



The Status of Snow Leopards Across High Asia



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

This **Special Issue** presents updated country-level status summaries of snow leopards across their range, summarizing distribution, population knowledge, threats, and conservation actions.

Snow Leopard Reports acknowledges IUCN Species Survival Commission (SSC) Cat Specialist Group and the wider IUCN Red List assessment community for their collaboration and guidance in strengthening the status information presented in this Special Issue.

Author guidelines and instructions for how to submit a manuscript are found at the journal's website, <https://publicera.kb.se/slr>

Snow Leopard Reports is published under the Creative Commons CC-BY 4.0 License, there are no fees for publishing in Snow Leopard Reports.

EDITORIAL TEAM:

• EDITORS IN CHIEF

- Örjan Johansson, Snow Leopard Trust & Swedish University of Agricultural Sciences (orjan.johansson@slu.se)
- Justine Shanti Alexander, Wildlife Conservation Society (justine.s.alexander@gmail.com)

• EDITORS

- Lingyun Xiao, Xian Jiaotong-Liverpool University
- Munib Khanyari, Nature Conservation Foundation

• EDITORIAL BOARD

- Bayarjargal Agvaantseren, Snow Leopard Conservation Foundation, Mongolia
- Dechen Lham, University of Zurich, Switzerland
- Ranjini Murali, Humboldt University, Germany
- Sandro Lovari, Siena University & Maremma Natural History Museum, Italy
- Shoaib Hameed, Snow Leopard Foundation, Pakistan
- Yanlin Liu, College of Life Sciences, Qinghai University, China

ISSN 2004-5255

Published by
The Snow Leopard Network (SLN) and
Swedish University of Agricultural Sciences (SLU)

SLR Logo: illustrated by Boqiao Liang

Cover Photo Credit: Prasenjeet Yadav

Back Photo Credit: Prasenjeet Yadav

Design and layout: Ritu Topa/arrrtcreations@gmail.com

Editorial Note

Modern snow leopard (*Panthera uncia*) science is relatively young. In the early 1970s, published scientific observations of the species were limited to scattered observations and one of the first global snow leopard distribution maps published in 1972 (Hemmer, 1972). Wild sightings were rarely documented and in 1971 George Schaller's photo of a snow leopard in Pakistan was front-page news of *National Geographic*. The 1980s marked the beginning of long-term field research, including the first intensive ecological studies and early telemetry work in Nepal (Ahlborn & Jackson, 1988; Jackson & Ahlborn, 1989). During the 1990s, the field expanded rapidly and there was a growing call for standardization. New survey methods were developed (including SLIMS protocols), habitat modelling using GIS was introduced, and the importance of local communities in snow leopard conservation became increasingly recognized (McCarthy et al. 2024). During this period, conservationists were realizing that protecting snow leopards wasn't just about data, but also about people co-existing with the species.



Figure 1. Photo by Prasenjeet Yadav



Figure 2. Global snow leopard meeting held in Seattle in 2002, convening researchers and practitioners, contributing to the Snow Leopard Survival Strategy and the formation of the Snow Leopard Network. (Photo thanks to the Snow Leopard Network.)

The early 2000s marked a shift toward coordination at a global scale and building a snow leopard community. The Snow Leopard Survival Strategy was published in 2003 (McCarthy & Chapron, 2003), alongside the establishment of the Snow Leopard Network, providing a shared platform for collaboration across countries and setting global priorities. It was at this time that technological advances reshaped the field. Camera trapping provided one of the first snow leopard population level assessments (using capture-recapture techniques) in 2006 (Jackson et al. 2006). This opened the door for much better understanding of the status of snow leopards at the population scale. Long-term study sites were established. Satellite GPS collars revealed new insights into movement, home-range size and dispersal, underlining how large areas snow leopard populations require (Johansson et al. 2016). By the 2010s, large-scale camera-trap surveys, genetic tools, and spatial capture-recapture models moved snow leopard research from inference to real understanding of population status (Sharma et al. 2014; Suryawanshi et al. 2021). More recently, initiatives such as PAWS (Population Assessment of the World's Snow Leopards) have enabled national and regional population assessments and strengthened the evidence base for global status evaluations (Sharma et al. 2024). This work continues as the snow leopard community works towards understanding trends and the species' level of vulnerability.

This Snow Leopard Reports Special Issue builds on that trajectory. It brings together twelve country updates.

This Snow Leopard Reports Special Issue builds on that trajectory. It brings together twelve country updates prepared alongside the ongoing snow leopard IUCN Red List and Green Status assessments. While the formal outcomes of those assessments will be published with the IUCN Cat Specialist Group in due course, these papers capture the work that underpins these global efforts.

This Special Issue came into being with a request from the IUCN Cat Specialist Group for an updated global status review, almost ten years after the previous IUCN Red List assessment (McCarthy et al. 2017). An open call for interest in participating or contributing was issued through the Snow Leopard Network in 2024. Lead authors were selected to coordinate each country contribution. In many cases, they worked closely with additional researchers, practitioners, and country government agencies to compile inputs and review evidence. In other countries, government structures took the lead in coordinating national efforts. Across contexts, the approach remained flexible, while strong coordination and country ownership were prioritised. This process has proved rewarding and offering special insights.

Some papers you will read synthesise existing literature and datasets into national overviews. Others present new analyses that add resolution to our understanding of snow leopard distribution, population status, and conservation priorities. A major breakthrough is the scientific community in China coming together to consolidate efforts across the country and provide a standardized national level population estimate that has not been available at this scale until now. Given that over 60% of snow leopard habitat lies within China, this contribution takes on a particular significance. These country level reports also draw upon the PAWS effort, with 6 countries having completed PAWS standardized assessments. All contributions build on earlier work, including the most recent global synthesis of snow leopard biology and conservation (McCarthy & Mallon, 2024), but with a more targeted focus. The result is a set of most recent profiles, developed collaboratively, that are comparable, transparent, and grounded in recent scientific findings.

Across the range, a clearer pattern is beginning to emerge: while knowledge is improving, it is also revealing a more uneven reality. While overall population estimates, particularly in China, represent a significant advance and suggest a broadly positive picture at national scale, in several parts of the range, particularly at the margins and in lower-elevation systems, there is now documented evidence of localised decline or loss, including sites in China reclassified from “possibly extant” to “possibly extinct” and confirmed range contractions in parts of Pakistan and Russia. At the same time, repeated survey efforts in countries such as Mongolia and Bhutan, and parts of Central Asia, are beginning to provide evidence of stable populations in well-protected or actively managed landscapes. However, these areas represent only a portion of the species’ range. In China, 19% of the ‘extant’ snow leopard range falls within protected areas, while in Mongolia 28.1% of predicted distribution is included within the State Protected Areas network (as reported in this volume), with the majority of the species’ distribution occurring outside formal protection in multi-use landscapes. Areas of uncertainty are also being more clearly delineated through improved survey coverage and application of standardized population assessment approaches. Together, this indicates that snow leopard persistence is increasingly associated with connected, well-managed landscapes, while more isolated populations face greater risk.

In several parts of the range, particularly at the margins and in lower-elevation systems, there is now documented evidence of localised decline or loss.

Snow leopard conservation today is complex. It extends well beyond ecology alone. It spans governance, infrastructure development, climate change, community livelihoods, and policy. Addressing these challenges requires cooperation across disciplines and institutions, across national frontiers and sustained engagement by governments, NGOs, researchers, and local communities working together. By 2026, the Snow Leopard Network has grown to more than 768 individual members, reflecting both the scale of the challenges ahead and the strength of the community



Figure 3. Snow leopard researchers and practitioners gathered in September 2025 in Hustai National Park, Mongolia to discuss the draft country chapters and synthesize evidence on snow leopard status, threats, and conservation priorities across range countries.

responding to them. Differences in perspective are inevitable in a field this diverse, but what matters is the willingness to come together, share evidence, and move forward collectively.

These country updates reflect that spirit. Led by in-country scientists, supported by diverse teams, and informed by a workshop in Mongolia (Figure 3), they bring together many voices and a shared effort. To me, they reflect the kind of collective commitment needed to secure the future of snow leopards across their range. Looking ahead, they also highlight the value of strengthening conservation efforts across borders and bringing organisations together around shared priorities and sustained investment.

This Special Issue took more than a year to prepare and would not have been possible without the many authors, reviewers, government representatives, practitioners, and researchers who contributed their time and expertise. Thank you to everyone who made it possible.

I hope you enjoy reading the Special Issue chapters as much as I did.

Justine Shanti Alexander, PhD
SLN Steering Committee Member
WCS Mongolia

References

- Ahlbom, G. and Jackson, R.M. (1988) Marking in free-ranging snow leopards in west Nepal: a preliminary assessment. In: Proceedings of the Fifth International Snow Leopard Symposium.
- Hemmer, H. (1972) *Uncia uncia*. Mammalian Species, 20, pp. 1–5.
- Jackson, R.M. and Ahlborn, G. (1989) Home range and movements of snow leopards (*Panthera uncia*) in Nepal. National Geographic Research, 5(2), pp. 161–175.
- Jackson, R.M. (1996) *Home range, movements and habitat use of snow leopard (Uncia uncia) in Nepal*. Unpublished report / dissertation.
- Jackson, R.M., Roe, J.D., Wangchuk, R. and Hunter, D.O. (2006) Estimating snow leopard population abundance using photography and capture–recapture techniques. Wildlife Society Bulletin, 34(3), pp. 772–781.
- McCarthy, T. and Mallon, D. (eds.) (2024) *Snow Leopards*. 2nd edn. Biodiversity of the World: Conservation from Genes to Landscapes. London: Academic Press (Elsevier).
- McCarthy, T.M. and Chapron, G. (2003) *Snow Leopard Survival Strategy*. Seattle, USA: International Snow Leopard Trust and Snow Leopard Network.
- McCarthy, T.M., Mallon, D.P. and Zahler, P. (2024) What is a snow leopard? Biogeography and status overview. In: Mallon, D. and McCarthy, T. (eds.) *Snow Leopards*. 2nd edn. Biodiversity of the World: Conservation from Genes to Landscapes. London: Academic Press, pp. 31–41. <https://doi.org/10.1016/B978-0-323-85775-8.00056-X>
- McCarthy, T.M., Mallon, D.P., Jackson, R., Zahler, P. and McCarthy, K.P. (2017) *Panthera uncia*. The IUCN Red List of Threatened Species 2017: e.T22732A50664030. Available at: <https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T22732A50664030.en> (Accessed: 13 January 2026).
- Sharma, K., Bayrakschmith, R., Tumursukh, L., Johansson, O., Sevger, P., McCarthy, T. and Mishra, C. (2014) Vigorous dynamics underlie a stable population of the endangered snow leopard *Panthera uncia* in Tost Mountains, South Gobi, Mongolia. PLOS ONE, 9(7), e101319.
- Sharma, K., Alexander, J.S., Durbach, I., Kodi, A.R., Mishra, C., Nichols, J., MacKenzie, D., Ale, S., Lovari, S., Modaqiq, A.W. and Zhi, L. (2024) PAWS: Population Assessment of the World's snow leopards. In: Mallon, D. and McCarthy, T. (eds.) *Snow Leopards*. 2nd edn. London: Academic Press, pp. 437–447.
- Suryawanshi, K.R., Reddy, A.R., Sharma, M., Khanyari, M., Bijoor, A., Rathore, D., Jaggi, H., Khara, A., Malgaonkar, A., Ghoshal, A. and Patel, J. (2021) Estimating snow leopard and prey populations at large spatial scales. Ecological Solutions and Evidence, 2(4), e12115.



Photo by Prasenjeet Yadav



Snow Leopard (*Panthera uncia*) Status in Afghanistan

CONTRIBUTORS:

Zalmai Moheb^{1*} & Peter Zahler²

KEYWORDS:

snow leopard; *Panthera uncia*; Afghanistan;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Moheb & Zahler.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

¹ University of Massachusetts Amherst

² Zoo New England

* Email: mohebzalmai@yahoo.com

1. Distribution

Several approaches have been used in the last few decades to draw both contemporary and historical ranges for snow leopard (*Panthera uncia*) in Afghanistan (Habibi 2003, Hunter & Jackson 1997, McCarthy & Chapron 2003, Moheb et al. 2024). Building on the previous distribution range, the Wildlife Conservation Society (WCS) conducted comprehensive habitat modelling in 2008 by combining previous survey records and priority zone analysis to produce a tentative distribution map for the snow leopard range in Afghanistan (Kanderian et al. 2009, Moheb & Paley 2016). As part of the effort to craft the snow leopard country chapter for Afghanistan for the 2nd edition of the book *Snow Leopards* (Mallon & McCarthy 2024), Moheb et al. (2024) further enhanced the species distribution map with recent survey data and other field records. The map produced by Moheb et al. (2024) depicts the distribution range in three categories: areas where the presence of the species has been confirmed through direct or indirect observations (camera trap data and other confirmed records); areas where presence of the species is likely as reported during interviews with local communities; and habitat suitable for snow leopards but where the recent presence of the species has yet to be confirmed.

Camera trapping and other field surveys have recorded evidence of snow leopards in Wakhan, Zebak and Ishkashim districts of Badakhshan (Moheb et al. 2024). Whereas other direct records of the species come from predation incidents reported by media, e.g., two snow leopard livestock predation (and subsequent capture) incidents were reported from Maymai District of Darwaz in northern Badakhshan

in 2019 and 2020 (Moheb et al. 2023, Moheb et al. 2024). Moreover, a snow leopard captured and GPS-collared in Pakistan crossed the border into Afghanistan and confirmed the presence of the species in eastern Nuristan (Chadwick 2008). Questionnaire surveys reported the presence of snow leopard in the eastern heights of Paryan District in Panjshir that borders Nuristan and Badakhshan and is within suitable habitat.

To date the potential geographical spread of the snow leopard range covers 10 provinces in north and north-eastern Afghanistan. These include parts of Badakhshan, Baghlan, Kapisa, Kunar, Laghman, Nangarhar, Nuristan, Panjshir, Parwan, and Takhar with the current confirmed presence areas being only in Badakhshan and Nuristan provinces. However, due to several decades of unrest in Afghanistan, most suitable snow leopard habitat is unexplored; therefore, part of the distribution range where snow leopard is confirmed is likely to increase in the future. As an example, a snow leopard livestock predation incident was reported for the first time from Keran-wa Munjan District of Badakhshan in 2023 (Moheb et al. 2023), after the snow leopard chapter for Afghanistan was published (Mallon & McCarthy 2024).

Taking all previous and current records into consideration, we revised the map published by the snow leopard chapter for Afghanistan (Moheb et al. 2024) and here we present an updated distribution map for snow leopards in Afghanistan (Fig. 1). The map presented here (Fig. 1) is slightly different from the map found in Moheb et al. (2024). Based on the mapping criteria required by the IUCN Red List, we divided the snow leopard previously known areas (Moheb et al. 2024) and recently confirmed places in two categories of “Extant” (~19,850 km²) and “Possibly Extant” (~32,505 km²) areas. “Extant” areas include all the areas with confirmed presence, and “Possibly Extant” include the areas where presence of the species has either been reported by local communities or the areas have been classified as likely habitat for the species based on a distributional gap analysis and habitat modelling conducted by WCS in 2009 (Kanderian et al. 2009).

Except for areas determined by the habitat modelling, the other records have been roughly georeferenced using district boundaries (the smallest administrative unit in the country) where the species has been directly recorded or reported by local communities during interviews and field surveys. Although using the district boundaries is not ideal

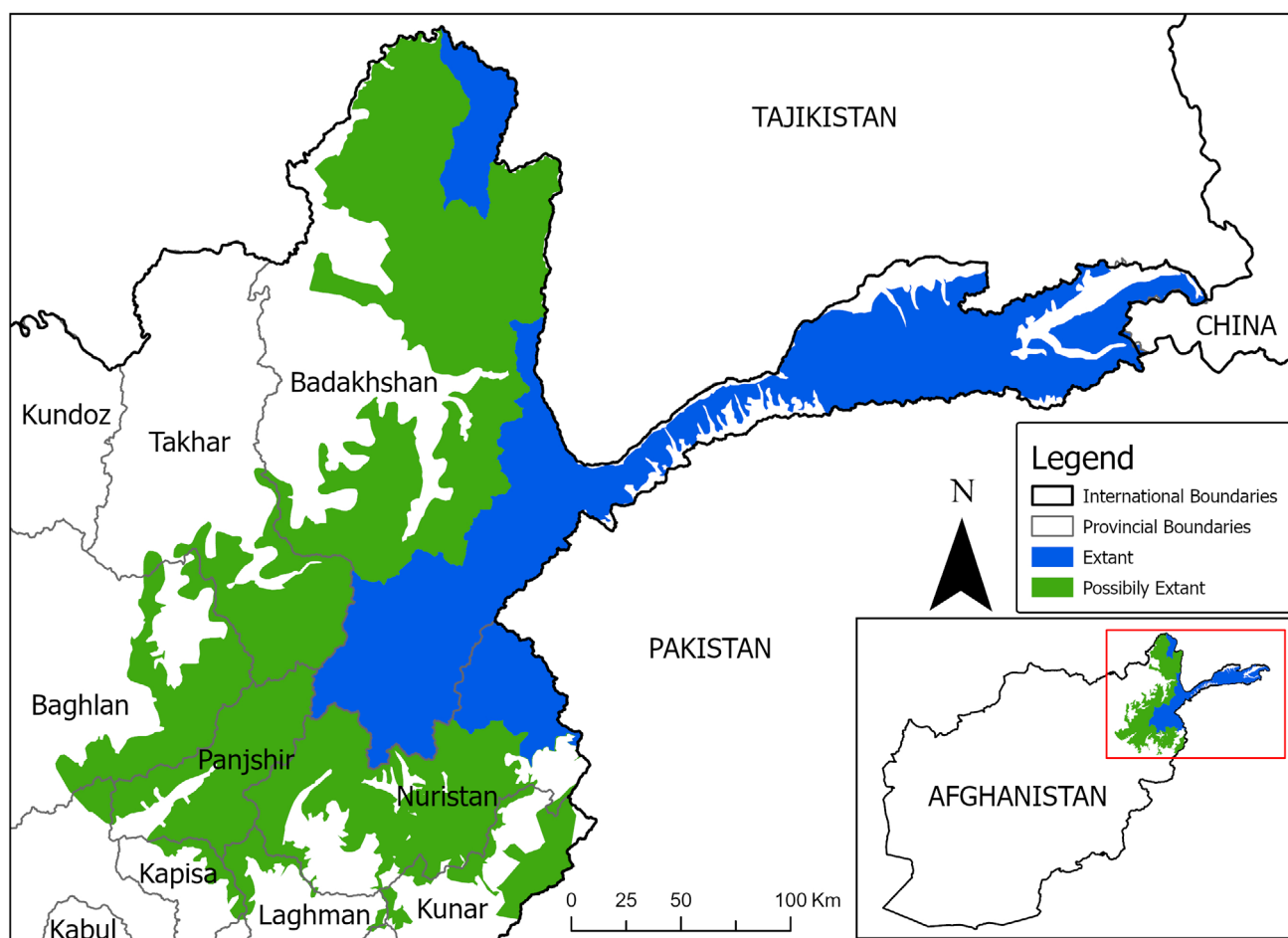


Figure 1. Proposed map for snow leopard distribution in Afghanistan: the updated version of the map produced for the snow leopard chapter for Afghanistan by Moheb et al. (2024).

and precise, we found no other alternative to classify the area as the species range. In addition, given that a snow leopard has traveled up to 45 km in a straight line in Afghanistan based on telemetry data (S. Ostrowski pers. comm., 2025) and the largely contiguous mountain topography of the area in northeastern Afghanistan, it is likely that the snow leopard uses most of the areas in the district where it has been recorded or reported.

2. Population

Although the snow leopard is a relatively widely studied animal in Afghanistan, there has been no comprehensive snow leopard population assessment at the national level. Nevertheless, based on camera trap studies of snow leopards in low, medium and high-density habitats in Wakhan National Park, WCS estimated a crude density of the species for different types of habitats in Afghanistan (Ostrowski & Moheb 2021). Following the steps articulated by Ostrowski & Moheb (2021), we extrapolated the population estimates to the areas recently added to the species confirmed range and came up with a rough population estimate of 213–253 adult snow leopards in Afghanistan.

Since there has been no systematic and inclusive population survey throughout the species range in the country, there are no data on sub-populations nor any information on population trends in Afghanistan. However, questionnaire surveys carried out in Nuristan (Karlstetter 2008), northern Badakhshan (Moheb & Mostafawi 2012, 2013), and Panjshir (Moheb et al. 2024) suggested an overall likely decline in snow leopard populations in those three areas. Nevertheless, the nearly two decades of conservation programs and community engagements have likely had a positive impact in raising public awareness and positive attitudes towards snow leopard in general across Wakhan National Park (Zahler & Paley 2024). Long-term camera trap research by WCS suggests that the Hindu Kush range in the western part of the national park contains the largest population of snow leopard in Afghanistan. In line with this, Wakhan National Park has been listed as one of the 24 globally important snow leopard landscapes throughout the species global range (GSLEP 2013, Sharma et al. 2024).

3. Threats

Threats to the snow leopard population are numerous in Afghanistan, although the lack of research makes it difficult to assess their impacts. Among the major threats are the likely decline in its prey population (ibex *Capra sibirica*, markhor *Capra falconeri*, argali *Ovis ammon polii*, and urial *Ovis vignei*); retaliatory killings over livestock predation

(exacerbated by negative attitudes of local communities towards large carnivores in general, including the snow leopard); wildlife trade and pelt markets; building roads and new infrastructure in snow leopard habitat; and direct and indirect impacts (e.g., poaching) from mining in mountainous habitats where snow leopards are likely to occur.

Although a comprehensive assessment of mountain ungulate populations is missing for Afghanistan, surveys and reconnaissance visits of WCS teams have reported a decline in mountain ungulate populations in several parts of the snow leopard range in Afghanistan (Moheb & Mostafawi 2012, 2013; Moheb et al. 2022). These declines are attributed to illegal hunting for food, competition and disturbance from excessive number of livestock, and habitat degradation due to agricultural and other human activities. A number of poaching incidents from Wakhan National Park were noted during the visits of governmental authorities from Afghanistan's National Environmental Protection Agency (NEPA) and WCS (S. Shirzad pers. comm., 2024).

Despite close attention by the NEPA authorities, local communities express concerns about poaching in Wakhan. The number of urial and ibex showed a significant decline in 2024 compared to the previous monitoring in 2018 (Moheb et al. 2022). Urial and ibex numbers showed over 75% and 60% decline in 2024 compared to what had been counted in 2018 with nearly identical methodologies. This decrease in number of both urial and ibex support the anecdotal reports of high hunting pressure on these mountain ungulates from the armed people in the area. Higher decline in the number of urial that utilize lower and more accessible areas is a substantial indication of heavy hunting pressure in the area. However, ibex, which stay higher up close to cliffs and are relatively less accessible to poachers, showed a slightly lower decline compared to urial.

Apart from some camera trap and telemetry studies carried out by WCS (Simms et al. 2011, Rahmani 2022), most of the snow leopard records from different parts of Afghanistan come from reports of livestock predation and retaliation by local communities (Rajabi 2022, Moheb et al. 2023). Mishra & Fitzherbert (2004) reported 10 cases of snow leopard deaths in Wakhan for the period 1989–2002. In line with that and based on community interviews, Moheb (2020) reported seven cases of snow leopard retaliatory killings for the period of 2008–2018 in Wakhan National Park.

Snow leopard pelts have historically been valuable in the wildlife trade market in Afghanistan. Rodenburg (1977) estimated that 50–80 skins were sold in Afghan markets per

year in the mid-1970s. However, hunting of snow leopard only for its pelt has rarely been reported in recent years. Fur market surveys reported the presence of snow leopard pelts in Kabul and some other cities in 2014, though the origin of the pelts was uncertain (Maheshwari et al. 2016). Prior to mid 2021 there was a large international presence in the country, both from various military units and numerous development agencies, and thus a clear market for fur items. However, no data exist for how often pelts were sold, and during that period many of the furs sold in these shops were said to be imported from other countries (e.g., Russia, Central Asian states), such as full mink and sable coats, so it is certainly possible that some snow leopard pelts were brought in from other countries as well. An illegal wildlife trade survey conducted before the political change in 2021 in different regions of Afghanistan did not find any snow leopard pelts in the fur markets in Afghanistan (M. Bashari pers. comm., 2025).

As part of the land transit expansion in the region, a road construction project has been initiated to connect Afghanistan with China. This road, still under construction, goes through the high altitudes of Wakhan National Park along the Silk Road (Smallwood & Shank 2019) that had previously been far removed from human development. Wakhan National Park, globally considered as an important snow leopard landscape, seems to be the main stronghold of the snow leopard in Afghanistan, yet this road initiative has so far overlooked many of the likely socio-ecological impacts in favour of immediate economic development. This road, connecting Afghanistan with China in the Pamir Knot where the magnificent Asian mountain ranges meet, also exposes the region's natural resources for exploitation that were distanced from economic access for centuries. This road, once completed, will cause landscape fragmentation for the snow leopard and its wild prey in the park and will enable fast access for poachers and wildlife traders.

Other threats to the snow leopard in Afghanistan include mining for minerals in mountainous habitats where snow leopards are likely to occur. While the mining activities may not cause much of a direct disturbance to the snow leopard itself, it can disturb wild prey species occurring in the area. Miners who are busy in heavy duty jobs, very far away from law enforcement personnel, not only disturb wild species with explosives and other mine extraction tools, but they usually have guns and can easily hunt wild species as a good nutritional supply while conducting tedious mining activities.

A lack of clarity about the validity of laws and policies enforced by the previous government to protect the snow leopard when encountered by a human or captured while

attacking livestock poses a huge threat to the species. With the political change in Afghanistan in mid 2021, although there is a general positive intention to protect wild species including the snow leopard, wild species suffer from uneven enforcements of policies and different personal attitudes in different parts of their range. For example, district authorities and NEPA officials in Kabul acted very quickly to rescue a snow leopard that attacked livestock five times within a short period and was trapped on several occasions in 2023 in Wakhan (Moheb et al. 2023); however, not very far from the area, another snow leopard was captured from a corral in Zebak on February 1, 2024, and kept in custody at the provincial governor's office in Faizabad, the capital city of Badakhshan for >21 months before it was transferred to Kabul Zoo, thanks to the tireless efforts by the Kabul Zoo authorities (Fig. 2). Capturing and relocation of depredating snow leopards is becoming a more serious threat to the species in recent years. The news about predator capture and relocation spreads rapidly through social media and people consider this action as a "more acceptable and less illegal" solution than killing problem snow leopards.



Figure 2: The captured female snow leopard was brought to Kabul Zoo in November 2025 after spending nearly two years in custody in Faizabad, the provincial capital of Badakhshan.
Photo courtesy of A.G. Saqib@Kabul Zoo.

The snow leopard and its wild prey suffer from the effects of climate warming across most of their range. A climate change vulnerability assessment conducted by WCS in northeastern Afghanistan revealed that several wild species including the snow leopard and its wild prey (e.g., argali) will face severe habitat loss under high-emissions scenarios (RCP8.5) (Elsen et al. 2023). Using species distribution models, WCS found that by 2100, suitable habitats for snow leopard could shrink by as much as 82% due to rising temperature and ecosystem changes, while low-emissions (RCP2.6) scenarios suggest a relatively stable situation.

The species core habitats in Wakhan and some other parts of northern Badakhshan may persist; however, according to the model, no new high-suitable areas are expected to emerge. This situation highlights the urgent need for climate resilient conservation policies and actions.

4. Conservation

Declaration of Wakhan District (10,950 km²) as a national park in March 2014 was the second largest step taken to conserve snow leopards in Afghanistan, the first being the placement of the species on the Protected Species List of Afghanistan in 2008 (NBSAP 2024). In June 2020, the government of Afghanistan declared Nuristan Province (9,266 km²), where snow leopard presence has been confirmed in the eastern districts of Barg-e Matal and Kamdesh, a protected area. Current efforts carried out by FAO and WCS to confirm the designation of the park and develop its future management are supported by the new administration. Areas with favourable habitats for snow leopards in Panjshir were surveyed before the collapse of the previous government, with the aim to declare new protected areas; however, with the political change in 2021, tensions increased in Panjshir that halted these conservation efforts.

Snow leopards mostly suffer retaliation against livestock depredation and recent trends show that most livestock predation happens during the winter or early spring seasons when some other natural disasters occur as well. There is a government budget allocation to compensate losses due to natural disasters in Afghanistan, which does not cover loss of assets due to snow leopard mass predation (the killing of multiple livestock in a single predation event, as sometimes happens in corrals). It is recommended that snow leopard mass predation also be considered as a natural disaster and thus compensation to be paid to the impacted shepherds to avoid retaliation against the predator.

Wildlife pelt markets can encourage poachers to hunt wildlife for their pelts (although the market for expensive pelts has likely declined with the departure of most international military and development personnel). Strict monitoring and enforcement in wildlife markets is essential to stop wildlife poaching for trade. Afghanistan's National Environmental Protection Agency (NEPA) needs to have close monitoring and enforcement of the fur market in Kabul and other big cities throughout the country.

Infrastructure development within the protected areas is inevitable as the potential long-term economic benefits overshadow the ecological benefits and ecosystem services; however, a strong environmental review should also be

carried out parallel to every infrastructural project at every level. The road cutting through Wakhan National Park is deemed as a very big, nation-wide project that will not only shorten the road access to/from China markets by months but also change the goods transit formula in the region. This leaves no space for conservationists to be able to resist this massive road project cutting through WNP, Afghanistan's main stronghold of wild species and wild places, but there is the possibility to advocate for a strong Environmental Impact Assessment (EIA) of the project site by a reputable environmental conservation professional company. The project EIA should really consider all the ecological needs of the wild species in the area and make sure to build infrastructure to ensure ecological connectivity, animal movements, wildlife management, and prevent overexploitation.

Similar to infrastructure development within and around the protected areas, there can be huge negative impacts from mining, and especially from the miners themselves, on ecosystems if not conducted properly. There should be rules and policies in place for mining within the protected areas so that it minimizes the negative impacts as much as possible.

5. Acknowledgements

We want to thank Stephane Ostrowski and Sorosh Poya Faryabi for their suggestions and inputs into this document, and we thank Justine Alexander for her support and guidance during the development of this assessment. We also thank Aziz Gul Saqib, Director of the Kabul Zoo for sharing the photo of the relocated snow leopard to the Zoo. Finally, we want to acknowledge Todd Fuller for his continued support to the authors during both good and bad times as we pursued conservation in Afghanistan.

The publication further acknowledges the IUCN SSC Cat Specialist Group for supporting the development of this country status series, as well as the wider Snow Leopard IUCN Red List assessment team for their guidance and collaboration during the snow leopard assessment process.

6. Conflict of Interest

The authors declare no known conflicts of interest.

7. References

- Chadwick, D. (2008). Out of the shadows: the elusive Central Asian snow leopard steps into a risk-filled future. *National Geographic*, 213, pp. 106–129.
- Elsen, P.R., Faryabi, S.P., Surya, G. and Grantham, H.S. (2023). *Climate change vulnerability assessment for the Panj–Amu River Basin, Afghanistan*. Wildlife Conservation Society.
- Global Snow Leopard and Ecosystem Protection Program (GSLEP) (2013). *Global Snow Leopard and Ecosystem Protection Program*. Bishkek, Kyrgyz Republic: Snow Leopard Working Secretariat.
- Habibi, K. (2003). *Mammals of Afghanistan*. Coimbatore, India: Zoo Outreach Organization.
- Hunter, D.O. and Jackson, R. (1997). A range-wide model of potential snow leopard habitat. In: Jackson, R. and Ahmad, A. (eds.) *Proceedings of the 8th International Snow Leopard Symposium*, Islamabad, November 1995. Lahore and Seattle: International Snow Leopard Trust and WWF–Pakistan, pp. 51–56.
- Karlstetter, M. (2008). *Wildlife surveys and wildlife conservation in Nuristan, Afghanistan, including scat and small rodent collection from other sites*. Unpublished report. Kabul: Wildlife Conservation Society.
- Kanderian, N., Johnson, M., Shank, C., Rahmani, H. and Sanger, R. (2009). *The fauna approach to identifying Afghanistan's biodiversity priority zones*. Programme of Work for Protected Areas (PoWPA) Technical Report. Kabul: National Environmental Protection Agency and Wildlife Conservation Society.
- Maheshwari, A., Niraj, S.K., Sathyakumar, S., Thakur, M. and Sharma, L. (2016). Snow leopard illegal trade in Afghanistan: a rapid survey. *CAT News*, 64, pp. 57–58.
- McCarthy, T.M. and Chapron, G. (eds.) (2003). *Snow leopard survival strategy*. Seattle, USA: International Snow Leopard Trust and Snow Leopard Network.
- Mallon, D. and McCarthy, T.M. (eds.) (2024). *Snow leopards: biodiversity of the world – conservation from genes to landscapes*. 2nd edn. Academic Press.
- Mishra, C. and Fitzherbert, A. (2004). War and wildlife: a post-conflict assessment of Afghanistan's Wakhan Corridor. *Oryx*, 38, pp. 102–105.
- Moheb, Z., Faryabi, S.P. and Paley, R. (2024). Snow leopard status and conservation in Afghanistan. In: Mallon, D. and McCarthy, T. (eds.) *Snow leopards: biodiversity of the world – conservation from genes to landscapes*. 2nd edn. Elsevier, pp. 451–460. <https://doi.org/10.1016/B978-0-323-85775-8.00040-6>
- Moheb, Z., Sahel, K., Fazli, M., Hakimi, M. and Ismaili, S. (2023). Snow leopard intrusions into livestock corrals in Badakhshan, Afghanistan. *Snow Leopard Reports*, 2, pp. 1–5. <https://doi.org/10.56510/slr.v2.12799>
- Moheb, Z., Rajabi, A.M., Jahed, N., Ostrowski, S., Zahler, P. and Fuller, T.K. (2022). Using double-observer survey methods to monitor spring urial and ibex populations in the Hindu Kush of Wakhan National Park, Afghanistan. *Oryx*, pp. 1–7. <https://doi.org/10.1017/S0030605322000412>
- Moheb, Z. (2020). *Livestock predation and snow leopard–human conflict in the Wakhan Valley of Wakhan National Park, northeastern Afghanistan*. PhD thesis, University of Massachusetts Amherst, USA.
- Moheb, Z. and Paley, R. (2016). Snow leopard status and conservation regional reviews and updates: Central Asia, Afghanistan. In: McCarthy, T. and Mallon, D. (eds.) *Snow leopards: biodiversity of the world – conservation from genes to landscapes*. Elsevier, pp. 409–417.
- Moheb, Z. and Mostafawi, S.N. (2013). *Biodiversity reconnaissance survey in Maymai District, Darwaz Region, Badakhshan Province, Afghanistan*. Unpublished report. New York: Wildlife Conservation Society.
- Moheb, Z. and Mostafawi, S.N. (2012). *Biodiversity reconnaissance survey in Darwaz Region, Badakhshan Province, Afghanistan*. Unpublished report. New York: Wildlife Conservation Society.
- National Environmental Protection Agency (NEPA) (2024). *National Biodiversity Strategy and Action Plan For Afghanistan (2024–2030)*. Kabul, Afghanistan.
- Ostrowski, S. and Moheb, Z. (2021). *A population estimate for snow leopards (Panthera uncia) in Afghanistan*. Unpublished report. New York: Wildlife Conservation Society.
- Rahmani, H. (2022). *Modelling snow leopard distribution, space use, movement patterns, resource selection and quantifying land-use/land-cover change in Wakhan National Park*. PhD thesis, University of Florida, USA.
- Rajabi, A.M. (2022). *A case of snow leopard predation on livestock in Asik Valley, Zebak District, Badakhshan Province, Afghanistan (31 December 2021)*. Unpublished report. Kabul: Wildlife Conservation Society.
- Rodenburg, W.F. (1977). *The trade in wild animal furs in Afghanistan*. Rome: FAO.
- Sharma, K., Alexander, J.S., Zakharenka, A., Kochorov, C., Rutherford, B., Varma, K. et al. (2024). The Global Snow Leopard and Ecosystem Protection Program. In: Mallon, D. and McCarthy, T. (eds.) *Snow leopards: biodiversity of the world – conservation from genes to landscapes*. 2nd edn. Elsevier, pp. 633–646. <https://doi.org/10.1016/B978-0-323-85775-8.00009-1>
- Simms, A., Moheb, Z., Ismaili, S., Ali, H., Ali, I. and Wood, T. (2011). Saving threatened species in Afghanistan: snow leopards in the Wakhan Corridor. *International Journal of Environmental Studies*, 68, pp. 299–312.
- Smallwood, P.D. and Shank, C.C. (2019). From buffer zone to national park: Afghanistan's Wakhan National Park. In: Lookingbill, T. and Smallwood, P. (eds.) *Collateral values: natural capital created by landscapes of war*. Landscape Series, vol. 25. Cham: Springer, pp. 213–234.
- Zahler, P. and Paley, R. (2024). Building governance structures and institutions for community conservation. In: Mallon, D. and McCarthy, T. (eds.) *Snow leopards: biodiversity of the world – conservation from genes to landscapes*. 2nd edn. Elsevier.



Snow Leopard (*Panthera uncia*) Status in Bhutan

CONTRIBUTORS:

Tashi Dhendup^{1,2*}

KEYWORDS:

snow leopard; *Panthera uncia*; Bhutan;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Dhendup et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

1 Department of Forests and Park Services, Ministry of Energy and Natural Resources, Royal Government of Bhutan, Thimphu 11011, Bhutan

2 Centre for Biodiversity and Conservation Science, School of the Environment, The University of Queensland, QLD, 4072, Australia

* Email: Tashidhend@gmail.com

1. Distribution

Snow leopards (*Panthera uncia*) are widely distributed across the high-altitude regions of northern Bhutan, with populations documented both within and outside protected areas. Among protected areas, they inhabit Jigme Khesar Strict Nature Reserve (JKSNR), Jigme Dorji National Park (JDNP), Wangchuck Centennial National Park (WCNP), and Bumdeling Wildlife Sanctuary (BWS). Outside these areas, they have been observed in the forest divisions of Paro and Thimphu. Snow leopards were also detected in Jigme Singye Wangchuck National Park in central Bhutan in 2018 (Letro et al., 2021) and in the Gedu Territorial Forest Division in 2021 (Dorji et al., 2024); however, their current presence in these areas has not been confirmed recently. Generally, snow leopards in Bhutan occur at elevations between 3500 and 5500 metres, with their suitable habitat estimated at 7,206 km² (Lham et al., 2021).

The snow leopard distribution map shown below (Figure 1) was developed based on recent occurrence data and habitat suitability criteria. Confirmed occurrence records were obtained from systematic nationwide camera trap surveys conducted in 2015-2016 and 2022-23, as well as scat surveys in 2023, which were verified through genetics (DoFPS 2016; NCD, 2023). Each confirmed detection point was buffered with an 8 km radius, corresponding to approximately twice the estimated movement parameter ($\sigma \approx 4.2$ km) from spatial capture-recapture models (NCD, 2023). The Extant range was defined as the intersection of these buffered areas with suitable elevation zones (3,500–5,500 m) derived from a national Digital Elevation Model (DEM). Possibly Extant areas were delineated as

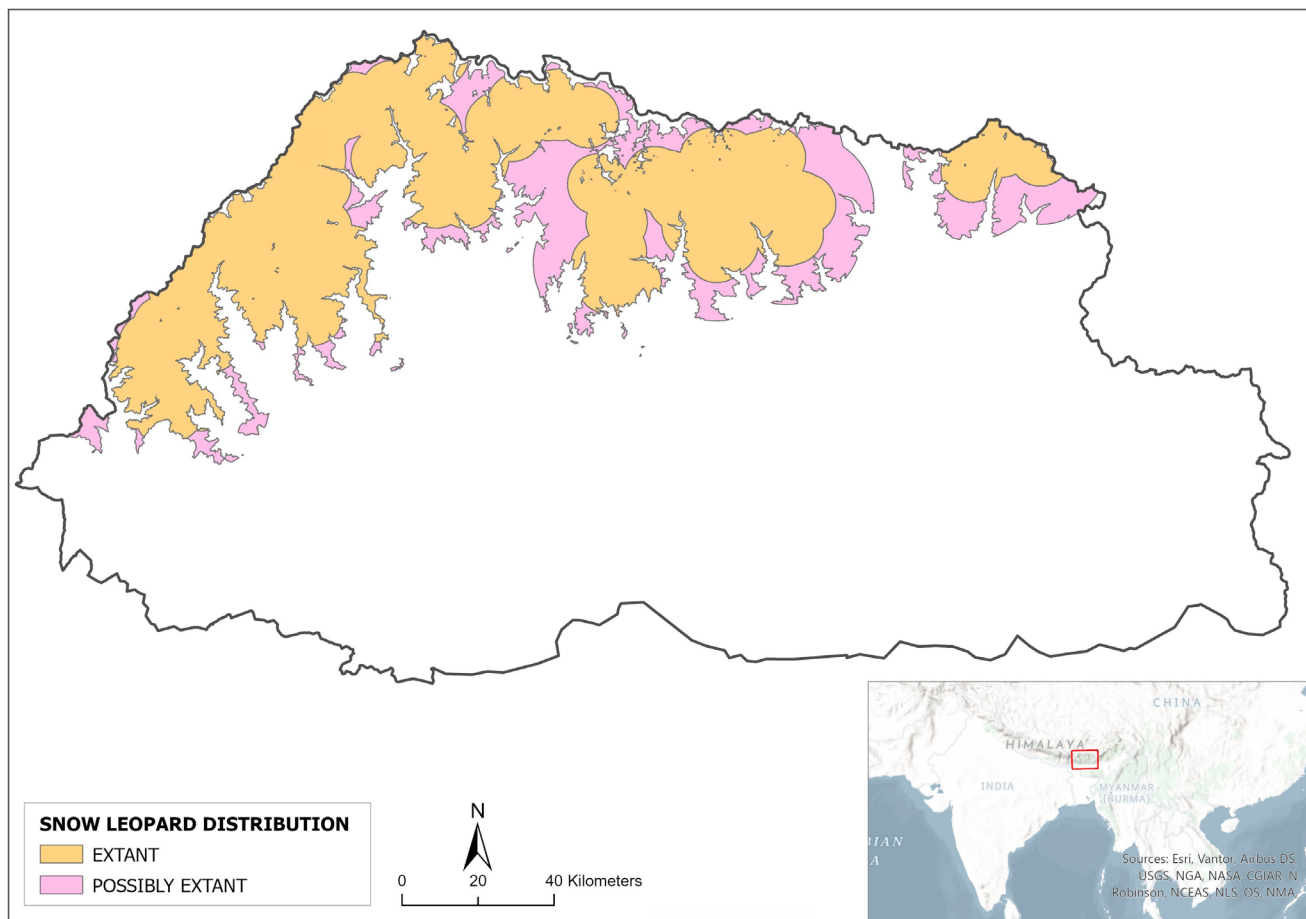


Figure 1. Snow leopard distribution in Bhutan, showing areas classified as Extant and Possibly Extant based on recent confirmed occurrence data, habitat suitability, and spatial modelling following IUCN Red List mapping standards.

contiguous suitable elevation areas within a 10 km margin of known occurrences, excluding the Extant polygons. All spatial analyses were conducted in R (packages: *sf*, *terra*), and final polygons were assigned attributes following IUCN Red List mapping standards (fields: PRESENCE, ORIGIN, SEASONALITY). The estimated Extant range covers approximately 6,971.358 km², and the Possibly Extant range covers an additional 2,317.714 km², with a total snow leopard distribution within Bhutan estimated at 9,288.071 km².

2. Population

Bhutan's current snow leopard population is estimated at 134 adult individuals (95% CI 121–148), with a density of 1.34 adult individuals (95% CI 1.20–1.48) per 100 km² (NCD, 2023). The population assessment used camera traps, and the design and data analysis followed the best practices and the Global Snow Leopard Ecosystem Protection Program (GSLEP) protocol in accordance with the Population Assessment of the World's Snow leopards (PAWS). From the camera trap images, 96 adult individuals were identified (45 males and 51 females) along with 10 cubs across the landscape.

Notably, the 2023 estimate of 134 individuals marks a 39% increase from the 96 (95% CI 79–112) individuals estimated in 2014–15 (DoFPS, 2016). However, this comparison must take into account the differing survey methodologies employed in the two surveys. The 2023 survey covered a considerably smaller area (1,240 km² compared to 3,232 km²). It also used a smaller grid size (2 km x 2 km versus 4 km x 4 km) and employed a higher density of camera stations (310 stations versus 202 stations) to improve the chances of recaptures. Nonetheless, the density estimation method remained consistent across both surveys.

Within Bhutan, Jigme Dorji National Park (4,316 km²) remains a key stronghold for the country's snow leopard population, with an estimated density of 6.2 individuals per 100 km² (SE $\pm$ 1.8, 95% CI = 3.5–11) recorded in the park's western region (Thinley et al., 2014). In contrast, Wangchuck Centennial National Park (4919 km²), the largest protected area in Bhutan, recorded a density of 2.39 individuals per 100 km² (CI = 2.67– 2.97) in the central region and 3.36 individuals per 100 km² (CI = 1.14 – 8.91) in the western region (WCNP & WWF, 2016). The two parks together comprise nearly 70% of Bhutan's snow leopard population.

3. Threats

Snow leopards face threats from habitat degradation and fragmentation caused by climate change, localised grazing pressure, and the collection of cordyceps and non-timber forest products by local communities (NCD, 2024). Snow leopards often come into conflict with humans due to livestock depredation, which increases the risk of retaliatory killings. Feral dogs are also present in

snow leopard habitats and are known to attack wildlife, potentially harming snow leopards and killing their prey, such as the blue sheep (*Pseudois nayaur*) and the takin (*Budorcas taxicolor*). Illegal hunting and trade are recorded to be minimal. Refer to Table 1 for a ranked assessment of direct threats to snow leopards in Bhutan, based on their scope, severity, and irreversibility, as identified during the national action planning process (NCD, 2024).

Table 1 Threat ranking for snow leopards based on Miradi¹ principles conducted for developing an action plan for snow leopards in Bhutan (NCD, 2024)

Sl. No.	Direct threats	Scope ²	Severity ³	Irreversibility ⁴	Total	Overall Threat Rating	Explanations
1	Illegal hunting	1	1	1	5	Low	Although almost negligible, illegal hunting remains a threat, mainly due to the porous border to the north (China).
2	Retaliatory killing	1	1	2	6	Medium	Due to livestock depredation, people might retaliate by snaring or poisoning animals, resulting in direct deaths.
3	Livestock depredation	3	3	2	14	High	Human-wildlife conflict can heighten the risk of persecution. This often fosters negative attitudes toward snow leopards and conservation efforts in general.
4	Prey depletion	1	1	1	5	Low	Declining prey populations, due to factors such as poaching, disease, and habitat degradation, can have demographic consequences for snow leopards and also escalate human-wildlife conflicts.
5	Diseases	1	2	3	9	Medium	Disease transmission from livestock to snow leopards and their wild prey
6	Habitat degradation and fragmentation	3	2	2	12	High	Invasive plant species can outcompete native alpine grasses and shrubs, deteriorating range-lands, causing prey populations to decline and increasing livestock grazing pressure, thereby creating competition.
7	Collection of cordyceps and NWFP	3	2	3	13	High	Excessive collection of cordyceps and non-wood forest products can disturb and degrade the environment. It also increases human presence in high-altitude areas, thereby disturbing the local animals.
8	Climate change	3	2	3	13	High	Upward shift of the tree line and loss of alpine meadows, which are essential habitats for wild prey
9	Localised grazing pressure	1	2	2	8	Medium	Overgrazing by livestock and competition with wild prey for forage.
10	Solid waste	1	1	1	5	Low	Waste from trekkers is often discarded improperly.
11	Feral dogs	2	2	1	9	Medium	Feral dogs have been observed attacking wild animals.
12	Interspecific competitions	1	1	1	5	Low	Competition with sympatric carnivores: Snow leopards spatially overlap with tigers and common leopards in several areas of Bhutan, indicating potential interspecific competition.
	Overall Threat Ranking				9	Medium	

¹ A national consultation meeting consisting of experts and foresters from the Department of Forests and Park Services scored each threat on scope, severity and irreversibility.

² spatial extent of the threat's impact

³ level of damage caused by the threat within its scope

⁴ degree to which the damage caused by the threat can be reversed

4. Conservation

Current actions in place

Legal Protection: The snow leopard is a fully protected species under the Forest and Nature Conservation Act of Bhutan 2023. Killing and engaging in the illegal trade of snow leopard parts and derivatives constitutes a third-degree felony, punishable by imprisonment and fines (RGoB, 2023).

Rigorous Monitoring: Rangers within and outside protected areas frequently monitor snow leopard populations within their jurisdictions. Every five to six years, a nationwide population assessment provides data on the country's population abundance and informs trend analysis (to date, this has happened in 2014-2015 and 2022-2023). Ranger monitoring programs, utilising the Spatial Monitoring and Reporting Tool (SMART) technology, are regularly conducted through patrolling and field activities. These efforts aim not only to protect wildlife but also to gather critical information on wildlife, including animal signs and indicators of poaching.

Incentive Programs: Certain parts of the snow leopard's range in the country have active, integrated conservation development programs. These activities are primarily implemented by government institutions, such as the Department of Forests and Park Services, the Department of Livestock, and the Department of Tourism, in consultation with local stakeholders. They are supported mainly by conservation partners through various projects.

The Department of Forests and Park Services has provided training and supported the construction of predator-proof corrals for herders in areas like JKSNR and JDNP. In the Soe region of JDNP, with the support of donors, the only primary school has been equipped with improved lighting, insulation, and adequate space, including a library for the students. The Department of Livestock also provides regular check-ups of livestock, as herders in Bhutan lose more yaks to gid (a parasitic disease) than to snow leopards. The Department of Tourism and the Department of Forests and Park Services, in partnership with the local government, have also helped establish eco-tourism infrastructures such as camps and eco-trails in several potential areas and organised festivals, among others, in snow leopard landscapes to attract tourists.

Awareness: Regular awareness programs are conducted in communities and schools within snow leopard habitats (Wangchuk & Dhendup, 2024).

Future conservation action needs

The Snow Leopard Conservation Action Plan 2024-2033 for Bhutan prioritises a multi-faceted approach to ensuring the species' survival in the country into the future. (NCD, 2024).

Firstly, it highlights enhanced protection through stronger law enforcement, increased ground patrols, and strategic use of technology to safeguard snow leopards and their prey. Secondly, the plan focuses on habitat preservation, aiming to maintain the integrity of vital habitats by reducing degradation and implementing restoration projects. Thirdly, it recognises the importance of community involvement, supporting integrated conservation and development programs and proactive measures to reduce human-wildlife conflict, thus protecting local livelihoods. Lastly, the plan emphasises the need for scientific progress through consistent monitoring and research, encouraging a better understanding of snow leopard ecology and the complex interactions between humans and wildlife.

5. Acknowledgements

This country status report acknowledges the continued leadership and commitment of the Royal Government of Bhutan to snow leopard conservation, particularly through the Department of Forests and Park Services under the Ministry of Energy and Natural Resources, and the dedicated efforts of park and field staff working across Bhutan's high-mountain landscapes.

The report also acknowledges the valuable contributions of national researchers, conservation practitioners, and partners in Bhutan whose long-term work and insights informed this synthesis. Special thanks are extended to Rinchen Dorji for representing Bhutan at the IUCN Red List and Green Status assessment workshop held in Mongolia, and for contributing to regional dialogue and collaboration during the assessment process.

The report further acknowledges the IUCN SSC Cat Specialist Group and the wider IUCN Red List assessment team for their guidance and collaboration as part of the 2026 snow leopard assessment. Support for coordination of this country status series is gratefully acknowledged through WCS Mongolia.

6. Conflict of Interest

The authors declare no known conflicts of interest.

7. References

- DoFPS (2016) *National Snow Leopard Survey of Bhutan 2014–2016 (Phase II): Camera Trap Survey for Population Estimation*. Department of Forests and Park Services, Thimphu, Bhutan.
- Dorji, R., Letro, Yangchen, S., Dendup, P., Dhendup, T. and Lhamo, Y. (2024). 'Rare and unusual snow leopard encounters in the broadleaf forest of the Bhutanese Himalayas', *Snow Leopard Reports*, 3, pp. 13–20. Available at: <http://dx.doi.org/10.56510/slr.v3.24118>.
- Letro, L., Duba, D., Tandin, T. and Wangdi, S. (2021). 'Rare capture of a snow leopard in Jigme Singye Wangchuck National Park, Bhutan', *Cat News*, 73, pp. 29–32.
- Lham, D., Cozzi, G., Sommer, S., Thinley, P., Wangchuk, N., Wangchuk, S. and Ozgul, A. (2021). 'Modelling distribution and habitat suitability for the snow leopard in Bhutan', *Frontiers in Conservation Science*, 2. Available at: <https://doi.org/10.3389/fcosc.2021.781085>.
- NCD (2023) *Snow Leopards Status in Bhutan: National Snow Leopard Survey Report 2022–2023*. Department of Forests and Park Services, Thimphu, Bhutan.
- NCD (2024) *Snow Leopard Conservation Action Plan for Bhutan 2024–2033*. Department of Forests and Park Services, Thimphu, Bhutan.
- RGoB. (2023). Forest and Nature Conservation Act. Thimphu, Bhutan
- Thinley, P., Dagay, Leki, Dorji, P., Namgyel, C., Yoenten, S., Phuntsho and Dorji, T. (2014). *Estimating Snow Leopard Abundance and Distribution in Jigme Dorji National Park, Bhutan: A Technical Report*. Department of Forests and Park Services, Thimphu, Bhutan.
- Wangchuk, T.R. & Dhendup, T. (2023). Snow leopard conservation in Bhutan. In book: *Snow Leopards (2nd Edition)*, Biodiversity of the World: Conservation from Genes to Landscapes. Wiley Publishing. DOI: 10.1016/B978-0-323-85775-8.00035-2
- WCNP and WWF (2016). *Population Status and Distribution of Snow Leopards in Wangchuck Centennial Park, Bhutan*. WWF Bhutan, Thimphu, Bhutan.



Snow Leopard (*Panthera uncia*) Status in India

CONTRIBUTORS:

Manvi Sharma ^{1*}, Ranjana Pal² &
Yash Veer Bhatnagar³

KEYWORDS:

snow leopard; *Panthera uncia*; India;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Sharma et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

¹ Ashoka University, Sonapat, India

² Wildlife Institute of India, Dehradun, India

³ International Union for Conservation of Nature,
New Delhi, India

* Email: manvi.sharma@ashoka.edu.in

1. Distribution

Snow leopards (*Panthera uncia*) in India are primarily found in the high-altitude regions of the Himalayas and Trans-Himalayas. Their habitat is characterized by steep, broken terrain, including cliffs, rocky outcrops, and ravines. The typical habitat has low above-ground productivity, and the vegetation is typically characteristic of dry alpine at higher elevations and subalpine in lower elevations (Chundawat, 1992; Fox et al., 1991). Although rare, snow leopards have also been reported from lower, forested regions of the Greater Himalaya (Bandyopadhyay et al. 2009). Snow leopards tend to be detected at elevations ranging from 3,000 to 5,500 meters, often above the tree line, where steppes, alpine meadows and rocky regions dominate. Their geographical range encompasses a large part of the western Himalayas, including the Union Territories of Jammu and Kashmir and Ladakh, and the states of Himachal Pradesh, Uttarakhand, and the eastern Himalayas including the states of Sikkim and Arunachal Pradesh.

The snow leopard in India is a protected species and receives the highest level of protection, i.e., protection under Schedule 1 of the Indian Wildlife Protection Act, 1972. India has established several protected areas to help conserve snow leopard habitats, including the Chanthang Cold Desert Wildlife Sanctuary (WLS), Great Himalayan National Park (NP), Pin Valley NP and Gangotri NP. The protected area network in India spans ca. 37,000 km² that covers approximately that covers approximately 34% of the snow leopard distribution range in India. (Bhatnagar et al., 2024).

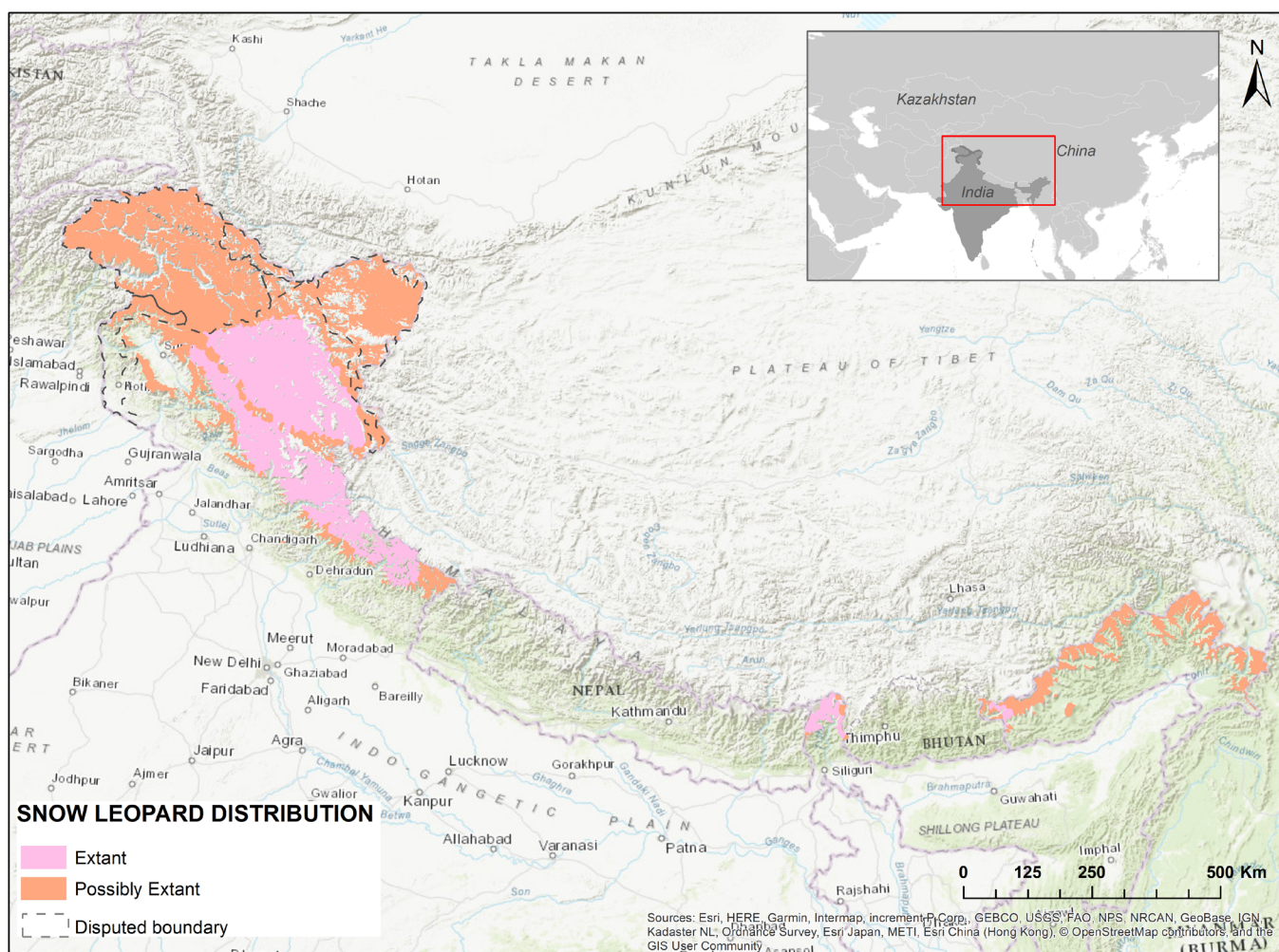


Figure 1: Map showing the extant and possibly extant region for snow leopard distribution in India. The map includes regions under dispute with Pakistan and China and the snow leopard distribution as well as the borders are indicative and subject to uncertainty.

