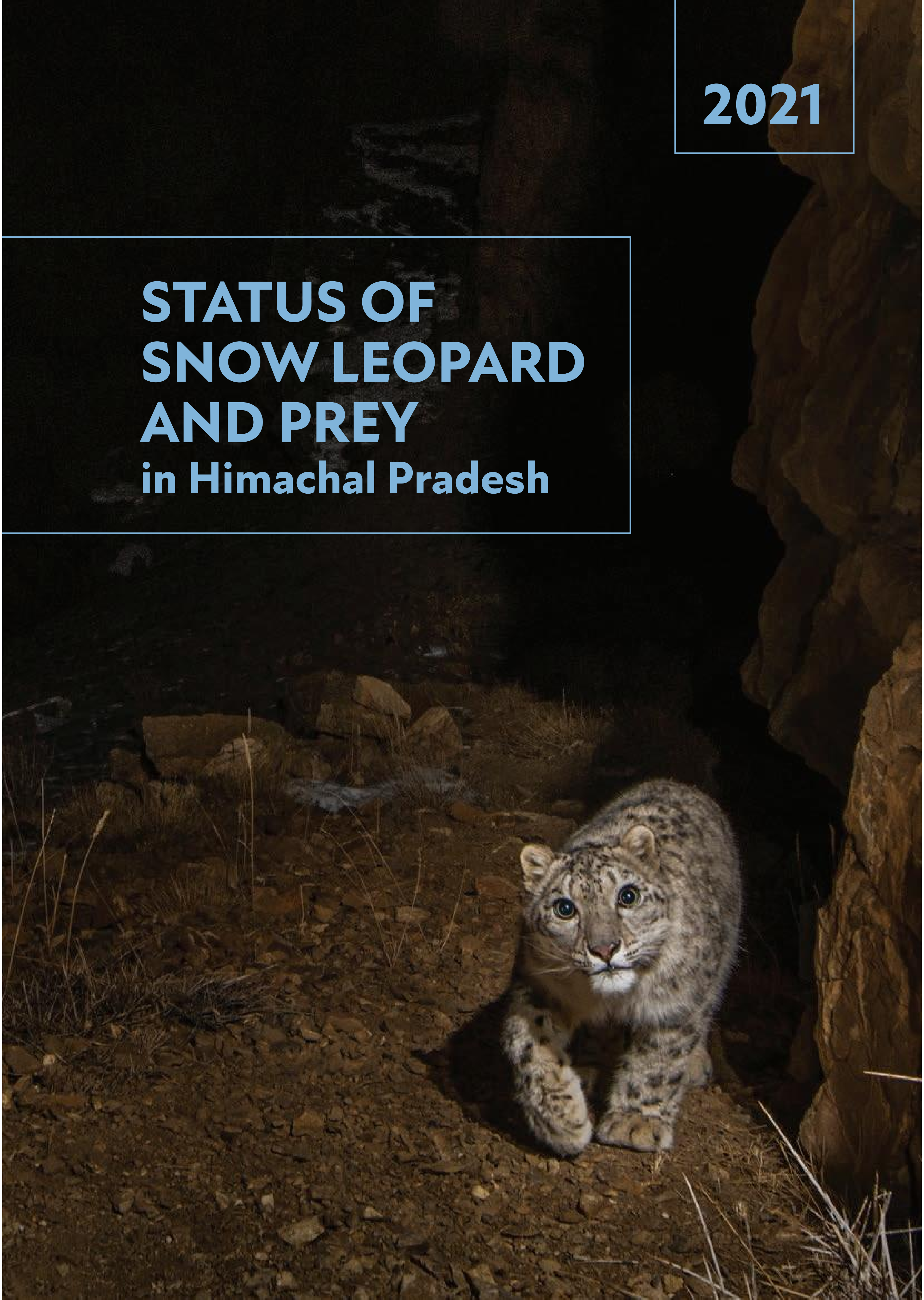
2021

STATUS OF SNOW LEOPARD AND PREY
in Himachal Pradesh



CITATION INFORMATION
Anon. 2021. Status of snow leopard and prey in Himachal Pradesh, 2021.
Wildlife Wing - Himachal Pradesh Forest Department, Government of Himachal Pradesh, Shimla.

COVER PHOTO BY
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nature conservation foundation

SNOW LEOPARD TRUST

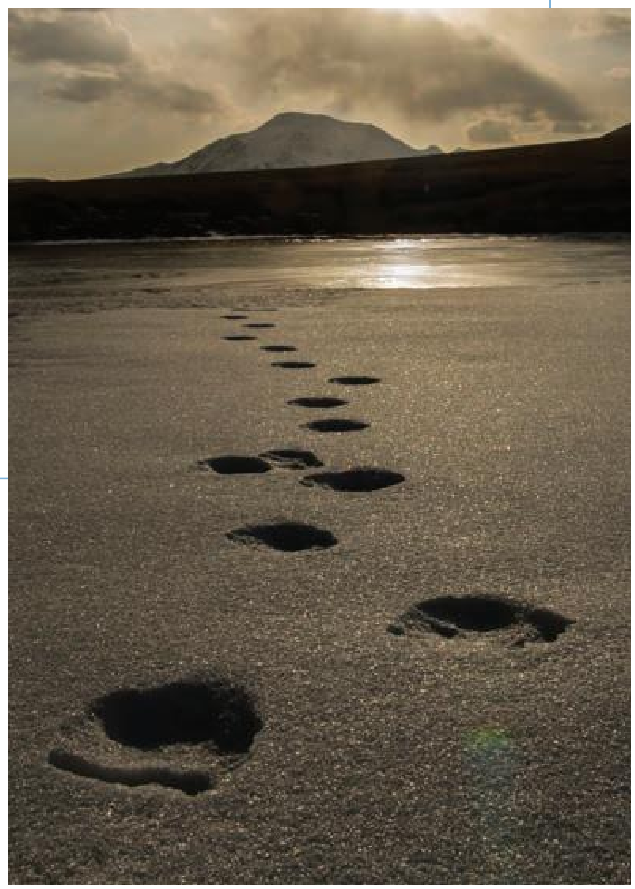

Photo by Prasenjeet Yadav

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Foreword

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The State of Himachal Pradesh has a unique geography with nearly half of its area being high elevation Himalayan and trans-Himalayan region. This region is rich with unique animal and plant species that are found only in the high mountain regions of the Himalaya and parts of Central Asia. Himachal Pradesh is home to unique high altitude wildlife that includes bharal, ibex, and the most iconic species of these mountains – the snow leopard, known as the Ghosts of the Mountain. The snow leopard habitat of Himachal Pradesh are a source of local and regional ecosystem services such as fresh water used by millions of people living downstream and in the plains, and sustains unique high-altitude cultures.

Himachal Pradesh has played a pioneering role in the conservation of the snow leopard. The management planning of the ~4000 km² Upper Spiti Landscape was the first dedicated effort under the Project Snow Leopard. This has been the first – and still among a handful – effort towards conservation of a large carnivore species outside of the protected area network. India has the third largest share of the snow leopards global distribution range and the Indian Hemis-Spiti landscape has been identified as one of the 20 landscapes to secure healthy populations of snow leopards across the cat's range. The first step towards conserving snow leopards is to conduct robust assessments of snow leopard populations which can help identify areas of priority for snow leopard conservation. Taking a lead among Indian States, Himachal Pradesh embarked on this task in 2018 in partnership with Nature Conservation Foundation. Our goal was to use scientifically robust techniques to estimate the snow leopard population of Himachal Pradesh in a systematic effort that surveyed 26,000 km² of snow leopard habitat. This exercise was complemented with population assessments of the prey species (bharal and ibex) of snow leopard across Himachal Pradesh.

I am delighted that these assessments have been completed as planned despite the uncertainties of the pandemic. The results from the assessments are encouraging and prepare us for better management of conservation of the charismatic snow leopards of Himachal Pradesh and the high altitude landscapes they inhabit. I congratulate all the officers on the Wildlife Wing for ensuring that this project is a success.

Photo by Prasenjeet Yadav

Executive Summary

The snow leopard (*Panthera uncia*) is a top-predator of the Indian Himalaya. Its occurrence is regarded as an indicator of ecological health. The Greater and Trans-Himalayan ranges constitute an important habitat for snow leopard towards the southern limit of its global distributional range. Potential snow leopard habitat in the Indian Himalaya is not limited to protected areas (PAs), but overlaps considerably with human-use areas. These areas are also home to local communities whose cultures, traditions and livelihoods are deeply linked to these landscapes. Acknowledging the importance of these areas, the Government of India launched Project Snow Leopard in 2008 to safeguard and conserve India's unique natural heritage of high altitude wildlife populations and their habitats by promoting conservation through participatory policies and actions.

The snow leopard is also the State animal of Himachal Pradesh and its habitat covers a majority of the districts of Lahaul-Spiti and Kinnaur. Its potential habitat also extends into the upper regions of the districts of Shimla, Kullu, Chamba and Kangra. Most of these areas are remote with the added challenge of limited accessibility during winter. All this makes snow leopards a difficult species to study, not just in Himachal Pradesh, but across its Indian range.

