



SNOW LEOPARD CONSERVATION

in Uttarakhand and Himachal Pradesh



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Species Conservation Programme
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FOREWORD

The Himalayas, the highest mountain system on planet Earth have always been a source of awe, inspiration and spiritual solace. Home to a wide diversity of flora and fauna, this mountain range has fostered human civilisations and cultures across ages. The Himalayas encompass a number of unique features, including wetlands, glaciers and the source of several rivers truly making it the water tower of Asia. As such, it is imperative to conserve this unique range of mountain ecosystems for the future well being of many natural species, including humanity.

WWF-India is privileged to be working in this region to support its conservation.

The snow leopard, an elusive and iconic species of the Greater and Trans-Himalayas is one about which little is known even today. This is especially true of the Indian Himalayas where information on snow leopard status and distribution is sketchy across most of its range. WWF-India has conducted surveys in parts of Uttarakhand and Himachal Pradesh in the Northern Himalayas to assess the status and distribution of snow leopard, its co-predators and prey species. This document presents the findings of our surveys which we trust will serve as a useful reference on the species in India and also as a base line on the areas surveyed . We further hope that some of the findings will be useful in the implementation of the recently launched Project Snow Leopard by the Ministry of Environment and Forests.

For upscaling conservation initiatives in the Himalayas, the need for more individuals to come forth is an imperative. We believe that such reports will inspire those who may like to study snow leopards in the field - though this is not the easiest of conservation efforts, given the terrain and climatic conditions - the environment in a larger sense, is unsurpassed on earth.

WWF-India compliments Aishwarya Maheshwari, the author of this report for his tenacity, diligence and hard work in carrying out the field work and preparing this report. We also compliment the initiatives of Dr. Diwaker Sharma, Mr. Sujoy Banerjee and many others, including the Forest Department personnel who supported the work in the mountains.

Ravi Singh,
Secretary General and CEO
WWF-India





Om Parvat at Askot WLS



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ABBREVIATIONS

AC	Assistant Commandant
AWLS	Askot Wildlife Sanctuary
DC	Deputy Commandant
GHNP	Great Himalayan National Park
GNP	Gangotri National Park
GPV	Govind Pashu Vihar
HP	Himachal Pradesh
I	Inspector
KWLS	Kugti Wildlife Sanctuary
NP	National Park
SDGI	Sunderdhunga Glacier
SI	Sub-Inspector
SWLS	Sangla Wildlife Sanctuary
VoFNP	Valley of Flower National Park
WII	Wildlife Institute of India
WLS	Wildlife Sanctuary
WWF	World Wide Fund for Nature



ABSTRACT

The Greater and Trans Himalayan regions of Uttarakhand and Himachal Pradesh have great potential in terms of wildlife (flora and fauna). This survey was the first ever survey for the snow leopard in Uttarakhand and some of the areas of Himachal Pradesh till date. It confirms the presence of snow leopard in Uttarakhand on the basis of indirect evidence. We could not find any evidence of snow leopard from surveyed areas in Himachal Pradesh – but it certainly does not mean that there are no snow leopards in the surveyed areas.

Areas above 3000m elevation were selected for this survey in 10 protected areas of both the states. Status and distribution of snow leopard was assessed through indirect evidence (n=13) found between 3190 and 4115m. On average, one indirect evidence of snow leopard was found for every 39km walked. About 39% of the evidence was found on the hill-slope followed by valley floor (30%), cliff (15%) and 8% from both stream bed and scree slope. Preferred mean slope was 28° (maximum 60°). Snow leopard-human conflicts were assessed through questionnaire surveys from Govind Pashu Vihar, Askot Wild Life Sanctuary and Dung (Munsiari) areas. They revealed that livestock depredation is the only component of conflict and contributed to 36% of the total diet (mule, goat and sheep) of snow leopard. Blue sheep and rodents together comprised 36.4% of the total diet.

Threats to snow leopard and its habitat were investigated through discussions with officials, staff in field, locals and through primary observations. Of the area surveyed, we found that 68.1% was used for pastoral activities in Uttarakhand and Himachal Pradesh and 12.3% area was affected by tourism, defence and developmental activities.

We also investigated the occurrence of other mammals such as Himalayan brown bear, Asiatic black bear, common leopard, wolf, red fox, blue sheep, Asiatic ibex, goral, Himalayan tahr, musk deer and Himalayan marmot in the areas surveyed.

The intensity and occurrence of threats (snow leopard-human conflicts, tourism, developmental activities, grazing and human settlements) varied among areas surveyed. Based on detailed analysis of scope (geographic extent), severity and irreversibility of threats, it is found that developmental activities pose medium level threat while grazing, tourism and human-snow leopard conflicts pose low to medium levels of threats.

No grazing was observed in Gangotri National Park, Valley of Flower National Park and Great Himalayan National Park as it is not allowed by forest department. Developmental activities such as construction of roads are a threat to snow leopard habitat at Nilang Valley, Askot Wildlife Sanctuary and Nanda Devi



Biosphere Reserve. Shepherds reported livestock depredation from snow leopard, Himalaya brown bear, Asiatic black bear and wolf.

Quantitative data on species abundance could not be collected in this survey and therefore, we recommend a comprehensive survey of snow leopard, associated species and potential habitats for snow leopard conservation. We propose Gangotri National Park, Askot Wildlife Sanctuary and Nanda Devi Biosphere Reserve be seen as potential habitats for snow leopard under Project Snow Leopard. There are other areas, viz., the Valley of Flower National Park, Tundah wildlife sanctuary, Great Himalayan National Park and Lippa Asrang wildlife sanctuary which should also be taken into consideration for snow leopard conservation.

The remote areas of Uttarakhand and Himachal Pradesh suffer from inadequate field staff, lack of checkpoints, lack of allowances/ incentives for field staff and lack of management plans for most of the Protected Areas. Therefore, we recommend well developed management plans, infrastructure and capacity building for field staff of PAs in both states.

To minimise different levels of threats such as developmental activities and grazing pressures in the high altitude areas we recommend well planned development and adequate grazing policy with local participation.



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INTRODUCTION AND BACKGROUND

The snow leopard (*Uncia uncia*) is a large cat native to the mountain ranges of central and southern Asia. It is widely distributed over an area of 3.02 million km² (Hunter and Jackson 1997) and highly threatened throughout its range. The total snow leopard population is estimated to be between 4,500 and 7,500 across 12 countries, *viz.*, Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russia, Tajikistan and Uzbekistan (Fox 1994; Jackson and Hunter 1996). It is categorized as endangered in the IUCN Red Data Book and is listed in Appendix I of the CITES. Habitat of snow leopard is characterized by cold, arid and semiarid shrub land, grassland or barren areas (Jackson and Hunter 1996).

Positions at the top of food chains make predator species, such as snow leopard, good indicators of the health of ecosystems. Wide diversity, high abundance and regular presence of predators are sure signs of good availability of broad range of prey species and other biodiversity within ecosystems (Wilson and Delahay 2001). The snow leopard serves as an indicator species for Asia's high mountain ecosystems and, requires large home ranges. Therefore, by protecting the snow leopard, entire high altitude ecosystem can be protected.

Unfortunately, information on the distribution and abundance is as scanty as the animal itself. Snow leopard is less studied than any other large felid such as tiger, lion and leopard in India. Its current range is poorly mapped due to the high and inhospitable terrain inhabited by snow leopard. Any attempt to study snow leopard in India started only in 1988 when Chundawat *et al.* estimated 95,000 km² as potential habitat for snow leopard in India, of which 72,000 km² was within Ladakh (includes about 20,000 km² within the disputed area between Pakistan and China). Hunter and Jackson (1997) estimated total potential habitat for snow leopard as 75,000 km² in India out of which only 14.4% area is protected.

Similarly, there are very few population estimates available. Fox *et al.* (1991), based on mean density of one animal/110 km² for good habitat and one animal/190 km² for lower quality habitat, estimated a population of some 500 animals in India. Mallon's (1984) estimated a population of only 100 - 300 snow leopards in Ladakh. These estimates are generally extrapolations based on the quality of snow leopard habitat in the surveyed areas.

Snow leopard has not been surveyed systematically in its range in India. Its presence is reported in Jammu and Kashmir and Himachal Pradesh (12 protected areas in each state); out of which the status of the species in many protected areas is uncertain. Similarly, other states such as Uttarakhand with 05, Sikkim



with 03 and Arunachal Pradesh with 01 protected areas have reported the presence of snow leopard. The information on the status, distribution and abundance of this elusive cat is generally poor.

In India, studies had been conducted in some of the protected areas of Jammu and Kashmir and Himachal Pradesh. But in rest of the states such as Sikkim and Arunachal Pradesh, the unprotected areas of snow leopard distribution range have been still unexplored. In Uttarakhand, wildlife surveys were conducted by Green (1985), Sathyakumar (1993 and 2003a) and Rawat (2005). But specific surveys on snow leopard were lacking. Researchers documented snow leopard information while conducting other studies in various regions of Uttarakhand (Green 1985, Sathyakumar 1993 and 2003a, Rawat 2002). Though Uttarakhand has very little area under Trans-Himalayan Biogeographic zone i.e. ideal habitat for snow leopard, there are many areas which fall in the transitional zone of Trans-Himalayas and Greater Himalayas. Similarly, the Trans-Himalayan zone of Himachal Pradesh, Lahaul-Spiti and Pangi Valley were studied for snow leopard and wildlife values by Bhatnagar (1996, 1997, and 2002) and Saberwal (1996) but some of the areas of Himachal Pradesh have very poor information about snow leopard.

Therefore, realising gaps in the available information on snow leopard in Uttarakhand and Himachal Pradesh, WWF-India initiated field surveys for snow leopard in these states.

OBJECTIVES:

The objectives of the survey were:

- 1. To study the occurrence and distribution of snow leopard.***
- 2. To assess snow leopard – human conflicts.***
- 3. To investigate grazing pressure and human disturbance in snow leopard habitat.***



SNOW LEOPARD HABITATS IN UTTARAKHAND AND HIMACHAL PRADESH

The snow leopard habitats for surveys were selected based on the information available and discussion with experts. The consultative process towards Project Snow Leopard was also of help in deciding the areas for survey.

In the precursor meeting of Project Snow Leopard (PSL) in 2006, Uttarakhand Forest Department proposed six districts for snow leopard conservation. These were Uttarkashi, Tehri, Rudraprayag, Chamoli, Pithoragarh and Bageshwar. The existing seven protected areas (PAs), viz. Gangotri NP (including Nelong Valley, Gomukh and Tapovan), Govind Pashu Vihar, Kedarnath Musk Deer Sanctuary, Nanda Devi Biosphere Reserve, Pindari, Sunderdhunga and Askot WLSs within these districts were included for PSL. All these PAs were taken into consideration and surveyed in this survey, except Kedarnath Musk Deer Sanctuary and Pindari as these areas have been surveyed in detail in the past (Satyakumar 1995; and ongoing project in Pindari). On the other hand additional areas - Dung and Valley of Flower NP were included after detailed discussions with biologists who reported the presence of prey species such as blue sheep from these areas.

During the PSL meeting (2006), Himachal Pradesh Forest Department proposed the inclusion of all areas above 3000m, in the survey. These were Lahaul, Spiti, Pangi, Kinnaur, Upper Chamba, Upper Kangra, Upper Kullu and Upper Simla. These districts include the following eleven PAs: Pin Valley NP, Kibber WLS Great Himalayan NP, Sainj WLS Tirthan WLS Lippa Asrang WLS Bandi WLS Kugti WLS Tundah WLS Dhauladhar WLS and Sangla (Raksham Chitkul) WLS. Of these, Lahaul, Spiti, Pangi were not included in this survey because information is already available from these areas on snow leopard. Therefore, five protected areas were selected for this survey: Great Himalayan NP, Kugti WLS Tundah WLS Sangla (Raksham Chitkul) WLS and Lippa Asrang WLS. But due to limitations of time only three PAs - Kugti WLS, Sangla (Raksham Chitkul) WLS and Great Himalayan NP were surveyed. Of these three, even the Great Himalayan NP was not studied extensively.

Overall, 13 Protected Areas (PAs) were selected for this survey, out of which ten were surveyed and are described here. Due to limitations three of PAs - Tundah WLS Lippa-Asrang WLS and Pangi Valley were not surveyed. Efforts made for the survey in each PA are summarised in table 1 and details regarding the survey routes and schedule are given in appendix 3.



Table 1: Total distance walked and sampling efforts (KM) in Uttarakhand and Himachal Pradesh.

S.No.	Area surveyed	Survey transects (Km)	Total distance walked (Km)
Uttarakhand			
1	Gangotri NP	142	226
2	Askot WLS	80	121
3	Govind Pashu Vihar	60	114
4	Sunderdhunga GI	11	98
5	Munsiari to Dung	36	118
6	Nanda Devi Biosphere Reserve	82	92
7	Valley of National Park	28	54
Himachal Pradesh			
8	Great Himalayan NP	16	60
9	Sangla (Raksham Chitkul) WLS	36	54
10	Kugti WLS	13	50





2.1 GOVIND PASHU VIHAR (GPV):

The GPV ($77^{\circ} 45'$ to $78^{\circ} 37'$ North and $30^{\circ} 55'$ to $31^{\circ} 18'$ East) is located in District Uttarkashi of Uttarakhand. The altitude of GPV WLS varies from 1290 m to 6387 m above MSL (Mean Sea Level). It falls under Biogeographic zone-2B of North-West Himalayas (Rodgers and Panwar, 1988). The major floral species found in the GPV are chir pine (*Pinus roxburghii*), cedar (*Cedrus deodara*), oak (*Quercus sp.*), rhododendron (*Rhododendron sp.*) etc. The area also harbours other endangered mammal species such as common leopard (*Panthera pardus*), Asiatic black bear (*Ursus thibetanus*), Himalayan tahr (*Hemitragus jemlahicus*), blue sheep (*Pseudois nayaur*) and musk deer (*Moschus chrysogaster*).