As research efforts expand, the estimated extent of snow leopard distribution in India has been revised. Earlier studies reported the extent of the snow leopard habitat to be ca. 75,000 km² (Chundawat et al., 1988). More recent assessments now estimate the snow leopard habitat in India to cover approximately ca. 120,000 km² (Bhatnagar et al., 2024).

The updated IUCN Red List distribution map for the snow leopard in India (Figure 1) was developed using verified occurrence data. This included published records, genetically confirmed scat samples, and photographic evidence from camera traps.

Elevation Filtering: Snow leopards primarily occupy high-altitude alpine zones between 3,000 and 5,500 meters, primarily between 3,000–5,500 m in the Western Himalaya (Chundawat, 1992; Fox et al., 1991; McCarthy & Chapron, 2003). To delineate these elevational areas, data were extracted from the Shuttle Radar Topography Mission (SRTM) digital elevation model (Jarvis et al., 2008). The raster reclassification tool in ArcGIS Pro was

used to identify and map areas within this elevation band, representing potentially suitable habitat.

Within each state, spatial coordinates of confirmed snow leopard occurrences from the past five years were compiled from published datasets and locations shared by expert scientists (Vardhan et al. 2025; K. Suryawanshi & R. Sharma, pers. comm., 2024). These locations are detections from camera trapping surveys and genetic analyses of scat samples. These confirmed detections were used to generate a Minimum Convex Polygon (MCP) in ArcGIS Pro according to the mapping standards in the IUCN Red List Assessment. Each MCP was subsequently intersected with hydrological catchment boundaries to delineate catchment zones with verified presence and was classified as Extant. Areas within the suitable elevation range, but without confirmed records in the past five years, were classified as Possibly Extant. These areas may support snow leopards but require further field verification through field-based surveys.

2. Population

Under the Project Snow Leopard, launched by the Government of India in 2009, a population estimation effort and the detailed protocol for conducting assessments was launched in 2019. Under Project Snow Leopard, a team of researchers from multiple institutions completed the first national-level survey to estimate snow leopard populations in 2023. This country-level effort provided the first robust estimate of snow leopard numbers in India (MoEFCC, 2023). These robust estimates were reached using the two-step protocol developed under the Snow leopard Population Assessment of India (SPAI) effort, which is based on the PAWS (Population Assessment of World's Snow leopards) effort. The effort involved 1,971 camera trap locations across the union territories of Ladakh and Jammu and Kashmir, and the states of Arunachal Pradesh, Himachal Pradesh, Sikkim, and Uttarakhand.

The camera trapping surveys detected 241 unique adult individuals and reported an estimated population size of 718 individuals. According to the report, the largest population was recorded in the Ladakh region, with 126 unique adult individuals detected by camera traps. However, a more recent published study using genetic data identified 72 unique individuals in Ladakh, based on large-scale scat sampling and genetic analyses (Vardhan et al., 2025), compared to the 126 individuals mentioned in the earlier report (MoEFCC, 2023). Vardhan et al. (2025) did not estimate the overall population size for this region and thus the total population may not be comparable.

An important development has been the documentation of snow leopards from previously unconfirmed regions such as Jammu and Kashmir (Khanyari et al., 2023), Sikkim (Sikkim Forest & Environment Department and WWF, 2025), and Arunachal Pradesh (WWF-India, 2023) over the last five years, along with robust estimates from all regions using camera-trapping methods (Suryawanshi et al., 2021; Pal et al., 2021).

As part of this national effort, regional density estimates for six regions were also reported. It is important to note that these region-wise estimates, based on administrative boundaries, may not represent sub-populations. Table 1 below provides a summary of regional wise estimates.

Population trends for snow leopards in India remain unknown. Prior to this robust estimate that followed the SPAI and PAWS (Population Assessment of World's Snow leopards) guidelines, it was estimated that India could host a population of about 516 (238-1039) snow leopards (Bhatnagar et al., 2016). The updated 2023 estimate now puts the estimated number at 718 individuals.

3. Threats

Historical threats

Snow leopards have historically been hunted for their prized fur, which remains in demand on international markets. Their body parts are also used in traditional medicine, especially in regions influenced by Tibetan and Chinese practices. Panjwani (1997) reports that trade in snow leopard skins continued in Jammu and Kashmir until the end of the 1990s. However, retaliatory killing is considered a bigger threat than illegal wildlife and poaching (Mishra et al., 2016; Snow Leopard Working Secretariat, 2013).

Livestock grazing pressure remains an important threat in the snow leopard habitats in India (Mishra et al., 2004; Suryawanshi et al., 2010; Sharma et al., 2024). The intensity of livestock grazing poses a major challenge, manifesting in increasingly complex ways as a stressor. Grazing patterns are increasingly shaped by market forces, particularly the demand for cashmere, leading to the decrease in some native livestock populations (horses, yak) in some areas and an expansion of transhumant herding. This shift has intensified grazing pressure, resulting in wildlife declines, particularly in regions such as Changthang (Tsewang et al., 2007; Singh et al., 2015; Morup et al., 2023).

Table 1: Regional Estimates of Snow Leopard Populations in India (MoEFCC 2023)

Region	Number of camera locations	Unique individuals	Density (per 100km ²)	Population size
Ladakh	956	126	0.34 ± 0.14	477
Jammu & Kashmir	135	9	0.75 ± 0.52	9
Himachal Pradesh	284	44	0.08 - 0.37	51
Uttarakhand	382	40	0.7 - 1.04	124
Sikkim	99	14	0.4 ± 0.11	21
Arunachal Pradesh	115	8	0.26 ± 0.11	36
Total	1971	241		718

Research has helped us understand the mechanisms by which high livestock densities can impact the population-level of snow leopard wild prey, such as blue sheep, *Pseudois nayaur*, and ibex, *Capra sibirica* (Mishra et al., 2004, Suryawanshi et al., 2010, Sharma et al., 2024). The high level of overlap in pastures between domestic and wild ungulates, through resource-driven competition, negatively impacts the prey of snow leopards. These insights are crucial for informing the scale and focus of future conservation interventions.

Emerging threats

Developmental pressures have led to large-scale land-use changes (e.g. agricultural expansion and infrastructure development) in the Indian Himalaya over the past decade (McCarthy & Chapron, 2003; Thakur et al., 2024; Bhatnagar et al., 2024; Sikkim Forest & Environment Department and WWF-India, 2025). Recent surveys show that not only ungulates show an increasing tendency to avoid roads, likely in response to growing disturbance from tourist activity and vehicular traffic but also signs of snow leopards (scats, scent marks, and pugmarks) decline closer to roads (Sikkim Forest & Environment Department and WWF-India, 2025). This is potentially the most important emerging threat because much of the snow leopard habitat is outside protected areas in India. Green energy initiatives, particularly solar parks, expand into snow leopard habitats posing new risks through habitat degradation and fragmentation (Patel et al., 2024). Additionally, the population of free-ranging dogs in the Himalayan regions is increasing, posing direct risks to carnivores and causing significant livestock losses for herders, which hinders wildlife conservation efforts (Pahuja & Sharma, 2021; Mahar et al., 2024).

4. Conservation

Conservation efforts for snow leopards are increasingly focused outside the protected area network – where much of their range is located. In the last five years, these efforts have focused on participatory, knowledge-driven, and landscape-scale programs (Khanyari et al., 2023; Bhatnagar et al., 2024; Young et al., 2024). Much of the community-led conservation actions have focused on minimizing livestock losses through predator-resistant corrals, insurance schemes for livestock, and encouraging pro-conservation behavior through handicrafts-based initiatives focused on women engagement (Alexander et al., 2022; Young et al., 2024).

About 34% of snow leopard range in India is within protected areas (Bhatnagar et al., 2024). Under the Government of India's Project Snow Leopard, each of the six states where the snow leopard is found, plans to identify at least one landscape (1000-5000 km²) which can be managed. These contiguous areas will have protected areas interspersed with multiple-use habitats (Bhatnagar et al., 2024). The Project Snow Leopard and the SECURE Himalaya project are two notable projects in India that have continued to work on conservation of snow leopards in India.

Future directions

Conservation efforts have traditionally prioritized reducing

livestock losses, but future strategies must adopt a multi-pronged approach (Mishra et al., 2024) that combines loss reduction with education, awareness, and livelihood improvements. Addressing the issue of free-ranging dogs is particularly critical. Potential solutions include ABC (Animal Birth Control) programs, consistent monitoring of dog-induced losses, and promoting dog adoption programs. Recently, much concerted efforts have been made by the Government of India to strengthen conservation planning through coordinated and evidence-based approaches. The launch of the International Big Cat Alliance (IBCA), along with discussions held with the National Board for Wildlife (NWL) around infrastructure development, shows the strategic, high-level engagement in wildlife conservation. In parallel, the Ministry of Environment, Forest and Climate Change (MoEFCC) is undertaking efforts to redevelop the Project Snow Leopard (PSL) framework and the SECURE 2.0 program to ensure they operate in a genuinely evidence-based, landscape-scale, and participatory manner. The Ministry is also moving towards establishing more formal partnerships with the armed forces, recognizing their role in conservation across remote and strategically important landscapes. Overall, the focus on well-funded, landscape-level, participatory, and cross-sectoral planning represents a robust and pragmatic approach, however, implementing these measures in remote landscapes, especially with the growing influx of tourists each year, presents significant challenges.

5. Acknowledgements

We thank the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India and State Forest Departments across the snow leopard range in India for their support under Project Snow Leopard and SPAI. We acknowledge the Wildlife Institute of India, WWF-India, and expert contributors, including Kulbhushansingh R. Suryawanshi, S. Sathyakumar, and Rishi Sharma, for data and personal communications.

We also thank the IUCN SSC Cat Specialist Group and the Snow Leopard IUCN Red List assessment team for guidance. The distribution map was prepared by Bayarjargal Khashbat (WCS Mongolia), and coordination of this country status series was supported by Justine Shanti Alexander (WCS Mongolia).

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Alexander, J.S., Bijoor, A., Gurmet, K., Murali, R., Mishra, C. & Suryawanshi, K.R. (2022). Engaging women brings conservation benefits to snow leopard landscapes. *Environmental Conservation*, 49(3), pp.180–186. <https://doi.org/10.1017/S0376892922000236>
- Bandyopadhyay, M., Dasgupta, T. & Krishnamurthy, R. (2009). New records of snow leopard in Great Himalayan National Park, Western Himalaya. *Cat News*, 70, pp.9–11.
- Bhatnagar, Y.V., Mathur, V.B., Sathyakumar, S., Pal, R., Ghoshal, A., Sharma, R.K., Bijoor, A., Raghunath, R., Timbadia, R. & Lal, P. (2024). Securing India's snow leopards: status, threats, and conservation. In: Mallon, D. & McCarthy, T. (eds.) *Snow Leopards* (2nd ed.). Academic Press, pp.513–529. <https://doi.org/10.1016/B978-0-323-85775-8.00003-0>
- Bhatnagar, Y.V., Mathur, V.B., Sathyakumar, S., Ghoshal, A., Sharma, R.K., Bijoor, A., Raghunath, R., Timbadia, R. & Lal, P. (2016). South Asia: India. In: McCarthy, T. & Mallon, D. (eds.) *Snow Leopards*. Academic Press, pp.457–469. <https://doi.org/10.1016/B978-0-12-802213-9.00036-5>
- Chundawat, R., Rodgers, W. & Panwar, H. (1988). Status report on snow leopard in India. In: *Proceedings of the Fifth International Snow Leopard Symposium*. International Snow Leopard Trust & Wildlife Institute of India, pp.113–120.
- Chundawat, R.S. (1992). *Ecological studies on the snow leopard and its prey species in Hemis National Park, Ladakh*. PhD thesis, University of Rajasthan, Jaipur, India.
- Fox, J.L., Sinha, S.P., Chundawat, R.S. & Das, P.K. (1991). Status of the snow leopard *Panthera uncia* in north-west India. *Biological Conservation*, 55, pp.283–298.
- Khanyari, M., Dorjay, R., Lobzang, S., Bijoor, A. & Suryawanshi, K. (2023). Co-designing conservation interventions through participatory action research in the Indian Trans-Himalaya. *Ecological Solutions and Evidence*, 4(2), e12232. <https://doi.org/10.1002/2688-8319.12232>
- Khanyari, M., Sanyal, O., Chandan, P., Bajaj, D., Sharma, C., Rana, M., Sharma, N., Bashir, T. & Suryawanshi, K. (2024). A new dawn? Population baselines of snow leopards and other mammals of the Kishtwar High Altitude National Park, India. *Integrative Conservation*, 3(3), pp.271–280. <https://doi.org/10.1002/inc3.61>
- McCarthy, T.M. & Chapron, G. (2003). *Snow Leopard Survival Strategy*. International Snow Leopard Trust & Snow Leopard Network, Seattle, USA.
- Mahar, N., Habib, B. & Hussain, S.A. (2024). Do we need to unfriend a few friends? Free-ranging dogs affect wildlife and pastoralists in the Indian Trans-Himalaya. *Animal Conservation*, 27(1), pp.53–64. <https://doi.org/10.1111/acv.12876>
- Mishra, C. (1997). Livestock depredation by large carnivores in the Indian Trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation*, 24(4), pp.338–343.
- Mishra, C., Redpath, S.R. & Suryawanshi, K.R. (2024). Livestock predation by snow leopards: conflicts and the search for solutions. In: Mallon, D. & McCarthy, T. (eds.) *Snow Leopards* (2nd ed.). Academic Press, pp.55–62. <https://doi.org/10.1016/B978-0-323-85775-8.00004-2>
- Mishra, C., Van Wieren, S.E., Ketner, P., Heitkonig, I.M.A. & Prins, H.H.T. (2004). Competition between domestic livestock and wild bharal *Pseudois nayaur* in the Indian Trans-Himalaya. *Journal of Applied Ecology*, 41(2), pp.344–354. <https://doi.org/10.1111/j.0021-8901.2004.00885.x>
- MoEFCC (2023). *Status of snow leopard in India*. Ministry of Environment, Forest and Climate Change, Government of India, New Delhi.
- Morup, T., Namgail, T. & Tsering, T. (2023). Wildlife versus livestock: conservation dilemma of the pastoralists of Changthang. In: Humbert-Droz, B., Dame, J. & Morup, T. (eds.) *Environmental Change and Development in Ladakh, Indian Trans-Himalaya*. Springer Nature, Cham, pp.147–161. https://doi.org/10.1007/978-3-031-42494-6_10
- Pal, R., Sutherland, C., Qureshi, Q. & Sathyakumar, S. (2022). Landscape connectivity and population density of snow leopards across a multi-use landscape in Western Himalaya. *Animal Conservation*, 25(3), pp.414–426. <https://doi.org/10.1111/acv.12754>
- Patel, J., Khanyari, M., Malhotra, R., Pawar, U.R., Bijoor, A., Sharma, D. & Suryawanshi, K. (2024). Snow leopards or solar parks? Reconciling wildlife conservation and green energy development in the High Himalaya. *Biological Conservation*, 299, 110793. <https://doi.org/10.1016/j.biocon.2024.110793>
- Singh, R., Sharma, R.K. & Babu, S. (2015). Pastoralism in transition: livestock abundance and herd composition in Spiti, Trans-Himalaya. *Human Ecology*, 43(6), pp.799–810. <https://doi.org/10.1007/s10745-015-9789-2>
- Sikkim Forest & Environment Department and WWF-India (2025) Statewide assessment of the population and density of snow leopards in Sikkim, India. Sikkim Forest & Environment Department, in collaboration with WWF-India, Gangtok, India. 31 pp.
- Snow Leopard Working Secretariat (2013). *Global Snow Leopard and Ecosystem Protection Program* Bishkek, Kyrgyz Republic.
- Suryawanshi, K.R., Bhatnagar, Y.V. & Mishra, C. (2010). Why should a grazer browse? Livestock impact on winter resource use by bharal *Pseudois nayaur*. *Oecologia*, 162(2), pp.453–462. <https://doi.org/10.1007/s00442-009-1467-x>
- Suryawanshi, K., Reddy, A., Sharma, M., Khanyari, M., Bijoor, A., Rathore, D., Jaggi, H. *et al.* (2021). Estimating snow leopard and prey populations at large spatial scales. *Ecological Solutions and Evidence*, 2(4), e12115. <https://doi.org/10.1002/2688-8319.12115>
- Thakur, M., Thakur, A. & Thakur, J. (2024). Habitat degradation and increasing human–wildlife conflicts in Himachal Pradesh: a review.
- Tsewang, N., Bhatnagar, Y.V., Mishra, C. & Bagchi, S. (2007). Pastoral nomads of the Indian Changthang: production system, land use and socioeconomic changes. *Human Ecology*, 35(4). <https://doi.org/10.1007/s10745-006-9107-0>
- Vardhan, V., Srinivas, Y., Khan, N., Raina, P. & Jhala, Y. (2025). Assessment of genetic diversity, population structure, and gene flow in snow leopards across Ladakh region, India. *European Journal of Wildlife Research*, 71(2), 26. <https://doi.org/10.1007/s10344-025-01907-6>
- Young, J.C., Alexander, J.S., Agvaantseren, B., Bijoor, A., Butler, A., Nawaz, M.A., Tang, P. *et al.* (2024). Collaborative conservation for snow leopards: lessons learned from successful community-based interventions. *Conservation Letters*, 17(6), e13062. <https://doi.org/10.1111/conl.13062>
- WWF-India (2023) State-wide assessment of the population and density of snow leopards in Arunachal Pradesh, India. WWF-India and Department of Environment, Forest and Climate Change (DoEFCC), India. 36 pp.



Snow Leopard (*Panthera uncia*) Status in Kazakhstan

CONTRIBUTORS:

Alexey Grachev ^{1,2,3}

KEYWORDS:

snow leopard; *Panthera uncia*; Kazakhstan;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Grachev et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

1 Institute of Zoology of Republic of Kazakhstan

2 Snow Leopard Foundation, Kazakhstan

3 Wildlife Without Borders, Kazakhstan

* Email: aleksey.al.grachev@gmail.com

1. Distribution

The north-western edge of the snow leopard's global range is situated in Kazakhstan, covering the Tien Shan, Dzungar Alatau, Tarbagatai, Saur, and Altai mountain ranges (Heptner & Sludskiy, 1972; Sludskiy, 1973; Grachev & Fedosenko, 1977). These transboundary mountain systems neighbor Uzbekistan, Kyrgyzstan, China, and Russia. With increasing economic development from the middle of the 20th century, the distribution area and number of snow leopards in Kazakhstan began to decline. Today, the snow leopard has disappeared from some peripheral ranges. Ongoing research in Kazakhstan suggests that over the past 20–30 years, the snow leopard population has been recovering (Grachev et al. 2023), albeit unevenly, and remains absent from certain key areas such as the Saur, Tarbagatai, and Uzynkara (Ketmen) ranges, as well as the Karatau (Figure 1). These areas are important for population connectivity and transboundary cooperation, and also offer insights into edge-of-range conservation in a changing world (Grachev et al. 2025).

In mapping the distribution of the snow leopard in accordance with IUCN Red List standards, we primarily relied on records of all known sightings of the species, as well as evidence of its presence. To determine the area of occupancy (Extant), all available snow leopard occurrence points collected during field surveys (from 2012 to present) were enclosed within polygons. The boundaries of each polygon were defined by the outermost occurrence points, with adjacent territories included up to limits imposed by natural barriers such as watershed ridges, plains bordering

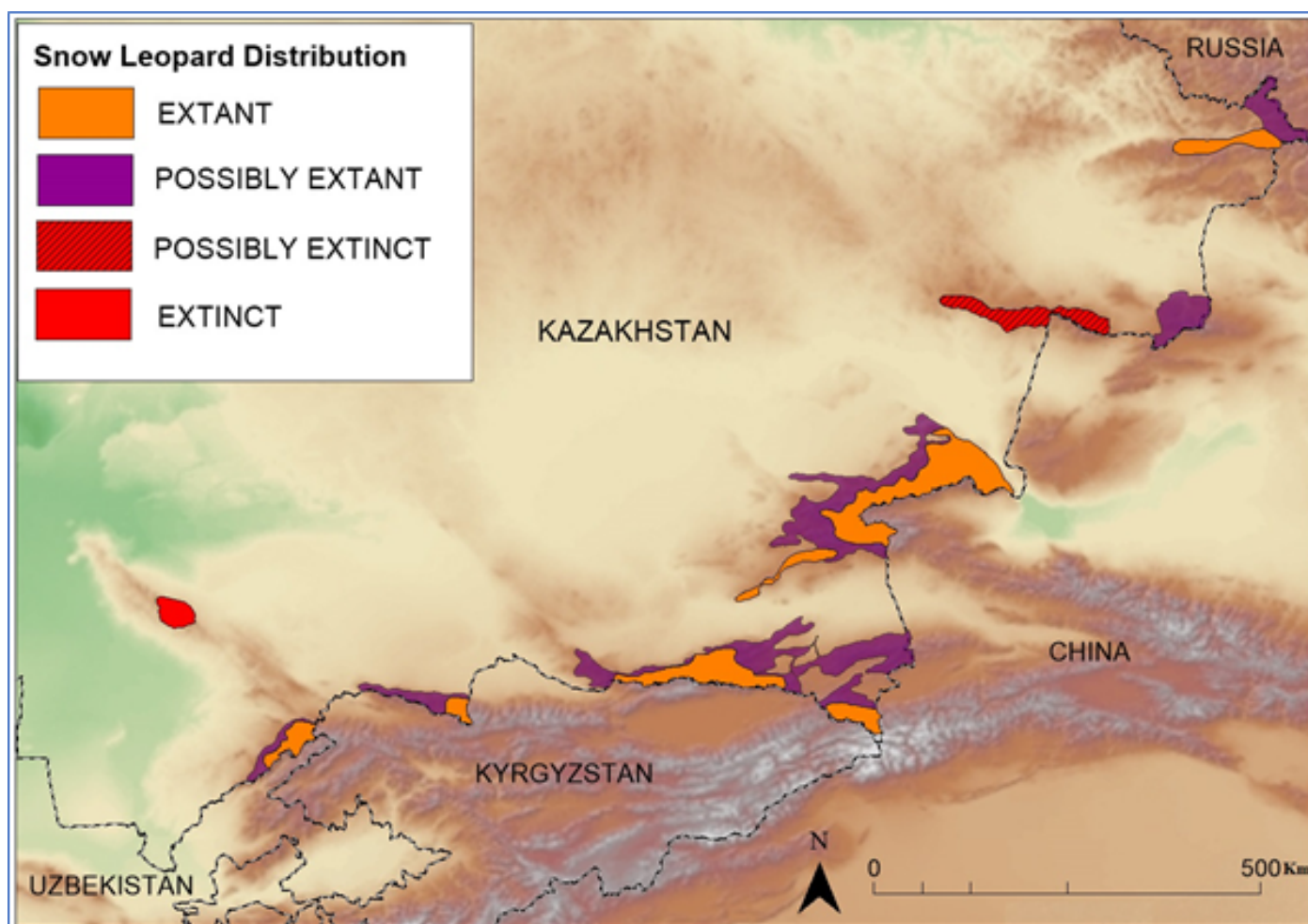


Figure 1. Distribution of the snow leopard (*Panthera uncia*) in Kazakhstan. Orange areas indicate extant range, where the species is confirmed or strongly inferred to occur based on recent records. Purple areas indicate possibly extant range, where presence is uncertain but considered likely based on habitat suitability and proximity to confirmed occurrences. Red hatched areas indicate possibly extinct range, where the species may have occurred historically but has not been confirmed in recent decades. Solid red areas indicate extinct range, where the species is considered no longer present. Range categories follow IUCN Red List mapping definitions.

mountain areas at the periphery of the range, state borders, and zones of increased anthropogenic pressure.

In addition, we applied a multi-scale species distribution model to identify factors influencing snow leopard abundance and developed a baseline model reflecting the historical distribution of the species in the country (Grachev et al., 2025). It is noteworthy that the simulation model fully reproduced all known snow leopard records in Kazakhstan since the early 20th century (Heptner & Sludsky, 1972; Sludsky, 1973; Grachev & Fedosenko, 1973), thereby proving to be a successful corrective strategy for identifying all ecological conditions capable of supporting the species' persistence in this region.

The extent of core areas (km²), classified by habitat quality (low, medium, and high), generally corresponded to the polygons delineated on the snow leopard distribution map (Figure 1). Specifically, the total area of polygons classified

as Extant was comparable to the area of high-quality habitat (90th percentile) in the model, whereas areas of medium-to-high habitat quality (80th percentile) corresponded to polygons classified as Possibly Extant.

Importantly, the model also indicated with considerable accuracy a site in the Syrdarya Karatau Range, which represents a peripheral northwestern spur of the Western Tien Shan where the snow leopard was last recorded about 100 years ago (Antipin, 1953). This site was classified as «Extinct».

Western Tien Shan. Snow leopard habitat includes the western end of the Talas Alatau, the Karzhantau ridge and the northwestern slopes of the Ugam and Maidantal ranges, along which runs the border with Uzbekistan. The Kyrgyz Alatau is transitional between the Western and Northern Tien Shan, and the Kyrgyzstan border runs along the ridge. In Talas Alatau, snow leopards occur in the Aksu-Zhabagly

Nature Reserve along the gorges of the Zhabagly, Aksu, Koksay, Aksai, Maidantal, Baldarbek, and Balabaldarbek rivers. On the Ugam Ridge in the Sairam-Ugam National Park, snow leopards occur along the valleys of the Sairamsu, Sary-Agyr, and Ugam rivers (Grachev, 2016). In the Kyrgyz Alatau, occupancy has only been consistently recorded along the Aspara and Merke gorges.

Northern Tien Shan. The Northern Tien Shan includes the Ile Alatau, Kungei Alatau, Ketmen (Uzynkara) and Terskey Alatau ranges. The primary snow leopard habitats occur on the northern slopes up to 4,000 m. Camera trapping and other surveys in Almaty Nature Reserve and Ile-Alatau National Park between 2012-21 indicated snow leopard presence widely across the region (e.g. Shilik, Turgen, Issyk, Talgar, Malaya and Bolshaya Almatinka, Kargalinka, Aksai, Kargauldy, Kaskelen, Chemolgan, Uzyn-Kargaly, Karakastek, Kastek) (Grachev et al., 2013, 2015, 2019, 2023). In Almaty Reserve, snow leopards are encountered down to 1,200 m.

In the eastern spurs of the Ile Alatau, the low mountains Turaigyr, Syugaty, Bolshoe and Small Buguty, snow leopards are only occasionally encountered. There are anecdotal reports of snow leopards in the Turaigyr, Boguty and Charyn Canyon mountains, but camera trap studies in the Bolshiye Boguty mountains in the winter 2015-16 and 2022-23 did not confirm their presence.

The Kolsai Kolderi National Park is located on the northern slope of eastern part of the Kungei Alatau. The creation of this national park in 2007 has improved habitats and snow leopards are more frequently encountered. As a result of research by the Institute of Zoology between 2012-20 using camera traps, snow leopards were recorded in almost all large gorges – Kaindy, Saty, Kulsai, Kurmekty, Taldy, Kutorga, Malye and Bolshie Uryukty, Karakiya, Karasai, as well as in the upper reaches of the Shelek River (Grachev et al. 2017).

The western part of the Ketmen (Uzynkara) ridge is located within Kazakhstan, with the eastern part in China. Snow leopards do not appear to live permanently in these mountains, although animals from neighboring China are anecdotally reported to have visited. However, residents and workers at hunting farms located in the central part of the ridge, consider the snow leopard to be absent.

The eastern part of the northern slope of the Terskey Alatau ridge is located within Kazakhstan, connected to the Kyrgyz Republic and China. In the 1970s and 1990s, the snow leopard was recorded in the upper reaches of the Karkara, Tekes, Bolshoi Kokpak, and Bayankol rivers (Fedosenko, 1982; Zhiryakov & Baidavletov, 2002). In 2018-19, they

were also recorded on camera traps in the tracts bordering China and Kyrgyzstan (Grachev et al., 2023).

Zhetysu (Dzungar) Alatau. The Dzungar Alatau consists of a series of east-west parallel ridges stretching for about 400 km, with isolated peaks exceed 4,000 m. The border with China runs along the crest of the ridge, with the northern slope in Kazakhstan. Two national parks, Zhongar-Alatau (3,560 km²), Altyn-Emel (3,077 km²) and three wildlife sanctuaries (Verkhne-Koksuisky, Toktinsky and Lepsinsky) are found here.

Snow leopard signs and sightings have been recorded over the past 20 years in numerous river valleys (from east to west: Chindaly; Tokhty; Terekty; Zhamanty; Kyzyltal; Tastau; Tentek; Lepsy; Aganakatty; Maly Baskan; Sarkand; Aksu; Bien; Koksus; and Usek), on the southwestern spurs of Toksanbay and Koyandytau ridges (Anenkov, 1992; Tushkenov, 2017; Zhatkanbaev, 2012; Grachev et al., 2023).

On the Altyn-Emel ridge snow leopards have previously only rarely been recorded, but in recent years they have become more frequent. Also, since 2017 a breeding population has been recorded year-round in the desert lowlands of Sholak, Degeres, Matai, in the Altyn-Emel National Park at an elevation of ~1,000 m. Due to high air temperatures, especially in summer (up to 40°C and more) predators lead mainly a nocturnal lifestyle, waiting out the summer heat in caves and rock niches. Concentrations of predators are observed near water sources, sometimes snow leopards can also be found in reed beds near watering places. Until the mid-1950s, the snow leopard was quite common in these mountains and its long absence followed uncontrolled illegal hunting in previous years.

Tarbagatai and Saur. The western half of the Tarbagatai ridge and the northern slope of its eastern half are located within Kazakhstan, neighboring China along the ridge of the Eastern Tarbagatai. The maximum elevation of the ridge is approximately 3,000 m.

Snow leopards have always been rare in Tarbagatai. In the 1960s and 1970s, no snow leopard tracks were found here, but in the late 1980s and early 1990s, several occurrences were recorded into Eastern Tarbagatai, apparently animals moving from China. Tarbagatai National Park (1,435 km²) was created in 2018 but, as yet snow leopards are not permanent residents.

Saur ridge, with a maximum elevation of 3,722 m, also shares the state border with China. Snow leopards were rare here in the middle of the 20th century (Sludsky, 1973). Anecdotal accounts of snow leopards by local communities were reported in 2010, 2013 and 2014 in the upper reaches

of the Kenderlyk, Karaungur, Akkezen and Chagan-Obo rivers.

Camera trap surveys during 2017 in the Saur mountains, failed to record snow leopards, although a snow leopard family group was observed in 2021 in the Ushtas tract, in the upper reaches of the Darnaozek River (tributary of the Kenderlyk River). At present there are no protected areas on Saur.

Altai. The Kazakh part of Altai includes several ridges of this vast mountain system. Snow leopards occur in the Southern Altai, Tarbagatai (Bukhtarminsky), Sarymsakty and Katunsky ridges, although infrequently (Grachev et al., 2023). Occasional snow leopards are recorded on the Kholzun, Koksuisky, and Ivanovsky ridges, which lie north of the main habitat. There are two key snow leopard habitats in the region, the first in the eastern half of the Southern Altai ridge and the Tarbagatai (Bukhtarminsky) ridge, and the second along the steep and inaccessible Sarymsakty ridge. Most records in these areas, both past and present,

are located on the territory of the Katon-Karagai National Park in the basin of the Bukhtarma River. Snow leopard tracks are very rarely found on the Katunsky Ridge and on the Ukok Plateau, to the north of their core area.

2. Population

The population of snow leopards in Kazakhstan at the beginning of the 1980s was estimated at 180-200 individuals (Fedosenko, 1982). In the early 1990s, the number of snow leopards in Kazakhstan was estimated from the literature at 80-100 individuals (Loginov, 1995). Estimates in the early 2000s were 100-110 individuals (Zhiryakov & Baidavletov, 2002); in the early 2010s, 110-130 (unpublished data, IoZ); and in the late 2010s, 130-150 individuals (unpublished data, IoZ). At present, the total number of snow leopards in Kazakhstan is estimated to be 152–189 individuals, with 77–97 in the Tien Shan, 71–83 in the Dzungar Alatau, 3–6 in Altai and 1–3 in Saur (Table 1).

Table 1 – Current number and average density of snow leopard populations in Kazakhstan

Region and Range	Current range (km ²)	Estimated population average density (per 100 km ²)	Number of individuals	Method used*	Year
Western Tien Shan					
Ranges Karzhantau, Ugamaskiy, Maidantalskiy, Talasskiy	1,700	0.7-0.9	12-15	Q, S-T, CT	2012-2014
Kyrgyz Alatau	800	0.6-1.0	5-8	CT	2020
Northern Tien Shan					
Ile Alatau	3,100	1.1-1.5	35-45	CT	2023-2024
Kungey Alatau	1,900	0.7-0.8	13-15	CT	2015-2017
Terskey Alatau	1,700	0.7-0.8	12-14	Q, CT	2018-2019
Uzynkara (Ketmen)	n/a	-	0	Q	2014, 2018
Dzungar Alatau					
Ranges Toksanbay, Dzungar Alatau (Central), Kungey, Tastau	9,500	0.5-0.6	50-60	S-T, CT	2022-2023
Sholak, Degeres, Matai, Altyn-Emel, Koyandytau ridge	1,400	1.5-1.6	21-23	CT	2022-2023
Saur-Tarbagatai					
Saur	n/a	-	1-3	Q, S-T, CT	2016, 2020
Tarbagatai	n/a	-	0	Q	2018-2019
Altai	1,800	0.2-0.3	3-6	S-T, CT	2017-2024
In total:	21,900		152-189		

* Q – questionnaire; S-T – snow-tracking; CT – Camera Traps

Northern Tien Shan. In the Ile Alatau, the number of snow leopards in the early 2000s was estimated at 30-35 individuals, of which 20-25 individuals continue to live and breed in Almaty Reserve (Dzhanyspaev, 2002; Zhiryakov & Baidavletov, 2002), with frequent sign and sighting encounters recorded. The creation of the Ile-Alatau National Park in 1996 secured significant areas of habitats in protection, and numbers increased due to movement of animals from Almaty Reserve. Recent field surveys have estimated the snow leopard population in the Ile Alatau at 35-45 individuals, with an average density of 1.29 individuals per 100 km². Despite intensive human impacts on these mountain landscapes due to proximity with large urban centers, including the 'super-city' of Almaty, the number of snow leopards in Ile Alatau remains stable.

In Kungei Alatau, camera trap surveys between 2015-2017 yielded estimates of 13-15 snow leopards, with an average population density of 0.74 individuals per 100 km² (Grachev et al. 2017).

In the Kazakh part of the Terskey Alatau, in an area of 1,700 km², recent surveys suggest 12-14 snow leopards, with an average density of 0.76 individuals per 100 km². Previously, in the late 1990s, the number of snow leopards here did not exceed 2-3 individuals (Zhiryakov & Baidavletov, 2002). Increased protection has been afforded by high-end hunting concessions, with well-organized and resourced protection and the absence of livestock in key areas, leading to increased numbers of wild ungulates.

Western Tien Shan. In the early 1980s, the snow leopard numbers in the Aksu-Zhabagly Nature Reserve were estimated at 10-12 individuals, with a population density of 1.3-1.6 individuals per 100 km² (Burgelo, 1986). By the early 1990s, estimates had declined to 7-8 animals (0.9-1.0 individuals per 100 km²; Shakula, 1995); with further declines to 2-3 individuals by the late 1990s (Kolbintsev, 2001). The current population of snow leopards in the reserve is estimated at 8-10 individuals. Additional animals in the Sairam-Ugam National Park, on the Karzhantau, Ugam, Maidantal, Talassky ridges, give a total estimate at 12-15 individuals, with an average density of 0.8 individuals per 100 km².

In the Kyrgyz Alatau, camera trapping in the Merken Forestry Enterprise (since 2025, the Merke Regional Nature Park) in 2020 suggested a population of 5-8 individuals (average density of 0.81 individuals per 100 km²), probably due to movement of animals from neighboring Kyrgyzstan.

In the Dzungar Alatau in the 1980s, 65-70 snow leopards occurred across 8,200 km², but the number decreased to

~50 individuals by 1990, of which 11 snow leopards lived in the western half of the ridge, 20-25 in the eastern half, the rest lived along the state border on the ridges (Anenkov, 1992). Results of recent surveys in the northeastern part of the Dzungar Alatau from the upper reaches of the Tentek River in the west to the end of the ridge in the area of the Dzungarian Gate in the east suggest 15-20 extant snow leopards. The total population in the Dzungar Alatau (including Toksanbai, Dzungar Alatau (Central), Kungei, Tastau ridges) is estimated at 50-60 individuals, and the average density is 0.58 individuals per 100 km².

Surveys carried out in 2022-23 along the southwestern spurs of the Dzungar Alatau, on the Sholak, Degeres, Matai, Altyn-Emel, Koyandytau ridges, suggest 21-23 individuals (average density of 1.57 individuals per 100 km²).

In the Kazakhstan Altai between the 1970s and 1990s, snow leopard occurred across approximately 1,800 km², supporting an estimated 14-18 individuals (Baidavletov, 1997). By 1995, this had declined to 10-15 (Zinchenko, 1995). By 2000 only 7-8 individuals were estimated to remain (population density of 0.3-0.4 individuals per 100km²; Zhiryakov & Baidavletov, 2002). Estimates of 10-12 individuals were made in 2009 (Loginov, Loginova, 2009). Recent surveys between 2017-24, suggest that numbers remain low, ~3-6 individuals (average density of 0.25 individuals per 100 km²). Recent limited surveys in the *Saur and Tarbagatai* mountains, did not suggest snow leopard numbers were recovering here either. Snow leopard were only encountered in the Saur mountains in 2021, with the number in these mountains estimated at only 1-3 individuals, with possibly none resident.

3. Threats

Poaching and trafficking

Poaching and trade in snow leopard parts in Kazakhstan were recorded during the 1990s and early 2000s but have become infrequent more recently. There remains insufficient official statistics on poaching and trade, but our surveys among communities in snow leopard habitats, and analysis of social network data, suggest that 5-10 snow leopards are illegally killed in Kazakhstan each year.

The issue of poaching is most acute in the mountains of the Dzungar Alatau, where large areas of snow leopard habitat remain unprotected. In the Kazakhstan Altai, snow leopard can be accidentally captured by traps set by poachers targeting musk deer (*Moschus moschiferus*) and brown bear (*Ursus arctos*). Evidence is scarce but by-catch might at least partially explain apparent declines in

snow leopard numbers in this region. Elsewhere, poaching impacts on snow leopard are not considered to significantly affect populations

Recent cases of direct and indirect persecution of snow leopard have been attributed to conflict with livestock farmers. Pastoralists are increasingly using chemically undetermined poisons imported across the border with China, to control other predators, mainly wolves, which are also threatening snow leopards. Increasing populations of snow leopard in Kazakhstan, including beyond protected areas, requires ongoing monitoring. Thus far, cases have been recorded in the Tien Shan and the Dzungar Alatau. Reductions in the snow leopard's natural prey due to illegal hunting remains the most important issue and requires further attention by national and local authorities.

Habitat degradation

The number of livestock declined sharply in the 1990s but has increased again in many areas within the snow leopard's range, including some protected areas. This has driven declines in natural prey species abundances through competition and reduced breeding rates. Snow leopard prey-switching to livestock occurs where natural prey has disappeared leading to conflict spirals with farmers, and potentially further persecution.

Infrastructure development

Infrastructure developments are causing increased habitat fragmentation, further isolating snow leopard populations. Road and rail infrastructure is being newly built, reconstructed or enhanced in response to new economic opportunities developments, such as the modern "Silk Road" along the Ili Basin. These have obstructed movement of snow leopards between the Northern Tien Shan and the Jungar Alatau, which is indicated as an important area for range-wide connectivity.

The construction of new fences, including those along international borders, has a negative impact on the regular seasonal migrations and movements of snow leopards and their principal prey species, such as Argali and Siberian ibex. Border fencing between China and Kazakhstan poses a particularly severe barrier to snow leopard dispersal, as demonstrated by satellite telemetry and visual observations (unpublished data). For example, in spring 2025, one snow leopard became entangled in barbed wire while attempting to cross the border fence. Addressing this problem will require modifications to fence design that facilitate wildlife passage, which in turn necessitates coordinated efforts between the two countries.

Human population growth and urbanization

The snow leopard range in Kazakhstan is increasingly

facing pressures from urban expansion, including the mega-city of Almaty, which has engulfed two large mountain gorges of the Malaya Almatinka and Bolshaya Almatinka rivers, into built-up and heavily populated suburbs. Snow leopards appear to have vacated these areas, allowing jackals and domestic dogs to become problematic for wildlife.

Disturbance

Disturbance factors affecting wildlife have been exacerbated by the massive and uncontrolled movements of people to the mountainous areas near the city of Almaty. Increases in accessibility for both organized and informal tourism coincides with the snow leopard breeding season, particularly in winter. The previous inaccessibility of snow leopard habitats was one of the main factors contributing to the species conservation. Further efforts are now urgently required, consolidated across numerous sectors, to ensure that snow leopards remain a contemporary cultural emblem of Kazakhstan and not a history lesson.

Climate Change

In the context of ongoing climate warming, glaciers are undergoing accelerated retreat, driven predominantly by rising summer temperatures. This process has profound implications for water availability, affecting both human populations and wildlife. The most pronounced retreat is observed in peripheral, low-elevation mountain ranges located near densely populated foothill regions, where arid summer conditions prevail and snowmelt together with glacial runoff constitute essential sources of water supply (Sorg et al. 2012; Shahgedanova et al. 2020).

Recently observed climate change is having fundamental environmental impacts, such as a shift in the timing and nature of snow cover in these mountains. This is especially noticeable in the Northern Tien Shan, with very little snow cover until the end of winter and the beginning of spring. This in turn results in ski resorts needing to produce artificial snow, leading to increased disturbance with polluting and noisy modern technology, as well as due to the increase of people in the mountains in winter. The Government of the Republic of Kazakhstan has approved a Concept of Tourism Industry Development, which envisions large-scale infrastructure expansion in the mountains. Against a backdrop of continued climate warming, such developments are likely to compound pressures on snow leopard populations.

Elsewhere, in the desert spurs of the Ileisky and Dzungar Alatau, where snow leopards live at low elevations, water sources (springs and small rivers) have been drying earlier. Remaining water sources, especially those outside of protected areas are utilized by cattle herders and become

inaccessible to snow leopards and their prey. Furthermore, declines in drinking water quality have been observed across the Turkestan region in south Kazakhstan. In response, the government launched a project to build several reservoirs in the mountain valleys of the Western Tien Shan. Such a large-scale project is expected to lead to further degradation of snow leopard habitats at the very edge of the species' range.

More broadly, climate change facilitates expanding human intrusion into previously undisturbed habitats, accelerating fragmentation of snow leopard range and undermining ecological connectivity. These processes not only threaten isolated populations but also reduce opportunities for gene flow across the species' range. Effective responses must therefore extend beyond national borders, prioritizing both the establishment of new protected areas and the ecological connectivity of existing ones through habitat corridors. Strengthening transboundary cooperation between range states will be critical to maintaining viable snow leopard populations under the combined pressures of climate change and intensifying anthropogenic activity.

4. Conservation

Research and Monitoring

Long-term research on snow leopards in Kazakhstan has been carried out by the government-based Institute of Zoology since its foundation in 1932. Early work laid the foundations for biodiversity conservation in Kazakhstan including the creation of protected areas, publishing the Red Book of Kazakhstan, and providing critical policy guidance for species and habitat protection. The Red Book of Kazakhstan lists snow leopard as Category III: "a rare species whose range and number are decreasing". The Snow Leopard Conservation Strategy (2011) and National Action Plans (2015, 2020, 2025) have been developed for Kazakhstan, further adopting the Global Snow Leopard & Ecosystem Protection Program (GSLEP) Bishkek Declarations (2013, 2017).

The recently established Snow Leopard Monitoring Center at the Institute of Zoology strengthens efforts to understand the state of snow leopard populations and their prey throughout Kazakhstan and establish effective conservation measures. Key areas of snow leopard habitat have been surveyed annually since 2012, working with protected area teams. In 2019, the first molecular genetic studies were initiated, making it possible to identify individuals and their sex.

In the period from 2021 to 2024, a total of 11 snow leopards were equipped with satellite collars within the territories of

Ile-Alatau National Park (Northern Tien Shan) and Altyn-Emel National Park (Dzungarian Alatau). Subsequent satellite telemetry research is planned in other regions of Kazakhstan in order to investigate the survival strategies and movement dynamics of snow leopards at the periphery of their distribution range.

National Policy and Legislation

The snow leopard is a national and state symbol of Kazakhstan, with great social and cultural significance. Their protection is enshrined by environmental policies and tightly observed regulations. In the 30-years since Kazakhstan's independence, 10 new protected areas have been created in snow leopard habitats, leading to apparent population increases.

At the legislative level, the protection of the snow leopard in Kazakhstan is regulated by key laws under the Criminal Code of the Republic of Kazakhstan: "On the protection, reproduction and use of Wildlife"; and "On Specially Protected Natural Territories". The legal framework for combating snow leopard poaching has been reinforced, introducing fines exceeding USD 20,000 along with criminal liability, including terms of imprisonment, as a deterrent measure.

Protected Areas

Protected areas have been established in Kazakhstan's mountain ecosystems, with three nature reserves (IUCN Category Ia) and eight national parks (Category II) in snow leopard range. Aksu-Zhabagly State Reserve (1,281 km²), Sairam-Ugam National Park (1,500 km²) and Merke Regional Nature Park (860 km²) are in the Western Tien Shan. Almaty Nature Reserve (717 km²), Ile-Alatau National Park (1,992 km²), Kolsai Kolderi (1,610 km²) and Charyn (1,270 km²) are in the Northern Tien Shan. Altyn-Emel (3,077 km²) and the newly created Zhongar-Alatau National Park (3,560 km²) are in the Dzungar Alatau. Markakol Nature Reserve (1,030 km²) and Katon-Karagai National Park (6,435 km²) are in Altai. There are no reserves or national parks in Saur, and the key ridges of Kyrgyz, Ketmen and Terskey Alatau in the Tien Shan, although there are four wildlife sanctuaries (IUCN category IV): Almatinsky (5,124 km²), Verkhne-Koksuisky (2,400 km²), Toktinsky (1,870 km²), and Lepsinsky (2,580 km²).

In Kazakhstan, protected areas safeguard a substantial portion of the mountain ecosystems that support the core of the national snow leopard population. Between 70% and 90% of the country's total population of the species is found within protected areas. These areas also provide conditions for successful reproduction and high cub survival. According to approximate estimates, between 30 and 50 snow leopard cubs are born annually in Kazakhstan.

The snow leopard and its ecosystems are relatively well protected in the Western Tien Shan, the Ile Alatau and Kungei Alatau ranges of the Northern Tien Shan, as well as in the Altai. In the Dzungarian Alatau, it would be advisable to expand the existing national park eastward. Effective protected areas are particularly needed in the Saur, Ketmen, and Terskey Alatau ranges. At present, the Government of Kazakhstan, in cooperation with other organizations, is working on the establishment of new protected areas and the enhancement of existing ones. In August 2025, a new Regional Nature Park «Merke» was established in the Kyrgyz Alatau Mountains (Western Tien Shan) for the conservation of the snow leopard.

Mitigating Human–Snow Leopard Conflicts

With the increasing number of snow leopards in Kazakhstan and their dispersal beyond protected areas, previously sporadic conflicts with livestock herders are becoming a serious threat. Outside protected areas, intensive land use leads to habitat degradation and a rise in conflict situations, resulting in direct persecution of the species: an estimated 5–10 individuals are killed annually by humans. Long-term monitoring has shown that the main source of conflict is depredation by young snow leopards dispersing from protected areas and attacking livestock or approaching herder camps. Satellite telemetry data (2021–2024, 11 individuals) confirmed that nearly all snow leopards leaving protected areas came into conflict with humans, particularly in the Dzungarian Alatau and its spurs. Additional risks are posed by hunting concessions, where the species may be regarded as a ‘harmful’ predator causing economic losses to trophy hunting enterprises. Although ungulate densities (the main prey species of snow leopards) are considerably higher in some hunting concessions than in protected areas, systematic monitoring of snow leopard populations is not carried out.

A dedicated program for resolving human–snow leopard conflict situations has not yet been adopted in Kazakhstan. However, the Institute of Zoology has undertaken limited efforts to translocate conflict individuals. In 2022–2023, two snow leopards were relocated to safer habitats, where they successfully adapted to the new environment. Given the seriousness of this threat, compounded by ongoing habitat degradation intensified by climate change, urgent conservation measures and an integrated approach are required. Priority actions include the resumption and expansion of the protected area network; providing economic incentives to local communities (e.g., compensation schemes, ecotourism support); strengthening protection and monitoring; implementing environmental education and awareness-raising on the ecological role of the snow leopard; and initiating a structured program for the translocation of conflict individuals to support

declining or locally extinct populations in Kazakhstan. Effective conflict resolution will require the joint efforts of government agencies, NGOs, and local communities.

5. Acknowledgements

This country status report acknowledges the long-term contributions of research institutions, protected area authorities, conservation organizations, and members of the research and practitioner community in Kazakhstan whose data, monitoring efforts, and expertise informed this synthesis. The report further acknowledges the IUCN SSC Cat Specialist Group and the wider IUCN Red List assessment team for their guidance and collaboration during the snow leopard assessment process. Support for coordination of this country status series was provided by Justine Shanti Alexander, WCS Mongolia.

6. Conflict of Interest

The author declare no known conflicts of interest.

7. References

- Annenkov, B.P. (1992). Modern distribution, numbers and conservation of rare mammals in the Dzungarian Alatau Range. In: *Protection and study of rare and endangered animal species in nature reserves: a collection of scientific papers*. Moscow, pp. 69–74. (In Russian)
- Antipin, V.M. (1953). To the ecology of the snow leopard. *Priroda*, 4, pp. 115–116. (In Russian)
- Baidavletov, R.Zh. (1997). On the biology of the snow leopard in the Southern Altai. In: *Rare species of mammals of Russia and adjacent territories: theses of reports of the international meeting*. Moscow, p. 9. (In Russian)
- Burgelo, T.B. (1986). Brief reports on the snow leopard. In: *Rare animals of Kazakhstan*. Alma-Ata: Nauka of the Kazakh SSR, p. 54. (In Russian)
- Dzhanispaev, A.D. (2002). Distribution and numbers of the snow leopard in the central part of the Ile Alatau. *Selevinia*, 1–4, pp. 208–212. (In Russian)
- Fedosenko, A.K. (1982). Snow leopard. In: *Mammals of Kazakhstan*, Vol. 3, Part 2: Carnivora (Mustelidae, Felidae). Alma-Ata: Nauka of the Kazakh SSR, pp. 222–240. (In Russian)
- Grachev, A.A., Grachev, Yu.A. and Baidavletov, R.Zh. (2013). Monitoring of snow leopard populations in Kazakhstan using camera traps. In: *Scientific and methodological foundations for the compilation of the State Cadastre of Wildlife of the Republic of Kazakhstan and neighboring countries*. Proceedings of the International Scientific and Practical Conference, Almaty, pp. 67–70. (In Russian)
- Grachev, A.A., Grachev, Yu.A. and Meldebekov, A.M. (2015). Preliminary results of the study and monitoring of the snow leopard (*Uncia uncia* Schreber, 1775) using camera traps in

- Kazakhstan. *Vestnik of Al-Farabi Kazakh National University. Ecology Series*, 44(2/2), pp. 512–518. (In Russian)
- Grachev, A.A., Grachev, Yu.A., Akhmetov, H.A. and Saparbayev, S.K. (2017). The National Park “Kolsai Kolderi” as a key area for the conservation and reproduction of the snow leopard in Kazakhstan. In: *Current issues of biodiversity conservation of the Northern Tien Shan*. Proceedings of the International Scientific and Practical Conference, Saty, pp. 6–10. (In Russian)
- Grachev, A.A., Grachev, Yu.A., Saparbayev, S.K., Dzhanyspaev, A.D., Kantarbayev, S.S., Bespalov, M.V., Bespalov, S.V. and Baydavletov, E.R. (2019). Snow leopard in the Zailiysky Alatau (Northern Tien Shan). *Selevinia*, 27, pp. 71–80. (In Russian)
- Grachev, A., Grachev, Y., Saparbayev, S., Bespalov, M., Baidavletov, Y., Dzhanyspaev, A. and Riordan, P. (2023). Conservation of snow leopards in Kazakhstan. In: Mallon, D. and McCarthy, T. (eds.) *Snow Leopards: biodiversity of the world – conservation from genes to landscapes*. 2nd edn. Elsevier, pp. 471–480.
- Grachev, A., Grachev, Y., Bespalov, M., Saparbayev, S., Baidavletov, Y., Konysbayeva, D., Riordan, P. and Atzeni, L. (2025). Snow leopard connectivity through transboundary areas surrounding the Dzungarian Basin in Kazakhstan. *Ecological Modelling*, 510, 111281. <https://doi.org/10.1016/j.ecolmodel.2025.111281>
- Grachev, Yu.A. and Fedosenko, A.K. (1977). Modern distribution and numbers of the snow leopard in Kazakhstan. In: *Rare mammals of the fauna of the USSR and their protection*. Moscow: Nauka, pp. 18–22. (In Russian)
- Grachev, Yu.A. (2016). Predatory and ungulate mammals of the Aksu-Zhabagly Nature Reserve and adjacent ridges of the Western Tien Shan. In: *Proceedings of the Aksu-Zhabagly State Nature Reserve*, Vol. 11. Almaty, pp. 437–456. (In Russian)
- Heptner, V.G. and Sludsky, A.A. (1972). Snow leopard (*Uncia uncia* Schreber, 1775). In: *Mammals of the Soviet Union*, Vol. 2, Part 2: Carnivores (hyenas and cats). Moscow: Vysshaya Shkola, pp. 212–244. (In Russian)
- Kolbintsev, V.G. (2001). Current state of populations of rare vertebrate species in the Aksu-Dzhabagly Reserve. In: *Biological diversity of the Western Tien Shan*. Proceedings of the Aksu-Dzhabagly State Nature Reserve, Vol. 8. Kokshetau, pp. 139–140. (In Russian)
- Loginov, O.Ya. (1995). Distribution of the snow leopard in the republics of the former USSR. *Irbis: Bulletin of the Snow Leopard Conservation Center*, 2, pp. 9–12. (In Russian)
- Loginov, O.Ya. and Loginova, I. (2009). *The snow leopard: a symbol of the Celestial Mountains*. Ust-Kamenogorsk: Satura. (In Russian)
- Shahgedanova, M., Afzal, M., Hägg, W., Kapitsa, V., Kasatkin, N., Mayr, E., Rybak, O., Saidaliyeva, Z., Severskiy, I. and Usmanova, Z. (2020). Emptying water towers? Impacts of future climate and glacier change on river discharge in the Northern Tien Shan, Central Asia. *Water*, 12, 627. <https://doi.org/10.3390/w12030627>
- Shakula, V. (1995). Snow leopard in the Aksu-Dzhabagly Nature Reserve. *Irbis: Bulletin of the Snow Leopard Conservation Center*, 12, pp. 5–9. (In Russian)
- Sludsky, A.A. (1973). Distribution and numbers of wild cats in the USSR. In: *Proceedings of the Institute of Zoology of the Kazakh SSR*, Vol. 34. Alma-Ata: Nauka of the Kazakh SSR, pp. 6–106. (In Russian)
- Sorg, A., Bolch, T., Stoffel, M., Solomina, O. and Beniston, M. (2012). Climate change impacts on glaciers and runoff in the Tien Shan (Central Asia). *Nature Climate Change*, 2, pp. 725–731.
- Tushkenov, S.N. (2017). Irbis in the Zhongar Alatau. In: *Current issues of biodiversity conservation of the Northern Tien Shan*. Proceedings of the International Scientific and Practical Conference, Saty, pp. 17–21. (In Russian)
- Zhatkanbayev, A.Zh. (2012). Records of snow leopard in southeastern Kazakhstan. In: *Zoological and game management research in Kazakhstan and adjacent countries*. Proceedings of the International Scientific and Practical Conference, Almaty, pp. 108–110. (In Russian)
- Zhiryakov, V.A. and Baidavletov, R.Zh. (2002). Ecology and behaviour of the snow leopard in Kazakhstan. *Selevinia*, 1–4, pp. 184–199. (In Russian)
- Zinchenko, Yu.K. (1995). Irbis in the mountains of the Kazakhstan Altai. *Irbis: Bulletin of the Snow Leopard Conservation Center*, 2, pp. 12–16. (In Russian)



Snow Leopard (*Panthera uncia*) Status in Kyrgyzstan

CONTRIBUTORS:

Zairbek Kubanychbekov^{1*}, Koustubh Sharma²,
Kubanychbek Zhumabai uulu³, Oliver Wearn²,
Ian Durbach⁶, Matt Raulerson¹, Chyngyz Kochorov⁴,
Tolkunbek Asykulov⁵, Maxim Koshkin¹,
Gulnura Zhumabay kyzy¹, Kabaev Eldiir¹

KEYWORDS:

snow leopard; *Panthera uncia*; Kyrgyzstan;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Kubanychbekov et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

1 Ilbirs Foundation, Bishkek 720005, Kyrgyzstan

2 Snow Leopard Trust, Seattle, WA, 98103, USA

3 Snow Leopard Foundation, Bishkek 720011, Kyrgyzstan

4 GSLEP, Bishkek 720040, Kyrgyzstan

5 NABU Kyrgyzstan, Bishkek 720011, Kyrgyzstan

6 Centre for Research in Ecological and Environmental
Monitoring, St Andrews University, Scotland, UK

* Email: zkubanychbekov@ilbirs.org

1. Distribution

Kyrgyzstan contains more than 125,000 km² of mountainous terrain above 2,000 m elevation, representing approximately 63% of the country. In Kyrgyzstan, snow leopards occur in the northern, southern, and western portions of the Tian Shan Mountain system. Within the Kyrgyz Tian Shan, the species is distributed across the Kyrgyz, Kungey, Terskey Ala-Too, Ferghana, Moldo-Too, Djetim, Kakshal, Talas, and Pskem ranges. In the Pamir-Alai system, snow leopards are present in the Turkestan, Alai, and Trans-Alai ranges.

