Government of Nepal
Ministry of Forests and Environment

STATUS OF Snow Leopard POPULATION IN NEPAL 2025

Department of Forests and Soil Conservation

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Citations

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Date:-

Foreword

Nepal is one of the few countries that provides a sanctuary for the snow leopard, a species whose presence is vital to the health of high-altitude ecosystems. As a key indicator species, the snow leopard reflects the well-being of the mountainous landscapes that sustain both unique biodiversity and essential ecosystem services for over a billion people. However, snow leopards continue to face significant threats, including retaliatory killings, habitat degradation, wildlife trafficking, and the exacerbating effects of climate change.

This report presents the findings of a comprehensive evaluation of snow leopard abundance and density across Nepal's key landscapes, offering critical insights into their spatial distribution. The estimated total abundance of snow leopards in Nepal is approximately 397 individuals, with a mean density of 1.56 individuals per 100 km². These findings highlight the importance of Nepal's western, central, and eastern landscapes for snow leopard populations, with all three landscapes being significant for conservation efforts. The study emphasizes the need for targeted conservation measures to protect these crucial habitats.

The results are reliable and scientifically robust, with a relatively low level of uncertainty, though further refinements in survey methods and additional ecological variables could enhance future population assessments. The use of camera traps and genetic analyses will be essential in strengthening future population monitoring efforts and informing conservation strategies.
These findings provide crucial guidance for snow leopard conservation in Nepal and contribute to ongoing national and regional efforts to secure the long-term survival of this iconic species. The study reinforces the need for continued rigorous monitoring and informed conservation strategies.

I extend my deepest gratitude to the advisory, technical and task force team, National Park staff, conservation area, conservation partners such as WWF Nepal and NTNC, individual researchers, community-based citizen scientists, and local communities whose dedication and tireless efforts have made this study possible. Special thanks to the Department of National Parks and Wildlife Conservation and Department of Forests and Soil Conservation for their leadership and steering forward this important work. Additionally, I acknowledge the contributions of local government bodies and all stakeholders who are committed to the conservation of Nepal's snow leopards.

Kathmandu, Nepal
15 April 2025

Deepak Kumar Kharal, PhD
Secretary

Acknowledgement

Nepal is committed to conserve and secure snow leopard population across the country. Status of snow leopard population in Nepal has generated a reliable and robust baseline status of snow leopards and prey, to aid informed conservation. This gives us pride and encouragement to continue our tireless efforts to save this enigmatic species.

The survey was conducted by the Government of Nepal, DNPWC-DoFSC in partnership with World Wildlife Fund-Nepal and National Trust for Nature Conservation. We would like to thank the advisory team and Dr. Sindhu Dhungana, former Director General- DNPWC, Mr. Bed Kumar Dhakal, Deputy Director General- DNPWC, Mr. Shiv Raj Bhatta, Senior Advisor- Conservation Programs, WWF Nepal, Dr. Shant Raj Jnawali- Senior Advisor- Biodiversity Conservation, WWF Nepal and Dr. Kanchan Thapa- Deputy Conservation Program Director, WWF Nepal for their support and advice in making this study a success. We also extend our thanks to the technical team members for their technical advice and recommendation for the study to materialize and who coordinated the entire process of report preparation.

We would also like to thank technical support team who tirelessly worked in data compilation, analysis and report preparation. We express our sincere gratitude to GSLEP- Dr. Koustubh Sharma, International Coordinator and Dr. Ian Durbach- Senior Research Fellow, University of St. Andrews for the technical support and validating our findings. Many thanks to the data contributors- Mr. Naresh Kusi, Himalayan Wolf Project and others mentioned above for making this assessment scientifically robust and reliable. Sincere thanks to data compilers- Ms. Swostika Thapa and Mr. Shreejan Gautam for their outstanding contribution. Additionally, we would like to thank all protected area and division forest staff, hardworking community members of Snow Leopard Conservation Committees and user committees, buffer zone user committees and citizen scientists for their active role and participation in the survey.

We hope this technical report will be useful to the policy makers, protected areas and divisional forest managers, conservationists, academia, and general readers nationally and internationally. Finally, we reiterate our sincere thanks to every individual and institution who contributed to this success in estimating snow leopard population of Nepal.

Badri Raj Dhungana
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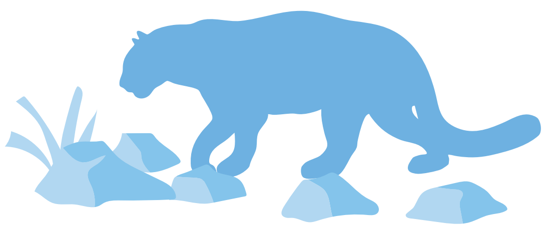
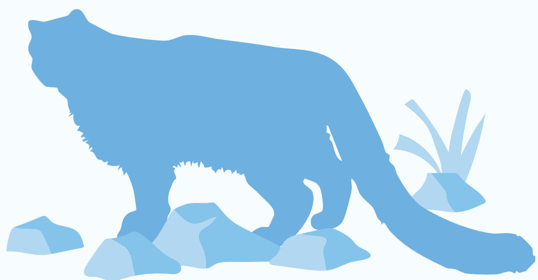


EXECUTIVE SUMMARY

The snow leopard (*Panthera uncia*), known as the "god of the mountains" by Nepal's mountain communities, is a key species representing the ecological health of high-altitude ecosystems throughout Central Asia and the Himalayas. Nepal plays a pivotal role in global snow leopard conservation, hosting 7-8% of the global population within just 1.6% of the species' range. As a key player, the country's ongoing efforts, supported by local communities and governmental initiatives, are essential for the long-term survival of the species. Notably, Nepal is integral to three of the 24 GSLEP priority landscapes, especially the Western Snow Leopard Conservation Landscape, which holds 60% of the national population. With a projected 40% loss of snow leopard habitat due to climate change, adaptive management strategies, such as the Snow Leopard Ecosystem Management Plan (SLEMP), are vital. With a global population estimated at 4,080 to 6,500 individuals, the species is classified as 'Vulnerable' by the IUCN, signaling a critical need for conservation efforts. In Nepal, an estimated 301–400 snow leopards reside in three major conservation landscapes—Eastern, Central, and Western—though nearly 42% of their habitat exists outside protected areas. However, estimation was conducted more than 15 years ago in 2008-2009 and Nepal lacks a reliable national estimate of snow leopard abundance and density based on standardized methods. This report presents a first comprehensive analysis of snow leopard abundance, density, and management strategies in Nepal's snow leopard landscapes, providing the most robust population estimates to date and offering critical insights into conservation efforts.

The study utilized a robust and comprehensive methodology to estimate snow leopard abundance and density in Nepal. The approach combined camera trapping, genetic surveys, in multi-session models, aligned with the GSLEP-PAWS guidelines, ensuring reliable population estimates. By incorporating advanced statistical tools, such as spatially explicit capture recapture models, the study addressed biases, resulting in a more reliable assessment compared to previous approaches. The study estimates Nepal's snow leopard population at 397 (95% CI: 331.11-475.60), with a density of 1.56 individuals per 100 km^2. The Western landscape holds the largest portion (60%) of Nepal's snow leopard population, with significant numbers in the Central and Eastern landscapes. The coefficient of variation (CV) for the top model was 9.3%, indicating relatively low uncertainty in the estimates. The integration of these diverse data sources and methods enhances the accuracy and scientific rigor of the findings, providing a strong foundation for future population monitoring and conservation planning in Nepal. The use of multi-session models overcomes limitations of previous methods, enhancing the accuracy of estimates and allowing for more reliable management decisions.

