

# **Status of Tiger Habitats in High Altitude Ecosystems of Bhutan, India and Nepal (Situation Analysis)**



**2019**

**Disclaimer:**

The views as expressed in this report do not necessarily reflect those of and cannot be attributed to the study advisors, contacted individuals, institutions and organizations involved. The information contained herein has been obtained from various sources, a review of publication, surveys, deliberations of the workshops conducted, and are to the best of our knowledge accurate. Despite all precautions taken to accurately reflect the information that was collected for this report, any errors pointed out subsequently by any party cannot lead to any liability on the part of the author. The contents of this report may be used by anyone providing proper acknowledgement.

**Citation:**

Status of Tiger Habitats in High Altitude Ecosystems of Bhutan, India and Nepal (Situation Analysis). Global Tiger Forum. 2019.

**Contact:**

Global Tiger Forum

Email: [mkapoor@globaltigerforum.org](mailto:mkapoor@globaltigerforum.org)

---

**PHOTO CREDIT:**

FRONT COVER: CAMERA TRAP IMAGE-SIKKIM, INDIA; BACK COVER: CAMERA TRAP IMAGE – BHUTAN



# STATUS OF TIGER HABITATS IN HIGH ALTITUDE ECOSYSTEMS OF BHUTAN, INDIA AND NEPAL (SITUATION ANALYSIS)



Supported by



Implemented by:



## Study Team

### GTF Team

Project Supervisor	Rajesh Gopal
Project Coordinator	Mohnish Kapoor
Finance Officer	Gin Chin Lam
Technical Officers	B.S. Bonal and Ridhima Solanki (India), Tenzin Wangchuk (Bhutan & Nepal)
Data Compilation, Report Layout, GIS Support	Ridhima Solanki
Data Entry and Analysis	Arun Kumar, Anjali Mehra, Hrishita Negi, and Roshan Puranik
Editorial Support	Rajiv Khangwal
Project Advisors	Keshav Varma and Satya Prakash Yadav

### Wildlife Institute of India

Principal Scientist (Design and Technical Inputs)	K Ramesh
Project Scientist (Database and Spatial Analyses)	Sujata Upgupta and A. Arunkumar
Advisor	V.B. Mathur
Project Intern (GIS support)	Raeesha Rehman
Data Sharing/Technical Inputs	Gopi GV, S Sathyakumar, Y.V. Jhala, and Qamar Qureshi

### Department of Forest and Park Services, Govt. of Bhutan

Nodal Officer Bhutan	Tandin
----------------------	--------

### National Tiger Conservation Authority, Govt. of India

Nodal Officer India	Nishant Verma
Advisors	Anup Nayak, Amit Mallick, Surendra Mehra, Vaibhav Mathur,

### Department of National Parks and Wildlife Conservation, Govt. of Nepal

Nodal Officer Nepal	Laxman Prasad Paudel
Ecologist	Haribhadra Acharya
Assistant Ecologist	Bhupendra Prasad Yadav



### Global Tiger Centre, Bhutan

Data and Field Coordination	Tshering Tempa and respective forest frontline at study sites
-----------------------------	---

### National Trust for Nature Conservation (NTNC)

Executive Director	Siddhartha B. Bajracharya
Program Manager	Chiranjibi Prasad Pokheral
Sr. Accounts officer	Bidur Prasad Pokharel
Conservation Officer	Saneer Lamachhane
Sr. Wildlife technician	Suman Malla
Wildlife Technician	Dev Raj Joshi
Wildlife Technician	Amar Singh Thakur
Wildlife Technician	Ganesh Rana
Wildlife Technician	Shreeram Tharu

### WWF-India Team

Project Advisors	Dipankar Ghose, Joydeep Bose, Yash Shethia, Sejal Worah, Ravi Singh
Technical Coordination	Pranav Chanchani, Rishi Kumar Sharma
Field Coordination	Christi Sylvia
GIS Support	Saloni Salaria
Finance and Logistics	Jagdish Upadhaya, Renu Atwal, Vikas Sharma
Communications Team	Indira Akoijam, Nishant Andrews, Nitisha Mohapatra

### WWF-India Uttarakhand Team

Administrative Support	Anil Kumar Singh, IP Bopanna, Joy Dasgupta, Meraj Anwar, Jaswant Kumar, Bhuwan Singh
Field Biologists	Devavrat Pawar, Soumya Bakshi, Jyoti Antil, Shariq Shafi, Prajakta Hushangbadkar, Rohit Ravi, Ashish Bista, Pranav Chanchani
Interns, Volunteers and Field Assistants	Ali Arzan, Aleem Khan, Bhupendra Kumar, Dhanwantari Dhoke, Tamanna Jasrotia, Namrata Anirudh, Ruchir Sharma, Sher Singh Bist

### WWF-India West Bengal & Sikkim Team

Administrative Support	Priya Shrestha, Partha Sarathi Ghose, Deependra Sunar, Amrit Gurung
Field Biologists	Megha Moktan, Siddhant Umariya, Rohan Pandit

Interns and Field Assistants	Arundeeep Singha, Kerlang Rani, Pemba Tshering, Phuchung Lachungpa, Rickchen Zimba
------------------------------	--

#### WWF-India Arunachal Pradesh Team

Administrative Support	Anupam Sarmah, Kamal Medhi, Gopal Mondal, Sikhar Jyoti Sharma
Field Biologists	Tridip Sharma, Sunit Das, Sujit Chakravarty, Janaki Mohan, Rohan Pandit, Christi Sylvia, Megha Moktan, Lham Tsering
Interns, Volunteers and Field Assistants	Kiran Dalvi, Mohan Sharma, Anirudh Nippani, Bhavnesh Desai, Prathamesh Amberkar, Shivam Sharma, Guyi Siram, Tape Yorpen, Thejavitso Chase, Pemba Romo, Dechin Pema Saingmo, Siten Nath

#### ACKNOWLEDGEMENTS

IUCN  
 KfW  
 Department of Forest and Park Services, Govt. of Bhutan  
 National Tiger Conservation Authority, Govt. of India  
 Department of National Parks and Wildlife Conservation, Govt. of Nepal  
 Global Tiger Centre, Bhutan  
 State Forest Department of Arunachal Pradesh, Sikkim, Uttarakhand and West Bengal (Chief Wildlife Wardens, Forest Divisions, Range Officers, Forest Guards)  
 Wildlife Institute of India  
 WWF India and Bhutan  
 National Trust for Nature Conservation, Nepal  
 Jigme Singye Wangchuk National Park, Bhutan  
 Wangchuk Centennial National Park, Bhutan  
 Bhutan Ecological Society  
 Representatives of local communities at each study sites

# Table of Contents

1	Foreword	vi			
			1	Background	2
3	Organization	2			
			5	Study Area	4
5	Project Profile	6			
			10	Methodology	6
7	Data Collection and Summary of Literature Review, Questionnaire Survey and Camera Trapping	18			
			58	Tiger Habitat Suitability Mapping and Corridor Connectivity in Eastern and Western Himalayas	8
9	Contours of High-altitude Tiger Action Plan for Bhutan, Nepal and India	72			
			76	Appendices	10

# 1. Foreword

---

**T**he instant report presents a “situation analysis” of tiger in high altitudinal range of Eastern and Western Himalayas, spread over three important tiger range countries of South Asia (Bhutan, India and Nepal).

While broadly highlighting the profile of high altitude tiger habitat, its suitability has been appraised for both East and West portions of Himalayas, along with corridor connectivity. The findings are based on representative primary data collection relating to tiger, co-predators, prey, habitat and interface issues relating to local people, supplemented with extensive secondary information. Contours of a futuristic high altitude tiger action plan has also been highlighted.

This situation analysis is the first of its kind and the inter-governmental platform of the Global Tiger Forum (GTF) facilitated a close collaboration with Government agencies and other collaborators.

The GTF is thankful to IUCN-KfW for the grant. The invaluable inputs from Government agencies of Bhutan, India and Nepal are gratefully acknowledged.

The Global Tiger Centre – Bhutan, WWF India and National Trust for Nature Conservation – Nepal deserve a special mention for their active collaboration, and field assistance in data collection.

The forum is thankful to the Landscape Evaluation and Visualization Lab of the Wildlife Institute of India for protocol consolidation, data analysis and GIS facilitation.

**Global Tiger Forum**

## 2. Background

---

The habitat of tiger is varied, encompassing several biomes and ecological conditions, viz. mangrove swamps, highlands, plains, rainforests, arid or semi-arid areas and mountainous regions. However, most of the high-altitude habitats, within the tiger range have not been surveyed for an appraisal of tiger presence, prey and habitat status. Hence, it becomes important to embark on a said appraisal, involving mapping of the habitat and carrying out a situation analysis for a future roadmap.

Tiger habitats in high altitude require protection through sustainable land use, as they are a high value ecosystem with several hydrological and ecological processes providing ecosystem services and adaptation to mitigate the ill effects of climate change. Since, several high-altitude habitats in South Asia have the spatial presence of tiger, active in-situ efforts are called for ensuring their conservation.

The instant situation analysis study aims to provide the rationale for stepping up high altitude conservation of the tiger, while identifying possible viable habitats, corridor linkages, anthropogenic pressures, and induced landscape level changes for evolving an in-situ conservation roadmap.

The study, led by the GTF, with range country governments of Bhutan, India and Nepal, along with conservation partners (WWF and country specific collaborators), has been supported by the Integrated Tiger Habitat Conservation Programme (ITHCP) of the IUCN and KfW.



## 3. Organizations

---

### **Global Tiger Forum (GTF)**

The only international, intergovernmental organization of its kind owned and manned by Tiger Range Countries (TRCs). The said forum, headquartered at New Delhi (India), has an overarching mandate of handholding TRCs for strengthening wild tiger conservation across its natural range. It is also an implementing arm of the Global Tiger Initiative Council (GTIC), for coordinating the Global Tiger Recovery Program (GTRP) launched earlier by the Global Tiger Initiative (GTI). GTF's goal is to highlight the rationale for tiger preservation and provide leadership and common approach throughout the world in order to safeguard the survival of the tiger, its prey and its habitat.

***Role: Lead Implementing Agency of the instant project.***

### **Range Country Government Partners**

- Nature Conservation Division Department of Forests & Park Services, Government of Bhutan
- National Tiger Conservation Authority, Government of India
- Department of National Parks and Wildlife Conservation, Government of Nepal

***Role: Permission and Facilitation for field data collection***

### **Wildlife Institute of India (WII)**

An internationally acclaimed research organization in the region, also offering training program, academic courses and advisory in wildlife research and management. The Institute is actively engaged in research across India on several issues related to wildlife and biodiversity.

***Role: Preparation of protocols and technical support for mapping and data analysis***

### **National Trust for Nature Conservation (NTNC)**

Established in 1982, is an autonomous and not-for-profit organization, mandated to work in the field of nature conservation in Nepal. The experience of the organization is in various fields like nature conservation, biodiversity as well as cultural heritage protection

ecotourism, and sustainable development since the past two decades. With activities of the Trust spread out across Nepal, currently projects are focused in the sub-tropical plains of Chitwan, Bardia and Kanchanpur forming lowlands to the Annapurna and Manaslu region of the high Himalayas, including the trans-Himalayan region of Upper Mustang and Manang. Some of the major activities are landscape level tiger and rhinoceros conservation, community-based conservation intervention, self-financing national conservation modality, eco-tourism model implementation, captive breeding and managing national zoo in the country.

***Role: Data collection in Nepal***

### **World Wildlife Fund for Nature (WWF)-India**

Engaged in wildlife and nature conservation in the country. It has an experience of over four decades in the field and has made its presence felt through a sustained effort, not only towards nature and wildlife conservation, but also through sensitizing people by creating awareness through capacity building and enviro-legal activism. The key areas of the work of WWF India include conservation of threatened wildlife species and their habitats, management of rivers, wetlands and their eco-systems, promoting sustainable livelihoods, environment education and awareness activities within a variety of social structures, mitigating the impacts of climate change, transforming businesses and markets towards sustainability and combating illegal wildlife trade.

***Role: Data collection in India***

### **Global Tiger Centre, Bhutan**

Established by the Department of Forests and Park Services, Royal Government of Bhutan, with an aim to understand and monitor the status of tigers and other wildlife in pristine tiger habitat. The center aims to play an important role in the regional conservation of wildlife species as Bhutan forms a critical linkage between two important tiger conservation landscapes (Northern and Central India with the North-East India and Northern Forest Complex of Myanmar).