In January 2018, the Wildlife Wing of the Himachal Pradesh Forest Department initiated a pioneering project to estimate snow leopard and its wild prey population in Himachal Pradesh.

This is among the first projects to be completed successfully, that has attempted an assessment at this scale. The techniques deployed for the project are scientifically robust and align with the protocols prescribed by the Ministry of Environment, Forest and Climate Change under Snow Leopard Population Assessment in India (SPAI). This protocol is being used to estimate snow leopard population across all five Himalayan States where snow leopards occur.

Over the last three years, the Wildlife Wing of the Himachal Pradesh Forest Department has partnered with the Nature Conservation Foundation (NCF) to execute this project. This included capacity building of frontline staff, extensive deployment of camera traps and retrieval and analysis of data that was compiled as a part of this massive exercise across snow leopard habitats of the State. This report provides the final results obtained from this exercise. Listed below is a summary of the main results obtained for this project:

1. This project is the first systematic effort at a large regional scale to estimate snow leopard population over an area of 26,112 km² that utilised a stratified sampling design. The entire snow leopard habitat of the State was first stratified into three categories: high, low or unknown snow leopard occurrence based on questionnaire surveys of local communities residing in these areas. Camera trap surveys were then carried out in areas under each of the categories. Thus this study ensures that there are no biases in sampling, which are otherwise common in snow leopard population studies.

2. Camera trapping surveys were conducted at 10 sites to representatively sample all the strata i.e. high, low and unknown. Snow leopards were detected at all the 10 sites suggesting that snow leopards are found in the entire snow leopard habitat in Himachal Pradesh – either as resident individuals of a population or as dispersing individuals navigating through these connecting habitats.

3. We detected 44 individual snow leopards on 187 occasions in this study. From this dataset of 44 individuals, we estimated that snow leopard population size is likely to be 51 individuals and this population can be reliably estimated to be upto 73 individuals.

4. Snow leopard density ranged from 0.08 to 0.37 individuals per 100 km² in Himachal Pradesh. The trans-Himalayan regions of Spiti and Pin valley recorded the highest densities of snow leopards.

5. For the entire snow leopard habitat, we assessed the populations of the primary wild ungulate prey of snow leopards – blue sheep *Pseudois nayaur* and ibex *Capra sibirica* using the double observer survey technique. Wild ungulate prey density ranged from 0.11 to 1.09 per km² . The trans-Himalayan region supports the highest densities of wild prey of snow leopards – the estimate of blue sheep population size was 891 for Spiti, and the ibex population size estimate was 224 for the Pin valley.

6. We find that the snow leopard density was positively correlated with the wild prey density indicating that higher wild prey densities corresponded to higher snow leopard densities. Spiti and Tabo recorded highest densities of both snow leopards and their prey; while Chandra and Bharmour recorded the lowest densities of both snow leopards and their prey.

Photo by Prasenjeet Yadav

7. Our camera-trapping survey recorded 28 species that includes carnivores, such as the brown bear, black bear, yellow throated marten, stone marten, masked palm civet, Himalayan weasel; pheasants, such as the monal, cheer pheasant, koklass pheasant, snow partridge; and ungulates, such as the musk deer. We detected the common leopard and the snow leopard in the same camera trap at two stations in the Great Himalayan National Park suggesting a habitat overlap between the snow leopard and the common leopard.

8. The entire camera trapping exercise has been led by a team of 8 local youth of Kibber village in Spiti who have been working on such surveys across the Upper Spiti Landscape since 2010. They were adequately supported by NCF researchers, frontline staff of the Himachal Pradesh Forest Department and members of the local community where studies were carried out.

These results are extremely encouraging and representative of the positive conservation efforts being made by the Wildlife Wing. They also reiterate the fact that local communities are the strongest allies for conservation, if their concerns can be factored into conservation planning.

The results provide a robust baseline for the Wildlife Wing to set up a long term monitoring project to track the population of snow leopard and its wild prey species. Himachal Pradesh can pursue a process similar to that followed for tiger census in India which is reported once every four years, while field work is ongoing. Such long-term studies are a very useful way to track the efficacy of on-ground conservation efforts, which allows the State to further set an example for others to follow.

कार्यकारी सारांश

हिमालय के भारतीय भाग में स्नो लैपर्ड (पैंथेरा अनसिया) यानी हिम-तेंदुआ एक चरम षिकारी है। इसकी मौजूदगी पर्यावरण के स्वास्थ्य की सूचक होती है। हिम-तेंदुए की ग्लोबल डिस्ट्रीब्यूषन रेंज की दक्षिणी सीमा की ओर, ग्रेटर और ट्रांस-हिमालयन श्रृंखलाएं इसका एक महत्वपूर्ण पर्यावास हैं। हिमालय के भारतीय हिस्से में हिम-तेंदुए का संभावित पर्यावास संरक्षित क्षेत्रों तक ही सीमित नहीं है, बल्कि मानव के इस्तेमाल वाले इलाकों से भी इसकी सीमाएं काफी मिलती हैं। इन क्षेत्रों में स्थानीय समुदाय भी रहते हैं जिनकी संस्कृति, परम्पराएं और आजीविका इन भू-प्रदेषों के साथ गहराई से जुड़ी हैं। इन इलाकों के महत्व को समझते हुए भारत सरकार ने २००८ में प्रॉजैक्ट स्नो लैपर्ड की षुरूआत की, ताकि ऊंचाई पर रहने वाले वन्य जीवों और उनके पर्यावासों, भारत की अनोखी प्राकृतिक विरासत की सुरक्षा और उसका संरक्षण किया जा सके। इस संरक्षण के संवर्द्धन के लिए प्रतिभागितापूर्ण नीतियों और कार्रवाइयों की मदद ली गई।

हिम तेंदुआ, हिमाचल प्रदेष का प्रतीक जीव भी है और इसका पर्यावास लाहौल-स्पीति और किन्नौर जिलों में अधिकतर स्थानों पर मिलता है। इसका संभावित पर्यावास षिमला, कुल्लू, चम्बा और कांगड़ा जिलों के ऊपरी हिस्सों तक भी फैला हुआ है। इसमें से ज्यादातर इलाके दूरदराज हैं, और सर्दियों के दौरान यहां तक पहुंच पाना काफी मुष्किल होता है। इसी वजह से हिम-तेंदुए का अध्ययन करना काफी मुष्किल है।

जनवरी, २०१८ में हिमाचल प्रदेष, वन विभाग के वन्य जीव संभाग ने हिमाचल प्रदेष में हिम तेंदुए और इसका षिकार बनने वाले जंगली जीवों का अनुमान लगाने की दृष्टि से एक अग्रणी परियोजना षुरू की। ये सफलतापूर्वक पूरी की जाने वाली आरंभिक परियोजनाओं में से एक है, जिन्होंने इतने बड़े पैमाने पर ये आंकलन लगाने की कोषिष की है। इस परियोजना के लिए जिन तकनीकों का इस्तेमाल किया गया, वे वैज्ञानिक रूप से दमदार हैं, और पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय के स्नो लैपर्ड पॉपुलेषन एसैसमैंट इन इन्डिया (एसपीएआई) के तहत प्रोटोकॉल से मेल खाती हैं। इस प्रोटोकॉल का इस्तेमाल हिमालय के उन सभी पांच राज्यों में हिम-तेंदुए की आबादी के आंकलन के लिए किया जा रहा है, जहां हिम तेंदुए मिलते हैं।

पिछले तीन वर्षों के दौरान, हिमाचल प्रदेष वन विभाग के वन्य जीव संभाग ने इस परियोजना को कार्यान्वित करने के लिए नेचर कन्जर्वेषन फाउंडेषन (एनसीएफ) के साथ मिल कर काम किया है। इसमें अग्रणी स्तर पर काम करने वाले स्टाफ का क्षमता निर्माण, व्यापक स्तर पर कैमरा ट्रैप लगाया जाना और बाद में आंकड़ों को हासिल करके उनका विष्लेषण षामिल रहा है, जिन्हें राज्य भर के हिम तेंदुआ पर्यावासों में चलाई गई व्यापक अभियान के दौरान संकलित किया गया था। यह रिपोर्ट इस अभियान के दौरान प्राप्त किए गए अंतिम परिणाम उपलब्ध कराती है। नीचे उन मुख्य परिणामों का सारांष मौजूद है, जो इस परियोजना से प्राप्त हुए:

१. इस परियोजना में स्ट्रैटिफाइड सैम्पलिंग डिजाइन का उपयोग करके २६११२ वर्ग किलोमीटर इलाके में पहली बार विषाल क्षेत्रीय स्तर पर एक योजनाबद्ध प्रयास किया गया। राज्य के हिम तेंदुए वाले पूरे पर्यावास को पहले तीन श्रेणियों में बांटा गयाः उच्च, निम्न और अज्ञात क्षेत्र जहान हिम तेंदुओं के दिखाई देने की सभावना है। और इस जानकारी को जुटाने के लिए इन इलाकों में रहने वाले स्थानीय लोगों के प्रष्न-आधारित सर्वेक्षण किए गए। फिर ऐसी हर श्रेणी में कैमरा ट्रैप सर्वे किए गए। तो ये अनुसंधान सुनिष्चित करता है कि इन नमूनों के साथ

