Rare and unusual snow leopard encounters in the broadleaf forest of the Bhutanese Himalayas

Rinzin Dorji [1,*] · Letro Letro [2] · Sonam Yangden [3] · Pema Dendup [3] · Tashi Dhendup [4] · Yangchen Lhamo [1]

1 Divisional Forest Office, Gedu, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Bhutan
2 Charles Sturt University, Australia
3 Divisional Forest Office, Sarpang, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Bhutan
4 Nature Conservation Division, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Bhutan
* Corresponding author, email: rinzindorji@moenr.gov.bt

Key words
Bhutan, broadleaf forest, divisional forest office, snow leopard

Abstract

The snow leopard *Panthera uncia*, a top predator in Central and South Asia, faces population declines due to habitat degradation, prey depletion, retaliatory killings, poaching, and climate change. In Bhutan, where the species is protected, we report two rare sightings in the Gedu region's broadleaved and fir forests, at 2,708 masl and 3,839 masl, respectively, which are lower than the typical species' prime habitats in Bhutan. These findings suggest that this area may function as an important corridor or a potential range expansion beyond typical high-altitude habitats (3,000 to 5,800 masl). This discovery underscores the species' ecological adaptability and highlights the need for enhanced conservation strategies, including habitat connectivity mapping and local community education. Additionally, it highlights

the importance of protecting and conserving habitats outside of protected areas for species' long-term persistence.

Introduction

The snow leopard *Panthera uncia* is a top predator in the high mountains of Central and South Asia. Listed as Vulnerable on the IUCN Red List of Threatened Species since 2017 (McCarthy et al., 2017), the global snow leopard population is estimated to be between 3,920 to 8,745 individuals (McCarthy et al., 2016), spanning 12 Asian countries. In the Himalayas, snow leopards are typically found at elevations between 3,000 to 5,800 meters above sea level (masl) (Lham et al., 2021). Despite its vast habitat, the snow leopard population faces a continual decline, primarily due to habitat degradation, dwindling prey populations, retaliatory killings, poaching, habitat degradation, ecotourism, and climate change (Bagchi & Mishra, 2006; DoFPS, 2016; Filla et al., 2022; Leki et al., 2018; McCarthy et al., 2017).

In Bhutan, the snow leopard is a protected species under Schedule I of the Forests and Nature Conservation Act of Bhutan 2023 (RGoB, 2023). The country is estimated to have a population of 134 individuals as of 2023 (DoFPS, 2023a). Conservation strategies in Bhutan are guided by a comprehensive snow leopard action plan (NCD, 2019), and the highland communities revere snow leopard as a mountain deity. Snow leopards are predominantly concentrated in the northern regions of the country in the protected areas such as Jigme Dorji National Park (JDNP), Wangchuck Centennial National Park (WCNP), and Jigme Khesar Strict Nature Reserve (JKSNR) (DoFPS,

2016). They are also found in alpine regions of Divisional Forests Office (DFO) of Paro and Thimphu, adjacent to these protected areas (DoFPS, 2016). Reports also indicate their presence in Bumdeling Wildlife Sanctuary (BWS) and Jigme Singye Wangchuck National Park (JSWNP) (NCD 2019; Letro et al., 2021).

Studies show that suitable snow leopard habitats in Bhutan are typically found within the elevation range of 3,500 to 5,500 masl, encompassing approximately 7206 km^2 of the country (Thinley et al., 2016; Lham et al., 2021). Based on the habitat characteristics and elevation, Dagala region in central Bhutan, located at the tri-junction of DFO Gedu (here on referred to as Gedu), DFO Thimphu and DFO Dagana (here on referred as Dagana), appears suitable for snow leopards (Letro et al., 2021) although no historical records of their presence exist in this region. Here, we report the rare captures of the snow leopard on two different camera traps in the cool broadleaved and fir forests of Gedu, on the lower stretches of the Dagala region, far away from prime snow leopard habitats in northern Bhutan. These observations provide evidence of this area being an important corridor or a potential species range expansion in the country, crucial for conservation planning and implementation of appropriate interventions.

