area and place it into 71 grid squares (5 km x 5 km), where 102 cameras were installed covering an area of approximately 1,775 km^2. Subsequent data is being compiled and consolidated.

4. The Lancang River head area

In April 2014, SCC provided training for 20 local villagers to establish a monitoring team in Diqing Village of Zaqing Town (later at the end of 2017 expanded to 40 trainees) and installed 38 cameras by 5 km x 5 km grid in a 900 km^2 area. Such monitoring has since been maintained and 550,999 images taken. Subsequently using the mark and recapture model based on the winter data, it was estimated that the local snow leopard population was 24 (SE = 1.36, 95%CI=24~30), of which 20 were adults (SE= 1.38, 95%CI=20~26). As estimated, the density in the sampled area was 1.9/100 km^2 (SE = 0.1) and the density of adults was 1.6/100 km^2 (SE = 0.1).

In November 2015, SCC began to offer camera monitoring training and eventually in November 2017 the monitoring network was extended to cover the whole of the township administered area. To achieve that, the 87-strong monitoring team installed 83 cameras within 77 grid squares, each being 5 km x 5 km, all covering an area of 1,925 km^2. Since then 356,648 images have been captured.

In March 2018, with joint effort by the Qiaonyu Foundation and CFCA, 105 cameras were set in place to cover the core zone of Baizha Protected Area. The 1,000km^2 survey area was divided into 40 grid squares, 5 km x 5 km each. For each grid square, two optimal camera sites were selected, and each site was equipped with an automatic infrared camera to capture images of various wild species such as the leopard, snow leopard, musk deer, deer, and the lynx. Subsequent data analyses are in progress.

5. The Qilian Mountains (Qinghai)

Since May 2017, Li Diqiang's CAF research group, as a technical support provider, has been working with the Qinghai Qilian Mountain Nature Reserve Administration to survey the Qilian Mountains as one united snow leopard monitoring team. As many as 154 cameras were installed within 69 grid squares (5 km x 5 km), as well as in the Huangzang Monastery sub-zone. As of September 2017, 37 cameras had achieved 176 automatic snow leopard image captures. A number of individuals were photographed in the Youhulu sub-zone and the area of Yanglong. Also collected during the survey were 88 animal feces samples, 35 of which were identified as snow leopards', and 10 snow leopards were successfully identified, 5 being male and the 5 others female. Individual identification and density estimation will be carried out on the basis of data to be collected in the next phase.

Gaps

Qinghai has achieved the largest survey area, which accounts for approximately 4.44% of the habitat in the province. Nevertheless, it's still far from the 20% coverage. Density surveys in Qinghai are primarily focused on the region of Sanjiangyuan and the Qilian Mountains, with gaps located in the southeast corner of Golog Prefecture, the Kunlun Mountains, and hills between the Qilian and Kunlun ranges.

3.3.3 Sichuan

Published works

Most snow leopard researches in Sichuan have been carried out in Ganzi and Wolong National Nature Reserve. Early on, Liao Hetan (1998) listed 10 counties where snow leopards had been reported, including Ya 'an, Baoxing, Jinchuan, Xiaojin, Aba, Ganzi, Dege, and Batang. According to Schaller (1998), sparse snow leopard distribution was confirmed in some panda reserves (such as Wolong) above the timberline.

Peng Jitai (2009) studied snow leopards in Ganzi by various means, including route surveys, sign-based surveys, interviews, trade statistics, and hunter visits. According to this study, there were 51 to 78 snow leopards in nine nature reserves in the counties of Shiqu, Dege, Baiyu, Xinlong, Ganzi, and Litang, and 400 to 500 snow leopards throughout the prefecture. In Ganzi Prefecture, 42 nature reserves have been established totaling 41,086 km^2, accounting for 26.48% of the prefecture administered area, and covering most of the snow leopard habitat. Local snow leopards have been well protected.

In 2009, the administration of Wolong National Nature Reserve worked with PKU and SCC and for the first time proved the existence of snow leopards in Wolong using camera traps (Li *et al*. 2010). From November 2013 to March 2016, Tang Zhuo *et al*. (2017) and Qiao Maiju *et al*. (2017) set up 27 camera traps at the Reshui Site of the Yinchanggou Gorge, the Muxiang Slope of the Tizi Gorge, and the Maogou Cave of the Weijia Gorge, to study snow leopards and their sympatric wildlife. About 120,000 entries were recorded on 7,056 camera working days. Images of snow leopards were captured at 10 camera traps, and the species was effectively detected for 43 times, with a relative abundance index of 6.09 (Tang Zhuo *et al* 2017). During 28 months of camera trapping, adult and young snow leopards were consistently recorded, indicating that snow leopards in Wolong had been living well.

Unpublished works

1. The Qionglai Range

Since 2016, PKU, as the technical leader and sponsor, has been working with Mianyang Teachers' College, among other organizations, to facilitate collaborations among nature reserves in the area concerned. In a larger context of the Ministry of Environmental Protection networking for biodiversity monitoring, work is being done to build local camera trapping networks in the nature reserves along the central Qionglai. From 2016 to 2017, the first snow leopard survey was conducted in Wolong Nature Reserve and has been maintained since. In 2017, snow leopard surveys were conducted in the Anzi River and Heishui River Nature Reserves within the municipality of Chengdu.

According to the data from Li Sheng of PKU, as of June 2018, the camera monitoring network in the central Qionglai included about 550 camera traps, using l km x l km grids as base quadrats. In each nature reserve, 3-5 monitoring quadrats were selected by altitude and vegetation gradient, and each quadrat had 20-40 grid squares, each provided with one camera trap. From 2016 to 2017, at least 26 snow leopard individuals were identified by camera trapping in Wolong. In 2017, Chengdu's snow leopard surveys showed the existence of at least 5 individuals in Anzi River and Heishui River Nature Reserves. Further population and density assessments based on camera data are in progress. Potential prey animals are diverse and abundant in the survey area and can support the long-term survival of local snow leopards. However, the presence of a large population of free-range livestock increases the risk of human-snow leopard conflict.

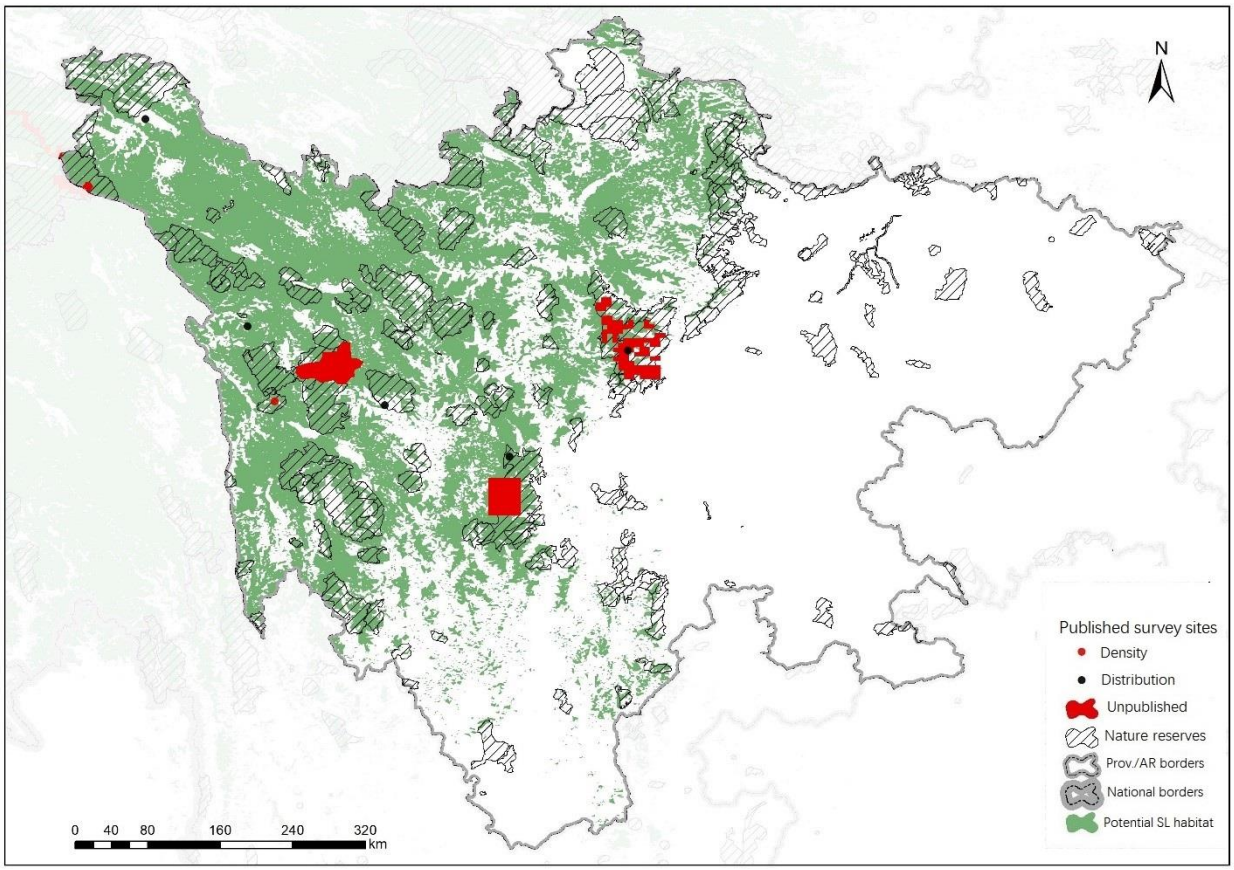

Fig. 3.3.3 Map of SL surveys in Sichuan

2. The Daxue Range

From 2016 to 2017, in a survey covering an area of 750 km^2 in Gongga Mountain National Nature Reserve, Yang Chuangming placed a total of 200 cameras by 5 km grid square in Gongga. At present, 110 valid snow leopard images have been obtained and more than 5 individuals have been preliminarily identified. Other data are being analyzed.

3. The Shaluli Range

From September to October 2016, the CAFA conducted surveys in Chaqing Songduo Nature Reserve of Baiyu County, as well as in Xinlong County and Luoxu Town of Shiqu County, Ganzi Prefecture, Sichuan. The research team installed 16 cameras along altitudinal gradients within a radius of 100 km^2 in Luoxu Town and 14 cameras in 7 zones especially selected within an area of 3,000 km^2 in Xinlong County. The survey in Chaqing Songduo Nature Reserve was mostly conducted through visits and questionnaires. The results showed the existence of snow leopards in all the three survey areas of Ganzi Prefecture and 6 other felids (leopards, lynx, golden cats, Chinese mountain cats, leopard cats, Pallas's cats) in Xinlong, apart from the snow leopard.

Gaps

Snow leopard surveys in Sichuan account for 2.85% of the habitat, and it's far behind the 20% target. At present, Sichuan is planning to undertake large-scale surveys in the Qionglai Mountains. The Minshan, Daxue, and Shaluli ranges need to be further surveyed.

3.3.4 Tibet A.R.

Published works

The snow leopard is widely distributed in Tibet Autonomous Region, more or less on a continuing basis along the north slopes of the Himalayas and the greater ranges across the Tibetan Plateau. An analysis by Zhou Yunyun *et al.* (2014) of fecal samples collected from 2006 to 2009 showed snow leopard presence in Changtang National

Nature Reserve of Tibet, although Schaller (1998) had previously concluded that snow leopards in Changtang Nature Reserve, as well as in the areas of the Gangdise and Nyenchen Tanglha, were rare and localized, and he attributed this to the low density of blue sheep and the lack of suitable habitat. During a large-scale survey Schaller once conducted in northwestern Tibet, he rarely encountered signs of a snow leopard. In the past decade, snow leopards have disappeared from an area of over 40,000km^2 south of Lhasa along the border of Bhutan. There are high blue sheep population densities and rocky mountain landscapes in south Changtang (including the counties of Xainza, south Nyima and south Shuanghu). There are many snow leopard signs in rocky mountains around the Serling Tso, indicating the potential effectiveness of the wildlife protection law (John Farrington, unpublished data).

A study by Bai *et al*. (2018) found that suitable habitat for snow leopards in Mt. Qomolangma Nature Reserve totaled 7001.93km^2, accounting for 22.72% of the reserve. The key habitat bordered on Nepal. Jackson (1994) estimated that there were as many as 100 snow leopards in Mt. Qomolangma Nature Reserve (33,910 km^2). In recent years, Mt. Qomolangma Snow Leopard Conservation Center, in partnership with the reserve and the BFU team, studied the status of snow leopards in the reserve. At four survey sites, Zhalong (112 km^2), Qudang (32 km^2), Rongxia (96 km^2) and Riwu (48 km^2), by line transect surveys and camera trapping, the density of the Mt. Qomolangma snow leopard population was estimated at 1.8-2.5/100 km^2, similar to that of the neighboring nature reserve in Nepal (Chen *et al*. 2016).

Unpublished works

Changtang

In the summer of 2015, the Forestry Department of Tibet Autonomous Region and Guangzhou Yuanwang Wildlife Conservation Services worked together to conduct a preliminary snow leopard population survey in Ali and Nagqu of Tibet Autonomous Region. With reference to habitat predictions, wildlife compensation records, the local forestry bureau's experience in Tibet, the research team selected two villages of Mayue Town, Xainza County, Nagqu City, to conduct snow leopard population surveys. The survey area was divided into 5 km x 5 km grids with 1 to 3 camera traps per grid square. As of January 2017, the data showed the existence of at least 20 adults/sub-adults and 5 cubs in a 550km^2 range. Using a spatial mark and recapture model, the population density was estimated at 3.04/100 km^2 (95% confidence interval 1.80 - 4.36, p=0.568), one of the highest densities measured by the same method.

By the end of 2017, the local camera monitoring network had been extended to cover the entire territory of Mayue Town, with 146 camera traps covering a total area of 2,000 km^2. During the same period of time, the Nagqu Management Sub-bureau of Changtang Nature Reserve worked with Yuanwang to set up 7 small-scale monitoring areas in 10 administrative villages of 6 towns in the counties of Shuanghu County and Nyima by sampling human impact along altitudinal gradients. Each monitoring area is 250 to 325 km^2, totaling 1,800 km^2 with 114 camera traps.

At present, the local camera monitoring network covers a total area of 3,800 km^2 with 260 camera traps at an average altitude of 5,050 m, making it the world's highest snow leopard monitoring network on a large scale. Over the past year, more than 95% of the cameras have remained steadily fastened and have captured a large number of snow leopard images. This fully indicates that the snow leopard distribution and population in Changtang very much likely far exceeds the previous expectations.

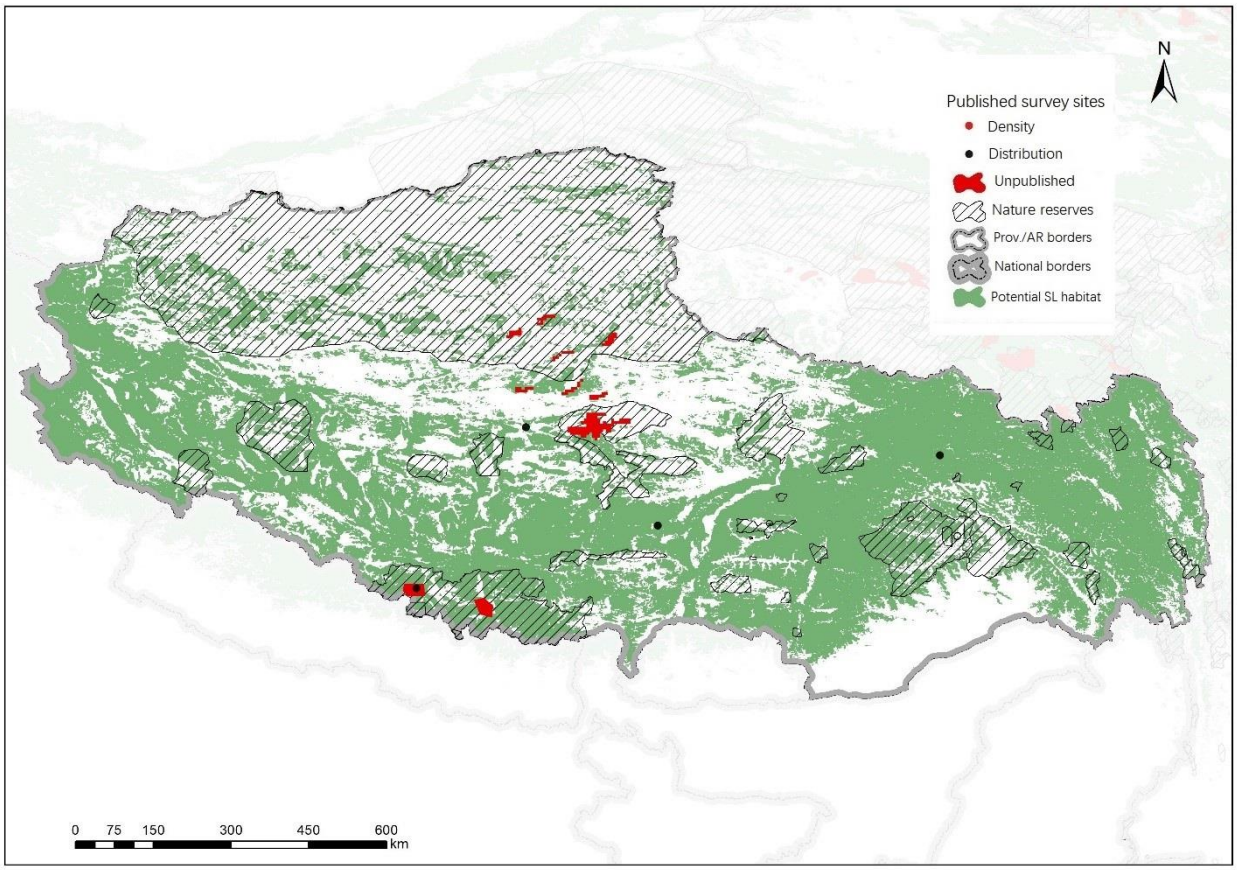

Fig. 3.3.4 Map of SL surveys in Tibet

Gaps

Only 0.68% of the vast snow leopard habitat has been reached in Tibet. At present, most of the population surveys conducted are focused on Mt. Qomolangma Nature Reserve and Changtang. The Himalayas and Gangdise-Nyenchen Tanglha ranges in southern Tibet have not been sufficiently surveyed.

3.3.5 Xinjiang A.R.

Published works

Snow leopards in Xinjiang are primarily distributed in the Kunlun, Tianshan, and the Altai ranges in the southern, central, and northern parts of the province respectively. Schaller (1988a) believes that for these suitable habitats the survival of snow leopards very much depends on sufficient food supply. The research results concerning the Altai Mountains show that concealment is the major determinant for snow leopard habitat selection (Xu Feng *et al*. 2006b).

Snow leopard population surveys have been conducted in several areas of Xinjiang. A survey conducted in 1988 showed the existence of 50-75 snow leopards in Kunlun Mountains Nature Reserve, with prey primarily being Himalayan marmots and blue sheep, and it concluded that the number of snow leopards in Xinjiang might not exceed 750 (Schaller *et al*. 1988). A line-transect survey in the eastern Altai and Tianshan showed that snow leopard signs in this area were already very scarce, primarily due to retaliatory hunting and the lack of food resources (Xu Feng *et al*. 2006). From 2014 to 2016, in the Tianshan area, by fixed-point observation and line-transect methods, Daoning Wu *et al*. estimated the Siberian ibex population density to be 154 ± 23/100 km^2, and by the food volume estimation method, the snow leopard density to be 1.31-2.58/100 km^2 (Wu *et al*. 2015). In the Tomur Summit Nature Reserve of the Tianshan Mountains, several researchers conducted snow leopard population and density surveys by various methods and determined the population density

in this area to be 0.32-5/100 km^2. A genetic survey showed that there were at least 9 snow leopard individuals in the reserve (Ma Ming *et al*. 2006; Xu Feng *et al*. 2006; Asvaghosa *et al*. 2011; McCarthy *et al*. 2008; Turghan *et al*. 2011).