***Role: Data Collection in Bhutan***

## World Wildlife Fund for Nature (WWF)-Bhutan

The oldest conservation partner of Bhutan. Since its formation in 1977 for supporting capacity development of local conservation staff, the said organization has evolved, with a full country level program involving several collaborators in conservation projects.

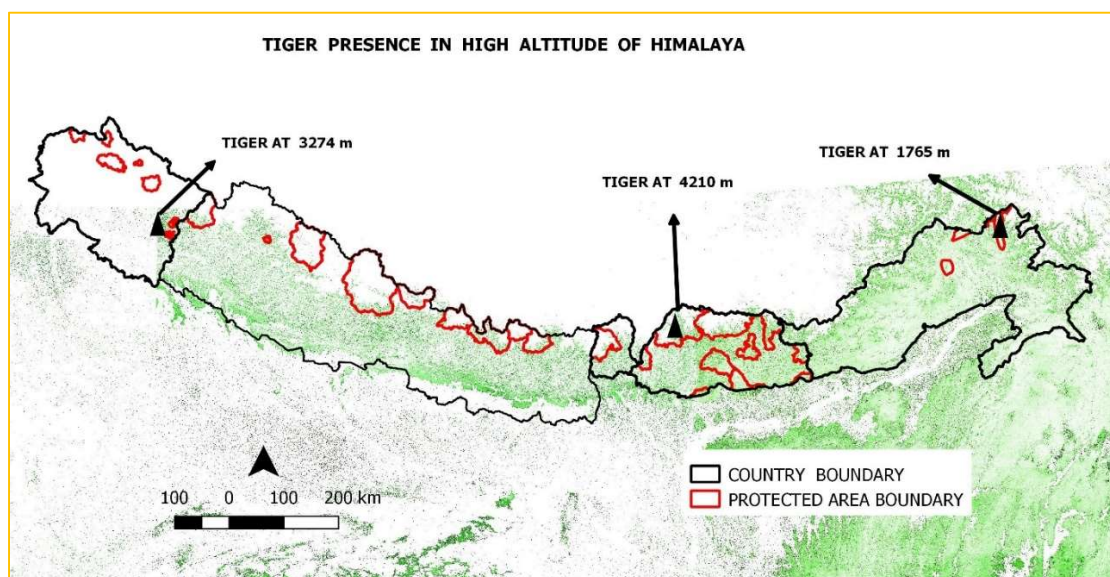
***Role: Data Collection in Bhutan (through the Global Tiger Centre, Bhutan)***

## 4. Study Area

The study area includes high altitude habitat portions of Nepal, Bhutan and India (covering five Indian states: Uttarakhand, Sikkim, West Bengal (Northern Portion) and Arunachal Pradesh).

Prior knowledge regarding spatial presence of tiger was the basis for deciding the study area, since several camera trap evidences of tiger were available from Bhutan and India. The study area chosen from Nepal was proximal to habitats in India with confirmed tiger presence.

In the past, tiger presence were reported from three Indian states. viz. Arunachal Pradesh, Uttarakhand and West Bengal at elevations of 1765m, 3274m and 2400m respectively. Tiger presence was reported from Bhutan at 4210m.



## 5. Project Profile

---

### OBJECTIVE

**S**TRENGTHENING HIGH ALTITUDE TIGER CONSERVATION THROUGH IDENTIFICATION, MAPPING OF HIGH-ALTITUDE TIGER HABITATS AND CORRIDORS IN BHUTAN, INDIA AND NEPAL, WHILE HIGHLIGHTING STRENGTHS, OPPORTUNITIES, WEAKNESSES AND THREATS OF SUCH AREAS TO ENABLE TIGER CONSERVATION, THROUGH A PORTFOLIO OF ACTIONS FOR TIGER AND LOCAL PEOPLE.

**OUTCOME 1. EVIDENCE AVAILABLE TO SCALE UP THE CONSERVATION EFFORTS FOR TIGER HABITATS IN HIGH MOUNTAIN REGIONS**

### OUTPUTS

- I. Identifying/Mapping Tiger/Co-predator and herbivore spatial use patterns on presence of tigers, co-predators, prey in high mountain ecosystems with respect to the inherent geographical attributes of the area, available welfare factors and weaknesses
- II. Identifying/Mapping Human induced land use patterns like agriculture, livestock grazing, collection of NTFP and other usufructs in high mountain tiger habitats

### ACTIVITIES

- i. Secondary data collection to identify high mountain habitats depicting (historical and recent) presence of tiger, co-predators, and prey
- ii. Consultation meetings/workshops with range country officials, conservation partners and scientific experts for selecting suitable sites for ground-truthing and finalizing the effort and scale for primary data collection
- iii. Field surveys to gather primary data and conduct analysis on predator, prey and habitat status, with human induced land use patterns
- iv. Analysis of primary and secondary data



## **OUTCOME 2. KEY WILDLIFE/TIGER CORRIDORS IN HIGH MOUNTAIN REGIONS ARE IDENTIFIED**

### **OUTPUTS**

- I. Map series containing geographical attributes, layered with forest cover, with locations of tiger bearing forests and corridors
- II. A series of maps layered over physical attributes and forest cover of the landscape showing human settlements, agricultural fields, and other relevant land uses, if any
- III. A set of maps indicating inherent and human induced vulnerability of the area to natural (landslides, drought, floods) and human induced threats (fire, infrastructure, change in land use for agriculture/urbanization, pollution and related aspects)

### **ACTIVITIES**

- i. Mapping habitat connectivity within the ecosystem and linkages with transitional habitats, using state of the art GIS techniques
- ii. Mapping natural and induced cover, land use patterns and change detection (over last two decades)

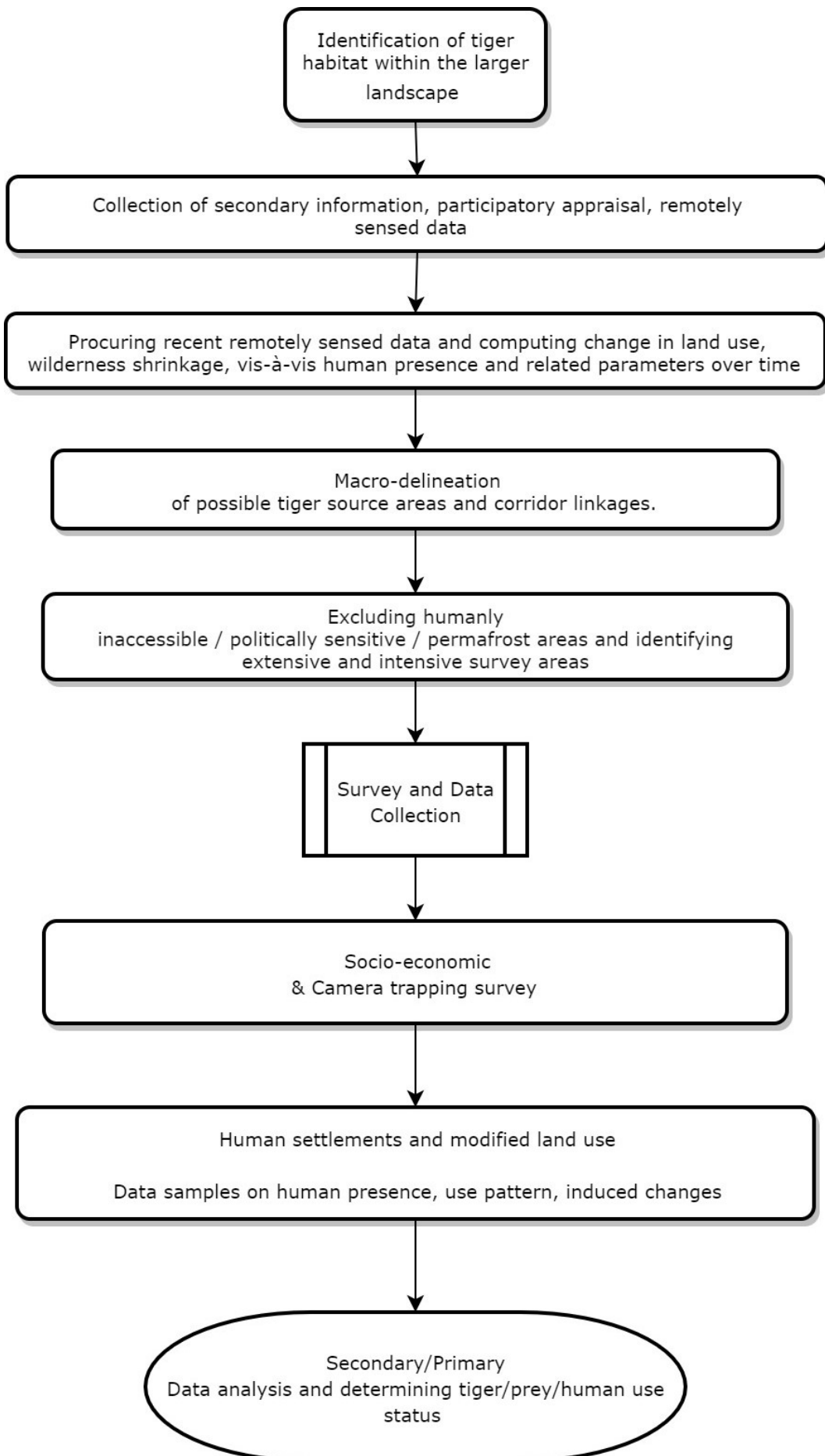
## **OUTCOME 3. ROADMAP FOR LONG TERM CONSERVATION EFFORTS FOR TIGERS IN HIGH ALTITUDE REGIONS**

### **OUTPUTS**

- I. Evolving a High Altitude Tiger Action Plan for Bhutan, Nepal and India, based on knowledge gained (geographical attributes, tiger/wildlife areas/corridors, human settlements and their practices), other land uses, and vulnerability, while highlighting the “umbrella” role of tiger as an ecological indicator for well-being of ecosystem services, with adaptations to climate change for long term, sustainable co-occurrence of tiger/wildlife and local people.

### **ACTIVITIES**

- i. Data and assessments from activities, along with inputs and consultations from range countries under outcome 1 and 2 used to develop a High-Altitude Tiger Action Plan for Bhutan, Nepal and India.



Analysis steps included:

- a.* stake-holder consultation
- b.* methodology finalization and site selection
- c.* regional level training of field staff, collection of field data
- d.* development of spatial database and secondary data
- e.* mapping potential habitat for tiger in high altitude
- f.* prioritization of sites for field survey based on grid approach
- g.* collation of socio-economic data and camera trap data, published literature information
- h.* analysis and modelling in GIS domain

## 6. Methodology

---

### APPRAISAL/GROUND-TRUTHING OF THE PRESENCE OF TIGER, CO-PREDATORS AND PREY ALONG WITH HUMAN INDUCED LAND USE CHANGES

The project team collected secondary data to identify high altitude habitats having presence of tiger, co-predators, and prey. The GTF, through its tiger range country focal points in Bhutan, India and Nepal, collated data available with government, conservation organizations and research institutes.

For the primary data collection, selection of sites was based on consultation meetings/workshops with range country officials, conservation partners and scientific experts. The project goal and overall implementation strategy was discussed and finalized in the inception workshop at Bhutan, followed by a one-day workshop at the Wildlife Institute of India on methodology, and listing of sites for field data collection. Training workshops were conducted for transfer of data collection protocol, and countries were requested to conduct training sessions for field staff in the said context. Ground truthing was done at the selected sites for firming up the effort and scale towards primary data collection.





Figure 6.1: Pictures from the Questionnaire Training Sessions







**Figure 6.2: A Glimpse of the Training Workshops conducted for Field Surveys of HAT project**

Field surveys were conducted for primary data collection relating to identified parameters. Such field data were collated with secondary information for ascertaining tiger presence in identified habitats. This was assimilated with inherent geographical attributes of the terrain, vis-à-vis tiger source area/corridor.