Materials and methods
Study Area

Gedu has an area of 1879.77 km^2 (Rai & Phuntsho, 2016) and is the largest division among 14 divisional forest office areas aside the protected areas network in Bhutan. Gedu is located in south-western Bhutan covering the entire Chukha District (highest administrative

body) and is bordered by Paro and Thimphu Districts in the North, Dagana in the East, Samtse District in the West, and Haa district in the North-East and India in the South (Figure 1). Gedu has diverse vegetation representation from alpine, temperate and subtropical ecological zones of Bhutan (Dhendup & Dorji, 2018; DoFPS, 2021) attributed to its wide elevation ranging from 150 to 4,450 masl. The assemblage of faunal species include but is not limited to tiger (*Panthera tigris*), clouded leopard (*Neofelis nebulosa*), dhole (*Cuon alpinus*), red panda (*Ailurus fulgens*), elephant (*Elephas maximus*), musk deer (*Moschus chrysogastor*), White-bellied heron (*Ardea insignis*) and Rufous-necked hornbill (*Aceros nipalensis*) (Dorji et al., 2021).
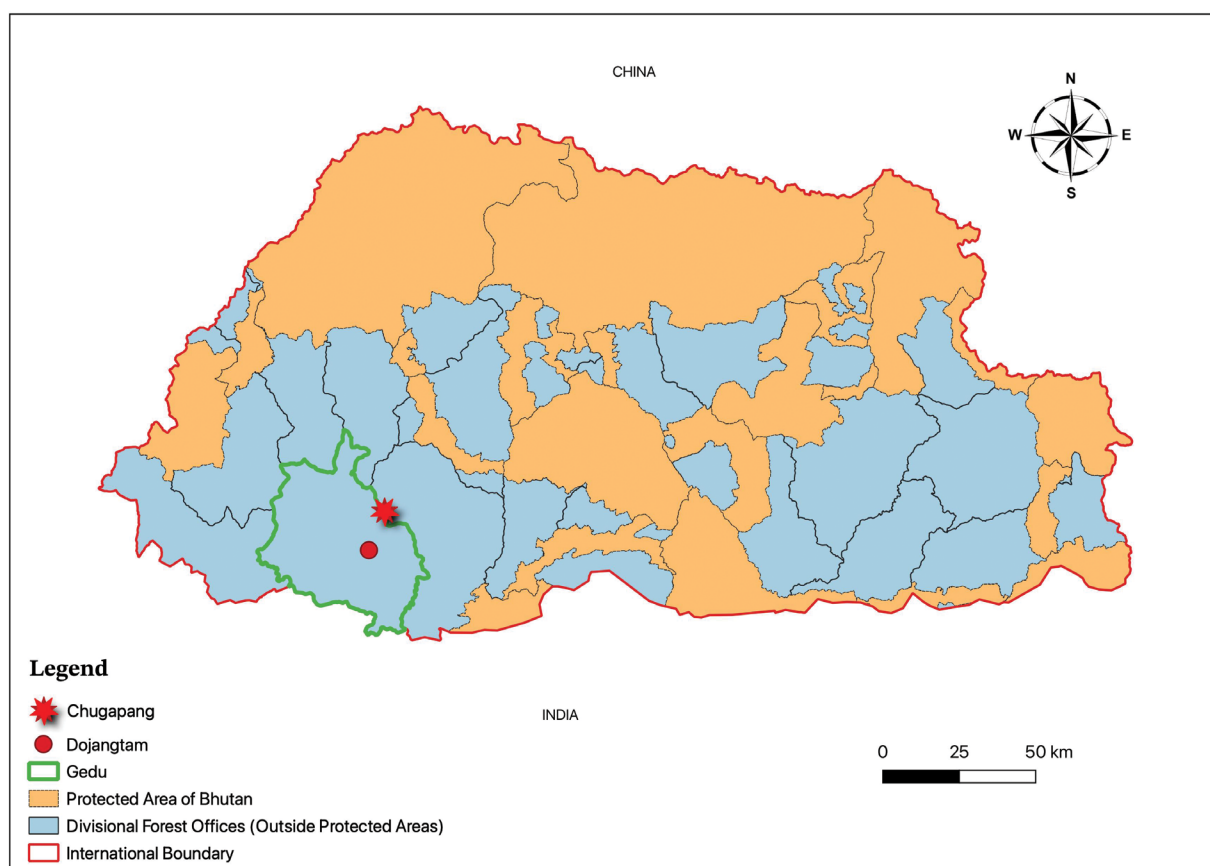
Figure 1: *Map showing location of Bhutan, Gedu and Snow Leopard capture locations.*