The national estimate provides the most robust evidence yet to the importance of Nepal to secure the future of the species, globally. These estimates are a testament to Nepal's conservation commitments, initiated traditionally through indigenous communities' faith, beliefs and values and sustained lately through leadership of key stakeholders – governments and communities. From a global perspective, strengthening conservation to address threats to snow leopards within Nepal, will help secure a significant proportion of the species' global population. Nepal is crucial for global snow leopard conservation, with nearly half of the population outside protected areas, the country's efforts—supported by local communities and the government—focus on habitat connectivity, transboundary cooperation with China, and addressing threats like human-wildlife conflict. Adaptive management strategies, such as the Snow Leopard Ecosystem Management Plan and the Snow Leopard Conservation Action Plan, along with infrastructure directives, are vital for balancing conservation goals with development in the face of climate change and increasing human-wildlife interactions.



1. INTRODUCTION

The snow leopard (*Panthera uncia*), revered as the "god of the mountains" by Nepal's mountain communities, is an iconic and charismatic species of the Himalayan Mountain ecosystems (Jackson et al., 2024). Spanning a vast yet fragmented range across Central Asia and the Himalayas, this elusive feline symbolizes the ecological health of high-altitude environments (Ripple et al., 2014). With an estimated global population of 4,080 to 6,500 individuals, the snow leopard underscores the fragile balance of these mountain landscapes (McCarthy et al., 2024). Classified as 'Vulnerable' by the International Union for Conservation of Nature (IUCN) and listed under Appendix I of the Convention on International Trade in Endangered Species (CITES), the snow leopard's conservation status signals an urgent need for protective measures (McCarthy et al., 2017). Additionally, climate change-induced shifts, such as declining snow cover and the upward migration of tree lines, are shrinking the species' habitat and increasing the likelihood of competition with other predators in the Himalayan region (Shen, 2020).

Nepal is home to an estimated 301–400 snow leopards in its northern Himalayan region, where the habitat is administratively divided into three snow leopard conservation landscapes: Eastern, Central, and Western (DNPWC and DoFSC, 2024). These landscapes encompass protected areas and significant habitats beyond formal conservation zones, with approximately 42% of Nepal's ~30,000 km² snow leopard habitat lying outside the protected area network (DNPWC and DoFSC, 2024). However, a reliable national estimate based on standard methods of snow leopard abundance and density is not available for Nepal.

Despite its status as one of the world's most iconic cats, the snow leopard remains one of the least studied, with limited data on its ecology, distribution, and population dynamics compared to tigers and lions (McCarthy et al., 2024). Challenges such as the species' elusive nature, low population densities, and vast territorial ranges complicate direct monitoring efforts(Belant et al., 2016). In Nepal, an estimated 301–400 snow leopards inhabit three key conservation landscapes—Eastern, Central, and Western—while approximately 42% of their habitat falls outside protected areas. However, this estimate is based on surveys conducted over 15 years ago (2008–2009), and Nepal currently lacks a reliable national assessment of snow leopard abundance and density using standardized methods (DNPWC, 2009). A robust population estimate of snow leopards is crucial for Nepal as it forms the foundation for effective conservation planning and policymaking (DNPWC and DoFSC, 2024). Reliable estimates allow for the assessment of population trends, enabling the identification of areas where the species is thriving or declining. This information is vital for allocating resources efficiently, prioritizing interventions, and designing targeted conservation strategies, such as habitat restoration or conflict mitigation. Moreover, snow leopards are not just ecological indicators of the health of Himalayan ecosystems but also hold significant cultural and economic value, particularly in the context of eco-tourism and community-based conservation programs. A well-founded population estimate also strengthens Nepal's international commitments to biodiversity conservation under frameworks like the Global Snow Leopard and Ecosystem Protection Program (GSLEP) and enhances its ability to advocate for transboundary conservation efforts. Without accurate population data, the effectiveness of ongoing conservation efforts risk being undermined, jeopardizing both the species and the integrity of the fragile mountain ecosystems they inhabit (Suryawanshi et al., 2019).

Recent technological advancements, including camera traps and genetic analysis of fecal samples, have provided valuable insights into snow leopard ecology, including their transboundary range, critical habitats, and dispersal corridors (Chetri et al., 2019; Shrestha and Kindlmann, 2020; Thapa et al., 2021). However, most studies focus on specific areas within Nepal's Himalayan range, underscoring the need for broader research across the country's snow leopard habitats to support comprehensive conservation strategies (SPNP, 2023; . This report provides first ever assessment of Nepal's snow leopard population status, distribution, and ecological dynamics, while outlining strategies to safeguard this remarkable species and its mountain ecosystem.

2. OBJECTIVE

The principal objective was to establish a reliable baseline population status of snow leopard in Nepal.

3. STUDY AREA

The snow leopard habitat in Nepal spans the northern belt of the country, including parts of the Himalayas and the Trans-Himalayan regions, stretched from Kangchenjunga Conservation Area (KCA), Taplejung district in the east to Api-Nampa Conservation Area (ANCA), Darchula district in the west covering 30,435.8 km2 (DNPWC and DoFSC, 2024). Their habitats extend both inside and outside of protected areas and are often connected through dispersal corridors. Of this around 58% (17,627 km2) falls inside protected areas, while nearly 42% falls outside (DNPWC and DoFSC, 2024) . In 2012, this entire snow leopard habitat in Nepal was administratively rearranged into three snow leopard landscapes: 1) Eastern landscape, 2) Central landscape, and 3) Western landscape (Figure 1; DNPWC, 2013). The three landscapes are distributed over 11 protected areas and 26 districts in 6 provinces.

These areas are characterized by steep terrain, rocky outcrops, and alpine vegetation, situated at elevations ranging from 3,000 to over 5,500 meters above sea level. Major habitat is characterized by cold climate and semi-arid to arid conditions, with temperatures often dropping below freezing, particularly during the winter months. Lower elevations, closer to the treeline, have a slightly milder but still temperate climate. Precipitation is primarily concentrated during the monsoon season (June to September) with snow during the winter (December to March), while the rest of the year remains relatively dry, especially in the Trans-Himalayan areas of Humla, Dolpa and Mustang (Mani, 1981). The extreme climatic conditions, coupled with seasonal variations, significantly influence vegetation patterns, wildlife behavior, and human livelihoods.

The habitat supports a sparse to moderate cover of grasslands, shrublands, and juniper bushes, interspersed with barren rocky landscapes (McCarthy et al., 2017). Vegetation types range from alpine grasslands and scrublands to coniferous forests at lower altitudes. Dominant plant species include rhododendrons (*Rhododendron spp.),* junipers (*Juniperus spp.*), and various alpine grasses (Caragana)