The primary elevational range of snow leopards in Kyrgyzstan is between 3,000 and 4,000 m. However, the species has been recorded as low as 2,000 m based on camera trap data (PASK, 2024), and field evidence suggests it may occur at elevations up to 4,500 m. Key protected areas supporting snow leopard habitat include Sarychat-Eertash State Nature Reserve, Khan-Tengri State Nature Park, Kan-Achuu State Nature Park, Alatau State Nature Park, Naryn State Nature Reserve, Besh-Aral State Nature Reserve, Kara-Shoro State Nature Park, Chon Kemin State Nature Park, and Padysha-Ata State Nature Reserve. Additional snow leopard habitat is also found within designated hunting concessions.

The previous snow leopard distribution map for Kyrgyzstan was developed in 2017 by Panthera, the

Wildlife Conservation Society, the Snow Leopard Trust, and the Snow Leopard Network (McCarthy et al., 2017; IUCN range map). The updated distribution map presented here is informed by findings from the 2024 Population Assessment of the Kyrgyz Snow Leopards (PASK, 2024) (Figure 1). Like earlier maps, the polygons for the ‘extant’ and ‘possibly extant’ areas were hand-drawn based on expert opinion. However, this time we improved the hand-drawn areas by validating them against extensive field data from 2018–2024, including: i) camera trap surveys (PASK, 2024), ii) more than 40 field surveys assessing snow leopard sign, and iii) local community interviews. This approach enabled a more robust, data informed estimation of snow leopard distribution across both surveyed and un-surveyed areas.

The updated map for 2024 confirms snow leopard presence in several areas previously classified as possibly extant. In particular, the Terskey Ala-Too Range north of Issyk-Kul, within Chon Kemin State Nature Park, was reclassified as extant following multiple snow leopard

detections recorded by camera traps between 2021 and 2024. Substantial portions of the Pamir–Alai system were also updated. In the Turkestan Range, camera trapping and field surveys conducted by The Nature and Biodiversity Conservation Union (NABU) within the framework of the PASK assessment confirmed snow leopard presence in and around Surmatash State Nature Reserve and Sarkent State Nature Park. Further east in the Pamir–Alai system, within the Alai Range, similar camera trapping and survey efforts conducted by Panthera confirmed snow leopard presence in and around the community-based conservancy of Bek-Tosot. Overall, ~78,800 km² have been identified as occupied by snow leopards (i.e. classified as ‘extant’) and ~14,800 km² have been identified as potentially being occupied by snow leopards (‘possibly extant’; Fig. 1).

2. Population

In 2017, the Bishkek Declaration identified the lack of reliable information on the global abundance and

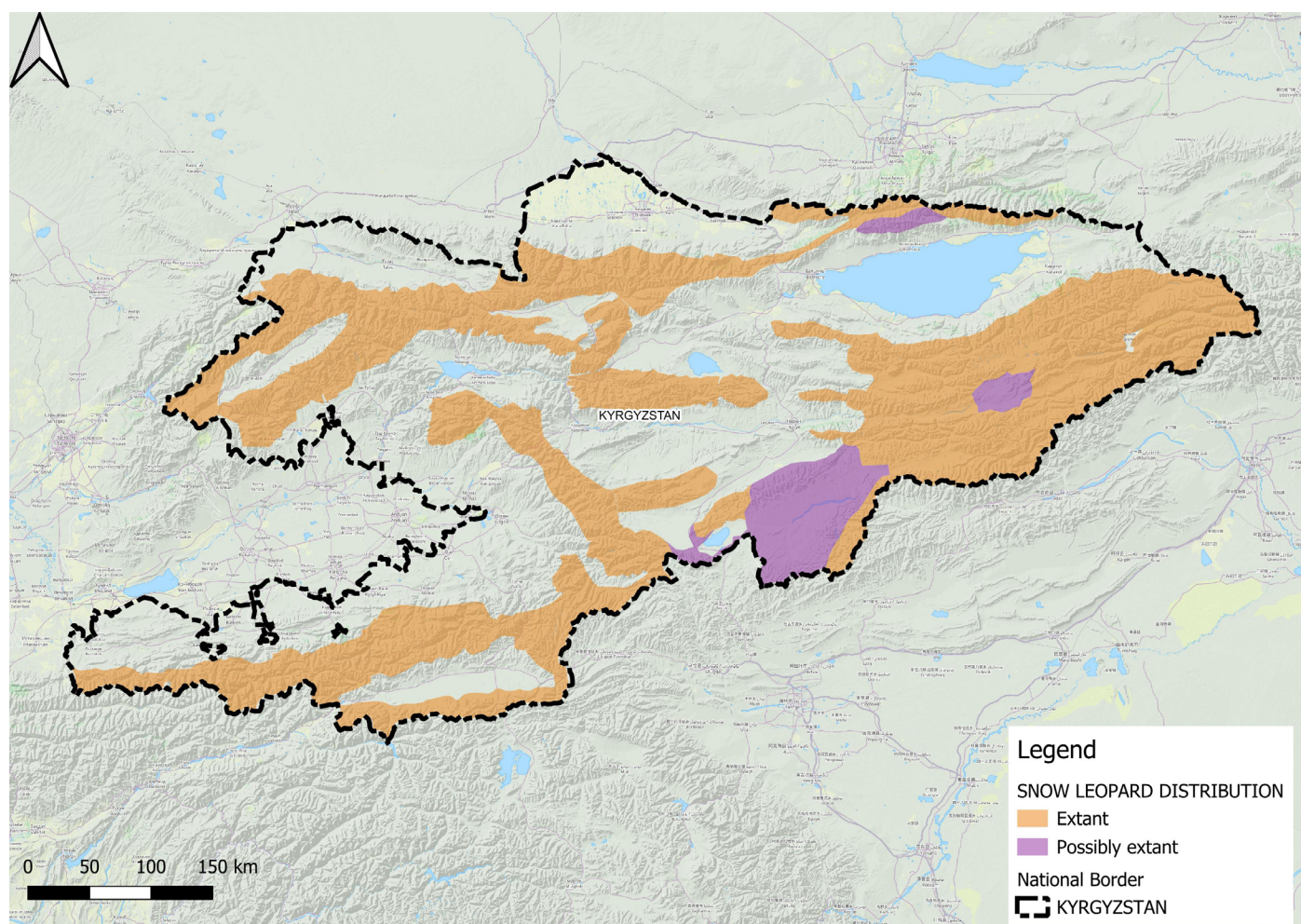


Figure 1. Snow leopard (*Panthera uncia*) distribution in Kyrgyzstan based on the IUCN Red List assessment criteria. Areas shaded in orange represent extant range, while areas shaded in purple represent possibly extant range. The distribution map was informed by information from the Population Assessment of Snow Leopards in Kyrgyzstan (PASK, 2024).

distribution of snow leopards as a critical knowledge gap. In response, a nationwide population assessment of snow leopards was conducted in Kyrgyzstan between 2020 and 2024. The resulting *Population Assessment of the Kyrgyz Snow Leopards* report was developed and approved under the framework of the Global Snow Leopard and Ecosystem Protection Program (GSLEP) (PASK, 2024). This assessment provides the first scientifically rigorous and comprehensive estimate of snow leopard abundance at the national scale (PASK, 2024).

The national snow leopard population abundance was estimated using data from 43 population survey sessions spanning the four-year study period, derived from 905 camera traps deployed across 589 locations within snow leopard habitat (PASK, 2024). Camera traps were typically deployed for periods ranging from 3 to 12 months to ensure adequate sampling coverage. In total, 372 snow leopard detection events were recorded, involving 150 unique adult snow leopards (PASK, 2024). These data were then analysed using multisession spatial capture–recapture (SCR) models which incorporated key ecological and anthropogenic variables, including elevation, terrain ruggedness, protected area status, and distance to the nearest road.

Based on SCR analyses, the estimated adult snow leopard population in Kyrgyzstan is approximately 300 individuals, with a 95% confidence interval of 246 to 366 (PASK, 2024). This estimate from the nationwide population assessment represents the most robust and up-to-date scientific basis

available for national conservation planning in Kyrgyzstan and long-term population monitoring under the GSLEP framework.

The mean snow leopard density across Kyrgyzstan was estimated at 0.24 individuals per 100 km², with a 95% confidence interval of 0.20 to 0.29 (PASK, 2024). Issyk-Kul oblast supported the highest estimated abundance, with approximately 72 individuals (Fig. 2). The highest densities of snow leopards were found to be in rugged mountainous terrain within protected areas, highlighting the importance of these areas for snow leopard conservation (PASK, 2024). However, no single protected area in Kyrgyzstan is sufficiently large to support a viable population independently, defined here as at least 50 individuals. This underscores the importance of maintaining a connected network of protected areas, community-managed reserves, and functional habitat corridors to ensure long-term population persistence.

Historical estimates of snow leopard abundance in Kyrgyzstan varied widely, ranging from 600 to 700 individuals (Koshkarev, 1989) to 1,200 to 1,400 individuals (Chichikin, 1973; Geits et al., 1983; Red Book of the Kyrgyz SSR, 1985) during the Soviet period, with a later estimate of approximately 150 individuals (Koshkarev and Vyrypaev, 2000). These earlier estimates were not derived from systematically collected data and rigorous statistical analysis and are therefore not directly comparable to the latest PASK assessment.

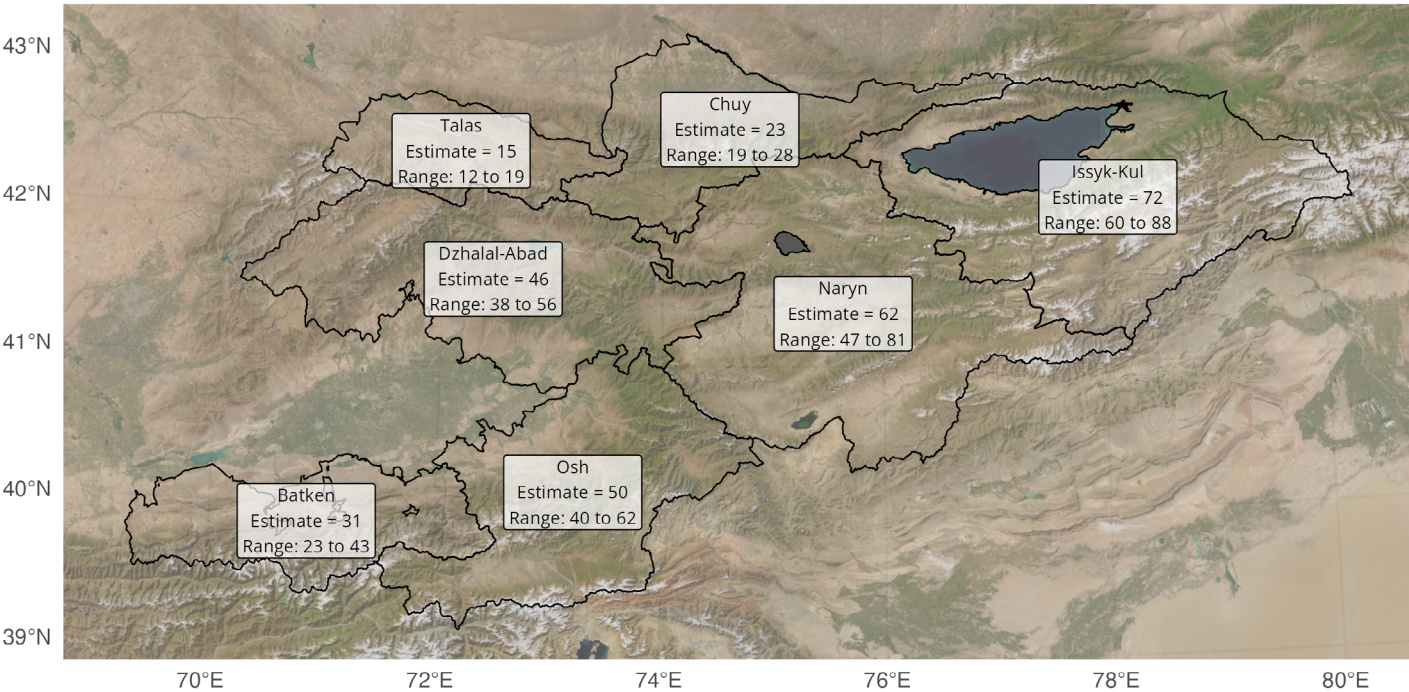


Figure 2. Number of adult snow leopards for each administrative region in the Kyrgyzstan (including uncertainty range), as estimated using spatial capture–recapture modelling of camera trap data under the Population Assessment of Snow Leopards in Kyrgyzstan (PASK, 2024)

3. Threats

Illegal hunting of prey species

Illegal hunting of key snow leopard prey species, particularly argali (*Ovis ammon*) and Siberian ibex (*Capra sibirica*), represents one of the most significant threats to snow leopard populations in Kyrgyzstan. These ungulates are hunted for personal consumption, commercial meat trade, and recreational purposes. As primary prey, they are critical to snow leopard survival, particularly during winter, with each adult snow leopard requiring an estimated 20 to 30 ungulates annually (Koshkin et al., 2024).

Illegal hunting pressure arises from multiple sources, including opportunistic hunters, organized sport hunting groups, and professional poachers supplying wild meat to markets. Declines in prey populations are projected to result in a 20 to 30% reduction in snow leopard numbers by 2034 if current trends continue (Koshkin et al., 2024). This threat is most pronounced in areas with weak law enforcement and high demand for wild meat, including middle-income urban consumers and customary practices in rural communities (Koshkin et al., 2024).

Effective prosecution of illegal hunting cases involving wild meat requires laboratory analysis to confirm species identity and distinguish wildlife from livestock. In Kyrgyzstan, existing laboratories are primarily equipped for livestock meat testing and lack the capacity to identify wildlife DNA. As a result, seized meat cannot be reliably attributed to protected species, limiting the ability of authorities to prosecute offenders and enabling poachers to evade legal consequences.

Retaliatory killings by pastoralists

Snow leopards are occasionally killed by herders in retaliation for livestock depredation. Direct evidence is limited due to the remoteness of incidents; however, interviews with herders and occasional confiscation of skins indicate that retaliatory killing does occur. Livestock depredation by snow leopards is reported most frequently in eastern Kyrgyzstan, particularly in the high-altitude pastures of Ak-Suu district in Issyk-Kul oblast. Additional incidents have been reported from Zheti-Oguz and Ton districts in Issyk-Kul, as well as from Naryn district.

Currently, there is no consolidated national dataset on snow leopard livestock depredation. Available information suggests that approximately 7 to 12 depredation incidents occur annually, affecting an estimated 50 to 200 livestock, primarily sheep (Ilbirs Foundation, unpublished). However, a comprehensive assessment has not yet been conducted to determine temporal trends.

Surveys conducted among herders in Enilchek, Kayindi, and Koilu, high-altitude areas within Ak-Suu district, documented 33 reported cases of livestock depredation attributed to snow leopards between 2022 and 2024 (Koshkin and Jumabaeva, in press). These data were obtained through interviews, and attribution uncertainty remains due to the lack of verified evidence distinguishing snow leopard attacks from those by other predators.

Anecdotal evidence suggests that some snow leopards have been killed in retaliation within these areas. Declining wild prey populations combined with increasing livestock numbers elevate the likelihood of human–carnivore conflict, potentially increasing retaliatory killings. Koshkin et al. (2024) estimate that up to 20% of the snow leopard population in Naryn and Issyk-Kul oblasts could be lost to retaliatory killing by 2034 if current trends persist. Enforcement capacity is limited in these remote regions, and compensation and conflict mitigation programmes remain insufficient in scale and coverage.

Illegal killing for trade

Despite high legal penalties and strengthened enforcement, targeted killing of snow leopards for skins and body parts continues at low but persistent levels. Snow leopard skins have been documented in domestic markets, and several attempted cross-border smuggling cases have been recorded over the past decade. Demand is believed to be driven by traditional medicine markets, as well as by trophy and taxidermy interests.

Although the current impact of trade-driven killing is relatively limited, it could increase if enforcement weakens, demand rises, or market access expands, particularly in connection with new infrastructure development. Retaliatory killings may also contribute to trade, as body parts from conflict-related incidents are sometimes sold.

Between 2020 and 2022, several documented cases highlighted ongoing threats from illegal killing and trade. In January 2020, an emaciated snow leopard estimated to be 11 to 12 years old was found in Jungal and transferred to Bishkek for veterinary care after being reported by a local resident (Orlova, 2020). Additional cases involved possession and attempted sale of snow leopard skins and skulls in Bishkek, Osh, and border areas near Kazakhstan, resulting in multiple arrests and prosecutions under wildlife protection laws (Roznev, 2021; Sputnik KG, 2022; Turmush, 2022; Kaktus, 2022).

Rangers often operate under dangerous conditions with limited logistical support. Encounters with armed illegal hunters, including individuals from outside the region, are not uncommon, and resistance during arrests has

been reported. To address these risks, a national incentive programme was introduced to reward rangers and community members for identifying and apprehending poachers, particularly in cases involving snow leopards or ungulates. The programme provides financial incentives, formal recognition, and promotes cooperation between local communities and protected area authorities.

Overgrazing and livestock competition

Livestock numbers in Kyrgyzstan have increased steadily, particularly in high-altitude areas, leading to intensified competition between domestic animals and wild ungulates for forage. Combined with declining pasture productivity, this pressure contributes to reductions in wild prey availability for snow leopards. Reduced prey abundance can force snow leopards into marginal habitats or increase reliance on livestock, reinforcing a feedback loop that heightens the risk of human–wildlife conflict and retaliatory killing.

Disease transmission

Disease transmission among livestock, domestic dogs, wild ungulates, and snow leopards is an emerging conservation concern. Overlap between high-altitude livestock grazing areas and wild ungulate habitats increases the risk of pathogen transmission. Snow leopards may be exposed to diseases such as brucellosis, sarcoptic mange, rabies, canine distemper, and intestinal parasites through contact with infected livestock, dogs, or prey species. While disease dynamics in snow leopards remain poorly studied, such infections could impair health, reduce reproductive success, and cause mortality. Disease impacts on prey species may further reduce food availability for snow leopards.

Weak law enforcement

Weak law enforcement is not a direct biological threat but represents a major constraint on effective snow leopard conservation. Although snow leopards are legally protected and listed in the Red Book of Kyrgyzstan, enforcement is inconsistent and under-resourced. Rangers working in remote mountain areas face severe logistical challenges, including difficult terrain, limited transport, inadequate communication infrastructure, and harsh climatic conditions. These factors restrict patrol coverage and limit timely responses to illegal activities.

Future potential threats

Infrastructure development

Planned infrastructure development poses a potential future threat, particularly the China–Kyrgyzstan–Uzbekistan railway planned through Naryn oblast. Construction activities are expected to increase human access to previously remote habitats and may elevate demand for snow leopard body parts among temporary

labour populations. Infrastructure development also risks habitat fragmentation, reduced connectivity, and restricted prey movements. In particular, the railway will cut across a critical area for the connectivity of snow leopard and prey populations between the Fergana range and Western Tian Shan. Although construction has only recently commenced and current impacts remain limited, projections suggest that by 2034, up to 20 to 30% of the local snow leopard population could be affected if mitigation measures are not implemented.

Climate change

Climate change represents a growing indirect threat to snow leopards by altering alpine ecosystems rather than through direct physiological stress. Snow leopards tolerate extreme temperatures ranging from -40°C to $+40^{\circ}\text{C}$; however, their dependence on cold, high-altitude environments increases vulnerability to habitat shifts. According to the 2023 Climate Vulnerability Assessment conducted under the Central Asian Mammals and Climate Adaptation project, suitable snow leopard habitat in Kyrgyzstan may increase by approximately 9%, but this expansion is accompanied by reduced connectivity due to upward treeline shifts and degradation of alpine zones. Such fragmentation may isolate populations and limit genetic exchange.

Climate-driven changes are also expected to affect prey distribution and habitat quality, increasing competition with livestock at higher elevations and bringing snow leopards into closer proximity with human activity. Extreme weather events have already caused large-scale prey mortality, such as the 2022 die-off in Issyk-Kul oblast, with potential cascading effects on snow leopard survival. Additionally, climate-related shifts in pathogen distribution may increase disease exposure, particularly in areas with expanding livestock presence.

4. Conservation

Legislation and policy framework

Snow leopard conservation in Kyrgyzstan is governed by a combination of international agreements and national legislation. Kyrgyzstan is a Party to the Convention on Biological Diversity (CBD, 1992), ratified under Law No. 40 on 26 July 1996; the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973), ratified on 30 November 2006 under Law No. 192; and the Convention on the Conservation of Migratory Species of Wild Animals (CMS, 1979), ratified on 22 November 2013 under Law No. 205. Together, these instruments form an integrated legal framework for snow leopard conservation, addressing species protection,

habitat conservation, and the prevention of poaching and illegal wildlife trade.

A major outcome of this framework was the establishment of the Global Snow Leopard and Ecosystem Protection Program (GSLEP) under the auspices of CMS. On 23 October 2013, the Global Snow Leopard Conservation Forum was held in Bishkek, Kyrgyzstan, during which 12 snow leopard range countries adopted the Bishkek Declaration, endorsed a ten-year Global Snow Leopard and Ecosystem Protection Program, and established the GSLEP Secretariat. GSLEP now serves as a transregional platform that brings together governments, non-governmental and intergovernmental organizations, local communities, and the private sector to conserve snow leopards and their high-mountain ecosystems.

At the national level, snow leopard conservation is incorporated into Kyrgyzstan's National Biodiversity Strategies and Action Plans, which serve as the primary policy instruments for implementing commitments under the Convention on Biological Diversity. These strategies prioritize biodiversity conservation, sustainable use of natural resources, and equitable benefit sharing.

Snow leopard protection is further codified in national legislation. The Law of the Kyrgyz Republic "On Wildlife" (adopted on 17 June 1999) regulates the protection of endangered species, including the snow leopard. The Law "On Specially Protected Natural Areas," last amended in 2021, establishes conservation regimes within protected areas that support snow leopard populations, including Sarychat-Eertash State Nature Reserve and Khan-Tengri State Nature Park.

Under Government Decree No. 145 (2005) "On Approval of the Lists of Rare and Endangered Animal and Plant Species," the snow leopard is listed in the Red Book of Kyrgyzstan, and all forms of hunting are strictly prohibited. Financial penalties for killing snow leopards have increased over time. Article 308 of the Criminal Code of the Kyrgyz Republic establishes fines of 500 to 1,000 calculation units (50,000 to 100,000 KGS) for the destruction of rare or endangered species listed in the Red Book, including damage to nests or eggs.

In addition, Cabinet of Ministers Decree No. 384 of 12 July 2024 increased the compensation rate for damage caused to a snow leopard to 2 million KGS, up from the previous rate of 1.5 million KGS. Offenders are liable for both criminal fines and compensation payments. Compensation rates for key prey species have also been revised, with argali set at 1.5 million KGS (previously 1 million KGS) and ibex at 300,000 KGS (previously 100,000 KGS).

The Code of Offenses of the Kyrgyz Republic further establishes penalties for violations related to wildlife protection, including damage to habitats, breeding sites, or migration routes, as well as the illegal export, transport, storage, or sale of wildlife specimens and their derivatives. In December 2023, Presidential Decree No. 369 formally designated the snow leopard as a national symbol of Kyrgyzstan.

The snow leopard is listed as Vulnerable on the IUCN Red List and is included in Appendix I of CITES, reinforcing its status as a specially protected species under both national and international legal frameworks.

Expansion and improved effectiveness of protected areas

Only 15% of the area identified as being occupied by snow leopards is currently protected. Including the 'possibly extant' area, the figure is even lower, at 13%. Recent conservation actions have focused on expanding and strengthening protected area networks and improving ecological connectivity for snow leopards and other species. One major initiative is the establishment of the Ak-Ilbirs (Snow Leopard) Ecological Corridor in Issyk-Kul oblast, covering the Sary-Jaz Valley and the Kakshaal-Too and Jety-Bel mountain ranges. The order establishing the corridor was signed on 15 April 2025. The corridor encompasses 792,050 ha and connects Khan-Tengri State Nature Park, Sarychat-Eertash State Nature Reserve, and Naryn State Nature Reserve.

In 2024, the Chatkal Ecological Corridor was established over an area of 64,105 ha to enhance connectivity between Sary-Chelek State Biosphere Reserve, Padysha-Ata State Nature Reserve, and Alatau State Nature Park.

Further expansion of the protected area network is planned for 2025, including the establishment of one state nature park (Chong-Alai) and two zoological reserves (Arka and Arpa), together covering more than 250,000 ha. The proposed Arpa reserve is intended to protect snow leopard habitat, and a new ecological corridor will connect Arpa with Kulun-Ata Nature Reserve, Kara-Shoro Nature Park, and Saimaluu-Tash Nature Park, strengthening landscape-scale connectivity for snow leopards.

Strengthening capacity of protected area and enforcement staff

The implementation of the Spatial Monitoring and Reporting Tool (SMART) across 11 protected areas and five community-based conservancies has substantially strengthened the capacity of protected area staff. SMART provides standardized tools for patrol planning, data collection, and wildlife monitoring, enabling evidence-

based management. Long-term application of the system has resulted in improved adaptive management, strengthened monitoring frameworks, and the accumulation of extensive wildlife datasets.

Capacity-building initiatives led by national and international conservation organizations have further strengthened anti-poaching and enforcement capacity. Training programmes have addressed effective patrolling, checkpoint operations, wildlife crime scene investigation, counter-wildlife trafficking, prosecution of wildlife crime, and first aid in remote areas. More than 200 protected area rangers, community-based conservancy rangers, and state inspectors have been trained, including staff from the Ministry of Natural Resources, Ecology, and Technical Supervision and the Issyk-Kul Ecological Police.

Targeted institutional support has also been provided to customs and border services. For the first time in Kyrgyzstan, sniffer dogs were trained to detect illegal wildlife products, including snow leopard and ungulate derivatives, and deployed at border checkpoints. Customs officers received training in their handling and use.

An electronic database for monitoring trade in CITES-listed species was developed in partnership with TRAFFIC. The database is accessible to customs, border control, veterinary services, and the General Prosecutor's Office, enabling verification of permits and identification of wildlife products. The system includes guidance on species identification and required documentation and is fully operational, with additional trainings planned.

A ranger incentive programme has also been established to recognize high-performing staff. Since its inception in 2014, the programme has rewarded 166 rangers across more than 150 cases.

Strengthening international and interregional cooperation

The Global Snow Leopard and Ecosystem Protection Program provides the primary mechanism for international and interregional cooperation on snow leopard conservation. GSLEP facilitates collaboration among range-country governments, scientific institutions, non-governmental organizations, and local communities, supporting cross-border cooperation, scientific data exchange, coordinated population monitoring, joint anti-poaching initiatives, and sustainable livelihood development.

Within this framework, Kyrgyzstan implements the Population Assessment of the Snow Leopard in Kyrgyzstan programme, aligned with the Population Assessment

of the World's Snow Leopards initiative. PASK applies standardized methodologies, including camera trapping, genetic sampling, and spatial capture–recapture modelling, to generate nationally robust population estimates and inform management decisions within protected areas and priority landscapes.

GSLEP has identified 20 priority landscapes across the snow leopard range, including key areas in Kyrgyzstan such as Sarychat-Eertash and Khan-Tengri. Ongoing efforts focus on expanding protected area coverage, strengthening management effectiveness, and integrating advanced monitoring technologies to improve conservation outcomes for snow leopards and their habitats.

5. Acknowledgements

This country status report acknowledges the Ministry of Natural Resources, Ecology, and Technical Supervision of the Kyrgyz Republic and its partner institutions for their continued commitment to snow leopard conservation, research, and monitoring. We also recognize the contributions of national conservation organizations, protected area administrations, researchers, and practitioners in Kyrgyzstan whose work informed this synthesis.

We acknowledge the Global Snow Leopard and Ecosystem Protection Program and its Secretariat for leading the Population Assessment of the World's Snow Leopards initiative, under which the nationwide Population Assessment of the Snow Leopard in Kyrgyzstan was conducted. The IUCN SSC Cat Specialist Group and the snow leopard IUCN Red List assessment team are gratefully acknowledged for their technical guidance during the updated IUCN assessment process. Coordination of this country status report was supported by Justine Shanti Alexander, Wildlife Conservation Society Mongolia.

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Code of Offences of the Kyrgyz Republic (2021) No. 128, 28 October.
Criminal Code of the Kyrgyz Republic (2021) No. 127, 28 October.
Kaktus (2022) 'A man shot a snow leopard for its skull and skin. He was detained in Bishkek'. *Kaktus Media*. Available at: https://kaktus.media/doc/468122_myjchina_zastretil_snejnogo_barsa_iz_zacherepa_i_shkyry_ego_zaderjali_v_bishkeke.html (Accessed: 23 July 2025).

- Koshkarev, E. (1989) *The snow leopard in Kirgizia*. Frunze: Ilim. 98 pp.
- Koshkin, M.A., Kabaev, E., Zhumabaykyzy, G. (2024). Meat from the mountains. Assessment of threats to snow leopards in the Issyk-Kul and Naryn provinces of the Kyrgyz Republic for the next 10 years. Ilbirs Foundation/Panthera. Bishkek (version 2).
- Koshkarev, E. and Vyrypaev, V. (2000) *What's happened to the snow leopard after the break-up of the USSR*. Report. International Snow Leopard Trust.
- Koshkin, M.A. and Zhumabay kyzy, G. (in press) 'Addressing human–wildlife conflict and snow leopard conservation in Kyrgyzstan: challenges and solutions', in *Proceedings of the regional conference "Conflict between wildlife and humans in Central Asia"*, Almaty, March 2025.
- McCarthy, T., Mallon, D., Jackson, R., Zahler, P. and McCarthy, K. (2017) 'Panthera uncia', *The IUCN Red List of Threatened Species*, 2017: e.T22732A50664030. Available at: <https://www.iucnredlist.org/species/22732/50664030> (Accessed: 5 August 2025).
- Mallon, D. and McCarthy, T. (eds.) (2023) *Snow leopards (2nd edn.)*. Amsterdam: Academic Press.
- Orlova, M. (2020) *Another rescued leopard was taken to Bishkek*. 24.kg. Available at: https://24.kg/obschestvo/140204_esche_odnogo_spasennogo_barsa_dostavili_vbishkek/ (Accessed: 23 July 2025).
- PASK Working Group (2024) *Population Assessment of Snow Leopards in Kyrgyzstan*. Bishkek: Global Snow Leopard and Ecosystem Protection Program (GSLEP).
- Presidential Decree No. 369 (2023) 'On recognition of the snow leopard as a national symbol of the Kyrgyz Republic', 29 December.
- Red Book of the Kyrgyz SSR (1985) *Rare and threatened species of animals and plants*. Frunze: Kyrgyzstan Publishing House. (In Russian).
- Resolution of the Cabinet of Ministers of the Kyrgyz Republic (2024) No. 384, *On amendments to the Resolution of the Government of the Kyrgyz Republic "On approval of tariffs for assessing damage caused to wildlife, plant resources, mumie (shilajit)-containing mineral raw materials, and fungi by legal entities and individuals"* dated 3 May 2013, No. 224. 12 July 2024.
- Roznev, I. (2021) *GKNB: A man who tried to sell snow leopard skins for USD 4.5 thousand was detained in Osh*. KLOOP.KG. Available at: <https://kloop.kg/blog/2021/04/19/gknb-v-oshe-zaderzhan-muzhchina-pytavshijsya-prodat-shkury-snezhnogo-barsa-za-4-5-tys/> (Accessed: 23 July 2025).
- Skrimizea, E., Crespi, A., Klishe, T., Renner, K. and Zebisch, M. (2023) *Climate risk assessment for mountainous communities of Tajikistan and Kyrgyzstan: implications for human–wildlife conflict, with a focus on snow leopards*. Bolzano, Italy: Eurac Research.
- Sputnik KG (2022) *Snow leopard skin and skull were attempted to be exported to Kazakhstan*. Sputnik Kyrgyzstan. Available at: <https://ru.sputnik.kg/20220119/kyrgyzstan-shkura-cherep-ilbirs-pogranichniki-1061352643.html> (Accessed: 23 July 2025).
- Taubmann, J., Sharma, K., Zhumabay uulu, K., Hines, J.E. and Mishra, C. (2015) 'Status assessment of the endangered snow leopard and other large mammals in the Kyrgyz Alay using community knowledge corrected for imperfect detection', *Oryx*, 50(2), pp. 220–230. <https://doi.org/10.1017/S0030605315000502>
- Turmush (2022) *In Issyk-Kul, a snow leopard went out to hunt and was killed; the skull was recovered*. Turmush. Available at: <https://www.turmush.kg/ru/news:1777468/> (Accessed: 23 July 2025).
- United Nations Environment Programme (2023) *Climate change vulnerability assessment of snow leopards*. Central Asian Mammals and Climate Adaptation (CAMCA) Project.



Snow Leopard (*Panthera uncia*) Status in Mongolia

CONTRIBUTORS:

Justine Shanti Alexander ^{1*},
Gantulga Bayandonoi², Bariushaa Munkhtsog³,
Purevjav Lkhagvajav⁴, Tserennadmid Nadia
Mijiddorj⁴, Choidogjamts Byambasuren⁴,
Bayaraa Munkhtsog⁵

KEYWORDS:

snow leopard; *Panthera uncia*; Mongolia;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Alexander et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

- 1 Wildlife Conservation Society, Mongolia Program, Ulaanbaatar, Mongolia
 - 2 WWF-Mongolia, Ulaanbaatar, Mongolia
 - 3 Irbis Mongolia Center, Ulaanbaatar, Mongolia
 - 4 Snow Leopard Conservation Foundation, Ulaanbaatar, Mongolia
 - 5 Institute of Biology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia
- * Email: Justine.s.alexander@gmail.com

1. Distribution

Mongolia supports the north-easternmost population of snow leopards (*Panthera uncia*). The species' distribution in the country is closely associated with suitable mountainous habitat (Bayandonoi et al. 2021a). Snow leopards primarily occur in the Mongolian Altai, Gobi Altai, and Khangai mountain ranges, as well as in the Sayan Mountains along the border with the Russian Federation (Bayandonoi et al. 2021a). However, snow leopards are also known to use non-mountainous terrain, including steppe habitats, for movement and dispersal between mountain ranges (Johansson et al. 2024).

Current understanding of snow leopard distribution in Mongolia is based on a rigorous occupancy modelling approach that incorporated both presence and absence data (Bayandonoi et al. 2021a). This represents a substantial improvement over earlier assessments that relied on expert opinion or presence-only models. The assessment was based on sign-based occupancy surveys covering 406,800 km² of potential habitat and indicated that previous range estimates both omitted areas currently used by snow leopards and included areas with a low probability of use (Bayandonoi et al. 2021a). For example, the predicted snow leopard range in the Khangai Mountains (Central Mongolia) is now larger than previously recognised, although estimated densities in this region remain very low.

The most recent estimate of potential snow leopard range in Mongolia is 326,617 km² (Figure 1), substantially

exceeding earlier estimates of 90,000–130,000 km² based on expert opinion (Mallon 1984; Schaller et al. 1994; McCarthy 2000). Within this area, snow leopard distribution is discontinuous, with populations fragmented in several regions. Fragmentation is particularly evident in the south-eastern Altai Mountains and in isolated pockets of the Khangai Mountains.

Connectivity between the Altai and Khangai ranges is constrained by extensive steppe areas, which may pose challenges for movement, particularly as these landscapes undergo increasing development, including the expansion of infrastructure such as roads and fencing. In the South Gobi, snow leopard habitat is characterised by isolated mountain massifs that are predicted to support relatively high densities. In addition, some areas previously considered unsuitable, such as the Ulaan Taiga and Khoridol Saridag Mountains, are now known to be used by snow leopards.

Occasional detections beyond the predicted mountainous distribution illustrate the species' capacity for long-distance movement. A snow leopard recorded in Ikh Nart Nature Reserve, approximately 266 km from the nearest known population, represents one of the easternmost records for the species (Wingard et al. 2023). Recent GPS-collar data further demonstrate that dispersing subadult snow leopards are capable of traversing extensive areas of steppe

and desert during exploratory movements, indicating that such landscapes do not represent absolute barriers to movement (Johansson et al. 2024).

Several important transboundary snow leopard populations occur along the Mongolia–Russia border. Key transboundary areas include the Altai Tavan Bogd Mountains in Mongolia and the Southern Altai Ridge in Russia; Tsagaan Shuvuut in Mongolia and the Tsagan-Shibetu and Shapshalsky ranges in Russia; the Siilkhem Mountains in Mongolia and the Sailugem–Chikhachev mountain ridges in Russia; and Ikh Soyon in Mongolia and the Eastern Sayan Range in Russia. Together, these landscapes maintain critical connectivity between Mongolian and Russian snow leopard populations (Bayandonoi et al. 2021a).

Along the Mongolia–China border, additional transboundary populations occur in the Chigertei Ridge and the Baitag Bogd–Takhiin Shar Nuruu–Khavtaga Mountain complex, which are bisected by the international boundary between the two countries (Bayandonoi et al. 2021a). Although individual snow leopards can move across extensive steppe habitats, population-level genetic analyses indicate limited contemporary gene flow between Mongolia and north-western China. Movement data further suggest that border fencing constrains cross-border dispersal, resulting in weak functional connectivity across

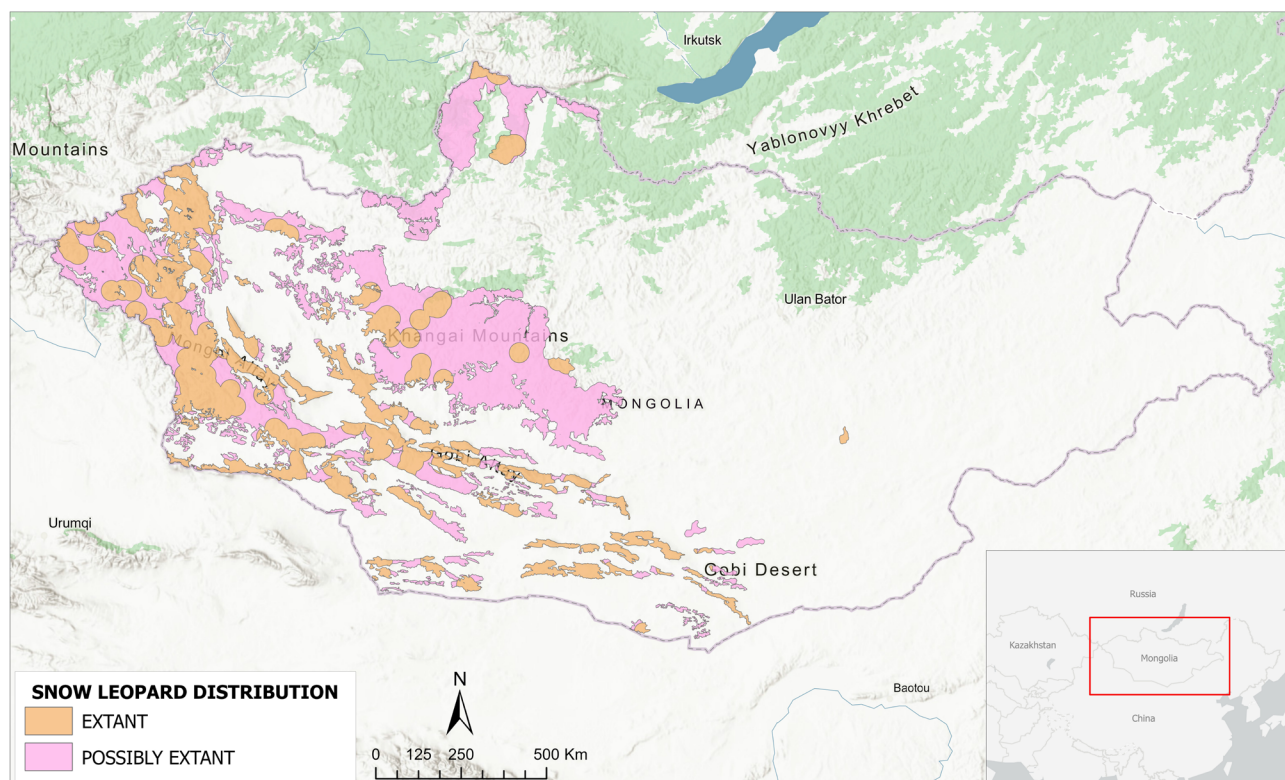


Figure 1. Distribution of the snow leopard (*Panthera uncia*) in Mongolia based on IUCN Red List mapping criteria. The shaded area (orange is classified as extant and pink is classified as possibly extant) represents the distribution within the country. The map is derived from Bayandonoi et al. (2021), which applied probabilistic occupancy modelling to assess snow leopard distribution across Mongolia.

the southern Gobi (Hacker et al. 2022; Johansson et al. 2024).

The updated IUCN Red List distribution map for snow leopards in Mongolia (Figure 1) is primarily based on probabilistic occupancy modelling combined with records of territorial signs. Figure 1 was adapted from Bayandonoï et al. (2021a, 2021b) to align with IUCN Red List mapping standards. The following criteria were applied during this adaptation:

Areas with a low probability of snow leopard occurrence were excluded from the potential range. Specifically, sampling units of 20 × 20 km with an estimated probability of presence below 2% were removed, effectively excluding much of eastern Mongolia, flat depressions, extensive steppe regions, and the forested north. Terrain characteristics were further refined by excluding steppe and valley areas with slopes below 5°, which are generally unsuitable as snow leopard territories. High-altitude mountain steppe was retained, while low-slope areas were considered occasional movement corridors rather than resident habitat. Non-habitat features, including lakes and sand dunes, were also excluded as unsuitable for snow leopards.

Areas were classified as *Extant* when located within 20 km of confirmed snow leopard territorial signs (pugmarks, scats, scrapes, or camera-trap detections) recorded between 2015 and 2024. Remaining areas that met the above criteria, had an estimated presence probability greater than 2%, but lacked recent evidence of residency or were considered non-resident based on opportunistic detections, were classified as *Possibly Extant*.

Several environmental factors influence snow leopard distribution across Mongolia. Terrain ruggedness is a key determinant, with areas of higher ruggedness more likely to be used by snow leopards (Bayandonoï et al. 2021a). Occupancy analyses indicate a preference for intermediate elevations, lower vegetation indices, and areas with limited forest cover (Bayandonoï et al. 2021a). In addition, the availability of primary prey species, particularly Siberian ibex (*Capra sibirica*) and argali (*Ovis ammon*), plays an important role in shaping snow leopard distribution patterns (Johansson et al. 2022).

2. Population

The most recent estimate of the snow leopard population in Mongolia is 953 adult individuals (95% confidence interval: 806–1,127), based on a nationwide assessment conducted

between 2017 and 2020 (Bayandonoï et al. 2021b). This assessment combined occupancy surveys with spatial capture–recapture analyses derived from camera-trap data and follows the methodological framework outlined under the Population Assessment of the World’s Snow Leopards (PAWS) guidelines (Sharma et al. 2019). Earlier population estimates for Mongolia have varied widely, reflecting the inherent challenges of monitoring an elusive species across a vast, remote, and topographically complex landscape. Previous estimates include approximately 700 individuals (Bold & Dorjzundui 1976), 557–1,127 individuals (McCarthy & Mallon 2016), c. 1,000 individuals (Munkhtsog et al. 2016), and 1,500–1,700 individuals (Schaller et al. 1994).

The current estimate refers specifically to adult snow leopards; inclusion of dependent cubs would increase the total population size. Mongolia supports the second largest snow leopard population globally, underscoring the country’s importance for the long-term conservation of the species (Munkhtsog et al. 2016). The population also plays an important role in maintaining regional connectivity and gene flow, particularly with populations in the Russian Federation.

Snow leopard density varies across Mongolia’s three occupancy strata (Bayandonoï et al. 2021a, b), with an overall mean density estimated at 0.31 individuals per 100 km². Areas classified as high density support a mean density of 0.61 individuals per 100 km² across 48,290 km², medium-density areas support a mean density of 0.35 individuals per 100 km² across 153,840 km², and low-density areas support a mean density of 0.09 individuals per 100 km² across 124,487 km². Spatial variation in density is influenced by a combination of habitat characteristics, prey availability, and broader landscape context.

Long-term monitoring in the Tost Mountains indicates that, although local population sizes may appear relatively stable over time, snow leopard populations are highly dynamic. In particular, high rates of immigration and emigration, especially among dispersing subadult individuals, contribute to population turnover and underline the importance of connectivity at the landscape scale (Sharma et al. 2014).

3. Threats

Snow leopards in Mongolia face multiple, interacting threats, largely driven by human activities and environmental change. These include habitat loss and degradation, depletion of the wild prey base, retaliatory killing following livestock depredation, illegal hunting

and trade, infrastructure development and mining, and the emerging impacts of climate change (Johansson et al. 2015; Sharma et al. 2014; Lukarevskiy et al. 2020; Alexander et al. 2021; Munkhtsog et al. 2024).

Habitat degradation and prey depletion

Habitat loss and degradation represent major threats to snow leopards in Mongolia, primarily driven by overgrazing associated with rapidly increasing livestock numbers (Munkhtsog et al. 2024). Since the early 1990s, livestock numbers have risen sharply, from approximately 25 million head in 1990 to over 71 million in 2022 (National Statistics Office of Mongolia, 2022). This expansion has led to widespread pasture degradation and increasing encroachment of livestock into snow leopard habitats, intensifying competition for forage and water resources (Berger et al. 2013; Munkhtsog et al. 2024).

High livestock presence is predicted to displace mountain ungulates, which tend to avoid heavily grazed areas, resulting in reduced availability of key prey species for snow leopards (Johansson et al. 2015). In addition, close spatial overlap between livestock and wild ungulates increases the risk of disease transmission. Mongolia's pastoral systems are characterised by the widespread presence of livestock-associated zoonotic pathogens, including brucellosis, anthrax, tuberculosis, and parasitic infections, which may pose indirect risks to wildlife populations (Tsogtbayar et al. 2025).

Wild prey depletion is further exacerbated by ongoing illegal and subsistence hunting of wild ungulates, which remains a concern in parts of Mongolia despite legal protections (Wingard & Zahler 2006; Munkhtsog et al. 2024). Local reductions in populations of Siberian ibex (*Capra sibirica*) and argali (*Ovis ammon*) may reduce natural prey availability for snow leopards and increase reliance on domestic livestock, thereby reinforcing negative interactions with herders and elevating the risk of retaliatory killing.

Retaliatory killing and negative human–carnivore interactions

Negative interactions between people and large carnivores remain a significant threat to snow leopards in Mongolia. Retaliatory killing following livestock depredation has been widely documented as an important source of snow leopard mortality across the country (Johansson et al. 2015; Alexander et al. 2021; Mijiddorj et al. 2018).

Snow leopards prey on a range of domestic animals, including sheep (*Ovis aries*), goats (*Capra hircus*), yaks (*Bos grunniens*), horses (*Equus ferus caballus*), and camels (*Camelus bactrianus*). Depredation occurs both on open pastures and at night-time corrals, with occasional multiple

animals killed in single events (Johansson et al. 2015; Mijiddorj et al. 2018). For example, in parts of the Gobi, livestock depredation frequently involves goats, which are of high economic importance due to cashmere production, as well as young, free-ranging horses during their first months of life (Mijiddorj et al. 2018). Losses of horses may be perceived as particularly severe given their cultural significance in Mongolia.

Grey wolves (*Canis lupus*) account for a substantial proportion of livestock losses in many parts of Mongolia, and cumulative losses attributed to several carnivore species can intensify negative perceptions toward predators (Mijiddorj et al. 2018; Johansson et al. 2015). Retaliatory responses are not always selective, and snow leopards may be targeted or incidentally killed even when they are not responsible for specific depredation events.

Patterns of livestock depredation and associated negative interactions are shaped by ecological conditions and the spatial and temporal overlap between livestock and carnivores.

In Mongolia's open rangeland systems, depredation risk is influenced by ongoing changes in herding practices. Mijiddorj et al. (2018) report that increasing herd sizes, reduced labour availability, and shifts toward more mobile herding using motorcycles have altered livestock supervision patterns, with animals often ranging over larger areas and remaining unattended for longer periods. Seasonal movements, topography, and local variation in wild prey availability further influence where and when depredation events occur, contributing to marked spatial and temporal variability in conflict intensity (Johansson et al. 2015; Mijiddorj et al. 2018).

Illegal hunting and trade

Illegal hunting and trade continue to pose a direct threat to snow leopards in Mongolia (Munkhtsog et al. 2024). The snow leopard is fully protected under Mongolian law, including the Law on Fauna and the Criminal Code, which prohibit the hunting, possession, transport, and trade of the species and prescribe criminal penalties for violations. Mongolia is also a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), under which the snow leopard is listed in Appendix I, prohibiting all international commercial trade.

Despite this legal protection, illegal killing persists. Snow leopards are primarily targeted for their skins, which are valued for luxury fur products, and for bones and other body parts that may be used as substitutes for tiger (*Panthera tigris*) products in traditional medicine markets. Recent confiscations of snow leopard skins at Mongolian

customs demonstrate that illegal trade remains active and that both domestic and cross-border trade routes continue to operate. Law enforcement data indicate eight confirmed cases of illegal snow leopard hunting and trade between 2014 and 2018, increasing to 18 cases between 2019 and 2023, indicating that illegal exploitation remains an ongoing concern (WWF-Mongolia 2024). In Mongolia, snow leopards killed in conflict situations may subsequently be sold or traded locally, linking retaliatory killing with illegal trade.

Infrastructure development and mining

Infrastructure development and mining represent increasing pressures on snow leopard habitats in Mongolia. Mongolia's economy has grown steadily in recent years, with real GDP growth of approximately 5% in 2024 and projected growth of around 6% in 2025, driven largely by mineral extraction and associated transport and infrastructure development (World Bank 2024). Roads, railways, border fencing, pipelines, and associated infrastructure can act as physical or behavioural barriers to movement, fragment habitats, and increase mortality risk for snow leopards and their prey (Zahler & Victurine 2024). These impacts are of particular concern in Mongolia, where snow leopard habitat often consists of isolated mountain massifs separated by steppe or desert landscapes. Movement between neighbouring mountain ranges is therefore important for dispersal and maintaining functional connectivity (Johansson et al. 2024). Linear infrastructure constructed across lowland areas may reduce landscape permeability and constrain movements between otherwise suitable habitats (Zahler & Victurine 2024; Gregory et al. 2025). Infrastructure development can also generate indirect impacts. Improved access to remote areas may increase human presence and disturbance and facilitate illegal hunting of both snow leopards and wild ungulates (Zahler & Victurine 2024).

Mining development can pose additional pressures on snow leopard habitats through direct and indirect pathways. Mongolia's mining sector is dominated by coal and copper extraction, with gold also contributing to national production, and has been a major driver of recent economic growth (World Bank 2024). Mining operations may result in habitat loss, degradation of water sources, increased traffic and noise, and changes in land use around key valleys and water points. In arid and semi-arid regions of Mongolia, where water availability is naturally limited, such activities may place additional pressure on areas also used by wildlife. Although the direct population-level impacts of mining on snow leopards and their habitats remain poorly studied, mining-related activities and associated infrastructure increasingly overlap with known snow leopard range.

Climate Change

Climate change represents an emerging pressure on snow leopard landscapes in Mongolia. Mean air temperatures in Mongolia have increased by approximately 1.7–2.0 °C since the mid-20th century, exceeding the global average, and this warming has been accompanied by increasing aridity and more frequent drought events (Nandintsetseg et al. 2021). Mongolia's National Adaptation Plan identifies pastures, water resources, and ecosystems as highly vulnerable to climate change, with increasing risks from drought, *dzud*, and heat extremes projected through mid-century (Government of Mongolia 2024). *Dzud* events, driven by the interaction of summer drought and severe winter conditions, have increased in frequency and have caused substantial livestock mortality, with indirect implications for grazing pressure and habitat condition (Nandintsetseg et al. 2020). Climate change is also expected to affect pastoral livelihoods and mobility, altering seasonal grazing patterns and migration routes, with knock-on effects for land use and habitat conditions within snow leopard range.

Although direct impacts of climate change on snow leopard ecology have not been quantified, climate-driven changes in vegetation productivity, water availability, and human land use are likely to influence prey distribution and livestock movements. Current evidence therefore suggests that climate change affects snow leopards primarily through indirect, ecosystem-mediated pathways.

4. Conservation

Conservation of the snow leopard in Mongolia integrates national legislation, protected area management, community-based initiatives, scientific research, and intergovernmental cooperation (Munkhtsog et al. 2024). Snow leopards are legally protected under Mongolian law, including the Law on Fauna and the Criminal Code, which prohibit hunting, possession, and trade. At the national level, the species is classified as *Very Rare*, affording it the highest legal protection status.

The Government of Mongolia has established an extensive protected area network that plays a central role in snow leopard conservation. As of 2025, approximately 28.1% of snow leopard habitat lies within the State Protected Areas Network, encompassing 52 protected areas that include key snow leopard landscapes. In addition, numerous local protected areas designated at the aimag and soum levels occur within the species' distribution. While these local protected areas are important in terms of spatial coverage, they often lack dedicated budgets, permanent staff, and management plans, and conservation actions are therefore frequently limited in practice despite formal designation.

Snow leopard conservation is guided by a series of national policies and strategies, including the National Biodiversity Conservation Policy (1996; revised 2015), the Snow Leopard Conservation Management Plan (1999), the Snow Leopard Conservation Policy (2005), the National Program on Conservation of Very Rare and Rare Wildlife Species (2011), the Mongolia National Snow Leopard and Ecosystem Protection Priorities (2013), and the National Programme for Biodiversity Conservation (2015). Mongolia completed a reassessment of the national Red List status of mammals in 2025, in which the snow leopard was classified as Endangered (Alexander et al. 2025).

Implementation and enforcement of snow leopard conservation measures involve multiple government agencies. The Ministry of Environment and Climate Change oversees national policy and protected area management through its Protected Areas Department and the Natural Resource Management Department. At the local level, aimag and soum government (including environmental agencies) are responsible for local conservation action outside protected areas. In addition, the Ecological Police, state environmental inspectors, the General Authority for Border Protection, and the General Customs Administration of Mongolia plays a role in addressing wildlife crime, including illegal hunting and trade of snow leopards and their prey. Coordination among actors is critical for effective law enforcement across Mongolia's large and remote landscapes.

Engagement of pastoral communities is a core component of snow leopard conservation in Mongolia. Community-based programmes aim to reduce negative human–wildlife interactions and increase local support for conservation. These include livestock insurance schemes that compensate herders for losses attributed to snow leopard predation (Alexander et al. 2021) and the construction of improved night-time corrals to reduce livestock depredation (Samelius et al. 2021). Broader community-based natural resource management initiatives also seek to support livelihoods and promote conservation-compatible land use through alternative income generation, value-added livestock production, and community-managed tourism.

Scientific research and monitoring provide an essential foundation for conservation planning. Long-term ecological studies in the Tost Mountains of southern Mongolia have generated detailed information on snow leopard home range size, reproduction, dispersal, survival, and population dynamics, highlighting the importance of immigration and emigration processes for local population stability (Sharma et al. 2014; Johansson et al. 2015; Johansson et al. 2022). At the national scale, repeated snow leopard population assessments using sign-based

occupancy surveys and camera trapping have improved estimates of abundance and distribution and support adaptive management (Bayandonoi et al. 2021a, b).

Transboundary cooperation is also important for snow leopard conservation, given the species' distribution along international borders. Mongolia collaborates with neighbouring countries, particularly the Russian Federation and China, through bilateral agreements and joint initiatives. Transboundary protected areas linking northern Mongolia and southern Siberia facilitate coordination in monitoring, research, and habitat protection for shared snow leopard populations (Munkhtsog et al. 2024).

5. Acknowledgements

We acknowledge the Ministry of Environment and Climate Change of Mongolia for its leadership and continued commitment to snow leopard conservation, and recognise the contributions of government agencies, non-governmental organisations, research institutions, and local communities working across the country. We thank the organisers and participants of the Snow Leopard Forum held in September 2025, jointly organised by the Ministry of Environment and Climate Change, WCS Mongolia, and the Snow Leopard Conservation Foundation, for facilitating dialogue on threats and conservation priorities. We further acknowledge the IUCN SSC Cat Specialist Group and the wider IUCN Red List assessment team for their guidance during the updated snow leopard assessment process, and thank Bayarjargal Khashbat and Altanbagana Yunden of WCS Mongolia for preparing the snow leopard distribution map.