Similarly, human induced changes in the landscape ecology (having an impact on the ecosystem) was assessed using a combination of remotely sensed data, GIS and ground-truthing to create a series of maps as highlighted below:

- ✓ Map series containing geographical attributes, layered with forest cover, with locations of tiger bearing forests and corridors
- ✓ A series of maps layered over physical attributes and forest cover of the landscape showing human settlements, agricultural fields, and other relevant land uses, if any
- ✓ A set of maps indicating inherent and human induced vulnerability of the area to natural (landslides, drought, floods) and human induced threats (fire, infrastructure, change in land use for agriculture/urbanization, pollution and related aspects)

## **Mapping corridor connectivity and assessing its status**

Habitat connectivity within the ecosystem and linkages with transitional habitats were delineated and mapped, using the state-of-the-art GIS based modelling techniques. Based on the same, spatial and temporal analyses were done to determine the existing connectivity status, including natural and induced cover, land use patterns and change detection (over last two decades).

### **Data collection (Field and GIS domain) and Analytical Protocol**

Based on tiger biology, a Boolean model was constructed to map potential habitat for tiger in the higher altitude. The said model included elevation, slope, habitat types and disturbance identified in the higher altitude, which also formed the basis for planning field level data collection. In order to keep uniformity in data collection and also for analytical robustness, hierarchical grid sampling was developed with a larger unit of 15km<sup>2</sup> grid cell, with the nested 5km<sup>2</sup> grid cells forming smaller units. Field data collection targeted presence/absence information within the larger 15km<sup>2</sup>, supported by sub-sampling in the 5km<sup>2</sup> grid cells. The administrative units (such as District and Division) have been taken as the basis and grids have been superimposed on these. However, field data collection was restricted to places identified as potential tiger habitats based on GIS modelling.

### **Spatial Database**

In collaboration with an ongoing project under the National Mission on Sustaining Himalayan Ecosystem (NMSHE), relevant spatial data base was created, viz. Digital Elevation Model, Land use and Land cover, Slope, Human Footprint, Administrative Boundary and Sampling Grids, were used for the current study. Administrative boundary of countries and other spatial layers were sourced from the Digital Chart of the World (DCW) and the Landscape Ecology and Visualization Laboratory of the Wildlife Institute of India.

The created database includes: Land use/Land cover, Digital Elevation Model and Human Footprint which account for human population, road network and urbanization. This database served as the source of spatial planning in terms of methodology, field data collection and analytical approach.

Looking into the topography and climatic variation, the analysis was done separately for Eastern and Western Himalayas.

#### **Preliminary Analysis for generating potential tiger habitats in the study area:**

*A-priori* knowledge of tiger ecology and Himalayan topography were considered to generate a potential tiger habitat for the entire study area. Tiger presence in higher elevation was expected upto the tree line area, which is around 3600m and 4200m in the western and eastern Himalayas respectively. Tiger presence requires adequate prey, cover, with least human disturbance. The broad-leaved and mixed forests comprising of conifer and broad-leaved species were used as surrogates for habitats supporting large prey species, such as Sambar. Likewise, the Normalized Difference Vegetation Index (NDVI) was used as a surrogate for cover, and the human footprint to define disturbance.

Each spatial layer was applied with Boolean Logic of expected suitability or unsuitability, and the maps were reclassified with binary response of 1 or 0 (1 for presence and 0 for absence). This was done for each of the spatial layers based on available knowledge of tiger. Integration of such Boolean maps resulted in the **Habitat Suitability Map** for tiger in the higher altitude, which provided an overview of the potential habitat (the maximum possible area) in each country, while indicating conservation areas which may be focused for active and passive in-situ tiger efforts. The resultant map also provided the basis for conducting questionnaire survey and field data collection.