Data collection

We conducted the camera trapping exercise from 8th March to 31st May 2022 in Gedu as a part of the second National Tiger Survey of Bhutan by setting up 57 camera trap stations each in a grid cell of 5x5 square kilometer. This includes the survey area extended into southern Dagala (Dagala-Gaytala ridge) on the northeast of Gedu. A pair of remote camera-traps set at least 2 meters apart were placed in

each of 57 camera trap stations at a height of 45 to 60 cm above ground on either side of the trail by maintaining a distance of 3 to 5 meters from the trail ensuring no two cameras were in the same line of view with 3 images per trigger (BTC, 2021; DoFPS, 2023b).

During the camera trap deployment, the location of every camera-trap station, vegetation composition within a 25 meters radius of each camera station and other information were recorded using Epicollect5 College (Imperial college London, 2021). The camera traps were monitored once in April 2022 to check the camera status, replace memory cards if full, and replace batteries if exhausted.

Results and Discussions

Snow leopards were captured at two camera trap stations: one in the fir forest zone at Chugapang at the border of Gedu and Dagana at an elevation of 3,839 masl and the other in the cool broadleaved forests in Dojangtam, Gedu at an elevation of 2,708 masl. The two camera traps captured a total of 1,161 images over 154 camera trap nights. The snow leopards were recorded on 20th March 2022 at Dojangtam, with five images taken between 15:49:17 and 16:48:15 hours, and on 26th March 2022 at Chugapang, with eight images taken between 14:40:05 and 14:40:10 hours (Figure 2). Eleven other mammal species were also recorded (Table 1). The images from the two camera traps were compared but we could not determine if they depicted the same individual due to insufficient imagery for rosette comparison. Additionally, the snow leopard images captured in two stations were compared with those from the national snow leopard survey of 2023 to check the recaptures but no matches were found.

These observations mark the first evidence of snow leopard presence in the Dagala region, suggesting either that this area represents an important corridor or a potential range expansion into Gedu, Thimphu, and Dagana. While the Chugapang location is closer to central alpine regions resembling typical snow leopard habitats, the Dojangtam location is in a cool broadleaved forest with 50 to 75 percent canopy cover, featuring species like *Castanopsis tribuloides, Quercus spp.*, and other dense shrubs, climbers, and epiphytes. This habitat is not typical for snow leopards, which are generally associated with alpine and subalpine zones which suggests that these observations may represent a snow leopard corridor between more typical snow leopard habitats. These observations may, on the other hand, also suggest a potential range expansion that may be linked to prey availability (Lovari et al., 2013) and their adaptability to different ecological zones.