2.2 GANGOTRI NATIONAL PARK (GNP):

The GNP ($30^{\circ} 50'$ to $31^{\circ} 12'$ North and $78^{\circ} 45'$ to $79^{\circ} 02'$ East) is located in the upper catchments of Bhagirathi river in Uttarakhand's Uttarkashi District. The park's north-eastern boundary is located along the International boundary with China. It falls under the Biogeographic zone-2B North-West Himalaya (Rodgers and Panwar, 1988).

The park area forms a viable continuity between Govind Pashu Vihar and Kedarnath Wildlife Sanctuary. High ridges, deep gorges and precipitous cliffs, rocky craggy glaciers and narrow valleys characterize the area. There is a variety in the elevation gradients ranging from 1800m to 7083m above MSL, which in turn reflects in the diverse biomes, from alpine meadows to subtropical communities.

So far 15 species of mammals and 150 bird species have been documented in the park (Paramanand *et al.* 2000). This includes some rare and charismatic species such as snow leopard, black bear, Himalayan brown bear (*Ursus arctos*), musk deer, blue sheep, Himalayan tahr, Himalayan monal (*Lophophorus impejanus*), Koklass (*Pucrasia macrolopha*) and Himalayan snowcock (*Tetraogallus himalayensis*).



2.3 SUNDERDHUNGA GLACIER (SDGL):

The SDGI is located adjacent to Nanda Devi Biosphere Reserve in the Bageshwar District of Uttarakhand. It represents the Biogeographic zone-2B of North-West Himalayas (Rodgers *et al.* 1988). Information on the area's wildlife is poor.

2.4 ASKOT WILDLIFE SANCTUARY (AWLS):



The AWLS is situated in the Pithoragarh District of Uttarakhand State. Established in 1986, it represents the Biogeographic zone-2B of North-West Himalayas (Rodgers *et al.* 1988) and spreads over an area of 599.93 sq km. It is located at Lat. 29.30-29.45 to Long. 80.20-80.25. The altitude varies from 2400 m to 5000 m above MSL. The broad vegetation types of the area are sub-alpine forest, Himalayan moist forest and alpine moist pasture.



2.5 MUNSIARI TO DUNG:

Munsiari and Dung areas are located in the Pithoragarh District of Uttarakhand. It represents the Biogeographic zone-2B of North-West Himalayas (Rodgers *et al.* 1988). There is very little information available about wildlife of Munsiari and Dung areas.



2.6 NANDA DEVI BIOSPHERE RESERVE (NDBR):

The NDBR (79° 40' and 80° 5' East and 30° 17' and 30° 41' North) is spread over an area of 2236.74 sq km across three districts – Chamoli, Bageshwar and Pithoragarh in Uttarakhand. It represents the Biogeographic zone-2B of North-West Himalayas (Rodgers *et al.* 1988). Large altitudinal variation (1800 m–7817 m) and the varied topography support rich biological diversity in NDBR. About 27% of the total area of the Reserve is covered by forest and alpine meadows while 66% is buried under perpetual snow. Human settlements, agriculture and wasteland (Sahai *et al.* 1995) occupy the rest. Asiatic black bear,



brown bear, musk deer, blue sheep, Himalayan tahr are some of the species found in the NDBR, in addition to snow leopard.

2.7 VALLEY OF FLOWER NATIONAL PARK (VOFNP):

The VOFNP (30° 41'- 30° 48' North and 79° 33' 79° 46' East) is spread over an area of 87.5 sq km in Chamoli District of Uttarakhand. The National Park is bounded by Gauri Parvat (6,590 m) and Rataban (6,126 m) in the east, Kunt Khal (4,430 m) in the west, Sapsring (5,038 m) in the south and Nilgiri Parvat (6,479 m) in the north. VOFNP became a World Heritage Site in 2005. The biological significance of VOFNP lies in its exquisite floral and faunal biodiversity with a myriad of alluring flowers.



2.8 GREAT HIMALAYAN NATIONAL PARK (GHNP):

The GHNP is situated between 31° 38' – 31° 45' North and 77° 20' – 77° 52' in Kullu District of Himachal Pradesh covering a total area of 755 sq km. The park consists of the catchments of Tirthan, Sainj, Jiwa and Parvati rivers flowing into the Beas river. The altitude varies from 1300 m to 6110 m above MSL. The

GHNP represents the Biogeographic zone-2A North-West Himalayas (Rodgers *et al.* 1988). The area is characterized by high ridges, deep gorges, precipitous cliffs, rocky glaciers and narrow valleys.



2.9 SANGLA (RAKSHAM-CHITKUL) WILDLIFE SANCTUARY (SWLS):

The SWLS was established in 1989. It is located in the Kinnaur District of Himachal Pradesh. It represents the Biogeographic zone-2B of North-West Himalayas (Rodgers *et al.* 1988) covering an area of 304 sq km. The broad vegetation types of this area are alpine arid pastures, alpine dry scrub and Himalayan dry temperate.





2.10 KUGTI WILDLIFE SANCTUARY (KWLS):

The KWLS is situated in the Chamba District of Himachal Pradesh. It represents the biogeographic zone-2A of North-West Himalayas (Rodgers *et al.* 1988). KWLS (Lat 32° 20' N and 32° 35' N and Long 76° 35' E and 76° 55' E), covers an area of 379 sq km. The altitude of KWLS varies from 2400 m to 5000 m above

MSL and it touches the Lahul-Spiti District of Himachal Pradesh State. The broad vegetation type represents the Himalayan moist temperate. The annual rainfall in KWLS is recorded as 1400 mm.



METHODS

The survey methods included scanning snow leopard habitats on the mountains after climbing within an altitudinal range in an area. Discussions were held with the locals aided by a well developed questionnaire. The methods were adopted based on the total time and other resources available. The details are given below:

3.1 SELECTION OF THE SITES FOR SURVEY

Based on the scarcity of information available on snow leopard from Uttarakhand and Himachal Pradesh, we identified these two states as gaps in the Snow leopard Information Management System (SLIMS). Altitudinal range of snow leopard (*i.e.* above 3000 m from MSL), prey availability, and continuity with the other snow leopard habitats at national and international levels were taken into consideration while designing the survey. In addition, discussions were held with the forest department and biologists who surveyed and worked in these areas and information was gathered on overall habitat and on the wildlife significant for snow leopard. A preliminary map was generated based on this information and areas were identified for the survey in these two states.



3.2 SNOW LEOPARD OCCURRENCE AND DISTRIBUTION SURVEY

Sign surveys were conducted in almost all snow leopard habitats above 3000m above MSL (the lowest snow leopard range in India) in Uttarakhand and Himachal Pradesh. Five types of signs were recorded:

- a) **scat** - snow leopard scat tends to be uniform in diameter (an average 1.8 cm) and comprises of several slightly constricted cords or connected with blocky segments (up to 8-10 cm; Janecka *et al.* 2008) with blunt ends
- b) **pug-marks** (*i.e.* tracks)
- c) **scrape** – a mark with hind paw consisting of an oblong depression with a pile of earth at one end
- d) **spray/urine** (scent-mark on rock surfaces by spraying them with urine)
- e) **claw-marking** – snow leopards may leave claw marks on tree trunks or rock faces.

Trekking routes and transects in potential snow leopard habitats (such as ridgelines, cliff edges) were used where snow leopard signs were most likely to be found. These routes were walked by a single observer and all signs of snow leopard and co-predators (such as common leopard (*Panthera pardus*), Asiatic black bear (*Ursus thibetanus*), Himalayan brown bear (*Ursus arctos*) and Tibetan wolf (*Canis lupus chanco*) were recorded. At each site, information on location, date, elevation, slope, aspects, land ruggedness, habitat types, distance from human habitation and nearest water point were recorded with the help of GPS. The habitats where snow leopard evidence was found were classified based on the parameters (such as landforms and habitats) of the Snow Leopard Information Management System (SLIMS) by Jackson and Hunter (1996); a standardized approach widely used in snow leopard research.

3.3 OCCURRENCE OF PREY SPECIES

Population distribution and behaviour of prey influence the quality of a predator's habitat and the health of predator populations. Therefore, knowledge about the prey species of any predator is a must to understand the ecology of the predator. During the present surveys, data were collected on the prey species of snow leopard. Survey routes were scanned carefully using an 8X binocular. On each sighting, animals were counted, classified and habitat variables such as topographic features, aspect, slope, altitude, major habitat features and activity of the group were recorded. Total number of animals sighted, group composition and mean altitude were recorded for prey species. The occurrence of many smaller prey species such as rodents, pika and hare was difficult to determine because of their habitat preference and behaviour.





Livestock at Govind Pashu Vihar

3.4 Food habits of snow leopard

The predator distribution coincides closely with its principal prey species. Estimating the consumption of any particular prey type by carnivores depends upon the reliable analysis of diet. The analysis of scats (Reynolds and Abeischer 1991, Chundawat and Rawat 1994) is one of the most reliable and thoroughly used techniques that have become fundamental tools in carnivore research and conservation.

Scats were collected on all survey routes wherever they were encountered. All scats were stored in polythene bags, and their GPS location, place, habitat and other parameters were recorded at the time of collection. These scats were oven dried and then crushed and teased for the indigestible material such as hairs, hooves, bones etc. All prey species were identified on the basis of the typical hair structure (cuticle and medullar). Composition of prey species in snow leopard diet was calculated based on the evidence found in scats.

3.5 SNOW LEOPARD – HUMAN CONFLICTS

The increasing interface between humans and large carnivores is resulting in a world-wide escalation of large carnivore – human conflicts (Madhusudan *et al.* 2003; Treves *et al.* 2003). Carnivores often cause serious economic losses. Livestock depredation by snow leopard has been reported throughout its range (Bhatnagar *et al.* 1999, Hussain 2003, Oli *et al.* 1994, Jackson *et al.* 1996, Mishra 1997, Jaypal 2000, Jackson *et al.* 2003, Sathyakumar 2003). Inadequate understanding of ecological and social issues of such conflicts makes the resolution of such conflicts more critical. Keeping this in view, information gathering of snow leopard-human conflicts was made an integral component of the survey.



During the survey, information on the attacks on livestock was gathered from all the shepherds who graze their livestock in the snow leopard habitat at more than 3000 m above MSL. Details about livestock such as number of livestock, animals owned by the family and livestock protection methods were asked informally, based on the questionnaire.

3.6 THREATS TO SNOW LEOPARD AND ITS HABITAT

During this survey, information such as evidence of human and livestock, developmental activity (road construction and hydroelectric dams), permanent or temporary human settlement present, construction of roads, tourism, signs of grass and tree cutting and lopping was collected. In addition, discussions were held with locals and forest department on the threats to snow leopard and its habitat. On the basis of the intensity of disturbances, these were categorized as high, medium and low – as described below:

Pressures*	High	Medium	Low
Grazing	10-15 livestock groups	6-9 livestock groups	<5 livestock group
Human settlements	26-50 households	15-25 households	<15 households
Tourism	75-200 tourists / day	20-74 tourists /day	<20 tourists/ day

* Pressures are further explained below:

Grazing: Average number of livestock in one group is 500. Only seasonal grazing takes place in snow leopard habitats

Human settlements: permanent / temporary

Tourism: Number of tourists per day and garbage material dumped by tourists

The intensity of pressures was analyzed with the Software *Miradi* Version 2.4 under three step analyses: scope, severity and irreversibility defined below:

I. Scope - Most commonly defined spatially as the proportion of snow leopard and its habitat that can reasonably be expected to be affected by a threat within ten years, given the continuation of current circumstances and trends.

- **Very High:** The threat is likely to be pervasive in its scope, affecting the snow leopard and / or its habitat across all or most (71-100%) of the surveyed areas.
- **High:** The threat is likely to be widespread in its scope, affecting the snow leopard and / or its habitat across much (31-70%) of the surveyed areas.



- **Medium:** The threat is likely to be restricted in its scope, affecting the snow leopard and / or its habitat across some (11-30%) of the surveyed areas.
- **Low:** The threat is likely to be very narrow in its scope, affecting the snow leopard and / or its habitat across a small proportion (1-10%) of the surveyed areas.

II. Severity - Within the scope, the level of damage to snow leopard and its habitat from the threat that can reasonably be expected, given the continuation of current circumstances and trends. For habitat, it is typically measured as the degree of destruction or degradation within the scope. For snow leopard, usually measured as the degree of reduction of its population within the scope.