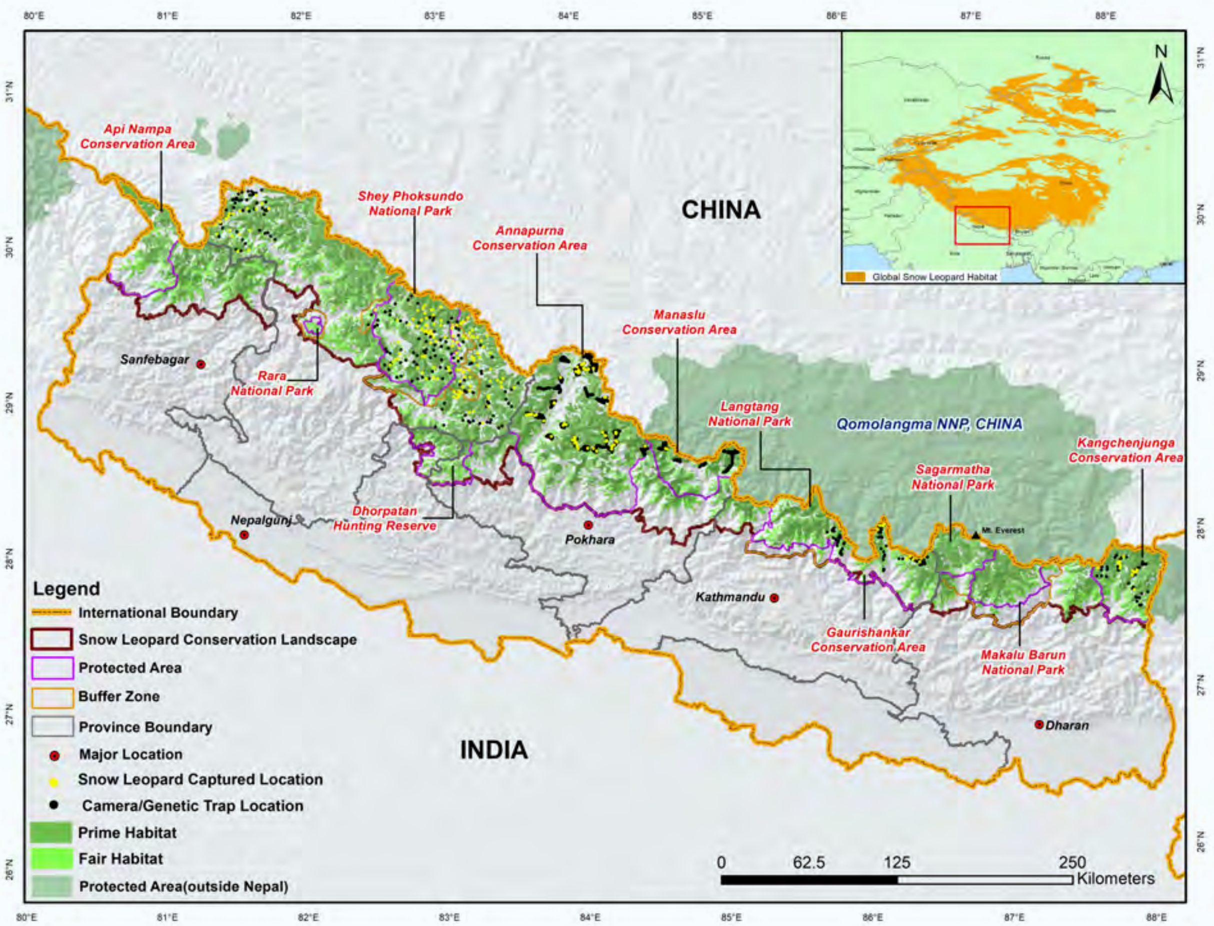


Figure 1: Snow leopard habitat in Nepal divided into three conservation landscapes spread over 11 protected areas in 6 provinces.

and herbs that sustain the region's herbivores. Medicinal plants such as *Cordyceps sinensis* and *Nardostachys jatamansi* also thrive in these areas, contributing to local economies and traditional medicine (Kunwar et al., 2013). Key prey species in these regions include blue sheep (*Pseudois nayaur*), Himalayan tahr (*Hemitragus jemlahicus*), and marmots (*Marmota spp.*; Shrestha et al., 2020). Co-predators such as the Himalayan wolf (*Canis lupus himalayensis*), Eurasian lynx (*Lynx lynx*), red fox (*Vulpes vulpes*), brown bear (*Ursus arctos*) and common leopard (*Panthera pardus*) share the habitat. Sporadic distribution of other species such as Tibetan fox (*Vulpes ferrilata*), Wild yak (*Bos mutus*), Kiang (*Equus kiang*), Tibetan gazelle (*Procapra picticaudata*), leopard cat (*Prionailurus bengalensis*), Pallas's cat (*Otocolobus manul*) and Argali (*Ovis ammon*) are also found. Lower altitude forest ungulates such as musk deer (*Moschus leucogaster*), mainland serow (*Capricornis sumatraensis*), and Himalayan ghoral (*Naemorhedus goral*) are occasional preys of snow leopards. Avian pheasant species including the Himalayan monal (*Lophophorus impejanus*), snow partridge (*Lerwa lerwa*), Tibetan partridge (*Perdix hodgsoniae*), chukar partridge (*Alectoris chukar*), Himalayan snowcock (*Tetraogallus himalayensis*), and Tibetan snowcock (*Tetraogallus tibetanus*) add to the supplementary diet of snow leopards (Acharya et al., 2011).

These high-altitude regions are also home to human communities, predominantly of Tibetan-origin ethnic groups such as the Sherpa, Tamang, Gurung and Dolpo. Their livelihoods largely depend on subsistence agriculture, livestock herding, and seasonal trade, with yaks and goats being key sources of income and sustenance (Aryal et al., 2016). Buddhism and sparsely Bon religion is practiced by the local communities in the north while Hindu religion dominates in the south. The primary source of income for the locals is agro-pastoralism with fairly widespread distribution of mountain tourism and trade. With the increasing advent of new roads in the north, livelihood options may change soon.

4. METHODS

4.1. Planning process

On May 10, 2024, under the leadership of Department of National Parks and Wildlife Conservation (DNPWC) and Department of Forests and Soil Conservation (DoFSC), supported by WWF Nepal a stocktaking workshop was organized in Dhulikhel. Representatives of GSLEP, WWF India, conservation partners- WWF Nepal, NTNC and ZSL Nepal and individual snow leopard researchers from Upper Karnali Landscape Initiatives (UKALI), Himalayan Wolves Project (HWP), Nepal Engineering College (NEC), Tribhuvan University (TU) and Czech Academy of Science (CAS) were present. The workshop focused on collating information on diverse population research being done on snow leopards and facilitate discussions on GSLEP-PAWS to generate national population baseline. All representatives unanimously agreed to come up with the national estimate of snow leopards in Nepal and demonstrated willingness to contribute the population data from different study areas conducted.

Subsequently, a Technical Task Force chaired by senior ecologist, DNPWC, comprising representatives of DNPWC and DoFSC, and wildlife biologists from WWF-Nepal and NTNC, and individual researchers from UKALI, HWP, TU and NEC were formed. The task force team, under the technical support by GSLEP, were responsible to collate and compile the population data, analyze and produce the report.

4.2. Data compilation

Data Framework and Individual identification

Combining data from multiple population studies across different areas to estimate a larger population using a multisession model in spatially explicit capture–recapture (SECR) is a recognized approach in ecological research (Efford, 2025a; Howe et al., 2022; Suryawanshi et al., 2021). This method allows for the integration of data from various sites to provide comprehensive population estimates of the larger spatial region (Suryawanshi et al., 2021). Population survey data of snow leopards were collected from 9 study regions across the Nepalese snow leopard habitat constituting 7 protected areas- Api Nampa Conservation Area, Shey-Phoksundo National Park, Annapurna Conservation Area, Manaslu Conservation Area, Langtang National Park, Gaurishankar Conservation Area and Kangchenjunga Conservation Area (Chetri et al., 2019; SPNP, 2023) and 2 outside protected areas- Humla-Limi valley (Lama unpublished) and Eastern Dolpa (DoFSC, 2024). Major surveys conducted were based on camera trap apart from ACA and MCA that were based on genetic scat survey (Table 1). Two surveys in ANCA and LNP were conducted on opportunistic scat collections. For camera trap study, survey design varied from 4x4 km2 to 8x8 km2 systematic grids while for genetic scat survey, surveys were conducted in interspaced 5x5 km2 grid sampling at 5-10 km intervals by conducting multiple transects of 0.2 to 6.2 km in length with average of 9.4 (SD ± 4.7) transects in the grids (Chetri et al., 2019).