Only preliminary survey data have been collected from other areas. From 2012 to 2014 in Bortala Mongolian Autonomous Prefecture, Xinjiang, by camera trapping, Alexander *et al*. found 11-15 adult snow leopards and 2 sub-adults (Alexander *et al*. 2016c). In the Beita mountain area of northeastern Xinjiang, Xu Feng *et al*. found 67 snow leopard signs and 23 Siberian ibex from 4 herds (Xu Feng *et al*. 2007). In Taxkorgan Nature Reserve, Jun Wang *et al*. collected carnivorous animal feces by the line transect method in 2009 and 2011 and found snow leopards distributed in the area and a high degree of diet overlap with wolves and red foxes (Wang *et al*. 2014).

Xinjiang was once rich in wildlife resources and then suffered great damage thereto during the Great Leap Forward and the Cultural Revolution. Human-wildlife conflict was the main reason that an organized killing of snow leopards occurred and was maintained until the 1960s (Schaller *et al*. 1988a). Now the species in this area is affected by human population growth, mining, and grazing (Turghan *et al*. 2011). Its future survival requires the conservation of large areas of habitat and anti-poaching measures. By 2013, Xinjiang had established 35 nature reserves, 20 of which have snow leopard distribution (Ma Ming *et al*. 2013). With reference to the previous studies based on camera traps, transects, and food volume estimates, it can be assumed that the majority, 588-837 individuals, are covered by PAs, accounting for 50-60% of the snow leopard population in Xinjiang. The densities in these nature reserves (over 2.51/100 km^2) are significantly higher than the means (1.93/100 km^2), indicating a positive outcome for the survival and reproduction of the species (Xu *et al*. 2014).

Unpublished works

1. The entirety of Xinjiang

Wild Xinjiang has conducted preliminary surveys on great snow leopard dispersion corridors formed by the three mountain systems in Xinjiang, assessing and mapping the connectivity of habitat and hot spots of snow leopards through interviews and camera trapping in the key snow leopard range areas throughout Xinjiang, such the East, West, and South Tianshan, Kunlun, Pamir Plateau, Altai and the mountain area northwest of the Junggar Basin. At present, with support from nature lovers and volunteers, the project team is working with forestry administrations, nature reserves, and NGOs to build a Urumqi-based network for data collection and monitoring that involves Hami, Yili, Altai, Aksu, Kashgar, Bayanbulak, Kyrgyz, and Bortala.

2. The Altai Range

The Altai Mountains is located in northern Xinjiang, along the northernmost edge of snow leopard range in China. In 2017, WWF launched the first monitoring project in the Altai Mountains in collaboration with Liangheyuan and Kalamaili Ungulate Nature Reserves. From April to July 2017, to survey the territory of Qinghe and Fuyun Counties in Altai, 39 cameras were installed covering approximately 500 km^2 of the habitat, and captured snow leopard images for the first time in the area. From May to August 2018, monitoring was conducted in Liangheyuan. Approximately 1,500 km^2 has been selected and 60 grid squares (5 km) identified. Further work has yet to be done. Although the Altai Mountains has always been considered as an important snow leopard distribution area, there has never been an explicit visual record before. This project has laid down the first visual data of the species, although based on some of the existing data, the snow leopard density in this area is not high as expected.

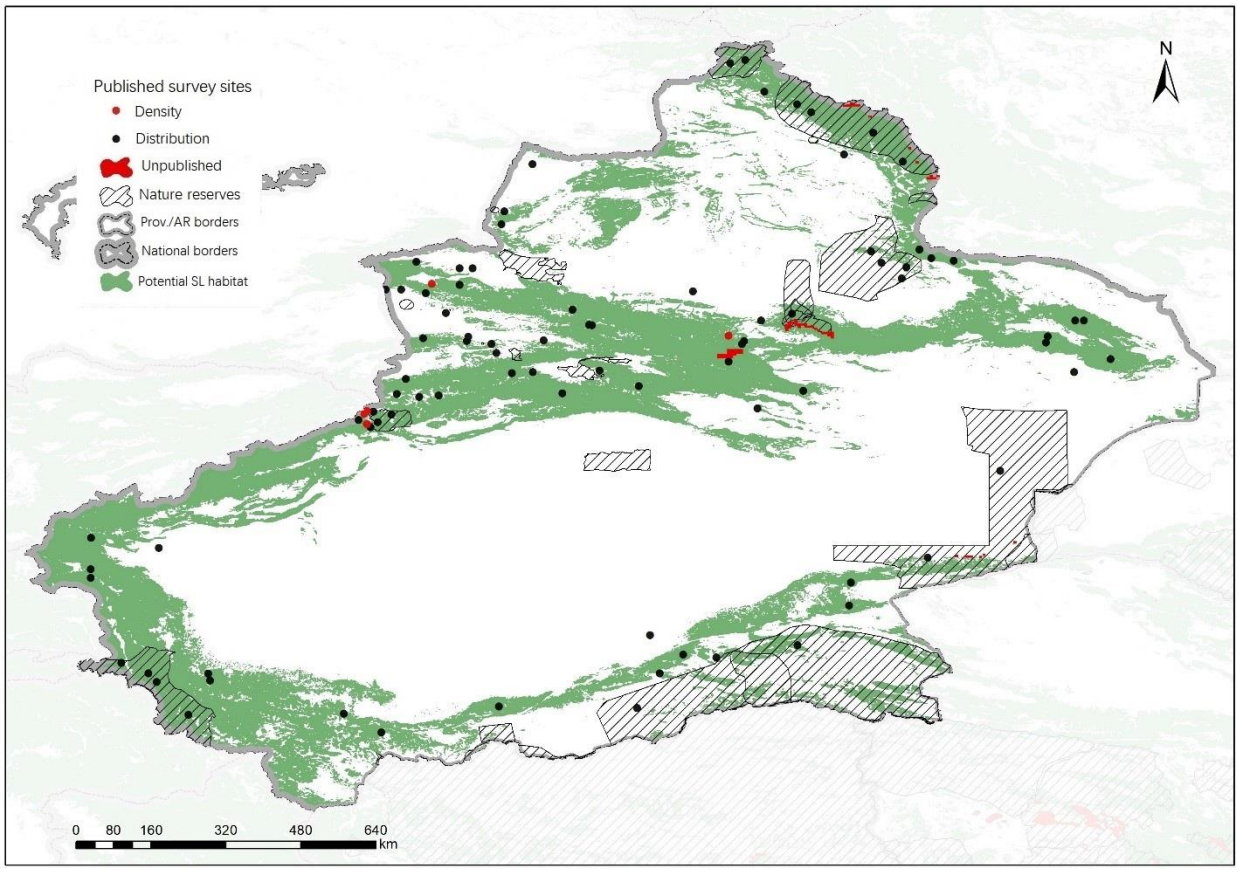

Fig. 3.3.5 Map of SL surveys in Xinjiang

3. The Tianshan Range

Since 2014, Wild Xinjiang has conducted the first snow leopard survey in the Tianshan area near Urumqi. By 2018, more than 60 snow leopard individuals had been found at two project sites, Nanshan and Dabancheng, and 11 breeding families had been recorded. Among them, the longest period of time in which an individual has been monitored has stretched over 4 years now. It was initially estimated that there were more than 100 snow leopards in and around Urumqi, constituting a unique snow leopard landscape.

4. The Altun Mountains

Since 2010, the Nature Reserve and Biodiversity Research Group of the Institute of Forest Ecology and Environmental Protection (IFEEP) has conducted camera-based surveys on a continuing basis in the northern foothills of the Altun Mountains with support from the Ministry of Science and Technology's "Comprehensive Survey Program for the Kumtag Desert" and the CAF fund for key CAF projects. Since the target area is of an arid desert type, cameras have been installed in as many as 7 waterhead areas to monitor bird and mammalian diversity and abundance. From 2010 to 2012, a total of 26 species were recorded. Specifically in 2 of the waterhead areas snow leopard presence was recorded with 5 auto photo captures. The monitoring data of 2013 to 2016 are still being analyzed. Visual data collected by Xinjiang's Lop Nor Wild Camel National Nature Reserve Administration showed snow leopard activities in the waterhead areas for three consecutive years from 2014 to 2016.

5. Other areas

In the summer of 2017 and January 2018, WWF conducted a survey of snow leopard habitat in Kalamaili Nature Reserve and the surrounding Junggar Basin, with a focus on identifying potential key snow leopard habitat in various areas, including the piedmont belts of the Altai Mountains, the Gobi desert of the eastern Junggar, and the Beita Mountain bordering on Mongolia.

Gaps

Most of the snow leopard habitat in Xinjiang is in the eastern and western Tianshan, Altun, and the Altai ranges. Although the distribution surveys conducted have involved all these areas more or less, the coverage still remains as low as 0.49% of the habitat. Therefore, population surveys are needed on a larger scale along the three major mountain ranges.

3.3.6 Inner Mongolia A.R.

Research is lacking on the snow leopard population size in Inner Mongolia; no organization currently is committed to such work, either. A survey by Schaller (1998) showed that the snow leopard was once distributed in most of the deserts along the border between Inner Mongolia and Ningxia, including the Dongda, Yabulai, Wulan, Daqing, Helan, and Longshou mountain ranges. In the late 1990s, the species was on the verge of extinction in Inner Mongolia, except for a few individuals that might still exist in some desert areas of the Langshan Mountains (Wang & Schaller 1996). Individuals lingering briefly along the border of Mongolia sometimes might have been killed. In January 2013, a snow leopard was sighted and photographed in this area. These mountain regions may constitute one of the major corridors linking the southern and northern snow leopard (Mongolia-Russia) populations.

3.3.7 Yunnan

Very few snow leopard studies have been conducted in Yunnan; currently there is no organization committed to such work, either. Potential snow leopard habitat in the province is limited to the Hengduan mountain ranges in the northwest, near Tibet, Sichuan, and Myanmar, where snow leopards have been reported (Ji 1999). From 1950 to 1999, snow leopards were found at three sites of northwestern Yunnan (Alexander *et al.*, 2016b). Although Smith & Xie (2008) thereafter noted that snow leopards still existed in these areas, the IUCN Red List announced the extinction of the species in Yunnan (Jackson *et al.*, 2008). Buzzard *et al.* (2017) conducted a survey in Yunnan from 2012 to 2014, hoping to assess the status of this species in the province. They selected four areas where snow leopards might exist. Despite reported sightings by 38 pastoralists and the captured images of many potential prey animals, such as blue sheep, no images of snow leopards were obtained in a total of 6,300 camera days, except images of a leopard at an altitude of 3,000 to 4,500 m. Therefore, snow leopards are very rare, if existent at all, in Yunnan, and require further study and research.

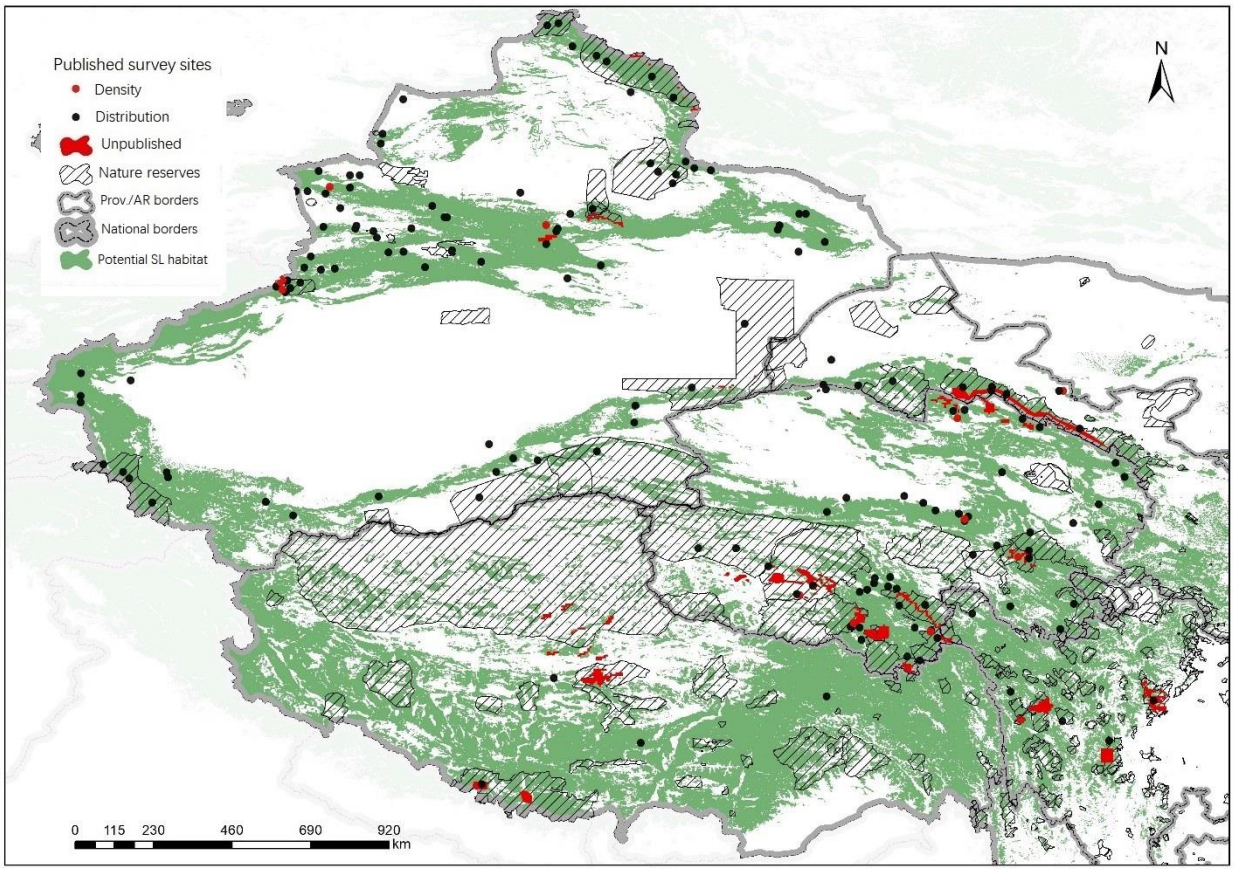

Fig. 3.3.5 Map of published and unpublished SL surveys throughout China

3.4 Conclusion

A look at the results from various provinces as described earlier revealed a considerable amount of information in the literature about snow leopard distribution (as marked by black dots), particularly in Xinjiang and Qinghai, but few surveys (as marked by red dots) on density estimation. Apparently, it is impractical to make inferences to a larger area based on the estimated density data that have been released in the published works.

A heterogeneous snow leopard distribution map that is sufficiently accurate and truthful is urgently needed. Hopefully, such heterogeneous distribution may be simulated using occupancy models if it is possible to synthesize all the efforts and results of surveys conducted in large nationwide grid squares (e.g. 20km x 20km) by whichever method was then applicable – interviews, sign, or camera traps, as PAWS proposed.

A summary of the existing surveys shows two major gaps: (1) the West Tianshan area bordering on Kyrgyzstan; and (2) the Gangdise-Nyenchen Tanglha and Himalayan mountain ranges in southern Tibet. To fill these gaps, much work still needs to be done to collect and consolidate the existing survey results and efforts.

Regional snow leopard population estimation is also imperative. At present, almost all the unpublished snow leopard surveys in progress have density estimation targets. These surveys are primarily based on grid-connected camera trapping, and are being conducted with rosette-based identification of individuals. In the future, the estimation of populations and population densities will be achieved using spatial/non-spatial mark and recapture models. As estimated, the area of all the camera-based surveys conducted amounts to 30,000 km^2, accounting for

approximately 1.7% of the snow leopard habitat throughout China. Compared to the 20% goal laid down under PAWS in terms of coverage of snow leopard population density surveys, we still have a long way to go.

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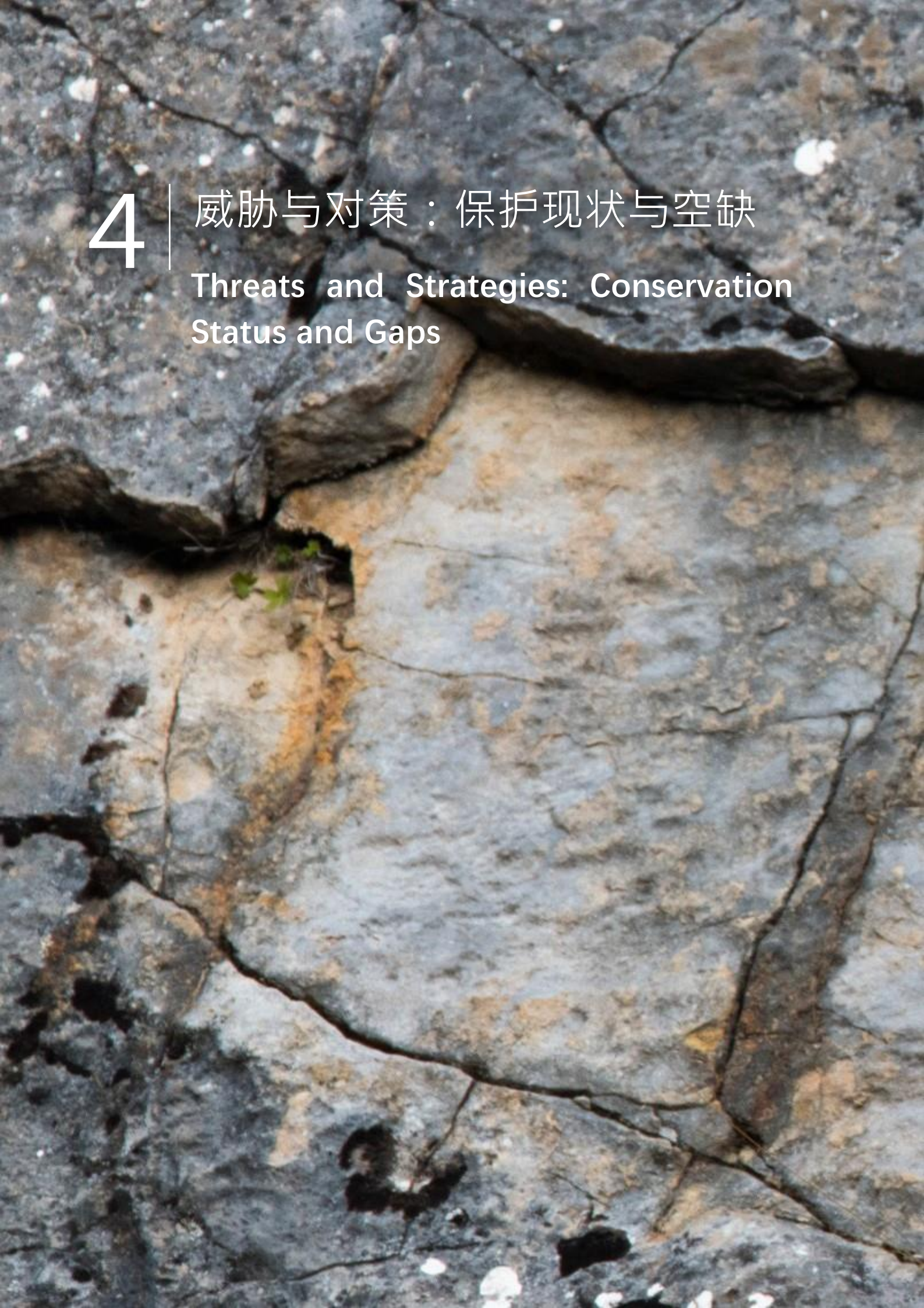

4 威胁与对策：保护现状与空缺

Threats and Strategies: Conservation Status and Gaps

Photo by Frédéric Larry in Namse Town, Yushu Autonomous

4. 1 Introduction

A poor understanding of threats, apart from the lack of basic information, may also hinder master planning for snow leopard conservation. In this chapter, we identified specific threats to snow leopards in China and rated them. In addition, we also reviewed the conservation actions that have already happened in various provinces, and further analyzed the gaps in snow leopard conservation on both national and provincial scales.