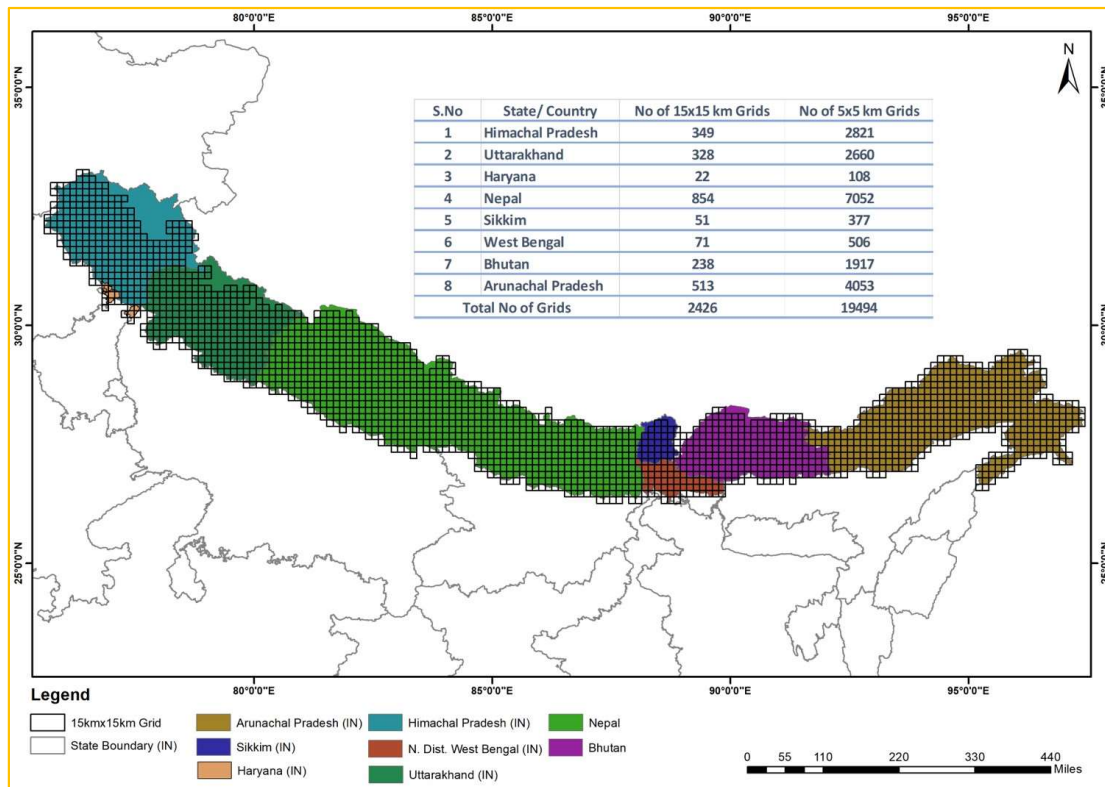


Figure 6.3: 15x15 km grids layered across the larger landscape

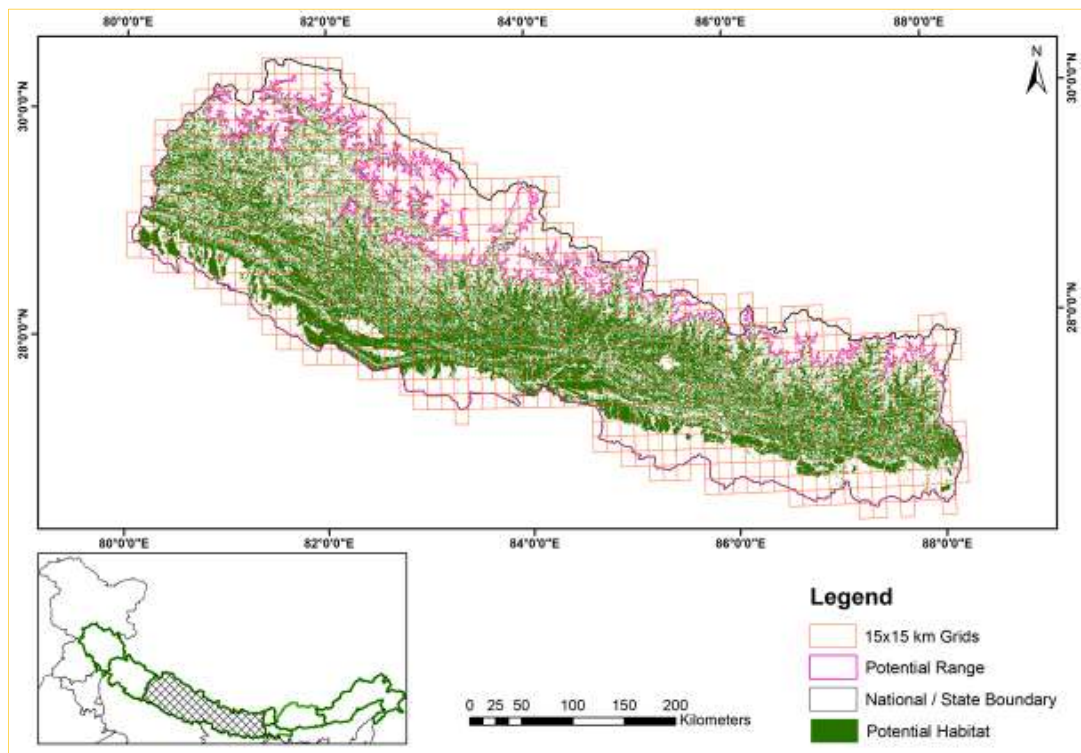


Figure 6.4: Map of potential habitat for higher altitude tiger in Nepal



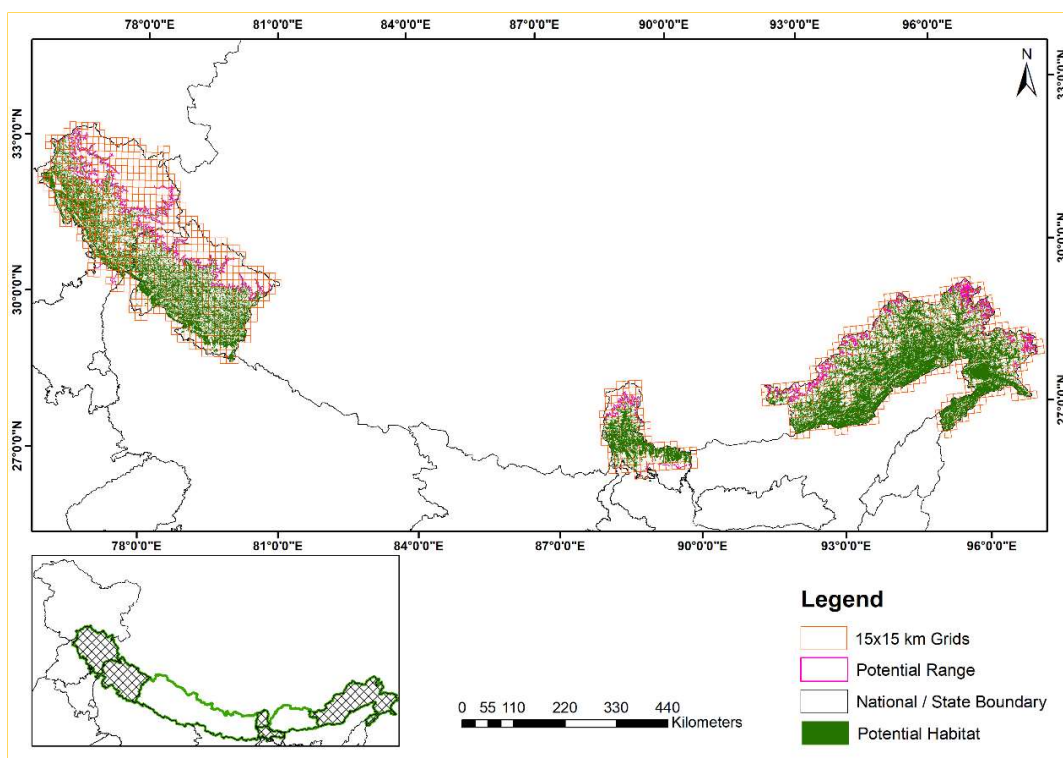


Figure 6.5: Map of potential habitat for higher altitude tiger in India

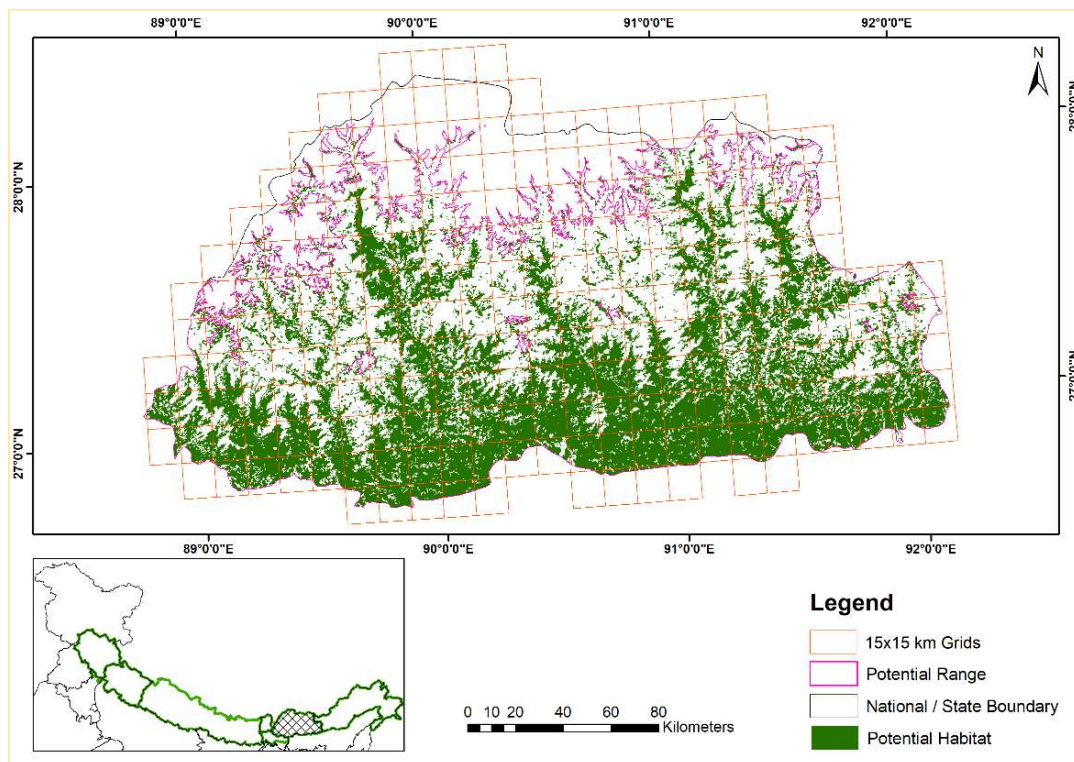


Figure 6.6: Map of potential habitat for higher altitude tiger in Bhutan



Potential Habitat (km<sup>2</sup>) for Tiger in the Higher Altitude Region (from selected districts)

Country	Potential Habitat (km2)
India	38,915
Nepal	2,213
Bhutan	11,543
<b>Total</b>	<b>52,671</b>

## 7. DATA COLLECTION AND SUMMARY OF LITERATURE REVIEW, QUESTIONNAIRE SURVEY AND CAMERA TRAPPING

### 7.1 BHUTAN

#### LITERATURE REVIEW FOR HIGH ALTITUDE

PUBLICATION/FOREST WORKING PLAN /PROTECTED AREA MANAGEMENT PLAN	AUTHOR AND YEAR	TIGER/WILDLIFE PRESENCE WITH AREA
Tiger Conservation Strategy for Kingdom of Bhutan	McDougal and Tshering 1998	Tigers photographed at 3900 masl altitude in Bhutan owing to its pristine ecosystem
<i>Tropical Ecology</i>	Sherpa et al. 2004	Biological corridors, mostly consisting of conifer-alpine-broadleaf vegetation type, serve as suitable paths for movement of important wildlife like the tiger, gaur, elephant, musk deer, snow leopard. These include Toorsa to Jigme Dorji to Jigme Singye Wangchuck to Thrumshingla to North corridor and Kulong Chhu; Royal Manas to Khaling to Sakteng
Nature's Strongholds: The world's greatest wildlife reserves	Riley and Riley 2005	Royal Manas National Park: Tigers, preying on spotted hog, sambar deer, hispid hare Black Mountains/Jigme Singye National Park: harbours serow, musk deers, golden leaf langur, barking deer, sambar, wild boar, red panda and tiger occasionally` Jigme Dorji NP: snow leopards, takins, blue sheeps, red panda, golden leaf langur monkey Khaling/Neoli Wildlife Sanctuary: protects tiger, elephants, gaur and possibly pygmy hogs and hispid hares Thrumshingla National Park: home to red pandas and tiger recently sighted at 12000 ft.

		Phipsoo Sanctuary: chital, elephants, gaur, golden leaf langur, tiger
WWF Bhutan		Tiger photographed in Bumdeling Wildlife Sanctuary at 3124m, last evidence for tiger presence was recorded in 1997 on the top of Dongla pass.
IUCN	2012	Tiger camera trapped at 3000 masl in Phrumsengla National Park in 2000 and at 4200 masl in Jigme Dorji National Park in 2012. Recent camera trapping in Wangchuk Centennial National Park recorded tiger picture at 4400 masl and pugmark evidence at 4600 masl
PhD thesis	Wang 2008	Prey species like Wild pigs, sambar deer, barking deer, macaques involved in human wildlife conflict and population estimation of predators like tiger (8) and leopard (16)
<i>Biological Conservation</i>	Wang and Macdonald 2009	Camera trapping using SECR framework in Jigme Singye Wangchuck NP between 2006-07 gave a figure of 8 tigers and 16 leopards, also including other animals like the himalayan black bear, serow, prey species like sambar, wild pig, barking deer and smaller cats like the asiatic golden cat and leopard cat
	Wang and Macdonald 2009	Tiger occupying areas away from human settlements
WWF Bhutan <i>Journal of Asia-Pacific Biodiversity</i>	Kandel et al. 2016	Presence of takin, serow, red panda, himalayan musk deer, himalayan Tahr, tiger, common leopard and clouded leopard in Jigme Khesar Strict Nature Reserve
<i>Agriculture, Ecosystems and Environment</i>	Thinley et al. 2017	Jigme Dorji National Park supports diverse ungulate community; sambar, barking deer, wild pig commonly seen. Tiger, leopard, dhole at lower elevations (<400 masl) and snow leopards at higher altitudes (>4000masl)
<i>Wildlife Research</i>	Leki et al. 2018	Lingzhi park range of Jigme Dorji national park estimated a count of >1700 blue sheep, primary prey species for sustaining healthy predator population like that of Snow leopard
Tiger Action Plan for Bhutan 2018-23		Tiger signs and photographs recorded from various areas, Bumdeling Wildlife Sanctuary, Jigme Khesar Strict Nature

		Reserve, Samtse and Tashigang Forest Division, where it was not recorded during the nationwide tiger survey
<i>Pastoralism: Research, Policy and Practice</i>	Jamtsho and Katel 2019	Livestock depredation cases (including yaks, sheeps and horses) by predators like Snow leopards, Tibetan wolf, tigers, dholes, black bear in Wangchuk Centennial National Park

## TIGER OCCUPANCY (QUESTIONNAIRE SURVEY)

The frontline staff of forest/wildlife department in Bhutan has proficiency in the use of camera traps for recording tiger presence. Prior to the questionnaire survey the field staff was briefed on the questionnaire format and use of camera trap was also reiterated.

A standardized questionnaire survey was done to collect information pertaining to wildlife in selected high altitude districts of Bhutan, including protected areas as indicated in the map below:

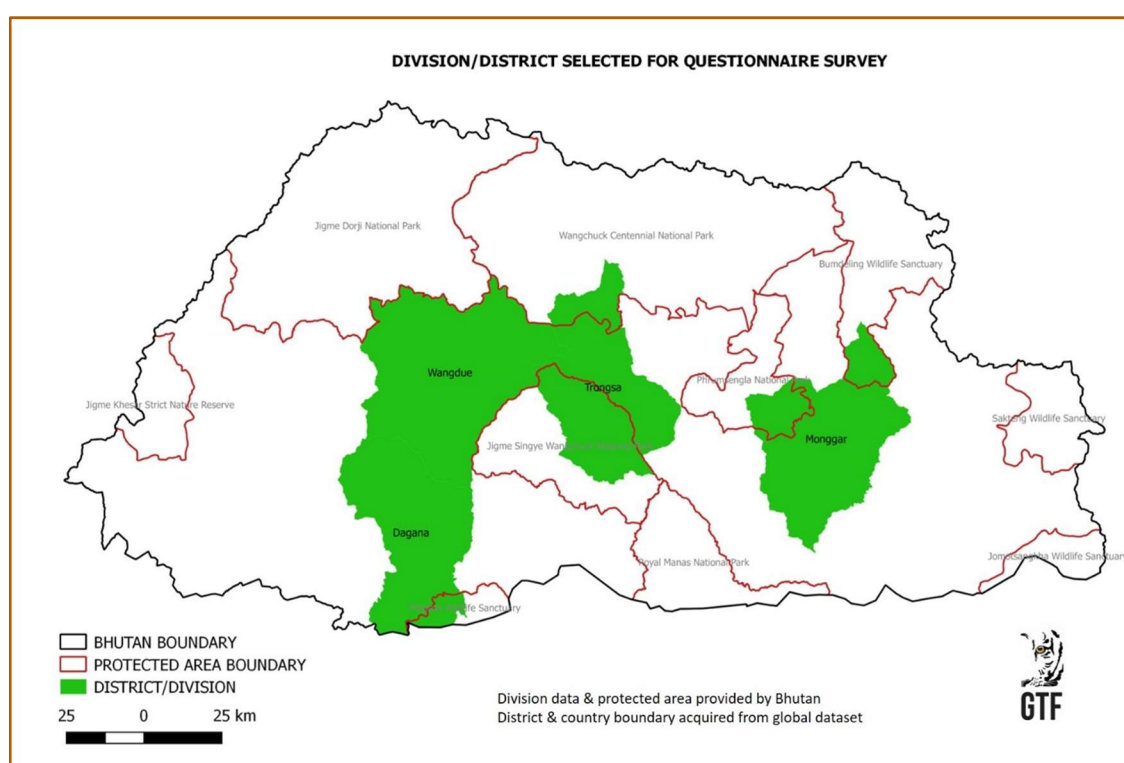
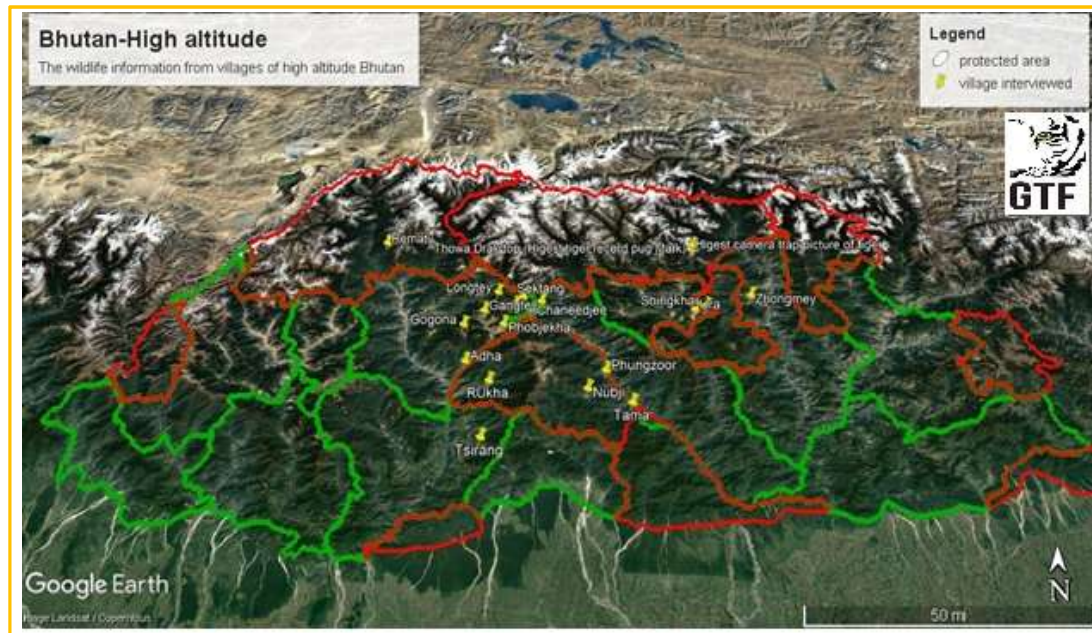


Figure 7.1.1: Selected protected area for high altitude questionnaire survey

The data collection was done during July 2018, and the surveyed villages were from: Jigme Singhe National Park, and Forest Divisions (Wangdi, Zhemgang, Tsirang, Tongsa), spatially covering most of the high altitudinal range of Bhutan (Figure No. 7.1.1).