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Photos by Prasenjeet Yadav

कोई पूर्वाग्रह जुड़ा नहीं है, जबकि हिम-तेंदुए की आबादी की अनुसंधान के मामले में ऐसा आम होता है।

२. १० जगहों पर कैमरा ट्रैपिंग सर्वे किए गए ताकि सभी क्षेत्रों के नमूने लिए जा सकें, उच्च, निम्न और अज्ञात क्षेत्रों में इन सभी १० जगहों पर हिम-तेंदुए पाए गए, जिससे पता चला कि हिमाचल प्रदेष के सभी हिम तेंदुआ पर्यावासों में हिम तेंदुए मौजूद हैं - ये या तो अपनी किसी आबादी का हिस्सा हैं, या फिर ये आपस में जुड़े पर्यावासों में आते-जाते रहते हैं।

३. इस अध्ययन में हमें १८७ अवसरों पर ४४ तेंदुए नजर आए। तेंदुओं के इन आंकड़ों से हमने अनुमान लगाया कि हिम तेंदुओं की संख्या ५१ होगी, और इनकी इस आबादी में इनकी संख्या ७३ तक हो सकती है।

४. हिमाचल प्रदेष में हिम तेंदुओं का घनत्व प्रति १०० वर्ग किलोमीटर में ०.०८ से ०.३७ पाया गया। स्पीति और पिन घाटी वाले ट्रांस-हिमालयन क्षेत्रों में हिम तेंदुओं का घनत्व सबसे ज्यादा पाया गया।

५. हिम तेंदुओं के पूरे पर्यावास में, हमने ये आंकलन लगाया कि हिम तेंदुए का षिकार बनने वाले, खुर वाले जीव हैं - ब्लू षीप (स्यूडोइस नायॉर) और आइबैक्स (कापरा सिबिरिका) इसके लिए डबल ऑबजर्वर सर्वे तकनीक का इस्तेमाल किया गया। षिकार बनने वाले, खुर वाले वन्य जीवों का घनत्व ०.११ से १.०६ प्रति वर्ग किलोमीटर रहा। ट्रांस-हिमालय क्षेत्र में हिम तेंदुए का षिकार बनने वाले वन्य जीवों का घनत्व सबसे ज्यादा है। स्पीति में ब्लू षीप की आबादी ८६१ थी, जबकि पिन घाटी में आइबैक्स की आबादी २२४ थी।

६. हमें ये पता चला कि हिम तेंदुए का घनत्व उसके षिकार बनने वाले जीवों के घनत्व से सीधा सम्बन्ध रखता है, यानी अगर षिकार बनने वाले जीवों का घनत्व अधिक होगा, तो हिम तेंदुए का घनत्व भी ज्यादा होगा। स्पीति और ताबो में हिम तेंदुए और उसके षिकार, दोनों का ही घनत्व सबसे अधिक पाया गया। जबकि चन्द्रा और भरमौर में हिम तेंदुए और उसके षिकार, दोनों का ही घनत्व सबसे कम मिला।

७. हमारे कैमरा ट्रैपिंग सर्वे में २८ प्रजातियों का पता चला, इनमें मांसाहारी प्रजातियां भी षामिल हैं, जैसे कि भूरा भालू, काला भालू, यलो थ्रोटेड मार्टिन, स्टोन मार्टिन, मास्क्ड पाम सिवेट, हिमालयन वीज़ल, फैजैन्ट, जैसे कि मोनाल, चीयर फैजैन्ट, कोकलाज फैजैन्ट, स्नो पार्ट्रिज, खुर वाले जीव, जैसे कि कस्तूरी हिरण। हमें ग्रेट हिमालयन नैषनल पार्क में दो स्टेषनों पर एक ही कैमरा ट्रैप के जरिये सामान्य तेंदुए और हिम तेंदुए के होने का पता चला। इससे ये मालूम हुआ कि हिम तेंदुए और सामान्य तेंदुए का इलाका एक दूसरे को ओवरलैप करता है।

८. कैमरा ट्रैपिंग के इस पूरे अभियान का नेतृत्व स्पीति के किब्बर गांव में रहने वाले ८ स्थानीय युवाओं की टीम ने किया, जो २०१० से अपर स्पीति लैंडस्केप में इस तरह के सर्वे करते चले आ रहे हैं। इनकी मदद एनसीएफ के षोधकर्त्ताओं, हिमाचल प्रदेष वन विभाग के अग्रिम स्टाफ और स्थानीय समुदायों के सदस्यों ने की, जहां ये अनुसंधान किया गया था।

ये परिणाम अत्यंत प्रोत्साहित करने वाले हैं और वन्य जीव संभाग ने संरक्षण से जुड़े जो सकारात्मक प्रयास किए, ये उन्हें दर्षाते हैं। इन नतीजों ने इस बात की भी पुष्टि कर दी कि अगर संरक्षण की योजना बनाते समय स्थानीय समुदायों की चिंताओं को ध्यान में रखा जाए तो यही लोग संरक्षण के मामले में सबसे सषक्त साथी साबित होते हैं। परिणामों से वन्य जीव संभाग को इस पर दृढ विष्वास हो गया है कि हिम तेंदुए और इसका षिकार बनने वाले वन्य जीवों की आबादी पर नजर रखने के लिए लम्बी अवधि की एक निगरानी परियोजना कायम की जा सकती है। हिमाचल प्रदेष में भी एक ऐसी ही प्रक्रिया षुरू की जा सकती है जो भारत में बाघों की गणना के लिए इस्तेमाल हुई थी, जिसके तहत हर चार साल में इनकी गिनती होती है, और इस दौरान फील्ड में काम जारी रह सकता है। लम्बी अवधि की ऐसी स्टडीज, जमीनी स्तर पर संरक्षण के प्रभावीपन का पता लगाने में काफी उपयोगी साबित हो सकती है, और यह राज्य दूसरों के लिए एक उदाहरण भी बन सकता है।

Photo by Prasenjeet Yadav

Photo by Prasenjeet Yadav

Introduction

Snow Leopard (*Panthera uncia*) is the State animal of Himachal Pradesh. It is a flagship species for the conservation of the high Himalaya. The snow leopard is the smallest member of the genus Panthera, but it's secretive behaviour, camouflage, and adaptation to the cold and rugged mountain habitat captures public imagination, making it one of the most charismatic species in the world. Nearly half of the geographic area of Himachal Pradesh is located within the high elevation Himalayan and trans-Himalayan region, which is the preferred habitat of the snow leopard. This region is rich with unique animal and plant species that are found only in the high mountain regions of the Himalaya and parts of Central Asia, such as the musk deer, brown bear, goral, monal, and cheer pheasant. The snow leopard habitat of Himachal Pradesh is a source of local and regional ecosystem services such as fresh water used by millions of people living downstream and in the plains, and sustains unique high-altitude cultures (Murali et al. 2017).

The snow leopard faces many threats throughout its distribution range. It is threatened by large scale developmental projects such as mining and large infrastructure; rising livestock populations that can out-compete the wild herbivore prey of the snow leopard; increasing conflict with the herding community leading to their persecution; and an increase in poaching for snow leopard body parts.

Globally, the snow leopard is found across the high mountains of twelve countries of South and Central Asia and India has the third largest share of snow leopard distributional range. The state of Himachal Pradesh has played a pioneering role in the conservation of the snow leopard. The management planning of the ~4000 km² Upper Spiti Landscape was the first dedicated effort under the Project Snow Leopard. This is the first and still among a handful of efforts towards conservation of a large carnivore species outside the protected area network. The State's conservation efforts acknowledge that the wildlife in the high elevation region is not restricted to protected areas but spread across the entire landscape. The management plan of the Upper Spiti Landscape provides a framework for landscape level conservation that goes beyond protected area boundaries and integrates the needs of the local agro-pastoral communities as a part of the conservation effort. These ideas were foundational in setting the Management Plan Guidelines by the Global Snow Leopard and Ecosystem Protection Program (GSLEP) (Sharma et al 2019).

There are no robust global snow leopard population estimates, but they are believed to be 3900 to 8745 snow leopards (McCarthy et al 2016). Recently, the IUCN down-listed the snow leopard from Endangered to Vulnerable (McCarthy et al 2017) category. However, this change was questioned by many national governments and scientists (Bishkek statement 2017; Ale & Mishra 2017). The data used in these assessments has been shown to be biased and unsuitable for global assessments (Suryawanshi et al 2017). To work towards global estimates of snow leopards, there is a need to sample large contiguous landscapes which include newer areas and a diversity of habitat types and management regimes (protected areas and multi-use landscapes). The governments of the twelve snow leopard range countries agreed to a collaborative effort called PAWS, or Population Assessment of World's Snow Leopards (The Bishkek Declaration 2017). The Indian government responded by releasing the methodological guidelines for a countrywide snow leopard population assessment titled SPAI or, Snow leopard Population Assessment in India (MOEF 2019).