4. 2 Methodology

4.2.1 Threat Identification

First of all, we engaged Chinese frontline snow leopard conservationists to select these threats based on the actual situations and with reference to the internationally recognized threats to the snow leopard as specified in *Snow Leopard Survival Strategy* (Snow Leopard Network 2013). Then, we searched and reviewed works in the literature concerning the threats, interviewed key informants in each province/autonomous region (AR), and looked into various threats thus identified. “Key informants” refer to forestry workers, frontline conservationists, and researchers who have been well informed of the situation across the country. For a list of their names, see the author(s) of each chapter. We have thus identified 21 threats.

4.2.2 Threat Rating

The key informants were engaged to give expert scores to the threats identified in each province/AR. According to the Threat Reduction Assessment (TRA, Salafsky & Margoluis 1999), they were to assess these threats in terms of “area," “intensity," and “urgency." "Area" refers to the size of the area affected; “intensity," the size of impact on the area affected; and “urgency," the degree of pressing immediacy of a threat. Scores were issued on a scale ranging from 1 to 5, with 5 being the highest and 1 the lowest. The summation of all scores to these three dimensions represents the total score of the threat in question. The expert scores issued for a single province were averaged to produce the final threat score of that province. Finally, the provincial threat score was multiplied by the ratio of suitable snow leopard habitat area to national habitat area as a weight. The individual scores of all the provinces concerned were weighted and added up as the national total score of each threat.

4.2.3 Conservation Cases

In the form of questionnaires to the key informants, we reviewed the snow leopard conservation actions that had been carried out or were being performed, as well as the policies, projects, and conservation activities from the local governments and protected areas (PAs) that have benefited snow leopards. We also identified the threats to which each conservation action should respond. With reference to the conservation measures that have been successfully implemented in other countries but not yet in China, we highlighted 19 conservation actions and corresponding threats (Table 4.3.2). Finally, we selected cases typical of these actions in China to provide references for snow leopard conservation agencies.

In the process of compilation, we found that governments at all levels, NGOs, communities, and other stakeholders had effectively contributed much to snow leopard conservation. However, it is not viable to present each and every case herein; we only selected one case for each type of conservation action.

Apart from typical conservation cases in various areas, we opted not to include the conservation actions that had been conducted in other countries or the Chinese policies that benefit snow leopards nationwide, such as wildlife legislation

and law enforcement, prevention and control of livestock epidemics, targeted measures for poverty alleviation, and eco-compensation (e.g. grassland eco-compensation). These policies provide the essentials for snow leopard conservation. Due to the limited length of this chapter, we can only list them in Table 4.3.2 to provide references for conservation gap analysis and target identification.

4.2.4 Conservation Gap Analysis

We listed the conservation actions (see Table 4.3.1 for details) by province/AR to correspond them with the provincial threat ratings (see Table 4.2.1 for details). Through such comparison, we identified conservation gaps in consideration of the following: 1) Which is a highly rated threat without any or sufficient conservation actions taken? 2) Which is a lowly rated threat without any conservation actions taken? Finally, we interviewed the key informants in each province to confirm the results of our conservation gap analysis and to preliminarily analyze the causes of these gaps.

4.3 Results

4.3.1 Threats

4.3.1.1 Threats to Snow Leopard Individuals

Retaliatory killing

Snow leopards and sympatric predators often prey on livestock and thereby inflict great losses on the local community. This may provoke locals' anger at large carnivores such as snow leopards and wolves, reduce their tolerance, and lead them to thinking that the only way to resolve such conflict is to kill the predating animals (Oli *et al*. 1994). In China, snow leopards seem to cause less livestock loss than in other snow leopard range states (Xu *et al*. 2008, Li *et al*. 2013, Alexander *et al*. 2015, Chen *et al*. 2016). Li *et al*. (2013) found that only 10% of the livestock loss incurred in the Sanjiangyuan region of Qinghai was related to snow leopards, 45% to wolves. and 42% to diseases. Li *et al*. (2013), Chen *et al*. (2016), Alexander *et al*. (2015) and Xu *et al*. (2008) found that in Sanjiangyuan and the portion of the Kunlun mountain range in Qinghai, the portion of the Qilian range in Gansu, and the Qomolangma region of Tibet, local pastoralists were more tolerant to snow leopards than to the other carnivores (e.g., wolves) that cause a greater livestock loss. In the East Tianshan Mountains of Xinjiang, a great number of Siberian ibex died of peste des petits ruminants (PPR) in 2016, resulting in a lack of wild prey, which in turn led to a sharp increase of the predation intensity of the local snow leopard population on domestic animals. Local pastoralists found it difficult to adapt to this recent change and showed low tolerance (This information was provided by Wild Xinjiang).

Poaching for illegal trade

Snow leopards are hunted, killed, and sold for their pelage and meat. All the snow leopard range states have legislated to conserve the species, and snow leopards have been included in CITES Appendix I since 1975. However, illegal trade in these states remains a constant threat to snow leopards. The Environmental Investigation Agency (EIA) reviewed the studies of Asia's illegal wildlife trade since 2005. As many as 151 snow leopard skins have been confiscated in 12 snow leopard range states since 2000. It is estimated that the Customs detected only about 10% of all the incidents that have happened. Therefore, in the past 12 years, there may be as many as 1,000 illegal deals involving snow leopard individuals, accounting for about 1/6 of the world's snow leopard population (EIA 2012). The latest research shows that in 2003 to 2014, 88 illegal deals involving 439 snow leopards were found in 11 snow leopard range states except Kazakhstan, accounting for 8.4-10.9% of the world's snow leopard population (Mahesh Wari & Niraj 2018). Specifically, China accounted for 50% (222 snow leopards) and Afghanistan for 30% (132 snow leopards). Although wildlife law enforcement and crime control efforts in these countries have been notably strengthened, the volume of trade in snow leopards nevertheless increased by 61% from 2003 to 2012 compared with that from 1993 to 2002. Li and Lu (2014) found 43 cases of hunting

and killing snow leopards in China from 2000 to 2013, involving at least 98 individuals. Early snow leopard products were mainly traded within the provincial borders. From 2010 onwards, the market began to expand to China's richer coastal cities, and to be more luxury oriented.

As estimated by Liu (1994), 200 to 300 snow leopards were hunted and killed in Tibet every year until the 1980s. The government's skin collection records showed that 88 snow leopards were killed in Qamdo, Tibet, alone from 1968 to 1971 (Schaller *et al.* 1988). In the 1990s, the government continued to kill snow leopards in order to control the number of carnivores. Zeng (2009) found that in the 1960s to the 1980s, the Sichuan provincial government purchased 20-30 snow leopard skins from local hunters every year. According to Zhang (1985), in Yili Kazakh Autonomous Prefecture of Xinjiang, an average of 30 snow leopard skins were traded per year from 1955 to 1965, and in 1965 the number spiked to 135. According to semi-structured interviews conducted by Li Juan *et al.*, about 11 snow leopards were killed each year in Sanjiangyuan, accounting for 1.2% of the local snow leopard population (Li & Lu 2014). A questionnaire survey by Ma (2012) showed that the volume of trade in poached animals had likely increased between 1960 and 2010. Through unannounced visits and questionnaire surveys, the Xinjiang Snow Leopard Team (XSLT) found about 387 cases involving the market deals and poaching of snow leopards and their products from 2002 to 2012 in Xinjiang (Ma 2012). Linxia, Gansu, had long been a trading center for animal skins and once lured as many as 80,000 traders. Asian big cat skins put up for sale reportedly originated from Afghanistan, Myanmar, China, India, Mongolia, Pakistan, Russia, and Vietnam (EIA 2008).

Live captures for zoos and museums

Of the 387 market deals and poaching events involving snow leopards and their products in Xinjiang, the top four were hunting found in the wild during field surveys (17%), zoo captures (16%), private skin collection (13%), and traditional Chinese medicinal application (9%) (Ma 2012). Snow leopards may wander off into human territory, may be left alone, or may be sick. Local people often do not know how to deal with this situation and may contact the zoo through the forestry system. This kind of response may deprive these snow leopards of potential chances to return to the wild. Some snow leopard bodies may also be resold as specimens for museum collection, which inadvertently incentivizes retaliatory hunting and poaching (information provided by SCC).

Unintentional killing while catching other species

Snow leopards may also get killed accidentally as a result of catching other wild animals with poison or traps. For instance, the traps set for musk deer along the Tongtian River in Qinghai pose a serious threat to snow leopards. In the winter of 2014, local villagers found in a valley hundreds of wire traps set amidst cypress trees, and it was very difficult for snow leopards and other animals to avoid them (information provided by SCC). Snow leopards might also fall victim to poisons and traps intended to kill wolves (Li *et al.* 2013). In western Sichuan, a large number of traps have been set against dwarf musk deer or white-lipped deer, especially in Yajiang County, where the density of such traps is astonishingly high (interview information from SCC). In addition, when reclaiming and maintaining alpine pastures, some locals often poison non-specific large carnivores to "clear the field," posing a great threat to snow leopards (information provided by Li Sheng of Peking University).

Snow leopard diseases

Few records show the death of snow leopards in the wild as a result of disease. Therefore, it is difficult to assess the severity of this threat. In 2000 to 2008, Hussain Ali examined the bodies of 14 snow leopards in Khunjerab, northern Pakistan, and found no obvious cases of death from disease. But like poaching, deaths caused by infectious diseases are easily underestimated. Snow leopard habitat is too rigged for researchers to find or investigate the deaths. Infectious diseases may be an inherent characteristic of the snow leopard population, but with rising pressure and the wider dispersion of domestic carnivores, the impact of infectious diseases increases, especially when the snow leopard population falls (Ostrowski & Gilbert 2016). Canine herpes virus (CHV) greatly affects wild Pantherinae. There have been two cases of

CHV in captive snow leopards, both infected with other pathogens (Fix *et al*. 1989; Silinski *et al*. 2003). Anthrax, caused by Bacillus anthracis, once caused the deaths of wild cats in Africa and has been reported in most snow leopard range areas. In April 2011, a snow leopard with a monitoring collar died in the Gobi desert of Mongolia. Although no definitive pathological examination was ever conducted on this animal, along with the fact that anthrax was not prevalent in this part of Mongolia, it could be inferred from its symptoms that anthrax was the fatal culprit as edema was notable in the neck of the dead snow leopard with uncondensed bloody secretions in its nasal cavity (K.Suryawanshi, personal correspondence).

Of 29 wild snow leopard fecal samples An Ni (2016) of China Agricultural University collected from the Sanjiangyuan region of Qinghai, 89.66% were detected with parasites, including cat coccidia, trichomonas, Toxocara felis, Toxocara lion, hookwormsa, Echinococcus or Taenia saginata, filamentous reticulum nematode, split trematode, and anterior and posterior trematode. In 2016 and 2017, a diagnosis of infectious disease turned negative upon the veterinary examination of two living snow leopards rescued and three dead snow leopards reported in Sanjiangyuan (information provided by SCC). In 2014, the snow leopard team of the crew of the documentary film "We are Born in China" found a half-year-old snow leopard that died rapidly after convulsions and epilepsy, possibly due to poisoning or disease. No consistent diagnosis was ever issued from the vets.

4.3.1.2 Threats Related to Habitat and Prey

Habitat degradation

Snow leopard habitat highly overlaps with the grazing areas. However, the world's grassland status is not promising, with nearly a half of the grassland degrading slightly to moderately and 5% severely (Brown 2008). Because of improper utilization and climate change, grassland desertification and degradation also threaten the snow leopard range areas in China (Harris 2010; Wang *et al*. 2015). This directly affects the populations of wild prey for snow leopards, thus limiting the latter's healthy growth.

Habitat fragmentation

In some snow leopard range areas, the terrain itself results in habitat fragmentation, such as isolated mountain ridges surrounded by human settlements in western Sichuan and northern Xinjiang. However, linear barriers such as fences and roads may further intensify such fragmentation, leading to the isolation of snow leopard and prey populations, loss of genetic diversity, and an increasing risk of extinction of isolated small populations. There is extensive snow leopard habitat in the border areas between China and countries to the west. It is almost impossible for large and medium-sized wild animals to cross the border fences. For instance, in the Altai Mountains area bordering on Mongolia and Xinjiang, the border fences completely block the migration of snow leopards, greatly endangering the Altai snow leopard population (information provided by WWF). Pasture fences used to demarcate real property can also hinder wild ungulates. Xu *et al* (2008) believes that the fragmentation of habitats as a result of fencing has affected the survival of wild ungulates and is also a potential threat to snow leopard populations in the gully region of the Kunlun Mountains in Qinghai. Li Juan (2012) discovered through a corridor analysis that the snow leopard population in the Kunlun and Qilian Mountains may be blocked by the Qinghai-Tibet Highway and Railway, and the same is true for the snow leopard populations in the Altai and Tianshan Mountains. In the East Tianshan of Xinjiang, the national highway and railway to Urumqi blocked the exchange of the snow leopard populations in the Nanshan Mountain of Urumqi and the Bogda Summit, while the highway at the Alataw pass might have cut the only passageway for snow leopard migration between the East Tianshan and the mountain area northwest of the Junggar Basin (information provided by Wild Xinjiang).

Prey losses to poaching and unintentional killing

With the lack of legal protection, a huge number of blue sheep have been hunted for locals to consume and export. Since 1958, an average of 100,000 to 200,000 kilograms of blue sheep meat have been exported from Qinghai every year (Schaller *et al*. 1988). Around 2000, the authorities

demanded the surrender of private guns, and the intentional killing of snow leopard prey animals, such as blue sheep, almost stopped. However, in western Sichuan there were still traps set up by locals or people from outside the villages, and some of these traps were intended to catch blue sheep, and the others deer and musk deer (to harvest antlers, pilose antlers, and musk). Still persistent in Batang County is the problem of government officials hunting with guns – not for economic gains, but to win "trophies" for the sake of recreation, collection, and game (interviews by SCC).

Prey losses to competition with livestock

A large number of studies have been carried out in China and abroad on the competitive relationship between domestic animals and wild prey for the snow leopard. A study by Mishra *et al*. (2004) in India's Ladakh Spiti Gorge found low ground biomass in heavily grazed grasslands as well as significant reductions in the density of blue sheep and the lamb-to-mother ratio before and after winter. Another study by Suryawanshi *et al*. (2010) found that in areas with high livestock density, blue sheep were forced to change their diet in winter by eating more dicotyledonous plants, and that the lamb-to-mother ratio significantly dropped in spring. However, Xiao Lingyun (2017) found that livestock did not cause a significant decrease in the density or lamb-to-mother ratio of blue sheep while Siberian ibex in Xinjiang had a notable behavior of avoiding sheep herding areas (information provided by Wild Xinjiang). In Sichuan Wolong Nature Reserve, overgrazing poses a threat to the local wild ungulates and may threaten the local snow leopard population (Information provided by Li Sheng of Peking University).

Prey losses to disease

In Asia, the invasion of livestock into wildlife habitat is common. Livestock may be the source of infectious diseases among wild ungulates and should be the primary target of disease surveillance. In addition, domestic animals may also force wild ungulates to migrate up in the mountains and enter sub-optimal habitat under greater living pressure, engraving the situation further (Ostrowski & Gilbert 2016). In 2007, an outbreak of sarcoptid mites in northern Pakistan caused hundreds of deaths among the local blue sheep population. As early as 1996, pastoralists first reported this disease: it persisted throughout the year and both males and females of all age were prone to it. Ten years later, this population had not recovered (Dagleish *et al*. 2007). From 1968 to 1971, about 80% of the Siberian ibex was infected in Aksu-Zhabagly Nature Reserve in Kazakhstan. In addition, outbreaks of acariasis have also occurred in Uzbekistan and Chatkal District of Kyrgyzstan (Fedosenko & Blank 2001). In the autumn of 2010, goat pneumonia broke out southwest of Hazratishoh, Tajikistan, killing at least 64 markhor (Ostrowski *et al*. 2011). From July to November 2007, PPR broke out in southwest Tibet, mostly affecting goats and sheep (Wang *et al*. 2009); by October 2007, both domestic animals and blue sheep had been ravaged by fatal PPR (Baoetal, 2011). From 2014 to 2016, PPR broke out in the East Tianshan area of Xinjiang, causing a large number of deaths among the local Siberian ibex population (Information provided by Wild Xinjiang).

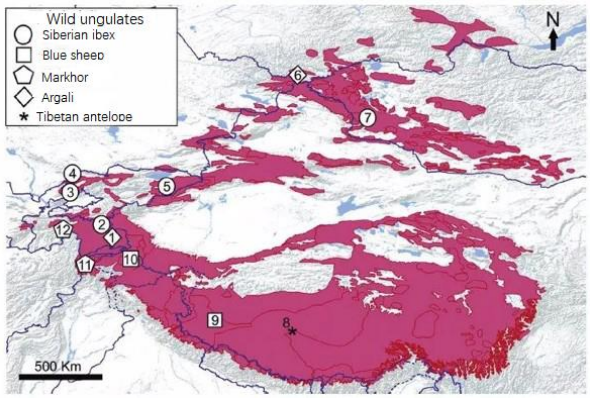

Fig. 4.3.1 Reported wild ungulate endemic outbreak sites in snow leopard range (marked in red) (Ostrowski & Gilbert 2016, first translated into Chinese by Yu Yang)

1. Rinderpest and anthrax / 1895-1898 / the Pamirs / Tajikistan
2. Contagious caprine pleuropneumonia / the 1940s / the Pamirs / Tajikistan
3. Sarcoptid mites / the late 1960s / the Pamirs-Altai / Uzbekistan
4. Sarcoptid mites / 1968-1971 / the Pamirs-Altai / Kazakhstan
5. Sarcoptid mites / the late 1960s / the Tianshan / Kyrgyzstan
6. Tuberculosis / 1989 / the Altai / Russia
7. Sarcoptid mites / ongoing / the Altai / Mongolia

8. Contagious caprine pleuropneumonia / 2012 / the Tibetan Plateau / China
9. PPR / 2007-2008 / the Tibetan Plateau / China
10. Sarcoptid mites / 1997-2007 / the Karakoram / Pakistan
11. Foot-and-mouth disease / 2011 / the Hindu Kush / Pakistan
12. Goat mycoplasma infection / 2010 / the Pamirs-Altai / Tajikistan

4.3.1.3 Threats Related to Policy and Cognition

Improper policies as a result of the general lack of awareness

In snow leopard range states, nearby locals, urban residents, and government agencies have very little awareness of how difficult the situation is for the species or why it needs to be conserved. These deficiencies in cognition, on the one hand, are resulted from insufficient data and research. On the other hand, the dissemination and communication of known information remain inadequate. The lack of awareness has led to the implementation of improper policies, such as China's heavily funded "Return Grazing Land to Grassland" program. Huge financial input in fence construction was originally intended to avoid the "tragedy of the commons" by demarcating real property and to establish rotational grazing and no-grazing measures to restore degraded pastures and protect biodiversity. However, many fences built have failed to facilitate grassland conservation and instead have increased grassland degradation in some areas (Li *et al*. 2017). They may also threaten the survival of wildlife.