- **Very High:** Within the scope, the threat is likely to destroy or eliminate, or reduce snow leopard and / or its habitat by 71-100% within ten years or three generations.
- **High:** Within the scope, the threat is likely to seriously degrade/reduce snow leopard and/or its habitat by 31-70% within ten years or three generations.
- **Medium:** Within the scope, the threat is likely to moderately degrade/reduce the target or reduce snow leopard and/or its habitat by 11-30% within ten years or three generations.
- **Low:** Within the scope, the threat is likely to only slightly degrade/reduce the target or reduce snow leopard and/or its habitat by 1-10% within ten years or three generations.

III. Irreversibility (Permanence) - The degree to which the effects of a threat can be reversed and the snow leopard and/or its habitat affected by the threat restored.

- **Very High:** The effects of the threat cannot be reversed and it is very unlikely the snow leopard and/or its habitat can be restored, and/or it would take more than 100 years to achieve this (e.g., habitat converted to a reservoir).
- **High:** The effects of the threat can technically be reversed and the snow leopard and/or its habitat restored, but it is not practically affordable and/or it would take 21-100 years to achieve this (e.g., wetland converted to agriculture).
- **Medium:** The effects of the threat can be reversed and snow leopard and/or its habitat restored with a reasonable commitment of resources and/or within 6-20 years (e.g., grazing by livestock).
- **Low:** The effects of the threat are easily reversible and the snow leopard and/or its habitat can be easily restored at a relatively low cost and/or within 0-5 years (e.g., hunting of prey base of snow leopard).

Target-Threat Rating - Miradi calculates threat ratings using a rule-based system for combining the scope, severity, and irreversibility criteria. These procedures involve specifying rules as to how different parameters should be combined with one another.



OCCURRENCE AND DISTRIBUTION OF SNOW LEOPARD

4.1 DISTRIBUTION AND HABITAT USE

Our survey confirms the presence of snow leopard in Uttarakhand, but we could not find any sign of snow leopard from surveyed areas in Himachal Pradesh. Due to weather limitations we were not able to cover all the areas of Himachal Pradesh that we initially planned to survey.

A total of 13 signs of evidence of snow leopard were found during the survey. These were in the form of scats (9) and pugmarks (4).

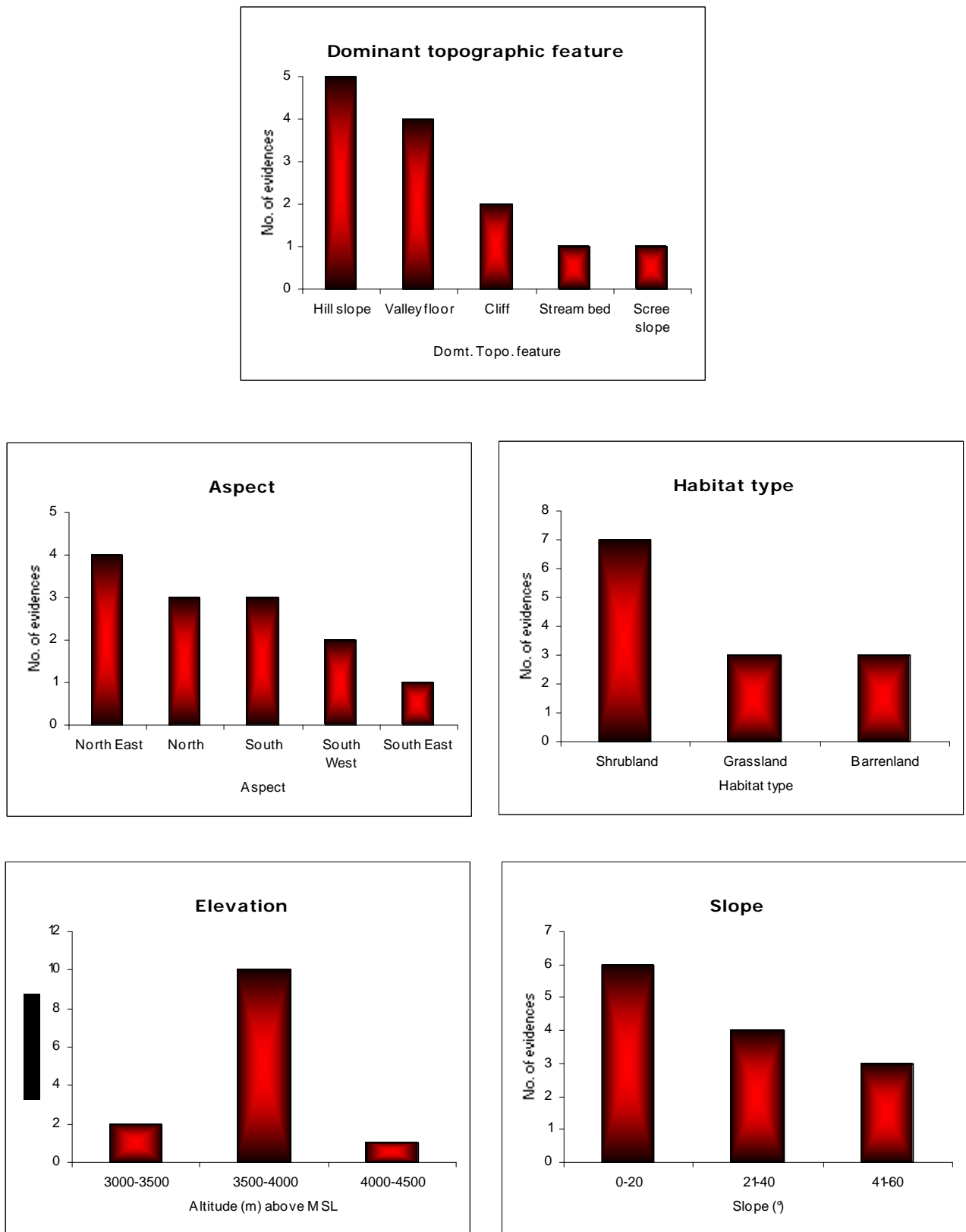
Snow leopard evidence was recorded from 3190 to 4115 m from MSL with mean altitude of 3783 m. Almost 54% of the evidence was recorded from shrub land habitat and 21.4% evidence was recorded from grassland and barren land. About 31% of the snow leopard evidence was recorded at a slope of 35°. About 39% of the evidence was found on the hill-slopes followed by valley floor (30%) and cliff (15%). Details about land form and habitat used by snow leopard are shown in Fig 1.



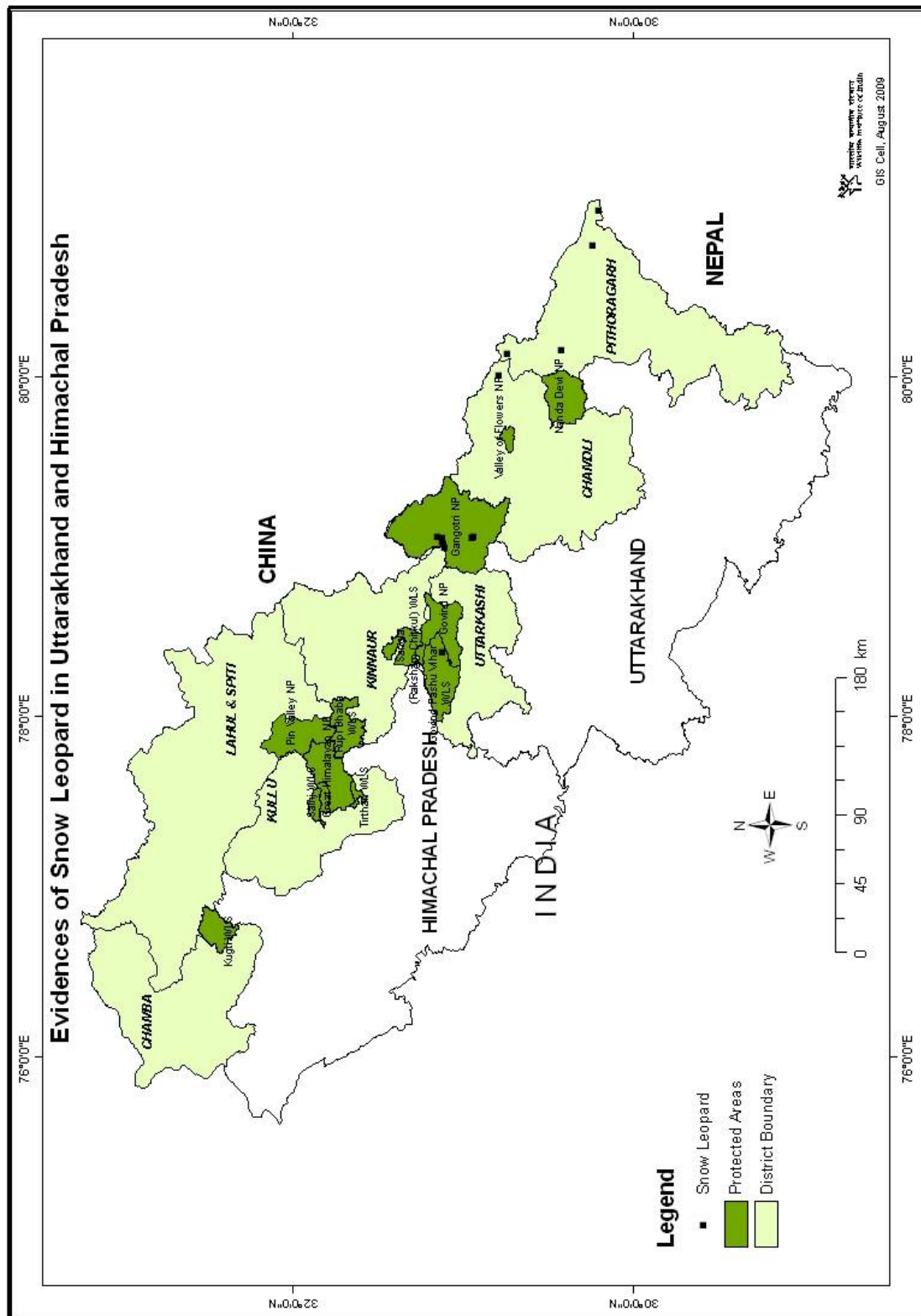
Snow leopard pugmark



Fig 1: Landform and habitat use by snow leopard.



Map 1: Location of snow leopard indirect evidence in surveyed areas of Uttarakhand and Himachal Pradesh.



4.2 OCCURRENCE OF PREY SPECIES

The most common wild prey species found was bharal or blue sheep. A total of 340 individuals were recorded in 23 groups from Gangotri NP, Nanda Devi BR, Askot WLS and Sangla (Raksham-Chitkul) WLS. Almost 73% sightings were recorded from open areas or areas classified as grasslands, 17% from shrub land and 10% from riverine patches. Another wild prey species recorded was Himalayan marmot along three survey routes in Askot WLS and Gangotri NP. A total of eight individuals were recorded from grasslands. One group of Asiatic ibex was recorded from Kugti WLS Himachal Pradesh with five individuals in shrub land habitat.

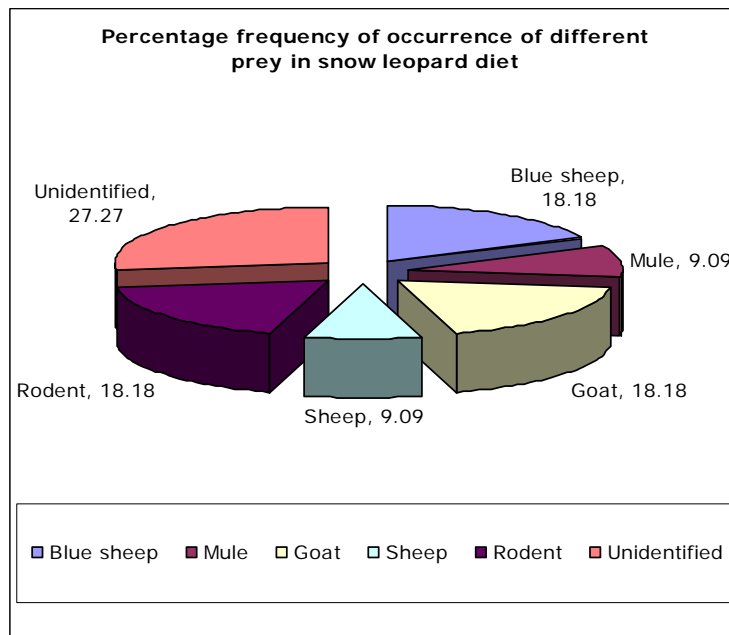
4.3 FOOD HABITS OF SNOW LEOPARD

A total of nine scats were found during the survey and were analysed for assessing the food habits of snow leopard. Prey species were identified on the basis of hair remains in the scats after examining their unique cuticle and medulla pattern under a microscope. A total of six prey species were identified in the scats (Fig 2), while three could not be identified. About 80% of the scats had single prey and 20% of the scats consisted of two prey species. Scat analysis showed that 36% of snow leopard diet comprised of domestic livestock (mule, goat and sheep) followed by blue sheep (18.2%) and rodents (18.2%).

The findings of snow leopard scat analysis are similar in some aspects with Chundawat *et al.* (1994) who reported that almost 96% scats consisted of single prey species. They reported 23.4% blue sheep in snow leopard diet followed by 12.5% domestic livestock (yak, goat and sheep) in Ladakh. But due to low sample size we are not able to document the food preference of snow leopard.



Fig 2: Food habits of snow leopard in Uttarakhand (April to December) 2009.



