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# Camera trapping reveals habitat overlap between snow leopards and common leopards in Gaurishankar Conservation Area, Nepal

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## Abstract

We provide camera trap records of the presence of two large predators: the snow leopard *Panthera uncia* and common leopard *Panthera pardus* from the same habitats in Lapchi Valley of Gaurishankar Conservation Area. Camera traps were laid for 2,304 (mean 88.62 ± SD 103.34) trap nights in 26 locations (elevation range: 2,140 to 4,350 m, area: 141.63 km2). A total of 55, 219 pictures were recorded from November 2022 to May 2023. Out of 26 camera stations, two camera stations captured the images of both species at an altitude of 4,000 m and 4,260 m in Lapchi Valley. The Relative Abundance Indices of snow leopards and common leopards were 7.51 ± SD 6.35 and 9.84 ± SD 6.35 per 100 trap days/nights, and independent detection rates were 0.41 and

0.52 respectively. This is the first evidence of habitat overlap between two large vulnerable predators in Gaurishankar Conservation Area. The nature of the coexistence or competition between these predators needs further investigation.

# Introduction

Both snow leopards *Panthera uncia* and common leopards *Panthera pardus* are classified as vulnerable on the IUCN RED LIST (Stein et al. 2020, McCarthy et al. 2017). The species faces several threats because of human encroachment including poaching and trade of their body parts. Data on population status and densities of the two species are limited for the Nepal Himalayas. Similarly, there is no robust population estimate globally, due to their elusiveness, harsh terrain in which they inhabit (snow leopards), and wider distribution (common leopards). However, IUCN RED LIST estimated a population of mature individual snow leopards to be in the range of 2,710 – 3,386 (McCarthy et al. 2017). No such estimates are available for common leopards, and it is believed that the suitable habitats have declined by > 30% globally in the last 22.3 years (Stein et al. 2020).

In 2016, in Qinghai Province, China, common leopard and snow leopard were photographed in the same location (Khagda 2017). Lovari et al. (2013a) found a diet overlap between snow and common leopards, but not in habitat use, in Sagarmatha National Park. However, there have been no records and evidence of the two species sharing the same habitat in Gaurishankar Conservation Area (GCA). In this manuscript, we provide the first evidence of the presence of snow leopards and common leopards in the same habitat in Lapchi Valley of GCA.

# Methods

## *Study Area*

We conducted a camera trapping survey from November 2022 to May 2023, in Lapchi Valley of GCA (Fig 1), GCA (area: 2,179 km$^2$, location: E 85° 46.8' - 86° 34.8' and N 27°34.2' - 28°10', altitude ranges: 968 – 7134 m asl.) is located in between two important national parks – Langtang National Park in the west, and Sagarmatha National Park in the east and acts as a biological corridor (Fig 1). It was established in 2010 and is managed by the National Trust for Nature Conservation. It covers three districts – Dolakha, Rammechhap, and Sindupalchok. The northern border is adjacent to the Tibetan autonomous region of the People's Republic of China. It is continuous with the largest nature reserve in Tibet, i.e., Qomolangma National Nature Reserve. The area is rich in both floral and faunal diversity due to diverse physiographic and climatic zones which vary from mid-hills to high mountains and from subtropical to arctic (GCA 2022). Nearly 70,000 people are living within GCA. The main source of income for the local communities are animal husbandry and terrace farming. At higher elevations, rangelands are used for grazing livestock such as goat, sheep, cow, horses, dzo (yak-hybrid), and yak. Transhumance traditions are also present in some remote northern villages, for example in Lapchi Valley where approximately 100 residents Buddhist community people live following a pastoral lifestyle. Lacphi Valley encompasses an important beyul and pilgrimage center for Tibetan Buddhism.