Weak policy implementation

Most of the snow leopard range areas are remote and hardly accessible with relatively impoverished human populations (Mishra *et al*. 2003). Even with proper policy, limitations in finance, manpower, and transportation may be the reason why the policy cannot be implemented effectively or not correctly at all. Chen *et al*. (2016) described specific problems in the implementation of the compensation policy for wildlife attacks in Tibet Autonomous Region. Similar problems exist in Qinghai Province (information provided by SCC). Potential applicants for such government compensation funds often must give up on their claims because they find it almost impossible to submit the required documentation on time with poor access to the outside world.

The lack of cross-border cooperation

Snow leopard habitats are distributed along various mountain systems and certainly cannot be bounded by administrative units. However, the establishment of PAs and the implementation of conservation policies only follow administrative boundaries, making cooperation difficult across PAs and borders. Within the national territory, it is difficult to formulate and implement a coordinated conservation plan between two provinces, to say nothing of cooperation across national borders. Areas beyond the border of a nature reserve (NR) or a province are often neglected and fraught with a high incidence of poaching due to their geographical remoteness. Therefore, promoting an inter-provincial joint patrol and anti-poaching mechanism is the key strategy to address this problem. The Qilian Mountains Snow Leopard National Park spanning across Qinghai and Gansu is a new attempt in this respect. The UNDP-GEF supported Snow Leopard Landscape Conservation Project in the Central Tianshan Mountains at the junction of Kyrgyzstan, Kazakhstan, and China is also an attempt at cooperation across national borders.

Insufficient grassroots conservation capacity

Nature reserves within snow leopard range are often limited by insufficient funds and manpower, apart from the lack of systematic and targeted skill training to conduct investigation, monitoring, and conservation of snow leopards and companion species. PAs in Sichuan are among the best in the country, but only a few national panda nature reserves have been provided with good skill training and have been enabled to carry out such work independently. However, snow leopard habitats in that province are mostly distributed outside the panda reserves. PAs in Tibet, Qinghai, and other provinces/ARs are so vast with manpower so limited that it is almost impossible to complete local snow leopard surveys with the existing amount of human resources assigned thereto.

The lack of awareness in local communities

At present, in China's snow leopard range areas, the vast majority of the local people are aware that snow leopards are protected animals and that killing them is illegal. A rudimentary ecological mindset has been developed among them. However, with pressing livelihoods and the current environmental system, the masses find little chance to get deeply involved in conservation in their hometowns. Generally they hold a negative attitude towards wildlife, and endogenous conservation power is extremely lacking at the grassroots level. In the absence of adequate supervision or compensation measures, the negative attitude may quickly turn into retaliatory killing or other acts to destroy natural habitat, posing a major threat to snow leopard conservation.

4.3.1.4 Potential Threats

Climate change

The world is undergoing rapid climate change. The assessment of the United Nations Intergovernmental Panel on Climate Change (IPCC2007) shows that the impact of climate change on Asian mountain areas is prominent. Through an analysis of snow leopard habitat, Li *et al*. (2016) found that as climate warmed up, snow leopard habitat elevated to higher latitude and altitude. Many areas of the Hengduan Mountains and Himalayas may no longer be suitable for snow leopards, and the fragmentation of snow leopard habitat around the world is further intensified. The impact of climate change on permafrost (Xue *et al*. 2009; Yang *et al*. 2018), glaciers (Yao *et al*. 2013), and meadows (Yu *et al*. 2010; Lehnert *et al*. 2016; Klein *et al*. 2007) is so far-reaching that ungulates, which are herbivorous by nature (Luo *et al*. 2015), and local pastoralists are affected (Vince 2010). These changes may eventually affect the survival of top predators such as snow leopards.

Human population growth and poverty

Human population growth, poverty, and habitat overuse are often closely related to biodiversity conservation (Adams *et al*. 2004). Biodiversity conservation must take social issues into account to achieve a win-win situation between social development and ecosystem conservation. Since the 1980s, this has gradually become the mainstream framework for conservation (McShane & Wells 2004). In snow leopard range areas, human population growth and poverty may lead to a series of problems such as grassland overutilization, wild ungulate reduction, and human-wildlife conflict intensification (Mishra *et al*. 2001, 2003). Therefore, a major contribution to conservation efforts is input in poverty alleviation, ecological compensation, alternative livelihood, and skill training, among other things, from both the government and non-governmental organizations.

Stray dog attacks

Free-range, ownerless, and stray dogs, namely the dogs that are not permanently tethered or under human supervision (with or without owners), account for 75% of the world's dog population (WSPA 2011). They are highly prolific and adaptable. Without proper control, these dogs may turn into predators, prey, and resource competitors and may even dominate the local ecosystem when they move into the wilderness and increase contact with wild animals (Butler *et al*. 2004; Wandeler *et al*. 1993). The collapse of the Tibetan mastiff market resulted in an increasing occurrence of stray dogs within snow leopard habitat on the Tibetan Plateau. Local pastoralists often witness them fighting and harassing snow leopards for food. In addition, as pathogen carriers and disseminators, stray dogs pose a potential threat to the entirety of the carnivore community. Further research is in progress (Liu Yuming, Peking University, unpublished information).

Cordyceps/herbal harvest inflicted disturbances

Some areas in snow leopard range attract a large number of cordyceps collectors during the harvesting season. Apart from direct disturbances to snow leopards and their pray, these visitors may also poach wild animals when they spot an opportunity to do so. For example, in Zhenda Town of Luoxu County, Sichuan, a small incidence of poaching and hunting occurs during the cordyceps season every year (interviews by SCC). The cordyceps harvesting season coincides with snow leopard breeding. This explains why there are always incidents in which snow leopard dents are exposed to "cordyceps diggers" every year. Without proper directive measures, the mother

snow leopard, which is naturally sensitive, may move with its cubs upon the exposure of its dent; the risk of the cubs falling prey to other carnivores thus increases.

In addition, the incidence of residents in some areas collecting traditional alpine Chinese herbs is also high (Fritillaria, Notopterygii Rhizoma, etc.). Worse, these herb collectors use firewood to cook food and prepare medicine, destroying a large area of ground vegetation on alpine meadows, which may lead to a decrease in the number of blue sheep (Baker *et al.* 2010).

Large-scale developments

There has been an alarming increase of infrastructure developments in snow leopard range states, especially in India, China, Russia, Kazakhstan, and other countries with fast economic growth. In Xinjiang, some large-scale transportation construction projects have split snow leopard habitat, and their disturbances are notable. In recent years, a number of highway and railway projects are being implemented or planned across the Tianshan Mountains. The works have directly changed the utilization of snow leopard habitat so much that no image of snow leopards was captured for several consecutive months (information provided by Wild Xinjiang). Tourism may also pose threats. In Sichuan, the local governments have taken greater efforts to build tourist facilities, and the number of tourists is increasing exponentially. The previously connected snow leopard habitat has been partitioned to varying degrees, reducing opportunities for cross-breeding. Under a 2017 camera-based snow leopard habitat monitoring project in Xiaojin Shuangqiaogou, Changpinggou, and Haizigou of the local nature reserve, for instance, only one of the 60 cameras captured a snow leopard image (Information provided by Wolong Nature Reserve).

Impacts of mining and hydropower development

Snow leopard range states such as China, Mongolia, Kyrgyzstan, Russia, and Tajikistan are rich in minerals, natural gas, and oil (Baker *et al.* 2010). Small gold deposits are widely scattered across the Gobi Desert of southern Mongolia, the Tibetan Plateau, and other areas. Mining directly destroys the bare rock mountains which snow leopards inhabit and increases the risk of poaching. Road developments also bring new threats to previously remote areas (Wingard & Zahler 2006). Mining activities present all over the Tianshan area are the worst threat to the local snow leopard population, further tearing it apart. Fortunately, in recent years, environmental supervision has greatly curbed the development of such activities. In the Tianshan area, snow leopard habitat has been cut in half by natural gas and oil pipelines, including the natural gas pipelines (G19, G31, G10) from Kazakhstan to the Chinese border and to Urumqi and Lanzhou, in addition to the proposed route to the Tarim basin, which will divide the northern and southern snow leopard populations (SLSS 2013).

4.3.2 Threat Ratings

Based on the expert assessment, the threats identified in each province are rated as follows (Table 4.3.1).

Table 4.3.1 Threat ratings (Red: high impact; yellow: medium impact; green: low impact)

Category 1 – Direct kills/captures	Qinghai	Tibet	Sichuan	Xinjiang	Gansu	Nationwide
Retaliatory killing						
Poaching for illegal trade						
Live captures for zoos and museums						
Unintentional killing while catching other species						
Snow leopard diseases						
Category 2 – Habitat & prey related						
Habitat degradation						
Habitat fragmentation						
Prey population losses to poaching and unintentional killing						
Prey population losses to competition with livestock						
Prey population losses to disease						
Category 3 – Policy and cognition related						
Improper policies						
Weak policy implementation						
The lack of cross-border cooperation						
Insufficient grassroots conservation capacity						
Limited motivation of community-based conservation						
Category 4 – Potential threats						
Climate change						
Human population growth and poverty						
Stray dog attacks						
Cordyceps/herbal harvest inflicted disturbances						
Large-scale developments						
Impacts of mining and hydropower development						

4.3.2.1 Qinghai

The overall threat rating for Qinghai is low. Specifically, the most highly rated threat is **insufficient grassroots conservation capacity** and the evaluators described it as "insufficient human and financial resources and limited capacity in the forestry system and the PAs, and basically no targeted work done for snow leopard conservation." Next is the threat of **stray dog attacks** and the evaluators described it as "widespread problems of stray dogs as a result of the collapse of the Tibetan mastiff market, the situation being more acute in southern Tibet than in northern Tibet." Following is **habitat fragmentation**, which was described as "core habitats split up by large-scale road constructions and human settlements, apart from the local impacts of pasture fences," and "the impacts of road reconstructions, upgrades, and new highways."

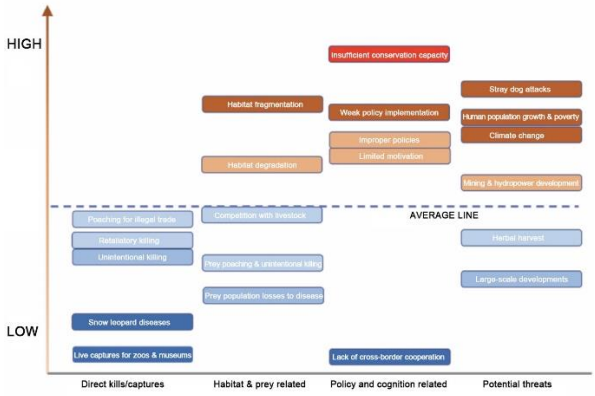

Fig. 4.3.1 Threat ratings for Qinghai

4.3.2.2 Tibet A.R.

Of all the provinces rated, Tibet Autonomous Region generally has the lowest threat rating. Specifically, the most highly rated threat is **climate change** and the evaluators described it as "the huge impact of climate change in Tibet Autonomous Region, where thawing permafrost and extreme weather may accelerate grassland degradation and seriously change ecological resources." Next is **insufficient grassroots conservation capacity**; the evaluators described it as " conservation authorities are strongly

capable of popularizing legal knowledge and taking preventative measures against poaching, but they are deficient in monitoring, preventing retaliatory kills, guiding community participation, and conservation, among other aspects." The third is **prey population losses to competition with livestock** and the evaluators described it as "extensive snow leopard habitats overlap human communities to a great extent throughout Tibet, except in Changtang. Although competition with livestock is a potential threat, no evidence shows that local competition with livestock has resulted in a decrease of prey populations."

4.3.2.3 Sichuan

The most highly rated threats in Sichuan are **insufficient grassroots conservation capacity** and **human population growth & poverty**. The first was described as "a primary result of an inadequate amount of human resources" and the latter, "the direct impact of human population growth and poverty on the alpine meadow grazing intensity." Next is the **lack of cross-border cooperation** and the evaluators described it as "the lack of communication and concerted action across administrative borders and nature reserves in snow leopard range, particularly the area of the Qionglai Mountains." The third is prey population losses to competition with livestock and the evaluators described it as "overgrazing is a common and serious problem on alpine meadows and seems to have intensified in areas such as the Qionglai Mountains."

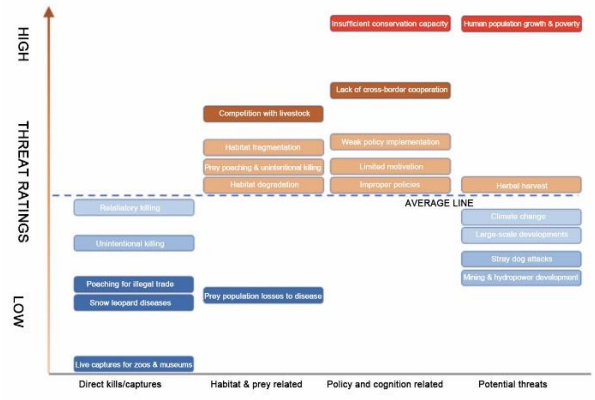

Fig. 4.3.3 Threat ratings for Sichuan

4.3.2.4 Xinjiang A.R.

The most highly rated threats in Xinjiang are **insufficient grassroots conservation capacity** and the **lack of cross-border cooperation**. The first was described as "an inadequate number of conservation workers and skills" and the latter, "it's unlikely to have cross-border cooperation while strong anti-terrorism measures are being implemented." The second is **prey population losses to disease** and the evaluators described it as " alarming decreases of Siberian ibex populations in many areas as a result of a large-scale epidemic in the Tianshan Mountains in 2014 to 2016." The third major threat is the **lack of awareness in local communities** and the evaluators described it as "a public awareness of animal conservation or legislation has generally been developed, with a fairly good attitude toward wildlife in ethnic minority areas."

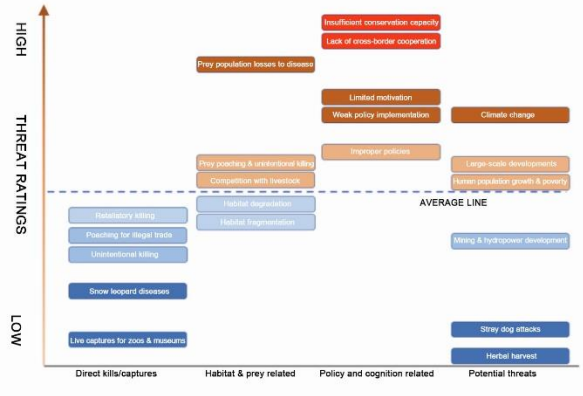

Fig. 4.3.4 Threat ratings for Xinjiang Autonomous Region

4.2.3.5 Gansu

The most highly rated threat in Gansu is **insufficient grassroots conservation capacity** and the evaluators described it as "although the two national nature reserves of Gansu have achieved a considerable level of field monitoring capacity for snow leopards, the capacity of conservation management for snow leopards in Gansu on the whole remains deficient while various issues persist, such as inadequate professionalism, an unsound patrol system, and the lack of targeted planning for the conservation management of snow leopards and their habitat." Next is **prey population losses to poaching and unintentional killing** and the evaluators described it as "though not specifically targeted, snow leopard prey may still be poached or fall into traps as reported in interviews or sometimes shown in visual data. This may indirectly affect snow leopards." The third is **unintentional killing while catching other species** and the evaluators

described it as "Gansu's highest incidence of wildlife poaching is attributed to the fact that Linxia has long been an animal skin trade center."

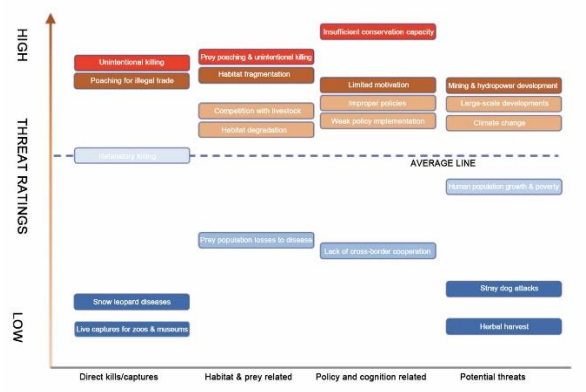

Fig. 4.3.5 Threat ratings for Gansu

4.2.3.6 Other areas

No threat ratings have been issued for Inner Mongolia and Yunnan as very few key informants can provide references for this study.

4.2.3.7 Nationwide

National threat ratings may be obtained using a weighted aggregate of the provincial threat ratings. The top four threats thus rated are **insufficient grassroots conservation capacity**, **climate change**, **limited capacity and motivation of community-based conservation**, and **human population growth & poverty** (the latter two tied in the third place). In the first category of threats (**direct kills/captures**), **retaliatory killing** was given the highest rate; in the second (**habitat and prey related), prey population losses to competition with livestock** came to the top; in the third (**policy and cognition related**), almost all the evaluators voted for **insufficient grassroots conservation capacity** as the greatest threat; and in the fourth (**potential threats**), they placed **climate change** atop.

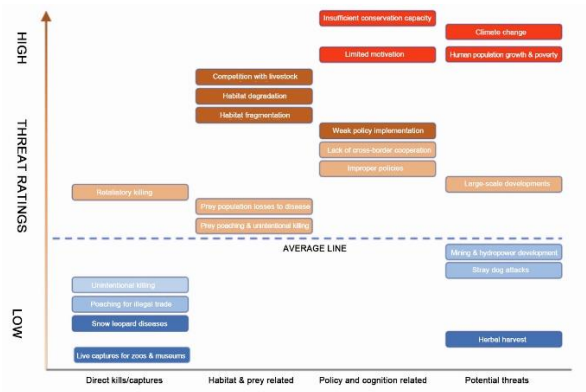

Fig. 4.3.6 National threat ratings

4.3.3 Conservation Actions

4.3.3.1 The Establishment of Protected Areas

- **NR monitoring and patrol**

Action taker(s): Sichuan Provincial Forestry Department; Wolong National Nature Reserve; Li Sheng's Research Group at Peking University (PKU)

Since 2016, PKU has been working with Mianyang Teachers' College, among other organizations, to coordinate various nature reserves in the Qionglai mountain area and to establish a regional camera trapping network in the Central Qionglai. A large number of human activities, mostly in the following categories, have been recorded by way of field work and camera trapping in and around the snow leopard habitat of the Qionglai Mountains: Grazing, harvesting, poaching, tourism, and infrastructure construction. Most activities in the first three categories have involved illegal access to the core zones of the nature reserves. Based on monitoring and threat assessment, targeted conservation actions have been successively carried out in each nature reserve. Since the network was established, the local nature reserve administrations have made considerable progress in understanding the status of wildlife.

In November 2017, Wolong Nature Reserve and Sichuan Provincial Forestry Department led the "Hengduan Mountain Snow Leopard Conservation Workshop" and released an "Wolong Snow Leopard Manifesto." At this workshop, the PKU School of Life Sciences (Li Sheng being the project director) and Wolong National Nature Reserve entered a cooperation agreement to jointly carry out snow leopard research and conservation. Since then, the PKU research team has achieved significant results in various dimensions of snow leopard research, including local prey and abundance, population sizes, and diet, based on data from the monitoring network.