**Figure 7.1.2: Villages surveyed in high altitude region of Bhutan**

In all, 49 responses were gathered from 20 villages. Local people largely practice farming, and major crops include: potato, maize, and paddy. The average human population of sampled villages amounted to 450, while the livestock averaged to 420. Some households (5 respondents from 3 villages) had watch dogs. Poaching was reported by 5 respondents (4 villages- Gogera, Gojira, Laslkhuthy, Segittheg).

Historical presence of tiger in the region was reported by 87% of respondents from 18 villages. Direct sighting and evidences were reported by almost 42% of said respondents between 2013 - 2018. Evidence pertaining to breeding tigress was reported by only 2 respondents around Sarpang and Narjosa villages, and a pugmark was also seen near Sarpang in 2018.

Human Wildlife interface conflicts due to wild dog (42%), tiger, leopard, bear, wild pig, sambar, macaque were reported.

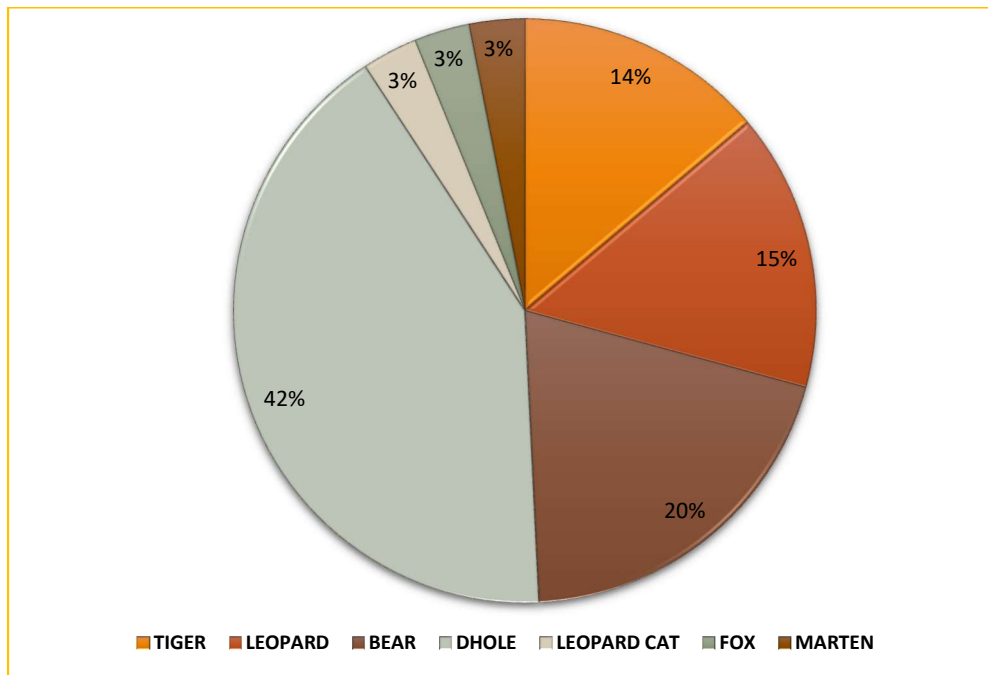


Figure 7.1.3: Conflict with carnivores

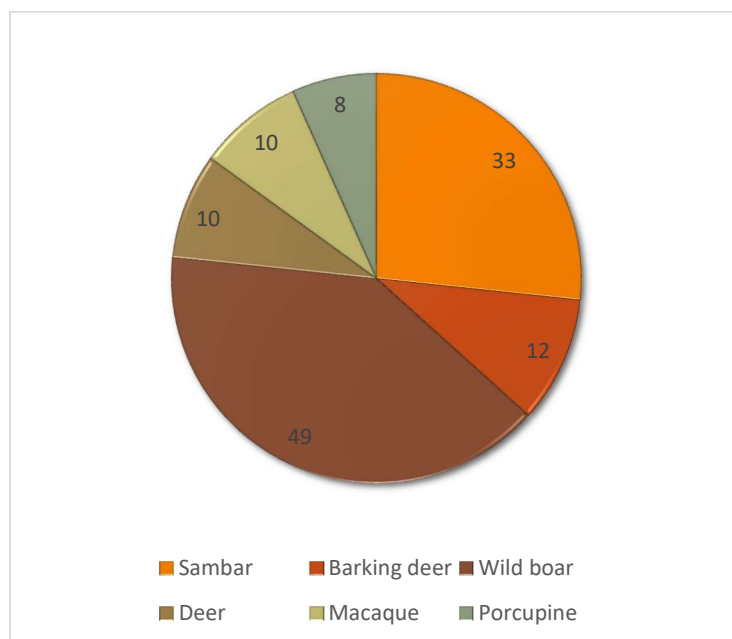


Figure 7.1.4: Number of households reporting herbivore conflict

The presence of snow leopard was not reported. However, occurrence of common leopard, black bear, sambar and wild pig was widely reported.

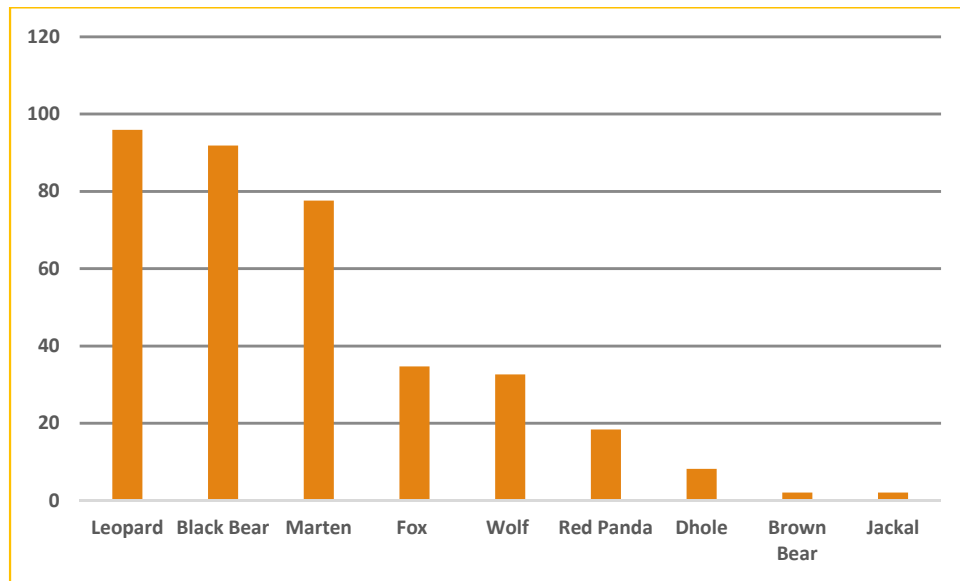


Figure 7.1.5: Carnivores reported from the region

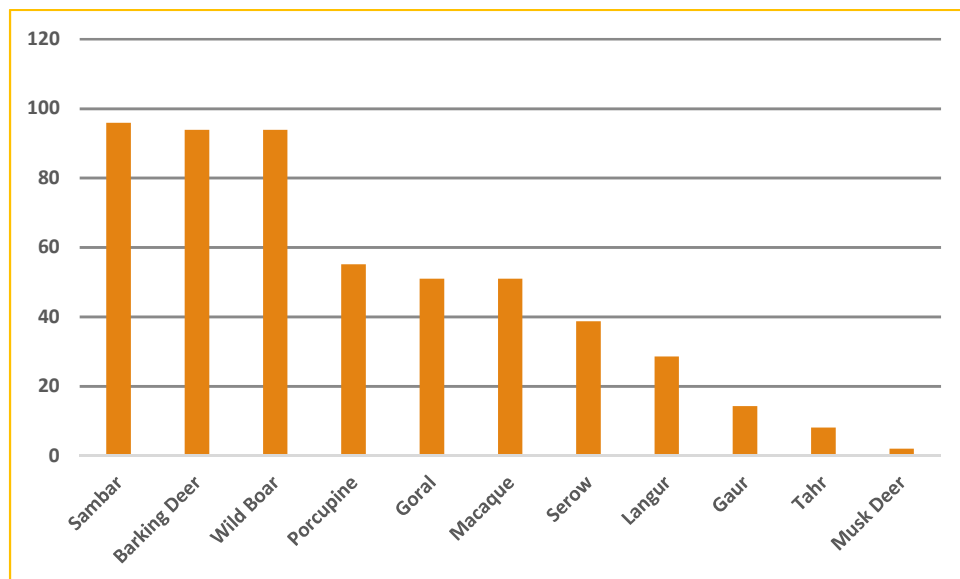


Figure 7.1.6: Herbivore reported from the region



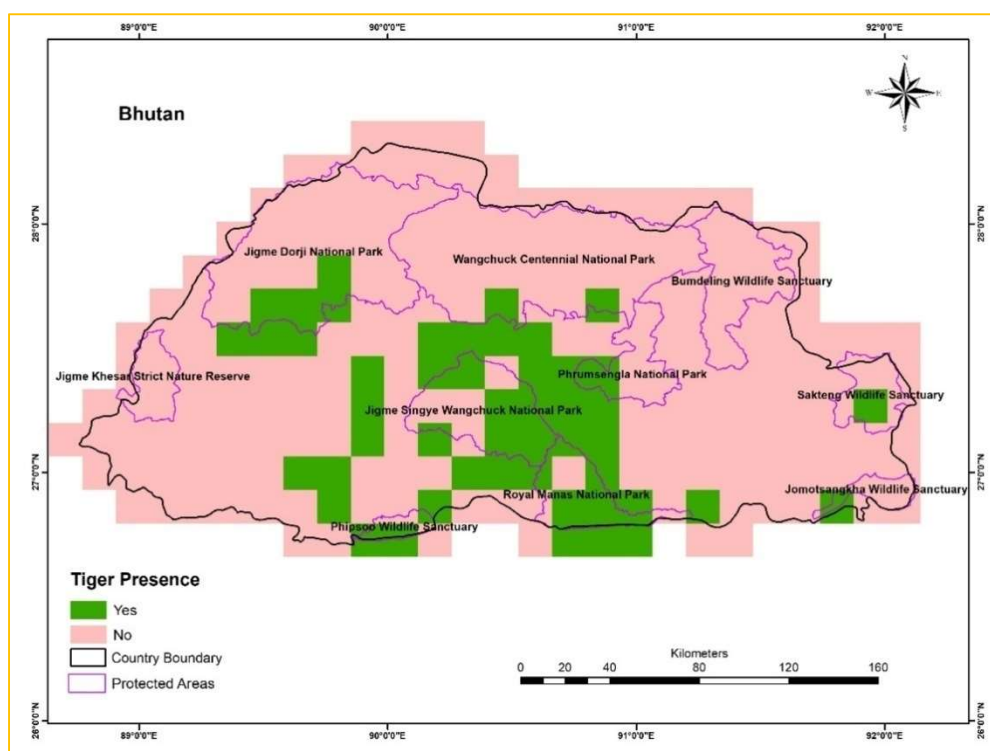


Figure 7.1.7: Questionnaire-Based Presence/Absence Survey and Results

## CAMERA TRAP FINDINGS

In all, camera traps were placed in 31 grids based on accessibility by foot in view of limited time and resources. Subsequently, the said grids were surveyed for wildlife/tiger evidence. The cameras were placed at most probable locations, vis-à-vis preferred trails. The cameras were positioned at appropriate height for capturing like tiger and other large mammals, while enhancing its sensitivity to capture smaller life forms like Pikas.

Details recorded at each camera station included: GPS location, date, name of the recorder, slope, aspect, terrain, trail type, distance from nearest village, presence of prey evidence and vegetation type. The SD card of each camera was allotted a unique number to facilitate image segregation.

Camera trapping was done for 3 months, based on past experience in the context of battery longevity in high altitudes characterized by comparatively fewer movements of wild animals. Hence, camera traps were not monitored in between, unlike conventional camera trapping to avoid frequent human presence in the area. Since some high mountains and passes become inaccessible during winter, camera traps in such locations were retrieved prior to the onset of

winter. The team mandated for setting the camera traps were also made responsible for data collection in respective blocks.