The snow leopard recorded at an elevation of 2,708 masl at Dojangtam in Gedu is lower than the predicted elevation range of 3,000 to 5,800 masl in the Bhutan Himalayas, suggesting unusual movement southward outside its preferred habitat (Lham et al., 2021; Thinley et al., 2016). In the Himalayan landscape, the lowest elevation at which snow leopards were previously recorded is 2,495 masl in the Great Himalayan National Park in India as reported by Bandyopadhyay et al. (2019). However, there are records of snow leopards inhabiting lower altitudes in China's Beita Mountain and southwestern Mongolia during autumn (Feng et al., 2006; McCarthy et al., 2005). The snow leopard in the two camera trap stations in our study was recorded in March 2022 after the
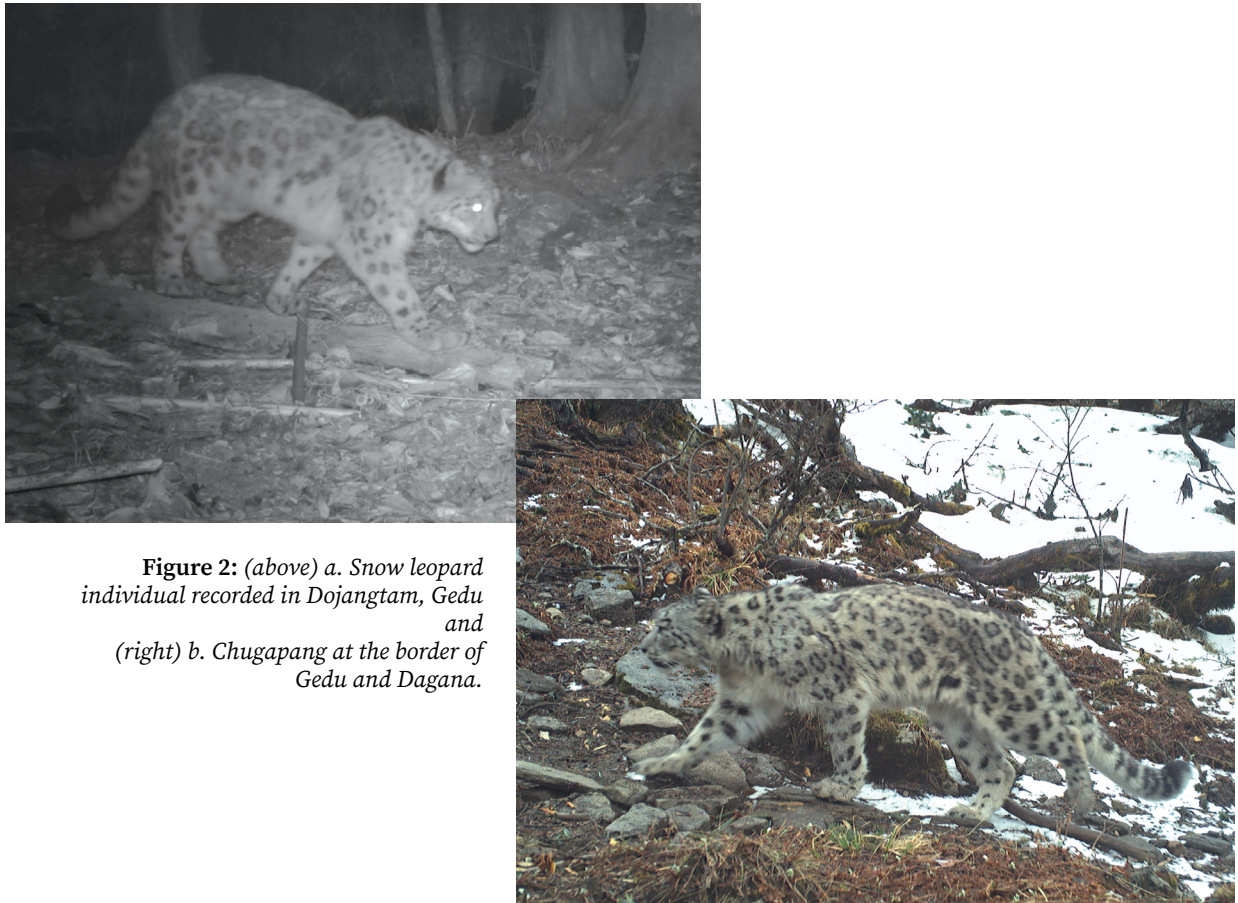
Figure 2: *(above) a. Snow leopard individual recorded in Dojangtam, Gedu and (right) b. Chugapang at the border of Gedu and Dagana.*

Common Name	Scientific Name	Family	IUCN Red List category as of 2024
Snow leopard	*Panthera uncia*	Felidae	Vulnerable
Himalayan red panda	*Ailurus fulgens fulgens*	Ailuridae	Endangered
Dhole	*Cuon alpinus*	Canidae	Endangered
Tiger	*Panthera tigris tigris*	Felidae	Endangered
Barking deer	*Muntiacus muntjak*	Cervidae	Least Concern
Marbled cat	*Pardofelis marmorata*	Felidae	Near-Threatened
Sambar	*Rusa unicolor*	Cervidae	Vulnerable
Asiatic golden cat	*Catopuma temminckii*	Felidae	Near-Threatened
Wild boar	*Sus scrofa*	Suidae	Least Concern
Assam macaque	*Macaca assamensis ssp. assamensis*	Cercopithecidae	Near-Threatened
Leopard	*Panthera pardus*	Felidae	Vulnerable
Yellow-throated marten	*Martes flavigula*	Mustelidae	Least Concern