Apart from studies conducted in Humla-Limi Valley (Lama unpublished; Kusi and Werhahn unpublished), GCA (NTNC unpublished; Koju unpublished), LNP and ANCA (DNPWC-WWF Nepal unpublished) all surveys were peer reviewed/government published studies/press released (Chetri et al., 2019; DNPWC, 2024; DoFSC, 2024; SPNP, 2023), data were directly compiled from the published datasets and spreadsheet were prepared as per the multisession model format. ANCA and LNP were excluded for the analysis due to very low detections (n= 1: ANCA and 2: LNP) and survey conducted opportunistically (unfit in multisession framework). For the former areas, multiyear and dual study datasets were available for Humla and GCA with partially overlapping areas. These data were further screened into individual tagging through triple blind observation process (DoFSC, 2024; Johansson et al., 2020; SPNP, 2023), and pooled into the dataset. Common individuals were also identified between the dual studies that had similar camera spacings, so as to increase the detections and range of snow leopard individuals. Sorting individual through sex wasn't conducted as accurately determining the sex of snow leopard individuals from camera trap images remains challenging due to their thick fur and unavailability of comprehensive body posture images which often lead to significant errors in population assessments (Johansson et al., 2020; Pereira et al., 2022; Royle et al., 2015).

For sites surveyed by camera traps, a maximum of 100 sampling days were selected to fit into the multisession model considering population closure (Bayandonoi et al., 2021; NCD, 2023; Suryawanshi et al., 2021). For Humla and GCA's multiyear datasets, selection was based on the survey period that had the maximum number of snow leopard individuals and their detections. Humla's survey period met within the 100 days sampling period, however for GCA the study areas varied high by space and time, therefore two survey sessions were designated to incorporate the space and number of snow leopard detections (Table 1).

For sites surveyed by genetic scat survey, each transect was discretized into 200-meter segments and treated the segment points as detectors and positive snow leopard ID located in the closest segment points was considered to be detected at those respective detectors (Efford, 2025; Pers. Comms. Dr. Ian Durbach). These study areas ACA-MCA were treated as one session like Chetri et al., (2019). A negligible temporal variation in detectability was assumed within each session, allowing all encounters to be aggregated into a single count (Efford, 2025a; MoEFCC, 2023).

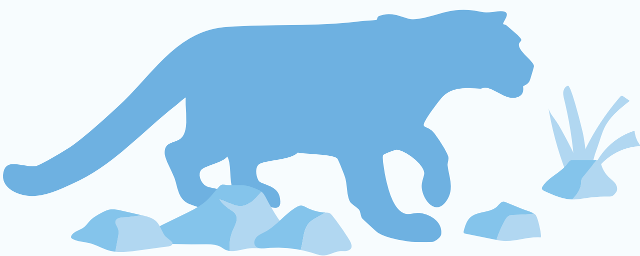
Table 1. Site wise details of data compiled used for the analysis from the collected raw datasets encompassing 7 study areas

SN	Study Area	Session	Survey Period	Snow Leopard Detections	Snow Leopard Individuals	Traps/ Detectors	Method	Snow Leopard Landscape	Prime Habitat Area (Survey Coverage %)*
1	Humla- Limi valley	1	Nov 2022-Feb 2023	70	16	75	Camera trap survey	Western	11,834 km² (44%)
2	Shey Phoksundo National Park	2	Nov 2019- Feb 2020	298	62	162			
3	Eastern Dolpa	3	May 2023- July 2023	79	24	65			
4	Annapurna Conservation Area and Manaslu Conservation Area	4	Nov 2013- Sept 2014	81	34	2373	Genetic scat survey	Central	4980 km² (57%)
5	Gaurishankar Conservation Area	5	Dec 2022- Feb 2023	8	5	67	Camera trap Survey	Eastern	4816 km² (22%)
6	Kangchenjunga Conservation Area	7	April 2024- June 2024	22	8	49			
I	Nepal			564	152	444 (Camera trap) & 2373 (Genetic)			21630 km² (43%)

* Prime snow leopard habitat was taken from DNPWC and DoFSC, (2024)

Selecting suitable covariates

The total area surveyed covered by the datasets was 43% (Table 1) of the total snow leopard habitat. Since multi-session framework enables the integration of data across multiple sessions and the estimation of model parameters are applicable to all sessions, extrapolation on non-surveyed areas requires suitable selection of ecologically meaningful covariates that influences snow leopard density depending upon the local environment. Based on the taskforce team with validation of GSLEP, covariates affecting topographical density (elevation, slope, ruggedness) and vegetation index (Normalized Difference Vegetation Index and distance to tree line) were used. For covariates influencing detection probability (lambda0) and movement (sigma), categorical covariates: study design “Design” and landscape “Landscape” were used. Observing the datasets and as per task force assessment, density in Nepal was influenced by the moderately distinct landscapes and vary by the study design that were adopted to collect the data. Furthermore, since merging genetic and camera trap data would produce unreal parameter estimates, these two were treated separately by fixing ‘genetic’ method as covariate in lambda0 and sigma (Pers. comms. Ian Durbach). Pearson correlation tests were conducted to assess potential multicollinearity among covariates(Efford, 2025b).



4.3. Data analysis: Snow leopard population abundance and density

Snow leopard density and population size were estimated using multi-session SECR models. All analyses were conducted using the SECR 3.2.1 package in R (Efford, 2025a). Spatial capture history matrix, a trap layout matrix, and a habitat mask excluding non-habitat areas were prepared as input files. A habitat mask was specified, with a buffer width of 20 km and a spacing of 1 km between mask points (fine enough to minimize the error of activity center estimation while remaining coarse enough to ensure computational efficiency), to create the state space around the trap locations. Preliminary analyses indicated that density estimates stabilized before this buffer distance and further increases in buffer width did not alter the estimates (Suryawanshi et al., 2021). Habitat mask points were provided with binary values indicating 1 as 'suitable' and 0 as 'unsuitable.' Mask points were considered suitable based on expert and field knowledge by selecting landcover: rangelands and barren (Karra et al. 2020), elevation upper limit of 5500 meters (Jackson et al., 2005;Jaxa/Meti, 2007) and treeline as lower limit using ArcGIS Pro (ESRI 2024). For abundance estimates of the country, masks of the combined three landscapes were used and for landscape wise estimates respected masks of the respective landscape boundaries were used.

Multiple models were run using combination of suitable covariates for the three parameters (Density, lambda0 and sigma) fixing 'genetic' as a covariate. Quadratic models of density influencing covariates were also used to have a more plausible influence over density (Pers. comms. Koustubh Sharma-GSLEP). All models were ranked based on Akaike's Information Criterion (AICc) models having delta AICc<2 (weightage >95%) to determine population estimates (Burnham and Anderson, 2002). Models were also assessed based on coefficient of variation (CV; %) to predict the bias in the estimate; models <20% are acceptable models having moderate uncertainty and standard precision (Efford and Mowat, 2014). The best-performing model was subsequently used to predict realized abundance and density for Nepal and the three landscapes.

5. RESULT

Total snow leopard individuals compiled from the selected seven sites were 152, highest in western landscape- 102 followed by central- 34 and eastern- 16. Multicollinearity was positive between all density influencing covariates ($P<0.05$) except ruggedness to elevation ($P= 0.17$) and NDVI ($P= 0.42$). Therefore, combination of correlated covariates to density were avoided while running multi session models and were run independently. The top-ranked model for snow leopard density had an AICc weight of 0.93 with highest influence of elevation over density function and combination of genetic and landscape over detection probability and movement (Table 3). All subsequent models had delta AICc >5. CV of the top model was 9.3 % (Table 3).