4.4 THREATS TO SNOW LEOPARD AND ITS HABITAT

The intensity and occurrence of threats (snow leopard-human conflicts, tourism, developmental activities, grazing and human settlements) varied among areas surveyed. We found that 68.1% of the area surveyed in Uttarakhand and Himachal Pradesh is under grazing and 12.3% area faces threats from tourism and defence activities. The details about these threats are given below:

4.4.1 SNOW LEOPARD – HUMAN CONFLICTS

We interviewed shepherds in Govind Pashu Vihar, Sunderdhunga Glacier, Askot WLS and Dung areas. No information was available from rest of the areas of Uttarakhand and Himachal Pradesh because no shepherd was found during the survey as the shepherds had moved down from snow leopard habitats in the months of August-September.

Livestock losses vary widely. For example, our survey in GPV indicated that the maximum livestock loss from snow leopard was 6.25% but it averaged 1.6% for four herds. The total loss was about USD 59,535. Similarly, in AWLS we found that the maximum livestock loss by snow leopard was about 1.25% in a herd but for eight herds it averaged 0.78%. The loss in Askot WLS is valued at USD 31,329 (Fig 3). The cost of livestock was estimated during interviews of the shepherds and includes cost of sheep and goats that varied among areas. All depredations occurred in summers when these shepherds visited the higher ranges of snow leopard habitat in Uttarakhand.



Our survey suggested that the shepherds are primarily concerned about the livestock depredation and there are very few permanent human settlement in the snow leopard habitats (>3000 m elevation) in Uttarakhand. The shepherds who graze their livestock in the snow leopard habitats reported livestock depredation in some areas of Uttarakhand. The other species involved in conflicts with humans were Asiatic black bear, common leopard, wolf and brown bear (Appendix 6).

Fig 3: Total value (\$) of livestock and loss by snow leopard in 2007 in three areas of Uttarakhand.

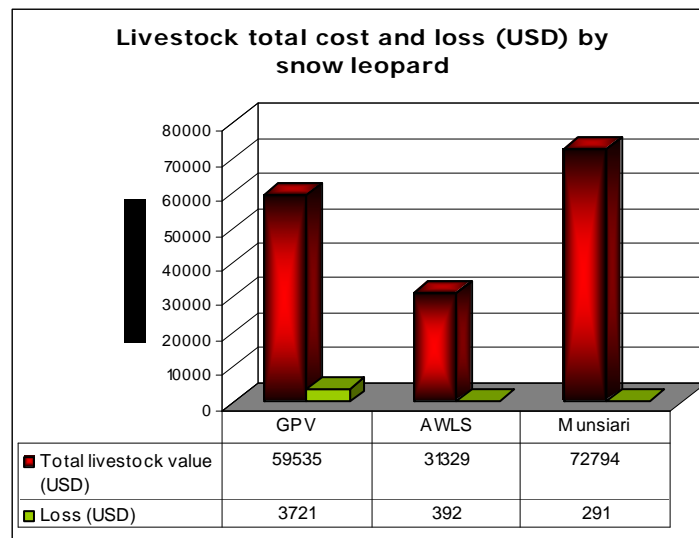
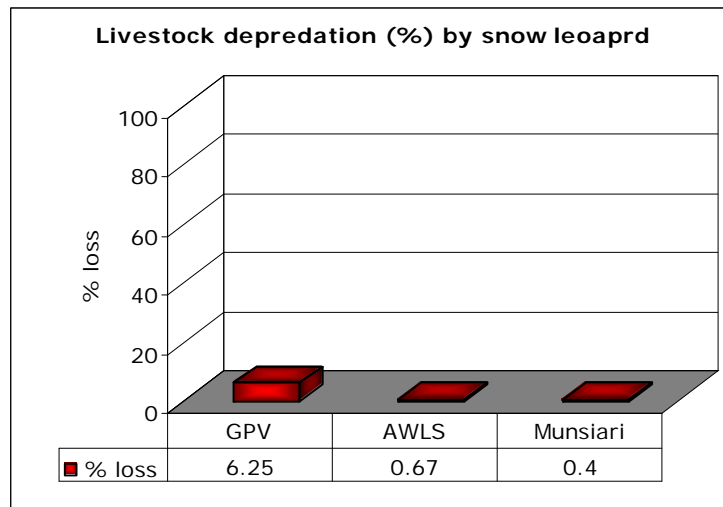


Fig 4: Livestock depredation by snow leopard in Govind Pashu Vihar, Askot Wildlife Sanctuary and Munsiari areas of Uttarakhand.



Tourism posed low threat to snow leopard habitat because tourism is confined to defined trek routes such as from Gangotri temple to Bhojbasa at Gangotri NP and Kailash-Mansarovar trek at Askot WLS.

Developmental activities such as road construction were categorized as medium threat to snow leopard habitat at Nilang Valley, Askot WLS and Nanda Devi BR. There is a great need to provide basic amenities to the local people and defence personnel in areas along the international borders in Uttarakhand and Himachal Pradesh. But many activities, such as construction of roads, are causing side effects that need to be dealt with immediately. At Nilang valley, it was observed that a gorge was blasted through to make a road. With the widening of existing roads and building of newer ones the threat of landslides has multiplied. The other important issue is the influx of labour from outside areas in large numbers who largely depend on natural resources for survival and some of them are also involved in illegal activities affecting wildlife.

Grazing was presently found as a medium threat to snow leopard habitat. No grazing was observed from Gangotri NP, Valley of Flower NP and Great Himalayan NP where it is not allowed by Forest Department. The severity of grazing was medium. It is interesting to note that in Govind Pashu Vihar, Askot WLS, Dung (Uttarakhand) as well as in Kugti WLS and Sangla WLS (Himachal Pradesh) several families drive their unproductive livestock to sub-alpine and alpine areas for unsupervised grazing during the snow free period (May to October).

Human settlements posed low threat to snow leopard habitat because there were very few human settlements that settled in snow free period and utilized natural resources. Human settlements (locals) were recorded from Govind PV, where one village was located in snow leopard habitat. In Askot WLS, three



villages that provide shelter for Kailash-Mansarovar tourists and two villages in Munsiri to Dung areas were settled in snow leopard habitat.

Defence settlements were recorded along India’s international border with China and Nepal at Gangotri NP, Askot WLS Nanda Devi BR and Sangla WLS. Unlike human settlements, these settlements were permanent and occupying snow leopard habitats but not dependent on the natural resources and therefore posed low threat to snow leopard habitats.

Fig 5: Summary of threats (Miradi 2.4) to snow leopard and its habitat in the surveyed areas of Uttarakhand and Himachal Pradesh.

Threat Ratings

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	Low	
■	Tourism		Low
■	Human settlements		Low
■	Grazing		Medium
■	Developmental activity		Medium
	Target threat rating	Low	Low

4.5 Limitations

The Trans-Himalayan zone of Uttarakhand and Himachal Pradesh represents ideal habitat for snow leopard. But Uttarakhand has very little portion under Trans-Himalayas and limits our accessibility in terms of International Borders, difficult terrain and harsh climatic conditions. The Trans-Himalayan zone of Himachal Pradesh has adequate information on snow leopard. Therefore, this survey was focused on the Trans-Himalayas of Uttarakhand and transitional zone with Greater Himalayas of both Uttarakhand and Himachal Pradesh.

The transitional zone of Trans-Himalayas and Greater Himalayas of Uttarakhand and Himachal Pradesh overlaps with common leopard (*Panthera pardus*) and snow leopard. It was very difficult to distinguish between indirect evidence such as scats and pugmarks, of these two felids by physical characteristics unless some additional parameters were not recorded such as scraps which can be easily differentiated between common and snow leopard. The other parameters which were utilized in this survey to overcome the confusion between these two felids were the secondary information provided by the shepherds (sighting, indirect evidence and livestock depredation reported), the overall characteristics of snow leopard habitat (rugged and broken terrain), and prey availability (primarily blue sheep and Asiatic ibex).



4.6 Other Observations

These rapid surveys were conducted in the remote areas of Uttarakhand and Himachal Pradesh. In these remote areas, the presence of forest department needs strengthening to combat poaching, regulate tourism and grazing. Otherwise, the chances of maintaining and improving snow leopard and its prey base and habitat will be poor. It is reiterated that protection of snow leopard and its habitat augurs well for the survival of the large human population that depends on the entire Himalayas for many products – ranging from water to medicinal plants.



OTHER HIGH ALTITUDE WILDLIFE OF UTTARAKHAND AND HIMACHAL PRADESH

Occurrence

The survey recorded the occurrence of 11 large mammal species in the areas of Uttarakhand and Himachal Pradesh. We derive our inferences based on direct and indirect evidence recorded and based on information given by shepherds. Determination of occurrence of snow leopard and associated species through sign surveys and persons interviewed is summarized in Table 2. We recorded a total of 87 direct and indirect signs of evidence of large carnivores. Details of evidence for other co-predators are given in Table 3.

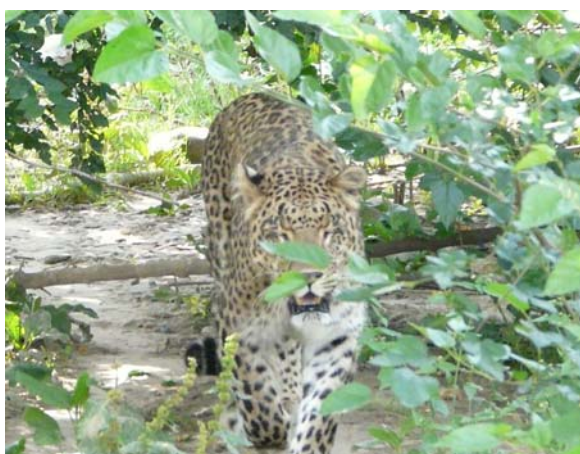
Table 2: Evidence used for determining the occurrence of large mammals during survey in Uttarakhand and Himachal Pradesh.

Animal species	Type of Indirect evidence recorded	Direct Sightings	Confirmed by Shepherds
Carnivores			
Common leopard	Scat, pugmark	None	Yes
Asiatic black bear	Scat, track	Yes	Yes
Brown bear	Scat, track, digging, stone-turning	Yes	Yes
Tibetan wolf	Scat, pugmark	No	Yes
Red fox	Scat, Pugmark	Yes	Yes
Herbivores			
Blue sheep	Pellet groups, horns, hoof mark	Yes	Yes
Himalayan tahr	Pellet groups	None	Yes
Asiatic ibex	Pellet groups, hoof mark	Yes	Yes
Musk deer	Pellet groups	No	Yes
Grey goral	Pellet groups	Yes	Yes
Himalayan marmot	Faeces	Yes	Yes



Table 3. Total number of direct and indirect evidence of large carnivores.

Large Carnivores	Sightings	Scat	Pugmark/Track	Digging	Total
Snow leopard	0	10	3	0	13
Leopard	0	4	0	0	4
Asiatic Black bear	2	7	1	0	10
Himalayan Brown bear	1	18	3	5	27
Tibetan Wolf	0	2	2	0	4
Unidentified	0	28	1	0	29
Total	3	69	10	5	87



Common Leopard: This leopard has a wide distribution in India. It is known to go to higher elevation areas in Himalayas in summers. Our surveys showed the elevation range of leopard (based on indirect evidence) to be from 3190 m to 3610 m with mean elevation of 3398 m. The indirect evidence was recorded on slopes ranging from 20° to 50°. Other details are provided below.

Leopard (n=04)				
Aspect		Slope	Habitat type	Landform-ruggedness
North	1	20° – 25°	Shrubland	Rolling 3 Flat 1
North east	1		3	
South	1		Forest	
South west	1		1	





Asiatic Black Bear: Asiatic black bear is found in the forests of Himalayas. Similar to common leopard it also tends to go to higher elevations in summers and come down in winters. Our surveys showed the elevation range to be from 3200 m to 3535 m (with mean elevation of 3374 m) for Asiatic black bear. Other parameters such as aspect, slope, habitat type and landform ruggedness where the evidence was found are given below.

Asiatic black bear (n=10)								
Aspect		Slope	Habitat type		Landform-ruggedness			
North	3	10° – 60°	Shrubland	6	Cliff	2		
North east	2				Very broken	4		
East	3				Forest	4	Rolling	3
South	2				Flat	1		



Himalayan Brown bear: Very few studies have been conducted on the status and distribution of Himalayan brown bear so far (Sathyakumar 2001 and 2006). Our surveys indicated that the mean elevation for brown bear is 3279 m. The evidence was recorded at slopes ranging from 0° to 60° with a mean of 24°. Information about other parameters is given below.

Himalayan Brown bear (n=27)								
Aspect		Slope	Habitat type		Landform-ruggedness			
North	7	0° – 60°	Barren	1	Cliff	2		
North east	5				Very broken	9		
South	2				Grassland	14	Rolling	6
South west	4				Shrubland	12	Flat	10
West	4							
North west	5							





Tibetan wolf: Tibetan wolf is a trans-Himalayan species. Its indirect evidence was found at an altitude of 3993 m. This species is a true co-predator for snow leopard in its range. The preferred slope was recorded from 0° to 30°. Other parameters are given below.