Table 1: *Mammalian species captured by camera traps along Dagala-Gaytala ridge under Gedu in the year 2022.*

unusually heavy snowfall in the first week of February 2022 in most parts of Bhutan with records of snowfall to elevations as low as 1,700 masl in Gedu (Kuensel, 2022). This event may have driven snow leopards to seek lower elevations, highlighting their vulnerability to climate change impacts (Forrest et al., 2012).

The unusual record of snow leopards in the broadleaf forests reported here suggests potential connectivity with snow leopard habitats in northern Bhutan. Previous species captures in Thimphu's alpine habitats, adjacent to JDNP, which harbors the largest number of snow leopards in the country (DoFPS, 2016), suggest a possible route through Dochula Pass (3,129 masl) between the prime snow leopard habitats, Dagala region, and Gedu (Figure 3). In Gedu's Dojangtam area, the camera trap captured both snow leopard and common leopard (*Panthera pardus*) at the same location, though at different times, likely to avoid interspecific aggression (Lovari et al., 2013). This indicates their co-occurrence at lower elevations in Bhutan. Similar overlaps and co-occurrences of snow leopards and common leopards were also reported in Nepal and Pakistan but at a higher elevation than what we recorded in this study (Bhatti et al., 2022).

Snow leopards typically rely on blue sheep as their prey in Bhutan, but this species is not
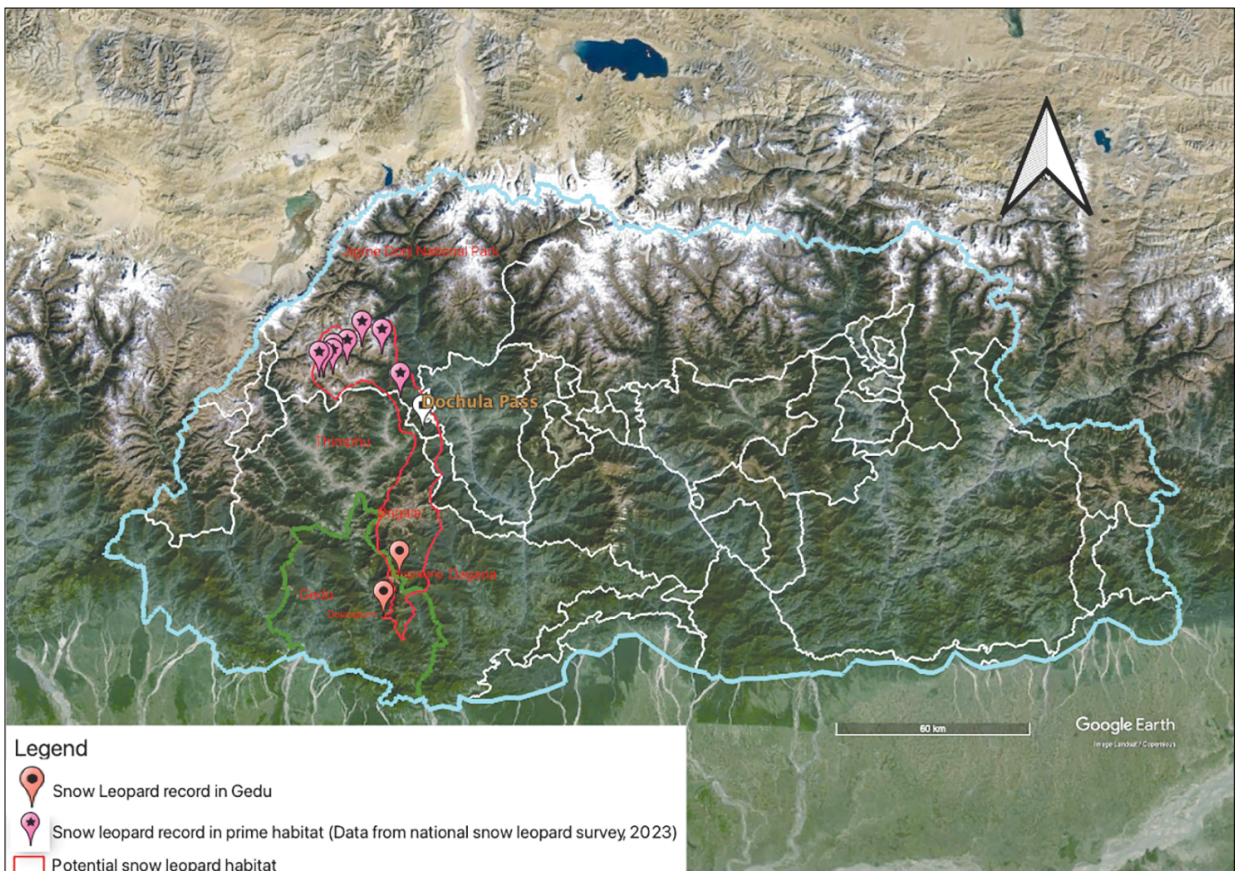