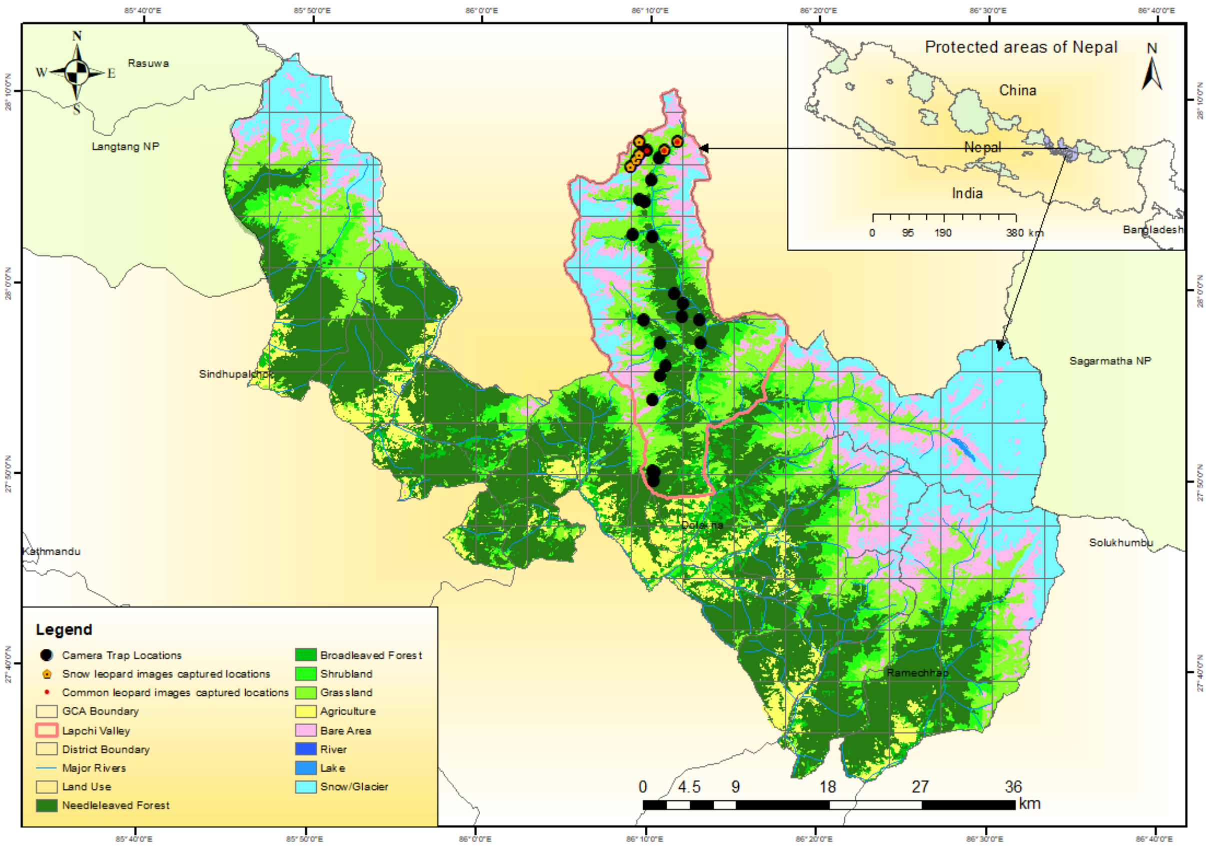


**Figure 1:** *Location map of the study area showing study grid cells.*

## *Site Selection and camera trapping*

We divided the entire Lapchi Valley into 5x5 km grid cells using ArcGIS. Camera traps were placed on major livestock trails, junction of the trails, ridgeline and in the mountain passes. Camera traps were deployed in 8 grid cells covering an area of 141.63 km$^2$ and monitored regularly. Each grid cell had one to two pairs of camera traps. In total, we deployed 40 camera traps across 26 locations at an elevation range of 2,140 to 4,260 m asl, with a minimum distance of 1 km between each trap. Regrettably, we lost 7 camera traps, so the analysis was conducted using data from 33 camera traps only.

## *Data management and analysis*

All camera trap images were managed by using CameraSweet program as described by Sanderson and Harris (2013). Relative Abundance Index (RAI) is expressed as the number of independent images per 100 trap nights (Harris et al. 2010; Jenks et al. 2011; Sanderson and Harris 2013). We computed RAI only for wild mammals. Other species photographs including humans, birds, yak, dog, horse, and unknown species were not included in the analysis. We defined capture events as separate images of a species at a particular location with a time gap of 30 minutes.

## Results

A total of about 55,219 pictures were recorded from November 2022 to May 2023. A comprehensive analysis was conducted on 1,816 photographs of various species obtained from camera traps (Table 1). Out of the 386 independent images, 29 images were of snow leopard from 6 camera locations, and 38 images were of common leopard from 8 camera locations. These images were captured over a span of 2,304 trap nights (mean 88.62 ± SD 103.34). Two camera stations located at Lyamadinka kharka (4,260 m) and Lapchi Deurali (4,000 m) capture images of both snow leopards and common leopards (Photo A and B). The Relative Abundance Indices of snow leopards and common leopards were 7.51± SD 6.35 and 9.84 ± SD 6.35 per 100 trap days/nights and independent detection rate are 0.41 and 0.52 respectively. Although scrape and pugmark signs of both common – and snow leopards were recorded near Lapchi village (3,870 m), we were able to obtain pictures of only common leopards. A total of 19 mammalian species were recorded from the Lapchi valley. The highest RAI recorded was of Himalayan musk deer (24.87) followed by Mainland serow (10.62), Leopard cat (10.1), Common leopard (9.84), and Snow leopard (7.51) respectively (see Table 1).