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Alexander, J.S., Agvaantseren, B., Gongor, E., Mijiddorj, T.N., Piaopiao, T., Redpath, S., Young, J. & Mishra, C. (2021). Assessing the effectiveness of a community-based livestock insurance program. *Environmental Management*, 68(1), 87–99. <https://doi.org/10.1007/s00267-021-01469-8>
- Alexander, J.S., Bayandonoi, G., Tserennadmid, M., Bayaraa, M., Munkhtsog, B., Purevjav, L., Gombobaatar, S., (2025). Snow leopard. Mongolian Red List of Mammals. Regional Red List Series Vol. 17. Second edition. National University of Mongolia, WWF-Mongolia, the Ministry of Environment and Climate Change, Mongolia. Ulaanbaatar. (In Mongolian)

- Bayandonoi, G., Sharma, K., Alexander, J.S., Lkhagvajav, P., Durbach, I., Buyanaa, C., Munkhtsog, B., Ochirjav, M., Erdenebaatar, S., Batkhuyag, B., Battulga, N., Byambasuren, C., Uudus, B., Setev, S., Davaa, L., Agchbayar, K.-E., Galsandorj, N. & MacKenzie, D. (2021a). Mapping the ghost: Estimating probabilistic snow leopard distribution across Mongolia. *Diversity and Distributions*, 27, 2441–2453. <https://doi.org/10.1111/ddi.13412>
- Bayandonoi, G., Lkhagvajav, P., Alexander, J.S., Durbach, I., Borchers, D., Munkhtsog, B., Munkhtogtokh, O., Chimeddorj, B., Sergelen, E. & Sharma, K. (eds.) (2021b). *Nationwide snow leopard population assessment of Mongolia: Key findings*. Summary report. Ulaanbaatar, Mongolia.
- Berger, J., Bayarbaatar, B. & Mishra, C. (2013). Globalization of the cashmere market and the decline of large mammals in Central Asia. *Conservation Biology*, 27, 679–689.
- Bold, A. & Dorjzundui, S. (1976). Snow leopards (*Uncia uncia*, Schreber) in the southern Gobi-Altai Mountain Range. *Institute of Biology, Mongolian Academy of Sciences*, 11.
- Government of Mongolia (2024). *National Adaptation Plan to Climate Change: Mongolia 2024–2030*. Ministry of Environment and Climate Change, Ulaanbaatar.
- Gregory, T., Lucas, C., Parker, M., Bayandonoi, G., Bhatnagar, Y.V., Borchers, D., Butt, H., Butynski, M., Buyanaa, C., Dhakal, M., Dorji, P., Freund, E., Hornett, D., Jagenia, R.K., Khan, N.A., Khan, M.S.H., Lkhagvajav, P., Nawaz, M.A., Neupane, P., Newman, K., Rosen, T., Sharma, K., Sharma, R.K., Shrestha, S., Solanki, R., Teixeira, F., Tshering, D., Ud Din, J. & Vannelli, K. (2025). *Guiding the future of linear infrastructure in snow leopard landscapes*. Global Snow Leopard Ecosystem Protection Program (GSLEP).
- Hacker, C.E., Atzeni, L., Munkhtsog, B., Galsandorj, N., Zhang, Y., Liu, Y. *et al.* (2022). Genetic diversity and spatial structure of snow leopards (*Panthera uncia*) reveal proxies of connectivity across Mongolia and north-western China. *Landscape Ecology*, 38, 1013–1031. <https://doi.org/10.1007/s10980-022-01573-y>
- Johansson, Ö., McCarthy, T., Samelius, G., Andrén, H., Tumursukh, L. & Mishra, C. (2015). Snow leopard predation in a livestock-dominated landscape in Mongolia. *Biological Conservation*, 184, 251–258.
- Johansson, Ö., Alexander, J.S., Lkhagvajav, P., Mishra, C. & Samelius, G. (2024). Natal dispersal and exploratory forays through atypical habitat in the mountain-bound snow leopard. *Ecology*, 105(4), e4264. <https://doi.org/10.1002/ecy.4264>
- Johansson, Ö., Mishra, C., Chapron, G. *et al.* (2022). Seasonal variation in daily activity patterns of snow leopards and their prey. *Scientific Reports*, 12, 21681. <https://doi.org/10.1038/s41598-022-26358-w>
- Lukarevskiy, V.S., Dalannast, M., Lukarevskiy, S. & Damdin, E. (2020). Factors determining the distribution and status of the snow leopard population (*Panthera uncia*) in western Mongolia. *Animal and Veterinary Sciences*, 7(6), 119–124. <https://doi.org/10.11648/j.avs.20190706.12>
- Mallon, D. (1984). The snow leopard (*Panthera uncia*) in Mongolia. In: Blomqvist, L. (ed.) *Proceedings of the IV International Snow Leopard Symposium*. Helsinki Zoo, pp. 3–10.
- McCarthy, T.M. (2000). *Ecology and conservation of snow leopards, Gobi brown bears, and wild Bactrian camels in Mongolia*. PhD thesis, University of Massachusetts.
- McCarthy, T.M. & Mallon, D. (2016). Snow leopards. In: Nyhus, P.J., McCarthy, T.M. & Mallon, D. (eds.) *Snow leopards: Biodiversity of the world*. Academic Press, pp. 644–661. <https://doi.org/10.1016/B978-0-12-802213-9.00068-7>
- Mijiddorj, T.N., Alexander, J.S. & Samelius, G. (2018). Livestock depredation by large carnivores in the South Gobi, Mongolia. *Wildlife Research*, 45(6), 550–561. <https://doi.org/10.1071/WR18009>
- Munkhtsog, B., Augugliaro, C., Bayraccismith, R., Munkhtsog, B. & McCarthy, T.M. (2024). Current status and conservation of snow leopards in Mongolia. In: Mallon, D. & McCarthy, T.M. (eds.) *Snow Leopards* (2nd ed.). Academic Press, London, pp. 555–564. <https://doi.org/10.1016/B978-0-323-85775-8.00005-4>
- Munkhtsog, B., Purevjav, L., McCarthy, T.M. & Bayraccismith, R. (2016). Northern range: Mongolia. In: Nyhus, P.J., McCarthy, T.M. & Mallon, D. (eds.) *Snow leopards: Biodiversity of the world*. Elsevier, pp. 493–500.
- Nandintsetseg, B., Boldgiv, B., Chang, J., Ciais, P., Davaanyam, E., Batbold, A., Bat-Oyun, T. & Stenseth, N.C. (2021). Risk and vulnerability of Mongolian grasslands under climate change. *Environmental Research Letters*, 16, 034035. <https://doi.org/10.1088/1748-9326/abdb5b>
- National Statistics Office of Mongolia (2022). *Statistical Yearbook of Mongolia 2022*. National Statistics Office of Mongolia, Ulaanbaatar.
- Samelius, G., Suryawanshi, K., Frank, J. *et al.* (2021). Keeping predators out: Testing fences to reduce livestock depredation at night-time corrals. *Oryx*, 55(3), 466–472. <https://doi.org/10.1017/S0030605319000565>
- Schaller, G.B., Tserendeleg, J. & Amarsanaa, G. (1994). Observations on snow leopards in Mongolia. *Proceedings of the Seventh International Snow Leopard Symposium*, 7, 33–42.
- Sharma, K., Bayraccismith, R., Tumursukh, L., Johansson, Ö., Sevger, P., McCarthy, T. & Mishra, C. (2014). Vigorous dynamics underlie a stable population of the endangered snow leopard (*Panthera uncia*) in the Tost Mountains, South Gobi, Mongolia. *PLOS ONE*, 9(7), e101319. <https://doi.org/10.1371/journal.pone.0101319>
- Sharma, K., Borchers, D., MacKenzie, D., Durbach, I., Sutherland, C., Nichols, J.D. & Mishra, C. (2019). *Guidelines for estimating snow leopard abundance and distribution using a combination of spatial capture-recapture and occupancy models*. Global Snow Leopard and Ecosystem Protection Program.
- Tsogtbayar, O., Munkhbayarlakh, B., Dorjsurenkhor, N. & Gray, G.C. (2025). Major livestock-associated zoonoses in Mongolia: An overview. *Zoonoses*, 5, 23. <https://doi.org/10.15212/ZOONOSES-2025-0007>
- Wingard, G.A., Oyungbat, R., Zebrowski, J., Reading, R.P., Garrouette, E., Tumurbataar, A., Otgongotob, B., Nyamsuren, B. & Murdoch, J.D. (2023). A new snow leopard record reflects the value of remote protected areas for connectivity. *Oryx*. <https://doi.org/10.1017/S003060532200120X>
- Wingard, J.R. & Zahler, P. (2006). *Silent steppe: The illegal wildlife trade crisis in Mongolia*. World Bank Mongolia Discussion Papers. World Bank, Ulaanbaatar.
- WWF-Mongolia (2024). *Illegal hunting and trade crime analysis in Mongolia (2013–2023)*. WWF-Mongolia, Ulaanbaatar. (In Mongolian).
- Zahler, P. & Victorine, R. (2024). Linear infrastructure and snow leopard conservation. In: Mallon, D. & McCarthy, T. (eds.) *Snow Leopards* (2nd ed.). Academic Press, London, pp. 123–128. <https://doi.org/10.1016/B978-0-323-85775-8.00049-2>
- World Bank (2024). *Mongolia Economic Update: Sustaining the Gains*. November 2024. International Bank for Reconstruction and Development / World Bank, Washington, DC.



Snow Leopard (*Panthera uncia*) Status in Nepal

Rinzin Phunjok Lama ^{1*}, Gopal Khanal²,
Hari Bhadra Acharya², Madhu Chetri³,
Narayan Koju⁴, Kamal Thapa⁵, Paras Bikram
Singh⁶, Samundra Ambuhang Subba⁷,
Sheren Shrestha⁸, Tashi R. Ghale¹, Naresh Kusi^{9,10},
Ashok Subedi³, Bikram Shrestha^{11,12}

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Lama et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

- 1 Upper Karnali Landscape Initiatives (UKALI), Simkot-6, Simikot, Humla, Nepal
 - 2 Department of National Parks and Wildlife Conservation (DNPWC), Babarmahal, Kathmandu, Nepal
 - 3 National Trust for Nature Conservation, P.O. Box. 3712, Khumaltar, Lalitpur, Nepal
 - 4 Center for Post Graduate Studies, Nepal Engineering College, Pokhara University, Nepal
 - 5 Dreamer Himalaya Expedition, Kathmandu, Nepal
 - 6 Biodiversity Conservation Society (BioCoS) Nepal, Bagdol, Lalitpur, Nepal
 - 7 Department of Wildlife and Natural Resources, College of Agriculture and Natural Resources, Tarleton State University, Stephenville, Texas, 76402, USA
 - 8 WWF Nepal, Baluwater, Kathmandu, Nepal
 - 9 Himalayan Wolves Project, Salenstein, Switzerland
 - 10 Department of Forestry and Wildlife Management, University of Inland Norway, Elverum, Norway
 - 11 Department of Biodiversity Research, Global Change Research Institute, Czech Academy of Sciences, Brno, Czech Republic
 - 12 Conservation Development Foundation Nepal, 44600 Kathmandu, Nepal
- * Email: rinzinplama@gmail.com

KEYWORDS:

snow leopard; *Panthera uncia*; Nepal;
country status; distribution; population;
conservation

1. Distribution

Snow leopards (*Panthera uncia*) are distributed across the northern regions of Nepal, primarily within alpine and subalpine zones at elevations ranging from 3,000 to 5,000 meters (Jackson, 1979; DNPWC & DoFSC, 2024; Khanal et al., 2024). Nepal's snow leopard range has been divided into three key landscapes: (1) Eastern Landscape, (2) Central Landscape, and (3) Western Landscape (Figure 1; DNPWC, 2013). These three landscapes include 26 districts and 11 protected areas (PAs). However, snow leopard presence has not been confirmed in all the areas. The western landscape covers 16,423.62 km² across 10 districts and four PAs; the central landscape spans 6,614.70 km² across eight districts and two PAs; and the eastern landscape encompasses 7,397.46 km² across eight districts and five PAs. In total, these landscapes comprise 30,435.78 km² of potential snow leopard habitat, of which approximately 58% lies within PAs, and 42% lies outside PAs (DNPWC & DoFSC, 2024).

The 2025 national snow leopard population assessment served as the foundation for Nepal's updated IUCN range map. Areas classified as Extant were defined based on confirmed snow leopard presence supported by camera trapping, genetic surveys, and other direct evidence compiled during the assessment. In contrast, Possible Extant areas were delineated based on landscape connectivity,

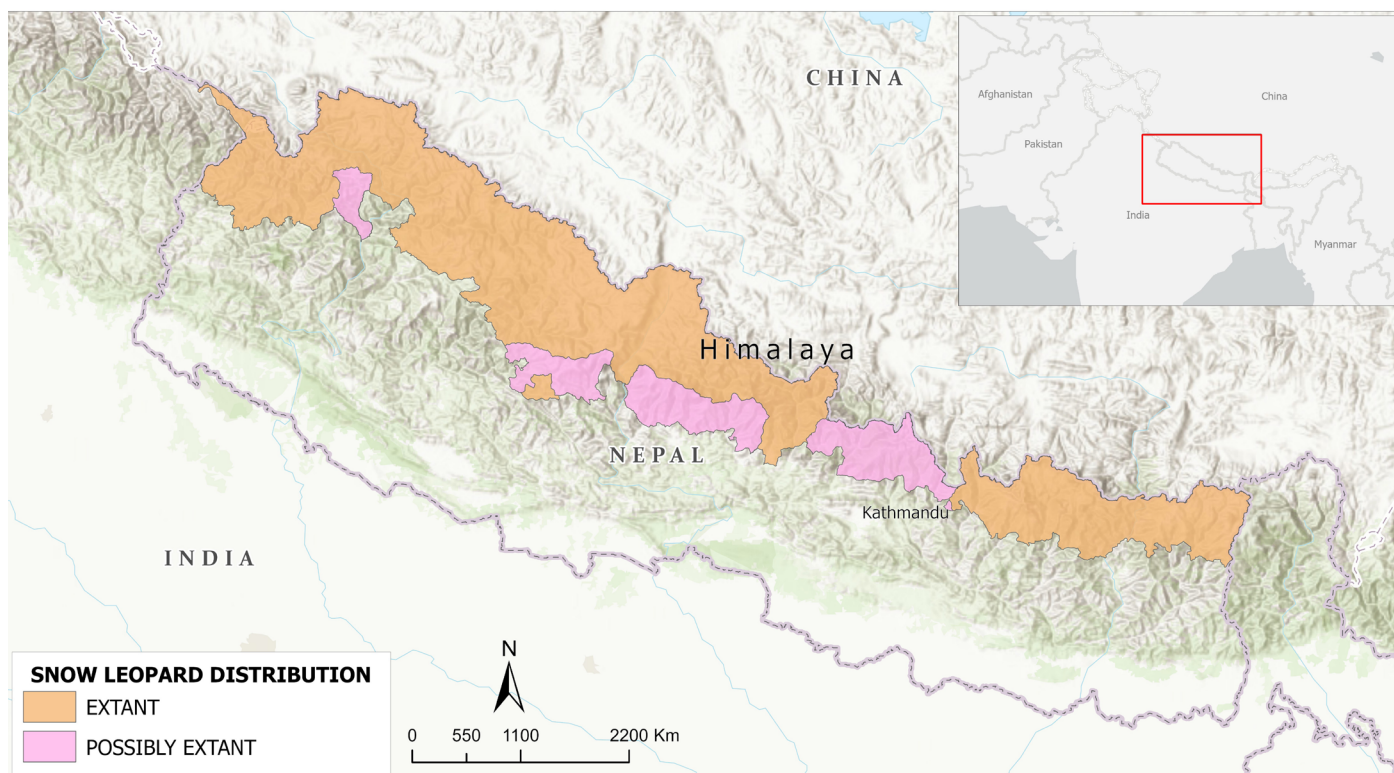


Figure 1. Distribution of the snow leopard (*Panthera uncia*) in Nepal. Orange areas indicate extant range, where the species is known or strongly inferred to occur. Pink areas indicate possibly extant range, where presence is uncertain but considered likely based on habitat suitability and proximity to confirmed records, following IUCN Red List mapping criteria.

suitable habitat characteristics, and expert knowledge, including regions where snow leopards are likely present but where confirmed records such as photographic evidence or genetic confirmation are lacking.

Annapurna Conservation Area has the largest extent of suitable snow leopard habitat (4,321.4 km²), followed by Shey Phoksundo National Park (3,613.3 km²). Both are among the most important PAs for snow leopards (Chetri et al., 2019b; SPNP, 2023; DNPWC & DoFSC, 2024). Outside the PA system, Humla District contains the largest potential snow leopard habitat (3,983 km²), followed by the Chharka Tangsong region in eastern Dolpa (1,918 km²), which lies between Shey Phoksundo National Park and the Annapurna Conservation Area (DNPWC & DoFSC, 2024).

Studies based on sign surveys, occasional sightings, and interviews with local communities also confirm snow leopard presence in several other PAs, such as Langtang National Park (Adhikari, 2004; Chalise, 2011), Api Nampa Conservation Area (Khanal et al., 2020a), and Dhorpatan Hunting Reserve (Gautam, 2016). However, no recent confirmations have been made using more robust methods such as camera trapping or genetic analysis of fecal samples. A radio-collared snow leopard from Kanchenjunga Conservation Area was documented traveling to Makalu Barun National Park (Subba et al.,

2025). Rara National Park, however, does not yet have confirmed records of snow leopard presence.

Outside the PA network, the species' distribution remains uncertain in some regions, including the corridor linking Langtang National Park and Manaslu Conservation Area, as well as Bajura District in far-western Nepal.

2. Population

In 2025, the Government of Nepal completed the first-ever nationwide population estimation of snow leopards using a multi-season Spatially Explicit Capture-Recapture (SECR) model. The estimated abundance was 397 snow leopards (95% CI: 331.11- 475.60), across 30,435.78 km² with a mean density of 1.56 individuals per 100 km² (95% CI: 1.30–1.87). This recent estimate highlights regional strongholds in population and density. Among the three landscapes, the western landscape has the highest abundance (234.08; 95% CI: 196.10- 279.42), accounting for 60% of Nepal's snow leopard population, followed by the central (89.42; 95% CI: 72.81- 109.82) and eastern (73.33; 95% CI: 61.41 -87.57) landscapes (DNPWC & DoFSC, 2025).

The 2025 national estimate falls in the range of the previous population estimate of 301-400 snow leopards (WWF Nepal, 2009), which was based on the sign encounter rate

extrapolations (DNPWC, 2013). The present assessment follows the Global Snow Leopard and Ecosystem Protection Program – Population Assessment of the World’s Snow Leopards (GSLEP-PAWS) guidelines (Sharma et al., 2019), with robust methodology and large sampling sites (DNPWC & DoFSC, 2025).

Shey-Phoksundo National Park (SPNP) supports the largest population of snow leopards, with an estimated density of 2.21 snow leopards per 100 km² and a total estimated population of 90 individuals (95% CI: 78–109) (SPNP, 2023). A previous study (Khanal et al., 2020b) recorded densities of 2.51 individuals per 100 km² (95% CI: 1.76–2.62) in Upper Dolpa and 1.21 per 100 km² in Lower Dolpa, both within SPNP, indicating substantial spatial variation in density. Additionally, DoFSC, (2024) estimated a population of 30 individuals (95% CI: 27–37) with a density of 1.5 per 100 km² (95% CI: 0.93–2.02) in eastern Dolpa, adjacent to the park.

In the Namkha region of Humla district, Lama et al. (in review) estimated a population of 39 individuals (95% CI 30.3–60.9), with a density of 1.84 per 100 km² (95% CI: 1.44–2.89). In the Api Nampa Conservation Area, the far-west corner of Nepal, Khanal et al. (2020a) projected a population of 6–9 individuals, based on prey biomass.

In the Annapurna–Manaslu landscape, Chetri et al. (2019b) estimated a mean density of 0.95 snow leopards per 100 km² (95% CI: 0.1–1.9 per 100 km²), with region-specific estimates of 1.07 per 100 km² in Annapurna and 1.16 per 100 km² in Bhimthang–Manaslu. Some hotspots within Annapurna Conservation Area, such as the upper Phu Valley of Manang, reported densities as high as 6 snow leopards per 100 km² (Wegge et al., 2012). Such high estimates may be due to the relatively small survey area (125 km²), which encompassed prime snow leopard habitat. Similarly, in Upper Mustang, Aryal et al. (2014) estimated a density of

Table 1: Snow leopard population and density estimates across Nepal by site or region

Site/Region	Estimated Population	Density (per 100 km ²)	Source
National (Nepal-wide)	397 (95% CI: 331.11–475.60)	1.56 (95% CI: 1.30–1.87)	(DNPWC & DoFSC, 2025)
Western Landscape	234.08 (95% CI: 196.10–279.42)	Not specified	(DNPWC & DoFSC, 2025)
Central Landscape	89.42 (95% CI: 72.81–109.82)	Not specified	(DNPWC & DoFSC, 2025)
Eastern Landscape	73.33 (95% CI: 61.41–87.57)	Not specified	(DNPWC & DoFSC, 2025)
Shey Phoksundo National Park (SPNP)	90 (95% CI: 78–109)	2.21 (95% CI: 1.76–2.62)	(SPNP, 2023)
Eastern Dolpa (adjacent to SPNP)	30 (95% CI: 27–37)	1.5 (95% CI: 0.93–2.02)	(DoFSC, 2024)
Namkha, Humla District	39 (95% CI: 30.3–60.9)	1.84 (95% CI: 1.44–2.89)	(Lama et al., in review)
Api Nampa Conservation Area	6–9		(Khanal et al., 2020a)
Annapurna–Manaslu Landscape	48	0.95 (95% CI: 0.1–1.9)	(Chetri et al., 2019b)
Annapurna (within above)	Not specified	1.07 (95% CI: 0.71–1.62)	(Chetri et al., 2019b)
Bhimthang–Manaslu (within above)	Not specified	1.16 (95% CI: 0.73–1.87)	(Chetri et al., 2019b)
Phu Valley, Manang (Annapurna area)	Not specified	6.0	(Wegge et al., 2012)
Upper Mustang (Annapurna area)	~22	1.9	(Aryal et al., 2014)
Lapchi Valley (Gaurishankar CA)	~6	2.14	(Koju et al., 2024)
Gaurishankar Conservation Area (GCA)	15 (95% CI: 5.57–35.92)	0.92 (SE 0.44)	(Chetri et al., in review)
Kanchenjunga Conservation Area (KCA)	13 (95% CI: 9–24)	1.0 (95% CI: 0.5–1.7)	(DNPWC, 2024)
Sagarmatha (Everest) National Park	4	0.7	(Lovari et al., 2009)
Sagarmatha	≥3	Not specified	(Křenová et al., 2022)

1.9 per 100 km², corresponding to an approximate population of 22 individuals.

In eastern Nepal, the Lapchi Valley within Gaurishankar Conservation Area recorded six individuals, with an estimated crude density of 2.14 snow leopards per 100 km² (Koju et al., 2024). In a survey conducted in the whole of Gaurishankar Conservation Area, 15 individuals were reported with an estimated density of 0.92 per 100 km² (Chetri et al., in review). In the far-east part of Nepal, in Kanchenjunga Conservation Area, a recent survey by DNPWC (2024) recorded 13 individuals (95% CI: 9.3–23.5), estimating a density of 1 per 100 km² (95% CI: 0.51–1.69). In contrast, a previous study using fecal genetics (Thapa et al., 2021) reported 19 individuals (10 males, 9 females), potentially including sub-adults, and projected a population of 24 with an estimated density of 3.9 per 100 km². This unusually high density should be interpreted with caution.

In Sagarmatha (Everest) National Park, Lovari et al. (2009) confirmed four individuals through fecal genotyping, estimating a density of 0.7 per 100 km², whereas Křenová et al. (2022) indicated a minimum of three snow leopards.

3. Threats

The Snow Leopard Conservation Action Plan (2024-2030) of the Government of Nepal has identified eight major threats to snow leopards, categorized as persisting and emerging threats (DNPWC & DoFSC, 2024). Persisting threats include human-wildlife conflict, wildlife crime, habitat fragmentation, loss and degradation, and wild prey depletion. Emerging threats consist of climate change impacts, diseases, illegal wildlife trade, and poorly planned infrastructure development.

Among the identified threats, human-snow leopard conflict over livestock predation and resulting retaliatory killing remains the most severe and enduring threat to snow leopards (Oli et al., 1994; Khanal et al., 2024; Chetri et al., 2019a; Lama et al., 2018; Jackson et al., 1996). The situation becomes more critical when snow leopards are involved in the mass killing of livestock, leading to heavy financial losses (Thapa, 2021). Numerous studies have emphasized the urgent need for effective conflict mitigation strategies (Filla et al., 2022; Thapa, 2021; Khanal et al., 2020b; Chetri et al., 2019a; Jackson et al., 1996; Oli et al., 1994).

Linear infrastructure, especially roads, poses an increasing threat by fragmenting habitats and facilitating human access to core snow leopard areas, thereby elevating the risks of illegal hunting and illegal wildlife trade (DNPWC & DoFSC, 2024; WWF Nepal, 2018). This threat is more

pronounced in areas outside PAs, where remoteness and rugged terrain hinder effective monitoring and law enforcement, which is also not adequate in PAs (R.P. Lama, pers. comm., 2025).

High human dependence on PAs for resource extraction continues to challenge snow leopard conservation in Nepal. In western Nepal, particularly in Shey-Phoksundo National Park, and Api Nampa Conservation Area, the seasonal influx of thousands of collectors harvesting Cordyceps (*Ophiocordyceps sinensis*), a highly valued parasitic fungus, causes significant disturbance to snow leopards, their prey and habitats (Lama, 2017). Furthermore, climate change is projected to reduce the extent of suitable habitats, increasing both the frequency and severity of human-wildlife conflicts, and alter predator-prey interactions as highlighted by several studies (Aryal et al., 2016; Lovari et al., 2013; Forrest et al., 2012). Furthermore, the combined effects of climate change and anthropogenic pressures are concurrently degrading and diminishing optimal habitats, undermining both wildlife viability and livestock-based food security for communities. These pressures intensify competition for dwindling resources, ultimately escalating human-wildlife conflicts (Farrington et al., 2024).

Recent camera trap studies have recorded common leopards in snow leopard habitats. Although these species may have coexisted for many years, the presence of multiple large predators in the same area is a matter of concern. Among them, snow leopards are often blamed for predation and thus the retaliation is higher compared to common leopard, whose occurrence is still unknown to many local people (Singh et al., 2025).

Other emerging threats associated with climate change, disease spillover, and poorly planned infrastructure development also have the potential to impact snow leopards in the future (DNPWC & DoFSC, 2024). Zoonotic diseases, transfer between wild prey and domestic livestock, and dog-mediated transfer to snow leopards can be fatal (Ng et al., 2019). In Shey-Phoksundo National Park, the country's main stronghold, disease (Mange/Scabies) seems to be one of the key emerging threats to snow leopards and wild prey such as blue sheep as multiple instances of disease-caused mortality have occurred (Gopal Khanal, pers. comm., 2025). However, current evidence on this issue remains limited (DNPWC & DoFSC, 2024; Lama et al., 2020). In a rare and alarming incident in 2023, an injured snow leopard was found in the lowland plains at just 146 m elevation, approximately 57 km from the nearest known habitat. This unprecedented foray into densely populated lower elevations signals snow leopard dispersal and highlights new, under-recognized threats to the species (Chetri et al., 2024).

4. Conservation

The snow leopard has been provided with legal protection by the National Park and Wildlife Conservation Act 1973, as one of the priority species for conservation in Nepal. The Snow Leopard Conservation Action Plan (2024–2030) guides the national priority efforts for snow leopard conservation (DNPWC & DoFSC, 2024), while specific climate-smart plans guide landscape-level priorities (MoFSC, 2017). Nepal's snow leopard conservation efforts have evolved significantly, from early community-based empowerment and conservation initiatives in the 2000s to a more integrated approach that combines local stewardship, development priorities, and targeted threat mitigation. The current approach primarily focuses on supporting local communities with tools and resources to coexist with snow leopards, including predator-proof corrals, income-generating programs, and mechanisms to offset livestock losses (e.g., livestock insurance schemes and compensation relief payments), while addressing context-specific priorities. However, recognizing the integrated nature of challenges and the need to find solutions that benefit both people and nature, Nepal government also prioritizes engagement with diverse non-conventional stakeholders including local governments, faith institutions, media among others (DNPWC & DoFSC, 2024). Efforts are also being made by these institutions to contribute to the government's vision for collaborative conservation (NBF, 2024).

Community-managed livestock insurance schemes and incentive-based conservation models (e.g., saving and credits, and revolving funds for communities, revenue sharing from national park income) have significantly reduced retaliatory killings (Gurung et al., 2011; Thapa et al., 2023). The Government of Nepal has endorsed the Wildlife-Friendly Infrastructure Construction Directives (2022), which guide infrastructure development in wildlife habitat. In addition, the Government of Nepal has revised the Wildlife Damage Relief Guidelines (2023), which streamline compensation for wildlife-induced damages, including livestock predation by snow leopards. However, the effectiveness of other efforts aimed at reducing livestock loss (e.g., corrals) and those targeting the decrease of hunting, illegal trade, and habitat loss is poorly understood. Nepal formulated the first one of its kind climate-smart snow leopard ecosystem management plan for its Eastern Himalayan Landscape, stepping up for integrating climate adaptation into species and landscape-level conservation (MoFSC, 2017).

Nepal has strong multi-stakeholder cooperation and collaboration in snow leopard conservation. Government agencies collaborate closely with NGOs/INGOs and

community-based organizations, such as Snow Leopard Conservation Committees (SLCCs), Buffer Zone Management Committees (BZMCs) and Community-Based Anti-Poaching Units (CBAPUs), to implement conservation programs. Nepal collaborates with neighboring countries through the South Asia Wildlife Enforcement Network (SAWEN), to combat cross-border wildlife trade. The Government of Nepal, through the Wildlife Crime Control Bureau (WCCB), which operates 34 units across the country, is actively engaged to curb wildlife crime (Koirala, 2025). Major stakeholders and conservation institutions have also focused on building climate resilience, strengthening community support, and technology-driven responses regarding snow leopard conservation (WWF Nepal, 2025; Pratihast et al., 2025; DNPWC & DoFSC, 2024). These tools enable real-time data sharing, mapping of high-conflict zones, and informed management interventions.

Conservation education is also being institutionalized, with snow leopard modules integrated into school curricula in Taplejung and Mustang district, fostering early awareness and behavioral change among students (Anil Adhikari, *pers. comm.*, 2025). Furthermore, ex-situ initiatives, such as snow leopard conservation education and captive management programs at the Central Zoo in Lalitpur, play a vital role in public outreach and awareness. Nepal has established the Himalayan Research Center in the Kanchenjunga Conservation Area to facilitate research on high mountain ecosystems and species such as snow leopard. Noting gaps in management high mountain rangelands, efforts have been initiated to develop co-management solutions, integrating modern science and traditional knowledge, engaging conservation authorities, communities and faith leadership (DNPWC & DoFSC, 2024).

Linking ecotourism with snow leopard presence, particularly in the Annapurna and Kanchenjunga regions has offered sustainable financing while promoting human-wildlife coexistence (Schutgens et al., 2019; Hanson et al., 2023). Additionally, Nepal actively engages in cross-border cooperation through platforms like the Global Snow Leopard and Ecosystem Protection Program (GSLEP), participating in national and international workshops that strengthen global snow leopard conservation efforts (GSLEP, 2020).

5. Acknowledgements

This country status report acknowledges the long-term commitment of the Department of National Parks and Wildlife Conservation under the Ministry of Forests and

Environment, Government of Nepal, in advancing snow leopard conservation, research, and monitoring across the country. Recognition is also given to Department of Forest and Soil Conservation, Nepal, conservation organizations, and members of the research and practitioner community in Nepal whose publications, insights, and long-term work informed this synthesis.

The publication further acknowledges the IUCN SSC Cat Specialist Group for supporting the development of this country status series, as well as the wider Snow Leopard IUCN Red List assessment team for their guidance and collaboration during the snow leopard assessment process. Thanks to Bayarjargal Khashbat, GIS Specialist with the WCS Mongolia, who prepared the snow leopard distribution map. Support for coordination of this country status series was provided by Justine Shanti Alexander, WCS Mongolia.

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Adhikari, J.N. (2004). *Ecological study of the snow leopard Uncia uncia* (Schreber, 1778) in Langtang National Park, Nepal.
- Aryal, A., Brunton, D., Ji, W., Karmacharya, D., McCarthy, T., Bencini, R. and Raubenheimer, D. (2014). Multipronged strategy including genetic analysis for assessing conservation options for the snow leopard in the central Himalaya. *Journal of Mammalogy*, 95(4), pp. 871–881. <https://doi.org/10.1644/13-MAMM-A-243>
- Aryal, A., Shrestha, U.B., Ji, W., Ale, S.B., Shrestha, S., Ingty, T., Maraseni, T., Cockfield, G. and Raubenheimer, D. (2016). Predicting the distributions of predator (snow leopard) and prey (blue sheep) under climate change in the Himalaya. *Ecology and Evolution*, 6(12), pp. 4065–4075. <https://doi.org/10.1002/ece3.2196>
- Chalise, M.K. (2011). Snow leopard (*Panthera uncia*), prey species and outreach in Langtang National Park, Nepal. *Our Nature*, 9, pp. 138–145.
- Chetri, M., Gautam, B., Yadav, R.K., Gurung, R.K., Thapa, P.J., Subedi, N. and Pokheral, C.P. (2024). An unusual lowest elevation record of snow leopard (*Panthera uncia*) in Nepal. *Snow Leopard Reports*, 3, pp. 46–56. <https://doi.org/10.56510/slr.v3.23128>
- Chetri, M., Odden, M., Devineau, O. and Wegge, P. (2019a). Patterns of livestock depredation by snow leopards and other large carnivores in the Central Himalayas, Nepal. *Global Ecology and Conservation*, 17, e00536. <https://doi.org/10.1016/j.gecco.2019.e00536>
- Chetri, M., Odden, M., Sharma, K., Flagstad, Ø. and Wegge, P. (2019b). Estimating snow leopard density using fecal DNA in a large landscape in north-central Nepal. *Global Ecology and Conservation*, 17, e00548. <https://doi.org/10.1016/j.gecco.2019.e00548>
- Department of National Parks and Wildlife Conservation (DNPWC) (2013). *National Snow Leopard Ecosystem Protection Priorities (NSLEPS)*, Nepal.
- Department of National Parks and Wildlife Conservation (DNPWC) and Department of Forests and Soil Conservation (DoFSC) (2024). *Snow Leopard Conservation Action Plan for Nepal (2024–2030)*. Kathmandu, Nepal.
- Department of National Parks and Wildlife Conservation (DNPWC) and Department of Forests and Soil Conservation (DoFSC) (2025). *Status of snow leopard population in Nepal*.
- Farrington, J.D. and Li, J. (2024). Climate change impacts on snow leopard range. In: Mallon, D. and McCarthy, T. (eds.) *Snow Leopards*. 2nd edn. Cambridge, MA: Academic Press, pp. 81–93. <https://doi.org/10.1016/B978-0-323-85775-8.00037-6>
- Filla, M., Lama, R.P., Filla, T., Heurich, M., Balkenhol, N., Waltert, M. and Khorozyan, I. (2022). Patterns of livestock depredation by snow leopards and effects of intervention strategies: lessons from the Nepalese Himalaya. *Wildlife Research*, pp. 1–19. <https://doi.org/10.1071/WR21169>
- Forrest, J.L., Wikramanayake, E., Shrestha, R., Areendran, G., Gyeltshen, K., Maheshwari, A., Mazumdar, S., Naidoo, R., Thapa, G.J. and Thapa, K. (2012). Conservation and climate change: assessing the vulnerability of snow leopard habitat to treeline shift in the Himalaya. *Biological Conservation*, 150(1), pp. 129–135. <https://doi.org/10.1016/j.biocon.2012.03.001>
- Gautam, S. (2016). *Distribution of snow leopards (Panthera uncia) and its wild prey in Barse Block of Dhorpatan Hunting Reserve*. BSc thesis, School of Environmental Science and Management (SchEMS), Pokhara University, Nepal.
- Global Snow Leopard and Ecosystem Protection Program (GSLEP) (2020). Global Snow Leopard and Ecosystem Protection Program Country Updates 2020. Available at: https://globalsnowleopard.org/wp-content/uploads/2021/08/Country_updates_2020.pdf
- Gurung, G.S., Thapa, K., Kunkel, K., Thapa, G.J., Kollmair, M. and Müller-Böker, U. (2011). Enhancing herders' livelihood and conserving the snow leopard in Nepal. *CAT News*, 55, pp. 17–21. <https://doi.org/10.5167/uzh-54225>
- Hanson, J.H., Schutgens, M., Baral, N. and Leader-Williams, N. (2023). Assessing the potential of snow leopard tourism-related products and services in the Annapurna Conservation Area, Nepal. *Tourism Planning and Development*, 20(6), pp. 1182–1202. <https://doi.org/10.1080/21568316.2022.2122073>
- Jackson, R. (1979). Snow leopards in Nepal. *Oryx*, 15(2), pp. 191–195. <https://doi.org/10.1017/S0030605300024327>
- Jackson, R.M., Ahlborn, G., Gurung, M. and Ale, S.B. (1996). Reducing livestock depredation losses in the Nepalese Himalaya. In: Timm, R.M. and Crabb, A.C. (eds.) *Proceedings of the 17th Vertebrate Pest Conference*, pp. 241–247.
- Khanal, G., Mishra, C. and Suryawanshi, K. (2020b). Relative influence of wild prey and livestock abundance on carnivore-caused livestock predation. *Ecology and Evolution*, 10(20), pp. 11787–11797. <https://doi.org/10.1002/ece3.6815>
- Khanal, G., Poudyal, L.P., Devkota, B.P., Ranabhat, R. and Wegge, P. (2020a). Status and conservation of the snow leopard *Panthera uncia* in Api Nampa Conservation Area, Nepal. *Oryx*, 54(3), pp. 421–428. <https://doi.org/10.1017/S0030605318000145>
- Khanal, G., Shah, K.B., Jackson, R.M. and Ale, S.B. (2024). Conservation of snow leopard in Nepal. In: Mallon, D. and McCarthy, T. (eds.) *Snow Leopards*. Elsevier, pp. 531–539. <https://doi.org/10.1016/B978-0-323-85775-8.00044-3>

- Koirala, K.R. (2025). Nepal collaborates with neighbors to gain wildlife crime intel but struggles with enforcement. Mongabay. <https://news.mongabay.com/2025/03/nepal-collaborates-with-neighbors-to-gain-wildlife-crime-intel-but-struggles-with-enforcement/>
- Koju, N.P., Bashyal, B., Buzzard, P., Shrestha, A. and Beisch, W.V. (2024). Estimating snow leopard population in Lapchi Valley, Gaurishankar Conservation Area, Nepal. *Snow Leopard Reports*, 3, pp. 57–68. <https://doi.org/10.56510/slr.v3.22840>
- Křenová, Z., Kindlmann, P., Shrestha, B. and Traxmandlová, I. (2022). Abundance of snow leopards and their prey in the Annapurna and Everest regions of Nepal. In: Kindlmann, P. (ed.) *Snow Leopards in Nepal*. Cham: Springer, pp. 89–107.
- Lama R.P., Lama, L.D., Ghale, T.R., Regmi, G.R. and Durbach, I. (in review). First population estimate of snow leopards in north-western highland of Nepal. (*Oryx*).
- Lama, R.P., Ghale, T.R., Suwal, M.K., Ranabhat, R. and Regmi, G.R. (2018). First photographic evidence of snow leopard *Panthera uncia* outside the current protected areas network in the Nepal Himalaya. *Journal of Threatened Taxa*, 10(8). <https://doi.org/10.11609/jott.3031.10.8.12086-12090>
- Lama, R.P., Ghale, T.R. and Regmi, G.R. (2020). Snow leopards in 2100: towards a real-world Nepal perspective. In: Regmi, G. and Huettmann, F. (eds.) *Hindu Kush-Himalaya watersheds downhill: landscape ecology and conservation perspectives*. Cham: Springer, pp. 677–684. https://doi.org/10.1007/978-3-030-36275-1_34
- Lama, T.L. (2017). *Impact of Yartsagunbu (Ophiocordyceps sinensis) collection on snow leopard (Panthera uncia) in Shey Phoksundo National Park, Dolpa District, Nepal*. Pokhara University, Nepal.
- Lovari, S., Boesi, R., Minder, I., Mucci, N., Randi, E., Dematteis, A. and Ale, S.B. (2009). Restoring a keystone predator may endanger a prey species in a human-altered ecosystem: the return of the snow leopard to Sagarmatha National Park. *Animal Conservation*, 12(6), pp. 559–570. <https://doi.org/10.1111/j.1469-1795.2009.00285.x>
- Lovari, S., Ventimiglia, M. and Minder, I. (2013). Food habits of two leopard species, competition, climate change and upper treeline: a way to the decrease of an endangered species. *Ethology Ecology and Evolution*, 25(4), pp. 305–318. <https://doi.org/10.1080/03949370.2013.806362>
- Ministry of Forests and Soil Conservation (MoFSC) (2017). *Snow Leopard and Ecosystem Management Plan (2017–2026)*. Kathmandu, Nepal.
- Nepal Buddhist Federation (NBF) (2024). *Faith plan for environment 2024–2034*. Nepal.
- Ng, D., Carver, S., Gotame, M., Karmacharya, D., Karmacharya, D., Pradhan, S.M., Rana, A.N. and Johnson, C.N. (2019). Canine distemper in Nepal's Annapurna Conservation Area: implications of dog husbandry and human behaviour for wildlife disease. *PLoS ONE*, 14(12), e0220874. <https://doi.org/10.1371/journal.pone.0220874>
- Oli, M.K., Taylor, I.R. and Rogers, M.E. (1994). Snow leopard *Panthera uncia* predation of livestock: an assessment of local perceptions in the Annapurna Conservation Area, Nepal. *Biological Conservation*, 68(1), pp. 63–68. [https://doi.org/10.1016/0006-3207\(94\)90547-9](https://doi.org/10.1016/0006-3207(94)90547-9)
- Pratihast, A.K., Sharma, N., Cappello, C., Schlueter, J., Van Eupen, M., Subedi, A., Tymofiev, I., Kaupisch, K. and Subedi, N. (2025). Community-based snow leopard monitoring through mobile technology. *Snow Leopard Reports*, 4.
- Schutgens, M.G., Hanson, J.H., Baral, N. and Ale, S.B. (2019). Visitors' willingness to pay for snow leopard *Panthera uncia* conservation in the Annapurna Conservation Area, Nepal. *Oryx*, 53(4), pp. 633–642. <https://doi.org/10.1017/S0030605317001636>
- Sharma, K., Borchers, D., Mackenzie, D., Durbach, I., Sutherland, C., Nichols, J.D., Lovari, S., Zhi, L., Khan, A.A., Modaqiq, W., McCarthy, T.M., Alexander, J. S. and Mishra, C. (2019). Guidelines for estimating snow leopard abundance and distribution using a combination of spatial capture-recapture and occupancy models. Submitted to the Steering Committee of the Global Snow Leopard and Ecosystem Protection Program; with financial support from Global Environment Facility, United Nations Development Program and Snow Leopard Trust. Pp. 54
- Singh, P.B., Saud, P., Aryal, P.C., Rai, P., Muntifering, J.R., Hu, H., Hu, Y. and Mainali, K.P. (2025). Decades of leopard coexistence in the Himalayas driven by ecological dynamics, not climate change. *Global Ecology and Conservation*, 57, e03401.
- Shey Phoksundo National Park (SPNP) (2023). *Population assessment of Shey Phoksundo National Park's snow leopard and prey*. Available at: https://dnppwc.gov.np/media/publication/Snowleopard_-_Population_Assessment_SPNP-2023.pdf
- Subba, S.A., Acharya, H.R., Shrestha, S., Koirala, S., Shrestha, R., Thapa, G.J., Thapa, K. et al. (2025). Lessons for transboundary snow leopard conservation: findings from a GPS telemetry study in Kangchenjunga Conservation Area, Nepal. *Integrative Conservation*, 4(1), pp. 45–56. <https://doi.org/10.1002/inc3.70008>
- Thapa, K. (2021). An experience of surplus killing of livestock by a snow leopard in Nepal. *CAT News*, 74, pp. 3–6.
- Thapa, K., Baral, S. and Rayamajhi, S. (2023). Effectiveness of human–snow leopard coexistence measures: a systematic analysis. *Journal for Nature Conservation*, 76, p. 126511. <https://doi.org/10.1016/j.jnc.2023.126511>
- Thapa, K., Schmitt, N., Pradhan, N.M.B., Acharya, H.R. and Rayamajhi, S. (2021). No silver bullet? Snow leopard prey selection in Mt. Kangchenjunga, Nepal. *Ecology and Evolution*, 11(23), pp. 16413–16425. <https://doi.org/10.1002/ece3.8279>
- Wegge, P., Shrestha, R. and Flagstad, Ø. (2012). Snow leopard *Panthera uncia* predation on livestock and wild prey in a mountain valley in northern Nepal: implications for conservation management. *Wildlife Biology*, 18(2), pp. 131–141. <https://doi.org/10.2981/11-049>
- WWF Nepal (2009). *Estimating snow leopard populations in the Nepal Himalaya*. Kathmandu, Nepal: WWF Nepal.
- WWF Nepal (2018). *Infrastructure assessment in snow leopard habitat of Nepal*. Kathmandu, Nepal: WWF Nepal.
- WWF Nepal (2025). Annual report 2025. WWF Nepal. <https://wwfasia.awsassets.panda.org/downloads/wwf-ar-2025-web-final-small.pdf>



Snow Leopard (*Panthera uncia*) Status in Pakistan

CONTRIBUTORS:

Saeed Abbas ^{1*}, Zakir Hussain³, Khadim Abbas³
and Hamera Aisha²

KEYWORDS:

snow leopard; *Panthera uncia*; Pakistan; country
status; distribution; population; conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Abbas et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

1 Center for Biodiversity Conservation and Natural Resource Management, Karakoram International University, Gilgit

2 WWF Pakistan, Lahore, Pakistan

3 Forest, Parks and Wildlife Department, Gilgit-Baltistan, Pakistan

* Email: saeed.abbas@kiu.edu.pk

Distribution

Snow leopards in Pakistan are confined to the remote high-mountain landscapes of the country's north. Their range spans the Hindu Kush, Karakoram, Pamir, and western Himalayan Mountain systems, covering parts of Gilgit-Baltistan, Khyber Pakhtunkhwa (especially Chitral, Swat, Dir, and Kohistan districts), and the Azad Jammu and Kashmir region (notably the Neelum Valley) (Yasmeen & Aslam, 2023). The species occupy rugged alpine and subalpine zones generally between ~3,000 and 5,500 m elevation, favoring steep terrain such as rocky cliffs, ravines, and high-altitude pastures above the treeline (Yasmeen & Aslam, 2023). The total potential snow leopard habitat in Pakistan is estimated at about 80,000 km² (Fox, 1989; Government of Pakistan, 2013). Within this broad area, prime habitat (areas with optimal elevation, slope, and prey availability) is thought to constitute roughly half of the range (Fox, 1989). Snow leopard presence is patchy and closely tied to the distribution of their ungulate prey and suitable cliff-dominated terrain.

Geographically, Pakistan's snow leopard range forms the southwestern extent of the species' global distribution. Important core areas lie in Gilgit-Baltistan, which alone accounts for over 60% of the country's snow leopard range and individuals (Hussain, 2003; Government of Pakistan, 2013). Two of Pakistan's largest protected areas, the Khunjerab National Park and Central Karakoram National Park are located here and harbor significant snow leopard populations (Rashid et al., 2021; GSLEP, 2018). The species' range in northern Pakistan connects with snow leopard populations in neighboring China, Afghanistan, and India,

underscoring the transboundary nature of its distribution. For example, the Khunjerab-Pamir region forms a contiguous corridor with China's Taxkorgan Reserve, facilitating genetic exchange between snow leopards in Pakistan and the larger population in China (Government of Pakistan, 2013). Similarly, in the Kashmir/Himalaya sector, Pakistan's snow leopard areas border those in India. These linkages highlight that Pakistan's snow leopards are part of a larger metapopulation spanning Central and South Asia. Maintaining connectivity across international borders is considered important for the species' long-term viability.

The below updated IUCN Red List range map (2026) of snow leopards in Pakistan aligns with Shoaib et al. (2021) "*Identifying Priority Landscapes for Conservation of Snow Leopards in Pakistan*", and Nawaz et al., (2025) "*From Shadows to Data: A Robust Population Assessment of Snow Leopards in the Highland Crossroads*". Both studies include the most comprehensive data records using camera traps and genetics from a significant part of the snow leopard range in Pakistan. In the updated IUCN map we use the following criteria:

Extant (Resident) (Presence Code 1): The core snow leopard range remains broadly similar to the IUCN 2017 map (McCarthy et al., 2017), encompassing the high mountains of Gilgit-Baltistan, northern Khyber Pakhtunkhwa (Chitral and adjacent areas), and Azad Jammu & Kashmir (Neelum Valley). These areas are confirmed as strongholds with regular, year-round snow leopard presence. For example, Pakistan's two largest national parks (Khunjerab and Central Karakoram) harbour significant snow leopards. Extensive camera-trap surveys from 2010–2019 detected 53 unique snow leopards across all four major mountain ranges (Hindu Kush, Karakoram, Pamir, and Himalaya), confirming continuous occupancy in these core zones (Nawaz et al., 2025). The draft map's Extant polygons thus align with known occupied habitat and transboundary linkages to neighbouring countries' populations.

Possibly Extant (Presence Code 3): Areas in pink represent regions where snow leopards may occur, but evidence remains limited or seasonally uncertain:

- Peripheral range and habitat quality: Shoaib et al. (2021) classified lower Chitral, parts of Astore, and

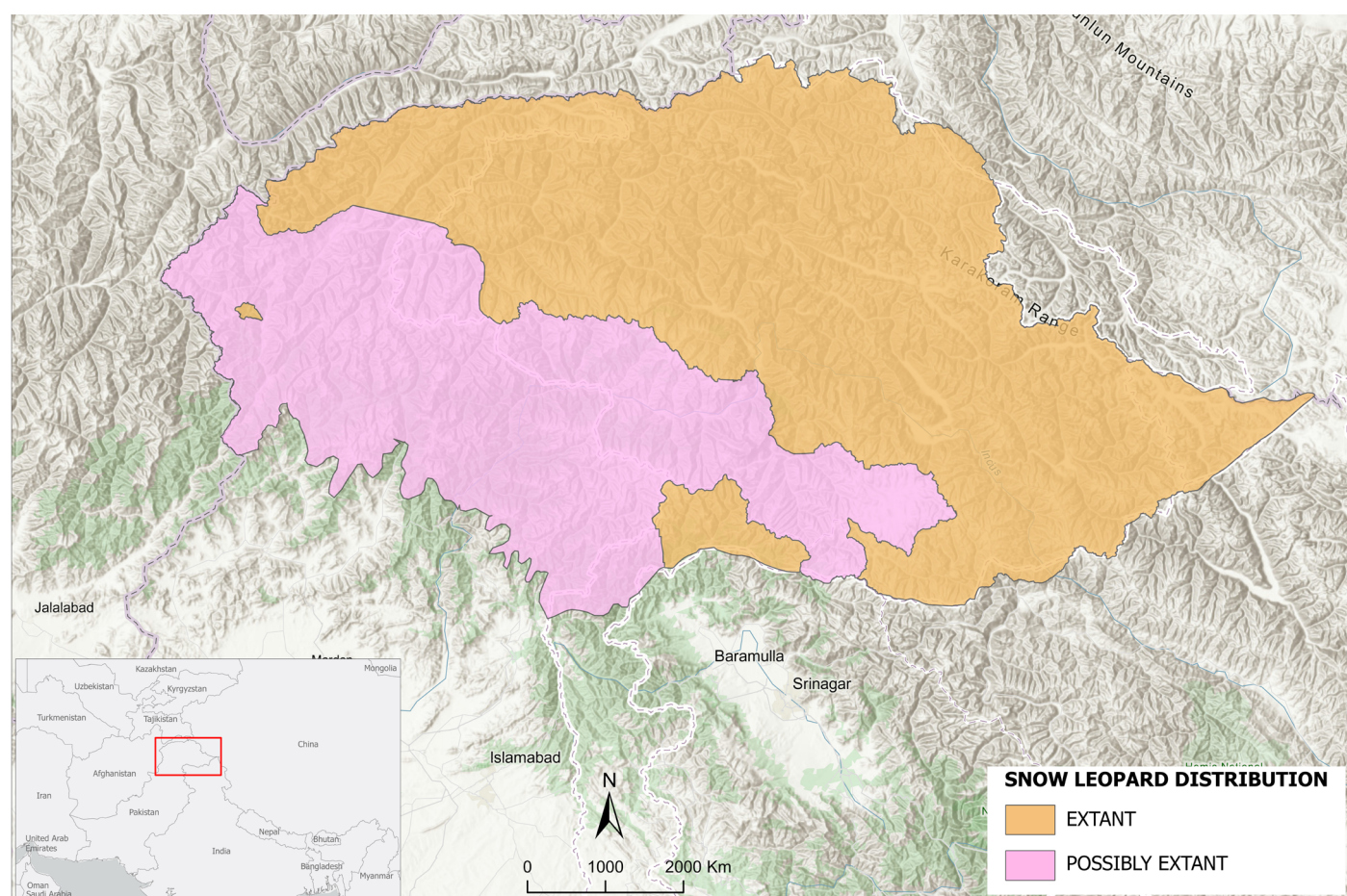


Figure 1: Distribution of the snow leopard (*Panthera uncia*) in Pakistan. Orange areas indicate extant range, where the species is known or strongly inferred to occur. Pink areas indicate possibly extant range, where presence is uncertain but considered likely based on habitat suitability and proximity to confirmed records, following IUCN Red List mapping criteria.

Neelum Valley as low-to-moderate suitability zones, supporting only occasional or transient use.

- Sparse or indirect records: Nawaz et al. (2025) found minimal or no camera-trap detections in southern Chitral and western Himalaya, despite historical presence. These zones fit the IUCN “Possibly Extant” category, indicating uncertain or irregular occupancy (IUCN, 2024).
- Local sightings and reports: Community-based data and WWF-Pakistan conflict records (Rashid et al., 2023) indicate sporadic snow leopard activity in these landscapes but insufficient confirmation for “Extant” classification.

The updated snow leopard distribution map below for Pakistan fully conforms to the IUCN Mapping Standards (v1.20). All polygons are coded correctly for Presence (Extant = 1; Possibly Extant = 3), Origin (1 – Native), and Seasonality (Extant = 1 – Resident; Possibly Extant = 5 – Seasonal Uncertain). Metadata includes species details, compilers (SLF & WWF-Pakistan, 2025), citations (Nawaz et al., 2025; Shoaib et al., 2021), and spatial reference (WGS 84 EPSG:4326). Polygon topology was validated to ensure no overlaps or slivers, and each polygon carries a single attribute set.

2. Population

Estimating snow leopard numbers in Pakistan has historically remained challenging, leading to a wide disparity in reported figures. Early qualitative assessments were largely guesswork. For instance, Schaller (1976) ventured that Pakistan might hold on to the order of 150–200 snow leopards based on anecdotal reports from hunters and locals. By 2003, a more systematic but still indirect evaluation by Hussain (2003) suggested the population could be between 300 and 420 individuals, with the higher figure often cited in subsequent literature as the upper range for Pakistan. This estimate was derived from extensive interviews and sign surveys across known habitats. However, later scrutiny revealed that these high numbers likely overestimated the true population. Extrapolation over large areas, double counting of individuals moving between survey sites, and optimistic assumptions about habitat occupancy all contributed to inflated figures (Din et al., 2020).

Over the last decade, efforts have been made to refine these estimates using empirical methods. Hameed et al. (2020) conducted intensive camera-trap surveys and sign-based occupancy analyses in several regions, and based on their data, they inferred a national total of only approximately 80–120 snow leopards. Similarly, Nawaz

and Hameed (2015) used non-invasive genetic sampling (scat DNA) in core habitats and were able to identify only 23 unique individuals in their survey of Khunjerab National Park (KNP) and adjoining valleys. This study area covers approximately 5,000–6,000 km², including KNP (~4,400 km²) and adjacent buffer valleys such as Misgar and Chapursan. Detecting just 23 individuals across such an extensive area indicates a low population density (~0.4–0.5 snow leopards per 100 km²), which is consistent with other empirical studies demonstrating that even Pakistan’s core snow leopard habitats support relatively sparse populations due to limited prey biomass and large territorial requirements (Hameed et al., 2020; Nawaz et al., 2025). This finding raised serious concerns that traditional approaches had overcounted snow leopards. Many prior surveys likely recounted the same wide-ranging cats multiple times. Collectively, more rigorous studies pointed to a population potentially under 200 animals, far fewer than earlier believed (Nawaz et al., 2025). Such a low number for a country of Pakistan’s size underscored the need for a robust nationwide assessment.

In response to the knowledge gap, a comprehensive population assessment was carried out over 2010–2019 by the Snow Leopard Foundation and partners (Nawaz et al., 2025). This study deployed 828 camera traps over 26,540 trap-days at 65 sites across the four mountain ranges, covering ~39% of Pakistan’s snow leopard range. From thousands of photographs, 53 individual snow leopards were identified by their unique coat patterns. Spatial capture-recapture modelling was then used to estimate population size and density. The resulting estimate was ~127 adult snow leopards (95% confidence interval: 88–182) for the areas surveyed. Extrapolating to un-surveyed habitats (many of which are lower quality) suggests the total national population is likely on the order of 150–200 adult snow leopards. This represents the first statistically robust estimate for Pakistan. Notably, it falls in line with the lower end of previous guesses (validating concerns that earlier high figures were too optimistic). While some uncertainty remains (parts of the range in southeastern Gilgit-Baltistan and Azad Jammu & Kashmir were not camera-trapped due to inaccessibility), the consensus is that Pakistan’s snow leopard population is well under 200 individuals. This low number emphasizes the species’ endangered status in the country.

Snow leopard density in Pakistan varies considerably with habitat quality and protection status. Overall densities are low. On average, the nationwide density from the recent SCR study is about 0.13 snow leopards per 100 km² (Nawaz et al., 2025), though this includes extensive tracts of suboptimal habitat. In known core areas, densities reach higher values. For example, long-term monitoring in Central

Karakoram National Park (CKNP) has reported roughly 1.2–2.0 individuals per 100 km², among the highest densities documented in Pakistan (Hameed et al., 2020). Similarly, Khunjerab National Park and adjacent conservancies are believed to support on the order of 1–1.5 snow leopards per 100 km². Camera trap surveys in parts of Baltistan (around the Hushe valley) indicated densities around 0.5–1.5 per 100 km², depending on local prey richness (Ali et al., 2020). Outside protected zones, densities drop sharply. For example, studies in community-managed landscapes in Chitral, Pakistan (around Chitral Gol National Park) reported snow leopard densities of 0.7–1.3 individuals per 100 km². However, lower densities and declining trends were observed in areas with higher human activity and reduced availability of key wild prey species, including Siberian ibex (*Capra sibirica*), blue sheep (*Pseudois nayaur*), and flare-horned markhor (*Capra falconeri*) (Rashid et al., 2023). In multiple remote valleys of the Pamir and upper Karakoram, occupancy models suggest that even when snow leopards are present, only a fraction of grid cells are used intensively, implying effective densities often below 1/100 km² (Din et al., 2022b). These figures illustrate that while Pakistan does host local hotspots of snow leopard abundance, the animal is generally thinly distributed across the landscape.

The snow leopard population in Pakistan is thought to be structured into a few subpopulations corresponding to major mountain blocks (e.g., Karakoram, Western Himalaya, and Hindu Kush). Genetic studies reveal low genetic diversity among Pakistan's snow leopards, suggesting a small effective population size and some degree of isolation between subgroups (Nawaz & Hameed, 2015). Inbreeding is a concern if connectivity is not maintained. Snow leopards have inherently low reproductive potential with females reaching sexual maturity at ~3 years and typically producing 1–3 cubs in a litter, but not annually (often only every second year). These life-history traits mean the population has a limited capacity for rapid growth and can decline quickly if adult survival drops. Human-caused mortality (whether from illegal hunting or retaliatory killing) can thus have an outsized impact. For example, the loss of just a few breeding females from a small subpopulation is expected to cause a noticeable decline. There is some evidence of source-sink dynamics; protected core areas may serve as sources, whereas border areas or conflict hotspots act as sinks where deaths outpace reproduction. Overall, experts believe the national population was in decline for most of the late 20th century due to heavy persecution and has only stabilized or slightly increased in recent years in core protected areas thanks to conservation efforts (Zaman et al., 2024). However, in unprotected zones, the decline likely continues in Pakistan. Without concerted action, the fragmented nature of Pakistan's snow

leopard population and its slow growth rate mean it would be difficult to recover from significant losses.

Long-term quantitative data on trends is scarce (a consequence of the previously unreliable estimates). Qualitatively, snow leopard numbers in Pakistan likely declined significantly during the 20th century, mirroring global trends, due to rampant hunting (both for trophies and predator control) and prey depletion. By the 2000s, the species had vanished from some fringe areas (e.g., parts of Swat and Kaghan where reports existed historically). Since the mid-2000s, increased protection and community-based programs may have stabilized the situation in key areas. For instance, local reports suggest that snow leopards are now occasionally seen in valleys where they had not been observed for decades, possibly indicating reoccupation as conflict killing abated. Reproductive evidence further supports the persistence of snow leopards in Pakistan's strongholds. Camera-trap surveys in Baltistan and Khunjerab have documented females with cubs, confirming breeding in these landscapes (Zaman et al., 2024). However, in fringe habitats with reduced prey availability and greater human disturbance, recent surveys have not produced similar evidence, indicating that occupancy in these zones remains uncertain (Shoaib et al., 2021).