Figure 3: *Map showing locations of snow leopard presence and potential movement route.*

18

recorded in the Gedu area. Instead, other prey such as wild pig (*Sus scrofa*), Goral (*Naemorhedus goral*), Musk deer (*Moschus chrysogaster*), domestic yaks (*Bos grunniens*) and horses (*Equus caballus*) are found in the Dagala-Gaytala region (Thinley et al., 2016; Lham et al., 2021). There were no official records of livestock depredation by the snow leopards in the Dagala-Gaytala region of Gedu. However, habitat disturbances through grazing, lopping, and tree felling were observed during the survey. It is imperative to educate local yak herders of the Dagala and Gaytala regions in Gedu about the presence of snow leopards, their ecological importance, and the need for coexistence for the species' survival. Considering Dagala-Gaytala areas in Gedu for important conservation areas outside the protected area regime in securing the species' habitats is recommended. Further, a telemetry study, as suggested by Letro et al. (2021), could provide additional insights into the unusual movement of snow leopards into southern Bhutan coupled with a thorough camera trap survey along these ridges is needed to better understand how these habitats are used. Additionally, studying prey species in light of the absence of the main prey, blue sheep, in this region is essential.

Acknowledgment

Conflicts of interest

The authors declare no conflicts of interest

References

Bagchi, S., & Mishra, C. (2006). Living with large carnivores: Predation on livestock by the snow leopard (Uncia uncia). *Journal of Zoology*, *268*(3), 217–224. https://doi.org/10.1111/j.1469-7998.2005.00030.x

Bandyopadhyay M., Dasgupta T. & Ramesh K. (2019). New records of snow leopard in Great Himalayan National Park, Western Himalaya. CATnews 70, 9–12.

BTC. (2021). *Camera Trapping Guideline and implementation modality for the national tiger survey 2021-2022, Bhutan Tiger Centre, Department of forests and park services, ministry of Agriculture and Forests, Gelephu, Bhutan (Pages 1-112).*

Dhendup, T., & Dorji, R. (2018). *Camera-trap records of small carnivores from Gedu Territorial Forest Division, Bhutan.* https://doi.org/10.13140/RG.2.2.21570.43202

DoFPS. (2016). *National Snow Leopard Survey of Bhutan 2014 – 2016 (Phase II): Camera Trap Survey for Population Estimation. Department of Forests and Park Services, Ministry of Agriculture and Forests, Thimphu, Bhutan.*

DoFPS. (2021). *Guidelines for Wildlife Habitat Management, Department of Forests and Park Services,Ministry of Agriculture and Forests, Royal Government of Bhutan, Thimphu.* https://doi.org/10.13140/RG.2.2.21300.53129

DoFPS. (2023a). *National Snow Leopard Survey Report.* https://www.dofps.gov.bt/reports/

DoFPS. (2023b). *Status of Tigers in Bhutan:The National Tiger Survey Report 2021–2022. Bhutan Tiger Center, Department of Forests and Park Services, Ministry of Energy and Natural Resources, Royal Government of Bhutan.*