5.1. Nepal's Snow leopard population

The estimated abundance of snow leopards in Nepal was 397 (95% CI: 331.11- 475.60), (Table 2). The mean density of snow leopards in Nepal was estimated at 1.56 individuals per 100 km^2 (95% CI: 1.30–1.87; Table 2). Western landscape held the highest abundance (234.08; 95% CI: 196.10- 279.42) followed by central (89.42; 95% CI: 72.81- 109.82) and eastern (73.33; 95% CI: 61.41- 87.57) landscape (Figure 3; Table 2). The coefficient of variation of the parameters and covariates estimated encounter rate (lambda0) at activity centers and movement parameter (σ) per session is provided in Annex 2 and 3.

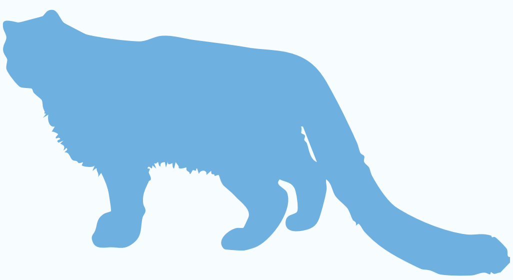


Table 2. Snow leopard population estimates in Nepal and landscapes, 2025.

Habitat	Model	E (N)	SE	95% Confidence interval
Nepal	D~std_elv + I(std_elv^2) lambda0~gen + land sigma~gen + land	**397**	**36.7**	**331-476**
Western		234	21.2	196-279
Central		90	9.4	73-110
Eastern		73	6.7	62-87

E(N): Expected Number which refers derived density to area; SE: Standard Error; covariates std_elv: standardized elevation, std_elv^2: square of elevation, combination of elv and elv^2 generates a quadratic function for covariates having bell shaped relation (increasing and decreasing at certain points) with density, genetic: method, land: landscape.

Table 3. Summary of Spatially Explicit Capture Recapture (SECR) models for population estimation of Nepal. Only the top five models are presented.

S.N.	Model	AICc	dAICc	AICcWT	CV (%)
1	D~std_elv + I(std_elv^2) lambda0~gen + land sigma~gen + land	3003.43	0	0.92	9.26
2	D~std_slp + I(std_slp^2) lambda0~gen + land sigma~gen + land	3008.77	5.34	0.06	9.09
3	D~std_ndvi + I(std_ndvi^2) lambda0~gen + land sigma~gen + land	3012.26	8.84	0.01	10.09
4	D~std_slp lambda0~gen + land sigma~gen + land	3016.09	12.66	0	9.24
5	D~std_elv lambda0~gen + land sigma~gen + land	3019.34	15.91	0	9.85

Model with covariates std: standardized, elv: elevation, elv^2: square of elevation slp: slope, slp^2: square of slope, ndvi: normalized difference vegetation index, ndvi^2: square of normalized difference vegetation index; AICc: Akaike's Information Criterion corrected; dAICc: delta AICc difference values between top model and respective model; AICcWT: Weightage of the model based on AICc values; CV: Coefficient of Variation expressed in percentage refers to the relative bias of the model in estimation.

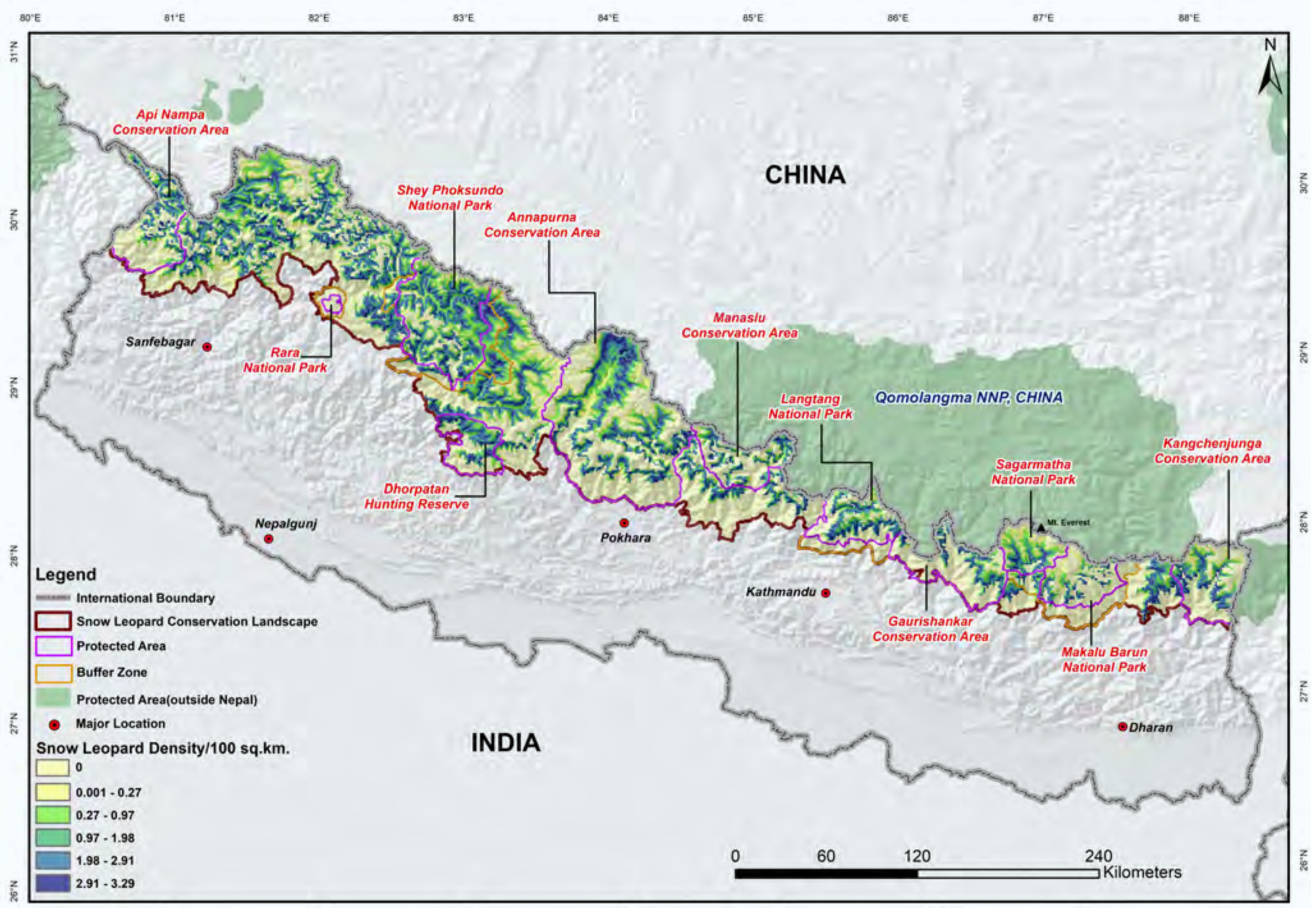


Figure 3. Surface density map of snow leopards in Nepal (scales denote density per 1 x 1 km² pixel).