These findings suggest that snow leopard populations in well-protected core habitats are currently stable, whereas peripheral ranges require continued monitoring to clarify their status. The new population baseline of 150–200 adults now serves as a reference point for future trend assessments and conservation planning.

3. Threats

Snow leopards in Pakistan face a variety of threats, predominantly driven by human activities. The major threats are summarized below in several categories:

Illegal hunting of snow leopards for their fur, bones, and other body parts is a severe and direct threat to the species. Snow leopard pelts have long been valued in the wildlife trade, and body parts (bones in particular) are sought for use in traditional Asian medicines. Pakistan, as part of the snow leopard's range, has been identified as one of the countries where high levels of illegal hunting occur for trade (Nowell et al., 2016). A survey estimated that 23–53 snow leopards may be hunted illegally annually in Pakistan, accounting for roughly 12–53% of the national population being removed each year (Nowell et al., 2016; Din et al., 2022). This level of offtake, if accurate, is biologically unsustainable and would rapidly decimate the population. While not all of these killings are confirmed, the figure highlights the magnitude of potential clandestine hunting. Actual documented cases

are fewer. For instance, an analysis of reported seizures and incidents from 2000–2018 suggested about 8 snow leopard killings per year were detected on average (Din et al., 2022), but many incidents likely go unreported in remote areas.

Much of the illegal hunting in Pakistan is thought to be opportunistic rather than conducted by specialized commercial groups (Din et al., 2022). In many cases, herders or local hunters who encounter a snow leopard (especially after it preys on livestock) may kill it and then subsequently sell the pelt or bones to traffickers. This means that conflict-driven killing (see below) and trade are often interlinked. Nonetheless, there is also evidence of more organized trafficking networks operating in the region: snow leopard skins and parts from Pakistan can be smuggled across the border into China or other countries where black-market demand exists (Nowell et al., 2016; Ahmad et al., 2022). The China-Pakistan Economic Corridor (CPEC), a major infrastructure initiative, has raised concerns that improved road connectivity might inadvertently facilitate wildlife trade unless enforcement is strengthened (Farhadinia et al., 2019; Ahmad et al., 2022). Snow leopard parts have been observed in online marketplaces and smuggling routes that include Pakistan (Nowell et al., 2016).

Despite legal protection under the relevant wildlife and biodiversity preservation acts of Gilgit-Baltistan, Khyber Pakhtunkhwa, and Azad Jammu & Kashmir, and listed in Appendix I of CITES, which prohibits international commercial trade, enforcement in the country's remote mountain regions is challenging. Sparse enforcement capacity, difficult terrain, and porous borders mean that illegal hunting can occur with a low risk of detection. When individuals are caught, prosecution and conviction rates have historically been low, although Pakistan's authorities have been increasing penalties for wildlife crime in recent years.

Conflict with local communities, particularly pastoralists, is another major threat to snow leopards in Pakistan. The high mountains of northern Pakistan are home to agro-pastoral communities who depend on livestock such as goats, sheep, cows, and yaks for their livelihood. These livestock frequently graze in alpine pastures that overlap with snow leopard habitat. As wild prey populations have declined or as livestock herds share these areas, snow leopards are known to prey on domestic animals. Livestock depredation can be significant: a single snow leopard can attack a corral and kill multiple sheep or goats in one incident, leading to substantial economic loss for a subsistence herder (Hussain, 2003). Studies in Baltistan have documented snow leopard diet including up to 30–40% livestock by frequency of occurrence, indicating

how common such predation can be in certain areas (Anwar et al., 2011).

Retaliatory killing of snow leopards by herders is reported to be widespread and is considered one of the leading causes of snow leopard mortality in Pakistan (WWF, 2016; Din et al., 2022). Herders may shoot, trap, or poison snow leopards in retribution for livestock losses, or preemptively to prevent future losses. Community surveys and expert opinion suggest that many snow leopards are killed every year across the species' range due to conflict (Nowell et al., 2016; Ahmad et al., 2022). In one well-publicized case, a snow leopard that had killed livestock was poisoned in Gilgit-Baltistan in 2017, illustrating that such persecution continues despite the species' protected status. Retaliatory killings can also feed into the illegal trade: rather than waste the carcass, a herder who kills a snow leopard out of anger may then sell the skin or bones, blurring the line between conflict killing and commercial illegal hunting (Din et al., 2022).

Several underlying factors exacerbate human-snow leopard conflict. Poverty and limited livestock insurance or compensation mean herders bear the full cost of losses. Traditional herding practices often involve leaving livestock unattended in pastures or poorly guarded nighttime corrals, which are vulnerable to predator attacks. Addressing human-wildlife conflict through better livestock protection, compensation schemes, and community engagement is therefore a critical component of snow leopard conservation in Pakistan (Hussain, 2000; Rasul et al., 2020).

Another threat to snow leopards in Pakistan is the decline of their natural prey base coupled with degradation of habitats. The mountainous ecosystems supporting snow leopards also host wild ungulates such as the Siberian ibex, flare-horned markhor, blue sheep (in the Karakoram/Pamir), Marco Polo sheep (*Ovis ammon polii*; in the Khunjerab area), and Himalayan musk deer (*Moschus chrysogaster*). These wild herbivores are the primary prey of snow leopards. Over the past several decades, many of these species have experienced population declines in Pakistan due to unregulated hunting and competition with livestock (Qureshi et al., 2017; Ahmad et al., 2022). Illegal hunting of ibex and markhor for meat or trophies remains a problem in some regions. For example, over 100 ibex were reportedly illegally hunted in a single incident to cater to illicit demand (Ahmad et al., 2022). Markhor, which were once abundant in parts of Khyber Pakhtunkhwa, were reduced to very low numbers by the early 2000s due to illegal hunting; although conservation efforts have helped some markhor populations recover, others remain at risk (Ahmad & Nabi, 2022).

In addition to human hunting, feral dogs have emerged as an emerging pressure on wild ungulates in certain areas. Feral and free-ranging dogs, often originating from villages, form packs that can hunt wild goats and sheep. A recent study in Chitral Gol National Park documented that 392 markhor were killed by feral dogs over a 15-year period (2006–2020), a significant toll on a small population (Khattak et al., 2021). Feral dog populations in the region have grown due to increased human settlements and improper garbage disposal, and they represent a novel predatory presence in the ecosystem (Khattak et al., 2021).

Habitat degradation and fragmentation further threaten snow leopards by reducing the carrying capacity for both the species and their prey. Although Pakistan's high mountains are relatively sparsely populated, human activities are expanding. Overgrazing by domestic livestock (goats, sheep, cattle) in alpine pastures can lead to erosion, loss of vegetative cover, and declines in forage for wild ungulates (Yasmeen & Aslam, 2023). In some valleys, nearly all accessible pastures are heavily used by livestock, leaving little "refuge" for ibex or other wild herbivores. Fuelwood collection and timber cutting at lower elevations degrade forested winter habitats used by prey species like markhor or musk deer. Mining and quarrying (for gemstones, minerals, and construction materials) have also increased in parts of Gilgit-Baltistan, causing disturbance and sometimes direct habitat loss in snow leopard areas.

Infrastructure development is a growing concern: road construction, border fencing in sensitive areas, and large-scale development projects threaten to fragment previously contiguous habitats (WWF-Pakistan, 2021). The CPEC project, which involves new highways and expanded traffic through the Karakoram, may create barriers to wildlife movement and open up remote areas to further exploitation (Nabi et al., 2018). Already, anecdotal reports suggest that wildlife is avoiding some of the new roads due to disturbance, and construction camps bring an influx of workers (and potentially illegal hunting activity) into fragile habitats. Cumulatively, these factors lead to a deterioration of the ecosystem that snow leopards depend on: fewer prey, less cover, and increased human presence. Habitat fragmentation can isolate snow leopard sub-populations into smaller pockets, raising the risk of local extirpation. Climate change (discussed below) is likely to exacerbate habitat-related issues, making conservation of large, connected landscapes even more vital.

Climate change poses a long-term threat to snow leopards and their high-mountain habitat. The Himalaya and associated ranges are experiencing above-average warming, which is expected to alter ecosystems profoundly. Warming temperatures are predicted to shift vegetation zones

upslope; model projections indicate that alpine habitats (the preferred zone of snow leopards and their prey) could contract significantly as the tree line rises (Farrington & Li, 2016). One modeling study predicted substantial losses (up to 30% or more) of climatically suitable habitat for snow leopards in parts of their range by 2070 under high-emission scenarios (Farrington & Li, 2016). In Pakistan, this could mean the gradual encroachment of forests and scrub into current alpine meadows, reducing open hunting grounds for snow leopards and leading to changes in prey communities.

Climate change is also expected to impact water regimes and glaciers in these mountains, potentially affecting both human livelihoods and wildlife. More erratic precipitation and glacial melt can alter pasture productivity and distribution of prey. Additionally, extreme weather events (heavy snowfalls, late spring storms) could directly cause prey die-offs. As lower elevations become warmer, there is a possibility of ecological competition intensifying. For example, the common leopard (*Panthera pardus*) has been recorded expanding its range upward into what was historically snow leopard-only terrain (Lovari et al., 2020). In Pakistan's Khyber Pakhtunkhwa and Azad Kashmir, increasing overlap between snow leopards (an alpine specialist) and common leopards (a mid-hill forest species) may occur as climate and land use changes allow the latter to occupy higher altitudes. This could lead to direct competition or even aggressive encounters between the two carnivores, though detailed studies are lacking.

Finally, climate change intersects human issues to heighten threats: As climate change stresses local pastoral livelihoods (e.g. through drought or pasture changes), communities might become less tolerant of predation or more dependent on exploiting natural resources, indirectly increasing pressures on snow leopards. There is also concern that climate impacts on agriculture could prompt governments to pursue more development (roads, dams) in marginal areas as economic measures, further fragmenting habitats (Nabi et al., 2019).

4. Conservation

Snow Leopard conservation efforts in Pakistan are multi-faceted, involving government agencies, local communities, and international partners. The species is legally protected and has been the focus of numerous initiatives aimed at reducing threats and strengthening its survival prospects. Key aspects of the conservation strategy are outlined below:

The snow leopard is fully protected by law in Pakistan. Hunting or trading the species is illegal under provincial

wildlife legislation (e.g., the Gilgit-Baltistan Wildlife Act and similar laws in Khyber Pakhtunkhwa), and the animal is classified as a “protected” under respective wildlife and biodiversity preservation acts of Gilgit-Baltistan, Azad Jammu & Kashmir and Khyber Pakhtunkhwa and declared “endangered” species nationally (Sheikh & Molur, 2003). Pakistan is also a signatory to CITES, which prohibits international commercial trade in snow leopard parts. In recent years, penalties for wildlife illegal hunting in Pakistan have been increased, and snow leopard offenses can carry substantial fines (up to 5 million PKR and imprisonment in up to 2 years). However, enforcement in remote mountain regions remains challenging due to limited resources and personnel. The government has been working to build capacity by training wildlife rangers and establishing community wildlife guards in key areas to improve law enforcement presence (Din et al., 2022).

Establishing and managing protected areas has been central to snow leopard conservation in Pakistan. Pakistan has designated several national parks, wildlife sanctuaries, and game reserves within the snow leopard’s range. Notably, Khunjerab National Park (KNP) in Gilgit-Baltistan, spanning approximately 4,400 km² of high-altitude terrain, was created in part to protect snow leopards and their prey. Adjoining KNP is the even larger Central Karakoram National Park (CKNP: around 10,000 km²), which encompasses a vast expanse of the Karakoram range including many remote valleys likely harboring snow leopards. Together, KNP and CKNP form a continuous protected landscape in northern Pakistan and are thought to safeguard a significant proportion of the country’s snow leopard population (Government of Pakistan, 2013). Other protected areas important for snow leopards include Chitral Gol National Park (77 km²) in Khyber Pakhtunkhwa, which, though small, protects a critical population of markhor that in turn supports a few snow leopards in the area, and various community-managed reserves in Gilgit-Baltistan (such as the Khunjerab Village Organization conservancies around KNP). In Azad Jammu & Kashmir, the recently established Machiara National Park and surrounding reserves cover montane forests and alpine zones that are potential snow leopard habitat.

While these protected areas are crucial, a large portion of snow leopard habitat in Pakistan lies outside formal PAs, on community or private lands. Conservation efforts have thus adopted a landscape approach, attempting to extend protection beyond park boundaries. This includes engaging local communities in surveillance and habitat protection (see below) and promoting land-use planning that considers wildlife corridors. Transboundary cooperation is also part of the strategy: for example, KNP in Pakistan and the Taxkorgan Nature Reserve in China

have been discussed as a possible transboundary peace park to facilitate collaborative management of shared snow leopard populations. Pakistan’s participation in the Global Snow Leopard & Ecosystem Protection Program (GSLEP) has reinforced its commitment to securing snow leopard landscapes; under this initiative, Pakistan identified its priority snow leopard landscapes and is working toward their long-term protection (GSLEP, 2018). Overall, enhancing protected area management (e.g., anti-poaching patrols, prey monitoring) and expanding coverage where needed remain ongoing priorities. Recent assessments suggest that existing protected areas, while valuable, need greater resources for effective patrolling and community outreach to reduce threats within their boundaries (Rashid et al., 2021).

Given that snow leopards occur across vast areas that include human-inhabited valleys, community involvement is essential for successful conservation. Pakistan has pioneered several community-based initiatives aimed at reducing human-snow leopard conflict and providing local benefits for conservation. One of the earliest and most famous efforts was the introduction of a livestock insurance scheme in Baltistan in the early 2000s (Hussain, 2000). Under this program, herders contribute to a community fund that compensates them for livestock killed by snow leopards. This innovative approach was designed to offset economic losses and thereby discourage retaliatory killing of the cats. The pilot insurance scheme proved effective in its initial years with participating communities reporting a reduction in snow leopard killings (Hussain, 2003). Today, similar community insurance or compensation programs (some supported by the government or NGOs) operate in parts of Gilgit-Baltistan and Chitral.

Another practical measure has been the construction of predator-proof corrals. Organizations such as the Snow Leopard Foundation (SLF) and WWF-Pakistan have worked with villagers to reinforce night-time livestock pens using iron grilles, stone masonry, or chain-link fencing (Snow Leopard Trust, 2018). By preventing snow leopards from entering corrals, these corral improvement projects dramatically cut down on surplus killings of livestock in a single incident. Dozens of such improved corrals have been built in conflict hotspot villages across Gilgit-Baltistan and Khyber Pakhtunkhwa, and they have shown immediate results in lowering depredation rates (Snow Leopard Foundation, 2024). Herder education and outreach programs have been implemented to raise awareness about snow leopard behavior and the importance of the species in the ecosystem. Many communities have traditional perceptions of the snow leopard as a pest or a threat; conservation programs have sought to shift these attitudes by involving respected local leaders, offering training in

livestock husbandry to reduce losses, and even developing eco-tourism opportunities around snow leopard viewing (Yasmeen & Aslam, 2023).

Community stewardships and incentive programs have also been introduced. In several valleys, local councils (Village Conservation Committees) have been formed and given a role in wildlife management – for instance, helping set up and patrol community-controlled hunting zones for sustainable harvest of certain ungulates. A well-known example is the *trophy hunting* program for ibex and markhor in Gilgit-Baltistan and Chitral. Since the 1990s, Pakistan, with support from international agencies, has allowed a small number of old male ibex and markhor to be hunted each year by foreign hunters for high fees, with 80% of the revenue returned to local communities. This scheme provides communities with a tangible stake in conserving wildlife; income from trophy hunting has funded village projects and community guards. The rationale is that if communities benefit financially from healthy wild ungulate populations, they will be more tolerant of predators and invest in anti-poaching. There is evidence that ungulate numbers have increased in some conservancies under this program. However, the trophy hunting approach has also been subject to debate and occasional misuse. In some cases, hunts have been allowed inside core zones of national parks (Rashid et al., 2021), and there are reports that the influx of hunters and tourists can create disturbances. Additionally, some locals perceive that benefits are not shared equitably. Pakistan’s conservation authorities continue to refine this program, for example, by adjusting quotas and ensuring transparency to maximize its positive impact on snow leopard conservation (Rashid et al., 2021).

Improving knowledge about snow leopard ecology and status has been a critical part of Pakistan’s conservation strategy, enabling more effective action. Historically, information on snow leopards in Pakistan was anecdotal. In recent years, concerted research efforts by Pakistani scientists and international collaborators have greatly expanded understanding. The use of camera traps, genetic analysis, and robust population modeling (as evidenced by Nawaz et al. (2025)’s nationwide study) is a major leap forward. The data from these surveys not only provided population estimates but also helped map snow leopard distribution more accurately, identifying key concentration areas and corridors (Nawaz et al., 2025). Ongoing monitoring in certain hotspots (e.g., periodic re-surveys in parts of Gilgit-Baltistan) is planned to detect population trends over time. Additionally, noninvasive genetic sampling (analysis of scat DNA) has been explored to complement camera trapping, with preliminary studies confirming snow leopard presence in areas like the Upper Swat and Azad Kashmir where camera studies are

logistically difficult (Hameed et al., 2020). These scientific efforts are essential for guiding conservation decisions, such as where to focus anti-poaching patrols or conflict mitigation efforts.

Pakistan has also embraced international cooperation for snow leopard conservation. In 2013, it became a signatory to the Bishkek Declaration and a founding member of GSLEP, through which it developed the National Snow Leopard and Ecosystem Protection Priority (NSLEP) document (Climate Change Division, 2013). This strategy laid out Pakistan’s long-term plan to secure snow leopard habitat and populations, and it aligns with the global goal of securing “20 snow leopard landscapes by 2020.” Pakistan identified at least three priority landscapes within its borders for intensive conservation action under this initiative. Through GSLEP and bilateral agreements, Pakistan has been sharing data and collaborating with neighboring range countries. For example, there have been joint training workshops with China and Afghanistan on camera trapping and survey methodologies, and dialogues on transboundary wildlife crime control (GSLEP, 2018). Information exchange on radio-collared snow leopards crossing borders has also occurred, helping to track movement ecology.

To address ongoing threats and consolidate conservation gains, the following realistic and achievable actions are recommended below:

- Scale up successful predator-proof corral construction, livestock insurance schemes, and community education programs across all key snow leopard landscapes to further reduce livestock losses and retaliatory killings.
- Strengthen the management of existing national parks (e.g., KNP, CKNP) by improving patrolling and community co-management. Designate new conservation areas and establish wildlife corridors to secure critical habitats and ensure genetic connectivity, particularly in transboundary regions adjoining China and Afghanistan.
- Invest in long-term ecological studies to monitor population dynamics, prey availability, genetic connectivity, and the effectiveness of conflict mitigation measures. Expanded non-invasive genetic sampling and periodic nationwide camera trap surveys will improve monitoring of snow leopard populations and habitat use.
- With projections indicating a 30–40% loss of snow leopard habitat by 2070 (Ahmad et al., 2022), conservation strategies must proactively protect future climate refugia, promote sustainable grazing practices, and restore degraded alpine ecosystems.

- Increase patrolling in snow leopard habitats, improve inter-agency coordination (wildlife, customs, police), and ensure harsher penalties for wildlife crime. Community-based informant networks can augment limited enforcement capacity in remote areas.
- Develop well-managed eco-tourism initiatives that generate alternative income for local communities, reducing their reliance on livestock and lowering human-wildlife conflict. Community involvement in tourism management is critical for success and conservation buy-in.
- Strengthen joint conservation efforts with neighbouring countries, including coordinated monitoring, intelligence-sharing on wildlife trafficking, and the establishment of transboundary protected areas or peace parks to secure cross-border snow leopard populations.

5. Acknowledgements

This country status report acknowledges the contributions of government authorities, research institutions, conservation organizations, and members of the research and practitioner community in Pakistan whose data, insights, and long-term work informed this synthesis. A special thanks to Dr. Muhammad Ali Nawaz and Dr. Hussain Ali from Snow Leopard Foundation Pakistan for their support in preparing this chapter. The publication further acknowledges the IUCN SSC Cat Specialist Group for supporting the development of this country status series, as well as the wider Snow Leopard IUCN Red List assessment team for their guidance and collaboration during the snow leopard assessment process. Thanks to Bayarjargal Khashbat, GIS Specialist with the WCS Mongolia, who prepared the snow leopard distribution map. Support for coordination of this country status series was provided by Justine Shanti Alexander, WCS Mongolia.

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Ahmad, S., & Nabi, G. (2022). Trophy hunting in Pakistan: The status and future prospects. *Wildlife Biology*, 28(3), e01041. <https://doi.org/10.1002/wlb3.01041>
- Ahmad, S., Nabi, G., Hacker, C. E., Strelnikov, I. I., & Luan, X. (2022). Increasing threats to snow leopard survival in Pakistan. *Frontiers in Ecology and Evolution*, 10, 818798. <https://doi.org/10.3389/fevo.2022.818798>
- Ali, H., Kabir, M., Hameed, S., Younas, M., & Nawaz, M. A. (2020). Habitat suitability and connectivity modeling of snow leopard (*Panthera uncia*) in the western Himalayas. *Ecological Indicators*, 113, 106179. <https://doi.org/10.1016/j.ecolind.2020.106179>
- Anwar, M. B., Jackson, R., Nadeem, M. S., Janecka, J. E., Hussain, S., & Beg, M. A. (2011). Food habits of the snow leopard (*Panthera uncia*) in Baltistan, northern Pakistan. *European Journal of Wildlife Research*, 57(5), 1077–1083. <https://doi.org/10.1007/s10344-011-0521-2>
- Climate Change Division. (2013). *Pakistan: National Snow Leopard and Ecosystem Protection Priorities (NSLEP)*. Government of Pakistan.
- Din, J. U., Ali, H., Nawaz, M. A., & Hameed, S. (2017). Human-snow leopard conflict across transboundary Pamirs. *Snow Leopard Foundation Report*. (Unpublished data cited in reports).
- Din, J. U., Bari, F., Ali, H., Ur Rehman, E., Adli, D. S. H., Abdullah, N. A., et al. (2022). Drivers of snow leopard poaching and trade in Pakistan and implications for management. *Nature Conservation*, 46, 49–62. <https://doi.org/10.3897/natureconservation.46.76036>
- Din, J. U., Hameed, S., Ali, H., Nawaz, M. A., & Kabir, M. (2022b). Snow leopard site occupancy and habitat use in the Pamir Mountain range of northern Pakistan. *Animals*, 12(8), 1034. <https://doi.org/10.3390/ani12081034>
- Farhadinia, M. S., Maheshwari, A., Marashi, S. A., Gholikhani, N., Ghoddousi, A., & Kachel, S. (2019). Infrastructure threatens the endangered Asiatic cheetah *Acinonyx jubatus venaticus* in Iran. *Oryx*, 53(1), 32–38. <https://doi.org/10.1017/S0030605317001102>
- Farrington, J. D., & Li, J. (2016). Climate change impacts on snow leopard range. In T. McCarthy & D. Mallon (Eds.), *Snow Leopards* (pp. 85–95). Academic Press. <https://doi.org/10.1016/B978-0-12-802213-9.00007-6>
- Fox, J. L. (1989). *A review of the status and ecology of the snow leopard*. Proceedings of the 5th International Snow Leopard Symposium. International Snow Leopard Trust.
- GEF. (2020). *Transforming human-carnivore coexistence in northern Pakistan*. Global Environment Facility Project ID 10215.
- Government of Pakistan. (2013). *National Biodiversity Strategy and Action Plan*. Ministry of Climate Change, Islamabad.
- GSLEP. (2018). *Global Snow Leopard & Ecosystem Protection Program: Stepping Forward*. Bishkek: GSLEP Secretariat.
- Hameed, S., Din, J. U., Ali, H., Kabir, M., Younas, M., Ur Rehman, E., et al. (2020). Identifying priority landscapes for conservation of snow leopards in Pakistan. *PLoS ONE*, 15(11), e0228832. <https://doi.org/10.1371/journal.pone.0228832>
- Hussain, S. (2000). Protecting the snow leopard and enhancing farmers' livelihoods: A pilot insurance scheme in Baltistan, Pakistan. *Mountain Research and Development*, 20(3), 226–231. [https://doi.org/10.1659/0276-4741\(2000\)020\[0226:PTSLAE\]2.0.CO;2](https://doi.org/10.1659/0276-4741(2000)020[0226:PTSLAE]2.0.CO;2)
- Hussain, S. (2003). The status of the snow leopard in Pakistan and its conflict with local farmers. *Oryx*, 37(1), 26–33. <https://doi.org/10.1017/S0030605303000123>
- IUCN. (2024). Mapping Standards and Data Quality for the IUCN Red List Spatial Data (Vol. 20, Issue January)
- Khattak, R. H., Xin, Z., Ahmad, S., Bari, F., Khan, A., & Nabi, G. (2021). Feral dogs in Chitral Gol National Park, Pakistan: A potential threat to the Kashmir markhor (*Capra falconeri cashmiriensis*). *Brazilian Journal of Biology*, 83, e245867. <https://doi.org/10.1590/1519-6984.245867>

- Lovari, S., Minder, I., Ferretti, F., Mucci, N., & Sayan, A. (2020). Coexistence of snow leopard (*Panthera uncia*) and common leopard (*Panthera pardus*): Ecological separation or competition? *Journal of Zoological Studies*, 7(4), 185–194.
- McCarthy, T., Mallon, D., Jackson, R., Zahler, P., & McCarthy, K. (2017). *Panthera uncia* (amended version of the 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22732A110552636. <https://doi.org/10.2305/IUCN.UK.2017-2.RLTS.T22732A110552636.en>
- Nabi, G., Ahmad, S., Khan, S. A., Li, D., & Li, X. (2018). The ecological effects of the China–Pakistan Economic Corridor: A potential road to green development. *Sustainability*, 10(8), 2937. <https://doi.org/10.3390/su10082937>
- Nabi, G., Hobbs, J., & Ahmad, S. (2019). Building resilience to climate change through adaptive governance: A case of northern Pakistan. *International Journal of Climate Change Strategies and Management*, 11(1), 146–163. <https://doi.org/10.1108/IJCCSM-07-2017-0135>
- Nawaz, M. A., & Hameed, S. (2015). Conservation genetics and non-invasive monitoring of snow leopards in Pakistan. *Unpublished report*, Snow Leopard Foundation Pakistan.
- Nawaz, M. A., Hameed, S., Din, J. U., Ali, H., Ahmad, S., Durbach, I., et al. (2025). From shadows to data: A robust population assessment of snow leopards in the highland crossroads (Pakistan). *bioRxiv*. <https://doi.org/10.1101/2025.03.26.645478>
- Nowell, K., Li, J., Paltsyn, M., & Sharma, R. K. (2016). *An Ounce of Prevention: Snow Leopard Crime Revisited*. TRAFFIC International.
- Qureshi, Q., Sathyakumar, S., & Rawat, G. S. (2017). Conservation of high-altitude biodiversity in the Indian Himalayas: Need for an integrated landscape approach. *Indian Forester*, 143(12), 1203–1214.
- Rashid, W., Shi, J., Dong, S., & Sultan, H. (2021). Issues and opportunities associated with trophy hunting and tourism in Khunjerab National Park, northern Pakistan. *Animals*, 11(4), 597. <https://doi.org/10.3390/ani11040597>
- Rashid, W., Sultan, H., Mehmood, M. T., Ahmad, R., & Khan, W. (2023). Insights from community perceptions on the human–snow leopard conflict in the Karakoram landscape, Pakistan. *Sustainability*, 15(4), 3725. <https://doi.org/10.3390/su15043725>
- Rasul, G., Hussain, A., Mahapatra, B., & Dang, T. H. (2020). The nexus approach to integrated water–energy–food security in Pakistan. *Environmental Science & Policy*, 104, 20–29. <https://doi.org/10.1016/j.envsci.2019.10.014>
- Sheikh, K. M., & Molur, S. (2003). *Status and red list of Pakistan's mammals*. Islamabad, Pakistan: IUCN Pakistan.
- Shoaib, M., Hameed, S., Ali, H., Din, J. U., & Nawaz, M. A. (2021). Identifying priority landscapes for conservation of snow leopards in Pakistan. *Snow Leopard Foundation Report*.
- Snow Leopard Foundation. (2024, September 9). Predator-Proof Corrals: Untapped Potential to Save Livestock, Livelihoods, and Snow Leopards. Snow Leopard Foundation Pakistan. <https://slf.org.pk/predator-proof-corrals-untapped-potential-to-save-livestock-livelihoods-and-snow-leopards-2/>
- Snow Leopard Trust. (2018). *Annual Report 2018*. <https://snowleopard.org>
- WWF-Pakistan. (2016). *Protecting the ghost of the mountains: Snow leopard conservation in Pakistan*. Lahore: WWF-Pakistan.
- WWF-Pakistan. (2021). *Infrastructure development and biodiversity conservation in Pakistan's mountains*. WWF-Pakistan Report.
- Yasmeen, R., & Aslam, I. (2023). Conservation strategies and human conflicts with snow leopard in Pakistan: A review. *Journal of Wildlife and Biodiversity*, 7(1), 40–54. <https://doi.org/10.5281/zenodo.6803386>
- Zaman, K. U., Rashid, W., & Abbas, S. (2024). Status, threats, and conservation of snow leopard (*Panthera uncia*) in Pakistan: An overview. *Pakistan Journal of Zoology*, 56(2), 421–432. <https://doi.org/10.17582/journal.pjz/2024.56.2.421>



Snow Leopard (*Panthera uncia*) Status in Russian Federation

CONTRIBUTORS:

Alexander Karnaukhov^{1*}

KEYWORDS:

snow leopard; *Panthera uncia*; Russian Federation;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Karnaukhov et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

1 Institute of Ecology and Evolution, Russian Academy of Sciences

* Email: a.s.karnaukhov@gmail.com

1. Distribution

The snow leopard's (*Panthera uncia*) distribution in Russia is concentrated in the Altai-Sayan region, where the species lives in the Altai, Western and Eastern Sayan mountain ranges, as well as the mountain massifs of Tyva and Buryatia. The total area of the key snow leopard habitat in the Russian Federation is about 37,350 km² (Strategy on Conservation of Snow leopards in the Russian Federation, 2014; Paltsyn et al., 2016; Karnaukhov et al., 2024).

In the Altai Republic, snow leopard habitat is located within Central, Southeastern and Eastern Altai, and includes the Katunsky Ridge, Northern and Southern Chuisky Ridges, Tabyn-Bogdo-Ola and Sailugem Ridges, Kuraisky Ridge, southern Shapshal Ridge, the Chulyshman Highlands, and Chikhachev Ridge. The total area of the key snow leopard habitat in the Altai Republic is about 13,500 km².

In the Tyva Republic, resident snow leopard populations are found on the eastern slopes of Chikhachev Ridge, Mongun-Taiga Massif, Tsagan-Shibetu and Shapshal Ridges, the western side of Western Tannu-Ola Ridge, and Sangilen Ridge. Snow leopards have also been documented in the Alashsky, Khemchiksky, Eastern Tannu-Ola, Akademik Obruchev, Ergak-Targak-Taiga, and Udinsky Ridges (Poyarkov et al., 2019). The total area of the key snow leopard habitat in the Tyva Republic is about 14,000 km².

In Krasnoyarsky Krai, a resident population of snow leopards inhabits the periphery of the Sayano-Shushensky

Reservoir within the Sayano-Shushensky State Biosphere Reserve and its buffer zone (specifically in the Khemchiksky and Kurtushubinsky Ridges). The total area of the key snow leopard habitat in Krasnoyarsky Krai is about 1,600 km² (Korablev et al., 2021).

In the Buryatia Republic, the best habitat for snow leopards is located on the Bolshoy Sayan Ridge (Karnaukhov et al., 2018). The species has an ongoing presence on the slopes of Okinsky, Tunkinsky, and Kropotkinsky Ridges. The total area of the key snow leopard habitat in the Buryatia Republic is about 8,300 km².

The distribution map in Figure 1 is based on MaxEnt model of snow leopard habitat (Kalashnikova et al., 2019; Karnaukhov et al., 2020). For this modeling we used 2,866 points of snow leopard sightings collected in Russia in 2000-2016. All variables for the habitat modeling were converted to Alber's Equal-area conic projection for the Northern Asia and spatial resolution of 1000 m. The modeling area encompassed all areas of potential snow leopard presence from Western Altai to Zabaikalsky Krai.

The following 10 variables were used for the modelling:

- Elevation. Source of data: CGIAR-CSI SRTM website <http://www.cgiar-csi.org/data/srtm-90m-digital-elevation-database-v4-1>
- Slope. Was built as derivative of Elevation variable
- Ruggedness. Was built as derivative of Elevation variable
- Aspect (with 4 categorical parameters: north, east, west, and south). Was built as derivative of Elevation variable
- Sum of precipitations in November-March. Source of data: Global Climate Data (WorldClim) modern period <http://www.worldclim.org/>
- Averaged fraction of snow cover in November-March. Source of data: MODIS/Terra Snow Cover Monthly L3 Global 0.05Deg CMG datasets <http://dx.doi.org/10.5067/IPPLURB6RPCN> (Hall, Salomonson and Riggs 2006)
- Fraction of snow cover in July (proxy of glaciers and permanent snowfields). Source of data: MODIS/Terra Snow Cover Monthly L3 Global 0.05Deg CMG

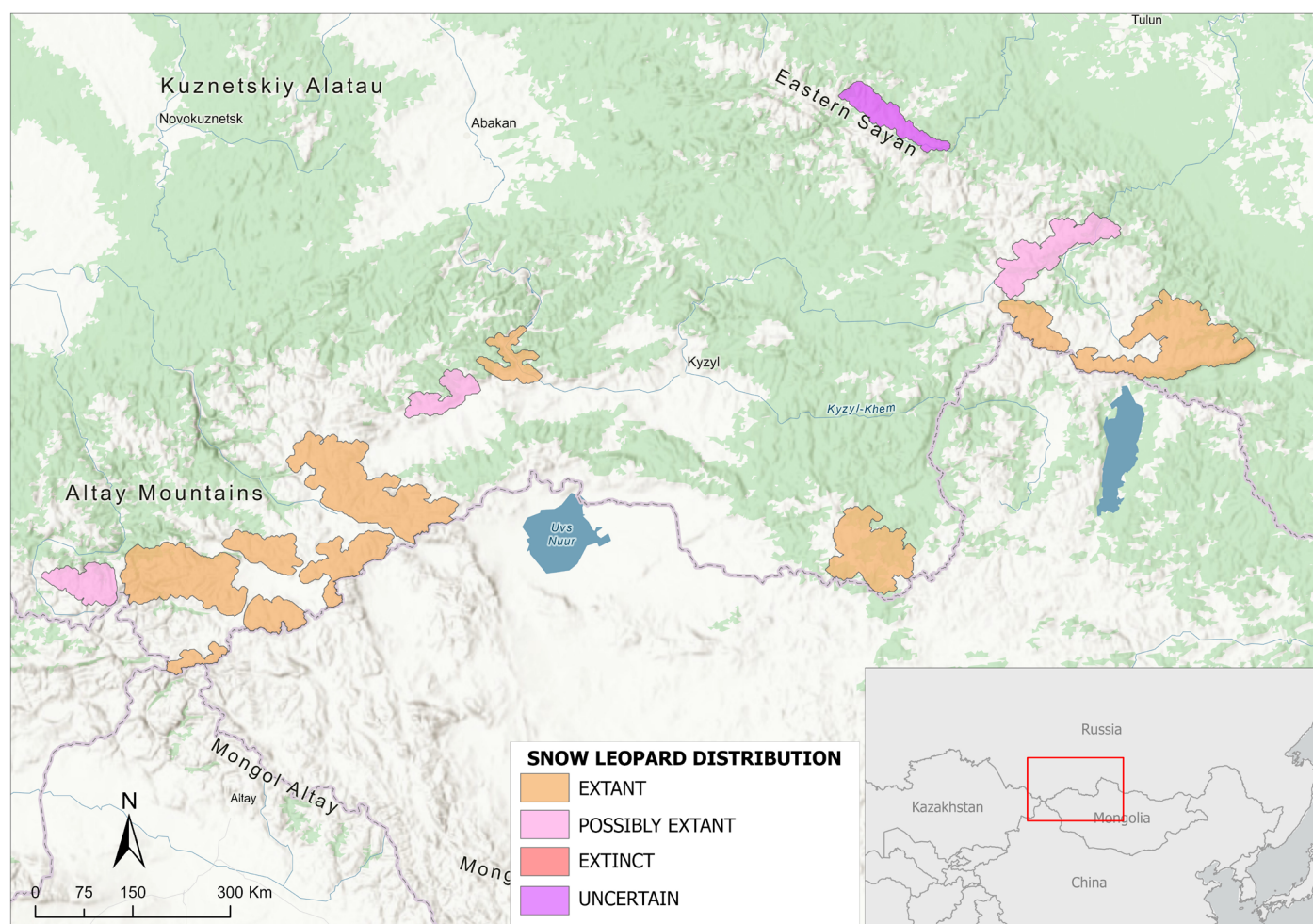


Figure 1. Snow leopard distribution in Russia mapped based on collated data sources (see below), showing areas classified as extant, possibly extant, and possibly extinct according to IUCN Red List standards.

datasets <http://dx.doi.org/10.5067/IPPLURB6RPCN> (Hall, Salomonson and Riggs 2006)

- Fraction of bare ground area (cliffs, screes, high mountain deserts). Source of data: MODIS Vegetation Continuous Fields (VCF) <http://glcf.umd.edu/data/vcf/>
- Fraction of tree cover. Source of data: MODIS Vegetation Continuous Fields (VCF) <http://glcf.umd.edu/data/vcf/>
- Fraction of grass and shrub cover. Source of data: MODIS Vegetation Continuous Fields (VCF) <http://glcf.umd.edu/data/vcf/>.

The modeling exercise was implemented in MaxEnt (Version 3.3.3k). A logistic type of MaxEnt modeling output (probability surface of species habitat) was used to interpret our results more intuitively, ten model replicates using the cross-validation function and a maximum of 5,000 iterations. For all other parameters default options were used. For evaluation of the model's ability to predict snow leopard habitat, two tools integrated in MaxEnt were used: (1) test omission rate and predicted area as a function of the cumulative threshold for 10 model replicates; (2) area under receiver operating characteristic curve (AUC) for 10 model replicates. Contribution of each variable in the habitat model was assessed using table for variables generated by MaxEnt. For classification of habitat types, only the averaged probability surface from 10 replicates was used. 10 percentile training presence logistic threshold was used as a threshold for extraction of all snow leopard

potential habitat from the probability surface. This value was 0.278. All pixels with a probability higher than 0.5 were classified as optimal snow leopard habitat.

The resulting raster model was digitized using standard QGIS tools. A 5-kilometer buffer was placed around the vector polygons and all openings inside the polygons were cut out. In addition, all random outcrops outside the historical range of the species were removed.

2. Population

The Katunsky, North and South Chuisky Ridges System (in the Altai Republic) is one of the largest areas of snow leopard habitat in the Russian part of the species' range, covering a total area of 6,000-8,000 km². Research conducted in this area in 2022 estimates the total snow leopard population at 23-24 adult animals (15-16 adult individuals in Argut river basin and 8 adult individuals in South and North Chuya Ranges), or 32-33 individuals including subadults and cubs. Camera traps confirmed these estimates, with each individual identified.

The Tabyn-Bogdo-Ola Ridge (in the Altai Republic) provides 800 km² of potential snow leopard habitat in the Russian portion of this ridge. Evidence suggests 3-4 snow leopards occupy the western part of the ridge, along the border with Kazakhstan and China. The total population

Table 1: Estimated Adult Snow Leopard Population by Region in Russia (2022–2023)

Province	Ridge/Area	Number Estimated (Adults)	Method Estimated	Year
Altai Republic	Katunsky, North and South Chuisky Ridges	23–24	Camera Traps	2022
	Tabyn-Bogdo-Ola Ridge	3–4	Camera Traps	2022
	Sailyugem Ridge	5	Camera Traps	2022
	Chikhachev Ridge with Talduair Massif	10–12	Surveys, Camera Traps	2022-2023
	Chulyshman Highlands	1–2	Surveys	2022
	Kuraisky Ridge	4–5	Camera Traps	2022
Tyva Republic	Mongun-Taiga Massif	2–4	Camera Traps	2023
	Tsagan-Shibetu, Shapshal, Western Tannu-Ola Ridges	11–12	Camera Traps	2022
	Sangilen Ridge	5–6	Surveys, Camera Traps	2023
Krasnoyarsky Krai	Sayano-Shushensky State Biosphere Reserve, Khemchiksky, Kurtushubinsky Ridges	5	Camera Traps	2022-2023
Buryatia Republic	Okinsky and Tunkinsky Ridges	7	Camera Traps	2022
Total for Russia		75–86		

of snow leopards on Tabyn-Bogdo-Ola Ridge is low, and the area is more likely used by snow leopards as a migration corridor to reach Altai Tavan Bogd, Sailugem, Southern Altai, and Southern Chuisky Ridges.

Sailugem Ridge (in the Altai Republic) has suitable snow leopard habitat on its western and central parts (covering a total area of 1,700 km²). Historically, the area supported a stable snow leopard population, but it was destroyed in the beginning of 1990s. The region is now naturally recovering following the establishment of Sailugemsky National Park. In 2022, 5 adult snow leopards were identified through camera trapping, along with 3 cubs (confirming that the population is reproducing).

The Chikhachev Ridge with Talduair Massif (within the Altai and Tyva Republics) spans an estimated 2,800-3,000 km² of transboundary snow leopard habitat between Altai Republic, Tyva Republic, and Mongolia. The snow leopard population on the Altaian side of Chikhachev Ridge is estimated at 10-12 individuals, with 7 adult snow leopards identified in the Altaian portion and 3 individuals in Tuvian part during 2022- 2023.

The Chulyshman Highlands (in the Altai Republic) contains approximately 500 km² of potential snow leopard habitat, primarily in the southeastern part of this mountain range where the species is occasionally observed. Currently, no more than 1-2 snow leopards continuously occupy this area, with sporadic sightings captured by camera traps, typically once per year in Altaisky Nature Reserve.

The Kuraisky Ridge (in the Altai Republic) encompasses 2,000 km² of snow leopard habitat. Ongoing camera trapping has recorded at least 4-5 adult snow leopards in the area, but monitoring remains challenging due to limited staff capacity and availability in Ak-Cholushpa Nature Park.

The Mongun-Taiga Massif (in the Tyva Republic) has approximately 500 km² of potential snow leopard habitat. The snow leopard population in this area is estimated at 2–4 individuals.

The Tsagan-Shibetu, Shapshal and Western Tannu-Ola Ridges (in the Tyva Republic) span approximately 7-8,000 km² of snow leopard habitat. This area forms a single habitat for one of the largest snow leopard populations in Russia. Key habitat in Shapshal Ridge is located in the southern part, where the Khemchik and Shui rivers headwaters intersect with Tsagan-Shibetu Ridge. In 2022, 11-12 adult snow leopards were recorded during a nationwide snow leopard census.

Another potential snow leopard habitat is situated at the intersection of Western and Eastern Tannu-Ola Ridges (covering approximately 1,300 km²). Currently it remains unclear whether snow leopards occupy this region continuously or only temporarily, as no confirmed snow leopard records have been made in the last decade.

The Sayano-Shushensky State Biosphere Reserve and the adjoining Khemchiksky and Kurtushubinsky Ridges (in the Krasnoyarsky Krai) encompass 1,500-2,000 km² of potential snow leopard habitat located at the intersection of Krasnoyarsky Krai and Tyva Republic. Snow leopards are typically found at elevations of 540-1,000 meters above sea level, only rarely climbing higher. Snow leopards are continuously present in this large area within the Sayano-Shushensky State Biosphere Reserve (covering an area of 130-150 km²). Since 2008, staff from Sayano-Shushensky State Biosphere Reserve have been engaged in a long-term camera trap monitoring project, collecting detailed data on the population's composition, number, and sex-age structure. After the decimation of this population by illegal hunting in 2014-2015, 2 snow leopards were translocated from Tajikistan to the Reserve in 2018. The population is now stable, with 5 adult individuals.

The Sangilen Ridge (in the Tyva Republic) spans approximately 4,700 km² of potential snow leopard habitat. Surveys conducted in 2004, 2009, 2012, 2017, and 2023 have found evidence of snow leopard activity in the Balyktyg-Khem River valley, in the valley and along the watershed that divides the Solbeldir River, at the headwaters of the Chokhyrtai River, near Mount Ulin-Khan, on the watershed divides of the Munguruk and Zhin-Khem Rivers, and at the headwaters of the Chokhyrtai and its tributary Munguruk. The snow leopard population in this area (Sangilen Ridge) is estimated at 5-6 adult individuals. It seems likely that the snow leopard population is heavily impacted by illegal hunting pressure, leading to a decline.

The Okinsky and Tunkinsky Ridges (in the Buryatiya Republic) intersect with Tyva Republic and Mongolia, encompassing approximately 8,000-8,500 km² of potential snow leopard habitat. In 2022, camera traps identified 7 adult snow leopards in this region.

According to data collected in 2022-2023, the total population of snow leopards in Russia is estimated to be no more than 70-90 adult individuals (Karnaukhov et al., 2024).

3. Threats

A number of natural and anthropogenic factors influence the status of snow leopards. All limiting factors affecting

snow leopards can be categorized into two main groups: direct and indirect threats.

Direct threats include the killing of snow leopards due to illegal hunting and retaliation for livestock attacks, live captures for captivity, and infectious disease.

Indirect threats primarily involve reductions in prey species population, economic infrastructure development within the snow leopard's range, and the loss of suitable habitat.

Illegal hunting

The level of illegal hunting has decreased in snow leopard habitat in Russia over the past decade. Currently, direct illegal hunting cases (with guns) are rare, with fewer than one case reported per year. However, snare-based hunting remains a serious threat to the species, and the practice is widespread throughout the snow leopard range in Russia, including within protected areas. Due to the snow leopard's use of habitual routes (reusing the same paths and routes to travel along ridges), it is easily caught in snares set along ridgelines and narrow mountain trails. Snow leopards are targeted for their valuable pelts and other body part derivatives but are also captured as bycatch in illegal snares set out for musk deer (*Moschus moschiferus*) and other ungulates (Strategy on Conservation of Snow Leopards in the Russian Federation, 2014).

Snare-hunting of snow leopards is the primary threat to the species in the Argut River basin, nearby parts of Katunsky, South Chuisky, and North Chuisky Ridges (Altai Republic), within the borders of Sayano-Shushensky State Biosphere Reserve and its buffer zone (Krasnoyarsky Krai), and on Sangilen Ridge (Tyva Republic). Snare-hunting is a lesser threat in the southern part of Shapshal Ridge, on the Chikhachev and Tsagan-Shibetu Ridges, and on Mongun-Taiga Massif (Tyva Republic).

Local residents are the primary perpetrators of illegal hunting with snares (targeting snow leopards or other species). The high value of snow leopard derivatives, musk deer and other species, drives this illegal activity. For many local people, it is one of the main sources of income in the snow leopard habitat. Snare hunters work in remote parts of the snow leopard's range, often remaining out of sight of enforcement agencies. If illegal hunting becomes highly intensive, critical populations could be completely extirpated within the next 10-15 years in Russia. Snare hunting does not occur in the highest elevation parts, above the treeline, of the snow leopard's range in Russia (Paltsyn et al., 2016).

Retaliatory killings

In certain regions, pastoralists who wish to protect their livestock from predation, and retaliate by killing snow leopards, present a significant threat to the species. This issue is most prominent in western Tyva (Chikhachev, Tsagan-Shibetu, and Shapshal Ridges, Mongun-Taiga Massif) and to a lesser extent in southeastern Tyva (Sangilen Ridge) and Altai Republic. There are virtually no snow leopard attacks on livestock in Buryatia Republic and Krasnoyarsky Krai.

Snow leopard attacks on livestock occur when domestic animals graze in rangelands that are directly in snow leopard habitats or when the populations of wild ungulates decline significantly due to illegal hunting. Livestock attacks are more common during winter months, especially in severe and high-snow winters. Snow leopards may attack both small livestock (goats and sheep) and large livestock (yaks and horses). Attacks may occur both in open pastures and in corrals or shelters where livestock are kept overnight. While snow leopard attacks on open pasture usually result in the death of one to three animals, an attack in an enclosure can lead to the death or injury of dozens of animals (up to 80), causing significant losses for herders. These corrals often trap snow leopards, as the cats cannot always escape through the hole in the corral's roof. Increasing livestock populations in snow leopard habitats not only increase the frequency of such conflicts but also outcompete wild ungulates, the snow leopard's natural prey, from mountain pastures (Paltsyn et al., 2016).

Decreased populations of primary prey species

The snow leopard population is directly influenced by the availability of its prey species. A reduction in the populations of ungulates (especially Siberian ibex *Capra sibirica*), the snow leopard's main prey base, is one of the key factors driving the decline in snow leopard populations.

Illegal hunting also affects the populations of the snow leopard's prey. In western Tyva, snow leopard attacks on livestock are believed to be driven by a significant decline in the population of wild ungulates due to intensive illegal hunting. Local residents report a sharp decrease in Siberian ibex population on the southern end of Tsagan-Shibetu Ridge following the construction of Mugur-Aksy - Kyzyl Highway. Ungulate populations (Siberian ibex) remain low in relatively accessible areas of snow leopard habitats, such as Southern Chuisky and Chikhachev Ridges, Mongun-Taiga Massif, Tsagan-Shibetu and Shapshal Ridges, and Sangilen Ridge. However, illegal hunting for ungulates (with the exception of illegal snare-hunting for musk deer) has a lesser impact on the snow leopard populations in the Argut River basin, due to its remoteness and inaccessibility,

and in the Sayano-Shushensky State Biosphere Reserve, due to enforcement regime.

Illegal snare hunting for musk deer, a prey species, is widespread in snow leopard habitats and further reduces the prey base.

Currently, hunting (second to livestock agriculture) is the main livelihood in Tyva, Altai Republics, and southern Krasnoyarsky Krai, following the collapse of the collective farming system and other state enterprises. Local residents possess a significant number of illegal firearms, a situation reflected in the annual confiscation of dozens of weapons. There are also documented cases of illegal hunting occurring within protected areas and snow leopard habitats.

Free-range livestock further exacerbates the depletion of wild ungulate populations in snow leopard habitats. In areas adjacent to herder camps, the population of wild ungulates are extremely low.

Ungulate populations in snow leopard habitats may decrease due to other occurrences, such as extreme winter events and epizootic disease.

Economic infrastructure development

Large-scale economic infrastructure development projects, both existing and planned, pose serious threats to snow leopard habitats.

Mining operations for minerals and other resources can lead to the degradation of key snow leopard habitats in the Altai-Sayan Ecoregion. Currently, the central part of the Chikhachev range, as well as the Sailugem and Sangilen ridges, face such threat due to planned large-scale mining projects (a series of complex ore deposits) in the proximity of a transboundary snow leopard population. These development projects will not only result in the direct habitat destruction but will also increase disturbance and risk of illegal hunting for both ungulates and snow leopards.

4. Conservation

Legislation

The snow leopard is listed in the Russian Red Book (Category 1), which designates species whose population has been reduced to a critical level such that the species could be eliminated entirely in the near future.

The harvesting of fauna species listed in the Russian Red Book, including snow leopards, is regulated by a decree dated 6 January 1997, N 13, titled “On confirmation of

the Rules for harvesting fauna belonging to species listed in the Russian Red Book, with the exception of water-based biological resources”. Under this decree, snow leopards can only be harvested in exceptional cases for specific purposes, such as with the goal of its conservation, scientific population monitoring, regulating population numbers, safeguarding public health, eliminating threats to human life, or controlling large-scale infectious diseases in livestock or other domesticated animals.

The trade in fauna listed in the Russian Federation Red Book (including snow leopards) is regulated by a decree of the Russian Federation government dated 19 February 1996, N 156, entitled “On the procedure to issue permits (administrative licenses) for trade in wild animals belonging to species inscribed in the Russian Red Book”. According to this decree, holding wild animals in captivity listed in the Russian Red Book, including snow leopards, is only permitted for the goal of conservation, reproduction of animals in artificially created environments, scientific purposes, or cultural/educational activities. Any release of such animals back to its natural environment must aim to support the conservation and/or increase their natural population. Snow leopards can only be harvested under exceptional cases, following a permit issued by Rosprirodnadzor (in accordance with the administrative procedures published by the Federal Oversight Service in the Area of Natural Resource Use). The harvest of flora and fauna listed in the Russian Red Book and affirmed by the Ministry of Natural Resources-Russian Federation decree dated 18 February 2013, N 60, (registered by the Russian Ministry of Justice, 25 June 2013, registration N 28880), according to the “Estimating procedures for calculating damage caused to fauna listed in the Russian Red Book as well as to other fauna not considered to be species targeted in hunting and fishing or caused to their habitat, affirmed on 28 April 2008 by decree N 107” at the Russian Ministry of Justice, the amount of damage inflicted by the destruction of one snow leopard is determined to be 1,100,000 roubles.

The snow leopard is listed in the Red Books of seven administrative regions in the Russian Federation: the Altai, Tyva, Khakasiya, and Buryatiya Republics, Irkutsk Oblast, Krasnoyarsky and Zabaikalsky Krai.

Key legislation governing the protection and use of natural of fauna resources, including the snow leopard, and their habitat includes:

- Federal law dated 10 January 2002, N 7, “On environmental conservation”;
- Federal law dated 24 April 1995, N 52, “On the animal world”;
- Federal law dated 14 March 1995, N 33, “On protected areas”; and

- Federal law dated 24 July 2009, N 209, “On hunting and the conservation of hunting resources and amendments to certain legislative acts of the Russian Federation”.

In addition to these laws, various regulations govern the protection and use of fauna resources, including the snow leopard, and their habitats, based on specific federal and regional frameworks (including departmental regulatory legal acts in various branches of the law, e.g. civil, criminal, administrative law).

The Federal Law “On the Animal World” provides the legal foundation for managing the conservation and use of animal resources, establishing government ownership of the wildlife within the boundaries of the Russian Federation. The federal law defines the authority of Russian federal agencies in managing wildlife and their habitats, outlines the rights of citizens and legal entities in conservation efforts, and sets out the government’s role in monitoring and conserving rare and endangered species like the snow leopard. The law establishes the necessity of conducting government population surveys of fauna species, the use of those surveys, maintaining government cadastres of fauna, conducting government monitoring of fauna and the implementation of governmental programmes on the conservation of fauna species and their habitats.

Federal Law No. 150, dated July 2, 2013, amended the Russian Code of Administrative Violations to include penalties for illegal harvesting, transport, and trade of protected animals. The law also established criminal liability for certain offenses related to species like the snow leopard, including contraband activities and violations related to international borders (Strategy on Conservation of Snow Leopards in the Russian Federation, 2014).

Despite these measures, enforcement remains challenging in many protected areas. Some protected areas require boundary adjustments and improvements in enforcement to better protect snow leopards. Transboundary cooperation between Russian and Mongolian conservation areas is also vital for protecting cross-border snow leopard populations (Karnaikhov et al., 2024).

The most significant protected areas for snow leopard conservation in Russia include:

- Sayano-Shushensky Biosphere Reserve,
- Ubsunurskaya Kotlovina State Biosphere Reserve,
- Sailyugemsky National Park,
- Tunkinsky National Park,
- Ak-Cholushpa, Belukha, Uch-Enmek and Ukok Quiet Zone Nature Parks,
- Tyva Nature Park.

These areas are crucial for the preservation of snow leopards and their habitats, but more coordinated and effective protection measures are needed to ensure their long-term survival.

Territorial enforcement

The total area of federal and regional protected areas (PAs), including buffer zones in snow leopard habitats, is 5,478,600 hectares. This means that 23% of the species’ potential distribution in Russia, encompassing all habitat types, is under formal protection. However, only 16% of the snow leopard’s favorable or high-quality habitat is currently protected.

Enforcement to protect snow leopards is inadequate in many protected areas. Changes in status, expansion, optimization of boundaries, and improvements to enforcement regimes are recommended for certain protected areas. To protect transboundary populations of snow leopards, it is important to ensure transboundary cooperation between Russian and Mongolian protected areas.

The northernmost population of snow leopards in Russia, with a population of 9-10 individuals, resides within the boundaries of Sayano-Shushensky State Biosphere Reserve and its buffer zone. The total area of potential snow leopard habitat on the boundary of Sayano-Shushensky Reservoir within the Reserve and its buffer zone is 100,000 hectares. The largest population of Siberian ibex in the Sayan Mountains, with an estimated 2,500 individuals, occupies this territory. This snow leopard population is stable as a result of the strict enforcement regime overseen by the Reserve’s rangers.

The Mongun-Taiga site in Ubsunurskaya Kotlovina Biosphere Reserve in southwestern Tyva is located in the highest part of the massif and occupies 15,890 hectares, including glaciers, snow fields, rock masses, and rubble and rock field tundras. This marks the upper boundary of snow leopard habitat. The buffer zone of this Reserve is the most significant area to snow leopard conservation in Tyva, covering 125,600 hectares. It includes snow leopard habitat on the Mongun-Taiga Massif, the eastern macroslope of Chikhachev Ridge, and the southern part of Tsagan-Shibetu Ridge on the Mongolian border. 8 to 10 snow leopards are estimated to occupy this area. The total population of ungulates in this area is low, with an estimation fewer than 200-300 individuals. The Reserve collaborates with various conservation agencies in enforcement efforts (an inter-agency antipoaching brigade was established) and works with local residents to prevent conflict between herders and snow leopards. Expanding the buffer zone and adding a new site on Tsagan-Shibetu Ridge would strengthen protection for the existing snow leopard population.

Sailyugemsky National Park, created in the Altai Republic in 2010, consists of three sites: Argut, Sailyugem and Ulandryk, covering a total area of 118,380 hectares. Snow leopard habitat is located inside the Argut (80,730 ha) and Sailyugem (34,400 ha) sites. The largest snow leopard population in Russia is located now in this area.

In 2002, Shavlinsky Regional Nature Refuge was re-established (after a closure of 2 years) by a decree of the Altai Republic government. The refuge covers 248,081 hectares and surrounds the Argut site of Sailyugem National Park on three sides. It includes optimal snow leopard habitat in the Argut, Shavla, Karakem, Bolshoy Ary-Yuly, Maly Ary-Yuly, and Sredny Ary-Yuly river valleys, with a high density of Siberian ibex (up to 18 animals/ km²).

Belukha Nature Park is located adjacent to the Argut site of Sailyugemsky National Park and Shavlinsky Regional Refuge to the west. Potential snow leopard habitat within the park is situated in the headwaters of the Akkem and Kucherla Rivers. Within the Natural Park, there are an estimated 400-500 Siberian ibex, sharing the landscape with musk deer and red deer. Uch-Enmek Nature Park, also located in Central Altai mountains near Argut river watershed, is adjacent to Sailyugemsky National Park.

Ak-Cholushpa Nature Park, located in the Kuraisky ridge, is important for snow leopard conservation in Russia as it is the only protected area in the ridge, providing a migration corridor between Inner Mongolian and Russia populations through the Chikhachev and Talduair ridges. Unfortunately, conservation efforts of the Park have been ineffective, and the snow leopard population is currently low.