- **NR capacity building**

Action taker(s): Qinghai Sanjiangyuan National

Park Administration

Since the Sanjiangyuan National Park project was piloted in 2016, a total of 16,421 pastoralists have been employed for an ecological stewardship program so that each household within the park is assigned corresponding responsibilities effectively in response to the issue of insufficient conservation capacity. In two following years the Sanjiangyuan National Park Administration invested more than 20 million yuan in training and engaged experts and organizations, such as Shanshui Conservation Center (SCC). The training covered environmental policies and laws, infrared camera monitoring, anti-poaching patrol, and biodiversity, among other topics. It has effectively enhanced the local conservation forces.

- **Building new PAs**

Action taker(s): East Tianshan State-owned Forest Administration, Wild Xinjiang

Since 2014, at the Nanshan project site in Urumqi, Wild Xinjiang has monitored the local snow leopard population on a continuing basis. In 2016, with support from the East Tianshan State-owned Forest Administration, Wild Xinjiang established the first monitoring station at the Nanshan project site in collaboration with several other NGOs, including SCC and China Green Development Foundation. This is part of the effort to establish Xinjiang's first PA called "Urumqi River Snow Leopard Reserve," along with two forest stewardship offices and a community-based conservation network that consists of 20 pastoralist households.

The reserve, under the framework of "public participation with forestry departments taking the lead," serves as a measure to carry out monitoring, anti-poaching patrol, community-based conservation advocacy, human-wildlife conflict mitigation, and public environmental education, among other things, with a core zone in the Urumqi River source area.

Up till now, as more work is being done in this PA, the local pastoralist community has expressed their understanding and support for snow leopard conservation. Human-wildlife conflicts have been alleviated, and no incidents of wildlife poaching have occurred in two years. In August 2018, all the polluting factories in the region were relocated and the last two mines shut down. By summarizing the outcomes of this pilot project, the East Tianshan State-owned Forest Administration has prepared a plan for its 11 sub-bureaus to carry out snow leopard survey and management capacity-building commitments within its jurisdiction, hoping to establish an East Tianshan National Park by 2020.

4.3.3.2 *In-situ* Conservation Actions

- **Human-wildlife conflict (HWC)**

Action taker(s): Sanjiangyuan National Park, Langcang River Source Area Administrative Committee; SCC

Preliminary surveys show that in 2015, averagely 4.6 heads of cattle per household were killed by snow leopards, leopards, jackals, wolves, etc, in Nyantho Village of Ansai Town - more than 5,000 yuan lost per household, the greatest loss being 23 heads in a single household. HWC is an ecological dilemma that may easily trigger avenge. It is also closely related to human livelihoods and may cause great personal losses. To resolve such conflict, we need to raise the levels of precaution first and then compensate for the damage done.

Since 2016, Sanjiangyuan National Park, Langcang River Source Area Administrative Committee has been working with SCC to pilot human-wildlife conflict compensation. Under this project, a 240,000 yuan "Lancang River Source Human-wildlife Conflict Fund" was established with a 100,000 yuan contribution from SCC and the Zadoi county government each plus a 3 yuan premium for each head of cattle insured. As of December 2017, a total of 220,000 yuan had been paid covering 222 wildlife attacks. Following the submission of the First Human-Wildlife Conflict Fund Report to the Sanjiangyuan National Park Administration, this insurance project was granted a 300,000 yuan counterpart fund to cover three villages of Namse in 2018 and is expected to scale up throughout Sanjiangyuan.

The following are two innovative measures for this paradigm: First, it lowers insurance claim verification costs and fully benefits the locals by delegating administrative duties, streamlining claim approval procedures, and allowing the local community to formulate insurance policies on its own; Second, the HWC Fund Management

Committee regulates that pastoralists assume responsibility for livestock management and that no claim be met in the case of negligence.

- **Community-based monitoring and patrol**

Action taker(s): The Forestry Bureau of Xainza County of Nagqu, Tibet; Guangzhou Yuanwang Wildlife Conservation Services

In 2016, with the support of Tibet Forestry Department, Xainza County launched a snow leopard research and conservation project. The county forestry bureau selected six local wildlife stewards and began to work with Yuanwang Services. The latter carried out a large number of training sessions on both theoretical and pragmatic fronts, including sign identification, the use of infrared cameras, GPS systems, and field survey designs. At first, the six pastoralist-turned wildlife stewards only took on supporting roles such as field guides, but soon they became the backbone of the monitoring mission. By now, they have fully taken on the tasks of maintaining the 2,000km^2 monitoring network and surveying prey animals, and have assisted the Changtang Nature Reserve Administration in conducting camera-based monitoring and training nature reserve rangers. In addition to their studies of snow leopard individual identification and database management, this pilot team is conducting grid patrol with the support of a modern patrol system and is engaged in the development of a local wildlife rescue system. In the meantime, the county forestry bureau and NGOs support the team in taking the initiative to promote the awareness of wildlife conservation among the villagers, organize community-based environmental activities, and to build anti-predator facilities. Given their extremely limited educational backgrounds (generally up to junior high schools), the team's performance best exemplifies that local people are fully capable of taking more important roles in wildlife conservation in their hometowns.

- **Science volunteers' monitoring and patrol**

Action taker(s): Wild Xinjiang; East Tianshan State-owned Forest Administration

"Wild Xinjiang," a non-governmental wildlife conservation group based in Urumqi, Xinjiang, has undertaken long-term survey and monitoring projects for local key snow leopard habitats in Xinjiang, in addition to the assessment of snow leopard dispersion corridors. From 2014 to 2018, with the management and support of the East Tianshan State-owned Forestry Bureau, they surveyed and monitored the snow leopard population on a continuing basis within a radius of 600km^2 on the outskirts of Urumqi, established an image database of more than 60 snow leopard individuals, and offered analyses and recommendations regarding the population status, threats, and conservation strategies of snow leopards in this area. Wild Xinjiang has also worked with forest public security departments to help publicize the law, capture poachers, and to volunteer in long-term field patrol. Over the past few years, hundreds of volunteers have joined in, fully engaged to assist in both online advocacy and field work. They have received wide media coverage and have had several documentary films broadcast on various media outlets, including China Central Television. Urumqi citizens and even people in Xinjiang at large have already developed a sense of pride in snow leopards. Wild Xinjiang has greatly drawn public attention to snow leopard conservation and has laid a clear signpost for wildlife conservation in the autonomous region.

- **Poverty alleviation / livelihood improvement**

1) Handicrafts

Action taker(s): Global Environmental Institute (GEI)

In recent years, Lungge, a Nyanpo Yutse village typical of the Sanjiangyuan community, has been fraught with such problems as grassland degradation, human-land tension, outgrown tourism, and the unbalanced development of resources. To address these threats, Global Environmental Institute (GEI) introduced the Conservation Stewardship Program (CSP).

GEI facilitated the process in which Lungge Village signed a conservation agreement with Sanjiangyuan Nature Reserve, whereby the rights, obligations, and interests of both parties were defined and some conservation rights were delegated to the local community. GEI joined the

nature reserve administration in helping the local community set up its own patrol team and draw a community-based conservation plan, providing conservation methods and tools, and taking a series of conservation actions such as patrol, environmental monitoring, and headwater cleaning. In addition, by entering an agreement under the CSP, GEI worked with both the nature reserve's administration and the local community to establish a conservation and development fund at the community level. On the one hand, the fund and its loan interest accruals provide the community with support to set up cooperatives and formulate sustainable livelihood plans concerning various socioeconomic undertakings, such as the development of responsible eco-tourism services, training in traditional handicrafts, and eco-friendly production. It also holds that 25% of the revenue must be returned to support community-based conservation. On the other hand, GEI invited experts on board to carry out community training on various topics, including patrol and monitoring skills, and to assist in capacity-building for product design and development, publicization, and business expansion. The CSP so empowers the community that locals may benefit from conservation practices. It has become a long-term mechanism mutually embedded in and inseparable from local lives.

Further, with reference to conservation assessment indicators from CI and other organizations, GEI has established a set of assessment criteria for CSP targeted areas, including three categories of benefits: ecological, economic, and social benefits. In this system, assessment is commissioned to third parties. Now, grassland management in Lungge Village has become more appropriate with notable ecological enhancement. The poaching incidence in the PA has greatly declined. The environment of bird habitat is effectively maintained; garbage at water sources like wetlands and lakes has been cleared; there are increasingly fewer tourists disturbing wildlife. The community fund increased from 50,000 yuan to 70,000 yuan, and the loans issued thereby have supported the livelihoods of more than 20 households in the cooperative. Relying on eco-tourism services and handicrafts, the local average income has increased by 100 to 150%. The community has been significantly more cohesive, the local public relations reconstructed, and the co-management of public resources has been achieved. The community is notably more adaptable and flexible to climate change. The paradigm of Lungge Village has become one of the best examples for pastoralist communities in Qinghai.

2) Nature experience

Action taker(s): Sanjiangyuan National Park, Langcang River Source Area Administrative Committee; SCC

Snow leopard conservation requires long-term community participation. Allowing the community to directly benefit from it and maintaining its enthusiasm is of great importance. In 2015, at the Namse Management and Conservation Station in Sanjiangyuan National Park, SCC worked with the park's administration to develop snow leopard targeted nature experience products based on camera monitoring results and the HWC verification data. Twenty-three households were chartered and trained to be boarding families and 5 nature experience routes devised. Also designed under the project was a booking website: https://valleyofthecats.org/. Up till now, Namse has received more than 60 natural experience groups from China and abroad, generating an average household income of more than 6,000 yuan.

Of all the revenue received thereunder, 45% go to the boarding families, 45% to the village's collectives, and 10% to the community's HWC insurance fund. The project team hopes that, by further carrying on these practices, a connection between natural experience and community-based conservation will be fully established and collective actions enabled for the latter.

- **Grazing management and fence removal**

Action taker(s) Qinghai Snowland Great Rivers Environmental Protection Association (SGREPA)

Ganda Village west of Yushu City hosts an important water source for the ancient capital town of Jiegu in Yushu Prefecture. With a population of over 370, the village only has 6,333 hectares of grassland. Through public

consultation, the village was divided into 23 comprehensively community protected areas and a natural resource management committee established consisting of the village committee, the monastery, the township government, non-governmental organizations, and schools, led by whoever may represent the locals by public election. The corresponding management system and work plan are based on the ecology of the community protected areas.

On account of its small size, the grassland in Ganda Village was not divided and allocated to households back in 1984 when it was a common practice for the government to release land from communes and lease it to individuals. The villagers, however, fenced their favorite parcels of grassland when a fencing program was implemented. Interviews by the SGREPA revealed that those fences had caused the greatest discord in the village: The positions of the fences and the difficulty for livestock to migrate created all sorts of problems. In 2017, motivated by the village committee, the co-management committee and the SGREPA, the villagers finally agreed to remove all the fences. Thus, the tension was resolved, making way for harmony to return to the village. The villagers confided that they were not happy to see that even the sacred mountain of Gasongzhou was laced up with fences. After those fences were removed, they felt that even the "spirit of land" in their hometown completely changed for the better.

- **Stray dog management**

Action taker(s): Gangri Neichog Research and Conservation Center (GNRCC)

Through targeted field studies since 2014, GNRCC has found a grave impact of stray dogs on wildlife and community safety. Thus, in view of the complexity of the problem, GNRCC advocated sterilization, encouraged local "adoption," increased the public awareness of disease prevention and sterilization, and sought donations and support from all walks of life.

In June 2017, 26 female dogs were spayed thanks to a vigorous push by the Baiyu Temple of Jiuzhi County, Golog Prefecture, along with grants from responsible companies and tech support of vet volunteers from outside the town. The program also provided training for local vets and greatly sped up the sterilization process by making apparatus and drugs available for vets with proven techniques. In addition, the community was incentivized for stray dog adoption. With owners, dogs are more likely sterilized, which may further prevent the transmission of echinococcosis from its source. Undoubtedly, the local community's strong support makes stray dog management possible in Tibetan areas.

- **Cordyceps harvest management**

Action taker(s): SCC

Cordyceps has become the most important – and considerably lucrative – resource for Tibetan plateau communities. Since 2011, SCC has been continuously observing cordyceps harvests in Yunta Village, Yushu City, hoping to improve the understanding of the traditional community management system on the Tibetan Plateau by studying the management of cordyceps as a public resource.

When in season, a 12-strong cordyceps management team would be set up consisting of the village secretary, the head and the accountant of the commune, and 9 production group directors. For sustainability, the management team has formulated a set of measures, such as controls on the number of gatherers from outside the village, garbage management, and bans on discriminative lumbering for firewood. Good results have been achieved.

As can be seen from the case of Yunta, the existing community management system should be fully leveraged to form a community-based mechanism for natural resource management, conservation, and other public affairs. Considering the complexities of the community and the residents ' discretion for management, a traditional village should be taken as the resource management unit.

- **Community awareness building and education**

Action taker(s): Qinghai Nyanpo Yutse Environmental Protection Association (NYEPA)

Since 2009, the NYEPA has been practicing snow leopard conservation on a continuing basis. In the early days, very few snow leopards would descend

to the human settlements because there was enough wild prey up in the mountain. Therefore, they were thought of as a very rare and mysterious animal. As a result of the massive hunting of wild animals in Qinghai at the end of the last century, snow leopards began to binge prey on domestic animals. At the beginning of this century, retaliatory killing also occurred from time to time in Qinghai.

With the support of institutions and individuals such as PKU, SCC, and Dr. George Schaller, a detail-oriented survey was conducted in 2011, involving more than 400 pastoralists and a large number of infrared cameras. They estimated that more than 40 snow leopards live in Nyanpo Yutse and that HWC intensification is related to the excessive hunting of natural prey of snow leopards in the last century. Based on this information, from 2011 onwards, NYEPA began to carry out targeted awareness building and education activities on snow leopard conservation for local pastoralists. The local "Through Their Eyes" crew has produced three documentary films on the monitoring of snow leopards and their conflicts with local pastoralists. These works have received nearly a thousand views at the multiple "village film festivals" organized by the NYEPA. In 2014, the NYEPA held a competition on photographing snow leopards with infrared cameras, all the contestants being locals. The NYEPA also awarded three pastoralist families for their most outstanding contribution to snow leopard conservation, thanking them for supporting the conservation of this rare species despite the long years of being vulnerable to their attacks. These model families were also issued a "Snow Leopard Conservation Certificate" at a community assembly so that their efforts could be more widely recognized.

Over the years, the NYEPA has kept providing open training courses in conservation and has had more than 2,000 locals attending. With a general belief that "all living beings are equal," locals didn't quite understand why snow leopards should be treated differently. To address this issue, the NYEPA started with an explanation the locals might easily understand and accept: Snow leopards are given more attention because they are national protected animals and, therefore, are entitled to more policy and financial support, and to protect them is to protect the surroundings they inhabit, which means that many more lives, large and small, get protected in Nyanpo Yutse, a place they 'd call home, too.

The local community collaborated with scientists to better understand the living conditions of snow leopards in Nyanpo Yutse. Thanks to the widely accepted Buddhist concept of "ahimsa," the snow leopard population in Nyanpo Yutse has been effectively conserved.

			PR establishment			*In-situ* conservation action											Policy & public advocacy				
Threat category	Threat	Impact level	NR mon. & patrol	NR capacity building	New PRs	Conflict prev.	HWC fund/ insurance	Poverty/ livelihood	Community/ volunteer mon. & patrol	Grazing mgt	Livestock disease control	Fence removal	Stray dog mgt	Herb harvest mgt	Commu-nity awn. & edu.	Livelihoods adaptive to climate change	Cons. plans	Eco-com-pensation	Develop-ment mgt.	Policy recom.	Publicity
Direct kills/ captures	Ret. killing		✓			✓	✓	✓	✓						✓						
	Poaching for illegal trade		✓						✓						✓						✓
	Live captures		✓						✓												
	Unintentional killing		✓			✓	✓	✓	✓						✓						
	SL diseases												✓								
Habitat & prey related	Habitat degr. & frag.				✓			✓		✓		✓						✓	✓		
					✓							✓							✓		
	Prey poaching &unintentional killing		✓						✓						✓						
	Competition with livestock							✓		✓								✓			
	Prey disease										✓										
Policy & cognition related	Impr. policies						✓										✓			✓	✓
	Weak poli. impl.														✓		✓			✓	
	Lack of coop.				✓																
	Insuf. cons. capacity			✓					✓						✓			✓			
	Limited motivation							✓	✓						✓			✓			
Potential threats	Climate change															✓					
	Human pop. & poverty						✓	✓										✓			
	Stray dog attacks												✓								
	Herbal harvest disturbances													✓	✓						
	Large-scale developments				✓														✓		
	Mining & hydropower				✓														✓		

Table 4.3.2 Conservation actions and corresponding threats to snow leopards and threat ratings (white columns represent actions not yet taken in China)

4.3.3.3 Policy and Public Advocacy

- **The management of development projects**

Action taker(s): Green River, CAS Northwest Institute of Plateau Biology

The Yanzhanggua, the first grand canyon of the upper Yangtze, is the best preserved area in all of the basin. However, once it might have been included as part of a hydropower construction project. Had such a plan been implemented, no watercourse along the Yangtze River would have been left in a natural state. With the help of Tsochi Village and the local monastery, Green River set up 39 camera traps across the 10-kilometer-long canyon. Five months of monitoring within a radius of less than 40km^2 revealed 9-14 snow leopard individuals, in addition to an increasing number of amazing images of other animals, such as blue sheep, white-lipped deer, Pallas's cats, brown bears, beech martens, musk deer, wolves, lynxes, and red foxes. What's more, the crisscross of ridges and ravines along the canyon gives a great variety of vegetation, including steppe, meadows, valley meadows, and hillside bushes. By channeling runoff down into the canyon, the unique rocky landform proves to be more conducive to the growth of grass, most notably Stipa, Kobresia, and Carex. Though not in a large area, these plants have a productivity and quality high enough to carry quite a few herbivores. A large body of data, images, and videos documented great biodiversity in the canyon and cultural diversity around it.

Then Green River drafted a study report by incorporating such information and submitted to the Qinghai Provincial Development and Reform Commission. The latter highly appreciated the effort and made it clear that no hydropower station would ever be allowed in such a biologically diverse area as the Yanzhanggua Canyon. Starting from this, Green River hopes to help local communities design and plan small-scale tourism by participatory and science-based approaches, and establish a community autonomous co-management framework, providing a path for local sustainable development in order to best preserve the natural and human ecology of the Yanzhanggua Canyon.

- **Public advocacy**

Action taker(s): Qi Xinzhang of Xining Zoo

The rapid development of new media has made it

essential to increase the public understanding of snow leopard research and conservation through online outlets like Weibo and WeChat. Almost every organization will be involved.

One example is Qi Xinzhang, deputy director of Xining Zoo, whose Weibo ID is " Round Paw." Since 2017 he has posted 352 tweets under a Super Weibo Topic, "Snow Leopard Rescue," based on the story of two wild snow leopards, Ling Xue and Ling Shuang, being rescued. These tweets altogether have won 120 million views. Apart from that, another Super Topic, " Snow Princess," which is after the name of the only artificially bred snow leopard to date, attracted 26 million views. With such publicity on Weibo, he has secured 209 physical donations worthy of 130,000 yuan to support the zoo's enrichment and other commitments.

While serving as a great boost to the public understanding of snow leopards, new media such as Weibo may show the whole process of rescuing snow leopards in zoos, forge the image and capability of the Chinese government authorities in wildlife rescue, and build a platform for public participation in wildlife conservation.