6. DISCUSSION

6.1. Snow leopard population abundance and density

The present study offers a comprehensive assessment of snow leopard abundance and density in Nepal, encompassing key snow leopard landscapes. The total estimated abundance was 396.84 individuals (95% CI: 331.11–475.60), with a mean density of 1.56 individuals per 100 km² (95% CI: 1.30–1.87). The western landscape demonstrated the highest estimated abundance (234.08; 95% CI: 61.41–87.57), underscoring its critical role in conservation efforts. In contrast, the central and eastern landscapes, with estimated populations of 89.42 (95% CI: 72.81–109.82) and 73.33 (95% CI: 61.41–87.57), respectively, represent key habitats that require targeted conservation actions. These national estimates align with previous studies, which indicated population sizes ranging from 300-401 (DNPWC and DoFSC, 2024) in 2009 and 350-500 (DNPWC, 2005) in the early 1990s. However, the earlier studies were based on outdated methodologies, such as crude sign encounter rate extrapolations over habitat suitability models (DNPWC, 2013). In contrast, the current study employs a more robust methodology consistent with the GSLEP-PAWS guidelines (GSLEP, 2020). Multi-session models incorporating camera trapping and genetic surveys offer more accurate, repeatable, and unbiased population estimates (Suryawanshi et al., 2021). These methods effectively reduce detection biases, account for population fluctuations, and integrate multiple data sources, making them far more reliable than older approaches (GSLEP, 2020). The coefficient of variation (CV) for the top model was 9.3%, indicating a relatively low level of uncertainty and biasness in the estimates (Efford, 2025a). In comparison, Bhutan's CV was 10.34%(NCD, 2023) and Mongolia's was 8.60% (Bayandonoi et al., 2021), suggesting that Nepal's estimates are comparable in terms of precision and scientific reliability. Nonetheless, further advancements, including the expanded use of camera traps and genetic analysis across other habitats, and application of surveys by either method conducted in a limited survey period could further enhance future population assessments.

6.2. Management implications

Having reliable baseline population estimates for snow leopards in Nepal is critical for evidence-based conservation management. These estimates will enable targeted conservation planning by identifying priority habitats and guiding resource allocation to areas of greatest need. They provide a reference for monitoring population trends, assessing the effectiveness of conservation interventions, and implementing adaptive management strategies. Accurate data also aids in mitigating human-snow leopard conflicts by predicting conflict-prone areas and fostering community engagement through trust and collaboration.

For instance, allocation of resources for future conservation initiatives appears critical in western snow leopard complexes to ensure long term population viability. Likewise, the findings also suggest that management of snow leopard populations beyond protected areas also holds the key for maintaining a healthy snow leopard population in Nepal. High density snow leopard areas such as Annapurna Conservation Areas receive heavy tourism flow prompting development of linear infrastructure like roads and point structures like hydroelectric dams thus necessitating the urgent need to ensure safeguard measures to avoid habitat degradation and fragmentation. Furthermore, high density areas should also aim towards implementing conflict mitigation measures to ensure that local communities are protected against the cost of living with snow leopards. In low density and high potential areas such as the Gaurishankar Conservation Area and Kangchenjunga Conservation Area, regular population monitoring and community awareness programs will be crucial to foster a conducive environment for snow leopards to thrive.

Additionally, baseline estimates strengthen policy advocacy, support transboundary conservation initiatives, and contribute to global programs such as the Global Snow Leopard and Ecosystem Protection

Program (GSLEP). Also, the estimates meet the commitment forwarded by the Government of Nepal to establish reliable population estimates of snow leopard to provide a benchmark for measuring success of snow leopard conservation initiatives. By serving as indicators of ecosystem health, these estimates inform habitat connectivity efforts, biodiversity conservation, and climate adaptation strategies. Furthermore, they enhance opportunities for sustainable eco-tourism and local livelihoods, while building long-term research and conservation capacity. Overall, reliable population data are foundational for safeguarding snow leopards and their habitats while promoting ecological and socioeconomic resilience.

Given below are some key approaches that could aid in strengthening conservation of snow leopards and sustainable development for the wellbeing of people:

Nepal - A global stronghold for snow leopards

These estimates provide the most robust evidence yet to the importance of Nepal to secure the future of the species, globally. In comparison to the global population estimates provided by the IUCN Red List, 2710-3386 mature individuals, Nepal's latest estimate of 331-476 snow leopards is about 12-14% of global population. This proportion is even more striking considering that Nepal hosts just about 1.6% of the global distribution range, estimated to be around 1.8 million sq km.

These estimates are a testament to Nepal's conservation commitments, initiated traditionally through indigenous communities' faith, beliefs and values and sustained lately through leadership of key stakeholders – governments and communities. From a global perspective, strengthening conservation to address threats to snow leopards within Nepal, will help secure a significant proportion of the species' global population.

Strengthening climate-integrated landscapes conservation

Nepal is home to three of the 24 GSLEP priority landscapes—Western, Central, and Eastern Snow Leopard Conservation Landscapes. While these regions share common features such as their location in the Himalayas and hosting some of the world's highest peaks, they differ significantly due to geographic, socio-economic, climatic, and ecological factors (McCarthy et al., 2024).

The Western landscape contains the largest snow leopard habitat and supports about 60% of Nepal's snow leopard population (234 individuals), while the Central and Eastern landscapes host 89 and 73 individuals, respectively (McCarthy et al., 2024). The Western and Central landscapes remain contiguous within Nepal, making habitat conservation and connectivity crucial for maintaining genetic exchange. The Eastern landscape, however, is divided by two natural barriers within Nepal but remains connected through habitats in China's Tibetan Autonomous Region, emphasizing the importance of transboundary cooperation with China and India (McCarthy et al., 2024).

Climate change poses a major threat, with projections indicating up to a 40% decline in Himalayan snow leopard habitat (McCarthy et al., 2024). Rising temperatures may increase competition with other predators and the risk of diseases. Nepal has prioritized climate-smart planning, becoming the first country to develop a climate-smart Snow Leopard Ecosystem Management Plan (SLEMP) in 2017, with efforts underway to extend similar planning to other landscapes (McCarthy et al., 2024).

Strengthening PAs and extending conservation beyond PAs

With >43% of Nepal's snow leopards (~172) found in areas beyond PAs, conservation prioritization must be done across the landscape. Population densities of SL in some areas outside PAs exceed those within certain PAs of Nepal, indicating their importance for snow leopard conservation. With snow leopards facing similar risks across the country, without interventions, these important areas risk becoming sinks and impacting the conservation gains made in pockets.

Nepal government supported by conservation institutions have therefore been working to strengthen PAs but also improve protection and conservation outside PAs. The government's SLCAP also identifies potentially new conservation measures to be applied to conserve snow leopard habitats outside PAs. Availability of snow leopard habitats and community's proximity to conservation through faith values provide a strong opportunity for Nepal to meet global targets, including the GBF target # 3 of securing 30% of the total land (and sea) areas by 2030.

Strengthening coexistence with snow leopards

Human-snow leopard conflict poses a serious threat to the species' long-term survival. Despite the deep-rooted Buddhist values that foster coexistence, mountain communities in Nepal may lose tolerance, especially in cases of surplus killing, leading to retaliatory snow leopard killings. Conflict intensity varies across Nepal's snow leopard conservation landscapes, influenced by factors such as prey decline, snow leopard density, and communities' reliance on livestock.

Conservation efforts have shown that community support can positively shift perspectives. For instance, in Kangchenjunga Conservation Area (KCA), community-managed livestock insurance schemes (LIS) have successfully prevented retaliatory killings (Gurung et al., 2011). Since 2012, Nepal's Wildlife Damage Relief Guidelines have provided compensation for livestock losses, with recent updates increasing payouts and including mountain livestock. However, access to relief remains a challenge due to remoteness, lack of awareness, and bureaucratic hurdles. Innovative approaches, such as citizen scientists in Shey Phoksundo National Park assisting with claims through LIS, have improved access and community engagement.

To enhance coexistence, preventive measures like improved herding practices and corral designs should be prioritized alongside compensation. Alternative livelihoods and decentralized clean energy solutions, such as solar mini grids, offer additional benefits. Regular site-specific conflict assessments and local monitoring are essential for effective management and sustained coexistence.

Strengthening wildlife crime management

Globally illegal trade is one of the key threats to wildlife, and snow leopards are no exception. Around 221-450 individual snow leopards are estimated to be traded annually (Nowell et al., 2016).