Ukok Quiet Zone Nature Park includes potential snow leopard habitat in the eastern part of the Sailyugem Ridge and on the northern macroslope of the Tabyn-Bogdo-Ola Ridge, on the borders of Russia, Kazakhstan, Mongolia, and China. The population of wild ungulates within the park (Altai argali *Ovis ammon*, Siberian ibex, Siberian musk deer, and red deer *Cervus elaphus*) is relatively low, but the area is an important migratory corridor for snow leopard populations from the Mongolian Altai, the Katunsky, Northern and Southern Chuisky Ridges, and Southern Altai Ridges.

Tuva Nature Park consists of several clusters, two of which are critical for snow leopard conservation in Russia – the Shuy and Shanchy sites. A stable snow leopard population exists in the Shuy watershed at the intersection of Tsagan-Shibetu and Shapshal ridges. Over the past three years, there has been a gradual recovery of the snow leopard population in the Shanchy site, which is near the Sayano-Shushensky and Ubsunurskaya Kotlovina Nature Reserves.

This area forms a single snow leopard habitat.

Tunkinsky National Park includes a small area of potential snow leopard habitat on the Tunkinsky Ridge along the Russia-Mongolia border. The snow leopard population in the park is low, with an estimate of no more than 2-3 individuals. Given the extensive industrial development in the Eastern Sayan Mountains (including the construction of mining enrichment facilities, major roads, and power transmission lines), there are insufficient protected areas for snow leopards in this region.

There are no protected areas in critical snow leopard habitats on the Russian side of the Chikhachev, Tsagan-Shibetu, and Sangilen Ridges.

Currently, there is no comprehensive territorial enforcement system for the entire snow leopard population in Russia. The importance of habitats vital for the species' conservation is rarely considered when selecting protected area categories and determining enforcement regimes for snow leopard habitats (Karnaikhov et al., 2024).

5. Acknowledgements

This country status report acknowledges the contributions of research institutions, conservation organizations, and members of the research and practitioner community in the Russian Federation and the region whose research, insights, and long-term work informed this synthesis. The report further acknowledges the IUCN SSC Cat Specialist Group and the wider IUCN Red List assessment team for their guidance and collaboration during the updated snow leopard assessment process. Thanks to Bayarjargal Khashbat and Altanbagana Yunden from WCS Mongolia, who prepared the snow leopard distribution map. Support for coordination of this country status series was provided by Justine Shanti Alexander, WCS Mongolia.

6. Conflicts of Interest

The author declares no known conflicts of interest.

7. References

- Karnaikhov, A.S., Paltsyn, M.P., Poyarkov, A.D., Hernandez-Blanco, J.A., Korablev, M.P., Chistopolova, M.D., Kuksin, A.N., Malikov, D., Malykh, S.V., Rozhnov, V.V., Spitsyn, S.V. and Castner, J. (2024). Snow leopard conservation in Russia. In: McCarthy, T. and Mallon, D. (eds.) Snow Leopards. 2nd ed. Elsevier, pp. 565–576.

- Kalashnikova, Y.A., Karnaukhov, A.S., Dubinin, M.Y., Poyarkov, A.D. and Rozhnov, V.V. (2019). Potential habitat of snow leopard (*Panthera uncia*, Felidae) in south Siberia and adjacent territories based on the maximum entropy distribution model. *Zoologicheskii Zhurnal*, 98(3), pp. 332–342. <https://doi.org/10.1134/S0044513419030061>
- Karnaukhov, A.S., Malykh, S.V., Korablev, M.P., Kalashnikova, Y.M., Poyarkov, A.D. and Rozhnov, V.V. (2018). Current status of the Eastern Sayan snow leopard (*Panthera uncia*) grouping and its nutritive base. *Biology Bulletin*, 45(9), pp. 1106–1115. <https://doi.org/10.1134/S106235901809008X>
- Karnaukhov, A.S., Korablev, M.P., Kuksin, A.N., Malykh, S.V., Poyarkov, A.D., Spitsyn, S.V., Chistopolova, M.D. and Hernandez-Blanco, J.A. (2020). *Snow Leopard Population Monitoring Guidebook*. WWF, Krasnoyarsk.
- Korablev, M.P., Poyarkov, A.D., Karnaukhov, A.S., Zvychnaya, E.Y., Kuksin, A.N., Malykh, S.V., Istomov, S.V., Spitsyn, S.V., Aleksandrov, D.Y., Hernandez-Blanco, J.A., Munkhtsog, B., Munkhtogtokh, O., Putintsev, N.I., Vereshchagin, A.S., Becmurody, A., Afzunov, S. and Rozhnov, V.V. (2021). Large-scale and fine-grain population structure and genetic diversity of snow leopards (*Panthera uncia* Schreber, 1776) from the northern and western parts of the range with an emphasis on the Russian population. *Conservation Genetics*, 22, pp. 397–410. <https://doi.org/10.1007/s10592-021-01347-0>
- Paltsyn, M., Poyarkov, A., Spitsyn, S., Kuksin, A., Istomov, S., Gibbs, J.P., Jackson, R.M., Castner, J., Kozlova, S., Karnaukhov, A., Malykh, S., Korablev, M., Zvychnaya, E. and Rozhnov, V. (2016). Northern range: Russia. In: *Snow Leopards* (1st ed.). Elsevier, pp. 509–517.
- Poyarkov, A.D., Munkhtsog, B., Korablev, M.P., Kuksin, A.N., Aleksandrov, D.Y., Chistopolova, M.D., Hernandez-Blanco, J.A., Munkhtogtokh, O., Karnaukhov, A.S., Lkhamsuren, N., Bayaraa, M., Jackson, R.M., Maheshwari, A. and Rozhnov, V.V. (2019). Assurance of the existence of a transboundary population of the snow leopard (*Panthera uncia* Schreber, 1776) at Tsagaanshuvuut–Tsagan-Shibetu SPA at the Mongolia–Russia border. *Integrative Zoology*, 15(3). <https://doi.org/10.1111/1749-4877.12420>
- Strategy on Conservation of Snow Leopards in the Russian Federation (2014). Approved in 2014 and updated in 2020.



Snow Leopard (*Panthera uncia*) Status in Tajikistan

CONTRIBUTORS:

Shannon M. Kachel^{1,2*}, Qobiljon Shokirov³,
Ismoil Kholmatov^{4,5}, Mirzonazar Mirzoev⁵,
Abdusattor Saidov⁶

KEYWORDS:

snow leopard; *Panthera uncia*; Tajikistan;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Kachel et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

1 School of Marine and Environmental Affairs, University of Washington, Seattle, USA

2 Woodland Park Zoological Society, Seattle, USA

3 Independent, Missoula, USA and Khujand, Tajikistan

4 Tajikistan Nature Foundation, Dushanbe, Tajikistan

5 Tajik National University, Faculty of Biology, Dushanbe, Tajikistan

6 Institute of Zoology and Parasitology, National Academy of Sciences of the Republic of Tajikistan, Dushanbe, Tajikistan

* Email: Shannon.kachel@gmail.com

1. Distribution

Snow leopards (*Panthera uncia*) are present in all major mountain ranges of Tajikistan (i.e., the Hissaro Alay and Pamir Mountains; Saidov et al. 2024), albeit at highly variable and uncertain densities and in some cases with unknown seasonality. Available evidence suggests that the species' distribution in Tajikistan is driven by a combination of terrain ruggedness and the distribution of mountain ungulate prey (Kachel et al. 2017, Kachel et al. 2022a, Kachel et al. 2022b) – ibex (*Capra sibirica*), argali (*Ovis ammon*), and markhor (*Capra falconieri*). According to Saidov et al. (2024), optimal habitats are rugged areas lying between 2000 and 4500 m in elevation. Even so, snow leopards occur at elevations as low as 1000 m along the Panj River, facilitated by the combination of rugged terrain and high markhor population density; on the high plateau of the Eastern Pamirs snow leopards have been observed upwards of 5000 m (Karimov et al. 2018).

In total, Tajikistan is estimated to hold approximately 85,700 km² of potentially suitable habitat (Figure 1), which we defined as ice-free areas between 5300 m altitude (the approximate uppermost detection of the species in the country) and above 2000 m (>1000 m in the Gorno-Badakhshan Autonomous Oblast - GBAO) where 1 km²-mean terrain ruggedness index >10. The majority of this area (53,940 km²) lies in the Pamir Mountains in GBAO. Although the flat high elevation valleys of the Eastern Pamirs do not constitute suitable habitat at the small scale, snow leopards have been regularly observed traversing these areas to access other areas of more rugged terrain (S. Kachel, unpublished data).

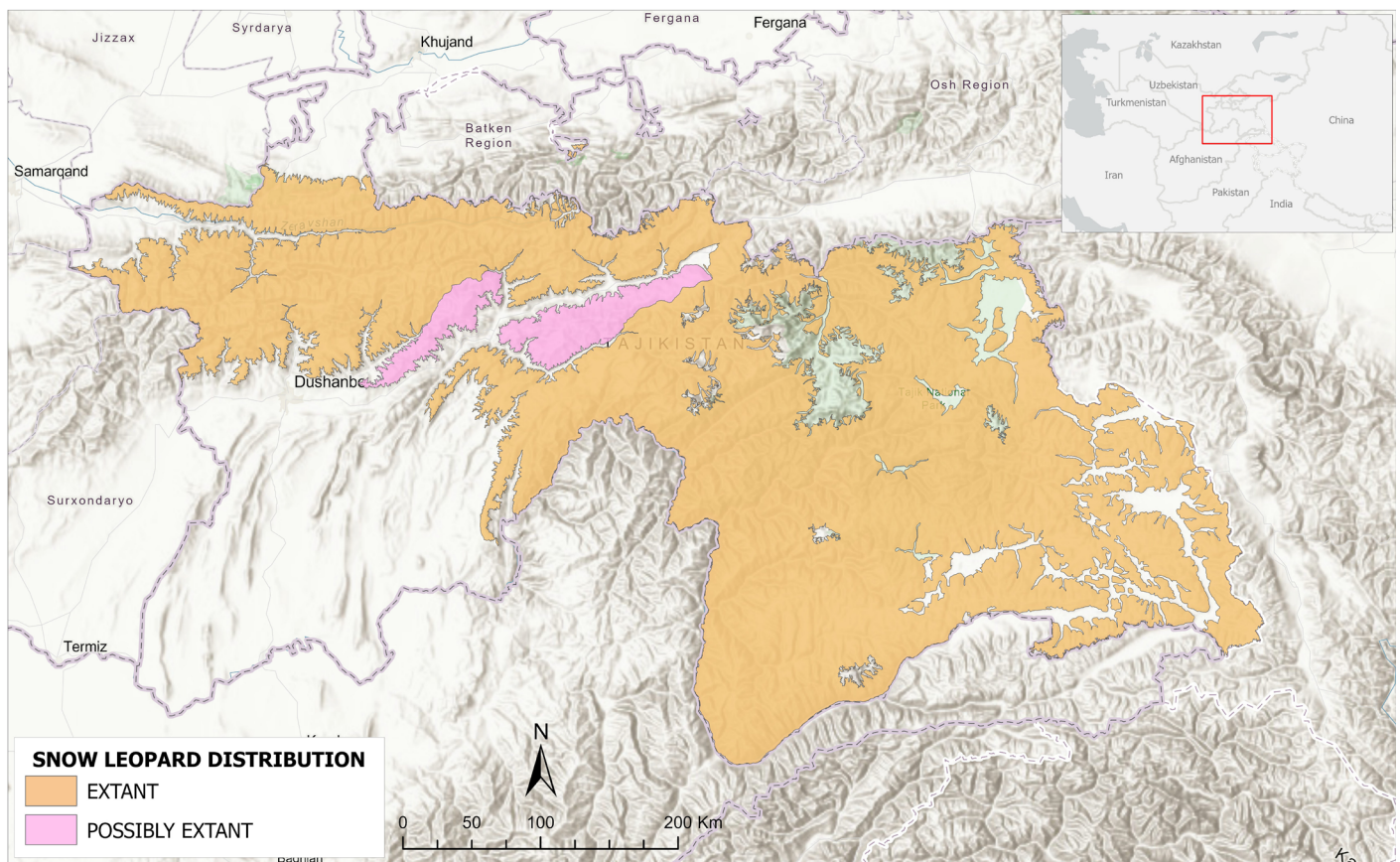


Figure 1. Distribution of the snow leopard (*Panthera uncia*) in Tajikistan. Orange areas indicate extant range, where the species is known or strongly inferred to occur. Pink areas indicate possibly extant range, where presence is uncertain but considered likely based on habitat suitability, following IUCN Red List mapping criteria.

Updated IUCN Red List Snow Leopard Distribution in Tajikistan

The updated distribution map for the IUCN Red List is based on a potential suitable habitat layer as well as published and unpublished records of snow leopard presence. To delineate potential habitat and create distribution polygons, we applied the following criteria sequentially:

- **Terrain and elevation filtering:** We used the ‘whitebox’ package (Lindsay, 2016) in R to calculate terrain ruggedness from a country wide digital elevation model at a resolution of approximately 30m (JAXA EORC, 2020). We then used a moving window filter to calculate 1 km²-mean terrain ruggedness index (TRI; at the original resolution). We removed areas >5300 m, <2000 m (or <1000 m in the Gorno-Badakshan Autonomous Oblast), and <10 TRI as calculated above.
- **Ahistorical isolated features:** We removed isolated “islands” of potential habitat <500 km² if surrounded by areas below 2000 m elevation (high elevation islands were retained) as these areas have no historical records of snow leopard presence.
- **Non-habitat features:** We removed lakes and areas covered by glacial ice as these are not suitable snow leopard habitat.

- **Cartography:** To avoid conveying false precision in the suitable habitat layer, we removed nunataks (‘islands’ surrounded by ice) <10 km², and filled remaining holes filtered due to terrain or ice cover if <50 km² (holes previously filtered due to elevation or lakes were retained).
- **Occurrence classifications:** Areas of suitable habitat were classified as “Extant” if they were both *a.* contiguous with, and *b.* <40 km Euclidean distance to recent (no older than 2015) published or unpublished occurrence records (sightings, camera trap detections, pugmarks, scrapes, scats, livestock depredations; including in neighboring countries), or geolocated reports obtained from key informant interviews in local communities indicating that snow leopards were likely present. Here, contiguous meant connected by uninterrupted potential habitat within the same mountain range (itself connected by uninterrupted high ground >2500 m) unlikely to require a traversing animal to cross glacial ice or gentle valleys (this final criterion was not applied to the high elevation valleys of the Eastern Pamirs, where snow leopards are regularly observed crossing valleys between sub-ranges). The buffer of 40 km was chosen based on observed major axes of GPS-collar relocations

of resident male snow leopards in neighboring Kyrgyzstan (i.e., the greatest distances between any two observed locations; Kachel 2021). Areas of suitable habitat that did not meet the above criteria and that also lacked records at least as recent as 2015 were classified as “Possibly Extant.” These areas encompassed portions of the Peter the Great and Qarotegin Ranges bordering the Rasht Valley.

2. Population

Despite localized research and monitoring efforts (e.g. Kachel et al. 2017, Karimov et al. 2018, Kachel et al. 2022b), no rigorous national population estimate is available (Saidov et al. 2024). The largest-scale density estimate available, estimated snow leopard densities across 20,000 km² in the Pamirs at 0.29 snow leopards per 100 km² (95%CI: 0.17–0.51; UNEP, 2024). This estimate was integrated over an area an order of magnitude larger than any other studies. Nonetheless, it is restricted to the Pamirs and is therefore likely biased relative to the national average density. Research efforts outside of the Pamirs have frequently failed to obtain sufficient spatial detections needed to estimate density (a fact likely due to a combination of insufficient sampling and low detection probabilities, but that could indicate lower densities as well).

Rather than extrapolating from GBAO to the rest of Tajikistan, we instead stratify, estimating separate population numbers in GBAO (the higher density stratum) and the rest of the country (the lower density stratum). As a proxy for a realistic range of snow leopard densities in our lower density stratum, we use estimates from Suryawanshi et al. (2021) for the Indian state of Himachal Pradesh — 0.19 snow leopards/100 km² (95%CI: 0.12–0.31) — estimates which are integrated over a comparably large area with a similar range of topography, habitats, and prey availability (e.g. Reading et al. 2020). Extrapolating with caution thus results in a national population estimate of approximately 130 – 374 snow leopards (mean, 217 animals; 92 – 275 animals in GBAO, and 38 – 99 animals elsewhere).

Saidov et al. (2024) previously estimated the total number of snow leopards between 250 – 280 individuals. Similarly, the government of Tajikistan held its official estimate at 250 animals (Red Book 2017). The latest update to the Tajikistan Red Book (2025) revised the official estimate upwards to approximately 500 individuals. The revision is based on documentation of more than 200 unique individuals identified via published and unpublished camera-trap and genetic analyses since 2012.

The data needed to estimate or infer population trends at

any scale in Tajikistan are lacking. As such, revisions to the estimated snow leopard population size (relative to the 2017 assessment) cannot yet be attributed to a genuine change in the underlying number of animals. Looking ahead, with targeted sampling and collaborative analysis/data sharing, a robust estimate of the total snow leopard population in Tajikistan should soon be achievable.

3. Threats

Livestock depredation and retaliatory killing

Livestock depredation by snow leopards and the resulting retaliatory killings and/or relocation of snow leopards, remains prevalent in the western GBAO. Many attacks on livestock occur inside barns or corrals in late fall and winter. Pamiri household barns typically have a mud roof with windows or skylights for ventilation and dropping hay down to feed the animals. Snow leopards enter through these openings, kill livestock, and often cannot jump back out to escape. These animals may be released, relocated (with unknown success), taken into captivity for rehabilitation (due to injuries associated with their capture and handling), or killed outright. TRAFFIC estimated that 45% of animals in Tajikistan captured in this manner ultimately funnel into the illegal wildlife trade (Tokubek Uulu et al. 2024). The Committee for Environmental Protection under the Government of Tajikistan has established a rehabilitation center near Murgab in the Eastern Pamir, with the objective of rehabilitating injured snow leopards for eventual release into the wild. The center features a 2-hectare fenced area with a closed structure, as well as smaller, separate fenced enclosures. The center has a staff of four permanent employees, including a veterinarian and animal caretakers.

The majority of the economic burden caused by snow leopards goes uncompensated. In the past, efforts by conservation organizations, and other institutions have assisted communities in predator-proofing corrals in summer pastures of the Pamirs. These corrals, primarily used during the summer when livestock are in high pastures, are generally perceived to be effective at deterring predators. However, the problem of household barns having open skylights remains a significant contributor to human-wildlife conflict during the winter months. To tackle this issue, conservation organizations constructed predator-proof community corrals in several villages within the GBAO of Tajikistan between 2016 and 2018. However, a survey conducted from 2019 to 2020 indicated that shared communal corrals may be ineffective there (Kachel, et al. 2022a). To avoid the difficulties of feeding their livestock, sharing common space with other livestock, and of separating out one’s own manure for fuel, many people

prefer to keep their livestock in household barns during the winter months. However, livestock owners who did not cover barn windows and skylights (with mesh or narrowly spaced metal bars) were nearly seven times more likely to report snow leopard depredations in the past 18 months (Kachel et al. 2022a), even after accounting for individual and habitat factors. Kachel et al. (2022a) recommended that in order to prevent snow leopard depredation at a meaningful level, conservation efforts should focus on retrofitting as many existing household barns as possible, at very large scales across the Pamirs.

Decline of key prey species

Hunting has been viewed as a significant contributor to the decline of key prey species in Tajikistan since the middle of the twentieth century, including ibex, argali, urial (*Ovis vignei*), and markhor (Michel et al. 2015; Michel and Rosen 2015; Michel and Rosen 2016; Michel and Karimov 2017). A civil war from 1992 to 1997 likely exacerbated the pressure on ungulate populations, by creating near-famine conditions for people in the mountainous regions of Tajikistan; with access to guns and limited availability of goods, people in local communities were often forced to hunt for survival (Shokirov and Backhaus 2020).

Over the last decade, many mountainous areas of Tajikistan have seen a significant apparent recovery of key prey species, thanks to the efforts of various institutions, community-based conservancies, private hunting concessions, government bodies, and international organizations. For instance, the population of markhor, previously estimated at fewer than 500 individuals in the early 2000s, has increased to approximately as many as 5,000 individuals (Akramov et al. 2022). Similarly, the argali sheep population, previously estimated at 26,500 in January 2018 was estimated at over 29,000 argali sheep just 3 years later (Institute of Zoology and Parasitology, National Academy of Sciences of Tajikistan, *unpublished report*). Recent work by Oshurmamadov (2021) estimates at least 24,000 ibex are present in the country, compared to 40,000 previously estimated to inhabit the country. Most urial habitat is found in Southwest Tajikistan, on the margin of the snow leopard's potential habitat. There, the urial population is threatened by illegal hunting and grazing related to its proximity to nearby villages and towns. Recent estimates suggest that the urial population stands at fewer than 500 individuals (Michel and Ghoddousi 2020).

In addition to illegal hunting, wild ungulates may be susceptible to disease transmission from livestock. Markhor in particular have previously experienced dramatic declines in response to zoonotic diseases also found in livestock (Ostrowski et al. 2011), although the dynamics involved are not well understood.

Climate Change

Tajikistan's mountains are predicted to serve as a vital refuge for the survival of snow leopards over the next 40 years amidst climate change (Li et al. 2016). Climate change is already impacting humans and wildlife throughout Tajikistan's mountain ranges. For example, it is currently affecting the ibex and argali sheep, which are key prey species for snow leopards. Studies (Zhuo et al. 2022) predict that in the coming decades, climate change may drive the ibex and argali sheep to higher elevations to escape heat and due to limited precipitation.

Illegal Wildlife Trade

It is thought that many of the snow leopards and snow leopard parts that end up in the illegal wildlife trade originating from Tajikistan are killed in retaliation following livestock depredation in household barns as described above. TRAFFIC estimates 45% of incidents of retaliatory capture and/or killing or non-target poaching of snow leopards in Tajikistan led to people attempting to sell the animals in illegal markets (Tokubek Uulu et al. 2024). By reducing livestock depredations, Tajikistan could likely diminish the likelihood of illegal hunting and further prevent snow leopards from entering the illegal wildlife trade.

According to the Committee for Environmental Protection under the Government of Tajikistan, approximately 4-5 snow leopards are killed each year. Sometimes, people still use traps to catch wolves in Tajikistan, especially in winter when wolves are near villages. It is easy for snow leopards to become caught in traps designed for wolves. Each year, members of conservation organizations and government institutions, such as protected area rangers, collect these traps to prevent the injury and killing of snow leopards (Saidov et al. 2024).

4. Conservation

Legal frameworks

The Government of Tajikistan protects snow leopards through various laws and legal frameworks. For instance, it regularly updates the species' status by publishing Tajikistan's Red Book. Since 1988, snow leopards have progressed from a classification of "rare species with a declining trend" (Narzikulov 1988) to Endangered status in 2015 and again in 2025 (Saidov et al. 2016). The Government of Tajikistan ratified the Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 2000, joined the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) in 2015 (Saidov et al. 2016, 2024), and joined the IUCN in 2025. In February 2024, the government of Tajikistan adopted a National

Program for the Conservation of Snow Leopard for 2024–2028. The Committee for Environmental Protection and the National Academy of Sciences, with the involvement of NGOs, are responsible for implementing this program. It prioritizes mitigating threats such as livestock depredation and prey decline, raising public awareness, and calls for establishing a national monitoring program for the snow leopard population. The program primarily seeks funding for its activities through grants.

Protected areas

Through the extensive network of reserves and national parks, the Government of Tajikistan establishes a foundation for protecting snow leopards and their prey. For example, three nature reserves, one biosphere reserve, one national park, four nature parks, and thirteen additional reserves with regulated resource use (“zakazniki”), help protect snow leopard habitats in Tajikistan. Snow leopards have been observed in Tajik National Park, Zorkul State Reserve, Romit State Reserve, Dashtijum State Reserve, and three nature parks (Shirkent, Sarikhosor, and Yagnob). Rangers from state institutions, national parks, and various protected areas implement patrolling and anti-poaching programs year-round to safeguard wildlife species, often collaborating with the private sector. (Saidov et al. 2024).

Community-based conservation and private hunting concessions

Various community-based conservancies and family-managed concessions lease land from the government of Tajikistan and manage ungulate trophy hunting programs across the Pamir Mountains, including the Hazratisho range in the Shurabad district (Saidov et al. 2024). These trophy hunting programs include key snow leopard prey species such as ibex, argali sheep, urial, and markhor. These trophy hunting programs provide financial incentives for managing communities and families to protect wildlife, limit poaching, and reduce livestock overgrazing (Michel et al. 2015). Many of these programs have confirmed the presence of snow leopards in their territories through direct observations, camera trap surveys or genetic sampling. For instance, several public protected areas have reported the presence of snow leopards, such as Darashaydara in Ishkashim District, Alichur in Murgab District, and Ravmeddara in Bartang Valley (Saidov et al. 2024). Snow leopards have been similarly documented in family-managed concessions in Murghab (Kachel et al. 2017) and Darvaz (S. Kachel and Q. Shokirov, *unpublished data*). As of today, based on surveys, roughly 70 snow leopards are present in territories managed by community-based conservancies (CITES 2019).

Institutions and civil society organizations

Studies and research on snow leopards are generally overseen by the National Academy of Sciences of Tajikistan, which recently updated the Red Book of Tajikistan (2025), featuring updates on current trends in the snow leopard population. Several NGOs are conducting camera trap studies in previously unstudied areas. Through these efforts, these institutions are engaging local communities on the ground by raising awareness about snow leopards and implementing people-centered approaches and development management plans to be carried out in national parks, reserves, and community-based conservancies.

5. Acknowledgements

This country status report acknowledges the contributions of research institutions, conservation organizations, and members of the research and practitioner community in Tajikistan and internationally whose research, insights, and long-term work informed this synthesis. The publication further acknowledges the IUCN SSC Cat Specialist Group for supporting the development of this country status series, as well as the wider Snow Leopard IUCN Red List assessment team for their guidance and collaboration during the snow leopard assessment process. Thanks to Ian Durbach for reviewing and providing comments to the population assessment. Thanks to Bayarjargal Khashbat and Altanbagana Yunden from WCS Mongolia, who prepared the snow leopard distribution map. Support for coordination of this country status series was provided by Justine Shanti Alexander, WCS Mongolia.

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Akramov, U., Najmiddinov, N., Ghoddousi, A., Khanyari, M., Moheb, Z., Sepahvand, P., Bhatnagar, Y.V. and Herrero, J. (2022). Markhor *Capra falconeri* monitoring in Tajikistan shows population recovery. *Oryx*, 56(4), pp. 493–493. <https://doi.org/10.1017/S0030605322000497>
- CITES (2019). *Community-based trophy hunting of ibex and markhor in Tajikistan*. Available at: <https://cites.org/sites/default/files/eng/prog/Livelihoods/casestudies/Tajikistanibex%26markhorlongrevSept26.pdf>
- JAXA EORC (2020). *ALOS Global Digital Surface Model ALOS World 3D–30 m (AW3D30), Version 3.1*. Japan Aerospace Exploration Agency.

- Kachel, S., Anderson, K. and Shokirov, Q. (2022a). Predicting carnivore habitat use and livestock depredation risk with false-positive multi-state occupancy models. *Biological Conservation*, 271, p. 109588. <https://doi.org/10.1016/j.biocon.2022.109588>
- Kachel, S., Karimov, K. and Wirsing, A.J. (2022b). Predator niche overlap and partitioning and potential interactions in the mountains of Central Asia. *Journal of Mammalogy*, 103, pp. 1019–1029. <https://doi.org/10.1093/jmammal/gyac026>
- Kachel, S., McCarthy, K., McCarthy, T. and Oshurmamadov, N. (2017). Investigating the potential impact of trophy hunting of wild ungulates on snow leopard *Panthera uncia* conservation in Tajikistan. *Oryx*, 51(4), pp. 597–604. <https://doi.org/10.1017/S0030605316000193>
- Li, J., McCarthy, T., Wang, H., Weckworth, B.V., Schaller, G.B., Mishra, C., Lu, Z. and Beissinger, S.R. (2016). Climate refugia of snow leopards in High Asia. *Biological Conservation*, 203, pp. 188–196. <https://doi.org/10.1016/j.biocon.2016.09.026>
- McCarthy, T. and Mallon, D. (eds.) (2024). *Snow Leopards* (Second Edition). Academic Press, London. <https://doi.org/10.1016/B978-0-323-85775-8.00001-7>
- Michel, S. and Karimov, K. (2017). Recovery of mountain ungulates in Tajikistan through community-based hunting management. *Caprinae*, August 2017, pp. 1–4.
- Michel, S., Michel, T.R., Saidov, A., Karimov, K., Alidodov, M. and Kholmatov, I. (2015). Population status of Heptner's markhor *Capra falconeri heptneri* in Tajikistan: challenges for conservation. *Oryx*, 49(3), pp. 506–513. <https://doi.org/10.1017/S0030605313000860>
- Michel, S. and Ghoddousi, A. (2020). *Ovis vignei*. The IUCN Red List of Threatened Species 2020: e.T54940655A54940728.
- Michel, S. and Rosen, T. (2015). *Capra falconeri*. The IUCN Red List of Threatened Species. Available at: <http://www.iucnredlist.org/details/full/3787/0>
- Michel, S. and Rosen, T. (2016). Hunting of prey species: a review of lessons, successes, and pitfalls – experiences from Kyrgyzstan and Tajikistan. In: *Snow Leopards*. Elsevier, pp. 236–244. <https://doi.org/10.1016/B978-0-12-802213-9.00016-X>
- Narzikulov, M. (1988). *Red Data Book of the Tajik Soviet Socialist Republic*. Dushanbe, Tajikistan: Donish.
- Oshurmamadov, N. (2021). *The ecology of the Siberian ibex (Capra sibirica) in the Pamirs*. PhD dissertation. Dushanbe, Tajikistan.
- Ostrowski, S., Thiaucourt, F., Amirbekov, M., Mahmadsheev, A., Manso-Silván, L., Dupuy, V., Vahobov, D., Ziyoev, O. and Michel, S. (2011). Fatal outbreak of *Mycoplasma capricolum* pneumonia in endangered markhors. *Emerging Infectious Diseases*, 17, pp. 2338–2341. <https://doi.org/10.3201/eid1712.110187>
- Reading, R., Michel, S., Suryawanshi, K. and Bhatnagar, Y.V. (2020). *Capra sibirica*. The IUCN Red List of Threatened Species 2020: e.T42398A22148720. <https://doi.org/10.2305/IUCN.UK.2020-2.RLTS.T42398A22148720.en>
- Red Book of the Republic of Tajikistan (2017). 2nd edn. Dushanbe, Tajikistan.
- Red Book of the Republic of Tajikistan (2025). 3rd edn. Dushanbe, Tajikistan.
- Saidov, A., Karimov, K., Amirov, Z. and Rosen, T. (2016). Central Asia: Tajikistan. In: *Snow Leopards*. Elsevier, pp. 433–437. <https://doi.org/10.1016/B978-0-12-802213-9.00033-X>
- Saidov, A., Karimov, K., Kholmatov, I. and Novikova, T. (2024). The snow leopard in Tajikistan. In: *Snow Leopards*. Elsevier, pp. 481–488. <https://doi.org/10.1016/B978-0-323-85775-8.00024-8>
- Shokirov, Q. and Backhaus, N. (2020). Integrating hunter knowledge with community-based conservation in the Pamir region of Tajikistan. *Ecology and Society*, 25(1). <https://doi.org/10.5751/ES-11253-250101>
- Suryawanshi, K., Reddy, A., Sharma, M., Khanyari, M., Bijoor, A., Rathore, D., Jaggi, H., Khara, A., Malgaonkar, A., Ghoshal, A., Patel, J. and Mishra, C. (2021). Estimating snow leopard and prey populations at large spatial scales. *Ecological Solutions and Evidence*, 2, e12115. <https://doi.org/10.1002/2688-8319.12115>
- Tokubek Uulu, B., Musing, L., Woolloff, A., Musuraliev, K., Kurmanov, S. and Meibom, A. (2024). *An assessment of wildlife trade in Central Asia*. TRAFFIC.
- UNEP (2024). *Vanishing Treasures project report: Biodiversity synthesis – Central Asia*. Vienna, Austria.
- Zhuo, Y., Wang, M., Zhang, B., Ruckstuhl, K.E., da Silva, A.A., Yang, W. and Alves, J. (2022). Siberian ibex *Capra sibirica* respond to climate change by shifting to higher latitudes in Eastern Pamir. *Diversity*, 14(9). <https://doi.org/10.3390/d14090750>



Snow Leopard (*Panthera uncia*) Status in Uzbekistan

CONTRIBUTORS:

Mariya Gritsina^{1*}, Elena Bykova¹, Mikhail Palsyn²,
Alexandr Esipov¹, Timur Abduraupov¹, Valentin
Soldatov¹, Bakhtoyr Aromov³, Akbar Rustamov⁴
Tolmas Aromov³, Dmitriy Golovtsov⁵, Anna Ten¹

KEYWORDS:

snow leopard; *Panthera uncia*; Uzbekistan;
country status; distribution; population;
conservation

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Gritsina et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

1 Institute of Zoology, Academy of Sciences of the Republic of Uzbekistan

2 International Consultant

3 Gissar State Nature Reserve

4 Ugam-Chatkal National Park

5 Chatkal State Biosphere Reserve

* Email: mgritsina@gmail.com

1. Distribution

Snow leopards (*Panthera uncia*) inhabit two mountain systems in Uzbekistan: the Western Tien Shan (including Ugam, Maidantal, Talass Alatau, Pskem, Chatkal, and possibly the Kuraminskyi ranges) and the Western Pamir-Alay system (comprising the Gissar, Baysun, Zarafshan, and Turkestan ranges). These populations are transboundary, shared with the Republic of Kazakhstan, the Kyrgyz Republic, and the Republic of Tajikistan. The total area of snow leopard habitat in Uzbekistan is estimated to be approximately 10,000–11,500 km² (Palsyn et al., 2022; Gritsina et al., 2023; Esipov et al., 2024).

2. Population

The total snow leopard population in Uzbekistan is estimated at 96–107 adult individuals. Of these, approximately 46–47 individuals inhabit the Western Tien Shan, and 50–60 individuals are in the Western Pamir-Alay. Seasonal transboundary movements contribute to variation in observed population sizes (Palsyn et al., 2022; Gritsina et al., 2023; Esipov et al., 2024). However, coordinated cross-border monitoring remains absent.

Several areas within the snow leopard's historical range, such as Zaamin Reserve (Turkestan Range), the Gissar Range outside Gissar Reserve, and the Baysuntau Range, still lack recent data (i.e., within the last 20 years) due to

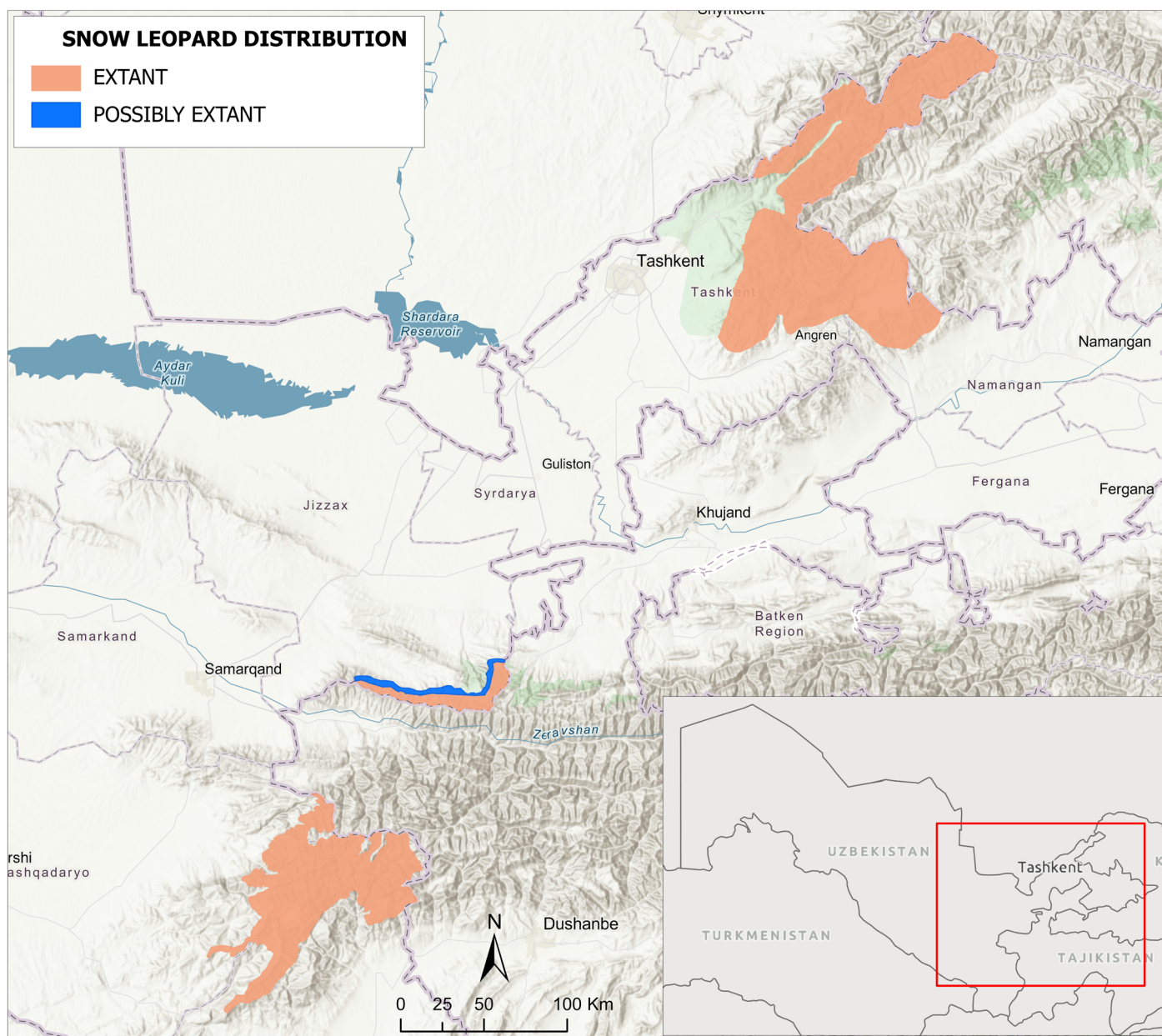


Figure 1. Snow leopard (*Panthera uncia*) range in Uzbekistan. Areas shown in orange represent regions with confirmed or inferred current presence of the species, while blue areas denote regions where occurrence remains uncertain but plausible based on suitable habitat and nearby records, consistent with IUCN Red List range definitions.

limited or no research effort. In February 2025, snow leopard presence was confirmed in the Tupalang River Valley (Gissar Range).

National Monitoring Framework

In 2018–2019, with support from the UNDP/GEF project “Sustainable Use of Natural Resources and Forestry in Key Mountain Regions Important for Globally Significant Biodiversity Species,” a national snow leopard monitoring system was initiated. The approach was based on a 5x5 km spatial grid, covering potential snow leopard habitats identified via spatial modelling.

Two monitoring approaches were used:

- Occupancy estimation through transect surveys (5–7 km) within each grid cell.
- Population density estimation via Spatial Capture-Recapture (SCR) using camera traps and DNA analysis of faecal samples.

A total of 510 cells covering 12,750 km² were identified in the Western Tien Shan and Western Gissar-Alai (Paltsyn et al., 2022). Between 2018 and 2019, field teams conducted surveys over 145 field days, amounting to a total of 904 person-days of effort, and covered 113 survey cells. Snow leopard presence was detected in 34 cells (30%), with track densities ranging from 0 to 0.33/km of transect. The

highest detection rates occurred from October to May, correlating with higher densities of wild ungulates (2.9–5.8 individuals/10 km²), lower livestock densities (0–67 animals/10 km²) and presence of snow cover. Fieldwork across seasons helped identify optimal survey periods (Paltsyn et al., 2022; Gritsina et al., 2023; Esipov et al., 2024).

Western Tien Shan

Altogether, 203 spatial cells (5,075 km²) are considered suitable habitat in the Western Tien Shan. Snow leopards were confirmed in 22 cells, with at least 5 individuals identified. The overall density was 0.23 individuals per cell (0.0092/km²), equating to a total estimate of 46–47 individuals in Western Tien Shan (Gritsina et al., 2023; Esipov et al., 2024).

From 2019–2022, camera trap surveys in the Pskem sub-region accumulated 9,368 camera trap-days. Snow leopards were photographed by 11 cameras across 6 cells, resulting in 31 capture events and 243 images. Analysis confirmed at least 4 individuals: 2 males and 1 female with a cub. Estimated population density was 0.3 individuals per cell (0.012/km²). Out of 113 suitable cells (2,825 km²) in Pskem, this suggests a population of approximately 34 individuals. In the Chatkal sub-region, snow leopards were recorded 11 times during the same period. Image quality limited individual identification, but snow leopard presence was confirmed in 7 cells. Estimated density was 0.14 individuals per cell (0.0056/km²) across 90 suitable cells (2,250 km²), indicating a population of 12–13 individuals.

Western Gissar-Alai

Camera trapping has only been conducted within the Gissar State Reserve, with regular observations of snow leopards. According to B. Aromov, two individuals were recorded each year in 2018–2019. In 2020, 28 photos and video records were obtained from which 16 individuals were identified (Gritsina et al., 2023).

3. Threats

Traditional snow leopard hunting

Historically, snow leopards were hunted for their skins, which were valued for clothing and as a status symbol. Killing a snow leopard was considered prestigious, reflecting the hunter's skill. During the Soviet era, red-listing and hunting bans were introduced; however illegal hunting continued. From 1960 to 1995, 11 snow leopards were killed near the Gissar Reserve (Aromov, 2001). A survey of the local population (Bykova et al., 2004) documented hunting by local communities between 1975 to 2003. Six of ten recorded incidents involved hunting snow leopards for skin or for sale to private zoos. The estimated annual

offtake during the survey period was 3–4 individuals in the Tien Shan; 2 in the Turkestan range, and 1 in the Sangardak range. The most recent confirmed illegal hunting incident occurred in 2004 in the Akbulak river basin (Western Tien Shan), where an individual attempted to sell a skin for USD 1,000 (A. Nuridjanov, personal communication). No subsequent confirmed cases have been officially reported.

In summary, an estimated 170–180 individuals have been killed from 1960 to 2004. There is no evidence of snow leopards being killed from 2004 to 2024. Since 1999, there have been no recorded cases of snow leopard skins, derivatives, or live individuals seized at international borders.

Live capture of cubs and adults

Although there were no records of cub captures during the Soviet era in Uzbekistan, live captures for private zoos became more common in the early 2000s. A snow leopard cub could fetch approximately USD 1,000 on the illegal market, while an adult would be worth USD 5,000–10,000. In 2012, a male cub from the Hissar Ridge was brought to a veterinary clinic in Samarkand, reportedly purchased from hunters. Between 2014 and 2024, there were unverified reports of at least two cubs captured from the Gissar Reserve and one from the Western Tien Shan for sale and captivity.

Conflicts with local herders

Perceptions of snow leopards as a threat to livestock are widespread. Depredation reports suggest snow leopards primarily attack goats and sheep, with occasional attacks on cattle, horses, and donkeys. Between 1960 and 1995, a total of 82 incidents of livestock depredation have been recorded in the Gissar Range, outside the reserve. One depredation incident involved the loss of 35 animals, although the average number per event is 5.5 (Bykova et al., 2004). These events can lead to retaliatory killings. Such depredation incidents may be linked to reduced availability of natural prey, potentially caused by disease outbreaks, overhunting, or habitat degradation. Under these conditions, it is hypothesized that snow leopards may shift their foraging behavior toward alternative prey sources, including domestic livestock.

More recent data from the Ugam-Chatkal National Park (Western Tien Shan) further illustrate the extent of livestock depredation. According to a questionnaire survey conducted in 2025 and covering the period 2015–2025, nine respondents reported snow leopard attacks, with a total of 58 livestock affected. Of these, 47 animals (81.0%) were killed and 11 (19.0%) injured. Nearly all incidents occurred at night (98.3%), with only one case recorded at dusk or dawn and none during daytime. Most attacks took

place on pastures (82.8%), although 17.2% occurred within corrals, indicating insufficient protection. Young animals constituted the majority of losses (75.9%). Cattle and sheep were most frequently involved (seven incidents each), followed by goats and horses (three incidents each), and a single reported case involving a dog. Survey responses also indicated that one snow leopard was reportedly killed in retaliation during the study period (Gritsina et al., 2025).

Reports indicate that livestock depredation increases during the winter months, when snow accumulation can limit the accessibility of wild ungulates such as ibex (*Capra sibirica*), making livestock potentially comparatively easier to hunt. During the summer, domestic herds are often left unattended during the daytime or supervised by children, who may not be able to effectively deter predators. Poorly constructed summer corrals further elevate predation risk; these enclosures typically consist of low walls without roofing, allowing easy entry by predators while restricting livestock from escaping. In winter, snow leopards have been reported to enter livestock pens through roofs made only of reeds or other insufficient materials.

Proximity to human settlements presents additional challenges in managing conflict. For example, Gissar Reserve is bordered by eleven Uzbek and Tajik villages. Long-standing tensions between the reserve administration and the predominantly unemployed residents of nearby Tashkurgan and Chopukh villages were ultimately addressed through a government-led relocation of approximately 500 individuals to lower-elevation farmland in the 2000s.

Armed human conflict

Minefields, remnants of the civil war in neighboring Tajikistan, are located along the border near the Gissar and Zaamin Reserves, areas frequently used by migratory animals. There have been documented instances where large mammals, including brown bears (*Ursus arctos*), ibex, and other species, triggered landmines. These mines have recently been deactivated.

Natural mortality

The Western Tien Shan region experiences deep snowfalls during winter, with avalanches being a common occurrence. Local reports indicate that at least three snow leopards have been killed by avalanches while hunting ibex in the Pskem River Valley in recent years.

Decrease of prey species populations

The decline of wild ungulate populations, particularly ibex, represents a significant threat to snow leopards. The ibex is extensively hunted illegally throughout its range, with an estimated 30 ibex hunted illegally annually from

Pskem Village alone in the Ugam-Chatkal National Park (Kashkarov, 2002). Even within protected areas, such as the Gissar Reserve, ibex populations remain vulnerable to illegal hunting. In addition to hunting, disease outbreaks have caused significant declines in prey populations; for instance, an outbreak of sarcoptic mange in the 1970s led to a dramatic decrease in the ibex population. Similar pressures affect other wild prey species across parts of the snow leopard's range, reflecting broader anthropogenic impacts on mountain ecosystems.

Subsistence hunting

Subsistence hunting for meat, pelts, and other body parts by local residents remains illegal but is challenging to quantify. Commonly targeted species include ibex, wild boar (*Sus scrofa*), and marmots (*Marmota*), hunted for consumption, fur, and traditional medicinal uses. In addition to direct hunting by local residents, marmot populations are also affected by predation from free-ranging shepherd dogs accompanying livestock. The expansion of seasonal grazing areas increases the frequency of encounters between dogs and marmots, further contributing to local population declines. Despite regulations limiting access to hunting areas and restricting firearm ownership, weak law enforcement combined with economic hardship in remote mountain communities contributes to the persistence of illegal hunting. Additionally, residents in these areas often have limited awareness of hunting regulations and conservation objectives. Over time, a decline in ungulate populations, degradation of marmot habitats, and reduced numbers of ground-nesting birds have been documented across the snow leopard's range in Uzbekistan.

Sport hunting

Sport hunting, primarily carried out by urban residents, is generally legal, though illegal practices persist. Birds are the main targets, with ungulates hunted to a lesser extent. Legal hunting has nonetheless contributed to declines in some ungulate populations. For instance, commercial hunting of wild boar in the Western Tien Shan during the late 1980s disproportionately affected breeding females, resulting in a sharp population decline. Although wild boar numbers are now recovering, they have not returned to historical levels. While wild boar are not preferred prey for snow leopards, this case exemplifies how overexploitation can significantly impact once-abundant species.

Disturbance factors: Human land use, collection of natural products

High-elevation mountain regions in Uzbekistan, particularly around Tashkent in the Tien Shan Range, are increasingly under pressure by human activities, including pastoralism, tourism, and recreation (hiking, skiing, paragliding, and rafting). These activities, along with urban

population growth, threaten mountain ecosystems. The Pamir-Alay Mountains face relatively less pressure but are still impacted.

A new threat is the construction of hydroelectric power plants, some near snow leopard habitats. Plans for 20–25 stations in Uzbekistan, along with similar projects in Kazakhstan, Kyrgyzstan, and Tajikistan, pose risks during the construction phase, including displacement of large wildlife, increased mortality in smaller species, habitat loss, and reduced prey availability. Additionally, construction may increase illegal hunting and the risk of fires.

Land seizures that reduce available rangelands may heighten competition for pastures between wild ungulates and livestock. This could lead to increased predation on livestock by snow leopards, prompting retaliatory illegal hunting. Reduced low-altitude winter habitats will concentrate feeding and migration patterns of ungulates, affecting non-constructed areas.

Changes in water levels and ice conditions from construction could prevent wildlife from accessing water and cause entrapment in ice, leading to mortality. Snow leopards may exploit these situations for hunting, but they could also be trapped. Increased infrastructure, including roads, will facilitate illegal hunting, which could increase due to easier access to previously remote areas. The expansion of mass tourism and new development will increase human-wildlife conflict, disturb snow leopard habitats, and further exacerbate these pressures.

Competition between wild prey and livestock

The use of high-elevation alpine meadows for seasonal grazing is widespread in Uzbekistan. During the Soviet era, these pastures were utilized by local pastoralists as well as those from neighbouring republics. However, due to economic hardship, herd sizes have significantly decreased. Currently, pasture use is restricted to Uzbek nationals, and only those who hold a license issued by the relevant authorities are permitted to graze livestock. These licenses specify the type and number of animals allowed. Up until 1990, the Pskem River basin was actively used for agriculture, with alpine territories utilized for grazing from March to September, reaching elevations of up to 4500 meters. This grazing was primarily carried out by Kyrgyz herders under long-term lease agreements. Grazing activity ceased in the early 1990s following the independence of the Central Asian Republics. Since 2025, livestock grazing in this territory has once again been fully prohibited.

In contrast, the Chatkal and Gissar ranges, characterized by higher human populations, continue to face significant

pressure from agriculture, particularly pastoralism. For example, 187,800 hectares of pasture within the Ugam-Chatkal National Park (Western Tien Shan) are currently under use. According to the Management Plan of the Ugam-Chatkal National Park, livestock numbers in the park include 34,208 head of cattle, 41,785 small ruminants, and 2,587 horses. In the regions of Bostanlyk, Parkent, and Kanangra, official figures report 161,900 head of cattle and 364,100 small ruminants (Beshko, 2016).

The absence of accurate information on pasture grazing capacity limits effective pasture management. A preliminary calculation of the grazing pressure on the Ugam-Chatkal National Park's pastures, based on available livestock population data and the park's pasture characteristics, suggests that each head of cattle occupies 0.69 hectares. This value exceeds the permissible stocking density of one head per hectare for these types of pastures, suggesting overgrazing (Mardonov, 2017).

Climate change

The increase in mean annual air temperatures in Uzbekistan has occurred amidst considerable natural variability, resulting in substantial inter-annual fluctuations. The rate of warming in the region exceeds the global average, with an observed increase of 0.27°C per decade. This trend is particularly relevant for water resources, as the glaciation of the entire Aral Sea basin is a critical source of freshwater for Uzbekistan. The rate of glacial retreat within the basin ranges from 0.1% to 1.65% per year, depending on specific regions and time periods. Between 1957 and 2010, significant reductions in glaciated area were recorded in the basins of the Pskem, Kashkadarya, and Surkhandarya rivers, including areas in neighbouring countries within these river basins. The total decrease in glaciated area in these basins amounted to 50.12 km², or 24% of the original area as of 1957. Across Uzbekistan, the reduction in glaciated area during the same period was 41.63 km², representing a 29.5% loss compared to the original extent (Third National Communication of the Republic of Uzbekistan under the UN Framework Convention on Climate Change, 2016).

4. Conservation

National legislation

The legal and legislative framework governing nature conservation in Uzbekistan comprises over 130 laws and by-laws, many of which directly or indirectly pertain to biodiversity conservation (Yunusov et al., 2015). The snow leopard is listed in the Red Data Book of the Republic of Uzbekistan (2019), an official state instrument for the conservation of rare and endangered species.

Recovery of fine and compensation for damages

Fines for damage to flora and fauna are imposed in accordance with Order No. 290 of the Cabinet of Ministers of the Republic of Uzbekistan, titled “On the regulation of the use of biological resources and the implementation of permit procedures in the field of natural resource use.” The fine for the killing of a snow leopard is set at 3,000 basic calculation units (BCU) for Uzbek citizens and legal entities, and USD 400,000 for foreign citizens, as per the Central Bank’s exchange rate. The fine is levied for each individual animal or its part (e.g., head, skin, or other body parts), regardless of age, size, weight, or sex. In cases of serious offenses, criminal liability may also be imposed under the Criminal Code. However, arrests of snow leopard poachers are virtually unheard of in Uzbekistan.

Action plan and methodology for snow leopard monitoring in Uzbekistan

The “Action Plan for Snow Leopard Conservation in the Republic of Uzbekistan (2021-2030)” was approved by the Cabinet of Ministers. This document is subject to regular monitoring and control. Additionally, the “Methodology for Snow Leopard Monitoring in the Republic of Uzbekistan,” adopted by the Ministry of Ecology, Environmental Protection, and Climate Change and the Academy of Sciences of the Republic of Uzbekistan in March 2022, outlines the regular collection and updating of data regarding snow leopard populations across various regions within Uzbekistan.

Protected areas

The snow leopard is protected within seven designated protected areas (PAs), comprising three state reserves and four national parks (one established in 2022). Upper Tupalang National Park (IUCN Category II), covering 27,851 hectares, was established in the Gissar Ridge in 2022. A 2,000-hectare buffer zone was also designated within the Gissar State Reserve to support conservation efforts.

To strengthen protected area management, the SMART (Spatial Monitoring and Reporting Tool) patrolling system has been implemented. It is currently operational in the Chatkal State Biosphere Reserve and Gissar State Reserve and is being introduced in the Ugam-Chatkal National Nature Park.

Raising awareness of the importance of the snow leopard and its ecosystems

Within the framework of the UNDP/GEF/Ministry of Ecology project, “Sustainable Natural Resource and Forest Management in Key Mountainous Areas Important for Globally Significant Biodiversity,” a baseline study was conducted on environmental awareness among local populations regarding mountain ecosystems, biodiversity,

and state conservation efforts. Surveys were conducted in villages in the Tashkent region (Kumushkon, Nevich, Chetsuv, Tanga Topdi, Pskem) and Kashkadarya province (Almati, Hisorak, Suvtushar, Gilan), covering 386 individuals. The findings emphasized the need to prepare and disseminate information to school teachers to improve local awareness.

The organization ‘EKOMAKTAB’ has developed educational programs for the celebration of ‘International Snow Leopard Day’ and ‘International Biodiversity Day,’ and has prepared work plans for environmental education in protected areas and collaboration with local communities. However, after the completion of the UNDP/GEF project, these activities have ceased.

Establishment of pasture cooperatives

Two pasture cooperatives have been established to coordinate the conservation and rational use of pasture resources among neighboring mountain villages: ‘Hisor Yaylovlari’ (304 ha) and ‘Muminobod Chorvasi’ (702 ha).

Strengthening international and interregional co-operation

Between 2017 and 2022, the UNDP/GEF/Ministry of Ecology project facilitated transboundary cooperation for snow leopard conservation between Uzbekistan, Kazakhstan, Kyrgyzstan, and Tajikistan. This cooperation led to the development of a Memorandum of Understanding (MoU), which was approved by Kyrgyzstan, Tajikistan, and Uzbekistan in 2021 under the patronage of the Global Snow Leopard and Ecosystem Protection Program (GSLEP). Kazakhstan is expected to accede to the MoU. A draft regional action plan has been developed and is under review by the member countries. In 2018, the 24th transboundary snow leopard landscape, “Western Tien-Shan,” was nominated for inclusion in the GSLEP network.

Future Conservation Needs

The conservation of snow leopard populations, their range, and associated ecosystems can only be ensured through the development and implementation of a comprehensive set of measures. These are outlined in the *Action Plan for Snow Leopard Conservation in the Republic of Uzbekistan (2021–2030)*, approved by the Cabinet of Ministers. However, due to the long-term and multi-dimensional nature of this task, several additional measures not included in the Action Plan have since been proposed (Gritsina et al., 2023), with some becoming especially relevant in the last two years. The key priorities are summarized below; completed tasks are not included.

To reduce illegal hunting, improving the skills of protected area (PA) rangers and strengthening the material and technical infrastructure of PAs are identified as critical needs. The adoption and consistent monitoring of SMART (Spatial Monitoring and Reporting Tool) reports at the national level is essential for tackling poaching. In parallel, stronger enforcement through judicial measures and awareness-raising campaigns targeting the illegal hunting of wild ungulates are needed. Improved collaboration between environmental inspectorates, conservation agencies, and border guards is also necessary, along with coordinated inspection efforts in snow leopard habitats located outside formally protected areas. A dedicated action program for transboundary snow leopard conservation has also been identified as a key step toward more coordinated and effective regional efforts.

The development of sustainable local livelihoods is a priority, with support for home-based production and eco-tourism recognized as practical ways to provide alternative income sources while advancing conservation objectives. In terms of environmental governance, priority actions include rezoning Ugam-Chatkal National Park, expanding the protected area network to include high-mountain regions, and establishing the proposed Pskem Reserve in the Western Tien Shan. Maintaining habitat connectivity is also a critical goal, requiring the creation of ecological corridors and the implementation of other effective area-based conservation measures (OECMs).

Understanding and addressing human–wildlife conflict, particularly between snow leopards and shepherds, is also a priority. Research and the development of targeted mitigation measures will be vital to ensuring coexistence and balancing conservation with the needs of rural communities.

In addition to these core priorities, several other proposals have been identified to strengthen snow leopard conservation:

- Prohibiting the construction of hydroelectric power stations within snow leopard habitats to protect sensitive ecosystems
- Establishing regular environmental education and outreach programs to increase awareness and foster conservation values among local communities
- Supporting research programs focused on snow leopards and their prey species
- Creating a continuously updated, web-based information platform on snow leopards and their ecosystems
- Establishing a rehabilitation center for predatory mammals

- Monitoring the impacts of climate change on snow leopards and their habitats, and developing appropriate mitigation strategies
- Strengthening international and interregional cooperation, and engaging the industrial sector in biodiversity conservation
- Creating a dedicated organization or NGO focused specifically on snow leopard conservation to ensure sustained and coordinated efforts over the long term

Together, these measures form a foundation for more effective and resilient conservation of snow leopards and the ecosystems on which they depend.

