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SPECIAL ISSUE | THE STATUS OF SNOW LEOPARDS ACROSS HIGH ASIA

Snow Leopard (*Panthera uncia*) Status in Bhutan

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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

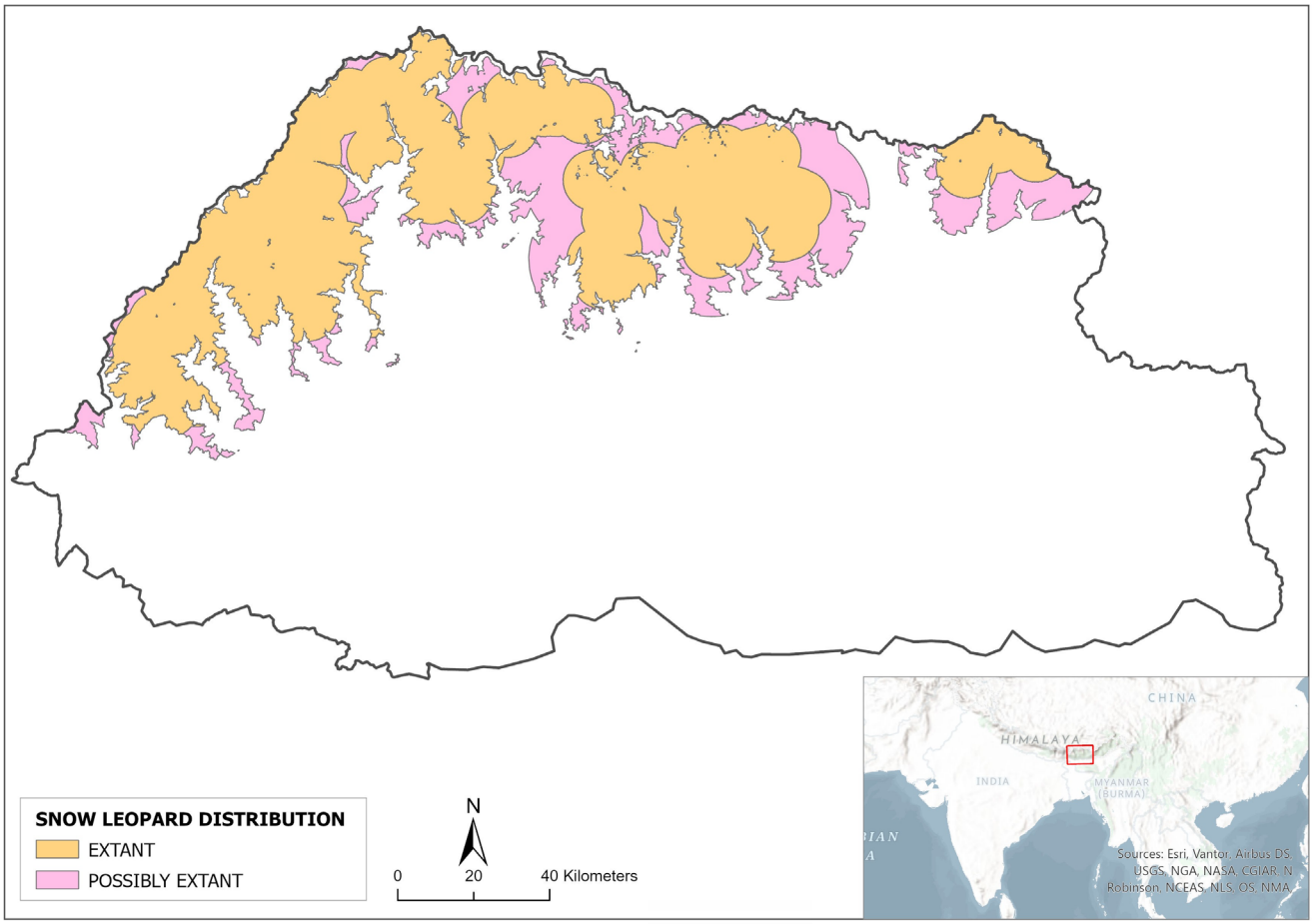

Figure 1. *Snow leopard distribution in Bhutan, showing areas classified as Extant and Possibly Extant based on recent confirmed occurrence data, habitat suitability, and spatial modelling following IUCN Red List mapping standards.*

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 ± 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 Miradi[1] principles conducted for developing an action plan for snow leopards in Bhutan (NCD, 2024)*

SI. 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.

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6. Conflict of Interest

The authors declare no known conflicts of interest.

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