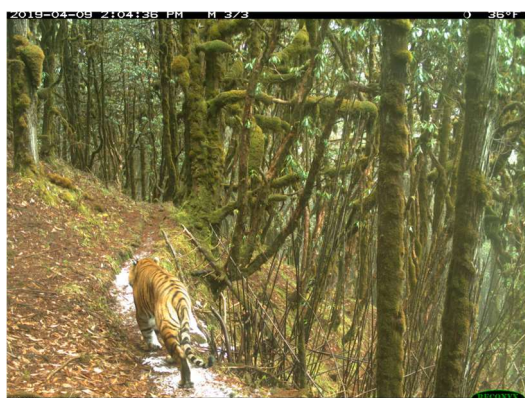
For each camera, date of monitoring, status of camera, battery percentage, and number of photographs were recorded in data sheet. Utmost care was taken to safely store memory cards to protect it from moisture and external damage. The images from memory cards were transferred to a computer, with backup in external hard drives.



**Himalayan Serow from Cam # GTF 1**



**Himalayan Black Bear from Cam # GTF 1**



**Tiger from Cam # GTF 1**



**Wild Pig from Cam # GTF 14**



**Red Panda from Cam # GTF 14**



**Asiatic Golden Cat Cam # GTF 14**



Tiger from Cam # GTF 14



Common Leopard from Cam # GTF 14



Wild Dog from Cam # GTF 3



Tiger from Cam # GTF 3

Figure 7.1.8: Camera Trap images from Bhutan

## 7.2 INDIA

### LITERATURE REVIEW FOR HIGH ALTITUDE

PUBLICATION/FORREST WORKING PLAN /PROTECTED AREA MANAGEMENT PLAN	AUTHOR AND YEAR	TIGER/WILDLIFE PRESENCE WITH AREA
Pithoragarh FD, Kumaon Circle, U.P. (1968-69 to 1977-78)	1971	Mostly confined to Kotkendri, Uprakot and Sheem blocks at the lowest extremity of Ladhiya valley. Corbett also located a tiger at Devidhura but generally they do not go beyond 1200 metres.
East Almora FD, Kumaon Circle, U.P. (1970-71 to 1979-80)	1971	Not inhabited of this division but during summer reported to enter Panar valley when the graziers return from Bhabar areas. Tiger was shot by Jim Corbet in Panar valley.
Nainital FD, Kumaon Circle, U.P. (1978-79 to 1987-88):	1978	Locally extinct but sometimes migrates from the adjoining Bhabar FD of Ramnagar and Haldwani to the Gola valley or Kosi valley in the Banolia and Lohakham blocks of Barhon range, Dhumsil and Loichusani and Mangioli blocks of Manora range and Gangikharak block of Kosi range. Darmani block near Managher.
Mountain Wildlife	1981	North west Sikkim (13000 ft) Sikkim road between Gangtok and Nathu la Pass (13000 ft)
East Almora FD, Kumaon Circle, U.P. (1980-81 to 1989-90)	1982	Near Panar valley by local information.
<i>Oryx</i>	Aparajita Datta October 1998	Pakhui Wildlife sanctuary, Doimara, Papum reserve forest in East and west Kameng Dist.
<i>Current Science</i>	Arunachalam, A. et al. (2004)	Namdapha nature reserve
High Altitude of Western Arunachal Pradesh, eastern Himalaya	Charudutt Mishra, M.D. Madhusudan, and A. Datta January 2006	Tawang and West Kameng Tiger were reported 2 decades ago in lower valley



Tropical lowland forest in the Eastern Himalayan Mountains.	Randeep Singh, Devendra S. Chauhan, Sudhanshu Mishra, Paul R Krausman and Surendra Prakash Goyal 2006	Pakke Tiger Reserve. Documented 10 photographs with capture rate of 1.3/100 trap days or 1 tiger every 71.8 trap nights.
Almora Forest Division, North Kumaon, U.P.(2006-07 to 2015-16)	2007	Two buffer zones- Jamariya and Kumariya which are connected to the boundaries of Corbett Tiger Reserve.
Civil and Soyam, North Kumaon, Uttarakhand(2009-10 to 2018-2019): Part - II	2007	May be present in the forests where pine, sal and oak trees are present
Pakke Tiger Resrve, Arunachal Pradesh, India.	Awadhesh Kumar and G.S. Solanki March 2009	Pakke Tiger Reserve
Bageshwar FD, North Kumaon, Uttarakhand(2009-10 to 2018-19): Part III	2009	Tiger present
<i>Sibcoltejo</i>	P. Chutia 2010	East Kameng, Papum Pare, Tawang, Lower Subansiri, West Kameng
<i>Oryx</i>	A. Aiyadurai, Navindar Sing, E.J. Milner October 2010	Anjaw, Lohit, East Kameng, Tawang.
Mussoorie FD, Yamuna Circle, Uttarakhand(2011-2012 to 2020-21): Part-I	2010	In 2005, tiger count recorded 3. In 2008, count become 1.
Uttarakhand: State of Environment Report	2012	Sonanandi WLS (Garhwal), Corbett NP(Nainital Pauri Garhwal), Rajaji
<i>CATnews</i>	Ankita Bhattacharya and Bilal Habib 2016	Tiger presence in Askot, Uttarakhand
The rapid survey of tigers and prey in Dibang Valley district, Arunachal Pradesh, India	G.V. Gopi, Y.V. Jhala, Q. Qureshi 2014	Adult male tiger in Dibang wildlife sanctuary. December 2012, three tiger cubs rescued from dry well in Angrim valley.
<i>Journal of Threatened Taxa</i>	A.S. Adhikarimayum and G.V. Gopi 26 November 2018	11 unique individuals were identified from that photographs including two cubs. Tigers reported in high altitude forests of Mishmi Hills (Bailey 1912).

	Aiyadurai (2007, 2014) reported tiger presence in Dibang. In 2012 two tiger cubs were rescued from Angrim valley, Anini Tehasil.
IBCN	Tibet-Sikkim Gangtok-Natu la-Zuluk-Rongli route
<i>Journal of Threatened Taxa</i>	Neora Valley N.P.,Buxa Tiger Reseve (W.B)-Sikkim Tista river-Rangit river Pangolakha Lava(W.B)-Sikkim Rangit river (Sikkim) - Tista Valley (West Bengal) Tingbila, Rayong, South Sikkim West Sikkim
<i>Journal of BNHS</i>	Lachung



## TIGER OCCUPANCY (QUESTIONNAIRE SURVEY)

The standardized format for questionnaire survey was used after briefing the frontline staff of field formations in 4 states: Uttarakhand, Sikkim, North Bengal and Arunachal Pradesh. The questionnaire survey consists of information based on the knowledge of the forest department staff for all of the states and where necessary, the communities were involved in sharing information for the same.

State	No. of Districts Covered from Total Administrative Districts	No. of Forest (Territorial) & Wildlife Divisions
Uttarakhand	11 out of 13	18
Sikkim	4 out of 4	8
North Bengal	3 out of 5	5
Arunachal Pradesh	7 out of 23	13

The said briefing/training sessions were conducted between August 2018 - March 2019. Further details regarding these training sessions is listed in Appendix 8.

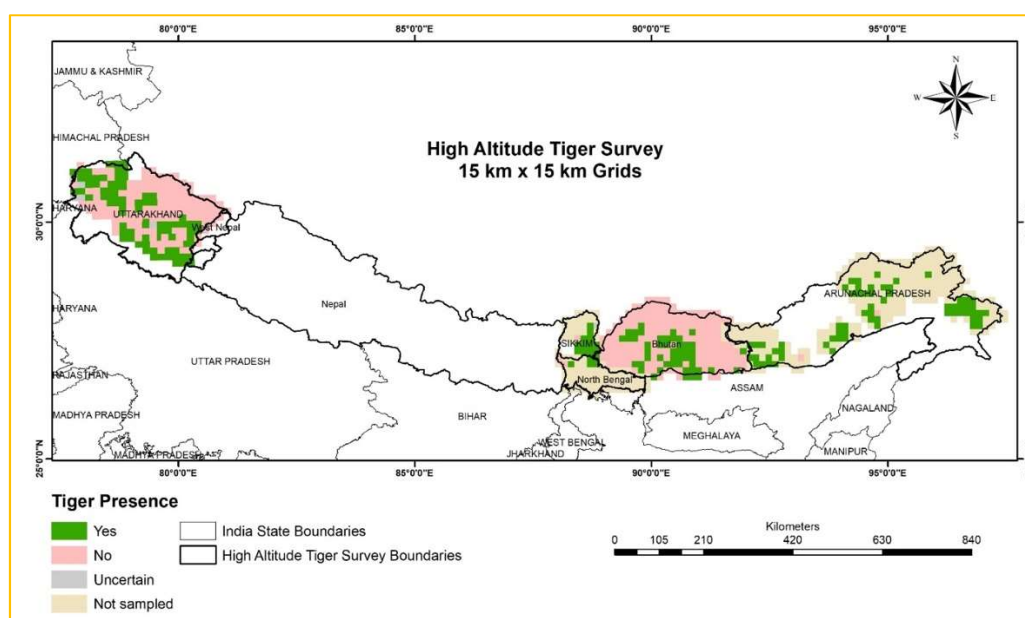


Figure 7.2.1: Questionnaire-based Presence/Absence Survey and Results

## UTTARAKHAND

Questionnaire Survey was conducted in 11 out of the 13 administrative districts of Uttarakhand. The predominant land use in the state of Uttarakhand is that of agriculture, which has the potential to act as cover for carnivores, besides luring wild herbivores for forage/browse. Uttarakhand experiences ongoing human-wildlife conflicts. Hence, the response in the said context was prominent, having reported conflicts with tiger, leopard, wild boar, sambar, and bear. Conflicts most often arise due to crop and livestock depredation.

District (Divisions)	No. of Responses	Predominant land-use	Response to Crop depredation (%)	Retaliatory Killing	Response relating to Tiger Presence (%)	Conflict with Tiger/ Leopard (%)	Last report of tiger presence
ALMORA (2)~	33	Agriculture (Wheat)	18	Wild Pig	9	73	2018
BAGESHWAR (1)~	64	Agriculture (Wheat, Rice)	17	Ghoral	21	72	2018
CHAMOLI (2)	53	Agriculture (Rice, Wheat)	26	Leopard	6	53*	2018
CHAMPAWAT (1)	40	Agriculture (Wheat, Rice)	43	Leopard, Wild Pig	40	23	2018
DEHRADUN (2)	28	Agriculture (Rice, maize)	18	-	21**	82 (LEOPARD)	2016, encumbered tigress seen in jabbar farm, Mussoorie
NAINITAL (1)	10	Forestry	30	Barking Deer, Sambar	50	80	2013, 2018
PAURI GARHWAL (1)	17	Agriculture (Wheat, Rice)	88	Wild Pig, Snake, Leopard, Barking Deer	12	94	2018
PITHORAGARH (1)	7	Agriculture (Rice, Wheat)	57	Wild Pig	14	14	2016
RUDRAPRAYAG (2)	151	Agriculture (Wheat, Rice)	31	-	11	47 (LEOPARD)	2018 (cubs reported) in Kedarnath Forest Division
TEHRI GARHWAL (2)	97	Agriculture (Wheat, Rice)	13	-	10	73 (LEOPARD)	2018, in Tehri Forest Division
UTTARKASHI (3)	104	Agriculture (Wheat, Rice)	17	Wild Pig, Leopard	22	44 (LEOPARD)	2018

\*Nanda Devi Forest Division only reported conflicts with Leopard, \*\* Tiger presence reported only from Mussoorie Forest Division, ~ Districts wherein conflict with Tiger was reported to be higher than conflict with Leopard.