5. Acknowledgements

This country status report acknowledges the contributions of research institutions, conservation organizations, and members of the research and practitioner community in Uzbekistan whose research, insights, and long-term work informed this synthesis. The authors are also grateful to David Mallon for his valuable contribution and support. The publication further acknowledges the IUCN SSC Cat Specialist Group for supporting the development of this country status series, as well as the wider Snow Leopard IUCN Red List assessment team for their guidance and collaboration during the snow leopard assessment process. Thanks to Bayarjargal Khashbat and Altanbagana Yunden from WCS Mongolia, who prepared the snow leopard distribution map. Support for coordination of this country status series was provided by Justine Shanti Alexander, WCS Mongolia.

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Action Plan for Snow Leopard Conservation in the Republic of Uzbekistan (2021–2030) (2021). *Action plan for snow leopard conservation in the Republic of Uzbekistan (2021–2030)*. Tashkent.
- Aromov, B. (2001). Snow leopard in the Gissar Reserve. In: *Proceedings of the Reserves of Uzbekistan*. Vol. 3. Tashkent: Chinor ENK, pp. 121–125. (In Russian)
- Beshko, N.Y. (2016). *Report on pasture status and their use in the project area*. UNDP/GEF project. In: *Sustainable use of natural resources and forest management in key mountain regions important for globally significant biodiversity*. Tashkent. (In Russian)
- Bykova, E., Esipov, A. and Aromov, B. (2004). Questionnaire as a method of collecting data on endangered species such as the snow leopard. In: *Protected areas of Central Asia*. Tashkent: Chinor ENK, pp. 208–214. (In Russian)

- Gritsina, M.A., Bykova, E.A., Paltsyn, M.Y., Ten, A.G., Aromov, B., Abduraupov, T.V., Soldatov, V.A., Esipov, A.A., Golovtsov, D.E., Aromov, T. and Kuzmina, L.A. (2023). *State of snow leopard populations in the Republic of Uzbekistan: existing and necessary measures for its conservation*. Tashkent: Baktria Press. (In Russian)
- Gritsina, M., Soldatov, V., Rustamov, A. and Michel, S. (2025). Report on the results of a questionnaire survey: Human– large carnivore conflict in the Ugam-Chatkal National Park (Uzbekistan). Project GIZ “Integrated Land Use Considering Climate Change in Central Asia”: Strengthening the basis for transboundary nature conservation in the Western Tien Shan through integrated watershed management. Tashkent, 54 pp.
- Esipov, A., Gritsina, M., Bykova, E., Aromov, B., Paltsyn, M. and Protas, Y. (2024). The snow leopard in Uzbekistan. In: *Snow Leopards: Biodiversity of the World – Conservation from Genes to Landscapes*. 2nd edn. Elsevier, pp. 489–503.
- Kashkarov, R. (2002). On the fauna of mammals (Carnivora and Artiodactyla) in the Pskem River Basin. *Selevinia: Kazakhstan Zoological Journal*, 1–4, pp. 150–158. (In Russian)
- Mardonov, B.K. (2017). *Report on land use data analysis in the Ugam– Chatkal National Natural Park*. UNDP/GEF project. In: *Sustainable use of natural resources and forest management in key mountain regions important for globally significant biodiversity*. Tashkent. (Manuscript, in Russian)
- Paltsyn, M.Y., Gritsina, M.A., Bykova, E.A., Ten, A.G., Esipov, A.V., Aromov, B., Soldatov, V.A., Golovtsov, D.E., Abduraupov, T.V., Kuzmina, L.A., Sherimbetov, K.S., Mardonova, L.B., Khyrramov, F.N. and Akhadov, A.A. (2022). *Snow leopard monitoring methodology in Uzbekistan*. Tashkent. (In Russian)
- Republic of Uzbekistan, Cabinet of Ministers (n.d.). *Order No. 290 on the regulation of the use of biological resources and the procedure for implementing permit systems in the field of nature use*. Available at: <https://lex.uz/ru/docs/2485767> (In Russian)
- Red Data Book of the Republic of Uzbekistan (2019). *The Red Data Book of the Republic of Uzbekistan*. Vol. 2: Animals. Tashkent: Tasvir.
- Republic of Uzbekistan (2016). *Third national communication of the Republic of Uzbekistan under the UN Framework Convention on Climate Change*. Tashkent. (In Russian)



Snow Leopard (*Panthera uncia*) Status in China

CONTRIBUTORS:

Chunyue Wei^{1,6}, Yixuan Liu², Miaomiao Liang¹,
Mingjie Chang², Yang Yu³, Yufang Gao⁴, Awang Jikmed⁵,
Xueyang Li^{1,6}, Juan Li⁷, Xiaoxing Bian⁸, Chenxing Yu⁹,
Yibin Li⁹, Yadong Xue¹⁰, Rui Xing¹¹, Xingran Xiong²,
Bin Liang¹², Sheng Li⁶, Hao Wang⁶, Xiang Zhao¹,
Jian Fan², Xingzhe Wang², Ziyun Zhu^{6,13},
Xinming Lian¹⁴, Peiyun Li⁷, Nan Jiang¹, Jiahui Wang¹⁵,
Wenyan Bai², Shujie Liang⁶, Xiaoyu Li^{1,6}, Yanbin Niu²,
Yiwen Ma², Yiwang Li¹⁶, Yanzhi Li¹⁶, Muhammad
Sajid Nadeem¹⁷, Zhi Lu⁶, Yanlin Liu^{9*}, Kun Shi^{2,15*},
Lingyun Xiao^{7*}

KEYWORDS:

China; conservation; country status;
distribution; *Panthera uncia*; population;
snow leopard

CORRESPONDING EDITOR: Örjan Johansson

HANDLING EDITOR: Justine Shanti Alexander

This article forms part of a Special Issue on the country-level status of snow leopards. All contributions were reviewed by members of the Snow Leopard Reports Editorial Team and did not undergo external peer review.

COPYRIGHT: © 2026 Wei et al.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

- 1 Shan Shui Conservation Center, Conservation Biology Building, Peking University, Beijing, China
 - 2 Eco-Bridge Continental, Beijing, China
 - 3 Wildbliw Media Co., Ltd., Shenzhen, China
 - 4 Conservation Edgewalkers, Qingyuan, Guangdong, China
 - 5 Plateau Nature Conservancy, Xining, China
 - 6 Peking University, Beijing, China
 - 7 Xi'an Jiaotong–Liverpool University, Suzhou, China
 - 8 Wildlife Conservation Society China Program, Beijing, China
 - 9 Qinghai Normal University, Xining, China
 - 10 Ecology and Nature Conservation Institute, Chinese Academy of Forestry, Beijing, China
 - 11 Wild Xinjiang, Urumqi, China
 - 12 School of Life Sciences, Inner Mongolia University, Hohhot, China
 - 13 Beijing Forestry Society, Beijing, China
 - 14 Northwest Institute of Plateau Biology, Chinese Academy of Sciences, Xining, China
 - 15 Beijing Forestry University, Beijing, China
 - 16 Nehnang Conservation Center for Nature and Culture, Lhasa, China
 - 17 PMAS-Arid Agriculture University, Rawalpindi, Pakistan
- * Corresponding authors:
Lingyun Xiao: Lingyun.Xiao@xjtlu.edu.cn
Yanlin Liu: 20231009@qhnu.edu.cn
Kun Shi: kunshi@bjfu.edu.cn

1. Distribution

China holds the largest proportion of the global snow leopard (*Panthera uncia*) range, with over 60% of the species' potential habitat located within its borders (McCarthy et al., 2017; Shi et al., 2024). Snow leopards are known to occur across eight provinces and autonomous regions in China: Tibet Autonomous Region, Xinjiang Autonomous Region, Qinghai, Gansu, Sichuan, Yunnan, Inner Mongolia Autonomous Region, and Ningxia Autonomous Region. Among these, Tibet Autonomous Region, Xinjiang Autonomous Region and Qinghai contain the largest extent of snow leopard habitat. According to the updated distribution map based on the IUCN Red List range classification (Figure 1b), the 'Extant' snow leopard range in China is estimated at 778,756 km², and the 'Possibly Extant' range is 618,573 km², totaling 1,397,329 km². Other previous estimates predicted 2,168,754 km² 'Extant' range and 52,728 km² 'Possibly Extant' range (McCarthy et al., 2017) and 1,216,289 km² of suitable habitat in China (Li et al., 2016a). These differences largely reflect methodological approaches, as earlier range estimates were primarily expert-derived, whereas the updated map is based on occurrence-driven habitat modelling and subsequently refined through expert validation, resulting in a more spatially explicit delineation of suitable habitat.

Snow leopard ranges in China are primarily distributed on the Tibetan Plateau and in surrounding mountain ranges, including the Himalaya, Hindu Kush, Pamir, Kunlun, Tian Shan, Altai, and Hengduan mountain ranges. The Qilian, Altai, and Tian Shan-Pamir-Hindu Kush-Karakoram mountain ranges are identified as the most likely to remain

stable snow leopard habitats in the face of climate change (Li et al., 2016a).

Although parts of Yunnan, Inner Mongolia, and Ningxia Autonomous Region fall within the species' historical range, recent records from these areas are sparse. In 2013, a young male snow leopard was observed in unusual habitat in Inner Mongolia Autonomous Region, roughly 40 km from Helan Shan, where the species had not been recorded for over three decades; the individual was subsequently captured and relocated (Shi et al., 2024). More recently in August 2024, snow leopards were recorded by camera traps in a Nature Reserve in Inner Mongolia Autonomous Region located on the northern slopes of the Yinshan Mountains and bordering Mongolia to the north (Bayan Nur Urat Desert Nature Reserve, 2025). In 2020, camera traps recorded video evidence of snow leopards in Helan Mountain National Nature Reserve at the border of Inner Mongolia and Ningxia Autonomous Region, representing the first confirmed presence in Helan Mountain in nearly 50 years (Shi et al., 2024). While in Yunnan province, camera traps documented snow leopard presence in February 2024 (State Council News Office of the People's Republic of China, 2024) and August 2024 (Yunnan Baima Snow Mountain National Nature Reserve Administration, 2025) at two neighboring locations approximately 50 km apart.

China shares over 10,000 km of national borders with 10 of the other 11 snow leopard range countries (Shi et al., 2024). Snow leopards have been recorded crossing international borders into countries like Nepal and India, underscoring the critical need for transboundary collaboration for long-term conservation (Subba et al., 2025).

Based on the updated distribution map, a substantial proportion (19%) of China's 'Extant' snow leopard range falls within legally designated protected areas, including protected areas (National Nature Reserves and National Parks) such as Sanjiangyuan, Qomolangma, Altun, and Qilian Mountains. However, connectivity between protected areas remains limited in some regions, and several important snow leopard landscapes remain outside formal protection, particularly in parts of western Sichuan, northern Xinjiang Autonomous Region, and eastern Tibet Autonomous Region.

At present, there are insufficient data to assess national-level trends in snow leopard distribution across China. However, localized records suggest a mixed picture. Occasional detections in historically occupied sites, such as Helan Mountain, may indicate limited reoccupation or increased survey effort, but they do not reflect broad recovery. In contrast, predicted local extirpations in parts of Xinjiang and Inner Mongolia Autonomous Region

(the margins of their range in China), where snow leopards were historically present but have not been reported for decades despite increasing camera trap and survey coverage, suggest a contraction in the species' distribution in some marginal areas.

Insights from population genomics help place these patterns in a longer-term context. Population genomic analysis of snow leopards (Yang et al., 2025) reveals two major genetic lineages: a northern lineage and a southern lineage. The southern lineage remains centred in the Qinghai–Tibet Plateau and adjacent mountains, while the northern lineage shows evidence of a long-term decline beginning around 1,000 years ago, with the loss of many eastern populations from their historical range (Figure 1b). This broader pattern is consistent with the apparent contraction at the margins of the current distribution.

1.1 Modeling the Global Distribution of Snow Leopard Habitat Using the MaxEnt Model

Within the global distribution range of snow leopards, we initially compiled 6,989 snow leopard occurrence records (2000–2025) with precise GPS locations from multiple existing datasets, after removing duplicate records. These data comprised:

- Occurrence records from Li et al. (2020). A total of 1,914 historical records originating from the 2008 Beijing Snow Leopard Forum were excluded because they lacked clear temporal information (potentially dating to the last century), resulting in 4,338 retained records.
- Records from the Global Biodiversity Information Facility (GBIF) database with precise locations (n = 61).
- Global snow leopard occurrence records compiled by Liang (2023) (n = 910).
- Camera trap–recorded occurrences from the Tibet Autonomous Region, China, reported by Bian et al. (2023) (n = 308).
- Camera trap–recorded occurrences from the Sanjiangyuan region, China, collected by the Shan Shui Conservation Center (SSCC), Peking University (PKU), Plateau Nature Conservancy, and the Nyanpo Yutse Conservation Association, as reported in Li et al. (2025) (n = 289).
- Camera trap–recorded occurrences from the Qinghai Province, China, collected by Qinghai Normal University (QHNU) (n = 69).
- The national-scale camera trap and genetic database maintained by SSCC/PKU (n = 1,014).

We further compiled 2,159 snow leopard occurrence records without precise GPS coordinates from within

China for the period 2000–2025. These records were obtained from published literature (n = 1,384), news reports (n = 42), and expert records (n = 733) (Supplementary Materials). Where available, occurrence locations were georeferenced by digitizing snow leopard distribution or occurrence maps. When maps were not provided, locations were assigned to the centroid of the smallest identifiable administrative unit (e.g. village, township, or Nature Reserve) and treated as imprecise occurrence points.

The study extent for the MaxEnt model was defined as a 500 km buffer (Li et al., 2016a) surrounding all 9,148 compiled snow leopard occurrence records, including both precise (n = 6,989) and imprecise (n = 2,159) points. Only the 6,989 precise occurrence records were used in the MaxEnt model. The imprecise occurrence records were excluded from model training but were used to define the spatial extent of the study area, ensuring broader geographic coverage of the species' range. To reduce spatial clustering and potential spatial autocorrelation among occurrence records, we applied spatial thinning using four minimum distance thresholds: 1, 5, 10, and 30 km. This resulted in four filtered datasets containing 2,482, 1,139, 700, and 319 occurrence points, respectively. To assess the influence of thinning distance on model performance, we compared models across the four datasets. The average test Area Under the Curve (AUC) was highest at the 5 km thinning distance (0.911), compared with 1 km (0.880), 10 km (0.907), and 30 km (0.890). Based on this comparison, a 5 km thinning distance was selected for subsequent modeling, resulting in a total dataset of 1,139 occurrence points. This comparison provides a simple sensitivity check on the influence of thinning distance on model performance.

We selected 39 environmental variables to fit the snow leopard habitat suitability model, including:

- 19 bioclimatic variables from the global climate database WorldClim 2.1 (30 arc-seconds resolution);
- 14 land-use factors from the University of Maryland's Global Land Use Harmonization dataset (LUH, 0.25° resolution);
- 4 topographic variables: elevation, slope, aspect, and terrain ruggedness index (TRI). Elevation data came from the 15 arc-seconds GEBCO layer, while slope, aspect, and TRI were derived from the elevation layer using spatial analysis tools in QGIS;
- 1 vegetation variable: Normalized Difference Vegetation Index (NDVI), sourced from NASA's MOD13Q1 (Terra, 250 m resolution);
- 1 human impact variable: Human Footprint Index (HFI), from the global 100-meter resolution terrestrial human footprint dataset (<https://datadryad.org/dataset/doi:10.5061/dryad.ttdz08m1f#usage>).

All variables were resampled to a uniform resolution of 30 arc-seconds.

We analyzed correlations among all environmental variables and, for highly correlated variables (correlation coefficient > 0.8), retained only those with higher contribution to the MaxEnt model. Variables contributing less than 0.2% to the model were excluded. Ultimately, 11 environmental variables were selected to build the snow leopard habitat suitability model, including: elevation, slope, terrain ruggedness index (TRI), annual mean temperature (bio1), maximum temperature of the warmest month (bio5), temperature annual range (bio7), mean temperature of the wettest quarter (bio8), mean temperature of coldest quarter (bio11), C3 annual crops (c3ann), and rangeland (range), potentially forested secondary land (secdf).

In the MaxEnt model, 70% of the data were used for training and 30% for testing. The model was run 10 times with repeated fittings, and the average result was retained. Model performance was evaluated using the AUC metric, with a mean AUC of 0.911 indicating good performance. We used the threshold corresponding to the maximum training sensitivity plus specificity logistic threshold (0.2678) to delineate potential suitable habitat for snow leopards from the habitat suitability map.

1.2 Post-processing the Habitat Suitability Map to Generate the Snow Leopard Range Map

To reduce fragmentation in the habitat suitability map, we applied a moving window smoothing technique with a 5-pixel circular window to the binary habitat classification (suitable/unsuitable) derived from the MaxEnt model. The majority filter reclassified each central pixel based on the most common value within its neighborhood. Subsequently, we removed habitat patches smaller than 50 km² and more than 30 km away from other patches as these small, isolated patches are unlikely to sustain snow leopards and may represent noise in the model predictions rather than actual habitat. We also filled holes smaller than 50 km² inside large habitat patches.

To define the currently 'Extant' range, we screened the full set of 9,148 snow leopard occurrence records and excluded records older than 10 years (i.e. prior to 2015), retaining 8,748 recent occurrence records. We classified suitable snow leopard habitat at the level of watershed units, as these provide a consistent spatial framework for assigning occurrence records within suitable habitat. Given that published home range estimates for snow leopards vary widely across the range, and are often based on limited sample sizes of resident adults and may include dispersing individuals (Yu et al., 2022; Shrestha et al.,

2025; Subba et al., 2025), we applied a movement-based approach to represent the likely area a snow leopard could use around a recorded location. We used a radius of 20 km around occurrence records to approximate this potential movement, equivalent to an area of approximately 1,257 km². To remain conservative, we applied a standardized buffer of 1,000 km² (equivalent to a radius of 17.8 km). Watersheds overlapping by at least 10% with these buffers were classified as having snow leopard presence. Suitable habitat within such watersheds (i.e., those with snow leopard occurrence records) was defined as ‘Extant’ habitat, whereas suitable habitat in all other watersheds without occurrence records was classified as ‘Possibly Extant’. Here, ‘Extant’ follows IUCN range terminology and refers to areas considered currently occupied based on recent occurrence evidence, whereas ‘Possibly Extant’ refers to

suitable areas where current presence remains uncertain.

Watershed delineation was conducted using ArcGIS software and the *Hydrology* toolset. The process began with the GEBCO elevation dataset (as described above), which was processed using a *Fill* operation to remove spurious sinks and depressions. Flow direction was then calculated to determine the primary direction of water movement for each grid cell, followed by computation of flow accumulation to estimate upstream contributing areas and identify channel networks using a threshold value of 800. Finally, watersheds were delineated using the *Watershed* tool, with defined pour points (outlets) as inputs. The mean area of the delineated watersheds was 1,088 km².

Table 1. Expert-validated revisions to snow leopard distribution status based on comparison between the 2017 IUCN range map and the updated, model-based range map.

ID	Region (Province)	Previous IUCN Range (McCarthy et al., 2017)	Updated IUCN Range (2026)	Expert Assessment	Final Distribution Classification	Area (km ²)
1	Longshou Mountain (Gansu)	Possibly Extant	Possibly Extant	Possibly Extinct	Possibly Extinct	999
2	Tuoli (Xinjiang)	Extant	Extant	Possibly Extinct	Possibly Extinct	489
3	Lang Mountain (Inner Mongolia)	Possibly Extant	Non-habitat	Possibly Extinct	Possibly Extinct	2,513
4	Wula Mountain (Inner Mongolia)	Possibly Extant	Non-habitat	Possibly Extinct	Possibly Extinct	745
5	Daqing Mountain (Inner Mongolia)	Possibly Extant	Non-habitat	Possibly Extinct	Possibly Extinct	2,183
6	Yabulai Mountain (Inner Mongolia)	Possibly Extant	Non-habitat	Possibly Extinct	Possibly Extinct	950
7	Beida Mountain (Inner Mongolia)	Possibly Extant	Non-habitat	Possibly Extinct	Possibly Extinct	293
8	Buerjin (Xinjiang)	Extant	Non-habitat	Possibly Extinct	Possibly Extinct	852
9	Hoboksar and Emin (Xinjiang)	Extant	Extant, Possibly Extant	Possibly Extant (seasonality uncertain)	Possibly Extant (seasonality uncertain)	2,438
10	Wuqia (Xinjiang)	Possibly Extant	Extant, Possibly Extant	Extant (with evidence)	Extant	15,904
11	Qapqal, Western Tianshan (Xinjiang)	Possibly Extant	Extant, Possibly Extant	Extant (with evidence)	Extant	935
12	Qinling Mountains (Shaanxi)	Non-habitat	Possibly Extant	Non-habitat	Non-habitat	1,650
13	Helan Mountain (Ningxia and Inner Mongolia)	Possibly Extant	Extant	Extant (with evidence)	Extant	776
14	Gonghe (Qinghai)	Possibly Extant	Possibly Extant	Extant (deductive)	Possibly Extant	2,553
15	Geermu (Qinghai)	Possibly Extant	Extant	Extant (deductive)	Extant	2,388
16	Bayan Nuru Mountain (Inner Mongolia)	Non-habitat	Non-habitat	Extant (seasonality uncertain, with evidence)	Extant (seasonality uncertain)	417
17	Wuliji (Inner Mongolia)	Non-habitat	Non-habitat	Extant (seasonality uncertain, with evidence)	Extant (seasonality uncertain)	417
18	Mazong Mountain (Gansu)	Possibly Extant	Non-habitat	Extant (seasonality uncertain, with evidence)	Extant (seasonality uncertain)	417

Note: Grey indicates changes after expert consultation on the updated range map.

1.3 Expert Consultation to Verify Snow Leopard Distribution Changes

We overlaid the updated snow leopard range map with the 2017 IUCN snow leopard range map to identify areas where potential changes in distribution status, such as local extinction or colonization, may have occurred. We focused on spatial discrepancies between the two maps that required further verification (Figure 1a), particularly areas classified as ‘Extant’ or ‘Possibly Extant’ in the IUCN map but identified as non-habitat in the updated range map.

To validate these areas, we consulted 12 national experts with extensive field survey experience and knowledge. Based on consultation with 12 experts, revisions were made to 12 regions and three new regions were added to the updated range map (Table 1). The final IUCN snow leopard range map, integrating MaxEnt model outputs, recent occurrence records, and expert consultation, is presented in Figure 1b. The updated ‘Extant’ range was estimated at 778,756 km², with a ‘Possibly Extant’ range of 618,573 km², resulting in a total range of 1,397,329 km². In addition, 9,024 km² was classified as ‘Possibly Extinct’.

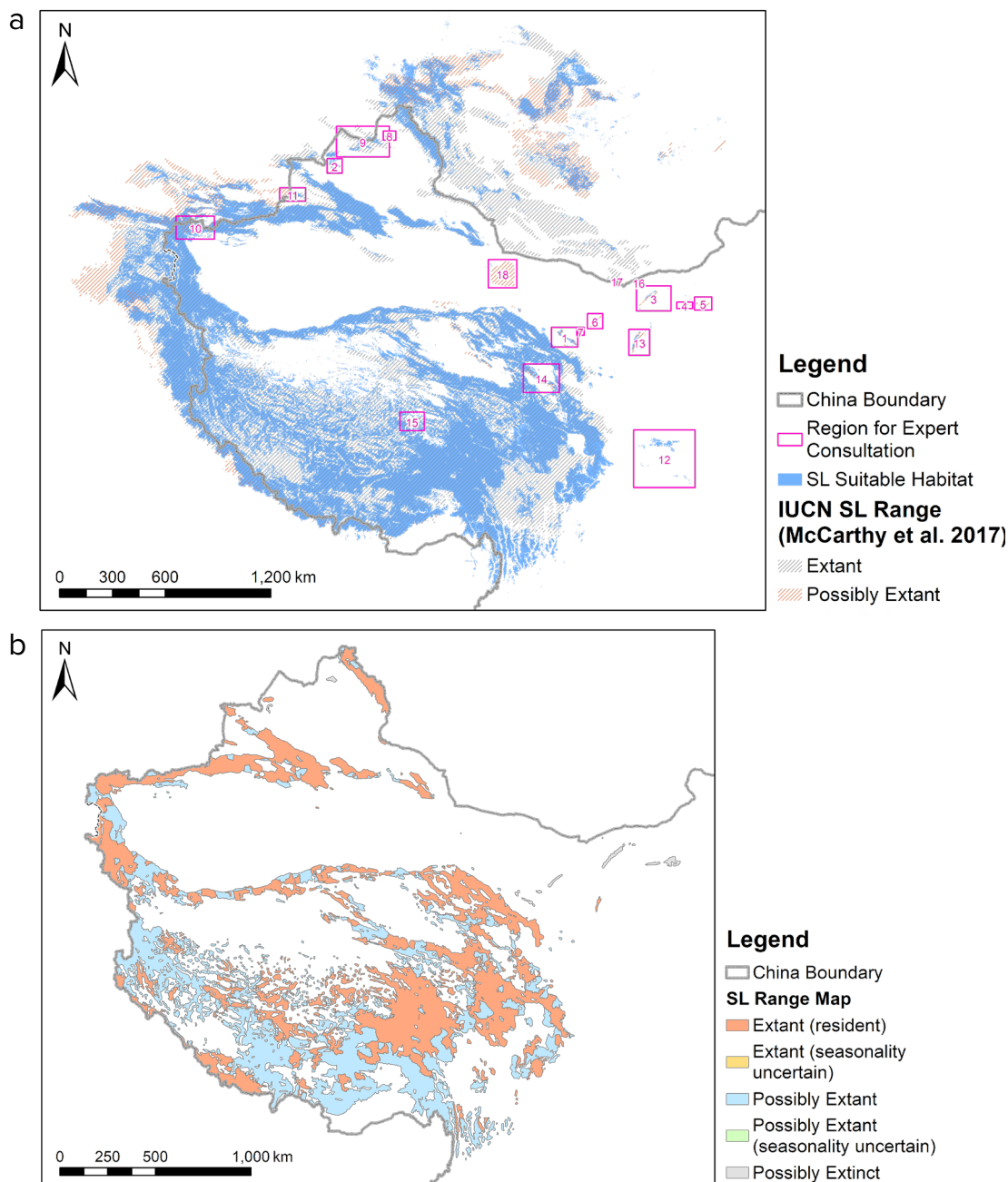


Figure 1. (a) Overlay of the 2017 IUCN snow leopard range map and the MaxEnt-derived habitat suitability map, highlighting regions with potential changes in distribution status and the 18 areas subjected to expert consultation. 1. (b) Revised IUCN snow leopard range map incorporating MaxEnt model outputs, recent occurrence records, and expert validation.

2. Population

Within China, early estimates suggested a snow leopard population of 2,000–2,500 individuals, representing approximately one-third to one-half of the global wild population (McCarthy and Chapron, 2003). A more recent assessment estimated an overall population of approximately 4,500 individuals in China, roughly double earlier estimates (Riordan and Shi, 2016). Although site-level estimates of snow leopard density have increased across China, large-scale systematic assessments (>10,000 km²) have been lacking. Based on a synthesis of systematic survey efforts conducted up to 2018, only approximately 1.7% of suitable snow leopard habitat in China had been scientifically sampled for density and abundance (Liu et al., 2019).

Based on published papers and reports, at least 66 site-level snow leopard population surveys have been conducted across China to date (December 2025), the majority of which employed camera trap methods (Table S1). These 66 survey sites were distributed across five provincial-level regions (Qinghai, Tibet Autonomous Region, Xinjiang Autonomous Region, Gansu, and Sichuan), with Qinghai Province hosting the largest number of studies ($n = 19$), particularly within the Sanjiangyuan and Qilian Mountains. Surveyed areas ranged from small-scale sites of approximately 30 km² to large landscapes exceeding 6,100 km². Most density estimates were derived from camera trap data analyzed using spatially explicit capture–recapture (SECR) models, with multi-session SECR approaches increasingly applied in recent years. Density estimates from the most robust local studies in China show considerable variation, ranging from 0.90 individuals per 100 km² in the Sanjiangyuan region of Qinghai Province (Li et al., 2025) to 1.40 individuals per 100 km² in the central Tibetan Plateau (Bian et al., 2023).

The first large-scale snow leopard population assessment conducted in China was recently completed in the Sanjiangyuan region of Qinghai Province, covering a total surveyed (mask) area of 32,899 km², with population estimates extrapolated to approximately 360,000 km² (Li et al., 2025). This study integrated and standardized camera trap data from 12 sites collected between 2015 and 2021 and estimated an average snow leopard density of 0.90 individuals per 100 km² (95% CI: 0.68–1.21 per 100 km²), corresponding to an estimated total population size of 1,002 individuals (95% CI: 755–1,341) across the entire region. The study also reported a set of more conservative population estimates derived for the survey region, ranging from 971 individuals (95% CI: 732–1,287) to 978 individuals (95% CI: 737–1,267). Even under these conservative

estimates, the Sanjiangyuan region alone is estimated to support approximately 11–21% of the previously estimated global snow leopard population (Li et al., 2025).

A population estimate for the Qilian Mountains is currently underway, covering approximately 14,250 km², alongside a province-level assessment for Sichuan Province with a planned survey area of 44,900 km². Once completed, these assessments will provide robust, landscape-scale population estimates for the Sanjiangyuan region, the Qilian Mountains, and Sichuan Province. Together with other surveyed areas, these sites encompass approximately 110,686 km² of snow leopard habitat, representing 7.9% of the updated snow leopard range in China ('Extant' and 'Possibly Extant' combined; total = 1,397,329 km²).

2.1 China National Population Estimate

Building on earlier efforts, including the 2018 Snow Leopard Network China report (Snow Leopard Network China, 2018), we aimed to produce a robust and updated national population estimate for snow leopards in China. To achieve this, we compiled density estimates from across the country through comprehensive literature searches and expert consultation, drawing on both published and grey literature. National-scale density extrapolation was conducted using a habitat stratification approach as outlined below.

2.1.1 Density Estimates Collection

We collated 41 snow leopard survey-related literature sources from across China, including grey literature. For each survey, we recorded information on geographic location, survey year, survey methods, survey area, the number of identified snow leopard individuals, density estimates, and population size estimates. For surveys that did not report density estimates, we calculated the snow leopard density by dividing the number of identified adult individuals by the reported survey area.

Initially, we compiled data from 95 site-level surveys reporting snow leopard density or abundance estimates across China. To ensure the use of the most reliable and representative estimates, we excluded surveys conducted in the same area, defined as having a high degree of spatial overlap within the same valley, mountain block, or contiguous local landscape unit, retaining only one survey in cases of substantial overlap. Survey area was defined using the spatial extent reported in the original studies, including SECR mask areas, bounding polygons of camera trap arrays, or aggregated survey extents derived from grid-based sampling (e.g. summed 5 km × 5 km cells). When overlap occurred, we prioritized surveys with larger spatial extent and more robust field or analytical methods, such as camera trapping or genetic sampling

combined with spatially explicit capture–recapture (SECR) analyses, as these provide more reliable and comparable density estimates. Survey timing was not used as a primary selection criterion; selection was guided by methodological robustness and spatial independence.

This screening process resulted in 25 sources comprising 66 surveys for analysis, of which 64 employed camera trapping, 50 applied SECR models, and 49 covered survey areas larger than 600 km² (Table 2; Table S1). Surveys using multi-session SECR models that jointly analyzed data from multiple adjacent survey areas were treated as surveys covering areas greater than 600 km², even when individual component survey sites were smaller than this threshold.

Table 2. Provincial summary of snow leopard population survey sites used for national population estimation, showing data collection methods, analytical approaches, and spatial extent.

Province	Number of survey sites	Survey sites using camera trap or genetic methods	Survey sites analyzed using SECR	Survey sites with area ≥600 km ²
Qinghai	19	18	16	16
Gansu	11	11	11	9
Tibet Autonomous Region	17	17	6	8
Xinjiang Autonomous Region	17	16	16	14
Sichuan	2	2	1	2
Total	66	64	50	49

From the dataset of 66 surveys, we applied a priori data quality criteria based on survey timing and statistical outliers. We excluded five surveys conducted before 2015. These surveys covered relatively small areas (<600 km²), which may lead to overestimation of snow leopard density (Suryawanshi et al., 2019), and/or employed methods other than camera trapping or genetic sampling. We then screened for outliers using the interquartile range (IQR) method by calculating the first quartile (Q1), third quartile (Q3), and the IQR (Q3 – Q1). Density estimates falling outside the range [Q1 – 1.5 × IQR, Q3 + 1.5 × IQR] were classified as outliers (Rousseeuw and Hubert, 2011). This resulted in the exclusion of four surveys with density estimates exceeding 2.2 individuals per 100 km².

To assess the impact of these data exclusions, we compared national population estimates generated with and without the inclusion of pre-2015 surveys and statistical outliers. Estimates were consistently higher when early surveys and outliers were retained, indicating that the filtered dataset yielded more robust and conservative population estimates. The effects of excluding early surveys and outliers are reported in Supplementary Results 1 and 2 (Tables S2 and S3). We further examined the sensitivity of population estimate results to the exclusion of surveys with crude density estimates (calculated as the number of adult snow

leopard individuals divided by survey area), which yielded results highly consistent with the main analysis, as reported in Supplementary Results 3 (Table S4).

2.1.2 Habitat stratification

We used Zonation v4 conservation planning software to rank the relative quality of snow leopard habitat predicted by the MaxEnt model. The habitat suitability output was clipped to China’s national boundary and used as the spatial extent for ranking. We applied the Core Area Zonation removal rule, which prioritizes the retention of grid cells with higher habitat suitability values.

To account for the wide-ranging and dispersal capabilities of snow leopards, a smoothing parameter of 30 km was applied during zoning to reduce habitat fragmentation (McCarthy et al., 2005). The edge removal option was selected to prioritize the removal of grid cells from habitat edges, thereby minimizing edge effects in conservation prioritization (Li et al., 2020). This process generated a continuous habitat quality ranking for each grid cell, with values ranging from 0 (lowest priority) to 1 (highest priority).

We plotted the 61 snow leopard density surveys against habitat ranking values and stratified them into three habitat quality classes: low-quality habitat (0.5–0.75), medium-quality habitat (0.75–0.9), and high-quality habitat (0.9–1) (Figure 2a). Given that surveys were largely absent in low-quality habitats (n=8), density extrapolation was restricted to medium- and high-quality habitats with rankings ≥0.75. These two strata comprise 83.5% of the total predicted suitable snow leopard habitat (84.3% of Extant range, 82.6% of Possibly Extant range) (Figure 2b). We further tested alternative threshold values for separating medium- and high-quality habitats, and found minimal impacts on the final population estimates, as reported in Supplementary Results 4 (Table S5).

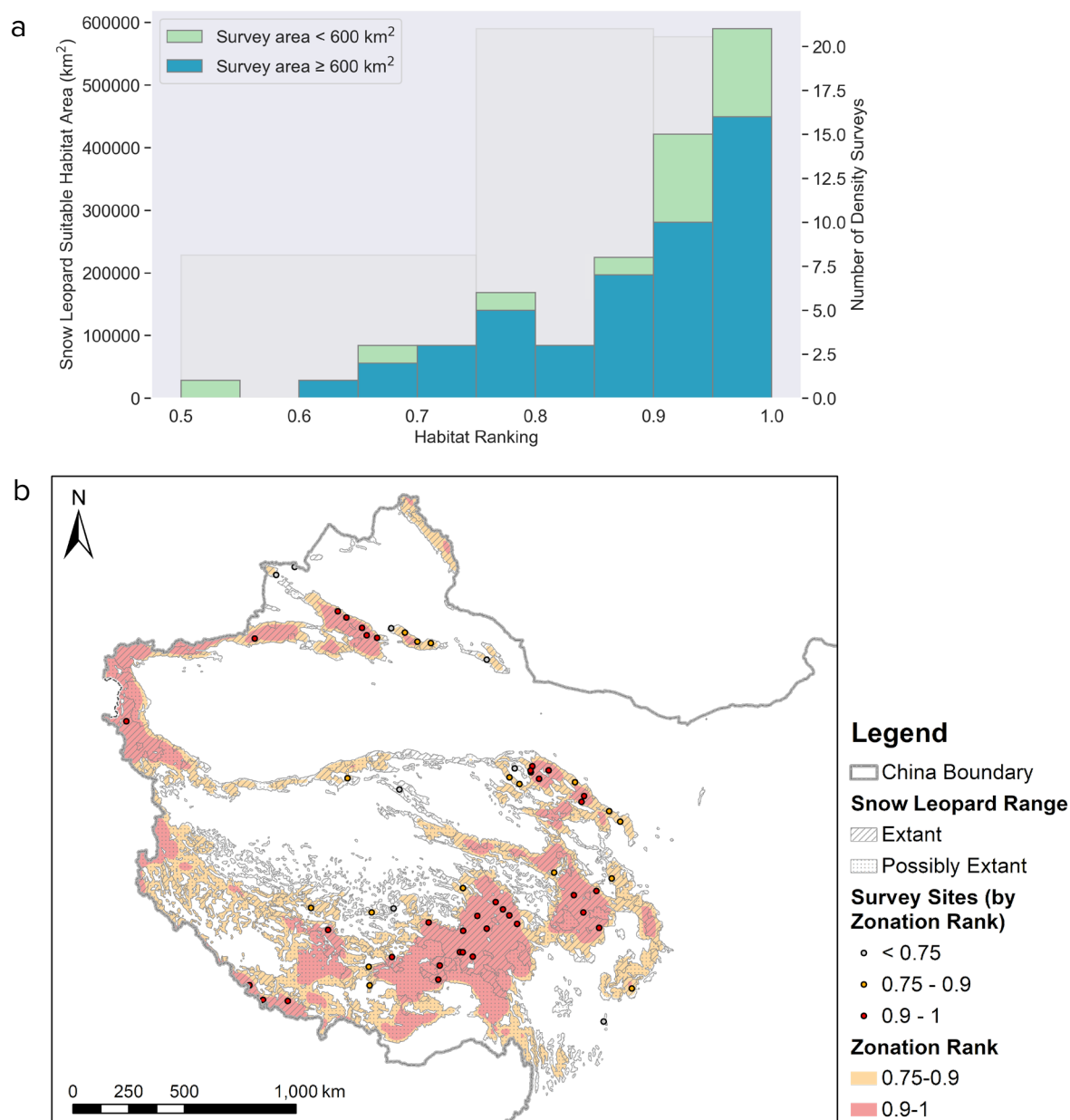


Figure 2. (a) Distribution of predicted snow leopard suitable habitat area along the MaxEnt-derived habitat quality ranking (primary y-axis; grey bars) and the distribution of the 61 population density surveys across habitat ranking classes (secondary y-axis; blue and green bars). **2. (b)** Spatial distribution of the 61 snow leopard density survey sites overlaid on the habitat quality ranking map in snow leopard range.

We note that large areas of western Tibet and Xinjiang Autonomous Region remain unsurveyed. Surveys are also comparatively scarce in lower-ranked habitats, indicating that survey efforts to date have been concentrated in higher-quality snow leopard habitats.

2.1.3 Primary population estimation based on habitat stratification

We first examined the relationship between habitat ranking values and snow leopard density estimates and found a generally positive association (Spearman's $\rho = 0.336$, $p = 0.011$; Figure 3a). Based on this relationship, we calculated average estimates for each habitat quality stratum (Figure 3b).

These stratum-specific density estimates were extrapolated to the corresponding habitat strata within areas classified as 'Extant' in the updated IUCN snow leopard distribution map (Figure 1b) to derive the primary national population estimate (Figure 3c). By multiplying the mean density by the 'Extant' habitat area within each stratum, the total snow leopard population in China was estimated at 5,232 individuals (95% CI: 4,114–6,351) (Table 3). As extrapolation was limited to areas classified as 'Extant' and with habitat rankings ≥ 0.75 (84.3% of Extant range), consistent with IUCN Red List guidance on current occupancy, this estimate is considered conservative; inclusion of 'Possibly Extant' areas and regions with lower habitat rankings would likely increase the total.

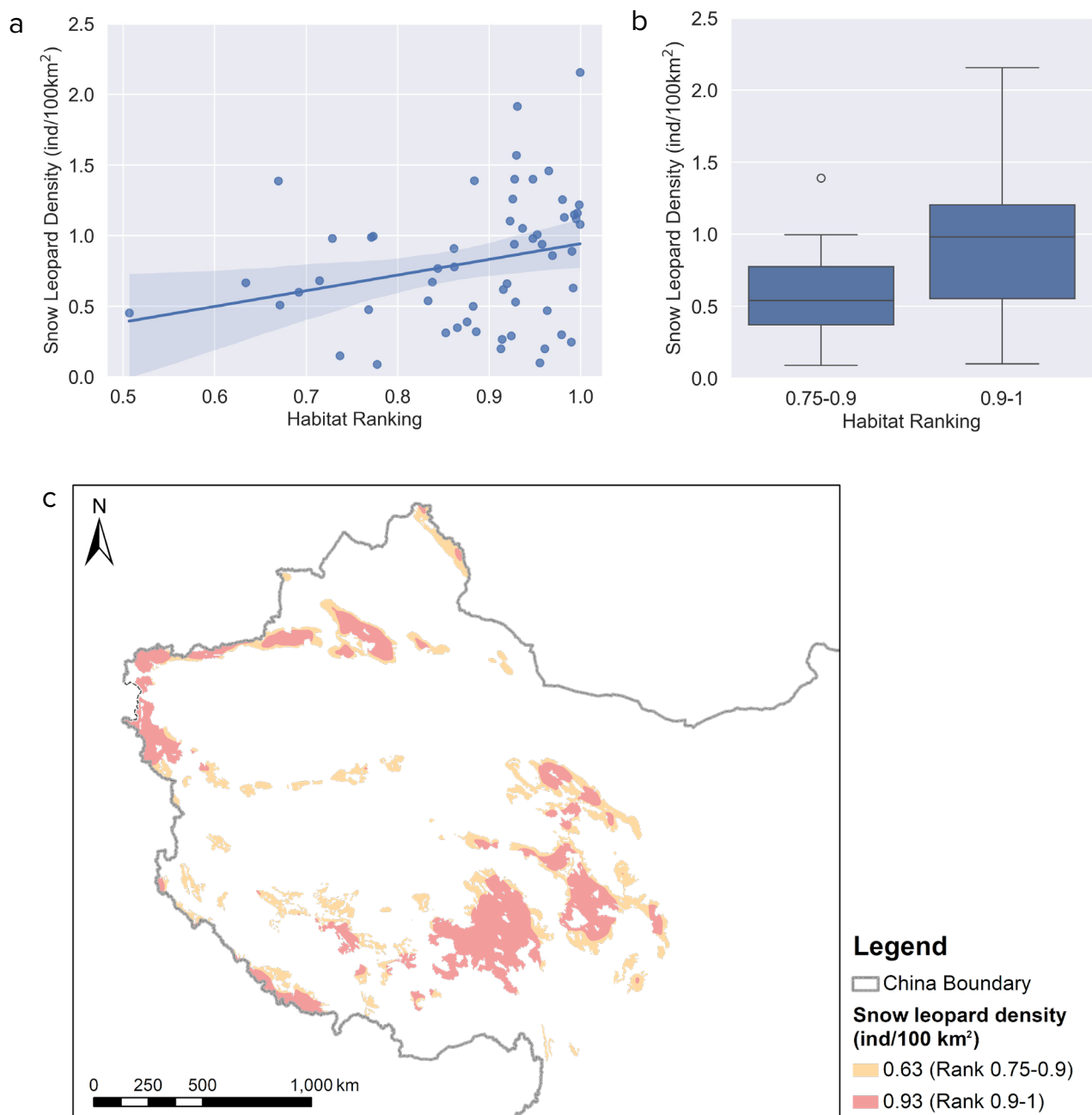


Figure 3. (a) Relationship between MaxEnt-derived habitat ranking values and snow leopard density estimates across surveyed sites. (b) Distribution of snow leopard density estimates within each habitat quality stratum, shown as boxplots indicating the median, interquartile range (IQR), and values within $1.5 \times \text{IQR}$. (c) Extrapolation of stratum-specific mean density estimates to areas classified as 'Extant' in the updated IUCN snow leopard distribution map to derive the primary national population estimate.

Table 3. Stratum-specific snow leopard density estimates (individuals per 100 km²) and extrapolated adult population estimates across the classified 'Extant' range in China. LCL and UCL denote the lower and upper bounds of the 95% confidence interval.

Rank Strata	Density (ind/100 km ²)	Total Area (km ²)	Abundance			
			Mean	SE	LCL	UCL
Medium (0.75–0.9)	0.63	291,085	1,840	257	1,337	2,344
High (0.9–1)	0.93	365,291	3,392	314	2,777	4,007
Total		656,376	5,232		4,114	6,351

Table 4. Provincial-level snow leopard adult population estimates across the ‘Extant’ range in China

Province	Population estimates (95% CI) across ‘Extant’ range
Qinghai	1,765 (1,401–2,129)
Xinjiang Autonomous Region	1,552 (1,217–1,887)
Tibet Autonomous Region	1,401 (1,106–1,696)
Gansu	280 (216–344)
Sichuan	220 (164–276)
Yunnan	14 (10–18)
Total	5,232 (4,114–6,351)

Provincial-level population estimates were derived using the same Extant range extrapolation approach, with stratum-specific density estimates scaled to ‘Extant’ habitat within each province (Table 4). Notably, by focusing on medium- and high-quality habitat only, this approach yields conservative population estimates and may exclude snow leopard populations in marginal range areas such as Ningxia and Inner Mongolia Autonomous Region.

2.1.4 Alternative population estimates and sources of uncertainty

To evaluate the sensitivity of the national population estimate to alternative spatial extrapolation assumptions, we applied two buffer-based extrapolation approaches based on the circular area of 1,000 km² (radius = 17.8 km).

This reflects upper-range estimates of snow leopard space use from GPS-collar studies (Yu et al., 2022; Shrestha et al., 2025; Subba et al., 2025). These approaches were used only for sensitivity analyses and not for the primary estimate. Unlike the primary estimate, which extrapolates across defined ‘Extant’ areas, these approaches restrict extrapolation to suitable habitat areas defined by occurrence records.

In the first approach, stratum-specific density estimates were extrapolated to suitable habitat within a 17.8 km buffer around individual snow leopard occurrence records (Figure 4a). In the second approach, density estimates were extrapolated to suitable habitat within a 17.8 km buffer around the minimum convex polygon (MCP) constructed from occurrence records within each mountain range (Figure 4b). This includes suitable habitat between occurrence points within each range and assumes connectivity within mountain ranges. These two approaches yielded population estimates of 3,037 individuals (95% CI: 2,399–3,675) and 5,308 individuals (95% CI: 4,173–6,443), respectively (Table 5).

Despite representing the most comprehensive national population assessment for snow leopards in China to date, several sources of uncertainty remain. Survey effort is unevenly distributed geographically and is concentrated primarily in higher-quality habitats, while large areas of western Tibet and Xinjiang Autonomous Region remain poorly surveyed. Consequently, density extrapolation may

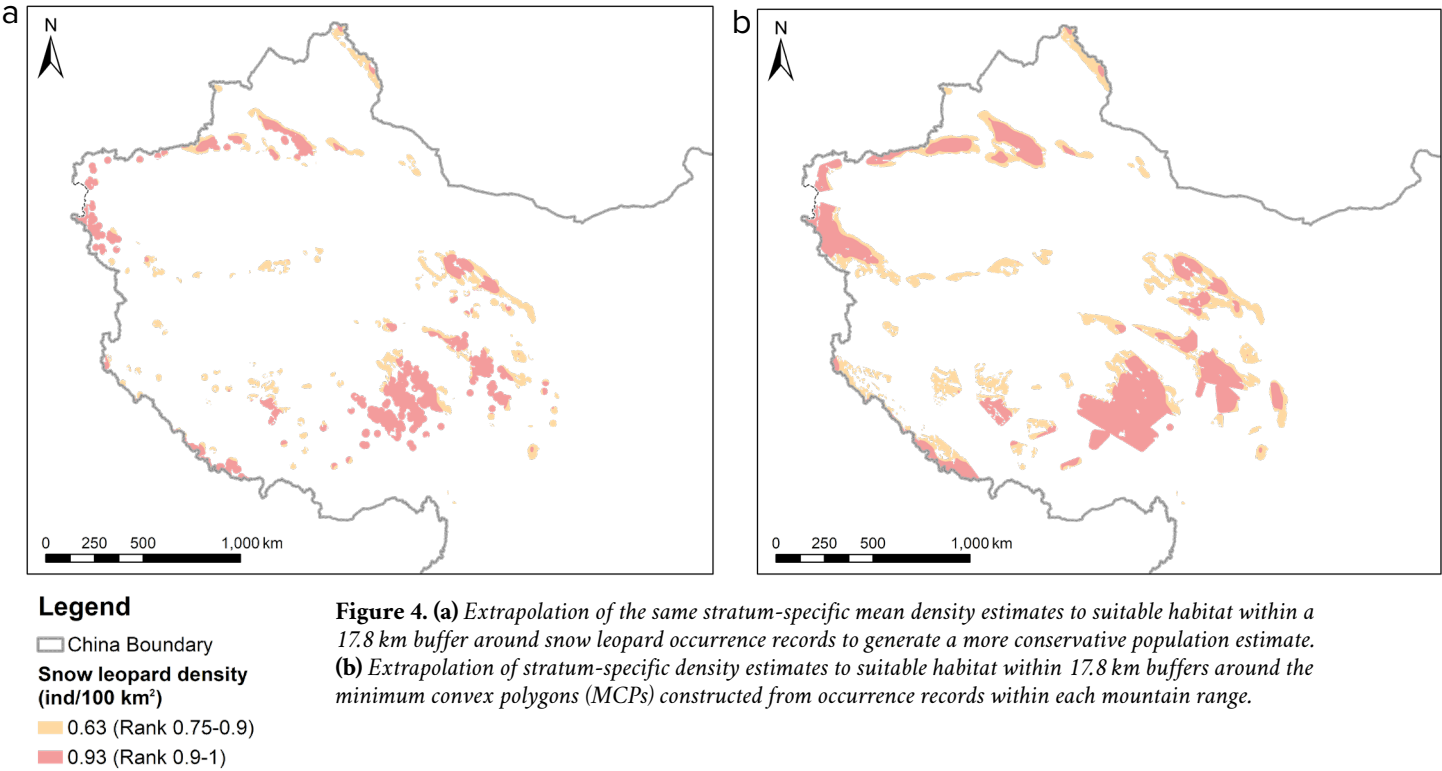


Table 5. Habitat-stratified snow leopard density estimates and extrapolated adult population sizes using buffer-based extrapolation approaches. LCL and UCL denote the lower and upper bounds of the 95% confidence interval.

Extrapolation method	Rank Strata	Density (ind/100 km ²)	Total Area (km ²)	Abundance			
				Mean	SE	LCL	UCL
a) 17.8 km buffer around occurrence records	Medium (0.75–0.9)	0.63	150,094	949	132	689	1,209
	High (0.9–1)	0.93	224,855	2,088	193	1,710	2,466
	Total		374,949	3,037		2,399	3,675
b) 17.8 km buffer around mountain range occurrence records MCPs	Medium (0.75–0.9)	0.63	296,904	1,877	262	1,364	2,391
	High (0.9–1)	0.93	369,475	3,431	317	2,809	4,052
	Total		666,380	5,308		4,173	6,443

be biased toward well-studied core habitats. In addition, extrapolation from site-level density estimates assumes that surveyed areas are representative of broader habitat strata, an assumption that may not hold consistently across China's ecologically heterogeneous snow leopard landscapes. The number and spatial distribution of available density estimates also remain limited, further contributing to uncertainty. Where sufficient data are available, developing province-level estimates would help address this variation by better capturing variation in density and survey coverage. Nevertheless, by integrating the best available empirical data and explicitly addressing known methodological biases, this framework provides a transparent and reproducible basis for national-scale population estimation that can be progressively refined as survey coverage expands.

We note that in contrast to PAWS approaches, which may extrapolate densities across all suitable habitat, the primary estimate presented here is restricted to areas classified as 'Extant'. This more conservative approach reflects current data limitations and aims to reduce uncertainty associated with extrapolating densities across large, heterogeneous, and under-sampled areas of China's snow leopard range. As survey coverage improves, future assessments may move toward broader extrapolation approaches where appropriate.

3. Threats

This review does not aim to provide a comprehensive reassessment of threats to snow leopards in China; a detailed and updated analysis is available in Shi et al. (2024). Snow leopard conservation in China is increasingly shaped by landscape-scale and systemic pressures rather than direct persecution. Rapid economic growth and land-use change in Central and Western China have intensified pressures

from overgrazing, infrastructure expansion, mining, and habitat degradation across much of the species' range (Chen et al., 2011; Alexander, 2015; Li et al., 2016a; Li et al., 2021). Prey depletion, driven by livestock competition, disease transmission, and free-ranging dog predation, has reduced prey availability and affected snow leopard populations (Li et al., 2019). Large transport and extractive projects in the Tibetan Plateau, Qilian Mountains, and Xinjiang Autonomous Region have introduced roads, noise, pollution, and permanent human presence into previously remote habitats. These developments reduce habitat connectivity and can alter prey distributions.

Climate change represents a pervasive and long-term threat that is likely to amplify existing pressures. Model projections suggest that substantial areas of suitable snow leopard habitat may be lost or fragmented due to upward treeline shifts, contraction of alpine zones, and changes in temperature and precipitation regimes (Forrest et al., 2012; Li et al., 2016a; Li et al., 2021). Climate-driven changes in vegetation structure and productivity are expected to affect wild prey and pastoral systems, causing a decrease in prey resources, with potential consequences for snow leopard distribution and human–wildlife interactions (Shen, 2020; Pörtner et al., 2022). Recent vulnerability assessments indicate that climate impacts may interact with expanding infrastructure and other human pressures, increasing risk in some snow leopard landscapes (Cong et al., 2025).

Policy and land-management interventions have also had unintended consequences for snow leopard conservation. In some regions, marmot and pika control programs implemented for plague prevention or grassland restoration have reduced prey availability (Alexander, 2015; Lambert et al., 2020). Extensive grassland fencing for pasture management has disrupted landscape connectivity, restricted wildlife movement, and caused direct mortality of wild ungulates (Tsering, 2009; Greenfield et al., 2021;

Zahler and Victurine, 2024). These impacts can indirectly affect snow leopards through reductions in prey abundance and mobility.

In contrast to these broad-scale pressures, threats from illegal hunting, trade, and retaliatory killing have declined in importance over recent decades. Strengthened legal protection, improved enforcement, and changing social norms have contributed to reduced levels of direct persecution (Li and Lu, 2014; Li et al., 2013; Hacker et al., 2020; Maheshwari and Niraj, 2018). In many regions, snow leopards account for a relatively small proportion of livestock losses compared to predators such as grey wolves (*Canis lupus*) or livestock disease. Studies indicate that local attitudes toward snow leopards are generally neutral or positive (Tang et al., 2023). The traditional medicinal use of snow leopard parts has largely ceased since the late 1990s (Li et al., 2013).

China contains more than 60% of the global snow leopard range, much of it remote and difficult to access. Research and conservation effort remain uneven and are concentrated largely within protected areas. Habitats outside protected areas, which may be important for dispersal and long-term population connectivity, receive less attention. Limited funding and conservation capacity at local levels further constrain effective threat mitigation in some regions.

4. Conservation

National conservation approaches for snow leopards in China have evolved rapidly over the past two decades. While detailed accounts are available elsewhere (Snow Leopard Network China, 2018; Shi et al., 2024), this section summarizes key policy, institutional, and community-based developments most relevant to current conservation status.

4.1 Policy frameworks and institutional context

Formal protection of snow leopards in China has been underpinned by a strong legal and policy framework. Snow leopards were designated as a Class I National Key Protected Species following the enactment of the *Law of the People's Republic of China on the Protection of Wildlife* in 1988, establishing the legal basis for strict protection (Li et al., 2013; Riordan and Shi, 2016). Subsequent policy reforms have increasingly emphasized ecosystem-level conservation rather than single-species management.

Since 2011, national policy has been strongly shaped by the concept of “ecological civilisation,” which has driven reforms in environmental governance and protected area management (Xu et al., 2017). A central outcome has been

the development of a National Park system intended to consolidate fragmented protected areas into larger, more coherent conservation landscapes.

4.2 Protected areas and landscape-scale conservation

Nature Reserves, as a category of protected areas, currently overlap with approximately 23% of the snow leopard range in China, a proportion higher than the global average of protected area overlap for snow leopards (Deguignet et al., 2014; Wang, 2022). Since 2017, the establishment of pilot National Parks, including Sanjiangyuan, Qilian, and Giant Panda National Parks, has significantly altered the spatial configuration of conservation areas within key snow leopard landscapes (Wang, 2022), and has further strengthened the scope and effectiveness of snow leopard conservation coverage.

The National Park system represents a shift toward landscape-scale conservation planning. This approach is particularly relevant for snow leopards, which require large, connected habitats and regularly move across administrative boundaries (Li et al., 2016b). By integrating previously separate reserves, National Parks aim to improve ecological connectivity and management consistency across snow leopard range areas.

4.3 Human–wildlife conflict and compensation mechanisms

Mitigating human–wildlife conflict has become a core component of snow leopard conservation policy in China. National legislation mandates compensation for damage caused by protected wildlife, with implementation led by provincial governments in collaboration with insurance providers (Chen et al., 2016). Provinces including Qinghai, Gansu, Tibet Autonomous Region, Sichuan, and Xinjiang Autonomous Region have established compensation schemes covering livestock losses attributed to snow leopards.

In parallel, locally managed compensation mechanisms have emerged as complementary approaches. In Zaduo County, Qinghai Province, a community co-managed fund established in 2016 allows herders to define compensation standards and verification procedures, increasing transparency and local acceptance (Xiao et al., 2019). Such community models complement government compensation frameworks, combining robust public funding with participatory local engagement.

4.4 Community-based Conservation

Given that snow leopard habitats in China largely overlap with diverse ethnic and pastoralist communities practicing nomadic lifestyles, community involvement is fundamental to effective conservation (Hacker et al., 2020). Successful

coexistence requires coordinated efforts among scientists, government officials, and local residents to address HWC and promote sustainable livelihoods.

Qinghai: Sanjiangyuan National Park and “Valley of the Cats”

Sanjiangyuan National Park, piloted in 2015, is a flagship example of community-based conservation. It was the first National Park in China to award a franchise for community-based tourism, the “Valley of the Cats” initiative in Zaduo County, launched in 2018. This project leverages the high snow leopard encounter rate to attract eco-tourism, generating over USD 350,000 in revenue by 2024, all retained within the community. The income supports host families, public welfare projects, and snow leopard conservation, providing alternative livelihoods that reduce pressure on natural resources.

Sanjiangyuan National Park has also invested heavily in capacity building, employing over 17,000 pastoralists in ecological stewardship. Training programs cover environmental policies, camera trap monitoring, anti-poaching patrols, and biodiversity conservation (Xiao et al., 2019). By mid-2019, 264 local rangers operated across nine monitoring sites, covering about 7,000 km², producing valuable data on snow leopard populations and ecosystem health (Jia et al., 2020).

Tibet Autonomous Region: Empowering Indigenous Conservationists

In Tibet Autonomous Region, a 2016 project in Shenja County trained six local wildlife stewards in wildlife monitoring techniques, including camera trapping and GPS use. These pastoralists, drawing on indigenous knowledge, became key contributors to a 2,000 km² monitoring network supporting the Changtang Nature Reserve (Bian et al., 2023). Their activities extended to wildlife rescue, patrols, awareness campaigns, and anti-predator measures, demonstrating the critical role of local people in conservation success.

