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SPECIAL ISSUE | THE STATUS OF SNOW LEOPARDS ACROSS HIGH ASIA

Snow Leopard (*Panthera uncia*) Status in Pakistan

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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,

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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

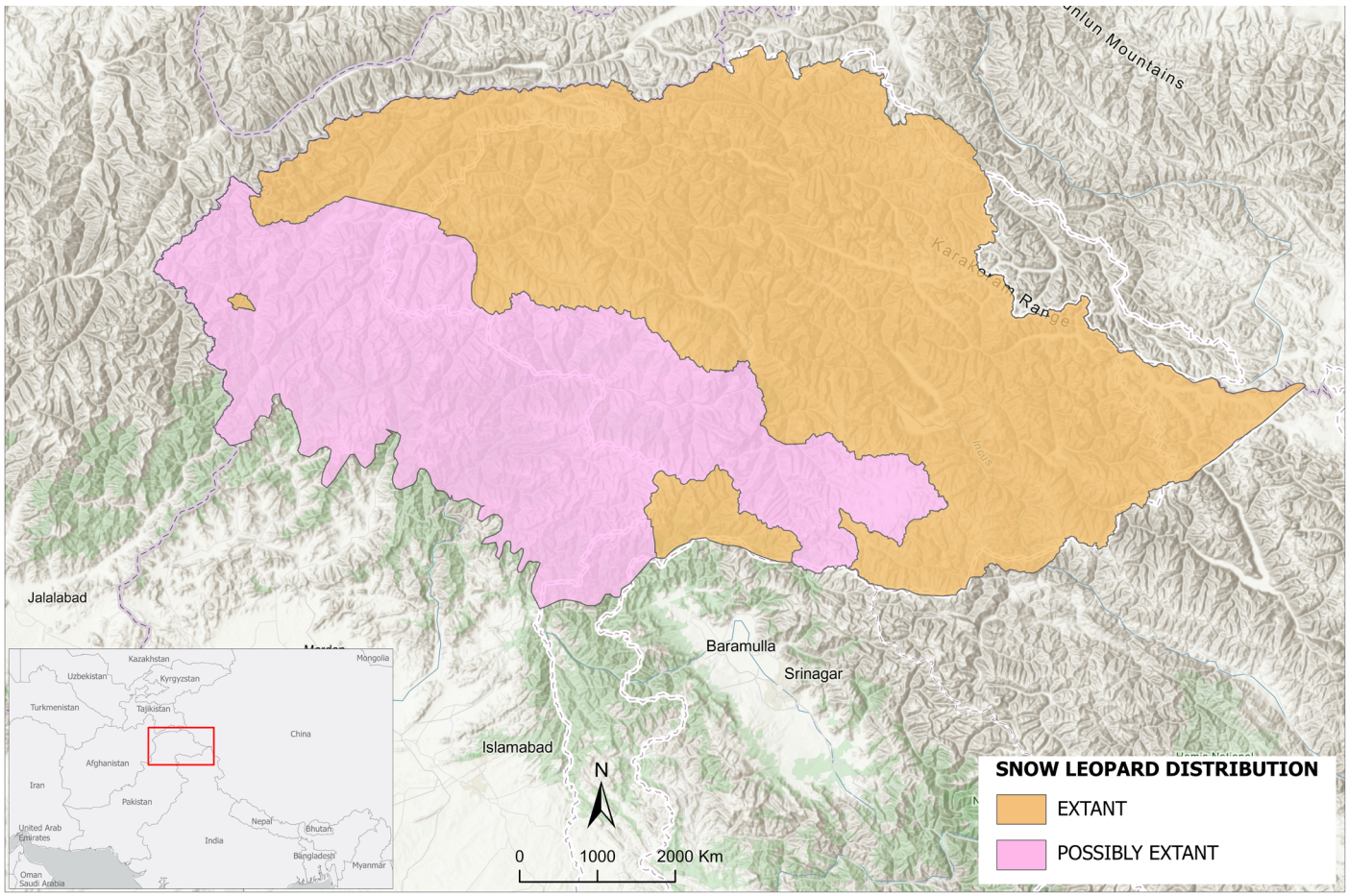

Figure 1: *Distribution of the snow leopard (Panthera uncia) in Pakistan. Orange areas indicate extant range, where the species is known or strongly inferred to occur. Pink areas indicate possibly extant range, where presence is uncertain but considered likely based on habitat suitability and proximity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

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6. Conflicts of Interest

The authors declare no known conflicts of interest.

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