Robust methods of estimating snow leopard population sizes come from the use of sample counts based on camera trap (Karanth & Nichols, 1998) or molecular genetics (Mondal et al., 2009) and a model for imperfect detection. A standard camera trap based estimation involves setting up remote sensor cameras in the area of interest. The cameras are placed in the micro- habitats that are preferred by snow leopards but spread across the study area in a uniform grid system or distributed randomly in space (Alexander 2015; Jackson, 2006; O'Connell, 2010; Sharma et al., 2014). Individual snow leopards are identified from photographs using individually distinct spot patterns on the fur and the data are analysed using individual capture histories to estimate abundance and area sampled (Alexander et al., 2015; Sharma et al., 2014). The method assumes that individual snow leopards can be identified accurately from camera trap photographs. Johansson et al (2020) found that even experts make mistakes in identification of snow leopards from photographs leading to possible overestimation of the population. Similarly, samples of snow leopard faeces can be collected from the area of interest with relatively uniform spatial coverage across the study area. Individual snow leopards are then identified by extracting and analysing DNA from these samples and the data are similarly modelled in a capture-recapture framework to estimate the abundance of snow leopards in the area sampled (Janecka et al., 2008; Mondal et al., 2009; Suryawanshi et al., 2017). The possibility of mis-identification of individuals exists in the genetic analysis as well (Janečka et al. 2008). Both these methods have become popular especially following their widespread adoption in monitoring tiger (Panthera tigris) populations (Karanth et al., 2004; Karanth & Nichols, 1998; Jhala et al 2019).

Photo by Prasenjeet Yadav

The primary objectives of this project were, 1. To estimate the population of snow leopards across the state of Himachal Pradesh. 2. To estimate the population of the prey species of the snow leopard (mainly bharal and ibex). This report presents the results of a state wide camera trapping exercise and prey survey exercise in the snow leopard habitat of Himachal Pradesh to address these objectives. We used the two-step method with an occupancy study based stratified design which has been proposed by the Ministry of Environment, Forest and Climate Change in the Snow Leopard Population Assessment of India guideline (SPAI) and the guidelines circulated by the Global Snow Leopard and Ecosystem Protection Program (GSLEP). We used simulations to estimate the impact of potential errors in the snow leopard photo identification process. We supported the camera trap based population estimates of snow leopards with estimates of prey density.

Photos by Prasenjeet Yadav

Methodology

Himachal Pradesh's snow leopard landscape is divided into valleys made by large rivers like Sutlej, Chenab, Beas, Parvathi and their tributaries which include Baspa, Kugti, Ravi, Spiti and others. Most watershed areas open into these main rivers. Large parts of this landscape are difficult to access given the breaks in the landscape caused by the numerous rivers and streams. The snow leopard inhabits landscapes of varied geology, starkly different climatic regimes, diverse vegetation and community structures. On account of the snow leopards being an elusive species that occurs in low densities, studies generally tend to target smaller areas with relatively high densities. Restricting estimation to small areas or solely to high density sites lead to bias in estimates by inflating densities (Suryawanshi et al. 2019). This bias is further amplified when extrapolated to larger regions of interest. Therefore, accurately estimating snow leopard density across the, requires adequate and representative sampling recognising the heterogeneity in the landscape. We use a two-step sampling process recommended by the PAWS guideline (Sharma et al . 2019/GSLEP) to ensure robust design and adequate coverage of the state. First is macro level sampling to identify the sites where camera-trapping and ungulate surveys are to be conducted and the second step is micro level sampling to deploy cameras and conduct surveys at each site.

Macro-sampling design

We first demarcated potential snow leopard habitat in the State by identifying areas that fall between 3000 meters and 6000 meters elevation, the typical elevation range of the species. Previous snow leopard occupancy estimates (Ghoshal et al. 2019) conducted in the regions of Kinnaur, Spiti, Lahaul and Chamba that cover a large fraction of the snow leopard habitat within the state, were used to categorise the region into 3 strata where camera trapping surveys were to be conducted. Regions with occupancy probability greater than 0.75 were recognised as potentially high-density, whereas regions with lesser occupancy probability were recognised to be of potentially low-density. Areas that are known to be snow leopard habitats but fell outside the purview of the occupancy survey were categorised as the third 'unknown' strata. We surveyed a total of 10 sites, 5 in the high-density strata, 3 in the low-density strata and 2 in the unknown strata.

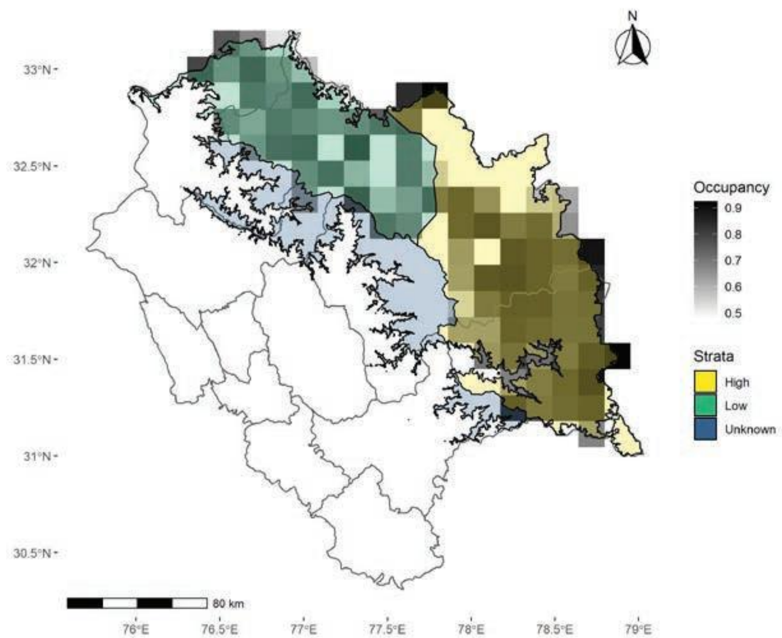


Figure 1: The potential snow leopard habitat in Himachal Pradesh stratified into 3 regions based on snow leopard occupancy – high (>0.75 occupancy), low (<0.75 occupancy) and the previously unsampled unknown stratum.

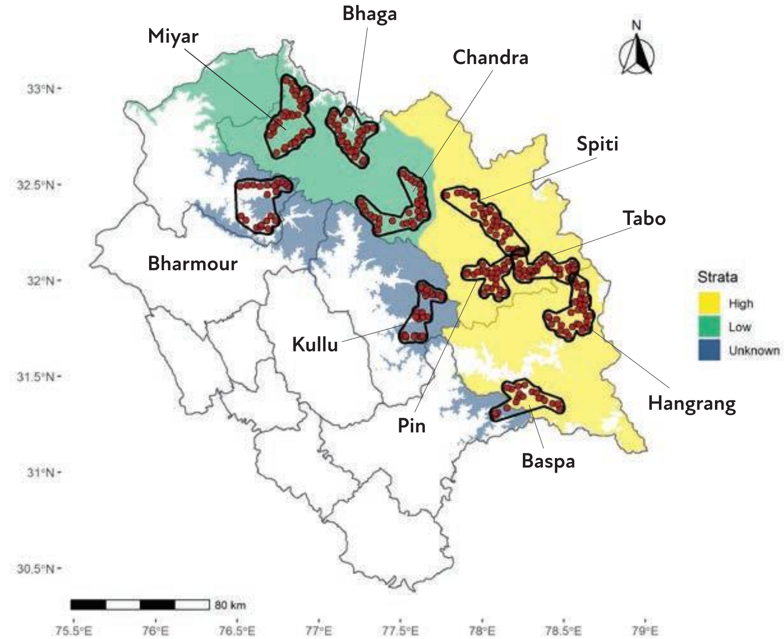


Figure 2: Camera trapping sites covering the three strata – high: Spiti, Hangrang, Tabo, Pin, and Baspa; low: Bhaga, Chandra, and Miyar; unknown: Bharmour and Kullu.

Micro-sampling design

Camera trapping survey

Areas with potential snow leopard habitats were demarcated in each site. These predominantly spanned ranges along the main river valley and ranges along valleys of larger tributaries. Slopes on both banks of the rivers, that were within the demarcated area were gridded into 4 x 4km cells. Snow leopard home ranges are known to vary greatly with estimates ranging from 12-39 km² in Nepal (Jackson and Ahlborn 1989, Jackson 1996) to 124-207 km² in Mongolia (Johannson et al. 2016). The camera-trap locations were selected to capture as many individuals as possible by multiple cameras, while optimising spatial coverage. Keeping this in mind, a grid size of 4 x 4km was chosen to ensure that it was less than the typical snow leopard home range to allow for recaptures across cameras. Since a clustered trapping design is difficult to implement given accessibility, we employed a uniform sampling design in all the 9 sites, except for Kullu. Cells that fell far below the elevation limits of snow leopard habitat (< 2000 m) and those covered in permafrost were excluded from the survey. Apart from a few cells which were completely inaccessible, one camera was deployed in each cell. Field teams deployed cameras, based on snow leopard signs such as hair, scat, scratch or spray marks and the presence of suitable microhabitats to maximise detection within each cell.