Wolf (n=4)				
Aspect		Slope	Habitat type	Landform-ruggedness
North	1	0° – 60°	Grassland	Flat
South	2		Shrubland	
South east	1			



Table 4: Altitude at which evidence of mammal species was recorded during the survey in Uttarakhand and Himachal Pradesh.

Species	Altitudinal range (m)	Mean Altitude (m)
Carnivores		
Snow leopard	3190-4115	3783
Common leopard	3190-3610	3398
Asiatic black bear	3205-3535	3374
Himalayan Brown bear	3100-4080	3279
Tibetan wolf	3720-4350	3993
Herbivores		
Blue sheep	3500-4600	3783
Himalayan tahr	3600	3600
Asiatic ibex	3660-3700	3680
Musk deer	3600-3700	3650
Himalayan marmot	4000-4405	4203



Himalayn Tahr



Musk deer



POTENTIAL HABITATS FOR SNOW LEOPARD CONSERVATION IN UTTARAKHAND AND HIMACHAL PRADESH

Selection of the potential habitats for snow leopard in Uttarakhand and Himachal Pradesh was done on the basis of direct and indirect evidence of snow leopard, co-predators, and prey and biotic pressure recorded. As far as the wildlife is concerned, a very important characteristic of the Greater and Trans-Himalayan region of Uttarakhand is that it provides almost continuous wildlife habitat. Almost the entire landscape has large mammals, including snow leopard, common leopard, Tibetan wolf, brown bear, Asiatic black bear, blue sheep, musk deer, Himalayan tahr and Asiatic ibex but the densities may vary depending on the quality of habitat. Snow leopard is threatened by grazing (leads to competition between wild and domestic ungulates), conflicts relating to crop and livestock depredation, and some levels of poaching of snow leopard, co-predators and prey species. On the basis of overall analysis (area profile) we propose that the following areas have good potential for snow leopard conservation.

- 1. *Gangotri National Park***
- 2. *Askot Wildlife Sanctuary***
- 3. *Nanda Devi Biosphere Reserve.***

There are some other areas which also represent the potential habitat for snow leopard but due to unfavourable climatic conditions and limitation of available time, these could not be properly surveyed or not surveyed at all. These areas should be surveyed to get a better picture of conservation status of snow leopard.

- 1. *Valley of Flower National Park***
- 2. *Great Himalayan National Park***
- 3. *Tundah Wildlife Sanctuary****
- 4. *Lippa Asrang Wildlife Sanctuary**.**

(* areas were not surveyed)



RECOMMENDATIONS

The present survey was a fairly rapid one and attempted to cover maximum snow leopard areas in Himachal Pradesh and Uttarakhand. Though, it had its own limitations, it could still collect and collate information to the extent of having a baseline and make suggestions for improved conservation of snow leopard and other wildlife in Uttarakhand and Himachal Pradesh. This, despite the fact that it constituted the first and longest survey of the snow leopard in Uttarakhand till date. It is also hoped that this information will be useful to the Government of India in its "Project snow leopard" by the Ministry of Environment and Forest, India (MoEF).

Based on the observation of the overall occurrence of wildlife and its habitat in the surveyed areas, the following measures are suggested to improve snow leopard conservation efforts:

1. Research and monitoring of wildlife: Information regarding occurrence and distribution of snow leopard from surveyed areas was largely lacking at the time when the survey was planned. We have assessed broad trends of wildlife occurrence with special emphasis on snow leopard in these regions but have not been able to get useful population estimates and seasonal movement of wildlife. It is important that the population estimates and seasonal wildlife movement be monitored to study the trend in the overall population so that conservation applications can be planned and implemented on a landscape level. We feel that there is a good chance of occurrence of better populations of wildlife in Himachal Pradesh state, which due to paucity of time this survey could not ascertain.

2. Mitigating snow leopard – human conflicts: Our survey suggested that shepherds are primarily concerned about their livestock depredation by snow leopard at Govind PV, Askot WLS and Munsiari areas. However, we do not have information about other areas. Therefore, we recommend that while interventions are made to mitigate the human snow leopard conflicts, there should be more efforts in the field at appropriate time to get information about snow leopard – human conflicts. In general, it is important to understand the causes of conflicts, as they can often be a manifestation of habitat degradation due to over-harvesting of the natural resources by humans. Conservation education efforts can help enhance the understanding of the value of sustainable use of natural resources and importance of wildlife and help in mitigating conflicts.

3. Livestock grazing and its impact on local vegetation and wildlife: This survey showed that livestock grazing is at present a low threat to snow leopard habitat. But overstocking of livestock may lead to habitat degradation and



decimation of wildlife as has been reported from other parts of Himalayas (Bagchi *et al.* 2004, and Mishra *et al.* 2000,). In general, we recommend that some areas need to be earmarked to be grazing free where wild ungulates can thrive without competition. Based on further study, rotational grazing regimes can be worked out and implemented with local support. This will need working with communities to sensitize them about the dangers of large population of livestock and limited resource availability in near future, and also to assure that longevity of better but less number of livestock increases due to better care.

4. Well planned development: Our survey showed that road construction at Nilang Valley, Askot WLS and Nanda Devi BR, if not adequately planned, may threaten existence of snow leopard. The roads cause habitat fragmentation and open the inaccessible areas to people and many times result in increased illegal activities (including hunting of snow leopard and its prey). It is suggested that while roads are planned, care should be taken to minimize habitat destruction. Furthermore, there should be provision of strong security and check points to curtail wildlife crime. Other developmental activity that can destroy the habitat of snow leopard is Hydropower projects in high altitude areas. It is suggested that an honest and credible Environment Impact Assessment (EIA) should be done before planning hydropower projects and snow leopard habitats should be excluded from such development as much as possible.

5. Infrastructure and Capacity building of field staff: During surveys, it was observed that infrastructure (chowkis and basic facilities for field staff) and strength of field staff was inadequate in the remote localities of Uttarakhand and Himachal Pradesh. Therefore, it is recommended that chowkis be constructed and basic facilities such as field gear and medical facilities be provided and staff be posted in these localities. It is important to deploy well trained staff in the required strength in protected areas. Continued on-job training is needed on numerous fronts such as: wildlife monitoring (for correct identification of wildlife evidence), wildlife law and legislation (for taking appropriate steps when recording wildlife crime).



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APPENDICES

1. DETAILED FINDINGS OF EACH OF THE AREAS SURVEYED

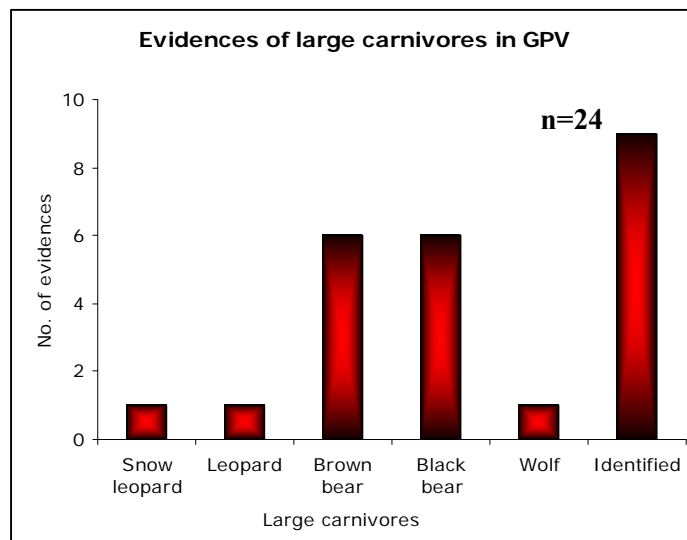
1. GOVIND PASHU VIHAR (GPV):

The survey was carried out during April 2008 and two areas viz., Har ki Doon and Ruinsara Valley, having snow leopard habitat were surveyed.

a. Snow leopard evidence

A total of 04 routes were surveyed for collecting the information on occurrence and distribution of snow leopard. Evidence (n=01) of snow leopard was collected from GPV, i.e. scat at the height of 3190 m from shrub land habitat, seasonal grazing (rangeland-use) area and in the high human disturbance area. The information about the other co – predators is summarised in the Fig 1.

Fig 1. Evidence of large carnivores in GPV.



b. Snow leopard – human conflicts

Livestock depredation was reported from GPV. Shepherds (n=04) were interviewed and there was one shepherd who reported livestock depredation by snow leopard. Overall, there was 6.25% livestock loss by snow leopard from GPV. Other large carnivores such as brown bear, wolf and leopard were also found involved in livestock depredation.

c. Grazing pressure and human disturbance

A total of 29 Km were surveyed for collecting information on grazing pressure and human disturbance. Of the total area surveyed we found 66% area under grazing and 02% under crop field. It posed medium level of threat to snow leopard habitat at GPV. Snow leopard-human conflicts (livestock depredation Fig. 3 and 4 of main text) were reported in the interviews by shepherds and they posed a low threat to snow leopard.



Fig 2. Summary of threats (Miradi 2.4) to snow leopard and its habitat in the surveyed areas of Govind Pashu Vihar.

Threat Ratings

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	Low	
■	Tourism		None
■	Human settlements		Low
■	Grazing		Medium
■	Developmental activity		None
	Target threat rating	Low	Low

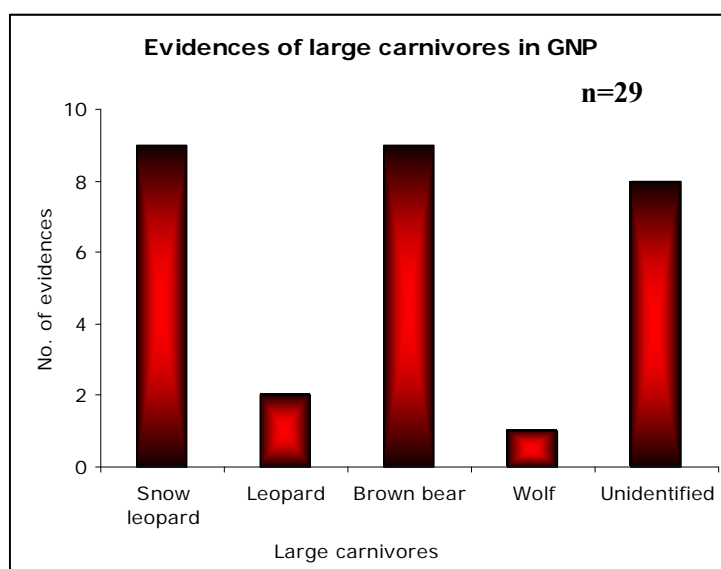
2. GANGOTRI NATIONAL PARK (GNP):

The survey was carried out during May, 2008 and Bhojbas, Tapoban and Nelong Valley were surveyed.

a. Snow leopard evidence

A total of 29 signs of evidence of large carnivores were found in the sampled area in GNP. Of these, nine (seven scats and three pugmarks) were of snow leopard. Of these nine, three were recorded from Nilang Valley to Tripani along 10 routes. The altitude varied from 3580 to 4100m in barren, grassland and shrub land habitats. The pressures were tourism and seasonal livestock grazing. The occurrence of evidence of the co-predators has been summarised here in Fig 3.

Fig 3. Evidence of large carnivores in GNP.



b. Snow leopard – human conflicts

No shepherd was found in GNP during the surveys and the forest department does not keep the snow leopard – human conflicts data. Therefore, it is not possible to comment on the conflicts situation in GNP.

c. Grazing pressure and human disturbance

There is no permanent human settlement in GNP except at Bhojbasa and Defence settlements at Nilang Valley. GNP faces pressures of tourism but is mostly restricted up to Gau-Mukh and tourist movements posed low threat for wildlife because number of tourists permitted per day was regulated. The movement on mules was banned inside the NP and tourist sites removed, except at Chirbasa and Bhojbasa. At Gangotri, construction of Hydro-Electricity Dam is categorized as medium threat to snow leopard habitat. In contrast, Nilang Valley faces grazing pressures (46%) and is categorized as medium threat to snow leopard habitat. Construction and widening of roads in Nilang Valley was categorized as low threat (23%) to snow leopard and its habitat.

Fig 4. Disturbance at snow leopard habitats in Gangotri NP and Nilang Valley.

Threat Ratings in Gangotri NP

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	None	
■	Tourism		None
■	Human settlements		None
■	Grazing		None
■	Developmental activity		Medium
	Target threat rating	None	Low

Threat Ratings in Nilang Valley

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	None	
■	Tourism		None
■	Human settlements		Low
■	Grazing		Medium
■	Developmental activity		Low
	Target threat rating	None	Low

3. SUNDERDHUNGA GLACIER (SDGL)

There was no evidence found of snow leopard in this area. Extreme livestock grazing, human disturbance and high seasonal grazing (80%) is found at SDGL.