## Discussion

The occurrence of snow leopards and common leopards in the same ranges raises many interesting questions for future research in the Gaurishankar Conservation Area. Similar records are also available from other snow leopard range countries (see Pal et al. 2022, Buzzard et al. 2017, Snow Leopard Trust 2017). In addition, recent record from the Great Himalayan National Park in Himachal Pradesh, India at an elevation of 2,495 m also indicates the potential cooccurrence of the common leopard with the snow leopard (Bandyopadhyay et al. 2019). With the changing climate, the tree line is moving upward (Hansson et al. 2021) which might create more suitable habitat for the highly adaptable common leopard, and shrink the habitat for more specialized snow

**Photo 1A & B.** *Snow leopard and common leopard in the same habitat. Snow leopard and Common leopard camera trap photos in Lapchi Valley of Gaurishankar Conservation Area, Nepal.*

| SN | Species | RAI (number of independent camera-trap captures/ 100 trap-nights) | Minimum-Maximum elevation (m) | IUCN Status |
|---|---|---|---|---|
| 1 | Asiatic Golden Cat Pardofelis temminckii | 0.26 | 3530* | NT |
| 2 | Royle's Pika Ochotona roylei | 0.26 | 4120* | LC |
| 3 | Kashmir Gray Langur Semnopithecus ajax# | 0.52 | 2140* | EN |
| 4 | Himalayan Marmot Marmota himalayana | 0.78 | 4070-4120 | LC |
| 5 | Yellow-throated Marten Martes flavigula | 0.78 | 2790-3750 | LC |
| 6 | Himalayan Tahr Hemitragus jemlahicus | 1.04 | 2640-3600 | NT |
| 7 | Wild Boar Sus scrofa | 1.3 | 2640-3340 | LC |
| 8 | Himalayan wolf Canis lupus chanco | 1.55 | 4000-4260 | LC |
| 9 | Northern Red Muntjac Muntiacus vaginalis | 1.81 | 2310-3240 | LC |
| 10 | Bharal/Blue Sheep Pseudois nayaur | 1.81 | 3870-4120 | LC |
| 11 | Himalayan Goral Naemorhedus goral | 1.81 | 2140-3340 | NT |
| 12 | Assam Macaque Macaca assamensis | 5.7 | 2140-2790 | NT |
| 13 | Himalayan Black Bear Ursus thibetanus | 5.96 | 2640-3750 | VU |
| 14 | Snow Leopard Panthera uncia | 7.51 | 3990-4260 | VU |
| 15 | Common Leopard Panthera pardus | 9.84 | 2790-4260 | VU |
| 16 | Leopard Cat Prionailurus bengalensis | 10.1 | 2310-4000 | LC |
| 17 | Himalayan/Mainland Serow Capricornis thar | 10.62 | 2640-3750 | VU |
| 18 | Red Fox Vulpes vulpes | 13.47 | 3460-4260 | LC |
| 19 | Himalayan Musk Deer Moschus leucogaster | 24.87 | 3220-4260 | EN |

Note: * Recorded only in one location, # species needs genetic verification

**Table 1:** *Relative Abundance Index (RAI) of the major species in Lapchi valley of Gaurishankar Conservation Area, Nepal.*

leopards. Forest et al. (2012) reveals that 50% of the current snow leopard habitat in the Himalayas will be altered due to shifting tree line, which will ultimately lead to shrinkage of snow leopard habitats and alpine zone. Currently, it is important to investigate whether the spatial overlap between the two predators leads to competition for food. Lovari et al. (2013a) found that the two species share food but not habitat in Sagarmatha National Park, which is adjacent to our study site. The snow leopard mostly preferred habitats above tree line and common leopard preferred forest habitats and sometimes visited the edge of tree line for hunting (Lovari et al. 2013a). Our camera trap that photographed both species was deployed in a human trail leading to Tibet and alpine pasture for livestock grazing. The lower slope is very close to the forest edge of the upper tree line dominated by Himalayan birch (*Betula utilis*) and the under scrub is dominated by dwarf Rhododendron (*Rhododendron nivale*) and Juniper (*Juniperus indica*). Lovari et al. (2013b), found that in areas where prey availability is limited, the two species live in sympatry and interspecific competition could develop at the junction of close and open habitats. This seems true in our study area, as the number of preferred prey species of snow leopards, mainly the blue sheep (Chetri et al. 2017) is very low. During May 2022, we counted a total of 32 individual blue sheep (*Pseudois nayaur*) in four herds. Other prey species found in the area are Himalayan musk deer (*Moschus leucogaster*) and a small number of Himalayan marmots (*Marmota himalayana*). Villagers also claim high livestock depredation, which reveals livestock may play an important role in substituting wild prey of both snow leopard and common leopards. Our camera traps also captured images of snow leopards from forest habitats at an altitude of 3990 m. We assumed this was mainly due to the low number of prey animals in the alpine zone. Snow leopards move to lower elevations in the forest habitats to hunt forest-dwelling species such as Himalayan goral (*Naemorhedus goral*), Himalayan musk deer, and Himalayan tahr (*Hemitragus jemlahicus*). This indicates that there might be a high habitat overlap between the two predators in GCA. However, our understanding of how these two species interact remains limited. There is a need to increase research efforts to understand how these two species associate, which may differ depending on environmental and biological factors. Further studies concentrating on seasonal movements, habitat use, and diet overlap might increase our knowledge of these important predators in GCA.

## Acknowledgments

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## Conflict of Interest

No known conflicts of interests.

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