Double-observer survey

Each of the 10 sites was further divided into smaller blocks for the ease of survey. Each block was surveyed keeping three main assumptions in mind: 1) that entire visual coverage of each block was possible during the survey, 2) two individual teams surveyed the area independently, and 3) the ungulate groups could be identified individually based on the age-sex composition of a herd, its location, and any other peculiarities that the teams could note. This method is based on the principles of mark-recapture theory. It is difficult to identify individual mountain ungulates, however, their groups, even if temporary, can be identified during sampling based on characteristics such as group size, age-sex composition, and location. The unit being "marked" and "recaptured" in the double-observer technique is the individual group.

Image processing and data analyses

Camera-trapping was done at 10 sites spread across snow leopard habitat in the entire State of Himachal Pradesh. We used Reconyx HC500 cameras that were installed for 60 days, during which, cameras were checked once for battery condition and for replacement of memory cards (see table 1 for camera-trapping effort for each site).

All snow leopard images were tagged using the digiKam image management software (https://www.digikam.org/). Errors in snow leopard image identification have been shown to bias estimates of density and population size (Johansson et al 2020). To minimise this bias, we conducted image identification and tagging in two stages – first identification stage followed by the review stage. In the first stage, one or two researchers carefully catalogued all the camera trap photos of snow leopards from each site. Rosette patterns from the face, limbs, rump, shoulder, upper parts of the tail and cheeks of the snow leopard were to identify different individuals. In the second stage, two different researchers reviewed all the individuals that were captured only once. In case of insufficient evidence for tag assignment as a new individual, we reverted the image as "unidentified" or in case of a misidentification, we assigned a new tag to the image. The changes were verified by a third reviewer independently and discrepancies were resolved by using a conservative approach. Following the individual identification for each site, we conducted image comparisons across sites.

After individual identification, images were assigned tags which were saved in their respective image metadata, from where they were read using the CamtrapR package (recordTable and recordTableIndividual) to generate a database of snow leopard capture history information. The CamtrapR package (built for the R statistical and programming environment) was used to create separate csv files for individuals captured for each site.

Photos by Prasenjeet Yadav

Table 1: Effort for camera-trapping survey at 10 sites

Name of site	Estimated Area (km2)	No. of camera traps deployed	No. of occasions (days)
Bhaga	480	30	60
Bharmour	352	21	60
Chandra	496	31	60
Kullu	480	30	60
Miyar	576	36	60
Pin	370	25	60
Baspa	320	20	60
Tabo	464	29	60
Hangrang	484	31	60
Spiti	760	31	60

Data analyses

Snow leopard density and population size were estimated using multi-session SECR (Spatially Explicit Capture-Recapture) models (Borchers 2012). SECR models explicitly use the spatial information of detection location at the camera traps, i.e., these models account for the heterogeneity in captures that arises because probability of capture in a specific trap depends on its location relative to the movement of the animal (Efford et al. 2009). The number of wild prey per site was estimated using the two survey mark-recapture method employing a Bayesian framework using the 'BBRecapture' package in the R statistical and programming environment (Fegatelli and Tardella 2013, Version 3.3.4, R Core Team, 2020).

Results

1 *44 individual snow leopards were detected on 187 occasions. Estimated snow leopard population size is likely to be 51 individuals and this population can be reliably estimated to be upto 73 individuals.*

2 *Snow leopards were detected at all the 10 sites suggesting that snow leopards are found in the entire snow leopard habitat in Himachal Pradesh – either as resident individuals of a population or as dispersing individuals navigating through these areas.*

3 *The trans-Himalayan regions of Spiti and Pin valley recorded the highest densities of snow leopards and snow leopard density ranged from 0.08 to 0.37 individuals per 100 km².*

4 *Wild ungulate prey density (blue sheep Pseudois nayaur and ibex Capra sibirica) ranged from 0.11 to 1.09 per km². The trans-Himalayan region supports the highest densities – the estimate of blue sheep population size was 891 for Spiti, and the ibex population size estimate was 224 for the Pin valley.*

Snow leopard population density and abundance

Sites varied in the number of detections - Spiti from the high occupancy stratum had 61 detections with 9 individuals; Chandra from the low occupancy stratum had 18 detections of 3 individuals, and Kullu from the unknown stratum had 22 detections with 2 individual snow leopards.

Snow leopard densities varied across sampling sites with a seven-fold difference between the highest and lowest density sites. Tabo, Hangrang, and Spiti had the highest densities of 0.37 (95%CIs: 0.18 – 0.72), 0.36 (95%CIs: 0.18 – 0.73), and 0.3 (95%CIs: 0.15 – 0.59) snow leopards per 100 km², while Bhaga from the low stratum recorded the lowest density of 0.05 (95%CIs: 0.01 – 0.24) snow leopards per 100 km² (Table 2). Snow leopard densities estimated for each stratum corresponded to the occupancy surveys – the high occupancy stratum showed a high density of 0.3 (95%CIs: 0.21 - 0.42) snow leopards per 100 km²; low occupancy stratum had a low density of 0.08 (95%CIs: 0.05 - 0.12) and the previously unsampled stratum had a density of 0.08 (95%CIs: 0.08 - 0.14) snow leopards per 100 km².

Table 2: Site wise details about camera trapping effort and results from 10 sampled sites in the Indian state of Himachal Pradesh. Estimated area is the number of 4 x 4 km grids with cameras times the area of the grid.

Name of site	Estimated Area (km2)	No. of camera traps deployed	No. of occasions (days)	No. of snow leopard detections	No. of individual snow leopards	Estimate snow leopard density per 100km² (95% CI)
Bhaga	480	30	60	9	1	0.05 (0.01-0.24)
Bharmour	352	21	60	1	1	0.06 (0.01-0.31)
Chandra	496	31	60	18	3	0.1 (0.03–0.29)
Kullu	480	30	60	22	2	0.1 (0.03–0.35)
Miyar	576	36	60	5	2	0.07 (0.02–0.26)
Pin	370	25	60	19	6	0.27 (0.12–0.61)
Baspa	320	20	60	7	3	0.18 (0.06–0.51)
Tabo	464	29	60	27	9	0.37 (0.18–0.72)
Hangrang	484	31	60	18	8	0.36 (0.17–0.73)
Spiti	760	31	60	61	9	0.3 (0.15–0.59)

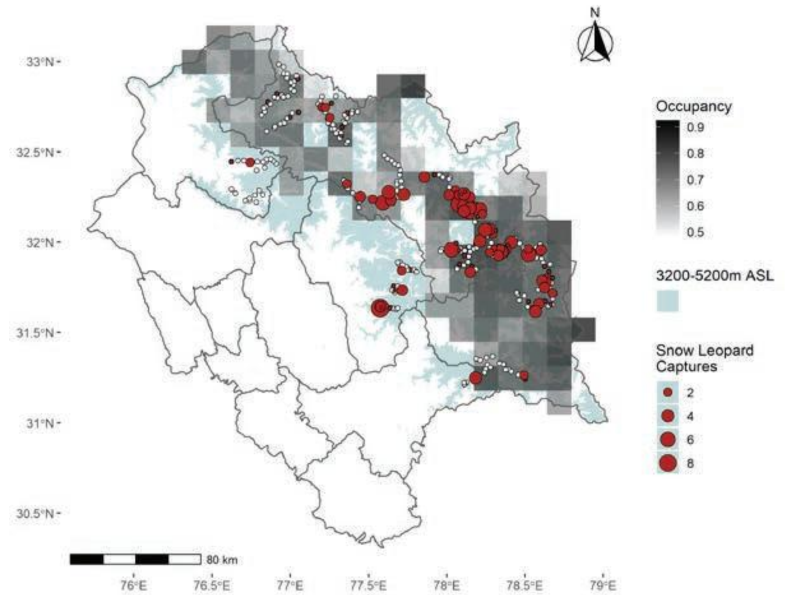


Figure 3: Snow leopard captures in each of the 10 sites surveyed. Red dots represent cameras where snow leopards were photographed. Larger dots indicate a higher number of occasions where snow leopards were captured. White dots represent cameras where no snow leopards were photographed. Black cells show snow leopard occupancy within a 15 x 15km grid as estimated by Ghoshal et al. 2019. The light blue region depicts the potential snow leopard habitat elevation range

This study used a robust sampling design that representatively sampled all types of snow leopard habitats unlike previous estimates that were based on sampling only from high density areas. For this study region, the population size is estimated to be between 44 to 73 snow leopards with a mean of 51 (95% CI 44 - 73) snow leopards. For our study region, the detection probability at the activity centres λ (lambda) was estimated to be 1.8 x 10-2 (95%CI: 1.3 x 10-2 - 2.5 x 10-2). The indicator of home range δ (sigma) from our study was estimated to be 8.5 km (95% CI: 6.9 – 10.41 km).