- **Policy recommendation**

Action taker(s): Sanjiangyuan National Park Administration; SEE Foundation; SCC

Since 2012, SCC has been forging a strategic relationship with SEE Foundation to promote conservation in Sanjiangyuan. Since 2011, SEE Foundation, SCC, Qinghai Provincial Legislative Affairs Office, Qinghai Provincial CPC Committee Party School, and some other institutions have sponsored four Sanjiangyuan Forums, bringing together government leaders and environmental authorities in Sanjiangyuan, as well as leading scholars and non-governmental organizations. One of the most important products of the forums is the Measures for Ecological Protection and Management of Sanjiangyuan in Qinghai as a way to carry out research and policy advocacy on the legislation for Sanjiangyuan. In the meantime, the project team also offered insights and recommendations as part of the expert advisory group to revise the "Regulations on Sanjiangyuan National Park" and the "Measures for Compensating Life and Property Losses to Attacks by Key Protected Terrestrial Wild Animals in Qinghai Province."

The SEE Foundation, SCC, Peking University, and Sanjiangyuan National Park also jointly founded the Namse Conservation Station in the Lancang River Source Zone of the said national park to promote *in-situ* research and conservation, Other efforts included the "Recommendations on Further Snow Leopard Conservation in Sanjiangyuan" to the Qinghai provincial CPC committee and government, jointly submitted by SCC, the Qinghai Provincial Party School, and the Zadoi county government. In August 2016, SCC's partner Cai Danzhou, the secretary of the CPC Committee of Zadoi County, in a video call reported to President Xi Jinping what had been accomplished of the pilot national park program in Namse, particularly the progress in local snow leopard research and conservation, which President Xi appreciated and lauded.

- **Conservation planning**

Action taker(s): National Forestry and Grassland Administration; Qinghai Provincial Forestry Department; Gansu Provincial Forestry Department

The National Forestry and Grassland Administration has commissioned Beijing Forestry University to formulate a conservation plan for snow leopards in China. In addition, Qinghai Provincial Forestry Department commissioned the Chinese Academy of Forestry to formulate provincial conservation plans, while the snow leopard conservation plan in Gansu Province was prepared with the support of the World Wildlife Fund (WWF). At the local level, Zadoi County of Yushu Prefecture commissioned SCC to prepare a county-level snow leopard conservation plan based on the county's 20% sampled area.

4.3.4 Conservation Gaps

4.3.4.1 Nationwide

The top three threats as hereby rated are **insufficient grassroots conservation capacity**, **climate change**, and **limited capacity and motivation of community-based conservation** (Fig. 4.3.6). None of the key informants presumes

that the direct hunting and killing of snow leopards is the most serious threat at present. This indicates a sound footing on which snow leopard conservation is based in China. The issues to be addressed are more fundamental and general, such as nature reserve capacity building, public participation, the contradiction between economic growth and environmental protection, and climate change, among other potential threats.

Insufficient grassroots conservation capacity

The gap referred to as insufficient conservation capacity is exhibited in the following: a) According to the area statistics, nature reserves (NRs) in China (400,000 km^2) only accounts for 22% of the national snow leopard habitat area (1.78 million km^2) (Fig. 4.3.8), leaving the vast snow leopard habitat outside NRs unprotected by law; b) Of all the existing NRs, in only a few can snow leopard surveys and monitoring be independently carried out due to the lack of funds, human resources, or capacity; c) For the NRs within snow leopard range, there are no full and targeted conservation plan or clear targets. d) Only three regions in China were incorporated into the GSLEP – Taxkorgan, Jengish Chokusu, and Yanchiwan, as a result of the limited sharing of official and non-governmental information. By intergovernmental cooperation among the member states, the GSLEP hopes to identify and protect 20 landscapes for snow leopard survival by 2020. This program can be used as an important measure supplementary to the original NR system, whereby community-based protected areas or national parks may be established and conservation plans formulated correspondingly.

To address this issue, the existing efforts mostly are to build the NR capacity and to conduct community/volunteer-based monitoring and patrol. The latter covers an area so limited that large expanses of snow leopard habitat both in and outside NRs cannot be effectively monitored and conserved. Therefore, the system needs to be optimized to engage more talents, to develop targeted training, and to establish an effective monitoring and patrol framework within NRs. In a NR where human settlement is present, local pastoralists may be used as an effective monitoring measure supplementary to professional conservation forces, such as the ecological stewardship system already adopted in Sanjiangyuan National Park. Outside the NRs, all localities need to formulate effective conservation mechanisms according to local conditions. Examples from which references may be drawn include wildlife stewards on the Tibetan Plateau and civil volunteers in Xinjiang.

Climate change

There is no conservation action against this threat to date. Other snow leopard range states primarily work to provide local communities with more livelihood options and enhance their adaptability to climate change under adaptive livelihood projects, while trying to curb habitat deterioration caused by climate change.

Limited capacity and motivation of community-based conservation

Whether it's inside or outside NRs, snow leopard habitat usually overlaps with human habitation. The community may become a threat to snow leopards, as in the case of retaliatory hunting and poaching, but more likely it can be of great help to snow leopard conservation, as has been fully testified by community-based conservation efforts in various parts of China (see the Conservation Cases section). How to further mobilize the community for snow leopard conservation and resolve resistance into motivation, in particular, has already been considered as one of the most important tasks for snow leopard conservation.

In the course of the existing responses, various approaches are being taken to propel the community to action:

1) Community awareness building. Carry out environmental campaigns related (or even unrelated) to the snow leopard to help the people understand the relationship between humans and nature and establish a common sense of responsibility for the ecological environment they live in;

2) Community-based monitoring and patrol. Enable locals to assume responsibilities for wildlife monitoring and patrol, as authorized by the government authorities, by providing them with training and necessary equipment, such as

infrared cameras, and widely publicize so (via newspapers, television and other media exposures) to strengthen the community's sense of love for and pride in wildlife around them, thus achieving a way of motivation;

3) Eco-compensation. Encourage payment for ecosystem services and monetize responsibilities for conservation, so that financial equality may be achieved with a community not only empowered to feel proud in their own conservation work, but also recognized for their huge efforts and sacrifices along the way; and

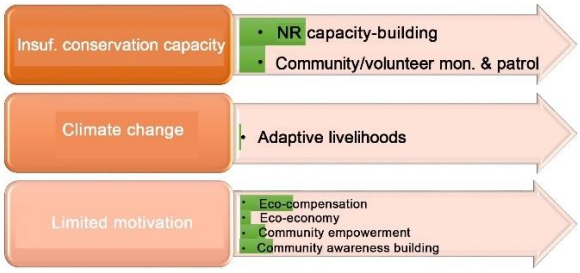

Fig. 4.3.7 Mostly highly rated threats nationwide and corresponding responses (Green bars represent how much a threat is alleviated, the more of them, the greater relief.)

4) Poverty alleviation / livelihood improvement. Although there is not necessarily a causal relationship between poverty and poaching, it is true that income generation in a way that is directly associated with conservation results will motivate the community more, such as wildlife tourism (see Natural Experience in the Conservation Cases section).

All Chinese provinces and autonomous regions within snow leopard range have explored some forms of awareness building, monitoring and patrol, and poverty alleviation / livelihood improvement at the community level, but their coverage remains too limited with the lack of sound civil-governmental cooperation, an effort to reach out to more snow leopard habitat by leveraging forces within the system. As a national policy, eco-compensation is widely practiced in western China, but mostly for grassland and forest, not for wildlife. A targeted eco-compensation policy is still needed in connection with the results of wildlife conservation, though the existing policy has proved indirectly beneficial to snow leopards.

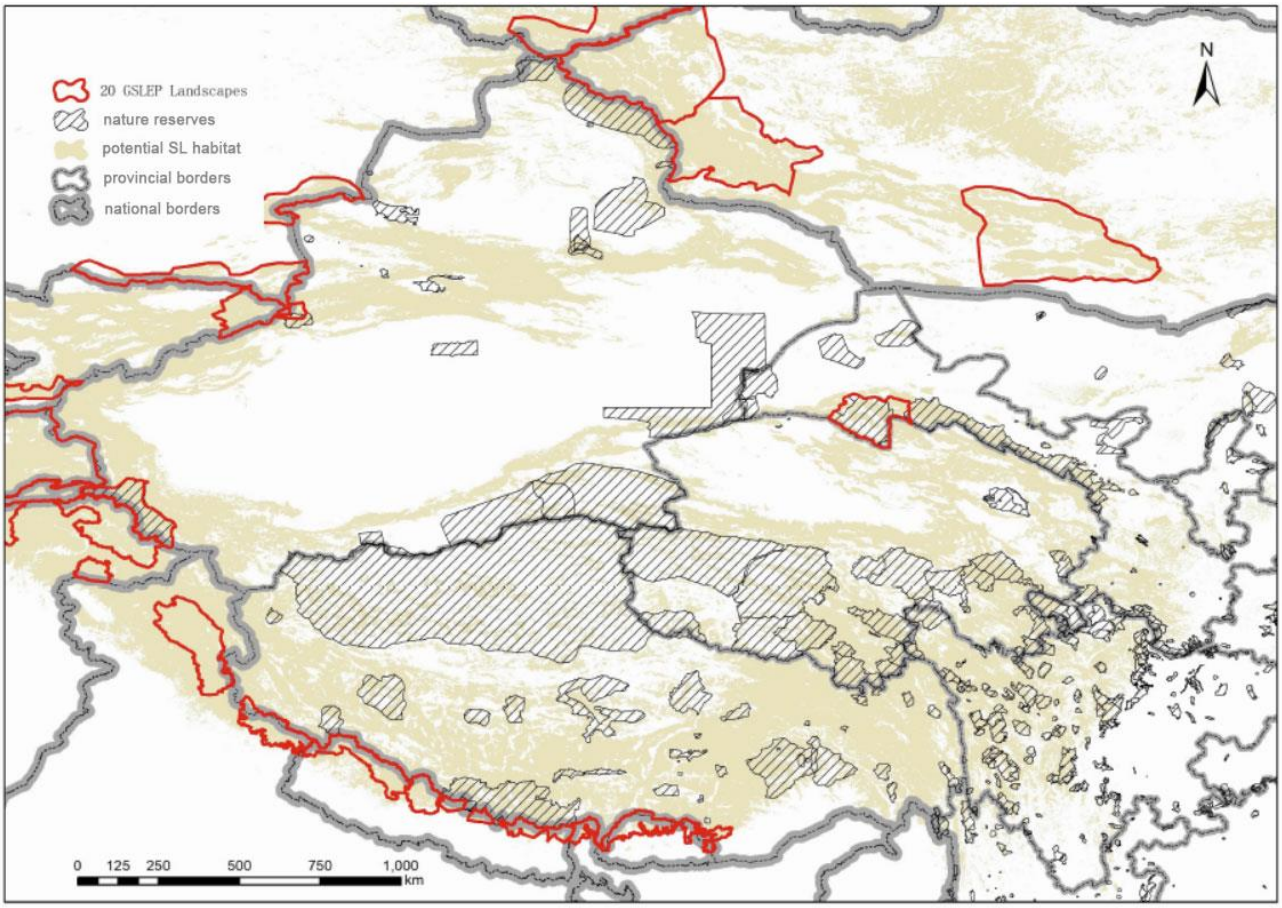

Fig. 4.3.8 The world's major SL landscapes and the relations of Chinese NRs to SL range

4.3.4.2 Qinghai

The overall threat rating for Qinghai is low. The most highly rated threats are **insufficient grassroots conservation capacity**, followed by **stray dog attacks** and **human-inflicted habitat fragmentation**. Although the threat of **climate change** is not among the top three, it is also included in the identification of conservation gaps because no corresponding measures have been taken to date.

Insufficient grassroots conservation capacity

NR capacity-building and community-based monitoring and patrol are existing responses to this threat, but still their coverage is too small relative to snow leopard habitat. Sanjiangyuan Nature Reserve, the largest of all the PAs in Qinghai, has only one state-registered staff member for each of its vast zones and, therefore, relies on the forestry public security system and work forces from free job markets to address its basic needs for fire prevention and anti-poaching patrol. The budg*et al*ready tightens with only one or two routine patrols a month (mostly vehicle and oil costs), not to mention large-scale wildlife population monitoring based on line transect surveys or camera traps. The rate of formal employment is higher in some sub-zones that were originally state-owned forest farms, such as Dongzhong, Baizha, and Jiangxi.

At present, grid-based wildlife monitoring has been conducted in the Dongzhong Forest Farm with the support of SCC, and in the Baizha, with the Qiaonyu Foundation and CFCA. A ubiquitous work force to support this practice in the most effective way may be the pastoralist community themselves. In some of the areas where community-based monitoring and anti-poaching patrol are piloted, good results have been achieved. Examples include the community-based camera monitoring and anti-poaching patrol projects SCC has initiated in partnership with the county-level governments of Yushu Prefecture, the Local Pastoralist Monitors in Sojia Town, and the community-based monitoring projects that Yuan Shang Cao has undertaken around the sacred Amne Machin Mountains. Sanjiangyuan National Park has also adopted the “pastoralist ranger" system, in which a large number of locals are engaged as environmental stewards. However, their job requirements and assessment criteria have yet to be defined. These are only early experiments.

Stray dog attacks

Existing responses to this threat are all small-scale attempts, including public pounds at the county jurisdictional level, SCC’s sterilization project in Zadoi, and the GNRCC’s vet training project in Nangqen and Golog. Huge gaps remain.

			PR establishment			*In-situ* conservation action											Policy & public advocacy				
Threat category	Threat	Scores	NR mon. & patrol	NR capacity building	New PRs	Conflict prev.	HWC fund/ insurance	Poverty/ livelihood	Commu-nity/volu-nteer mon. & patrol	Grazing mgt	Livestock disease control	Fence removal	Stray dog mgt	Herb harvest mgt	Commu-nity awaren. & edu.	Livelihoods adaptive to climate change	Cons. plans	Eco-com-pensation	Develop-ment mgt.	Policy recom.	Publicity
Direct kills/ captures	Retaliatory killing	4.7	✓			✓	✓	✓	✓						✓						
	Poaching for illegal trade	5.0	✓						✓						✓						✓
	Live captures for zoos and museums	1.0	✓						✓												
	Unintentional killing while catching other species	4.7	✓			✓	✓	✓	✓						✓						
	SL diseases	2.0											✓								
Habitat & prey related	Habitat degradation	6.7			✓			✓		✓		✓						✓	✓		
	Habitat frag.	8.0			✓							✓							✓		
	Prey poaching and unintentional killing	4.3	✓						✓						✓						
	Competition with livestock	5.3						✓		✓								✓			
	Prey disease	3.0									✓										
Policy & cognition related	Impr. policies	7.0					✓										✓			✓	✓
	Weak poli. impl.	7.7															✓			✓	
	Lack of coop.	0.7			✓																
	Insuf. cons. capacity	9.7		✓					✓												
	Limited motivation	7.0							✓						✓			✓			
Potential threats	Climate change	7.33														✓					
	Human pop. & poverty	7.3					✓	✓										✓			
	Stray dog attacks	8.3											✓								
	Herbal harvest disturbances	4.7												✓	✓						
	Large-scale developments	3.3			✓														✓		
	Mining & hydropower	6.3			✓														✓		

Table 4.3.3 Conservation actions and threat ratings in Qinghai (white columns represent actions not yet taken in the province)

Habitat fragmentation

Existing responses to this threat are the management of development projects and fence removal. The establishment of new PAs is a response not yet taken. Environmental inspection has been highly effective and successful in curbing a great number of ongoing or planned development projects in Qinghai. No big gap exists in this regard. Grassland fencing is originally a consequence of improper policies. For responses to this problem, policy recommendations need to be considered. The heavily funded "Return Grazing Land to Grassland" program, for instance, was implemented with major input in fencing. Removing fences, instead of building more as intended under the said program, in the core zone of Sanjiangyuan National Park, marked a leap of progress in policy making.

Climate change

The threat of climate change is particularly notable in the alpine desert region of western Qinghai. Issues like the melting of permafrost and glaciers as a result of climate change have already occurred in Hoh Xil, Qumalai, and other areas. This indicates a major gap as there is no conservation action to date against this threat. The adaptive livelihood projects developed in other snow leopard range states may be referenced. This kind of work is primarily intended to provide local communities with more livelihood options and enhance their adaptability to climate change, while trying to curb habitat deterioration caused by climate change.

4.3.4.3 Tibet A.R.

Of all the provinces rated, Tibet Autonomous Region overall has the lowest threat rating. The most highly rated threat is **climate change**, followed by **insufficient grassroots conservation capacity** and *prey population losses to competition with livestock*. Although the threat of **stray dog attacks** is not among the top three, it is also included in the analysis of conservation gaps because no corresponding measures have been taken to date.

Climate change

Northern Tibet has a huge impact of climate change. The rate of climate change in this area is more than twice the global means. Extreme weather and melting permafrost exacerbate grassland degradation. This constitutes a major gap as there is no conservation action against this threat to date. Also noted, however, is a high-

elevation resettlement project that has taken place to move some of the population to the southern cities and suburbs of Tibet, as showcased by Rongma Town of Nyima County, Nagqu. This measure will significantly relieve pressure on local ecology and the existing human-wildlife competition for natural resources. In addition, the traditional nomadic livelihood and lifestyle are highly dependent on grassland resources and are poorly adaptable to climate change. Other snow leopard range states may provide references to more livelihood options, such as fine livestock products, handicrafts, and eco-tourism, to raise the local community's adaptability to climate change and lower their dependence on natural resources.

Insufficient grassroots conservation capacity

The environmental authorities of Tibet are quite capable and effective, having invested heavily in law enforcement, law education, and the establishment of a patrol system for NRs, among other inputs. As roughly estimated and surveyed, the number of commercial snow leopard poaching cases has dropped to a sporadic few and even to zero in some areas. But deficiencies remain in scientific monitoring, conservation risk assessment, retaliatory kill prevention, and community mobilization. At present, NR capacity-building in response to this threat is still at its infancy: Only pilot monitoring missions have been taken at several management and conservation stations in the counties of Xainza, Shuanghu, and Nyima, Naqu, including camera monitoring and indoor interviews on human-wildlife conflict among pastoralists nearby. Therefore, insufficient conservation capacity remains one of the major gaps for local NRs. Fortunately, the environmental authorities have become more aware and willing to explore new possibilities in this regard. In the meantime, community mobilization may also be considered given the difficulty to cover key habitats with official conservation forces across the vast land of Tibet. A good example of this is the Wildlife Stewardship System established for community-based monitoring and anti-poaching in Changtang and Serling Tso National Nature Reserves in 2008.

			PR establishment				*In-situ* conservation action											Policy & public advocacy				
Threat category	Threat	Scores	NR mon. & patrol	NR capacity building	New PRs	Conflict prev.	HWC fund/ insurance	Poverty/ livelihood	Commu-nity/volu-nteer mon. & patrol	Grazing mgt	Livestock disease control	Fence removal	Stray dog mgt	Herb harvest mgt	Commu-nity awaren. & edu.	Livelihoods adaptive to climate change	Cons. plans	Eco-com-pensation	Develop-ment mgt.	Policy recom.	Publicity
Direct kills/ captures	Retaliatory killing	3	✓			✓	✓	✓	✓						✓						
	Poaching for illegal trade	0	✓						✓						✓						✓
	Live captures for zoos and museums	0	✓						✓												
	Unintentional killing	0	✓			✓	✓	✓	✓						✓						
	SL diseases	0											✓								
Habitat & prey related	Habitat degradation	4			✓			✓		✓		✓						✓	✓		
	Habitat fragmentation	3			✓							✓							✓		
	Prey poaching and unintentional killing	0	✓						✓						✓						
	Competition with livestock	5						✓		✓								✓			
	Prey disease	0									✓										
Policy & cognition related	Improper policies	0					✓										✓			✓	✓
	Weak poli. impl.	0													✓		✓			✓	
	Lack of coop.	0			✓																
	Insufficient conservation capacity	6		✓					✓						✓			✓			
	Limited motivation	4							✓						✓			✓			
Potential threats	Climate change	8														✓					
	Human pop. & poverty	4					✓	✓										✓			
	Stray dog attacks	3											✓								
	Herbal harvest disturbances	0												✓	✓						
	Large-scale developments	3			✓														✓		
	Mining & hydropower	1			✓														✓		

Table 4.3.4 Conservation actions and threat ratings in Tibet (white columns represent actions not yet taken in the AR)

Prey population losses to competition with livestock

Though highly rated, this threat is thought to be poorly studied without solid evidence that livestock has impacted prey populations. The lack of scientific studies constitutes a major gap with

respect to this threat.