Dorji, R., Letro, L., Tandin, T., Pema, P., & Karma, K. (2021). *Baseline Biodiversity Report of Gedu Forest Division.*

Farrington, J. D., & Li, J. (2016). Chapter 8—Climate Change Impacts on Snow Leopard Range. In T. McCarthy & D. Mallon (Eds.), *Snow Leopards* (pp. 85–95). Academic Press. https://doi.org/10.1016/B978-0-12-802213-9.00008-0

Feng, Ma, M., Shou-jing, Y., & Munkhtsog, B. (2006). Autumn Habitat Selection by Snow Leopard (Uncia uncia) in Beita Mountain, Xinjiang, China. *Zoological Research, 27*, 221–224.

Filla, M., Lama, R. P., Ghale, T. R., Filla, T., Heurich, M., Waltert, M., & Khorozyan, I. (2022). Blue sheep strongly affect snow leopard relative abundance but not livestock depredation in the Annapurna Conservation Area, Nepal. *Global Ecology and Conservation, 37*, e02153. https://doi.org/10.1016/j.gecco.2022.e02153

Forrest, J. L., Wikramanayake, E., Shrestha, R., Areendran, G., Gyeltshen, K., Maheshwari, A., … & Thapa, K. (2012). Conservation and climate change: Assessing the vulnerability of snow leopard habitat to treeline shift in the Himalaya. *Biological Conservation, 150*(1), 129-135.

Imperial college London. (2021). *Epicollect5* [Computer software]. https://five.epicollect.net

Kuensel, B. D. N. (2022). *In Pictures: Snowfall 2022.* Kuensel Online. https://kuenselonline.com/in-pictures-snowfall-2022/

Leki, Rajaratnam, R., Shrestha, R., Thinley, P., Rajaratnam, R., & Shrestha, R. (2018). Establishing baseline estimates of blue sheep (Pseudois nayaur) abundance and density to sustain populations of the vulnerable snow leopard (Panthera uncia) in Western Bhutan. *Wildlife Research, 45*(1), 38–46. https://doi.org/10.1071/WR16218

Letro, L., Duba, D., Tandin, T., & Wangdi, S. (2021). *Rare capture of snow leopard in Jigme Singye Wangchuck National Park, Bhutan.*

Lham, D., Cozzi, G., Sommer, S., Thinley, P., Wangchuk, N., Wangchuk, S., & Ozgul, A. (2021). Modeling Distribution and Habitat Suitability for the Snow Leopard in Bhutan. *Frontiers in Conservation Science, 2*, 781085. https://doi.org/10.3389/fcosc.2021.781085

Lovari, S., Minder, I., Ferretti, F., Mucci, N., Randi, E., & Pellizzi, B. (2013). Common and snow leopards share prey, but not habitats: Competition avoidance by large predators? *Journal of Zoology, 291*(2), 127–135. https://doi.org/10.1111/jzo.12053

McCarthy, T., Fuller, T., & Munkhtsog, B. (2005). Movements and activities of snow leopards in Southwestern Mongolia. *Biological Conservation, 124*, 527–537. https://doi.org/10.1016/j.biocon.2005.03.003

McCarthy, T., Mallon, D., Jackson, R., Zahler, R., & McCarthy, K. (2017). *The IUCN Red List of Threatened Species*. IUCN Red List of Threatened Species.

McCarthy, T., Mallon, D., Sanderson, E., Zahler, P., & Fisher, K. (2016). *What is a Snow Leopard? Biogeography and Status Overview* (pp. 23–42). https://doi.org/10.1016/B978-0-12-802213-9.00003-1

NCD. (2019). *Bhutan Snow Leopard Conservation Action Plan.* https://globalsnowleopard.org/wp-content/uploads/2021/08/Bhutan-Snow-Leopard-Conservation-Action-Plan-2018-2023.pdf

Rai, A., & Phuntsho, P. (2016). *LAND USE AND LAND COVER OF BHUTAN 2016 MAPS AND STATISTICS.*

RGoB. (2023). *Forest and Nature Conservation Act of Bhutan.*

Thinley, P., Lham, D., & Wangchuk, N. (2016). *National Snow Leopard Survey of Bhutan – Phase I: Sign and Prey Base Survey.*