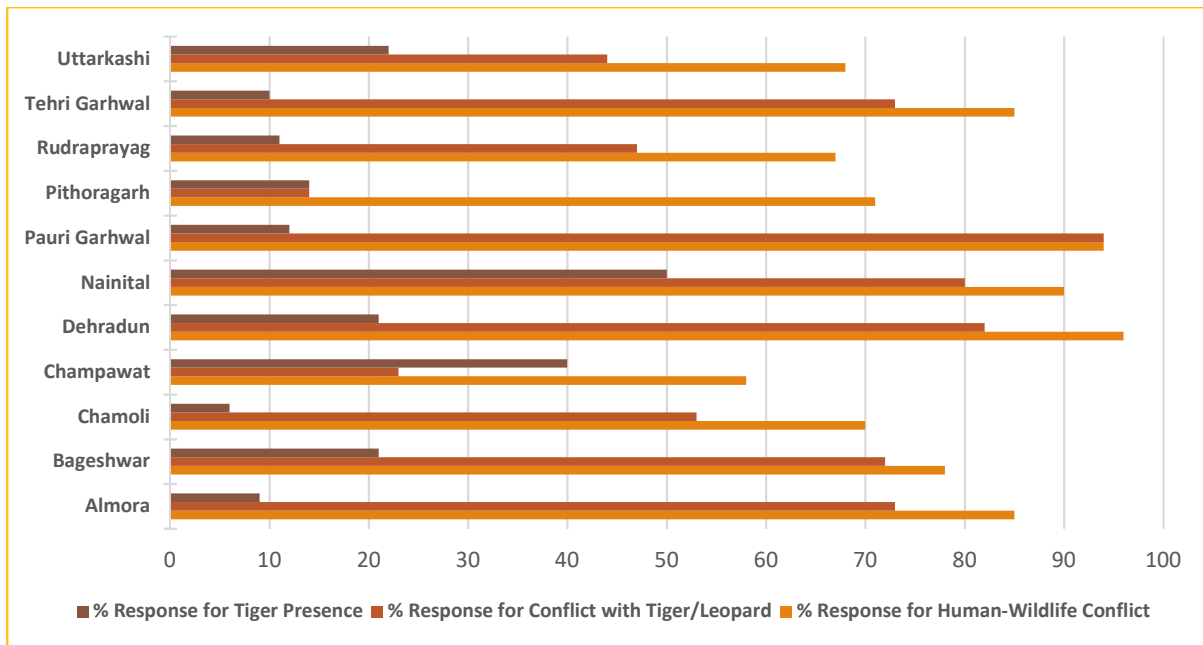


Figure 7.2.2: Percentage comparison of Conflicts reported in Uttarakhand

Figure 7.2.2 represents comparison of human-wildlife conflict in Uttarakhand against the reported Tiger presence in the area.

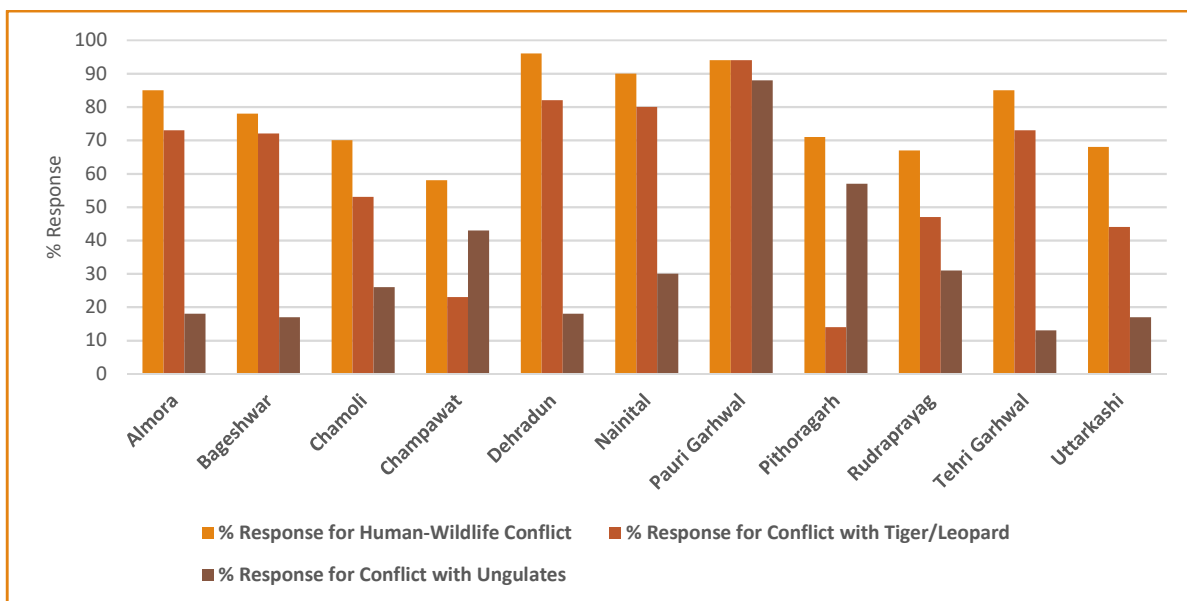


Figure 7.2.3: Percentage comparison of Conflicts with Carnivores and Ungulates reported in Uttarakhand

Figure 7.2.3 gives an overview of all human-wildlife conflict in Uttarakhand wherein conflicts with ungulates are probable cases of crop depredation.

## CONFLICT ANIMALS IN UTTARAKHAND

<b>ALMORA</b>	<b>BAGESHWAR</b>	<b>CHAMOLI</b>
<ul style="list-style-type: none"> <li>• Wild Pig</li> </ul>	<ul style="list-style-type: none"> <li>• Sambar</li> <li>• Goral</li> </ul>	<ul style="list-style-type: none"> <li>• Wild Pig</li> <li>• Goral</li> <li>• Common Leopard</li> <li>• Black Bear</li> </ul>
<b>CHAMPAWAT</b>	<b>DEHRADUN</b>	<b>NAINITAL</b>
<ul style="list-style-type: none"> <li>• Wild Pig</li> <li>• Common Leopard</li> </ul>	<ul style="list-style-type: none"> <li>• Common Leopard</li> <li>• Black Bear</li> </ul>	<ul style="list-style-type: none"> <li>• Tiger</li> <li>• Wild Pig</li> <li>• Common Leopard</li> <li>• Barking Deer</li> <li>• Sambar</li> </ul>
<b>PITHORAGARH</b>	<b>RUDRAPRAYAG</b>	<b>TEHRI GARHWAL</b>
<ul style="list-style-type: none"> <li>• Wild Pig</li> </ul>	<ul style="list-style-type: none"> <li>• Common Leopard</li> <li>• Wild Pig</li> </ul>	<ul style="list-style-type: none"> <li>• Wild Pig</li> <li>• Sambar</li> <li>• Common Leopard</li> </ul>
<b>PAURI GARHWAL</b>	<b>UTTARKASHI</b>	
<ul style="list-style-type: none"> <li>• Common Leopard</li> <li>• Wild Pig</li> </ul>	<ul style="list-style-type: none"> <li>• Common Leopard</li> <li>• Black Bear</li> </ul>	



Common Leopard - *Panthera pardus*



Jackal - *Canis aureus*



Asian Black Bear - *Ursus thibetanus*



Masked Civet - *Paguma larvata*



Tiger *panthera tigris*

Figure 7.2.4: Camera Trap images from Uttarakhand

## SIKKIM

Questionnaire survey was conducted in all four districts of Sikkim. As many as 27 responses were received from the Northern district and 48 from the East. 17 responses were received from West Sikkim and 11 responses from South Sikkim. The districts and forest divisions of Sikkim have overlapping boundaries.

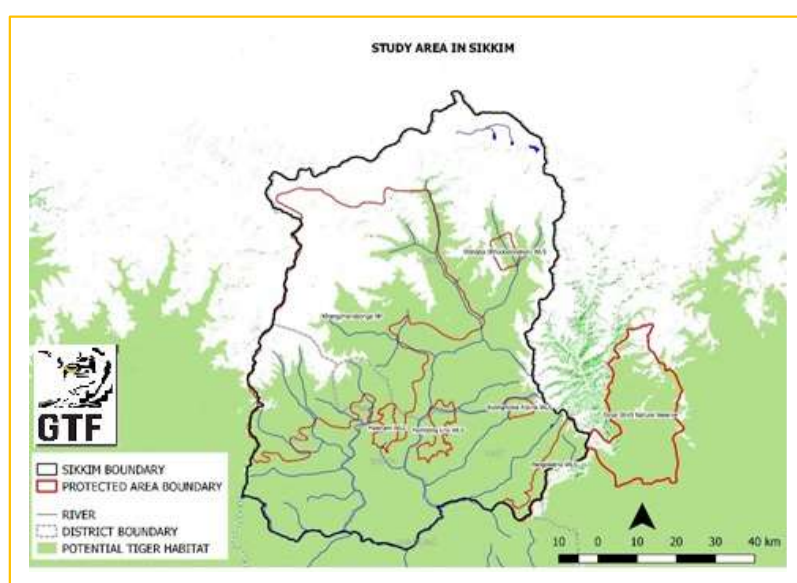
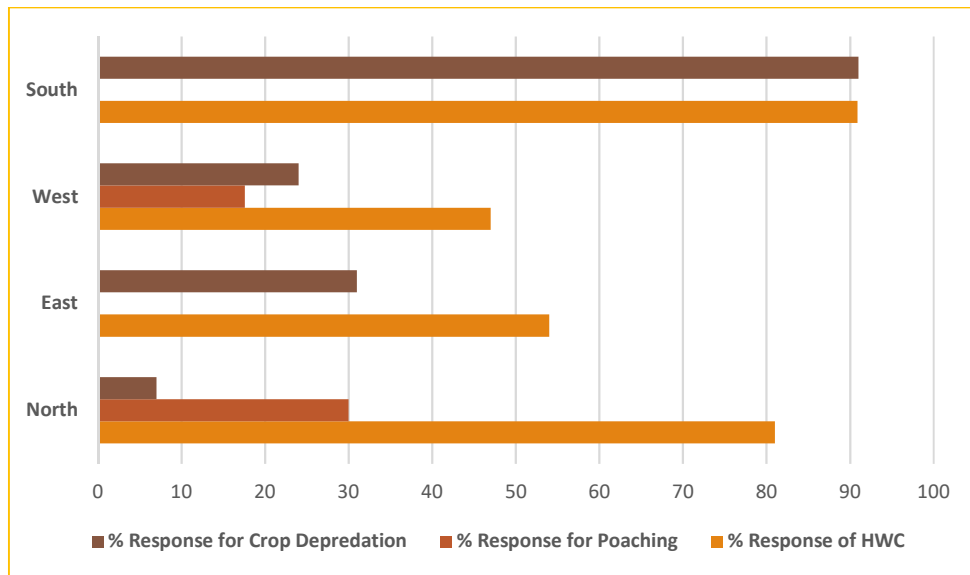


Figure 7.2.5: Study in Sikkim

Maximum Human-wildlife conflict was reported from South Sikkim, followed by North Sikkim. The major conflict animals were wild boar and macaque in both areas along with black bear conflict reported from North Sikkim. Indirect evidences of tiger presence were noticed in North, South as well as East Sikkim in 2018.

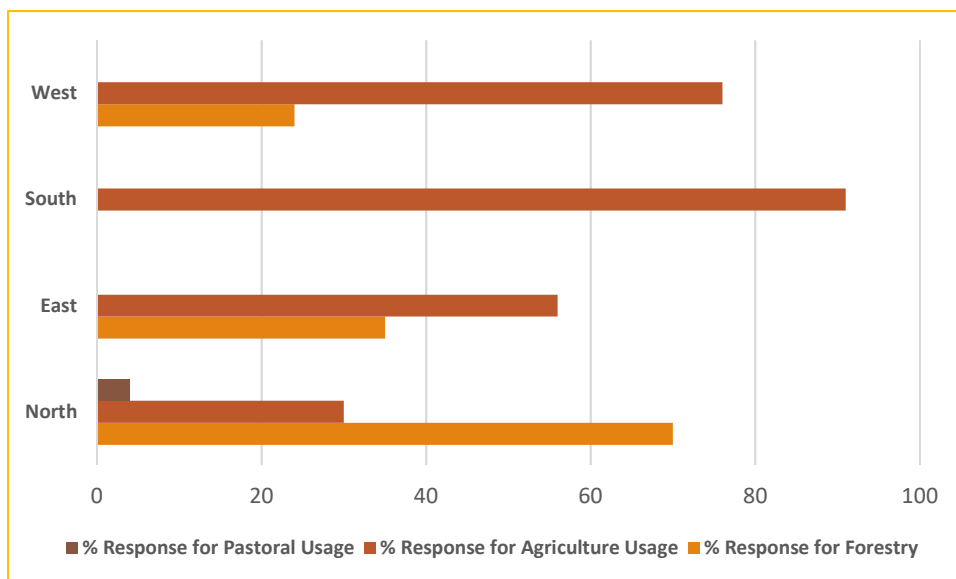
District (Divisions)	No. of Responses	Predominant land-use	Response to Crop depredation (%)	Retaliatory Killing	Response relating to Tiger Presence (%)	Conflict with Tiger/Leopard (%)	Last report of tiger presence
North Sikkim (2)	27	Forestry	7	Wild Boar, Macaques, Porcupine	41	-	2017
East Sikkim (2)	48	Agriculture (Cardamom, Maize)	31	Ungulates	85	8	2017, 2018
West Sikkim (2)	17	Agriculture (Cardamom, Potato)	24	Wild Boar, Barking Deer, Porcupine	12	12 (LEOPARD)	-
South Sikkim (2)	11	Agriculture (Cardamom, Rice, Maize)	91	Porcupine, Macaques, Wild Boar, Peacocks	9	9 (LEOPARD)	2018





**Figure 7.2.6: Human-wildlife Conflict compared against Crop Depredation, and Animal Killing in all 4 districts of**

Poaching was reported from 2 districts of Sikkim to a certain extent. West Sikkim reported the killing of Black Bear and Wild Boar, whereas North Sikkim reported the killing of Musk Deer, Barking Deer and Black Bear.