Nepal has fared extremely well in wildlife crime control, including achieving multiple zero poaching years in case of the tigers and rhinos. Yet, experience shows that these threats exist perpetually. In case of snow leopards, not much is known. However, the 2016 global assessment indicated threats to snow leopards in Nepal from poaching exists; the assessment also estimated that ~75% of snow leopards traded from Nepal were linked to conflicts and retaliatory killing. Moreover, with increasing access through development of infrastructures, wildlife crime risks may be aggravated.

Improving protection both inside and outside PAs will aid to reduce risks of snow leopard poaching. Government and enforcement agencies will need to be strengthened further, through capacity building and equipped for improved anti-poaching and wildlife crime management.

Local communities' engagement through institutionalization and strengthening of CBAPUs will also aid improving protection. With examples of traditional monasteries established to prevent violence against wildlife, and Buddhism values and leadership still holding immense influence, faith-based approaches to wildlife crime management is an opportunity to improve protection of snow leopards and other wildlife in these landscapes.

Improvement of coordination within and among Wildlife Crime Control Bureau (WCCB) cells of SL bearing areas, improved transboundary collaboration with neighboring countries, and engagement of conventional and non-conventional stakeholders, are among the priorities identified for improved protection of snow leopards in Nepal.

Strengthening sustainable infrastructure development and holistic management

Nepal plays a crucial role in snow leopard conservation, supporting a significant portion of the global population. As a flagship species, snow leopards help safeguard mountain ecosystems that contribute to the national economy through tourism, agriculture, and essential ecosystem services like water security and climate change mitigation. Investing in their conservation ensures long-term economic and ecological benefits.

However, infrastructure development in Nepal's snow leopard landscapes poses significant challenges. At least 13 north-south linear infrastructure projects are in various stages of development. While their impact is currently minimal, unplanned expansion can fragment habitats, disrupt wildlife movement, and reduce genetic diversity, threatening snow leopard survival. Habitat degradation may also push snow leopards closer to human settlements, increasing conflict.

Nepal's 2022 Wildlife-Friendly Infrastructure Construction Directive has primarily been implemented in the lowlands, with little application in high-altitude regions. Adapting this directive for mountain landscapes requires research on ecological sensitivities, wildlife movement, and socio-cultural factors. Poorly planned infrastructure also threatens local communities by causing landslides, drying water sources, and altering hydrogeology.

A holistic, interdisciplinary approach is essential for sustainable development. By integrating biodiversity conservation and climate resilience, Nepal can ensure thriving snow leopard habitats while securing long-term benefits for both people and nature.

Strengthening Evidence-Based Conservation

Nepal is known to have contributed significantly to global understanding of snow leopards and their habitats. Yet, snow leopards and their habitats globally remain among the most understudied of the big cats. Research must remain a key priority, not only to assess status of species and situations, but to aid improved understanding of complexities for improved management planning.

This study provides the best estimate available of Nepal's snow leopard population, applying modern analytical tools to overcome limitations of resources and geography. However, with improved technologies, and investments in conservation, periodic national snow leopard population assessments will aid understanding trends, indicating potential impacts of conservation approaches or enhancing knowledge about additional influencing factors. Additionally, specific and robust population studies in certain PAs, where intensive data was unavailable for this study, and where specific unique parameters may influence populations, would be useful; for instance, in Dhorpatan HR (with managed hunting), Sagarmatha NP (with high trekking and tourism) and Api Nampa CA (noting potential proximity to wildlife trade hubs).

Other than snow leopard population research, efforts must also be made to enhance understanding of other species in snow leopard landscapes as well as interspecific interactions. Monitoring the impacts of climate change, infrastructure development, socio-economic changes among others will also aid informed conservation planning and adaptations. Documentation of traditional knowledge has also been prioritized for adaptive application to address conservation challenges.

Strengthening partnerships for holistic well-being of people and nature

Conserving nature is essential for human well-being and survival. Snow leopard and ecosystem conservation directly support local livelihoods and broader community welfare. However, conservation is often viewed as the responsibility of specialists or government agencies, limiting its effectiveness. For lasting success, a wider range of stakeholders must be involved.

Nepal's constitution mandates environmental stewardship for all citizens, while the federal structure assigns conservation leadership to local governments alongside provincial and federal authorities. The Snow Leopard Conservation Plan (SLCAP) 2024 highlights the role of local governments in integrating conservation with sustainable development. The Ministry of Federal Affairs and General Administration (MoFAGA) plays a key role in aligning federal and local priorities for long-term community well-being.

Faith groups are crucial partners, especially in indigenous mountain communities. The Nepal Buddhist Federation, representing over 3,000 monasteries, has developed a Faith Plan for Environment, aligning religious values with national conservation priorities. Protected Areas like Shey-Phoksundo National Park (SPNP) collaborate with monasteries and traditional healers (Amchis) to integrate indigenous knowledge with modern conservation.

Efforts also involve schools, universities, women's groups, businesses, and technical experts. Strengthening partnerships and fostering collaboration ensures both snow leopard conservation and sustainable development goals are met.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7. REFERENCES

Bayandonoi, G., Lkhagvajav, P., Alexander, J.S., Durbach, I., Borchers, D., Munkhtsog, B., Munkhtogtokh, O., Chimeddorj, B., Sergelen, E., Sharma, K., 2021. Nationwide Snow Leopard Population Assessment of Mongolia: Key Findings. Ulaanbaatar.

Belant, J.L., Bled, F., Wilton, C.M., Fyumagwa, R., Mwampeta, S.B., Beyer, D.E., 2016. Estimating Lion Abundance using N-mixture Models for Social Species. Sci Rep 6, 35920. https://doi.org/10.1038/srep35920

Burnham, K.P., Anderson, D.R., 2002. Model Selection and Multimodel Inference, a Practical Information-Theoretic Approach, Second. ed. Springer-Verlag, New York.

Chetri, M., Odden, M., Sharma, K., Flagstad, Ø., Wegge, P., 2019. Estimating snow leopard density using fecal DNA in a large landscape in north-central Nepal. Glob Ecol Conserv 17. https://doi.org/10.1016/j.gecco.2019.e00548

DNPWC, 2025. Population assessment of Kangchenjunga Conservation Area's snow leopards. Kathmandu.

DNPWC, 2013. National Snow Leopard & Ecosystem Protection Priorities of Nepal. Kathmandu.

DNPWC, 2009. Snow leopard conservation in the Sacred Himalaya Landscape (SHL) and Northern Mountain Landscape (NML) in the Nepal Himalaya (July 2008 – June 2009). Kathmandu.

DNPWC, 2005. The Snow Leopard Conservation Action Plan for the Kingdom of Nepal. Kathmandu.

DNPWC and DoFSC, 2024. Snow leopard conservation action plan for Nepal (2024-2030). Kathmandu.

DoFSC, 2024. Population assessment of eastern Dolpa's snow leopard. Kathmandu.

E ord, M., 2025a. Package "secr."

E ord, M., 2025b. Multi-session models in secr.

E ord, M.G., Mowat, G., 2014. Compensatory heterogeneity in spatially explicit capture–recapture data. Ecology 95, 1341–1348. https://doi.org/https://doi.org/10.1890/13-1497.1

GSLEP, 2020. PAWS Guidelines. Bishkek.