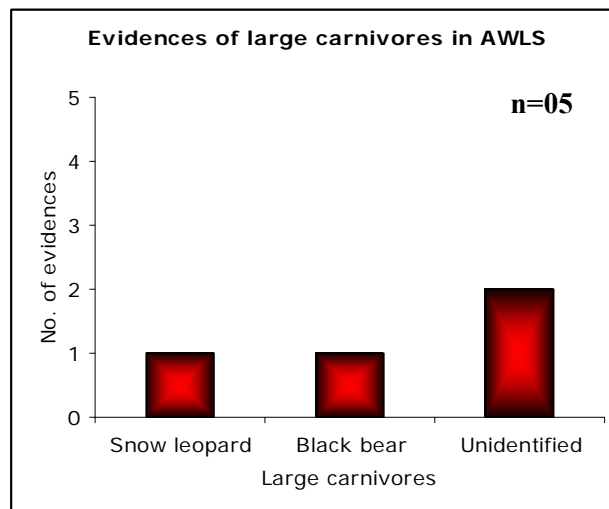
4. ASKOT WILDLIFE SANCTUARY (ASKOT WLS):

The Kailash-Mansarovar track was surveyed till Nabadhang and Om Parvat during June, 2008 in AWLS in snow leopard base-line survey.

a. Snow leopard evidence

One evidence (scat) of snow leopard was found at the height of 4000 m from MSL at shrub land habitat. The occurrence of evidence of the co-predators has been summarised in Fig 5.

Fig 5. Evidence of large carnivores in Askot WLS.



b. Snow leopard – human conflicts

Based on the interview of four shepherds, it was found that total livestock depredation (Fig. 3 and 4 of main text) by snow leopard is 0.67% (i.e. 10 of 1525) in 2007 in the areas surveyed of AWLS.

c. Grazing pressure and human disturbance

Seasonal grazing (54%) is one of the major threats and categorized as a medium threat to snow leopard habitat in AWLS. In addition, Kailash-Mansarovar track and Aadi-Kailash are one of the pilgrim sites in Askot WLS. Permanent human settlements till Gunji offer shelter for pilgrims on these tracks. But tourists are restricted to these tracks and posed a low threat to snow leopard habitat. Efforts from forest department are also minimizing these threats through awareness programmes for locals. Construction of roads was categorized as low threat to snow leopard habitat because it was started recently from Garbadhar and has not yet reached snow leopard habitats. Direct threat to snow leopard through conflict with humans was categorized as low. Livestock depredation by snow leopard and co-predators was also reported from Askot WLS (Appendix 6).



Fig 6. Human disturbance at snow leopard habitat in Askot WLS.

Threat Ratings

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	Low	
■	Tourism		Low
■	Human settlements		Low
■	Grazing		Medium
■	Developmental activity		Low
	Target threat rating	Low	Low

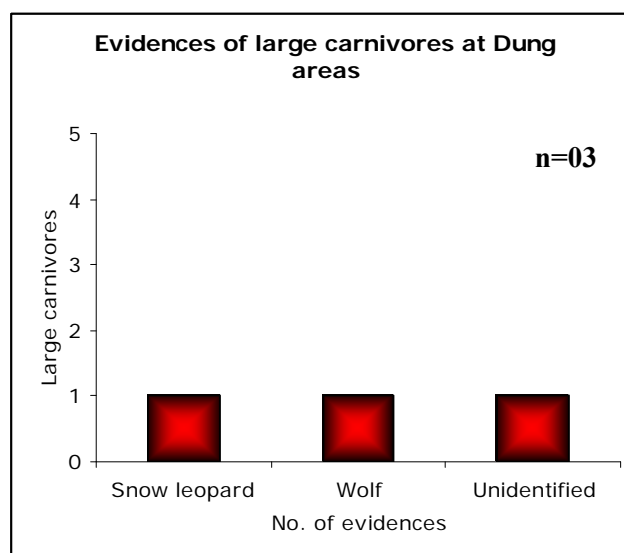
5. MUNSIARI TO DUNG:

Millam and Dung areas were surveyed to collect information on direct and indirect evidence of snow leopard during June, 2008.

a. Snow leopard evidence

Data were collected along 02 routes (36 Km). There was one evidence (scat) found of snow leopard at 3500m, in shrub land habitat and the rangeland-use was for seasonal grazing. The information about the co-predators is summarised in Fig 7.

Fig 7. Evidence of large carnivores at Dung.



b. Snow leopard – human conflicts

A total of four shepherds were interviewed for investigating snow leopard-human conflicts in Munsiari areas. They reported livestock depredation (0.40%) by snow leopard (Fig. 3 and 4 of main text).



c. Grazing pressure and human disturbance

Most of the areas surveyed at snow leopard habitat found under seasonal grazing (56%) and posed medium threat to snow leopard habitat. Human settlements were found in snow leopard habitat and categorized as low threat because all settlements were temporary. Cases of snow leopard-human conflict (livestock depredation) were recorded and categorized as low threat to snow leopard (Fig 8).

Fig 8. Human disturbance at snow leopard habitat in Munsiari to Dung.

Threat Ratings

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	Low	
■	Tourism		None
■	Human settlements		Low
■	Grazing		Medium
■	Developmental activity		None
	Target threat rating	Low	Low

6. NANDA DEVI BIOSPHERE RESERVE:

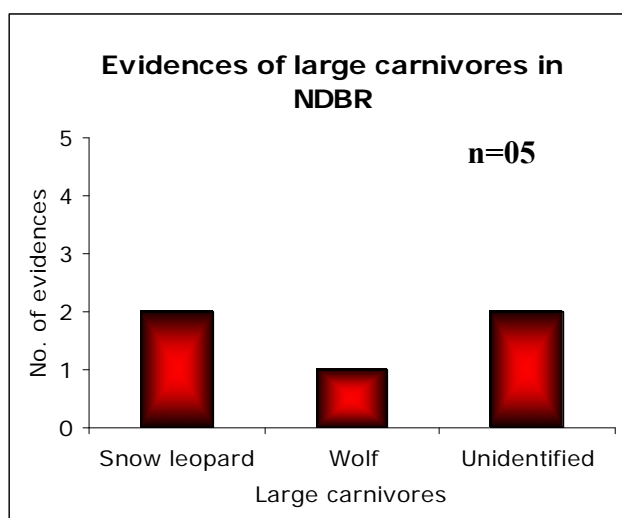
In broad terms, Lapthal, Rimkhim, Sumna and Niti Valleys were surveyed in September 2008 for collecting information on snow leopard along 05 trekking routes.

a. Snow leopard evidence:

A total of 102 km was walked, of which 92 km was surveyed as it was above 3000m in the snow leopard habitat. One fresh track of snow leopard was recorded in the Rimkhim Valley at an elevation of 4000 m above MSL and one scat was collected from Lapthal Valley. The occurrence of other co-predators has been summarized in Fig 9.



Fig 9. Evidence of large carnivores in Nanda Devi BR.



b. Grazing pressure and human disturbance

In Nanda Devi BR, grazing was recorded in 47% of the areas surveyed and it posed a low threat to snow leopard habitat. Construction of roads was categorized as medium threat to snow leopard habitat and roads were constructed at 21 Point *i.e.* 05 km before from Sumna. Defence posts were the only human settlements in Nanda Devi BR and posed low threat to snow leopard habitat (Fig 10).

Fig 10. Human disturbance at snow leopard habitat in Nanda Devi BR.

Threat Ratings

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	None	
■	Tourism		None
■	Human settlements		Low
■	Grazing		Low
■	Developmental activity		Low
	Target threat rating	None	Low

7. VALLEY OF FLOWER NATIONAL PARK (VOFNP):

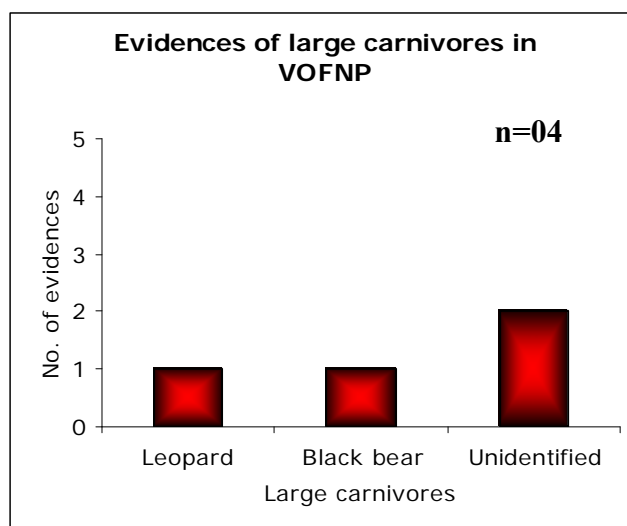
Two areas were surveyed in the base-line survey on snow leopard in VOFNP a) Kunt Khal and b) Tipra Glacier during September, 2008.



a. Snow leopard evidence:

In a total of 28 km sampling effort, there was one unidentified (snow leopard/leopard) scat collected from Kunt Khal at an elevation of 3520 m of VOFNP and one track was recorded of black bear.

Fig 11. Evidence of large carnivores in VOFNP.



b. Grazing pressure and human disturbance

There is no grazing activity allowed inside VOFNP. At the time of survey (September 2008), the tourist activity was very low and could not be treated as human disturbance inside the Park. Thus, there is no disturbance found in VOFNP during survey.

8. GREAT HIMALAYAN NATIONAL PARK (GHNP):

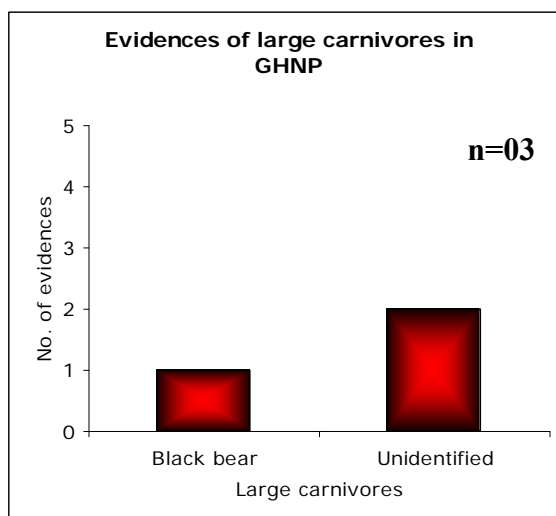
In GHNP, due to a heavy land-slide in the month of September 2008, much of the high altitude snow leopard habitats were not accessible. Therefore, information was collected only from Kobri areas of GHNP during September, 2008.

a. Snow leopard evidence:

We could not find any evidence of snow leopard in the areas surveyed of GHNP. One unidentified scat was collected of a carnivore species at an elevation of 3635 m and one scat was unidentified, which may be of Asiatic black bear or brown bear.



Fig 12. Evidence of large carnivores in GHNP.



b. Grazing pressure and human disturbance:

Grazing is not allowed inside the park therefore there is no grazing pressure in GHNP. Similarly, there was no human disturbance recorded during the survey since there is no permanent human settlement inside GHNP.

9. SANGLA (RAKSHAM-CHITKUL) WILDLIFE SANCTUARY (SWLS):

Dumti was surveyed (October, 2008) for snow leopard base-line survey in SWLS. There was no evidence recorded of snow leopard. No direct or indirect evidence of co-predators was found in SWLS during the survey.

10. KUGTI WILDLIFE SANCTUARY (KUGTI WLS):

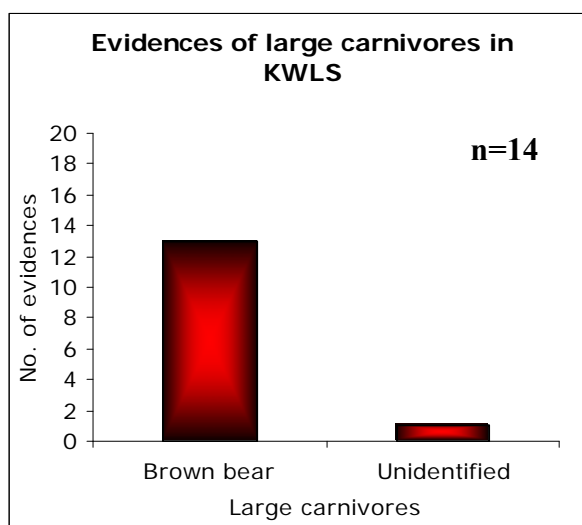
Duggi-Relang and Baggi-Tal areas were surveyed during November, 2008 for collecting direct and indirect evidence of snow leopard in Kugti WLS.

a. Snow leopard evidence:

We could not find any evidence of snow leopard during the survey from KWLS. Rather, one unidentified scat of a carnivore was collected at an elevation of 3150 m above MSL. Kugti WLS is well-known for frequent sightings of brown bear and we recorded 13 signs of evidence of brown bear including one direct sighting. Informants (locals and forest staff) were familiar with common leopard but could not identify snow leopard in Kugti WLS.



Fig 13. Evidence of large carnivores in Kugti WLS.



b. Grazing pressure and human disturbance:

Grazing pressure was recorded in 68% of the areas surveyed in Kugti WLS. Kugti WLS faced grazing from neighbouring districts (Lahul and Spiti) also and unsupervised livestock grazing was also recorded from there, which is categorized as medium threat to snow leopard habitat. Burning of alpine meadows was observed in areas surveyed of Kugti WLS and categorized as medium threat to snow leopard habitat. There was no shepherd found during the survey. Thus, no information was available on snow leopard-human conflict from Kugti WLS.