4.3.4.4 Sichuan

The most highly rated threats in Sichuan are **insufficient grassroots conservation capacity** and **human population growth and poverty**, followed by the **lack of cross-border cooperation** and **prey population losses to competition with livestock**. Three more threats, though not ranked among the top three, lack proper responses to date: **snow leopard diseases**, **climate change**, and **disturbances caused by cordyceps/herbal harvest**.

Insufficient grassroots conservation capacity

This gap manifests itself in the following issues:

a) Snow leopard habitat in Sichuan is largely distributed in the west part of the province such as Ganzi and Aba, where several national, provincial, and prefectural NRs have been established and where efforts have been made to protect and manage wildlife. However, as several of the NRs have no regular staff base for management and routine conservation work, issues like conservation power, capacity, and intensity for these grassroots facilities are worthy of attention;

b) NRs in Sichuan are relatively well funded. Some national NRs established for panda conservation are among those with the greatest human capacity in the country. The executives of some of these NRs and NGOs, such as CAFA, have done some snow leopard monitoring work, but their coverage remains very limited; and

c) Strong commitment is present to tasks such as hiring forest guards on temporary terms, along with a good capacity of community participation, but what it takes to properly allocate resources, balance snow leopard conservation and community development, and address other issues with conservation planning and capacity remains to be further discussed. In the meantime, grassroots work forces are uneven in terms of professional development in conservation. Specifically, 1) following the cease of field work subsidies, more than 95% of the NRs' principal field workers became passive towards their conservation jobs, resulting in a substantial loss of the field work forces; 2) many frontline workers are poorly educated and know very little in the field; 3) the NRs lack a healthy turnover of staff and a sufficient amount of fresh blood; and 4) the NRs' technical staff have very few opportunities for skill training, including monitoring skills.

			PR establishment			*In-situ* conservation action											Policy & public advocacy				
Threat category	Threat	Scores	NR mon. & patrol	NR capacity building	New PRs	Conflict prev.	HWC fund/ insurance	Poverty/ livelihood	Commu-nity/volu-nteer mon. & patrol	Grazing mgt	Livestock disease control	Fence removal	Stray dog mgt	Herb harvest mgt	Commu-nity awaren. & edu.	Livelihoods adaptive to climate change	Cons. plans	Eco-com-pensation	Develop-ment mgt.	Policy recom.	Publicity
Direct kills/ captures	Retaliatory killing	6.5	✓			✓	✓	✓	✓						✓						
	Poaching for illegal trade	3.5	✓						✓						✓						✓
	Live captures for zoos and museums	0	✓						✓												
	Unintentional killing	5	✓			✓	✓	✓	✓						✓						
	SL diseases	3											✓								
Habitat & prey related	Habitat degradation	7			✓			✓		✓		✓						✓	✓		
	Habitat fragmentation	8.5			✓							✓							✓		
	Prey poaching and unintentional killing	8	✓						✓						✓						
	Competition with livestock	10						✓		✓								✓			
	Prey disease	3									✓										
Policy & cognition related	Improper policies	7					✓										✓			✓	✓
	Weak poli. impl.	9													✓		✓			✓	
	Lack of coop.	11			✓																
	Insufficient conservation capacity	13.5		✓					✓						✓			✓			
	Limited motivation	7.5							✓						✓			✓			
Potential threats	Climate change	6														✓					
	Human pop. & poverty	13.5					✓	✓										✓			
	Stray dog attacks	5											✓								
	Herbal harvest disturbances	7												✓	✓						
	Large-scale developments	6			✓														✓		
	Mining & hydropower	4.5			✓														✓		

Table 4.3.5 Conservation actions and threat ratings in Sichuan (white columns represent actions not yet taken in the province)

Human population growth and poverty

The following are two manifestations of this gap. First, grassland has been deteriorating in many areas of the West Sichuan Plateau, where animal husbandry is the main income generator. Poverty directly affects the grazing intensity of alpine meadows. Wire fences around the pastures isolate snow leopards and their prey habitats and compress their living spaces. In addition, issues like retaliatory killing persist. The targeted poverty alleviation projects carried out in recent years have an extensive coverage and should be of great help in alleviating this threat.

Second, although many local communities within snow leopard range are environmental minded with positive influences from the government's conservation campaigns and Buddhist beliefs, the persisting problem of wildlife poaching, particularly the poaching of prey animals, such as blue sheep, will directly affect the survival of snow leopards. In some areas with a high human population density and a low public awareness of conservation, it is even more difficult to eradicate poaching because poaching might seem more readily lucrative than doing odd jobs in the city.

The lack of cross-border cooperation

Snow leopard habitat expands across administrative boundaries and protected areas. Up till now, no cooperation mechanism has been established across the NRs in Sichuan due to budget constraints and administrative divisions. As a result, little cooperation has taken place across protected areas, administrative regions, and mountain systems, and cross-border cooperation is difficult to coordinate. To better conserve snow leopards and their ecosystem, the question of how to practice monitoring and conservation in a coordinated way remains worthy to be further discussed.

Prey population losses to competition with livestock

Grazing on alpine meadows is a common and serious issue and has recently become worse in areas like the Qionglai Mountains. Its impact on prey populations has not been studied, thus constituting a big gap.

Snow leopard diseases

This is a major gap given the great challenges in snow leopard disease data collection and surveillance.

Climate change

No responses have been taken to date. References may be drawn to adaptable livelihood projects implemented in other snow leopard range states.

Disturbances caused by cordyceps/herbal harvest

No responses have been taken. References may be drawn to the cordyceps harvest management initiatives SCC has taken with the local government's support: The local community takes a role in regulating and supervising seasonal harvests (see 4.3.2 for details).

4.3.4.5 Xinjiang A.R.

The most highly rated threats in Xinjiang are **insufficient grassroots conservation capacity** and the **lack of cross-border cooperation**, followed by **prey population losses to disease** and the **lack of public awareness in local communities**. Four more threats, though not ranked among the top three, lack proper responses: **Snow leopard diseases**, **prey population losses to competition with livestock**, **climate change**, and the threat of **stray dog attacks**.

Insufficient grassroots conservation capacity

This gap is present in the following situations. First, only a small part of the vast snow leopard habitat in Xinjiang is protected under the existing NR system, primarily parts of the Altai, West Tianshan, Altun, Kunlun, and the Pamirs. At present, all levels of NRs are fundamentally instrumental to snow leopard conservation as livestock management and measures against logging, mining, unauthorized entrance, etc. have been set in place. However, their capacity in collecting and managing basic monitoring data, as well as in identifying and responding to threats, remains generally deficient. This is primarily attributed to the small size of official management staffing and the lack of relevant skill training. Second, most of the snow leopard habitat in Xinjiang is not

incorporated in the NR system. For example, the 11 sub-bureaus of the East Tianshan State-owned Forest Administration have covered the most important snow leopard landscape of the Tianshan Mountains, but no single NR has been established in the area. Their major duties still are forest management, tree nursery, and fire prevention. This system further weakens wildlife conservation capacity, apart from the lack of use of counterpart resources.

The lack of cross-border cooperation

Xinjiang borders on eight countries. The Altai, West and South Tianshan, the mountains northwest of the Junggar Basin, and the Pamirs Plateau are all complete snow leopard habitats connected with the neighboring countries. However, due to the needs of border security and stability, border isolation facilities have already divided these cross-border habitats, cut the wildlife migration passageways, and blocked gene exchange among snow leopard populations.

Disease

The threat of disease mostly concerns Siberian ibex. In 2015 to 2016, an endemic (PPR) broke out extensively across the Tianshan Mountains, causing a sharp decline in the local prey population, which in turn led to human-wildlife conflicts and exacerbated the threat of retaliatory hunting against snow leopards. The most possible response to date is livestock disease prevention and surveillance.

		PR establishment			*In-situ* conservation action											Policy & public advocacy				
Threat	Scores	NR mon. & patrol	NR capacity building	New PRs	Conflict prevention	HWC fund/ insurance	Poverty/ livelihood	Commu-nity/volu-nteer mon. & patrol	Grazing mgt	Livestock disease control	Fence removal	Stray dog mgt	Herb harvest mgt	Commu-nity awaren. & edu.	Livelihoods adaptive to climate change	Cons. plans	Eco-com-pensation	Develop-ment mgt.	Policy recom.	Publicity
Retaliatory killing	6	✓			✓	✓	✓	✓						✓						
Poaching for illegal trade	5	✓						✓						✓						✓
Live captures for zoos and museums	1	✓						✓												
Unintentional killing	5	✓			✓	✓	✓	✓						✓						
SL diseases	3											✓								
Habitat degradation	6.5			✓			✓		✓		✓						✓	✓		
Habitat frag.	6			✓							✓							✓		
Prey poaching and unintentional killing	7.5	✓						✓						✓						
Competition with livestock	7						✓		✓								✓			
Prey disease	12									✓										
Improper policies	8.5					✓										✓			✓	✓
Weak poli. impl.	10													✓		✓			✓	
Lack of coop.	13.5			✓																
Insufficient capacity	13.5		✓					✓						✓			✓			
Ltd. motivation	10.5							✓						✓			✓			
Climate change	10														✓					
Human pop. & poverty	7					✓	✓										✓			
Stray dog attacks	1.5											✓								
Herbal harvest disturbances	0												✓	✓						
Large-scale dvpm.	7			✓														✓		
Mining & hydropower	5.0			✓														✓		

Table 4.3.6 Conservation actions and threat ratings in Xinjiang (white columns represent actions not yet taken in the AR)

The lack of awareness in local communities

Snow leopard habitat in Xinjiang mostly overlaps with grazing areas, and the local minority groups' traditional use of snow leopard skins and other wildlife products gives rise to poaching activities. In recent years, the authorities at all levels have done remarkably well in anti-poaching, gun control, and raising the public awareness of the Wildlife Conservation Law. People in pastoral areas generally have a good understanding of the said law, but they have not established a friendly attitude to or pride in the large predating animals, such as snow leopards, that may attack livestock. Therefore, community awareness building and education should be strengthened to connect ethnic cultures to snow leopard conservation and environmental protection.

Snow leopard diseases

This is a major gap given the great challenges in snow leopard disease data collection and surveillance.

Prey population losses to competition with livestock

The impact of livestock on prey populations has not been studied, thus constituting a gap.

Climate change

No responses have been taken to date. References may be drawn to adaptable livelihood projects implemented in other snow leopard range states.

Stray dog attacks

In some areas, stray dogs can be considered as a threat to snow leopard prey, but no prominent threat has yet risen therefrom.

4.3.4.6 Gansu

The most highly rated threat in Gansu is **insufficient grassroots conservation capacity**. The second is **prey population losses to poaching and unintentional killing**. The third is **unintentional killing while catching other species**. Four more existing threats, though not among the top three, lack proper responses: **Snow leopard diseases**, **climate change**, and **stray dog attacks**,

Insufficient grassroots conservation capacity

The two national NRs in Gansu have achieved a considerable level of field monitoring capacity for snow leopards, but overall, Gansu's capacity for snow leopard conservation and management remains deficient while various issues persist, such as an inadequate amount of professionalism, unsound patrol system, and the lack of targeted planning for the conservation and management of snow leopards and their habitat. A transition towards the national park system creates new opportunities and with that hopefully new mechanisms and training will be made available with new blood pooling in. Most of the local communities have moved away from the NRs, but some pastoralists remain in the snow leopard inhabited areas and can be trained to assist in conservation.

Prey population losses to poaching and unintentional killing & unintentional killing while catching other species

The severity of poaching is very difficult to assess. Hunting activities usually become known through informal interviews with key informants. By camera monitoring snow leopard habitat, traps can be found, albeit in a small number. Snow Leopards are unlikely to be direct targets, but they may fall into these traps. A 2014 community survey in the Qilian Mountains showed that the local attitude towards snow leopards was more tolerant than that towards other carnivores. Therefore, there is no clear evidence that the retaliatory killing or hunting of snow leopards is the primary problem. However, hunting other species such as blue sheep may be so. Hunters with guns caught by cameras and some wire traps found in the wild might have targeted at blue sheep. More patrol forces are needed, and the role of the national park administration becomes particularly important in the alpine areas where community-based conservation is rendered implausible as local communities have relocated. Furthermore, years of booming animal skin trade in Linxia have given Gansu the highest incidence of wildlife poaching in China. Law enforcement is a key solution to this problem – and a major gap as well.

Snow leopard diseases

This is a major gap given the great challenges in snow leopard disease data collection and surveillance.

Climate change

No responses have yet been taken. References may be drawn to adaptable livelihood projects implemented in other snow leopard range states.

Stray dog attacks

No responses have yet been taken. References may be drawn to the GNRCC stray dog management project in Nangqen County, Qinghai (see 4.3.2 for details).

			PR establishment						*In-situ* conservation action									Policy & public advocacy				
Threat category	Threat	Scores	NR mon. & patrol	NR capacity building	New PRs	Conflict prevention	HWC fund/ insurance	Poverty/ livelihood	Commu-nity/volu-nteer mon. & patrol	Grazing mgt	Livestock disease control	Fence removal	Stray dog mgt	Herb harvest mgt	Community awaren. & edu.	Livelihoods adaptive to climate change	Cons. plans	Eco-com-pensation	Develop-ment mgt.	Policy recom.	Publicity
Direct kills/ captures	Retaliatory killing	6.4	✓			✓	✓	✓	✓						✓						
	Poaching for illegal trade	8.7	✓						✓						✓						✓
	Live captures for zoos and museums	1.3	✓						✓												
	Unintentional killing	9.1	✓			✓	✓	✓	✓						✓						
	SL diseases	2.0											✓								
Habitat & prey related	Habitat degradation	7.3			✓			✓		✓		✓						✓	✓		
	Habitat fragmentation	8.9			✓							✓							✓		
	Prey poaching and unintentional killing	9.2	✓						✓						✓						
	Competition with livestock	7.8						✓		✓								✓			
	Prey disease	3.8									✓										
Policy & cognition related	Improper policies	8.1					✓										✓			✓	✓
	Weak policy implementation	7.7													✓		✓			✓	
	Lack of cross-border cooperation	3.6			✓																
	Insufficient conservation capacity	10.2		✓					✓						✓			✓			
	Limited motivation	8.3							✓						✓			✓			
Potential threats	Climate change	7.5														✓					
	Human pop. & poverty	5.5					✓	✓										✓			
	Stray dog attacks	2.42											✓								
	Herbal harvest disturbances	1.33												✓	✓						
	Large-scale developments	8			✓														✓		
	Mining & hydropower	8.33			✓														✓		

Table 4.3.7 Conservation actions and threat ratings in Gansu (white columns represent actions not yet taken in the province)

4.4 Conclusion

Insufficient grassroots conservation capacity, **limited capacity and motivation of community-based conservation**, and **climate change** are the primary threats identified nationwide. Each province is distinctly characteristic in terms of threat rating and is different from one other. However, they are similar in that no massive hunting of snow leopards ever occurred and that management-related issues like insufficient grassroots conservation capacity are often most highly rated. Still many gaps exist in the conservation actions taken against these threats. It is necessary to take conservation measures most appropriate to local conditions.

This is China's first attempt to assess threats to snow leopards using standardized and quantitative methods. Admittedly, the number of key informants and expert opinions involved herein are quite limited; there is still much room for improvement. We hope that relevant organizations and individuals across the country will join efforts to promote snow leopard conservation in China with good faith in assessing threats more accurately and comprehensively, further identifying conservation gaps, and sharing the lessons learned.

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5 通往雪豹大国之路：未来五年工作建议

Towards a Leading Edge: Recommendations for the Next Five Years

Photo by Frédéric Larry in Namse Town, Yushu

5.1 Introduction

Snow leopards are widely distributed in China, the extent of threats varying across different provinces/autonomous regions (ARs). Although a lot of information and conservation gaps exist, snow leopards in China are generally in a good condition as compared to other snow leopard range states.

In recent years, China has gradually put more effort in snow leopard conservation and has made considerable progress therein. Expeditious work has been done for snow leopard surveys and monitoring, the development and maintenance of a nature reserve-based conservation management system, the optimization of a compensation system against wildlife attacks, and international cooperation and exchange. Now with the ongoing establishment of Sanjiangyuan and Qilian Mountains National Parks, China is exploring integrated regional conservation measures. Private investment in and public awareness of conservation are also growing rapidly. In 2013, a "China Snow Leopard Conservation Action Plan (Internal Review Draft)" was prepared. China will further strengthen its capacity in areas such as compensation, law enforcement, surveys and monitoring (S&M), international cooperation and community-based conservation, as the State Forestry and Grassland Administration announced at the International Conference for Snow Leopard Conservation 2018 in Shenzhen.

On the basis of this Action Plan and the identification of threats and conservation gaps as highlighted in the preceding chapter, we hereby propose to focus on five dimensions in the next five years (2019-2023): (1) to carry out a national snow leopard census; (2) to improve the capacity of patrol, monitoring, and management of protected areas (PAs); (3) to establish integrated community-based conservation model sites; (4) to prepare a master conservation plan for key snow leopard landscapes; and (5) to further establish the Snow Leopard China network.

These efforts will help understand the overall status of snow leopards in China, make conservation actions more effective and focused, facilitate the survival of snow leopards in key areas, optimize the utilization of conservation resources, and promote domestic and international cooperation. In five years, the landscape of snow leopard conservation in China will likely be one in which " the private sectors are sufficiently empowered and mobilized with the government taking the lead." By then, China's snow leopard research and conservation will reach a new height and inform the world of its insights and methods.

5.2 China Snow Leopard Conservation Action Plan 2013

In 2013, the China Snow Leopard Conservation Action Plan (Internal Review Draft) identified four major threats to snow leopards in China, namely, "degradation of natural habitats by grazing," " climate change and wildlife diseases," "illegal mining and improper road construction," and "poaching of snow leopard prey," in addition to five major problems affecting the effectiveness of conservation: " insufficient coverage of nature reserves to snow leopard range areas," " insufficient grassroots conservation capacity," "insufficient data on snow leopard populations and habitat," "insufficient public awareness and education," and "low compensation for snow leopard attacks." Moreover, 12 actions were proposed in 5 dimensions: "scientific research and monitoring," "the development of conservation management systems," "community," "publicization," and "international cooperation." (Table 5.3.1)

This comprehensive action plan provided the first Chinese guidelines for conservationists at all levels by systematically reviewing the snow leopard conservation status in the country as well as all available conservation measures for the species.