Xinjiang Autonomous Region: Building Community Networks

With support from the East Tien Shan State Forest Administration and NGOs, Wild Xinjiang established monitoring stations and forest stewardship offices in 2016 as part of efforts to create the Urumqi River Snow Leopard Reserve. A community-based network of 20 pastoralist households was formed, fostering local understanding and support for snow leopard conservation. This initiative reduced poaching incidents and laid the groundwork for future National Park development.

4.5 Public Engagement and the Role of Digital Media

Recent conservation efforts have increasingly incorporated digital platforms and technological innovation. Notably, the snow leopard has become an iconic and widely popular species online, raising broad public interest in its conservation and associated ecosystems. Public engagement initiatives using online payment platforms, social media, and artificial intelligence have expanded awareness of snow leopard conservation and generated financial support for field activities. While not substitutes for long-term institutional investment, these approaches have broadened participation and visibility of snow leopard conservation beyond traditional stakeholders.

Awareness Raising Programs

Alipay’s “Ant Forest”: Launched in 2016, this mobile program incentivizes users to reduce carbon emissions by awarding “green energy points” convertible into donations for conservation projects, including snow leopard habitats. The program combines environmental education with gamification, engaging millions and promoting behavioral change.

WeChat Mini-Programs: In collaboration with WWF, Tencent developed interactive programs for International Snow Leopard Day in 2020, featuring games and educational content that simulate snow leopard monitoring activities and promote ecological knowledge.

JD.com AI Challenge: In 2019, JD.com hosted an innovation challenge to develop AI tools for individual snow leopard identification, highlighting the importance of data processing in conservation and attracting youth participation.

Tencent Public Welfare: SSCC 2018 fundraising campaign for Sanjiangyuan National Park raised USD 82,000 to support HWC mitigation and community training, using storytelling and camera trap images to engage donors.

Sina Weibo Campaigns: The 2019 “Safeguard Snow Leopard Habitat Action” campaign aimed to raise USD 300,000 for anti-poaching, monitoring, and compensation programs, leveraging the platform’s massive user base to boost public awareness.

Overall, snow leopard conservation in China has shifted from isolated, site-based interventions toward more integrated, landscape-scale and community-engaged approaches. Strong legal protection, expansion of National Parks, structured compensation mechanisms, and growing community participation have created a robust foundation for conservation. However, ensuring effective coordination

across regions, sustaining long-term funding, and integrating climate adaptation into conservation planning remain key challenges.

5. Acknowledgements

We acknowledge the long-term efforts of national and provincial agencies in China in advancing snow leopard conservation, research, and monitoring. We also thank Chinese research institutions, conservation organizations, and practitioners whose work informed this synthesis. We are grateful to Snow Leopard Network China for support to snow leopard research and conservation, and to the IUCN SSC Cat Specialist Group for supporting this country status report series and the associated assessment process. We thank Dr. Ian Durbach for reviewing the statistical analyses, and Dr. Justine Shanti Alexander for coordinating this special issue and overseeing the review process.

We thank all co-authors' teams for providing information and support for this analysis. We extend our gratitude to the authors of the published studies from which snow leopard distribution data were extracted to build the MaxEnt model. We acknowledge the many researchers and practitioners whose work over past decades has contributed to the broader body of snow leopard knowledge considered in this analysis, including Som Ale, Madhu Chetri, Shoaib Hameed, Bing He, Rodney Jackson, Diqiang Li, Xuchang Liang, Sandro Lovari, Ming Ma, Kyle McCarthy, Thomas M. McCarthy, Charu Mishra, Owen Nevin, Kristin Nowell, Mikhail Yurievich Paltsyn, Marco Salvatori, George B. Schaller, Diwakar Sharma, Koustubh Sharma, Uttam Babu Shrestha, Dazhao Song, Ashok Subedi, Byron Weckworth, Feng Xu, Xin Yang, Meng Yao, and Yuguang Zhang.

6. Conflicts of Interest

The authors declare no known conflicts of interest.

7. References

- Alexander, J. (2015). *Advancing research and conservation of snow leopards in the Qilianshan Mountains of China: Management and methodological implications*. PhD thesis, Beijing Forestry University, Beijing, China.
- Bayan Nur Urat Desert Nature Reserve (2025). Infrared camera captures state first-class protected animal snow leopard for the first time. WeChat Official Account.
- Bian, X., Liang, X., Weckworth, B., Jyal, D., Hull, V. and Yang, L. (2023). Spatial density estimate of the snow leopard (*Panthera uncia*) in the central Tibetan Plateau, China. *Integrative Zoology*, **18**, 677–687. <https://doi.org/10.1111/1749-4877.12672>
- Chen, H., Yin, K., Wang, H., Zhong, S., Wu, N., Shi, F., Zhu, D., Zhu, Q., Wang, W. and Ma, Z. (2011). Detecting one-hundred-year environmental changes in western China using seven-year repeat photography. *PLoS ONE*, **6**, e25008.
- Chen, P., Gao, Y., Lee, A.T., Cering, L., Shi, K. and Clark, S.G. (2016). Human–carnivore coexistence in Qomolangma (Mt. Everest) Nature Reserve, China: patterns and compensation. *Biological Conservation*, **197**, 18–26.
- Cong, W., Li, J., Zhang, Y., Huang, T., Gao, S., Yu, J., Zhang, Y., and Li, D. (2025). Snow Leopard habitat vulnerability assessment under climate change and connectivity corridor in Xinjiang Uygur autonomous region, China. *Scientific Reports*, **15**, 14583. <https://doi.org/10.1038/s41598-025-98909-w>
- Deguignet, M., Juffe-Bignoli, D., Harrison, J., MacSharry, B., Burgess, N.D. and Kingston, N. (2014). *2014 United Nations list of protected areas*. Cambridge: UNEP-WCMC.
- Forrest, J.L., Wikramanayake, E., Shrestha, R., Areendran, G., Gyeltshen, K., Maheshwari, A., Mazumdar, S., Naidoo, R., Thapa, G.J. and Thapa, K. (2012). Conservation and climate change: assessing the vulnerability of snow leopard habitat to treeline shift in the Himalaya. *Biological Conservation*, **150**, 129–135.
- GBIF.org. (2025). GBIF occurrence download (*Panthera uncia*) [Data set]. The Global Biodiversity Information Facility. <https://doi.org/10.15468/dl.5jarje>
- Greenfield, S.M., Norris, A.C., Lambert, J.P., Zhang, J., Ma, B., Deng, L., Sun, K. and Riordan, P. (2021). Ungulate mortality due to fencing and perceptions of pasture fences in part of the future Qilianshan National Park. *Journal of Resources and Ecology*, **12**, 99–109.
- Hacker, C.E., Janecka, J.E., Jackson, R.M., Li, D. and Zhang, Y. (2020). Pastoralism partnerships: recognizing the value of local involvement in China's snow leopard conservation efforts. *Sustainability*, **12**, 6491.
- Jia, D., Li, P., Zhao, X., Cheng, C., Xiao, L. and Lü, Z. (2020). Overview of the Sanjiangyuan community-based camera-trapping monitoring platform. *Biodiversity Science*, **28**, 1104–1109. <https://doi.org/10.17520/biods.2019322>
- Lambert, J.P., Geldard, R.P., Li, Y., Sun, K. and Riordan, P. (2020). Little evidence that plateau pika (*Ochotona curzoniae*) colonies influence habitat use by the Qinghai toad-headed agama (*Phrynocephalus vlangalii*). *Journal of Arid Environments*, **183**, 104263.
- Li, J. and Lu, Z. (2014). Snow leopard poaching and trade in China 2000–2013. *Biological Conservation*, **176**, 207–211.
- Li, J., McCarthy, T.M., Wang, H., Weckworth, B.V., Schaller, G.B., Mishra, C., Lu, Z. and Beissinger, S.R. (2016a). Climate refugia of snow leopards in High Asia. *Biological Conservation*, **203**, 188–196.
- Li, J., Wang, W., Axmacher, J.C., Zhang, Y. and Zhu, Y. (2016b). Streamlining China's protected areas. *Science*, **351**, 1160. <https://doi.org/10.1126/science.351.6278.1160-a>
- Li, J., Weckworth, B.V., McCarthy, T.M., Liang, X., Liu, Y., Xing, R., Li, D., Zhang, Y., Xue, Y., Jackson, R., Xiao, L., Cheng, C., Li, S., Xu, F., Ma, M., Yang, X., Diao, K., Gao, Y., Song, D., Nowell, K., He, B., Li, Y., McCarthy, K., Paltsyn, M.Y., Sharma, K., Mishra, C., Schaller, G.B., Lu, Z. and Beissinger, S.R. (2020). Defining priorities for global snow leopard conservation landscapes. *Biological Conservation*, **241**, 108387.
- Li, J., Xue, Y., Hacker, C.E., Zhang, Y., Li, Y., Cong, W., Jin, L., Li, G., Wu, B., Li, D. and Zhang, Y. (2021). Projected impacts of climate change on snow leopard habitat in Qinghai Province, China. *Ecology and Evolution*, **11**, 17202–17218. <https://doi.org/10.1002/ece3.8358>

- Li, J., Yin, H., Wang, D., Jiagong, Z. and Lu, Z. (2013). Human–snow leopard conflicts in the Sanjiangyuan Region of the Tibetan Plateau. *Biological Conservation*, **166**, 118–123.
- Li, X., Wei, C., Chen, X., Jia, D., Li, P., Liang, S., Jikmed, A., Gao, Y., Zhao, X., Chu, M., Sharma, K., Alexander, J.S., Lu, Z. and Xiao, L. (2025). First large-scale assessment of snow leopard population in China using existing data from multiple organizations. *Biodiversity and Conservation*, **34**, 1039–1055. <https://doi.org/10.1007/s10531-024-03007-4>
- Li, X., Xiao, L., Liang, X., Cheng, C., Feng, C., Zhao, X., Liu, Y., Bian, X., He, B., Zhang, C., Alexander, J.S., Xing, R., Huang, Y., Jikmed, A., Xierannima, Song, D., Huang, Q., Peng, K., Yin, H., Lian, X., Yang, X., Li, S., Shi, X., Yang, C., Lu, Z. (2019). Ongoing threats and the current status of snow leopard conservation in China. *Biodiversity Science*, **27**, 932–942.
- Liang, M. (2023). *The distribution of the snow leopard in the face of climate change and potentially altered biotic interactions*. Master's thesis, Wageningen University & Research.
- Liu, Y., Li, X., Liang, X., Liu, Y., Chen, C., Li, J., Tang, P., Qi, H., Bian, X. and He, B. (2019). Where and how many? The status of snow leopard (*Panthera uncia*) density surveys and knowledge gaps in China. *Biodiversity Science*, **27**, 919–931.
- Maheshwari, A. and Niraj, S.K. (2018). Monitoring illegal trade in snow leopards: 2003–2014. *Global Ecology and Conservation*, **14**, e00387.
- McCarthy, T.M. and Chapron, G. (2003). *Snow leopard survival strategy*. Seattle: International Snow Leopard Trust.
- McCarthy, T.M., Fuller, T.K. and Munkhtsog, B. (2005). Movements and activities of snow leopards in southwestern Mongolia. *Biological Conservation*, **124**, 527–537. <https://doi.org/10.1016/j.biocon.2005.03.003>
- McCarthy, T., Mallon, D.P., Jackson, R., Zahler, P. and McCarthy, K. (2017). *Panthera uncia*. The IUCN Red List of Threatened Species 2017: e.T22732A50664030. <https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T22732A50664030.en>. Accessed on 18 April 2025.
- Pörtner, H.-O., Roberts, D.C., Tignor, M.M.B., Poloczanska, E.S., Minterbeck, K., Alegria, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A. and Rama, B. (eds.) (2022). *Climate Change 2022: Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the IPCC. Cambridge: Cambridge University Press.
- Riordan, P. and Shi, K. (2016). China: current state of snow leopard conservation. In: McCarthy, T. and Mallon, D. (eds.) *Snow Leopards*. London: Elsevier, pp. 523–531.
- Rousseeuw, P.J. and Hubert, M. (2011). Robust statistics for outlier detection. *WIREs Data Mining and Knowledge Discovery*, **1**, 73–79.
- Shen, Q. (2020). The effects of climate change on snow leopards in the Hengduan Mountain region. *IOP Conference Series: Earth and Environmental Science*, **552**, 012002. <https://doi.org/10.1088/1755-1315/552/1/012002>
- Shi, K., Xiao, L., Atzeni, L., Lyu, Z., Liu, Y., Wang, J., Liang, X., Liu, Y., Zhao, X., Alexander, J.S., Weckworth, B., Lu, Z. and Riordan, P. (2024). Snow leopard status and conservation in China. In: Mallon, D. and McCarthy, T. (eds.) *Snow Leopards*, 2nd edn. London: Academic Press, pp. 577–601. <https://doi.org/10.1016/B978-0-323-85775-8.00021-2>
- Shrestha, P., Pandey, D., Sherpa, P., Shah, P., and Sharma, D. K. (2025). Tracking the Ghosts of the Himalayas: Snow Leopard Conservation Insights From Satellite Collar Data. *Ecology and Evolution*, **15**, e70802. <https://doi.org/10.1002/ece3.70802>
- Snow Leopard Network China (2018). *Snow leopard survey and conservation status in China*. Beijing.
- State Council News Office of the People's Republic of China (2024). “King of the Snow Mountains”, the snow leopard, makes its first appearance in Yunnan. *Xinhua Net*.
- Subba, S.A., Acharya, H.R., Shrestha, S., Koirala, S., Shrestha, R., Thapa, G.J., Thapa, K., Shrestha, A., Malla, S., Bhattarai, G.P., Poudyal, L.P., Khadka, M.B., Gurung, G.S., Bhatta, S.R., Dhakal, M., Subedi, N., Pradhan, N.M.B., Bhandari, A.R., Jnawali, S.R., Limbu, K.P., Dhakal, B.K. and Thapa, K. (2025). Lessons for transboundary snow leopard conservation: findings from a GPS telemetry study in Kangchenjunga Conservation Area, Nepal. *Integrative Conservation*, **4**, 45–56. <https://doi.org/10.1002/inc3.70008>
- Suryawanshi, K.R., Khanyari, M., Sharma, K., Lkhagvajav, P. and Mishra, C. (2019). Sampling bias in snow leopard population estimation studies. *Population Ecology*, **61**, 268–276.
- Tang, P., Suryawanshi, K.R., Xiao, L., Mishra, C., Lu, Z. and Alexander, J.S. (2023). Factors shaping the tolerance of local Tibetan herders toward snow leopards. *Journal for Nature Conservation*, **71**, 126305. <https://doi.org/10.1016/j.jnc.2022.126305>
- Tsering, D. (2009). Grassland privatization and fencing projects and their impacts on nature reserves and wildlife in the Changtang region of Tibet, China. *Tibetan Studies*, **3**, 85–93.
- Wang, J. (2022). *A multiscale assessment of snow leopard distribution, habitat use and landscape connectivity in a new national park in China*. PhD thesis, Manchester Metropolitan University.
- Xiao, L., Di, H., Cheng, C. and Liang, X. (2019). *Safeguard the Mountain Spirit: Conservation status of the snow leopard in China*. Beijing: Peking University Press.
- Xu, W., Xiao, Y., Zhang, J., Yang, W., Zhang, L., Hull, V., Wang, Z., Zheng, H., Liu, J., Polasky, S., Jiang, L., Xiao, Y., Shi, X., Rao, E., Lu, F., Wang, X., Daily, G.C. and Ouyang, Z. (2017). Strengthening protected areas for biodiversity and ecosystem services in China. *Proceedings of the National Academy of Sciences of the United States of America*, **114**, 1601–1606. <https://doi.org/10.1073/pnas.1620503114>
- Yang, L., Jin, H., Yang, Q., Poyarkov, A., Korablev, M., Rozhnov, V., Shao, J., Fu, Q., Hernandez-Blanco, J.A., Zhan, X., Yu, L., Alexandrov, D., Dai, Q., Munkhtsog, B., Du, X., Munkhtsog, B., Ma, L., Chen, W., Malykh, S., Jin, Y., He, S., Zhang, T., Wu, G., Shi, Y., Wei, F. and Hu, Y. (2025). Genomic evidence for low genetic diversity but purging of strong deleterious variants in snow leopards. *Genome Biology*, **26**, 94. <https://doi.org/10.1186/s13059-025-03555-0>
- Yu, C., Ding, N., Li, Y., Liu, Y., Lyu, Z., Munkhtsog, B., Wu, J., Ma, Z., Se, Y., Pei, W., Gao, Y., Zhang, Y., Han, Q., and Shi, K. (2022). Preliminary results from applying satellite-tracking on snow leopards for the first time in China. *Global Ecology and Conservation*, **40**, e02346. <https://doi.org/10.1016/j.gecco.2022.e02346>
- Yunnan Baima Snow Mountain National Nature Reserve Administration (2025). Yunnan again records wild images of snow leopards. Yunnan Forestry and Grassland Bureau.
- Zahler, P. and Victorine, R. (2024). Linear infrastructure and snow leopard conservation. In: Mallon, D. and McCarthy, T. (eds.) *Snow Leopards*, 2nd edn. London: Academic Press.



Snow Leopard (*Panthera uncia*) Status in China

Supplementary Materials

This supplementary material provides additional data and sources supporting the analyses presented in the main manuscript.

Tables

Table S1 lists the 66 snow leopard density surveys included in the population estimation analysis

Table S1. 66 snow leopard density surveys collected as final input data for the National Population Estimation

ID	Province	Survey Site	Year	Survey Method	Density Estimation Method	Survey Area
1	Qinghai	Sanjiangyuan - Angsai	2018–2019	CT	MS SECR	1,470
2	Qinghai	Sanjiangyuan - Diqing	2015	CT	MS SECR	818
3	Qinghai	Sanjiangyuan - Yunta	2015	CT	MS SECR	80
4	Qinghai	Sanjiangyuan - Nianbao Yuzhe	2020–2021	CT	MS SECR	30
5	Qinghai	Sanjiangyuan - Dongge Cuona Lake	2019–2020	CT	MS SECR	883
6	Qinghai	Sanjiangyuan - Qumalai	2018–2019	CT	MS SECR	1,375
7	Qinghai	Sanjiangyuan - Ganglong Township	2021	CT	MS SECR	862
8	Qinghai	Sanjiangyuan - Anme Machin	2021	CT	MS SECR	1,669
9	Qinghai	Sanjiangyuan - Hebei Township	2021	CT	MS SECR	624
10	Qinghai	Sanjiangyuan - Suojia	2020–2021	CT	MS SECR	643
11	Qinghai	Sanjiangyuan - Chengduo (CD0114)	2018–2019	CT	MS SECR	432
12	Qinghai	Sanjiangyuan - Chengduo (CD1530)	2018–2019	CT	MS SECR	519
13	Qinghai	Sanjiangyuan - Yage Valley	2014	CT	CE	40
14	Qinghai	Zhiyu Village, Gouli, Dulan County, Haixi Prefecture	2008	SS, IT	CE	1,900
15	Qinghai	Gouli region, Dulan County, Haixi Prefecture	2005–2007	CT	CE	300
16	Qinghai	Huangnan Prefecture	2023–2024	CT	SECR	1,150
17	Qinghai	Qilian Mountain National Park (QMNP) (Qinghai) (high density)	2017–2021	CT	MS SECR	6,100
18	Qinghai	QMNP (Qinghai) (medium density)	2017–2021	CT	MS SECR	
19	Qinghai	QMNP (Qinghai) - Youhulu	2020–2021	CT	SECR	400
20	Gansu	QMNP (Jiuquan) (high density)	2022–2023	CT	MS SECR	4,150
21	Gansu	QMNP (Jiuquan) (medium density)	2022–2023	CT	MS SECR	
22	Gansu	QMNP (Jiuquan) - Shulenanshan Mountain, Yanchiwan	2015–2016	CT	SECR	400
23	Gansu	QMNP (Zhangye) - Machang	2019	CT	SECR	650

ID	Province	Survey Site	Year	Survey Method	Density Estimation Method	Survey Area
24	Gansu	QMNP (Zhangye) - Qifeng	2013–2014	CT	SECR	375
25	Xinjiang	Bortala Alataw Mountain - Northern part	2023–2024	CT	SECR	425
26	Xinjiang	Bortala Alataw Mountain - Southern part	2023–2024	CT	SECR	575
27	Xinjiang	Western Tianshan Nature Reserve	2020–2021	CT	SECR	500
28	Xinjiang	Tianshan	2013–2015	PB	PB	1,643
29	Xinjiang	Tomur Nature Reserve	2020–2021	CT	SECR	1,000
30	Sichuan	Gongga Mountain	2016–2017	CT	CE	750
31	Tibet	Mayue Township, Shenzha County, Naqu	2018	CT	SECR	1,950
32	Tibet	Nima Township, Nima County, Naqu	2021–2023	CT	CE	770
33	Tibet	Deqing Township, Bange County, Naqu	2021–2023	CT	CE	320
34	Tibet	Baling Township, Shuanghu County, Naqu	2021–2023	CT	CE	603
35	Tibet	Maqu Township, Anduo County, Naqu	2021–2023	CT	CE	878
36	Tibet	Chadang Township, Nierong County, Naqu	2021–2023	CT	CE	543
37	Tibet	Gongri Township, Baqing County, Naqu	2021–2023	CT	CE	398
38	Tibet	Rongbu Township, Suo County, Naqu	2021–2023	CT	CE	404
39	Tibet	Niwu Township, Jiali County, Naqu	2021–2023	CT	CE	333
40	Tibet	Xiangmao Township, Seni County, Naqu	2021–2023	CT	CE	376
41	Tibet	Yangxiu Township, Biru County, Naqu	2021–2023	CT	CE	278
42	Tibet	Qomolangma National Nature Reserve (Dingriand Dingjie County)	2014–2020	CT	SECR	1,400
43	Tibet	Qomolangma National Nature Reserve (Nielamu County)	2014–2020	CT	SECR	525
44	Tibet	Qomolangma National Nature Reserve (Jilong Section)	2023–2024	CT	SECR	4,000
45	Tibet	Bujia Mountain (Dingqing County)	2020–2021	CT	SECR	1,275
46	Tibet	Dingqing County, Changdu	2021–2022	CT	CE	2,091
47	Tibet	Nailang Valley, Duilongdeqing District, Lhasa	2024	CT	SECR	54
48	Sichuan	Qionglai Mountains	2020	CT	SECR	1,600
49	Xinjiang	Altun Mountains - Altun	2024	CT	SECR	1,500
50	Xinjiang	Altun Mountains - Qiemo	2024	CT	SECR	1,500
51	Gansu	QMNP (Jiuquan) - Danghenanshan Mountain, Yanchiwan	2017-2018	CT	MS SECR	550
52	Gansu	QMNP (Jiuquan) - Yemananshan Mountain, Yanchiwan	2017	CT	MS SECR	625
53	Gansu	QMNP (Jiuquan) - Shulenanshan Mountain, Yanchiwan	2016-2017	CT	MS SECR	325
54	Gansu	QMNP (Zhangye) - Longchanghe	2018	CT	MS SECR	450
55	Gansu	QMNP (Zhangye) - Qifeng	2017	CT	MS SECR	450
56	Gansu	QMNP (Zhangye) - Sidalong	2017	CT	MS SECR	325
57	Xinjiang	Eastern Tianshan - Banfanggou	2022	CT	MS SECR	325
58	Xinjiang	Eastern Tianshan - Hami	2021-2022	CT	MS SECR	850
59	Xinjiang	Eastern Tianshan - Hutubi	2021-2022	CT	MS SECR	250
60	Xinjiang	Eastern Tianshan - Jimusaer	2021-2022	CT	MS SECR	350
61	Xinjiang	Eastern Tianshan - Mulei	2021-2022	CT	MS SECR	800

ID	Province	Survey Site	Year	Survey Method	Density Estimation Method	Survey Area
62	Xinjiang	Eastern Tianshan - Miquan	2021-2022	CT	MS SECR	275
63	Xinjiang	Eastern Tianshan - Qitai	2021-2022	CT	MS SECR	375
64	Xinjiang	Eastern Tianshan - Shawan	2021-2022	CT	MS SECR	150
65	Xinjiang	Eastern Tianshan - Urumqi Nanshan	2021-2022	CT	MS SECR	275
66	Xinjiang	Eastern Tianshan - Wusu	2019	CT	MS SECR	225

Note: For survey method, CT = Camera trapping, PB = Prey Biomass, SS = Sign Survey, IT = Interview. For density estimation method, MS SECR = Multi-Session SECR, PB = Prey Biomass, CE = Crude estimate of dividing number of snow leopard individuals by the survey area. For detailed data sources of each survey, please see data sources below.

To assess the influence of pre-2015 surveys, we performed population estimation without excluding these early datasets. Table S2 presents the average density of each stratum and the total estimated snow leopard population size across the ‘Extant’ range in China under the scenario retaining early survey data. The total population estimate is 7,259 when outliers are retained, and 6,023 when outliers are excluded.

Table S2. The density estimation in each stratum and the overall population estimate with early surveys retained.

Data Used (No. surveys)	Rank Strata	Density (ind/100 km ²)	Total Area (km ²)	Abundance			
				Mean	SE	LCL	UCL
All survey data (66)	Medium (0.75–0.9)	1.20	291,085	3,486	914	1,695	5,277
	High (0.9–1)	1.03	365,291	3,773	389	3,011	4,535
	Total		656,376	7,259		4,706	9,811
All survey data excluding outliers (64)	Medium (0.75–0.9)	0.77	291,085	2,251	376	1,514	2,987
	High (0.9–1)	1.03	365,291	3,773	389	3,011	4,535
	Total		656,376	6,023		4,525	7,522

To assess the effect of outliers, we conducted population estimation while retaining outlier density surveys. Table S3 summarizes the average density of each stratum and the overall population size estimation of snow leopards in China, which amounts to 6,585 (4,317–8,854).

Table S3. The density estimation in each stratum and the overall population estimate with outliers retained.

Data Used (No. surveys)	Rank Strata	Density (ind/100 km ²)	Total Area (km ²)	Abundance			
				Mean	SE	LCL	UCL
All survey data after 2015 (61)	Medium (0.75–0.9)	0.96	291,085	2,800	754	1,322	4,278
	High (0.9–1)	1.04	365,291	3,785	403	2,995	4,575
	Total		656,376	6,585		4,317	8,854

Among the 61 surveys included, 12 did not report density estimates. For these sites, we applied a crude density calculation as the number of adult snow leopard individuals divided by the reported survey area. To evaluate the influence of these crude density estimates, we additionally conducted a sensitivity analysis excluding the 12 surveys. This subset retained only surveys with SECR-derived density estimates and removed outliers via the interquartile range (IQR) method. Table S4 shows the average density of each stratum and the overall estimated snow leopard population size in China using only SECR-based survey data, which amounts to 5,196 (4,003–6,389), differing by only 0.7% from the main result.

Table S4. The density estimation in each stratum and the overall population estimate with crude density estimates excluded.

Data Used (No. surveys)	Rank Strata	Density (ind/100 km ²)	Total Area (km ²)	Abundance			
				Mean	SE	LCL	UCL
SECR density surveys, outliers excluded (45)	Medium (0.75–0.9)	0.61	291,085	1,763	291	1,193	2,332
	High (0.9–1)	0.94	365,291	3,434	318	2,811	4,057
	Total		656,376	5,196		4,003	6,389

We also assessed the sensitivity of population estimates to the classification thresholds for medium and high habitat quality strata, varying them from 0.8 to 0.95 in increments of 0.05. This analysis yielded estimates ranging from 5,232 to 5,433 (Table S5), representing a variation of less than 3.8%.

Table S5. The density and population estimation using different stratum threshold.

Threshold used		0.8	0.85	0.9	0.95
Area (km ²)	Medium stratum	91,736	160,270	291,086	455,008
	High stratum	564,640	496,106	365,291	201,369
Density (ind/100 km ²)	Medium stratum	0.64	0.65	0.63	0.79
	High stratum	0.86	0.87	0.93	0.91
Population estimate		5,416	5,352	5,232	5,433

Figures

Complementing Table S2, Figure S1 presents descriptive distributions for the dataset including pre-2015 surveys. The relationship between habitat rank values and density estimates showed a generally positive trend, both when including outliers (Spearman’s $\rho = 0.194$, $p = 0.118$, Figure S1a) and excluding outliers (Spearman’s $\rho = 0.276$, $p = 0.027$, Figure S1c). Data distribution within each stratum is illustrated in Figure S1b (with outliers) and Figure S1d (without outliers).

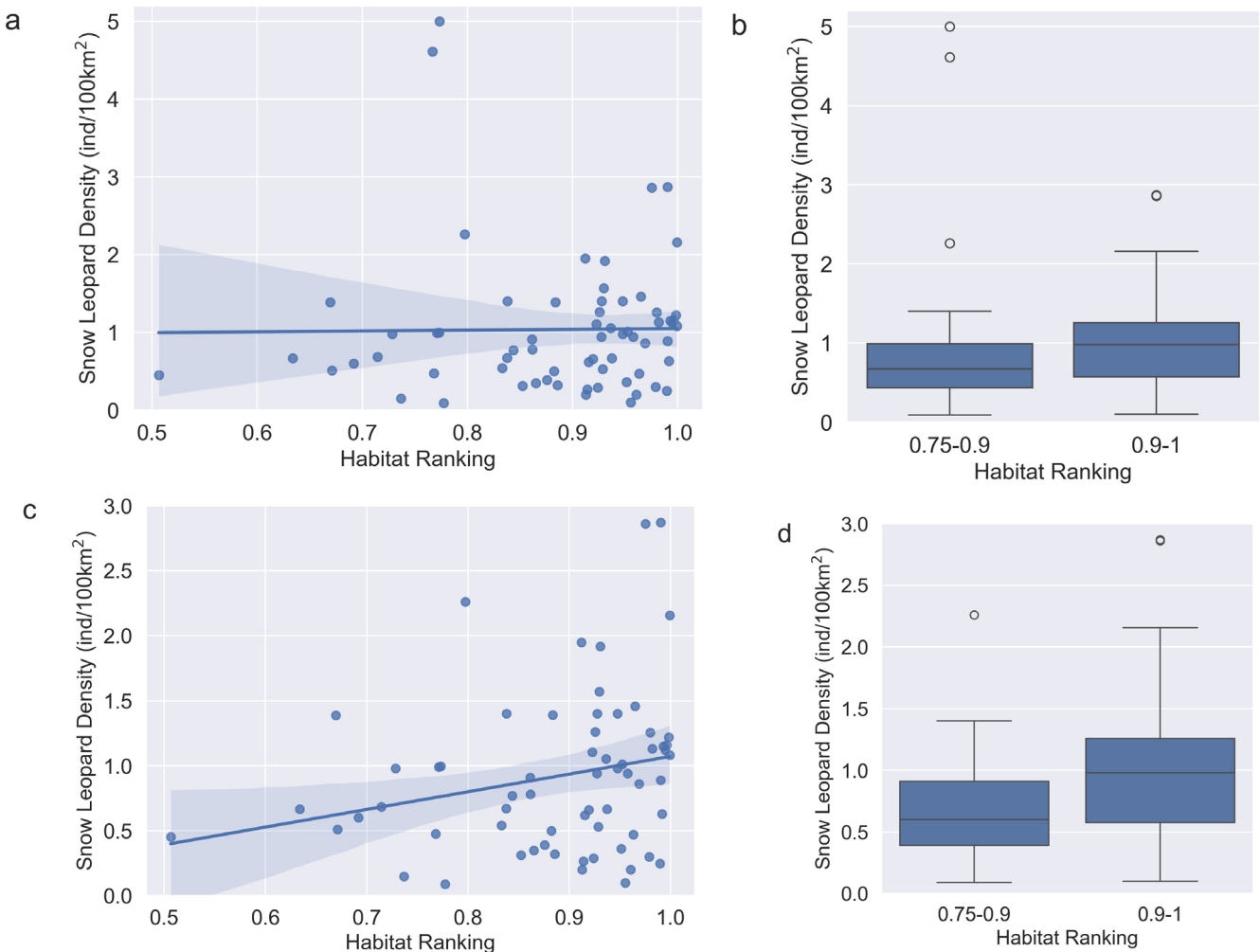


Figure S1. (a) (b) show the scenario including surveys before 2015 with outliers, while (c)-(d) show the scenario including surveys before 2015 without outliers. (a) and (c) depict the relationship between snow leopard habitat rank values and density estimates. (b) and (d) display boxplots showing the median (line), first and third quartiles (box), and range of typical data values within 1.5×IQR (whiskers) of density estimates within each habitat stratum.

Complementing Table S3, Figure S2 presents descriptive distributions for the dataset retaining outliers. The relationship between habitat rank values and density estimates exhibited a generally positive relationship (Spearman's $\rho = 0.289$, $p = 0.024$, Figure S2a). Figure S2b illustrates the data distribution within each stratum.

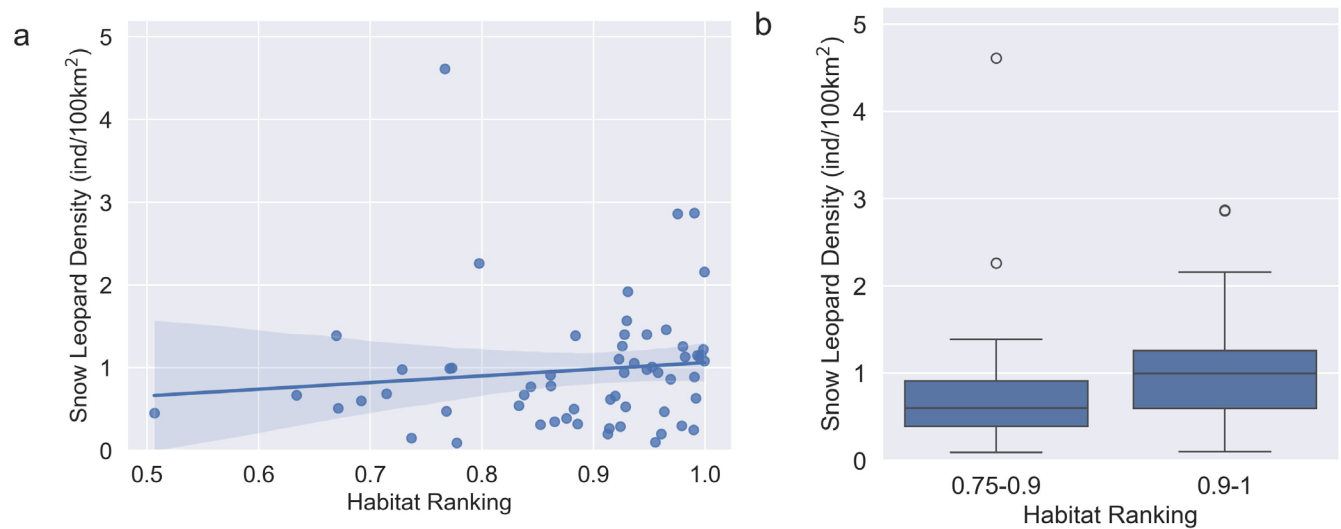


Figure S2. (a) (b) show the scenario with outliers retained.
(a) Relationship between snow leopard habitat rank values and density estimates.
(b) Boxplot showing the median (the line), the first and third quartiles (the box), and the range of typical data values within 1.5×IQR (the whiskers) of the density estimates within each habitat stratum.

Complementing Table S4, Figure S3 shows descriptive distributions for the dataset that excludes crude density estimates and the associated outliers. Habitat rank values and density estimates showed a significant positive correlation (Spearman's $\rho = 0.383$, $p = 0.009$; Figure S3a). Figure S3b illustrates the data distribution within each stratum.

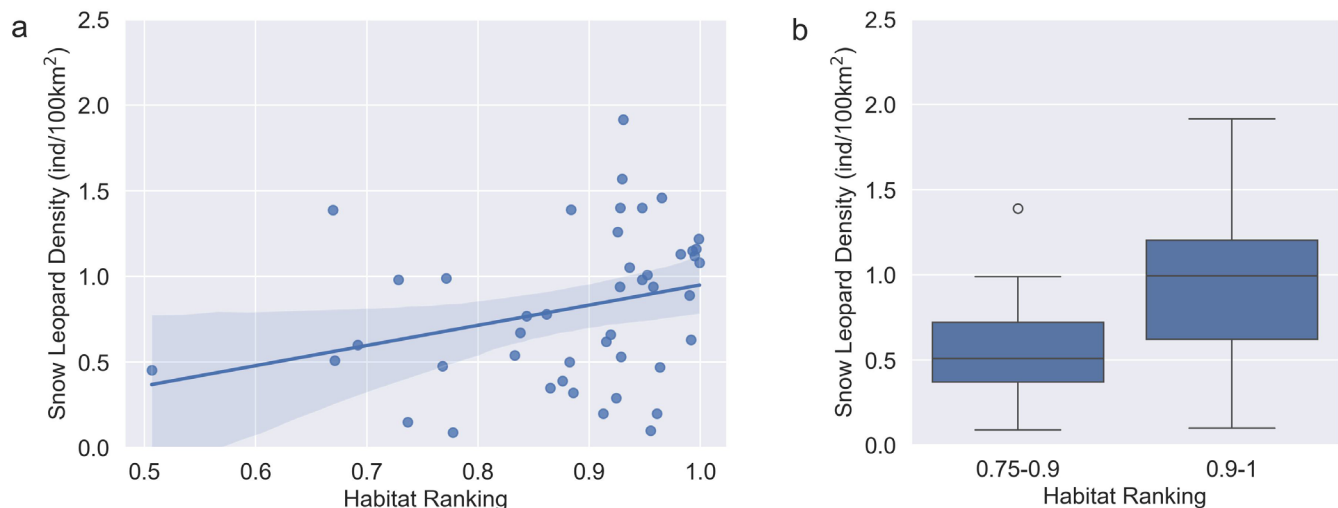


Figure S3 (a)-(b) show the scenario with crude density estimates excluded.
(a) Relationship between snow leopard habitat rank values and density estimates.
(b) Boxplot showing the median (the line), the first and third quartiles (the box), and the range of typical data values within 1.5×IQR (the whiskers) of the density estimates within each habitat stratum.

Data Sources

References for Table S1

- Li, X., Wei, C., Chen, X., Jia, D., Li, P., Liang, S., Jikmed, A., Gao, Y., Zhao, X., Chu, M., Sharma, K., Alexander, J. S., Lu, Z., & Xiao, L. (2025). First large-scale assessment of snow leopard population in China using existing data from multiple organizations. *Biodiversity and Conservation*, 34(3), 1039–1055. <https://doi.org/10.1007/s10531-024-03007-4>
- Zhang, L., Lian, X., & Yang, X. (2020). Population density of snow leopards (*Panthera uncia*) in the Yage Valley Region of the Sanjiangyuan National Park: Conservation implications and future directions. *Arctic, Antarctic, and Alpine Research*, 52(1), 541–550. <https://doi.org/10.1080/15230430.2020.1816341>
- Wu, G. (2009). Snow Leopard Preliminary investigation in zhiyueun dulan country of Qinghai province. *Journal of Animal Science and Veterinary Medicine*, 28(6), 33–34.
- Xu, A. (2007). Status, conservation and some ecological aspects of sympatric Tibetan brown bear and snow leopard on the Qinghai-Tibetan Plateau, China. [Doctoral dissertation, Northeast Normal University].
- Li, Y. (2022). Study on the environmental capacity, habitat assessment and climate change impact of Snow leopard (*Panthera uncia*) in Qilian-Mountain National Park. [Doctoral dissertation, Chinese Academy of Forestry].
- Wang, J. (2021). A multiscale assessment of snow leopard distribution, habitat-use and landscape connectivity in a new national park in China. [Doctoral dissertation, Manchester Metropolitan University].
- Zhang, C., Ma, T., & Ma, D. (2024). Status of the snow leopard *Panthera uncia* in the Qilian Mountains, Gansu Province, China. *Oryx*, 58(2), 255–260. <https://doi.org/10.1017/S0030605323000340>
- Alexander, J. S., Zhang, C., Shi, K., & Riordan, P. (2016). A granular view of a snow leopard population using camera traps in Central China. *Biological Conservation*, 197, 27–31. <https://doi.org/10.1016/j.biocon.2016.02.023>
- Wu, D., MaMing, R., Xu, G., Zhu, X., & Buzzard, P. J. (2015). Relationship between ibex and snow leopard about food chain and population density in Tian Shan. *Selevinia*, 516, 186–190.
- Bian, X., Liang, X., Weckworth, B., Jyal, D., Hull, V., & Yang, L. (2023). Spatial density estimate of the snow leopard, *Panthera uncia*, in the Central Tibetan Plateau, China. *Integrative Zoology*, 18(4), 677–687. <https://doi.org/10.1111/1749-4877.12672>
- Shi, X. (2023). The Status and Conservation of Snow Leopards (*Panthera uncia*) in Qionglai Mountains, Sichuan Province. [Doctoral dissertation, Peking University]
- Ding, N. (2023). Population assessment of snow leopards (*Panthera uncia*) in Qilianshan National Park and East-central Tianshan. [Master thesis, Beijing Forestry University].
- Yang, C. (2020). A study on the distribution of snow leopard (*Panthera uncia*) and the relationships with its sympatric species and livestock activities in the Gongga Mountain. [Doctoral dissertation, Sichuan University].

References for snow leopard occurrence points

- Ale, S. B., Thapa, K., Jackson, R., & Smith, J. L. D. (2010). The fate of snow leopards in and around Mt. Everest. *Cat News*, 53, 19–21.
- Ale, S. B., Shrestha, B., & Jackson, R. (2014). On the status of Snow Leopard *Panthera uncia* (Schreber, 1775) in Annapurna, Nepal. *Journal of Threatened Taxa*, 6(3), 5534–5543.
- Anwar, M. B., Jackson, R., Nadeem, M. S., Janečka, J. E., Hussain, S., Beg, M. A., Muhammad, G., & Qayyum, M. (2011). Food habits of the snow leopard *Panthera uncia* (Schreber, 1775) in Baltistan, Northern Pakistan. *European Journal of Wildlife Research*, 57(5), 1077–1083.
- Aryal, A., Shrestha, U. B., Ji, W., Ale, S. B., Shrestha, S., Ingty, T., Maraseni, T., Cockfield, G., & Raubenheimer, D. (2016). Predicting the distributions of predator (snow leopard) and prey (blue sheep) under climate change in the Himalaya. *Ecology and Evolution*, 6(12), 4065–4075.
- Atzeni, L., Cushman, S. A., Bai, D., Wang, J., Chen, P., Shi, K., & Riordan, P. (2020). Meta-replication, sampling bias, and multi-scale model selection: A case study on snow leopard (*Panthera uncia*) in western China. *Ecology and Evolution*, 10 (14), 7686–7712.
- Bai, D., Chen, P., Atzeni, L., Cering, L., Li, Q., & Shi, K. (2018). Assessment of habitat suitability of the snow leopard (*Panthera uncia*) in Qomolangma National Nature Reserve based on MaxEnt modeling. *Zoological Research*, 39(6), 373–386.
- Bai, H., Yin, L., Su, H., Gao, F., Mu, Y., Zhang, Y., Tong, Y., Xu, W., Cao, Q., Yang, W., & Xu, F. (2022). Monitoring bird and mammal resources in Xinjiang Tianshi Bogda Peak Nature Reserve using infrared cameras. *Arid Land Geography*, 45(3), 847–859.
- Bao, X., Wang, L., & Pei, P. (2022). First discovery of snow leopard traces in Anxi extreme arid desert nature reserve in Gansu. *Forest and Mankind*, 3, 86–89.
- Bian, X., Liang, X., Weckworth, B., Jyal, D., Hull, V. and Yang, L. (2023). Spatial density estimate of the snow leopard (*Panthera uncia*) in the central Tibetan Plateau, China. *Integrative Zoology*, 18, 677–687.
- Bocci, A., Lovari, S., Khan, M. Z., & Mori, E. (2017). Sympatric snow leopards and Tibetan wolves: Coexistence of large carnivores with human-driven potential competition. *European Journal of Wildlife Research*, 63(6), 92.
- Buzzard, P. J., MaMing, R., Turghan, M., Xiong, J., & Zhang, T. (2017). Presence of the snow leopard *Panthera uncia* confirmed at four sites in the Chinese Tianshan Mountains. *Oryx*, 51(4), 594–596.
- Chetri, M., Odden, M., & Wegge, P. (2017). Snow Leopard and Himalayan Wolf: Food Habits and Prey Selection in the Central Himalayas, Nepal. *PLOS ONE*, 12(2), e0170549.
- Chu, W., Jiang, Z., Li, K., Hu, D., Chen, G., Chu, H. (2020). The snow leopard in Altai Mountains, near the Sino-Mongolia border, and its conservation significance. *Biodiversity Science*, 28(4), 442–444.
- Cong, W., Li, J., Zhang, Y., Huang, T., Gao, S., Yu, J., Zhang, Y., & Li, D. (2025). Snow Leopard habitat vulnerability assessment under climate change and connectivity corridor in Xinjiang Uygur autonomous region, China. *Scientific Reports*, 15 (1).
- Cong, W., Zhang, Y., Huang, T., Li, J., Xu, J., Zhang, S., Li, H., Xue, Y., & Zhang, Y. (2024). Dietary composition and niche partitioning of sympatric carnivores in Altun Mountain National Nature Reserve. *Acta Theriologica Sinica*, 44 (6), 695–705.

- Convery, I., Baibagyssov, A., Baiturbayev, K., Deecke, V., Janyspayev, C., Velden, D., Smith, D., & Nevin, O. (2016). Fuzzy Logic modelling of Snow Leopard populations in response to threats from climate change.
- GBIF.org. (2025). GBIF occurrence download (*Panthera uncia*) [Data set]. The Global Biodiversity Information Facility. <https://doi.org/10.15468/dl.5jarje>
- Hameed, S., Din, J. U., Ali, H., Kabir, M., Younas, M., Ur Rehman, E., Bari, F., Hao, W., Bischof, R., & Nawaz, M. A. (2020). Identifying priority landscapes for conservation of snow leopards in Pakistan. *PLOS ONE*, 15(11), e0228832.
- Hou, X. (2022). Habitat assessment research of snow leopard in Menyuan area of Qilian Mountain National Park of Qinghai and surrounding counties. [Master's thesis, Beijing Forestry University].
- Ismaili, R. R. R., Peng, X., Li, Y., Ali, A., Ahmad, T., Rahman, A. U., Ahmad, S., & Shi, K. (2024). Modeling Habitat Suitability of Snow Leopards in Yanchiwan National Reserve, China. *Animals*, 14 (13), 1938.
- Jackson, R. M. (1996). Home range, movements and habitat use of snow leopard (*Uncia uncia*) in Nepal. [Doctoral dissertation].
- Janečka, J. E., Jackson, R., Yuquang, Z., Diqiang, L., Munkhtsog, B., Buckley-Beason, V., & Murphy, W. J. (2008). Population monitoring of snow leopards using noninvasive collection of scat samples: A pilot study. *Animal Conservation*, 11(5), 401–411.
- Jianhui, G., Yibin, L., Ruifen, W., Chenxing, Y., Jian, F., & Kun, S. (2023). MaxEnt Modeling for Predicting Suitable Habitats of Snow Leopard (*Panthera uncia*) in the Mid-Eastern Tianshan Mountains. *Journal of Resources and Ecology*, 14 (5).
- Karmacharya, D. B., Thapa, K., Shrestha, R., Dhakal, M., & Janečka, J. E. (2011). Noninvasive genetic population survey of snow leopards (*Panthera uncia*) in Kangchenjunga Conservation Area, Shey Phoksundo National Park and surrounding buffer zones of Nepal. *BMC Research Notes*, 4, 516.
- Li, F., Li, L., Wu, G., Yuan, L., Meng, C., Guo, H., Zhou, Y., Ma, C., Gao, Y., Xue, Y., Li, D., & Dai, Y. (2023). Habitat suitability assessment of *Panthera uncia* in Qilian Mountains of Qinghai based on MAXENT modeling. *Acta Ecologica Sinica*, 43 (6), 2202–2209.
- Li, J., McCarthy, T. M., Wang, H., Weckworth, B. V., Schaller, G. B., Mishra, C., Lu, Z., & Beissinger, S. R. (2016). Climate refugia of snow leopards in High Asia. *Biological Conservation*, 203, 188–196.
- Li, J., Weckworth, B. V., McCarthy, T. M., Liang, X., Liu, Y., Xing, R., Li, D., Zhang, Y., Xue, Y., Jackson, R., Xiao, L., Cheng, C., Li, S., Xu, F., Ma, M., Yang, X., Diao, K., Gao, Y., Song, D., Nowell, K., He, B., Li, Y., McCarthy, K., Paltsyn, M. Y., Sharma, K., Mishra, C., Schaller, G. B., Lu, Z. and Beissinger, S. R. (2020). Defining priorities for global snow leopard conservation landscapes. *Biological Conservation*, 241, 108387.
- Li, J. (2021). Study on diversity and activity rhythm of birds and mammals based on infrared camera trapping in sample areas of the upper reaches of Nujiang River, Tibet. [Master's thesis, Hunan Normal University].
- Li, J., Xue, Y., Hacker, C. E., Zhang, Y., Li, Y., Cong, W., Jin, L., Li, G., Wu, B., Li, D., & Zhang, Y. (2021). Projected impacts of climate change on snow leopard habitat in Qinghai Province, China. *Ecology and Evolution*, 11, 17202–17218.
- Li, S., Li, Y., Xiang, Y., Zhou, L., Wang, H., Bai, M., & Deng, S. (2024). Diversity and spatial and temporal distribution pattern of large and medium-sized mammals in the eastern Qinghai-Tibet Plateau. *Journal of Sichuan Forestry Science and Technology*, 45 (2), 48–62.
- Li, X., Wei, C., Chen, X., Jia, D., Li, P., Liang, S., Jikmed, A., Gao, Y., Zhao, X., Chu, M., Sharma, K., Alexander, J. S., Lu, Z. and Xiao, L. (2025). First large-scale assessment of snow leopard population in China using existing data from multiple organizations. *Biodiversity and Conservation*, 34, 1039–1055.
- Li, Y., Zhang, Y., Xue, Y., Zhang, Y., Zhang, Y., Gao, Y., & Li, D. (2022). Analysis of Conservation Gaps and Landscape Connectivity for Snow Leopard in Qilian Mountains of China. *Sustainability*, 14 (3), 1638.
- Liang, M. (2023). The distribution of the snow leopard in the face of climate change and potentially altered biotic interactions. Master's thesis, Wageningen University & Research.
- Liu, Y., Li, X., Liang, X., Liu, Y., Cheng, C., Li, J., Tang, P., Qi, H., Bian, X., He, B., Xing, R., Li, S., Shi, X., Yang, C., Xue, Y., Lian, X., A. W., Xie, R., Song, D., ... Lv, Z. (2019). Where and How many? The status of snow leopard (*Panthera uncia*) density surveys and knowledge gaps in China. *Biodiversity Science*, 27 (9), 919–931.
- Lu, Q., Hu, Q., Shi, X., Jin, S., Li, S., & Yao, M. (2019). Metabarcoding diet analysis of snow leopards (*Panthera uncia*) in Wolong National Nature Reserve, Sichuan Province. *Biodiversity Science*, 27, 960–969.
- Ma, B., Pan, G., Li, L., Chen, Y., Li, Y., Liu, Y., Balik, J., Sun, S., & Shi, K. (2021). Preliminary study on habitat suitability of snow leopard (*Panthera uncia*) in central Tianshan Mountains. *Acta Theriologica Sinica*, 41(1), 1–10.
- Maheshwari, A., & Sharma, D. (2015). Snow leopard conservation in Uttarakhand and Himachal Pradesh, WWF India, New Delhi.
- McCarthy, K. P., Fuller, T. K., Ming, M., McCarthy, T. M., Waits, L., & Jumabaev, K. (2008). Assessing Estimators of Snow Leopard Abundance. *Journal of Wildlife Management*, 72(8), 1826–1833.
- McCarthy, T., Mallon, D., Sanderson, E. W., Zahler, P., & Fisher, K. (2016). What is a snow leopard? Biogeography and status overview. In *Snow leopards* (pp. 23–42).
- Meng, X., Yao, Y., & Yu, Q. (2024). Application of the maximum entropy model in snow leopard habitat conservation area planning. *Chinese Journal of Wildlife*, 11, 293–303.
- Qiao, J. (2022). Distribution and behavior of leopard (*Panthera pardus*), snow leopard (*Panthera uncia*) and gray wolf (*Canis lupus*) in Gongga Mountain, Sichuan Province. [Master's thesis, Sichuan Agricultural University].
- Rashid, W., Shi, J., Rahim, I. ur, Qasim, M., Baloch, M. N., Bohnett, E., Yang, F., Khan, I., & Ahmad, B. (2021). Modelling Potential Distribution of Snow Leopards in Pamir, Northern Pakistan: Implications for Human–Snow Leopard Conflicts. *Sustainability*, 13(23), 13229.
- Salvatori, M., Tenan, S., Oberosler, V., Augugliaro, C., Christe, P., Groff, C., Krofel, M., Zimmermann, F., & Rovero, F. (2021). Co-occurrence of snow leopard, wolf and Siberian ibex under livestock encroachment into protected areas across the Mongolian Altai. *Biological Conservation*, 261, 109294.
- Salvatori, M., Oberosler, V., Augugliaro, C., Krofel, M., & Rovero, F. (2022). Effects of free-ranging livestock on occurrence and interspecific interactions of a mammalian community. *Ecological Applications*, 32(7), e2644.
- Schaller, G. B. (2000). *Wildlife of the Tibetan steppe*. University of Chicago Press.

- Subba, S. A., Acharya, H. R., Shrestha, S., Koirala, S., Shrestha, R., Thapa, G. J., Thapa, K., Shrestha, A., Malla, S., Bhattarai, G. P., Poudyal, L. P., Khadka, M. B., Gurung, G. S., Bhatta, S. R., Dhakal, M., Subedi, N., Pradhan, N. M. B., Bhandari, A. R., Jnawali, S. R., ... Thapa, K. (2025). Lessons for Transboundary Snow Leopard Conservation: Findings From a GPS Telemetry Study in Kangchenjunga Conservation Area, Nepal. *Integrative Conservation*, 4 (1), 45–56.
- Wang, D., Chen, J., Yang, H., Luo, W., Li, B., Ai, L., & Xie, Q. (2025). First Documentation of Snow Leopard (*Panthera uncia*) Presence in the Core Area of Mt. Siguniang National Nature Reserve, China. *Integrative Conservation*, 4 (3), 272–276.
- Wang, D., Jiang, L., Lian, X., Liu, W., Zhao, C., Wu, Y., Zhou, Z., & A, D. (2021). New distribution record of snow leopard in Haidong City, Qinghai Province, China. *Journal of Zoology*, 56 (3), 478–480.
- Wang, D., Li, Q., Hou, L., Su, X., & Lian, X. (2024). Spatiotemporal overlap among snow leopard, bharal, and free-ranging livestock: Suggestions on mitigating human-snow leopard conflict. *Global Ecology and Conservation*, 53, e03029.
- Wang, D., Li, Q., Su, X., & Lian, X. (2025). Potential Risk of Heightened Human-Large Carnivore Conflicts Under Projected Future Climate Change Scenarios in the Sanjiangyuan Region, China. SSRN.
- Wang, J., Li, J., Hu, W., Tursun, R., Yuan, H., & Bao, X. (2025). A Survey of Bird and Mammal Diversity in Chagangliang Nature Reserve of Gansu Province. *Journal of Gansu Forestry Science and Technology*, 50(1), 83-90, 95.
- Wang, T., Ma, Y., Wu, H., He, Z., Hu, A., Gao, S., Zhang, Y., & Li, J. (2024). Activity patterns and spatial distribution of snow leopard (*Panthera uncia*) in eastern Altun Mountains. *Acta Theriologica Sinica*, 44(6), 729-737.
- Wang, X. (2024). Study on the Species of Large and Medium-Sized Mammals and Terrestrial Birds in the Yarlung Zangbo River Jiacha Gorge-Based on Infrared Camera Observation. [Master's Thesis, China West Normal University].
- Wang, Y., Tao, S., Chen, X., Kong, Y., Shah, A., Ye, C., & Pang, M. (2014). Using Infra-Red Camera Trapping Technology to Monitor Mammals along Karakorum Highway in Khunjerab National Park, Pakistan. *Pakistan Journal of Zoology*, 46, 725–731
- Wu, H., Ma, Y., Wang, T., He, Z., Wan, S., Xue, Y., & Li, J. (2024). Diversity of Mammals and Birds in the Water Sources of An'nanba Wild Camel National Nature Reserve in Gansu Province. *Forest and Grassland Resources Research*, 1, 48-55.
- Xia, X., Li, F., Fan, J., Li, Y., Gong, J., Wang, X., Rachel, B. L.-A., Liang, Y., Zhu, Y., & Shi, K. (2025). Potential Disturbance to Native Carnivore Community Caused by Stray Dogs in the Helan Mountains against the Background of Snow Leopard Reintroduction. *Journal of Resources and Ecology*, 16 (2).
- Xiao, C., Bai, D., Lambert, P. J., Li, Y., Laba, Z., Gong, Z., Riordan, P., & Shi, K. (2022). How Snow Leopards Share the Same Landscape with Tibetan Agro-pastoral Communities in the Chinese Himalayas. *Journal of Resources and Ecology*, 13(3), 483-500.
- Yang, C. (2020). A study on the distribution of snow leopard (*Panthera uncia*) and the relationships with its sympatric species and livestock activities in the Gongga Mountain. [Doctoral dissertation, Sichuan University].
- Yin, X. (2022). The diversity of mammals in the Miyaluo Nature Reserve, Sichuan province, China. [Master's thesis, Sichuan University].
- Yu, C. (2023). Research on Land Use Pattern Optimization in Qilian Mountains of Qinghai Province Based on the Perspective of Snow Leopard Habitat Network. [Master's thesis, Yunnan University of Finance and Economics].
- Zhang, G. (2024, June 7). What does it mean that snow leopards frequently appear in Xining. *Xining Evening News*, A3.
- Zhou, Y. Y., Feng, J. C., Duo, H. R., Yang, H. L., Li, J., Li, D. Q., & Zhang, Y. G. (2014). Population survey and genetic diversity of snow leopard (*Uncia uncia*) in Qinghai-Tibet Plateau as revealed by fecal DNA. *Acta Theriologica Sinica*, 34, 138–148.
- Zhu, G., Hu, D., Ma, D., Zhang, J., Wang, D., Zhang, G., A, C., Wang, L., Ma, C., Dai, Q., & Wang, Y. (2024). A Study of Snow Leopard *Panthera uncia* Habitat Corridors in Qilian Mountain National Park (Gansu Area). *Chinese Journal of Zoology*, 59 (4), 493–504.



Snow Leopard
REPORTS
<https://publicera.kb.se/slr>

Become a Snow Leopard Network Member:

VISIT <https://snowleopardnetwork.org/become-a-member/>

EMAIL US info@snowleopardnetwork.org