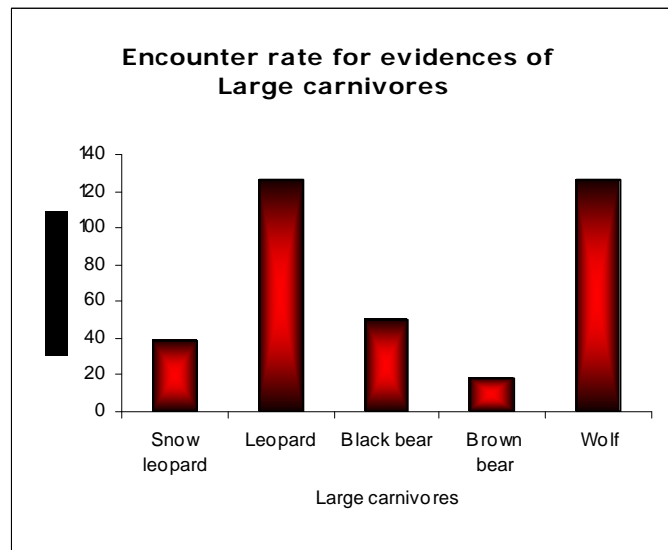
Fig 14. Human disturbance at snow leopard habitat in Kugti WLS.

Threat Ratings

	↓Threats↓ / ⇒Targets⇒	Snow leopard	Snow leopard habitat
■	Snow leopard-human conflicts	None	
■	Tourism		None
■	Human settlements		None
■	Grazing		Medium
■	Developmental activity		None
	Target threat rating	None	Low



Appendix 2: Encounter rate of large carnivores' evidence along survey efforts (per Km walked).



Appendix 3: Details of survey schedule and routes taken in the survey.

Date	Route taken	Distance walked (Km)	
		Surveyed distance	Total distance walked
Govind Pashu Vihar			
19 Ap. 08	Sankri to Taluka	-	12
20 Ap. 08	Taluka to Osla	-	15
21 Ap. 08	Osla to Harki Doon	12	12
22 Ap.08	Harki Dun to Mandal lake	04 (*2)	08
22 Ap. 08	Harki Doon to Osla	12	12
23 Ap. 08	Osla to Ruinsara	10	10
24 Ap. 08	Ruinsara Valley	04	04
24 Ap. 08	Ruinsara to Osla	14	14
25 Ap. 08	Osla to Taluka	-	15
26 Ap. 08	Taluka a to Sankri	-	12
Gangotri National Park and Nelong Valley			
05 My.08	Gangotri to Bhojbasa	14	14
06 My. 08	Bhojbasa to Tapovan	08	08
07 My. 08	Tapovan	04	04
08 My.08	Tapovan to Bhojbasa	08	08
09 My.08	Bjojbasa to Gangotri	14	14
15 My. 08	Bheroghati to Sonam* (by vehicle)	42 (*2)	84
16 My. 08	Nelong Valley	11	11
17 My.08	Nelong to Naga to Jadon	13 (*2)	26
18 My.08	Naga to Sonam	10	10
19 My.08	Sonam to Tripani	10 (*2)	20
20 My. 08	Sonam to Hindoligad	27	27
Sunderdhunga Glacier			
27 My. 08	Khalidhar to Dhakuli	-	11
28 My. 08	Dhakuli to Jatoli	-	15
29 My. 08	Jatoli to Kothalia	-	16
30 My. 08	Kothalia to Madtoli	5.5 (*2)	11
30 My. 08	Kothalia to Khati	-	11
31 My. 08	Khati to Khalidhar	-	22
Askot Wildlife Sanctuary			
07. Jn. 08	Garbadhar to Bundi	-	19
08 Jn. 08	Bundi to Gunji	15	18
09 Jn. 08	Gunji to Nabidhang	18	18
10 Jn. 08	Nabidhang to Om Parvat	5.5 (*2)	11
10 Jn. 08	Nabidhang to Gunji	18	18
11 Jn. 08	Gunji to Bundi	15	18
12. Jn. 08	Bundi to Garbadhar	-	19



Munsiari-Dung			
16 Jn. 08	Dummer to Rergari	-	15
17 Jn. 08	Rergari to Relikot	-	16
18 Jn. 08	Relikot to Milam	18	18
19 Jn. 08	Milam to Dung	09 (*2)	18
20 Jn. 08	Milam to Relikot	18	18
21 Jn. 08	Relikot to Lilam	-	24
22 Jn. 08	Lilam to Selapani	-	09
Nanda Devi Biosphere Reserve			
02 Sept. 08	21 Point to Sumna	-	05
03 Sept. 08	Sumna to Lapthal	14	14
04 Sept. 08	Lapthal to Chudang	08	08
04 Sept. 08	Chudang to Lake	02	02
05 Sept. 08	Chudang to Laha	04 (*2)	08
05 Sept. 08	Chudang to Lapthal	08	08
06 Sept. 08	Lapthal to Sumna	14	14
07 Sept. 08	Sumna to Rimkhim	14	14
08 Sept. 08	Rimkhim to Sumna	14	14
08 Sept. 08	Sumna to 21 Point	-	05
Valley of Flower National Park			
14 Sept. 08	Govindghat to Ghangharia	-	13
15 Sept. 08	Ghangharia to Kunt Khal	07 (*2)	14
16 Sept. 08	Ghangharia to Tipra Glacier	07 (*2)	14
17 Sept. 08	Ghangharia to Govindghat	-	13
Great Himalayan National Park			
27 Sept. 08	Gushaini to Rolla	-	10
28 Sept. 08	Rolla to Nada	-	12
29 Sept. 08	Nada to Kobri	08	08



30 08	Sept.	Kobri to Rolla	08	20
01 Oct.	08	Rolla to Gushaini	-	10
Sangla (Raksham Chitkul) Wildlife Sanctuary				
11 Oct.	08	Chitkul to Nagasti	-	03
12 Oct.	08	Nagasti to Dumti	18	24
14 Oct.	08	Dumti to Chitkul	18	27
Kugti Wildlife Sanctuary				
11 08	Nov.	Dharol to Kugti	-	07
13 08	Nov.	Kugti to Duggi	-	08
14 08	Nov.	Duggi to Relang	3.5 (*2)	07
15 08	Nov.	Duggi to Kugti	-	8
17 08	Nov.	Kugti to Baggi	01	07
18 08	Nov.	Baggi to Tal	2.5 (*2)	05
19 08	Nov.	Baggi to Kugti	01	07

(*2): return track.



Appendix 4: Approximate area covered (% of the total area) in the survey under snow leopard habitat.

Area (total area sqkm)	Parts surveyed	% of the total Area	Routes taken	% of Parts Surveyed
Govind PV (481 km²)	Osla, Har ki Doon, Jamdar Gl, Mandal lake, Ruinsara	15%	Osla-Har ki Doon Osla-Ruinsara	10%
Gangotri NP (2200 km²)	Gaumukh Uttarakhand , Tapoban, Shivling, Nilang, Jadon, Sonam, Tripani	20%	Gaumukh Uttarakhand - Shivling Nilang-Tripani	15%
Sunderdhunga GI	SDGlacier	10%	Kothalia-SDGI	05%
Askot WLS (599.93 km²)	Bundi, Gunji, Kalapani, Nabidhang, Om Parvat	15%	Bundi-Om Parvat	10%
Munsiari	Milam, Dung	15%	Relikot-Dung	10%
Nanda Devi BR (5148km²)	Sumna, Laphal, Chudang, Laha, Rimkhim	15%	Sumna-Laha Sumna-Rimkhim	12%
Valley of Flower NP (87.5 km²)	Kunt Khal, Tipra Glacier	10%	Ghangharia- Kunt Khal Ghangharia-Tipra GI	08%
Great Himalayan NP (755 km²)	Kobri, Rolla	05%	Nada-Rolla	03%
Sangla WLS (304 km²)	Dumti	10%	Nagasti-Dumti	05%
Kugti WLS (379 km²)	Duggi, Baggi	05%	Kugti-Duggi Kugti-Baggi	03%

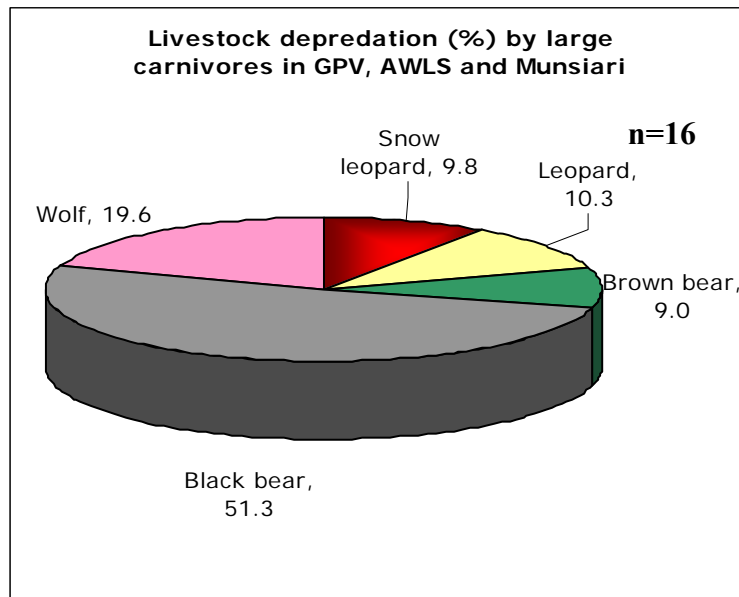


Appendix 5: Local and scientific names of mammals covered in survey in Uttarakhand and Himachal Pradesh with their legal conservation status.

Species Name	Scientific Name	Local Name (referred as in Uttarakhand and Himachal Pradesh)	Indian Wildlife Protection Act, 1972
Snow leopard	<i>Uncia uncia</i>	Barfani cheetah, tharua (Uttarakhand)	I
Common leopard	<i>Panthera pardus</i>	Bagh (Uttarakhand, HP)	I
Asiatic black bear	<i>Ursus thibetanus</i>	Bhalu (Uttarakhand), richh (HP)	I
Brown bear	<i>Ursus arctos</i>	Lal bhalu (Uttarakhand), ghai (HP)	I
Tibetan wolf	<i>Canis lupus chanko</i>	Shanku	I
Red fox	<i>Vulpes vulpes</i>	Lomdi	II
Blue sheep	<i>Pseudois nayaur</i>	Bharad (Uttarakhand)	I
Himalayan tahr	<i>Hemitragus jemlahicus</i>	Karth (HP)	I
Asiatic ibex	<i>Capra ibex</i>	Tringol (HP)	I
Musk deer	<i>Moschus chrysogaster</i>	Kasturi (Uttarakhand, HP)	I
Grey goral	<i>Nemorhaedus goral</i>	Pirj (HP)	III
Himalayan marmot	<i>Mormota himalayana</i>	Phea (Uttarakhand)	II



Appendix 6: Shepherd responses (n=16) on livestock depredation (%) by large carnivores in Govind Pashu Vihar, Askot Wildlife Sanctuary and Munsiari to Dung.



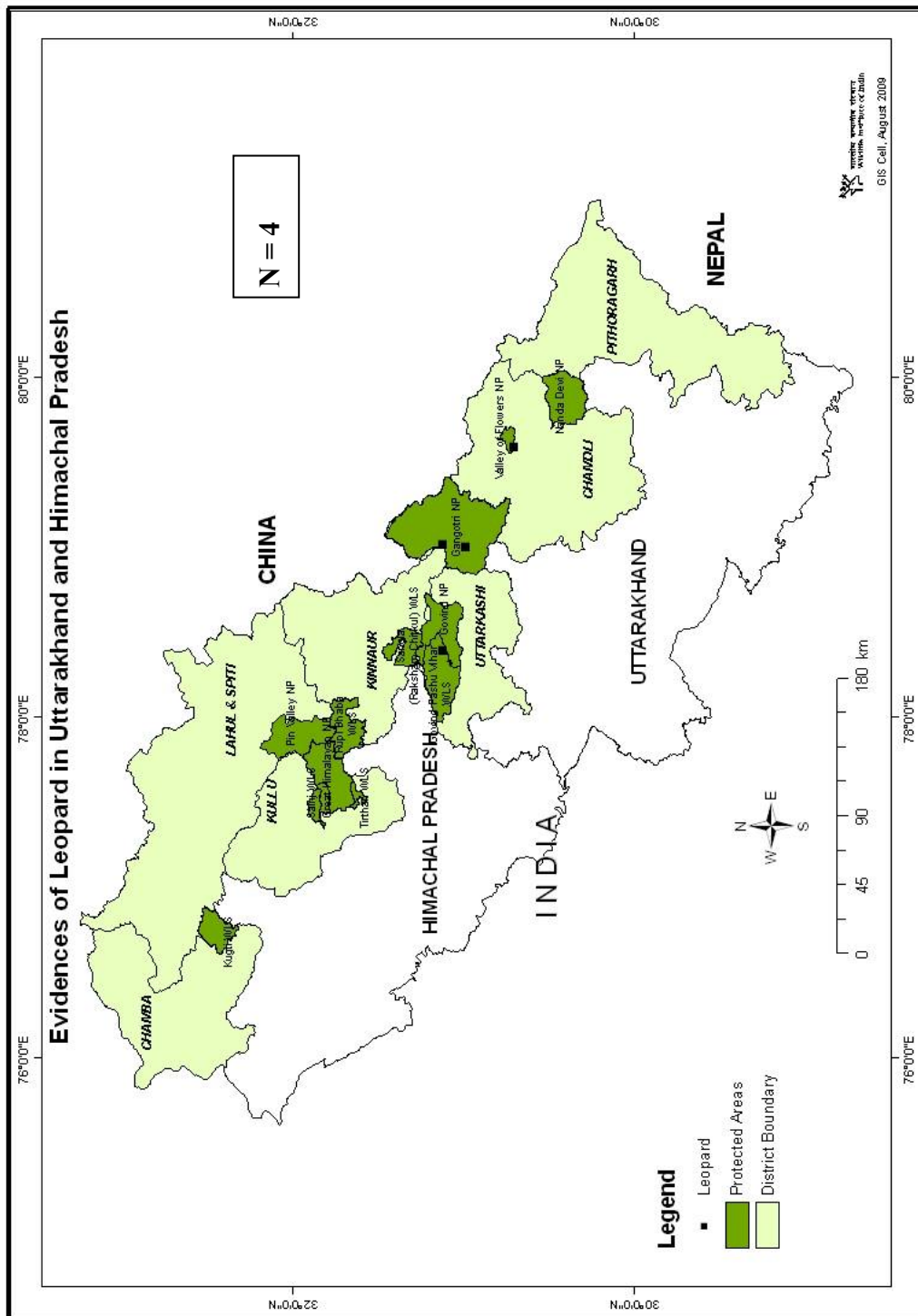
Appendix 7: Comparative elevation and slope for snow leopard and co-predators.