Howe, E.J., Potter, D., Beauclerc, K.B., Jackson, K.E., Northrup, J.M., 2022. Estimating animal abundance at multiple scales by spatially explicit capture–recapture. Ecological Applications 32, e2638. https://doi.org/https://doi.org/10.1002/eap.2638

Jackson, M., Hunter, O., Dawn, D., Hunter, L., Mccarthy, T., Townsend, S., 2005. Surveying Snow Leopard Populations with Emphasis on Camera Trapping. Snow Leopard Conservancy. https://doi.org/10.1111/j.1540-5834.2012.00708.x

Jackson, R.M., Lama, W.B., Thakali, S., 2024. Chapter 15 - The role of mountain communities in snow leopard conservation, in: Mallon, D., McCarthy, T. (Eds.), Snow Leopards (Second Edition). Academic Press, pp. 159–170. https://doi.org/https://doi.org/10.1016/B978-0-323-85775-8.00031-5

Johansson, Ö., Samelius, G., Wikberg, E., Chapron, G., Mishra, C., Low, M., 2020. Identi cation errors in camera-trap studies result in systematic population overestimation. Sci Rep 10, 6393. https://doi.org/10.1038/s41598-020-63367-z

McCarthy, T., Mallon, D., Zahler, P., 2024. Chapter 3 - What is a snow leopard? Biogeography and status overview, in: Mallon, D., McCarthy, T. (Eds.), Snow Leopards (Second Edition). Academic Press, pp. 31–41. https://doi.org/https://doi.org/10.1016/B978-0-323-85775-8.00056-X

MoEFCC, 2023. Status of Snow leopard in India (SPAI). Delhi.

NCD, 2023. National snow leopard survey report 2022-2023. Thimpu.

Pereira, K.S., Gibson, L., Biggs, D., Samarasinghe, D., Braczkowski, A.R., 2022. Individual Identi cation of Large Felids in Field Studies: Common Methods, Challenges, and Implications for Conservation Science. Front Ecol Evol 10. https://doi.org/10.3389/fevo.2022.866403

Ripple, W.J., Estes, J.A., Beschta, R.L., Wilmers, C.C., Ritchie, E.G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M.P., Schmitz, O.J., Smith, D.W., Wallach, A.D., Wirsing, A.J., 2014. Status and Ecological E ects of the World's Largest Carnivores. Science (1979) 343, 1241484. https://doi.org/10.1126/science.1241484

Royle, J.A., Sutherland, C., Fuller, A.K., Sun, C.C., 2015. Likelihood analysis of spatial capture-recapture models for strati ed or class structured populations. Ecosphere 6, art22. https://doi.org/https://doi.org/10.1890/ES14-00148.1

Shen, Q., 2020. The E ects of Climate Change on Snow Leopards at the Hengduan Mountain Region, in: IOP Conference Series: Earth and Environmental Science. IOP Publishing Ltd. https://doi.org/10.1088/1755-1315/552/1/012002

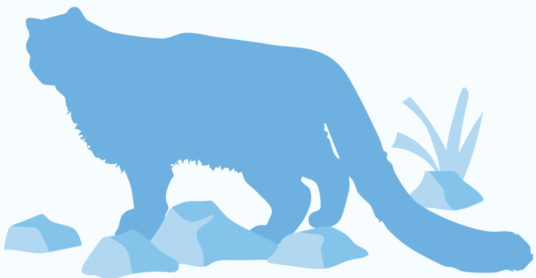
Shrestha, B., Kindlmann, P., 2020. Implications of landscape genetics and connectivity of snow leopard in the Nepalese Himalayas for its conservation. Sci Rep 10. https://doi.org/10.1038/s41598-020-76912-7

SPNP, 2023. Population asessement of Shey- Phoksundo National Park's snow leopard and prey. Kathmandu.

Suryawanshi, K., Reddy, A., Sharma, M., Khanyari, M., Bijoor, A., Rathore, D., Jaggi, H., Khara, A., Malgaonkar, A., Ghoshal, A., Patel, J., Mishra, C., 2021. Estimating snow leopard and prey populations at large spatial scales. Ecological Solutions and Evidence 2, e12115. https://doi.org/https://doi.org/10.1002/2688-8319.12115

Suryawanshi, K.R., Khanyari, M., Sharma, K., Lkhagvajav, P., Mishra, C., 2019. Sampling bias in snow leopard population estimation studies. Popul Ecol 61. https://doi.org/10.1002/1438-390X.1027

Thapa, K., Schmitt, N., Pradhan, N.M.B., Acharya, H.R., Rayamajhi, S., 2021. No silver bullet? Snow leopard prey selection in Mt. Kangchenjunga, Nepal. Ecol Evol 11, 16413–16425. https://doi.org/https://doi.org/10.1002/ece3.8279



TEAM CONTRIBUTIONS

Technical team: Conceptualization, coordination and lead, project administration, writing-review & editing;
Technical support team: Conceptualization- equal, methodology, data curation, data analysis, writing original draft.

ANNEXURES

Annex 1. Result sharing by DNPWC to Ministry of Forests and Environment

Annex 2. List of data contributors for final snow leopard population assessment of Nepal

SN	NAME/INSTITUTION	SITE
1	Rinzin Lama- UKALI	Western Humla
2	Naresh Kusi- HWP	Northwestern Humla
3	DNPWC- WWF Nepal	Api Nampa Conservation Area, Shey-Phoksundo National Park, Dolpa, Langtang National Park and Kangchenjunga Conservation Area
4	Narayan Prasad Koju, PhD- NEC	Gaurishankar Conservation Area
5	NTNC	Gaurishankar Conservation Area
6	Madhu Chetri, PhD- NTNC	Annapurna Conservation Area and Manaslu Conservation Area

Annex 3. Logarithmic parameter estimates of the top model (D/100 sq. km. is only the parameter estimates of Density used to estimate the derived final density)

SESSION	ESTIMATES	D/100 SQ. KM.	LAMBDA0	SIGMA
1	Mean	0.43	0.07	1855.49
	SE	0.26	0.01	79.10
	LCL	0.14	0.06	1706.83
	UCL	1.29	0.09	2017.11
2	Mean	0.35	0.07	1855.49
	SE	0.25	0.01	79.10
	LCL	0.10	0.06	1706.83
	UCL	1.21	0.09	2017.11
3	Mean	3.16	0.07	1855.49
	SE	0.61	0.01	79.10
	LCL	2.17	0.06	1706.83
	UCL	4.59	0.09	2017.11
4	Mean	1.09	0.0004	2252.39
	SE	0.72	0.0001	266.27
	LCL	0.34	0.0002	1788.00
	UCL	3.53	0.0006	2837.41
5	Mean	0.18	0.01	2347.60
	SE	0.50	0.01	442.19
	LCL	0.01	0.01	1628.13
	UCL	3.18	0.03	3384.99
6	Mean	0.58	0.01	2347.60
	SE	0.65	0.01	442.19
	LCL	0.10	0.01	1628.13
	UCL	3.42	0.03	3384.99
7	Mean	0.03	0.01	2347.60
	SE	0.43	0.01	442.19
	LCL	0.00	0.01	1628.13
	UCL	2.73	0.03	3384.99

SE: Standard Error, LCL: 95% Lower Con dence Limit, UCL: 95% Upper Con dence Limit

Annex 4. Coefficient values estimate of parameters and covariates of the top model in uencing density

ESTIMATES	BETA	SE.BETA	LCL	UCL
D	-8.296	0.163	-8.615	-7.977
D.STD_ELV	-1.168	0.412	-1.975	-0.361
D.I(STD_ELV^2)	-1.228	0.527	-2.261	-0.195
LAMBDA0	-2.657	0.100	-2.853	-2.462
LAMBDA0.GEN	-5.197	0.258	-5.703	-4.692
LAMBDA0.LAND	-1.651	0.383	-2.402	-0.900
SIGMA	7.526	0.043	7.442	7.609
SIGMA.GEN	0.194	0.124	-0.050	0.438
SIGMA.LAND	0.235	0.191	-0.139	0.609

STD: Standardized, ELV: elevation, ELV^2: square of elevation, LAMBDA0: detection probability, SIGMA: movement, GEN: genetic, LAND: landscape

Annex 5. Density covariate e ects: in uence of the top quadratic covariates (elevation, slope and NDVI) in snow leopard density.