Table 5.3.1 SL conservation actions proposed in the China Snow Leopard Conservation Action Plan 2013 (Internal Review Draft)

Dimension	Aspect	Proposed Action
Survey and monitor SL population and habitat dynamics, strengthen basic research and conservation planning	SL population and habitat surveys and monitoring	Key areas: Pamir Kunlun - Karakoram, Himalayas, Hengduan, Tianshan, Altai, Helan, Gangdise - Tanggula - Hoh Xil - Bayan Har, Yinshan, Qilian
		Set up an expert group to develop technical plans as well as survey and monitoring procedures
		Collect information about the terrain, vegetation, roads, human settlements, and so forth in SL range and surrounding areas, carry out ground truthing to assess habitat status, and predict future key SL habitats and corridors by modelling.
		Process data, prepare population and habitat assessment reports, establish a GIS database for SL conservation
		Follow up monitoring work
	More basic research in climate change, habitat restoration, population ecology, and other relevant fields	Engage specialists in project design and submission in important areas of research such as climate change, habitat restoration and population ecology
		Collect meteorological data from research-targeted areas and analyze the impacts of climate and other ecological factors.
		Investigate human activities such as mining, road construction, and grazing in SL habitat, analyze their impacts on SL populations and habitat, and propose measures for habitat restoration and management optimization
		Carry out basic research in SL population ecology and other areas by non-invasive approaches such as camera trapping
	Sound planning for SL conservation	Carry out conservation strategy research and planning based on survey results to identify high-quality habitats
		Prioritize SL conservation in key areas and prohibit improper construction works
		Coordinate the implementation of ecological projects in various regions and assess their effectiveness
Optimize conservation management systems and promote habitat conservation	Optimization of SL population and habitat conservation and management under the NR system	Promote PA establishment, adjust the zoning of PAs based on the survey results to conserve key populations and habitats
		Identify and fill conservation and monitoring gaps
		Establish a snow leopard conservation expert group to coordinate and support snow leopard survey and monitoring work
		Delineate conservation and monitoring responsibilities within each PA
	Capacity building	Supplement manpower needed to exercise the duties of each conservation management unit
		Upgrade equipment and skills and set up work guidelines on field patrol, habitat restoration, community coordination, etc.
		Provide training at various levels
		Build an information sharing mechanism and coordinate the operations of various conservation management units
		Regularly assess the effectiveness of conservation management
	SL habitat conservation,	Formulate rules and measures to strengthen field patrol, control illegal mining and improper grazing activities, and remove traps

	restoration, and expansion	Assess the impacts of overgrazing, pasture fencing, illegal mining, road construction, excessive tourism and other human activities on SL populations and habitats, and submit proper policy proposals regarding relevant regulations
		Control hunting and farming activities along key corridors.
		Study and formulate necessary policies to restore SL habitats.
		Regularly assess the effectiveness of conservation management
Balance between SL conservation and community development	Compensation for losses to SL attacks	Streamline SL attack reporting and verification procedures
		Facilitate compensation to cover all SL range areas
		Reasonably raise compensations in view of actual losses and explore possibilities with commercial insurance.
		Check claims and payments on a regular or random basis, and local attitudes
	Protection and prevention	Promote public education to raise the community's awareness of protection and protective measures
		Gradually guide community residents to change their loose grazing pattern and improve protective fences
		Gradually transition from sporadic to concentrated settlement
	Piloting and demonstrating eco-friendly livelihood paradigms	Systematically study local lifestyles, assess their impacts on snow leopards, prey and habitats, and identify economic behaviors that need to be adjusted
		Study alternative work and life patterns and encourage the community to set examples spontaneously
		Gradually encourage eco-friendly lifestyles by assessing the economic and environmental benefits of pilot projects
		Establish a project supporting, reward and punishment system to align snow leopard conservation with community development
Raise public awareness of law enforcement; combat illegal activities	Legal capacity building, law enforcement, inspection, and special operations	Collect reports, actively carry out market investigations and analyze illegal cases, and identify the key sources, places, transfer methods and the networks of poaching and smuggling
		Improve the equipment, training, and cognitive capacity of law enforcement agencies in key areas
		Develop systems for anti-poaching patrol, market inspection, law enforcement bulletin, joint consultation, and accountability, optimize the inter-agency cooperation mechanism
		Strengthen anti-poaching information management and risk control
		Carry out joint law enforcement, inspection, and special operations, strengthen the analyses of illegal activities
	Publicization and education	Carry out multifaceted publicity campaigns through a variety of media outlets to raise the public awareness and cognition of SL conservation
		Set up signs in key locations, border areas and markets to promote SL conservation and encourage the public to stop buying SL products
		Set up hotlines and online reporting portals, incentivize the public to provide clues to illegal activities

		Select appropriate typical cases to carry out intensive publicity campaigns
		Establish a conservation volunteer platform to promote volunteer engagement in surveys and other activities
Expand international cooperation	Optimizing international cooperation mechanisms	Discuss with the states concerned future cross-border cooperation actions in the Pamirs, Altai, Himalayas and other border areas within SL range
		Promote exchange between states and research/conservation institutions
		Promote the exchange of information and the development of law enforcement mechanisms in the border trade zones of the states concerned
		Facilitate information flows between the Customs of the states concerned
		Regularly assess the effectiveness of cross-border conservation

5.3 Snow Leopard Survey and Conservation Status in China 2018

This report draws on the list of snow leopard threats recognized in the international academic and conservation communities, identifying threats to snow leopards in various provinces and autonomous regions of the country based on an accumulation of research and conservation work in recent years, and rating them according to the evaluations of frontline specialists. The top 14 threats are the following: "Insufficient grassroots conservation capacity," "climate change," "limited motivation of community-based conservation," "human population growth and poverty," "competition with livestock," "habitat degradation," "habitat fragmentation," "weak policy implementation," "the lack of cross-border cooperation," "improper policies," "large-scale developments," "retaliatory killing," "prey population losses to disease," and "poaching and unintentional killing of prey."

Overall, the categories, "policy and cognition related threats" and "habitat and prey related threats," are rated high and "poaching and unintentional killing of prey" low. The evaluators have expressed concern about the potential impact of climate change, human population growth and large-scale developments. In addition, the " lack of scientific study and awareness" has become a universal gap in China's snow leopard conservation.

The first category of threats, namely "direct kills/captures," is rated low, reflecting recent progress in snow leopard habitat patrol, law enforcement, legal awareness, and other actions that have effectively averted this direct threat. In the fourth category, the evaluators generally view "mining and hydropower development" as a low threat. To some extent, this result reflects the achievements of the country's hugely invested environmental policies, such as the management of ecological red-lines and the establishment of ecological civilization, since the 18th National Congress of the CPC.

In both assessments of 2013 and 2018, " habitat degradation," "climate change," "insufficient grassroots conservation capacity," "the lack of scientific study and awareness," and "limited capacity and motivation of community-based conservation" were considered as major threats or important issues. This shows that work in these areas may not have led to significant results in the past five years. Therefore, priority should be given to these important and urgent areas in the future allocation of conservation resources, and input should be adjusted accordingly. For example, the evaluators generally believe that grassroots conservation capacity building should shift its focus from hard power to soft power as soon as

possible. At the same time, resource input should target potential beneficiaries who most likely can make a difference. For instance, "local community" is one of the key words in this assessment, which directly corresponds to at least eight conservation threats or problems.

This assessment found that China's snow leopard conservation has passed an initial milestone of preliminary investigation, anti-poaching, and large-scale control against habitat destruction. In the future, a comprehensive approach to both conservation and people's livelihood improvement will be needed. This requires better performance mechanisms, implementation methods and assessments of mitigating interventions. One example is the lack of rigorous assessment of eco-compensation and wildlife attack compensation policies now widely implemented in snow leopard range areas in China. It is necessary to construct a comprehensive intervention system and a resource scheduling system to optimize conservation input and maximize effectiveness.

5.4 Recommendations for the Next Five Years (2019-2023)

Following the 2018 Shenzhen Consensus on Global Snow Leopard Conservation, we suggest that by 2023, a national survey be complete of 20% of suitable snow leopard habitat in China, a paging monitoring management system built for 7 key PAs, 5 community-based conservation model sites established, a snow leopard conservation plan prepared in 5 key provinces and ARs, and the "Snow Leopard China" network strengthened, promoting the harmonious relationship between man and nature in China's alpine mountain ecosystem.

5.4.1 The Implementation of a 20% Suitable SL Habitat Survey

Background

In recent years, China has achieved rapid progress in snow leopard surveys, but their coverage remains very limited, accounting for only 1.69% of suitable habitat for snow leopards in the country (0.49% in Xinjiang, 4.06% in Gansu, 4.44% in Qinghai, 0.68% in Tibet, 2.85% in Sichuan). Huge gaps still exist in our understanding of this species, making it impossible for an accurate assessment of threats to conservation in various range areas and targeted conservation strategy making. Therefore, snow leopard population surveys and monitoring are essential and should be prioritized in terms of input.

Objectives

To sample survey 20% of China's snow leopard habitat (approx. 340,000 km^2) and to accurately estimate the number of snow leopards in the country as per internationally proven survey standards and scientific methods.

Actions

First, conduct a large-scale snow leopard population survey. Select 20% snow leopard habitat according to the results of snow leopard distribution modelling and the actualities of each province and carry out the survey correspondingly by way of interviews, sign, camera trapping, and fecal DNA identification. Use occupancy models and spatial mark and recapture models to analyze the survey data. In accordance with the gap analysis, priority is recommended for the West Tianshan area and the Gangdise-Nyenchen Tanglha and Himalayan mountain ranges in Tibet.

Second, monitor snow leopard population dynamics in local areas. In Gansu, Xinjiang, Qinghai, Tibet, and Sichuan where snow leopards are mainly distributed, build at least one long-term monitoring network with local research and conservation teams to cover at least 10,000 km^2 suitable snow leopard habitat.

Third, carry out threat assessment and research. Promote quantitative assessment of threats, such as retaliatory hunting, human-wildlife conflict, habitat degradation and fragmentation, climate change, snow leopard and prey diseases, and study threat evolving mechanisms.

Such surveys and monitoring should reach a capacity of the international caliber, and can be horizontally compared to gradually establish a baseline database for snow leopards in China. The existing surveys and monitoring covering the entire span of the mountain system in the Qilian National Park can provide good references for other PAs.

5.4.2 The Establishment of a M&P System for 7 Key PAs

Background

China's awareness building for wildlife legislature has been hugely successful; the management of PAs has been continuously optimized, and law enforcement efforts generally have been strengthened. As assessed for the provinces concerned, commercial poaching currently is not a global threat to snow leopards in China. However, the species is usually distributed in geographically complex and remote areas. Effective management is difficult to implement with full coverage. Illegal trade is and will continue to be inevitable in these areas. Therefore, stronger PA management capacity with a high-level law enforcement team for stewardship is a primary measure to maintain current progress and a prerequisite for comprehensive conservation work as well.

In China's snow leopard range, some PAs have healthy snow leopard populations. These key PAs include Qilian Mountains National Park, Sanjiangyuan National Park, Changtang National Nature Reserve (Tibet), Serling Tso National Nature Reserve (Tibet), Mt. Qomolangma National Nature Reserve (Tibet), Jengish Chokusu National Nature Reserve (Xinjiang), and Wolong National Nature Reserve (Sichuan). For these PAs to achieve a long-lasting substantial impact on snow leopard conservation in China, it is necessary to first establish patrol, monitoring, and management systems, strengthen conservation power, and optimize management frameworks.

Objectives

To establish a monitoring and patrol (M&P) system for 7 key PAs.

Actions

First, establish a M&P management system for key PAs to standardize M&P practices. Recommended actions include grid management, breaking down and delineating duties, quantifiable performance assessment, establishing a carrot or stick mechanism, fully mobilizing the public and other social forces, and purchasing community-based conservation services (e.g. local patrollers and wildlife stewards) as an effective supplement to official employment. By now, several conservation stations - hard power - have been built in Changtang National Nature Reserve of Tibet, where information management tools have been used to optimize management and M&P carried out with public forces. Good results have been achieved and can be used for reference.

Second, conduct comprehensive capacity-building training and tailor it to different tiers of management. For conservation authorities at the provincial level, the training will be focused on the progress and dynamics of international snow leopard research and conservation, large-scale conservation effectiveness assessment, snow leopard conservation planning and public communication methodology; for PA administrations, theoretical approaches to surveys and monitoring, grid conservation, data management and performance assessment;; and for grassroots conservation units, the management of conservation stations, snow leopard sign identification, camera trap maintenance, ecological data collection, and terminal operation, among other topics. Such training can take various forms, including intensified instruction, field practice, and visits/exchanges.

Third, carry out nature education for the public. In

September 2017, the General Office of the CPC Central Committee and the General Office of the State Council released the Master Plan for the Establishment of the National Park System, specifying that "national parks will be maintained in a way that is easily accessible to the public, with focuses on promoting the functionality of ecosystem services, offering nature education, and providing fun opportunities for people to approach, experience, and understand nature. Efforts will be made to encourage public participation and engagement, raise the public awareness of conservation, and to boost national pride." Snow leopards can suitably serve as a channel to educate the public on wildlife and ecosystem conservation.

5.4.3 The Establishment of 5 Community PAs

Background

A harmonious co-existence between humans and wildlife in the alpine mountain ecosystem is one of the recognized goals within the global snow leopard conservation community. The Bishkek Declaration 2013 and the Shenzhen Consensus on Global Snow Leopard Conservation 2018 both have reaffirmed this goal. China's existing PA system covers only 22% of the snow leopard range in the country. In other words, most snow leopards in China share habitat with farmers and pastoralists outside the PAs. To maintain sustainability, it is necessary to align the economic development of local communities with snow leopard conservation as the latter's future largely depends on which role these communities are going to take.

Objectives

To establish at least 5 integrated community-based model PAs in key provinces/ARs where snow leopards are distributed: Tibet, Xinjiang, Qinghai, Gansu, and Sichuan.

Actions

First, establish a mitigation mechanism, as well as pilot preventative measures and compensation programs, for human-wildlife conflict. The frequency of snow leopard attacks and losses incurred thereby should be significantly reduced with a local positive shift in attitude towards snow leopard conservation.

Second, establish an incentive conservation fund. Directly link external incentives to local conservation effectiveness: The effectiveness of local community-based conservation will be assessed through scientific monitoring, and positive conservation outcomes will be taken as a precondition for the local community to receive monetary incentives. Mobilize public participation in conservation at the grassroots level with a stronger sense of ownership and pride in good outcomes. Empower the community in preparing and implementing local conservation plans. Respect and strengthen the community's ability to manage public resources.

Third, explore a green livelihood framework. Establish a special fund to support local communities in exploring eco-friendly green livelihood paradigms, such as Nature Watch Festivals, high-end wildlife tours, nature education bases, traditional handicrafts, and professional labor export. Now integrated community-based conservation has been practiced in the Lancang riverhead area through measures such as wildlife attack insurance, community monitoring, nature education, and eco-tourism, gradually building up a framework of integrated conservation. Good results have been achieved and can be used for reference.

Fourth, review and scale up demonstration and pilot work. Review the paradigms and mechanisms that can be replicated and scaled up, and provide useful references for more communities and local governments within snow leopard range.

5.4.4 SL Conservation Planning for 5 Key Provinces/ARs

Background

Snow leopard conservation in China has entered an era where it requires a comprehensive approach to make more changes happen: Integrated measures will be needed to optimize the use of conservation resources. Landscape-wide methodical intervention is a key step in Chinese snow leopard conservation. Landscape conservation has become an internationally proven practice. The GSLEP's "20 by 20" goal, for instance, promises that 20 of the world's landscapes for snow leopard survival will be protected by 2020. This program is expected to urge the snow leopard range states to draw feasible and effective conservation plans on a landscape scale. However, China's participation in the GSLEP is significantly inadequate in terms of the number and area of the landscapes to be protected thereunder.

Each of the provinces/ARs involved remains lagged with conservation plans and pilot projects restrictively localized, despite a considerable amount of recent experience in snow leopard conservation. No plan has been prepared to cover the whole of a province/AR. Therefore, we recommend the formulation of universal conservation strategies and action plans based on snow leopard surveys and monitoring, NR capacity building, and community-based conservation demonstration in the next five years.

Objectives

To prepare master conservation plans at the provincial/regional level in key provinces/ARs where snow leopards are distributed, including Tibet, Xinjiang, Qinghai, Gansu, and Sichuan.

Actions

First, synthesize and consolidate the results of surveys, monitoring and threat assessment in each province/AR concerned to identify important snow leopard landscapes. Following the GSLEP, a priority landscape should be a large connected habitat of at least 100 fertile individuals.

Second, develop a vision and goal of snow leopard conservation in each province/AR concerned, and clearly define its resource guarantee and intervention mechanisms, accountabilities, governance structures, and principal partners, in addition to effectiveness assessment. For priority landscapes to be protected, population dynamics monitoring, threat dynamics assessment, and integrated conservation and control are recommended.

Third, build a reliable mechanism for sharing, assessing, and promoting snow leopard conservation work in each province/AR concerned to support the expansion of good experience and to quickly fill the short-term gaps.

Fourth, promote international exchange and properly use global financial and intellectual resources in snow leopard conservation to support the launch and implementation of conservation plans in the province/AR concerned.

Qinghai and Gansu have already started conservation planning at the provincial/regional level and will provide references for the other provinces/ARs.

5.4.5 Empowering Snow Leopard China

Background

China would not have progressed in snow leopard conservation over the past ten years without close collaboration between the government and the private sector. With executive and leading government power, an increasing number of organizations, groups, and individuals have been engaged and a wide range of social resources mobilized. Civic input is a major drive for the cause. The future of snow leopard conservation in China will still require such concerted efforts.

Objectives

To empower Snow Leopard China and make it grow into a platform for domestic and international exchange and cooperation.

Actions

First, establish a joint snow leopard conservation conferencing routine in China to promote coordination and information exchange between the government and international non-

government conservation agencies.

Second, engage universities, scientific research institutes, professional wildlife conservation groups, community development organizations, environmental foundations, specialized media, and business enterprises from China and abroad to actively participate in China's snow leopard conservation within the national framework of laws and regulations.

Key areas of collaboration include investigation and research of snow leopard distribution and population dynamics, assessment of threats to snow leopard conservation, demonstration and promotion of new technologies, community-based conservation and green development, M&P capacity building for NRs, nature education and publicization, and international exchange.

Third, establish an international expert group for snow leopard conservation to provide technical capacity-building and professional services for Chinese NRs and non-governmental teams. Promote the government ' s practices in outsourcing conservation services.

Fourth, assist in improving visitor education functionality in key PAs and build local publicity centers for snow leopard conservation in China. Recognize outstanding role models among grassroots groups, conservation workers, and volunteers. Support the production of literary works, documentaries, and short videos that reflect the snow leopard and its conservation. Build a "China Snow Leopard Conservation Volunteer Platform."

Fifth, raise awareness among people living within snow leopard range, with a focus on promoting locals' senses of pride in their hometowns and developing a positive attitude toward wildlife, on the basis of activities designed to popularize legal knowledge. Such awareness building effort will take various forms, such as multimedia presentations, courseware on environmental protection, articles for daily use and cultural creativity, and community wildlife-photographing contests.

5.5 Conclusion

With firm steps towards an ecological civilization comes a historic opportunity before us: We will very much likely coexist in peace with snow leopards and share natural bounty in the vast mountains of western China. We believe that this animal will leave yet another marvelous page in China's history of wildlife conservation and once again will mark our outstanding contributions to the world's biodiversity conservation.

China is not only the country where most snow leopards live; it will also become a source of origin for pioneering thoughts and practices in the field of snow leopard and mountain conservation. With its ample actions, China has shown to the world that we are well on track to lead the way for the future of this feline species.

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