Category	Snow leopard	Common leopard	Asiatic Black bear	Himalayan Brown bear	Wolf
Mean elevation (m)	3783	3397	3374	3279	3992
Mean slope (°)	28	32	41	23	15

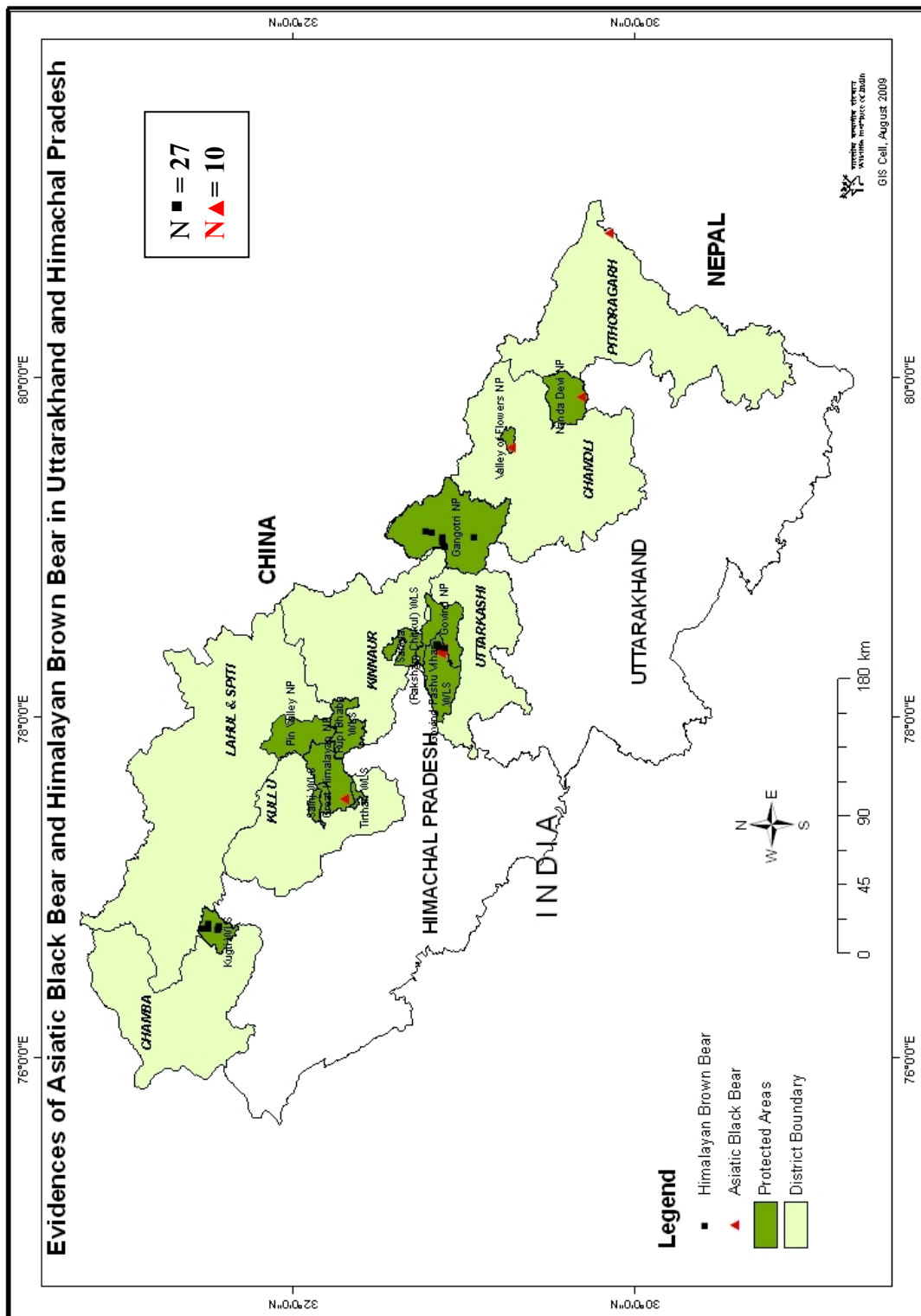


Appendix 8. Maps

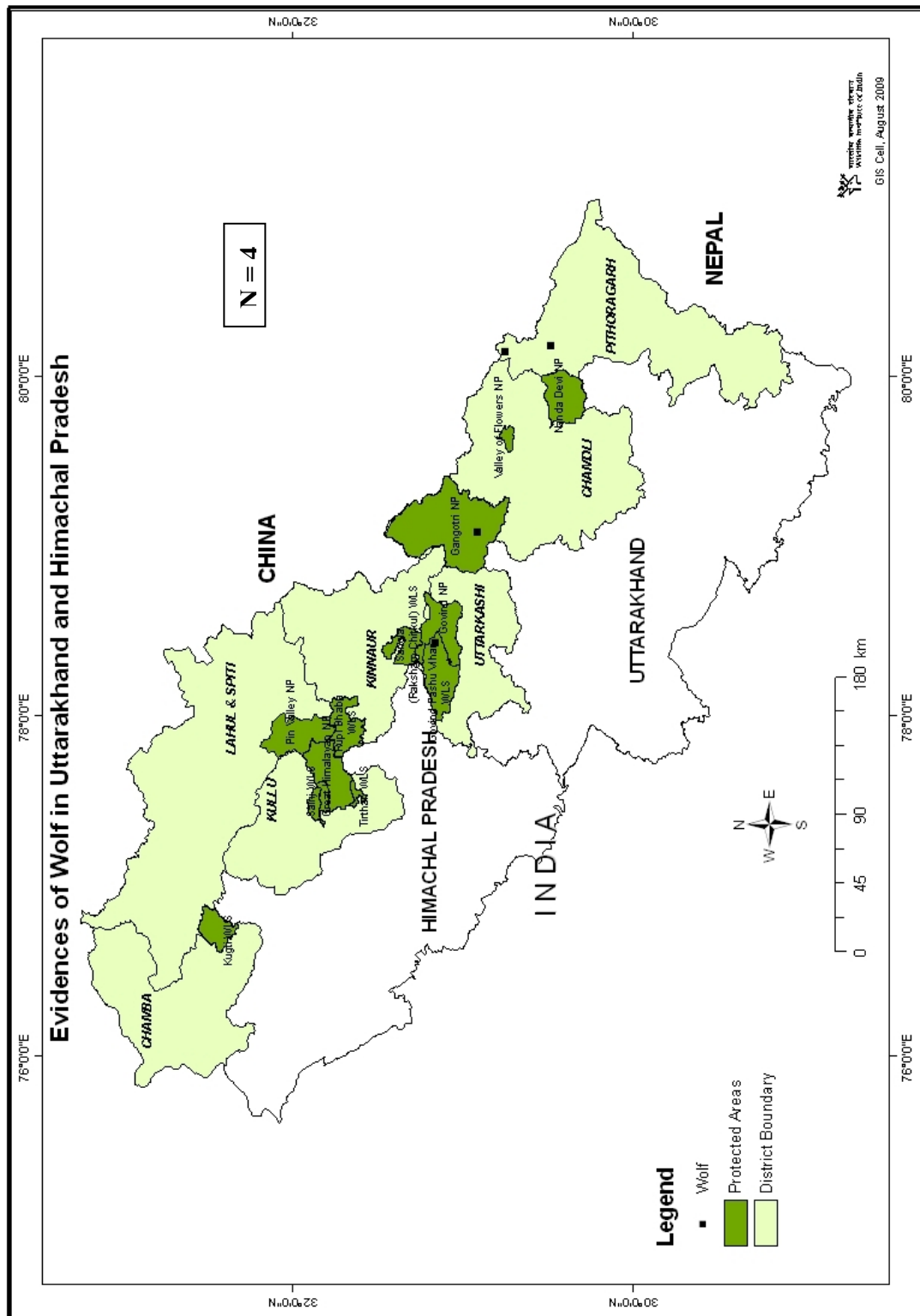
Map 2: Locations of common leopard evidence in Uttarakhand and Himachal Pradesh.



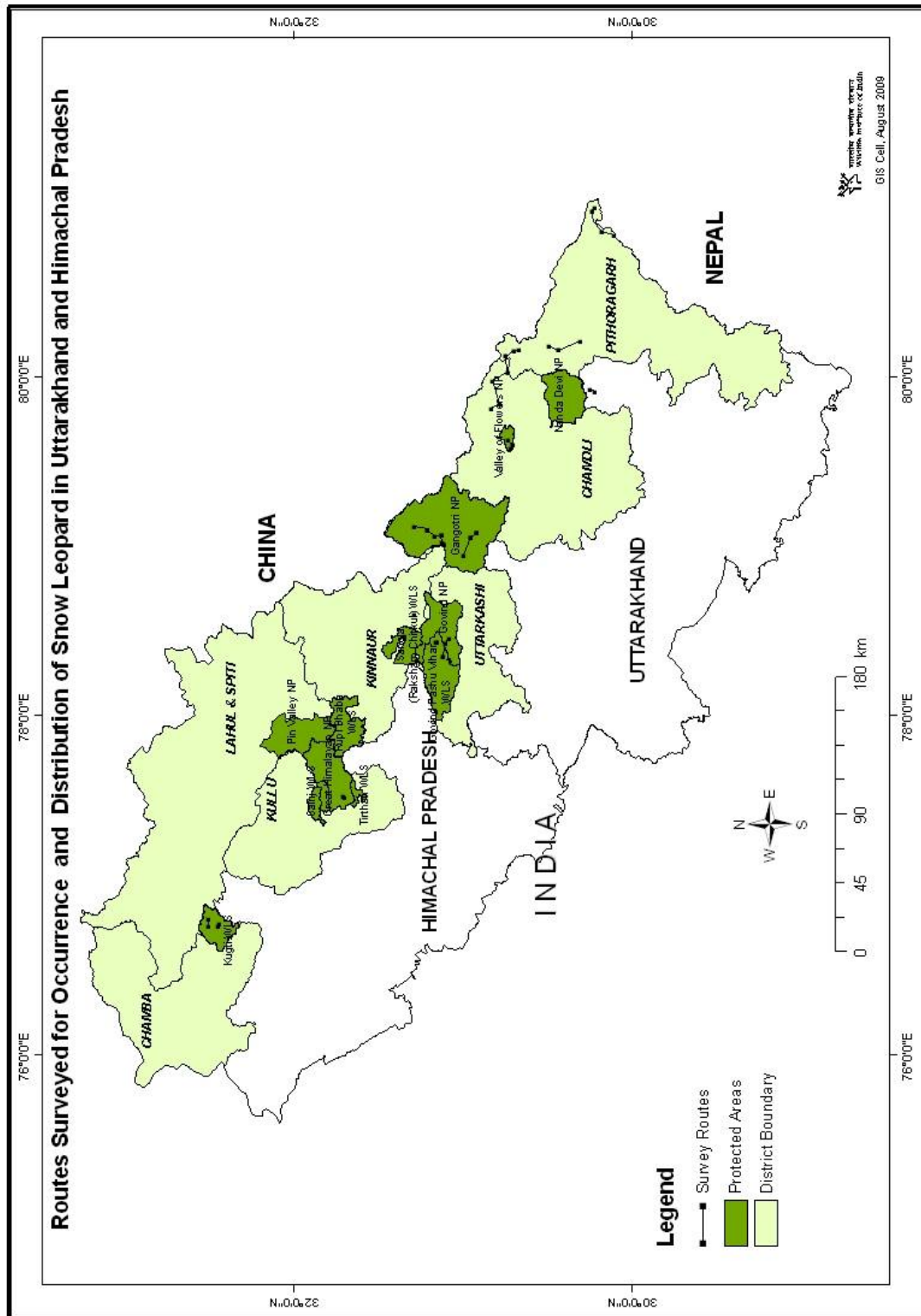
Map 3: Locations of Asiatic Black bear and Himalayan Brown bear evidence in Uttarakhand and Himachal Pradesh.



Map 4: Locations of wolf evidence in Uttarakhand and Himachal Pradesh



Map 5: Routes surveyed for occurrence and distribution of snow leopard in Uttarakhand and Himachal Pradesh





On field at Gangotri National Park

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