Ungulate density

The total area of all the 10 sampled sites was 4,489 km² and it was surveyed on foot, covering 749 km of transects which were walked two times by the two observer teams. Blue sheep was recorded in Spiti, Tabo, Hangrang, and Baspa, whereas ibex was recorded in all sites except in Kullu, Tabo and Baspa. We also recorded tahr in Kullu and Bharmour regions. The highest wild prey density was recorded in Spiti (1.09 individuals km^{-2}; 1.074 individuals km^{-2} – 1.14 individuals km^{-2}) and the lowest in Chandra (0.11 individual km^{-2}; 0.08 individuals km^{-2} – 0.22 individuals km^{-2}). Solely for blue sheep, the site with the highest density was Spiti (0.99 individuals km^{-2}; 0.97 individuals km^{-2} – 1.040 individuals km^{-2}) and the lowest was Baspa (0.19 individuals km^{-2}; 0.13 individuals km^{-2} – 0.44 individuals km^{-2}). Solely for ibex, the site with the highest density was Pin (0.75 individuals km^{-2}; 0.75 individuals km^{-2} – 0.86 individuals km^{-2}) and the lowest was Chandra (0.11 individual km^{-2}; 0.08 individuals km^{-2} – 0.22 individuals km^{-2}). Table 3 below summarises results from all the 10 sites.

Table 3: Results from ungulate double-observer surveys from 10 sites

Block	Year	Species	Effort Km	Area km²	Abundance (95% CI)	Density (95% CI)
Pin	2016	Ibex	45.5	298	224 (224-256)	0.75 (0.75-0.86)
Spiti	2017	Blue Sheep	96.5	816	810 (790-850)	0.99 (0.97-1.04)
		Ibex			94 (82-127)	0.12 (0.10-0.16)
		Combined			891 (872-932)	1.09 (1.07-1.14)
Tabo	2017	Blue Sheep	43.5	341	351 (342-392)	1.03 (1.00-1.15)
Hangrang	2017	Ibex	119.4	589	99 (84-156)	0.17 (0.14-0.26)
		Blue Sheep			454 (435-505)	0.77 (0.74-0.86)
		Combined			547 (519-600)	0.93 (0.88-1.02)
Bhaga	2018	Ibex	124	456	229 (200-290)	0.5 (0.44-0.64)
Miyar	2018	Ibex	88	604	164(142-254)	0.27 (0.23-0.42)
Chandra	2018	Ibex	47.4	447	47 (35-100)	0.11 (0.08-0.22)
Baspa	2019	Blue Sheep	66.2	480	93 (62-212)	0.19 (0.13-0.44)
Kullu	2019	Blue Sheep	51.42	256	177 (163-229)	0.69 (0.64-0.89)
		Tahr			79 (59-163)	0.31 (0.23-0.64)
Bharmour	2019	Tahr	67.3	202	109 (87-177)	0.54 (0.43-0.88)
		Ibex			33 (25-81)	0.16 (0.12-0.40)

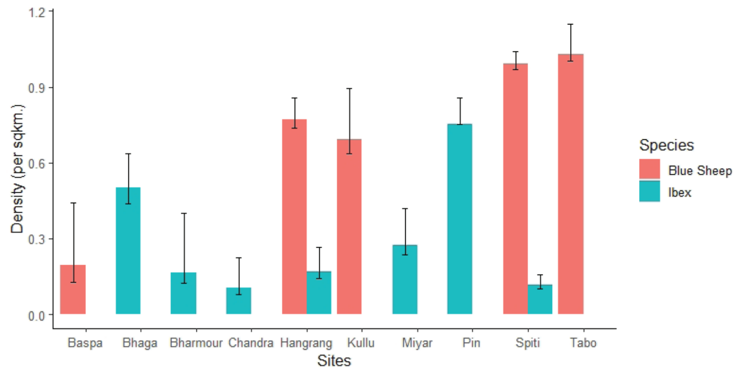


Figure 4: Results from double-observer surveys for prey density from 10 sites

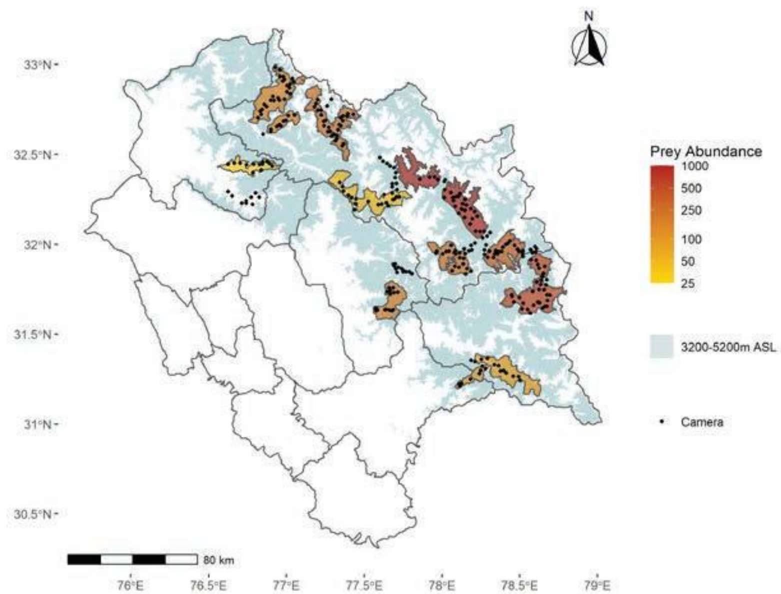


Figure 5: Estimated prey abundance using double observer surveys in the 10 surveyed sites. The light blue region depicts the potential snow leopard habitat elevation range. Black dots represent deployed cameras.

Relationship between snow leopard and prey density

Prey density was shown to have a positive relationship with snow leopard density (slope = 0.25, SE = 0.08, P = 0.01, R2 = 0.51). Sites with a high density of prey population, such as Tabo (Mean = 1.03, 95% CI = 1.01 - 1.15 prey per km²) and Spiti (Mean = 1.09, 95% CI = 1.07 - 1.14 prey per km²) were shown to have high densities of snow leopards (Tabo: 0.37 with 95% CI: 0.18 – 0.72; Spiti: 0.3 with 95%CIs: 0.15 – 0.59 snow leopards per 100 km²). On the other hand, Bharmour and Chandra that reported low densities of prey were shown to have low snow leopard densities.

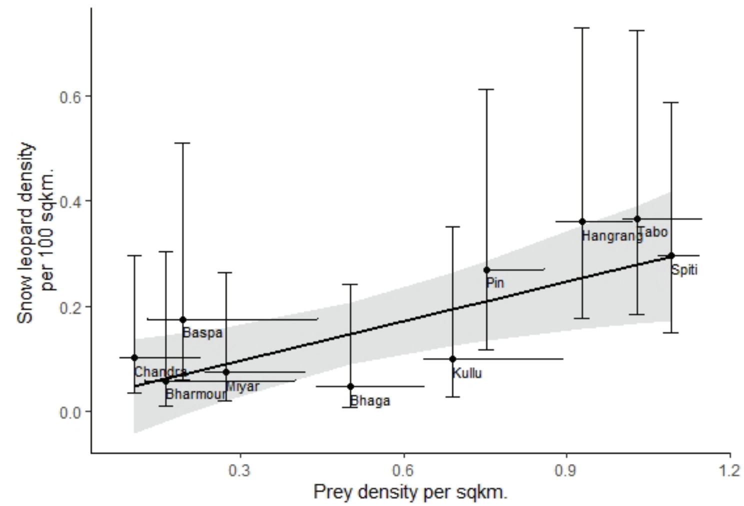


Figure 6: Snow leopard density and prey density is positively correlated across sites. Line represents predicted relationship from a weighted linear regression model (slope= 0.25, SE= 0.08, P= 0.01, R^2= 0.51) and shaded region represents 95% CI on the model prediction.

Site Information

Photo credit: NCF

Photo credit: NCF

Baspa

The Baspa valley covers large parts of the Rakcham-Chitkul Wildlife Sanctuary and its adjacent areas (notably the Rupin pass region towards Jhaka and Jiskun). The valley's lower reaches consist of oak and pine forest along with Indian birch and diverse species of rhododendron. The camera trap area in Baspa region included parts of Baspa valley from Shong village to Nagasti area beyond Chitkul with areas lying within the Rakcham-Chitkul Wildlife Sanctuary. Both sides of Baspa river were surveyed and the area was extended from Sangla Kanda towards Udug naal area beyond Rupin pass and before Jakha-Jiscoon village. The ungulate survey region extended from near Sangla town till the last Indo-Tibetan Border Police (ITBP) check-post in the Dumti region. Both banks of the Baspa river were surveyed. In addition to this, a narrow yet long valley SW of the Sangla town, from Rupin pass down towards the Jakha-Jiskoon villages was also surveyed.

We detected 3 snow leopard individuals on 7 occasions from this site in our camera traps. In addition, we detected black bear, brown bear, Himalayan weasel, mountain weasel, leopard cat, jackal, stone marten, yellow-throated marten, monal, koklass pheasant, snowcock, snow partridge, and musk deer in our camera traps. The ungulate surveys revealed blue sheep abundance to be 93 (95% CI: 62-212).

Bhaga

The Bhaga region falls within the Lahaul region of the Lahual-Spiti district. This region falls under the Trans-Himalayan eco-region and experiences harsh winters and most of the precipitation is mainly in the form of snowfall. The temperature ranges from 300C in summer to -350C in winter. The area is mostly considered a dry alpine region dominated by graminoids, sedges and a few shrubs. Camera trapping for this site was centered around the village of Darcha and surrounding valleys with a coverage within the Kugti Wildlife Sanctuary. Sampling area included the region NW from Darcha towards Shinko la, SE from Darcha towards Yoche, and NE from Darcha towards Zingzing/Bar-Baralacha La. Both banks of the river Bhaga and its tributaries were covered. These valleys and catchments formed the sampling area of the ungulate survey as well.

We detected 1 snow leopard individual on 7 occasions from this site in our camera traps. In addition, we detected mountain weasel, red fox, stone marten, chukar partridge, and snowcock in our camera traps. The ungulate surveys revealed ibex abundance to be 229 (95% CI: 200-290).

Bharmour

Bharmour falls within the Pir Panjal range of the Himalaya with varying altitude from 1350m- c.6000m. and is drained by the Ravi river that originates near the Garechu glacier, at the bottom of the Kugti pass. July-August are the warmest months (mean monthly temperature of 26.08 oC) while January-February are the coldest (with temperature below -10 oC accompanied with heavy snowfall) (Mohanta & Chauhan 2014). The camera trapping for this site was centered around Bharmour town for the Kugti area and Nayagraon for the Holi area. We detected 1 snow leopard individual on 1 occasion from this site in our camera traps. In addition, we detected black bear, brown bear, common leopard, Himalayan weasel, mountain weasel, leopard cat, jackal, stone marten, yellow-throated marten, masked palm civet, monal, koklass pheasant, snowcock, snow partridge, goral and musk deer in our camera traps from Bharmour. The ungulate surveys revealed that Himalayan tahr abundance was 109 (95% CI: 87-177) and ibex abundance estimate was 33 (95% CI: 25-81).

Chandra

The regions between Batal and Tokpo Yongma (including Chandratal) and large parts of the left bank were not surveyed for ungulates given the extreme weather conditions and lack of access due to unseasonal heavy snowfall. The Chandra region falls within the Lahaul-Spiti district and this region is a basin drained by the Chandra river, a sub-basin of the larger Chenab river. The camera trapping for this site was conducted on both banks of the Chandra river from Khoksar till Batal and then northwards into the Chandertal region till Tokpo Yongma (which eventually leads to Baralacha la) covering areas within the Chandertal Wildlife Sanctuary. The ungulate surveys were largely limited to the right bank of the Chandra river from Khoksar till Batal.
We detected 3 snow leopard individuals on 14 occasions from this site in our camera traps. In addition, we detected brown bear, mountain weasel, stone marten, marmot, snowcock, and chukar partridge in our camera traps. The ungulate surveys revealed that ibex abundance estimate was 47 (95% CI: 35-100).

Hangrang

Hangrang valley is the second-largest valley in Kinnaur district in Himachal Pradesh. This valley borders the area of Spiti in the upper Kinnaur region and is very close to Tibetan border of the North and Eastern side of Himachal Pradesh. This whole area experiences a harsh winter and most of the precipitation is mainly in the form of snowfall. The temperature ranges from 250C in summer to -350C in winter. The area is mostly considered a dry Alpine area. The camera trapping and ungulate surveys in this site covered the same areas. In addition to the Hangrang valley, extending from the Khab bridge till Hango village along with its adjacent areas, sampling for this site also included the Upper Sutlej valley and the Ropa valley.

We detected 8 snow leopard individuals on 18 occasions from this site in our camera traps. In addition, we detected brown bear, stone marten, yellow-throated marten, jungle cat, leopard cat, red fox, snowcock, and chukar partridge in our camera traps. The ungulate surveys revealed that ibex abundance estimate was 99 (95% CI: 84-156) and blue sheep abundance estimate was 454 (95% CI: 435-505).

Kullu

This area consists of high mountain ridges, some upwards of 5,800 m, and is divided into three gorges - Tirthan, Sainj and Jiwa Nala - based on the streams that flow through each. Large parts of this region consists of moist temperate oak and conifer forests, along with high altitude birch and fir interspaced with sub-alpine pastures (Baviskar 2003). The camera trapping for this site was split between three valleys, Tirthan and Sainj (within the Great Himalayan National Park) and Parvati valley (within Kheerganga National Park). For the ungulate surveys we covered the Tirthan (Kubri top and Tirth) and Sainj (Rakthi and Chengar) and did not cover Parvati valley.

We detected 2 snow leopard individuals on 18 occasions from this site in our camera traps. In addition, we detected brown bear, black bear, common leopard, Himalayan weasel, mountain weasel, leopard cat, stone marten, yellow-throated marten, vole, red fox, cheer pheasant, koklass pheasant, chukar partridge, goral, and musk deer in our camera traps. The ungulate surveys revealed that blue sheep abundance estimate was 177 (95% CI: 163-229) and tahr abundance estimate was 79 (95% CI: 59-163).

Bhaga

Miyar is a long narrow valley of c.75 km which is located in the Lahual range of the Western Himalayas between the Pir Panjal and Zanskar ranges (Apollo et al. 2018). Thirot is relatively shorter but is covered with a similar extent of glaciers. For both valleys, travelling in from the valley mouths, the landscape transitions from Greater Himalaya temperature pine, birch and rhododendron forests to Alpine and nival zones along an increased elevation gradient. The camera trapping for this site was done across the entire length of Miyar and its neighbouring Thirot valley. The sampling regions for the camera trapping and ungulate surveys were similar.

We detected 2 snow leopard individuals on 5 occasions from this site in our camera traps. In addition, we detected brown bear, mountain weasel, stone marten, red fox, snowcock, snow partridge, chukar partridge, and musk deer in our camera traps. The ungulate surveys revealed that ibex abundance estimate was 164 (95% CI: 142-254).

Pin

This area is situated in the catchment of the Pin River within the Pir Panjal range of the Himalayas. Overall, the terrain is rugged with most regions having an inclination between 30 and 60 degree. The camera trap areas for this site included the Ensa nallah and its surrounding region (around and beyond Mudh village), around Sangnam village and the core region of the Pin valley National Park roughly west of Sagnam village, including the Geychang-Thango area and their connected side valleys. The ungulate survey was conducted in the same area.

We detected 6 snow leopard individuals on 18 occasions from this site in our camera traps. In addition, we stone marten, red fox, and chukar partridge in our camera traps. The ungulate surveys revealed that ibex abundance estimate was 224 (95% CI: 224-256).

Spiti

The Spiti landscape in the Indian trans-Himalayas is a high altitude (3500-6700 m) region covering an area of about 7,600 km². The temperature ranges from -40°C in peak winter to 30°C in summer. Vegetation is broadly classified as 'dry alpine steppe' (Champion and Seth 1968). The camera trapping survey covered the region solely on the left-bank of the Spiti river from around the Lossar village area downstream till Demul covering parts of the Kibber Wildlife Sanctuary. The ungulate survey area covered the same region as well.

We detected 9 snow leopard individuals on 52 occasions from this site in our camera traps. In addition, we detected mountain weasel, stone marten, red fox, snowcock, wolly hare, snowcock, and chukar partridge in our camera traps. The ungulate surveys revealed that blue sheep abundance estimate was 810 (95% CI: 790-850) and ibex abundance estimate was 94 (95% CI: 82-127).

Tabo

This site was sampled along the main Spiti river valley between the villages of Schilling and Sumra. This region also falls within the Indian Trans-Himalayas, but with slightly lower altitudes than the Spiti site. The temperatures can range from summer highs of 30°C to winter lows of -30 °C. The vegetation in the region is classified as "dry alpine steppe" (Champion and Seth 1968). The camera trapping and ungulate survey areas predominantly overlapped for this site. This covered both the right bank and left bank areas of Spiti rivers, between the villages of Schilling to Sumra. The surveys were centered from the village of Tabo.

We detected 9 snow leopard individuals on 25 occasions from this site in our camera traps. In addition, we detected mountain weasel, stone marten, red fox, snowcock, wolly hare, snowcock, and chukar partridge in our camera traps. The ungulate surveys revealed that blue sheep abundance estimate was 351 (95% CI: 342-392).

Photos by Prasenjeet Yadav

Photos credit: NCF

Non targeted carnivore species detections

Although the primary objective of the camera trap exercise is to generate a long term data for snow leopard population monitoring, these camera traps also captured other animals. We have identified and tagged 28 non target species (Table:) in these camera traps from 10 sites (Table:). We have utilised these data to understand distribution of various non targeted carnivore species in Trans Himalayas. Species with more than 30 detections were used for these analyses.

Species	Capture
Red fox	783
Stone marten	282
Dog	112
Yellow throated marten	49
Brown bear	46
Masked palm civet	39
Black bear	33
Himalayan weasel	31
Mountain weasel	31
Leopard cat	26
Common leopard	14
Wolf	03
Jackal	02
Jungle cat	01

Future Work

This project is the first scientifically robust assessment of snow leopard and its prey population in the State of Himachal Pradesh. This is likely among the first project of its kind to have been completed, at this scale, anywhere across the global snow leopard range. This exercise presents two opportunities for the future:

– *It provides baseline information to the Wildlife Wing to set up a long term monitoring project to track the population of snow leopard and its wild prey species;*
– *It provides a landscape level status, which can be extended to understand the perspectives and motivations of local communities and how it affects conservation action in these regions of the State.*

In terms of systematic long-term monitoring, the State can pursue a process similar to that followed for tiger census in India. The national tiger census is reported once every four years, while field work is ongoing. Himachal Pradesh can choose to further strengthen study design by increasing simultaneous deployment of camera traps and building more capacity among frontline staff to lead such studies in the field. Long term studies can become a very useful way to track the efficacy of on-ground conservation efforts.

The results from this study provide a snapshot of snow leopard and prey estimates across the landscape based on primary evidence. There is a scope to build on this information to understanding the perspectives and motivations of local communities, since these are inevitably linked with the results of on-ground conservation efforts. Local lifestyles, traditional practices and cultural beliefs have a significant role in conservation as well as human wellbeing of communities inhabiting the high Himalayan regions. Capturing such information can allow the Wildlife Wing to develop plans that are aligned to the expectations of local communities residing in these regions.

Capacity Building

An important part of the project was to build local capacity among frontline staff for conducting ecological field surveys. During the course of the project, frontline staff was trained in a camera-trapping prior to expeditions in the landscapes that were surveyed as part of the assessm

The one-day training covered the following topics:

1. Introduction to Population Assessment of the World's Snow Leopards (PAWS) and state-wide estimation of snow leopard and its prey species in Himachal Pradesh
2. An introduction to camera trap studies and types of camera traps
3. Mapping of landscape for areas of high wildlife value, which was led by frontline staff
4. How to plan and conduct a camera trap study with a session on setting up and operating camera traps in the field

Photo credit: NCF

In addition to this, the participants were informed about the various kinds of datasheets used in the project like installation datasheet, monitoring datasheet and removal datasheet. They were also apprised about the workflow of data management, identification and analysis that would follow the field work. Following the training, we led the setting of camera traps in these respective landscapes. Several of the trained frontline staff participated in these exercises which stretched on for up to a fortnight. These cameras had to be monitored once in the 60-day monitoring period and retrieved at the end of 60 days.

In all, 73 frontline staff were trained during the course of the project. This is in addition to similar training programs that have been conducted in Spiti in the previous years. The locations where day-long training programs were carried out include:

Division	Location	No. of attendees	Conducted on
Lahaul	Keylong	19	14 May 2018
Sarahan	Sangla	3	6 May 2019
Bharmour	Bharmour	30	22 May 2019
GHNP	Sai Ropa	21	11 June 2019

We also informed local communities of the camera trapping exercise in order to prevent any sense of intrusion into their areas, as well as to seek their participation and support in the exercise.

The entire camera trapping exercise was led by a team of 8 local youth of Kibber village in Spiti who have been working on such surveys across the Upper Spiti Landscape since 2010. They were given advanced training at the start of each year in order to ensure that they were fully prepared to lead field work. Such training was carried out at the start of 2018 and 2019. This advanced training was carried out over a month at NCF's head office in Mysore. During this time the team was trained in:

1. Specifics of camera trapping including capture-recapture methods and double-observer surveys (5 days)
2. Handling outdoor medical emergencies (1 day)
3. Conducting interview surveys (1 day)
4. Module on PARTNERS principles for community-based conservation (2 days)
5. Basics of project management and developing work plan for upcoming year (2 days)
6. Working with data in Excel (1 day)
7. Spoken English and basics of writing and reporting (2 days)
8. Workshop on mental health and well-being with a focus on coping up with long durations of field work (1 day)

Shorter training modules were carried out at the start of every field expedition. They were adequately supported by NCF researchers, frontline staff of the HPFD and members of the local community where cameras were set up.

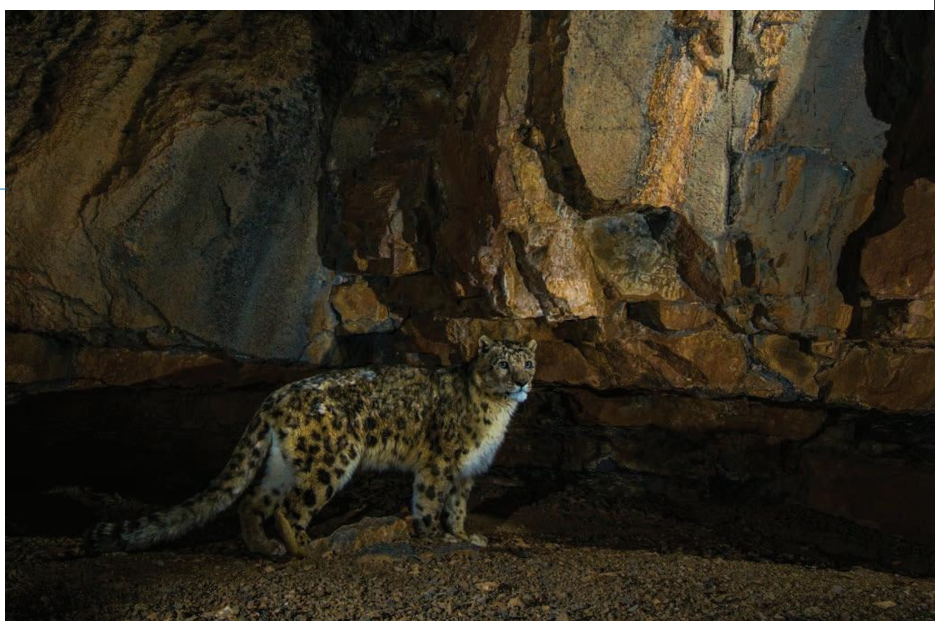
Training for frontline staff of Forest Department in camera trapping in Bharmour (2019)

Community awareness meeting and Forest Department training for camera trapping in Sangla (2019)

Training for frontline staff of Forest Department in camera trapping in Keylong (2018)

Acknowledgments

This project was carried out as a collaborative effort by the Wildlife Wing of the Himachal Pradesh Forest Department and the Nature Conservation Foundation (NCF), Mysuru. Several officers of the Wildlife Wing of Himachal Pradesh Forest Department played an important role across various stages of this project. We list the names of all these officers, field officers and frontline staff in acknowledgement of the role they played in ensuring the success of this project:



Photos by Prasenjeet Yadav

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The Great Himalayan National Park (GHNP):
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DFO (Wildlife) at GHNP,
RFOs of Sainj and Sairopa,
Forest guards: Shri. Bintu and Shri. Om Prakash,
Shri. Govind Thakur, the caretaker at Sairopa.

Chamba (Wildlife) Division:
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Shri. Sunny Verma,
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RFOs of Chamba Wildlife and administrative divisions,

Sarahan (Wildlife) Division:
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Shri. Bahadur Singh (RFO Sangla),
Shri. Parmanand Dharek (BO Sangla),
Forest Guards: Shri. Vinod Thakur,
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Lahaul Forest Division:
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Kinnaur Forest Division
DFO Shri. Angel Chauhan,
Range Forest Officer Pooh,
Shri. Vanish Thakur,
The Indo-Tibetan Border Police officials who provided permissions for survey under their jurisdiction.

Spiti (Wildlife) Division
DFOs who have served over the years:
Shri. Hardev Negi, Shri. Rajeev Sharma,
Shri. Rajesh Sharma and Shri. T.R Dhiman,
RFO Shri. Devender Singh Chauhan
Frontline staff of the Spiti (Wildlife) Division.

We would also like to stress on the critical role played by community members in each of the locations where we conducted field work. This work could not have been done without their active participation and large hearted support.

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Photos by Prasenjeet Yadav

Appendix

Snow leopard Profiles


BAS1


BAS2


BAS3


BHG1


BHR1


CHA1


CHA2


CHA3


HAN1


HAN2


HAN3


HAN4


HAN5


HAN6


HAN7


HAN8


KUL1


KUL2


MIT1


MIT2


PIN1


PIN2


PIN3


PIN4


PIN5


PIN6


SPI1


SPI2


SPI3


SPI4


SPI5


SPI6


SPI7


SPI8


SPI9


TAB1


TAB2


TAB3


TAB4


TAB5


TAB6


TAB7


TAB8


TAB9

nature
conservation
foundation

SNOW
LEOPARD
TRUST