**Figure 7.2.7: Percentage response representing land-use patterns in all 4 districts of Sikkim**



Musk Deer - *Moschus moschiferus*



Marbled Cat- *Pardofelis marmorata*



Spotted Linsang- *Prionodon pardicolor*



Satyr Tragopan- *Tragopan satyra*



Golden Cat - *Catopuma temminckii*



Himalayan Serow- *Capricornis thar*



Red Panda- *Ailurus fulgens*



Large Indian Civet- *Viverra zibetha*



Steppe Eagle - *Aquila nipalensis*

**Figure 7.2.8:** Camera Trap images from Sikkim



## WEST BENGAL

Questionnaire Survey was initially conducted only in the wildlife divisions of North Bengal, and later on in order to gain a better overview, few territorial divisions were also requested to share information in the form of the standard questionnaire. A total of 112 responses were obtained from project areas in Kalimpong district, and 41 responses were received from project areas in Darjeeling district. Animals involved in human-wildlife conflict include: leopard, elephant, Himalayan black bear and macaque. The land-use is mainly agriculture followed forestry.

District (Divisions)	No. of Responses	Predominant land-use	Response to Crop depredation (%)	Retaliatory Killing	Response relating to Tiger Presence (%)	Conflict with Tiger/Leopard (%)	Last report of tiger presence
Darjeeling (3)	41	Agriculture (Cardamom)	17	Barking Deer, Macaques, Wild Boar	2	10 (LEOPARD)	-
Kalimpong (2), Jalpaiguri (1)*	112	Agriculture (Cardamom)	9	Barking Deer, Porcupine	25	3	2017

\*Gorumara WLD is spread across 2 districts

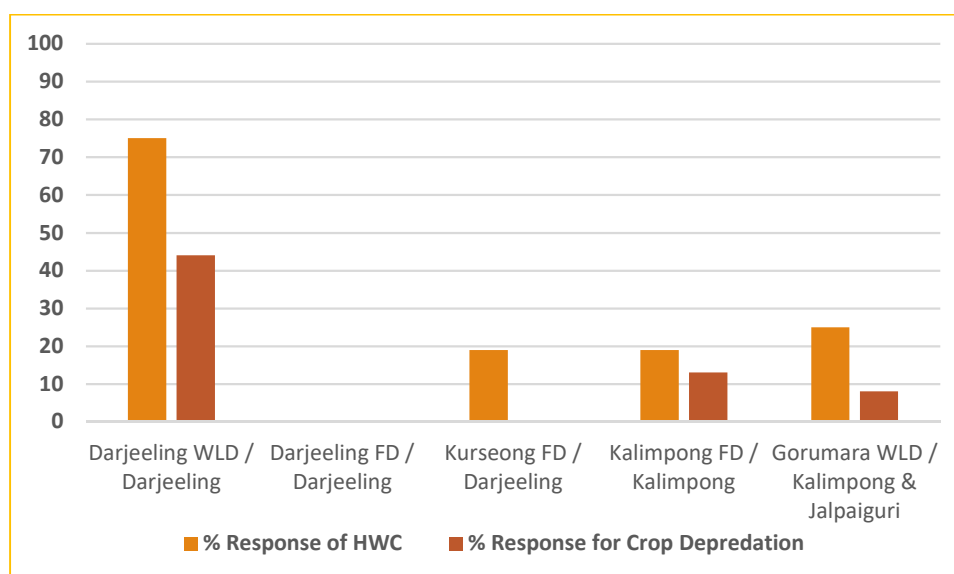
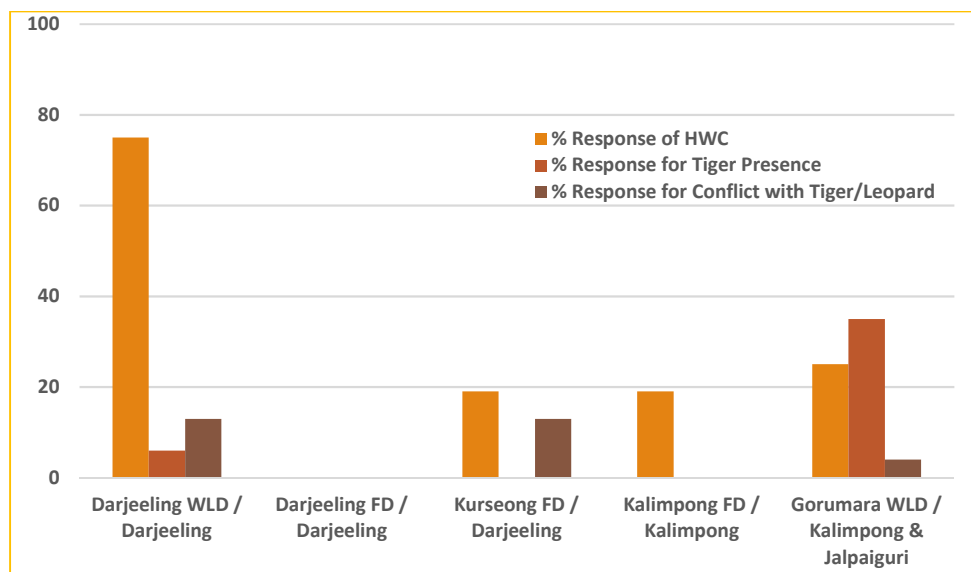


Figure 7.2.9: Human-wildlife Conflict and Crop Depredation in North Bengal



\*Darjeeling WLD & Kurseong FD reported conflict only with Common Leopard

Figure 2.7.10: Conflict representation with respect to the presence of Tiger & Leopard based on Percentage

Darjeeling Wildlife Division reports comparatively high human-wildlife conflict, and the area also faces increasing pressure from tourism-related disturbance activities.

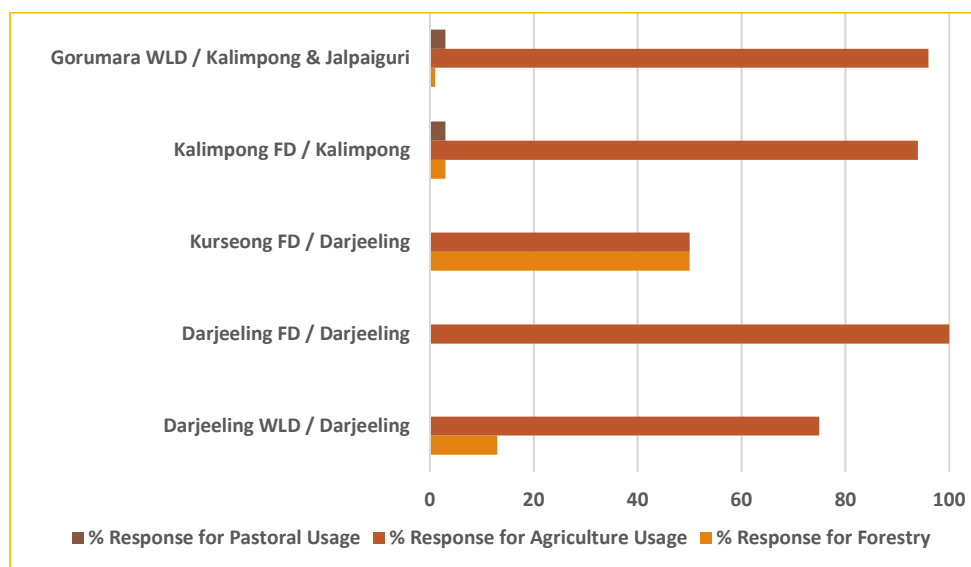


Figure 7.2.11: Land-use Patterns in North Bengal based on Percentage Response

Although agriculture seems to be the dominant form of land use, there is some amount of pastoral land use in North Bengal represented in Kalimpong district.



Assamese Macaque (*Macaca assamensis*)



Common Leopard (*Panthera pardus*)



Kalij Pheasant (*Lophura leucomelanos*)



Indian Barking Deer (*Muntiacus muntjac*)



Yellow-throated Marten (*Martes flavigula*)

**Figure 7.2.12:** Camera Trap images from West Bengal



## ARUNACHAL PRADESH

Questionnaire Survey was conducted in 8 districts of Arunachal Pradesh representing parts of western, central as well as eastern Arunachal Pradesh. Considerable responses were received from the Siang and Anjaw areas of eastern Arunachal Pradesh.

District (Divisions)	No. of Responses	Predominant land-use	Response to Crop depredation (%)	Retaliatory Killing	Response relating to Tiger Presence (%)	Conflict with Tiger/Leopard (%)	Last report of tiger presence
TAWANG (1)	2	Agriculture (Potato, Maize)	-	-	-	-	-
WEST KAMENG (4)	14	Agriculture (Rice, Maize)	86	Porcupine, Wild Boar, Sambar	93	-	-
LOWER SUBANSIRI (2)	16	Agriculture (Rice)	6	Wild Boar	100	38	2016
WEST SIANG & SHI-YOMI (1)	165	Agriculture (Rice, Maize)	-	Wild Boar, Barking Deer, Sambar	92	0.6	2018
UPPER SIANG (2)	35	Agriculture (Rice, Maize)	31	Wild Boar	71	6 (LEOPARD)	-
ANJAW (1)	18	Agriculture (Maize, Cardamom)	11	Ungulates	100	6	-
DIBANG VALLEY (2)	1	Forestry, Pastoral	100	Wild Boar	100	-	2018

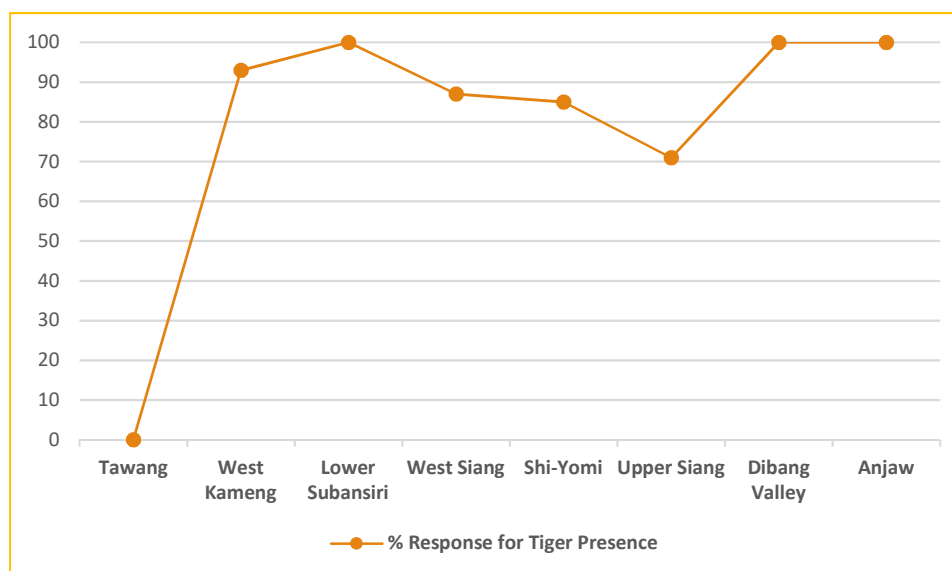
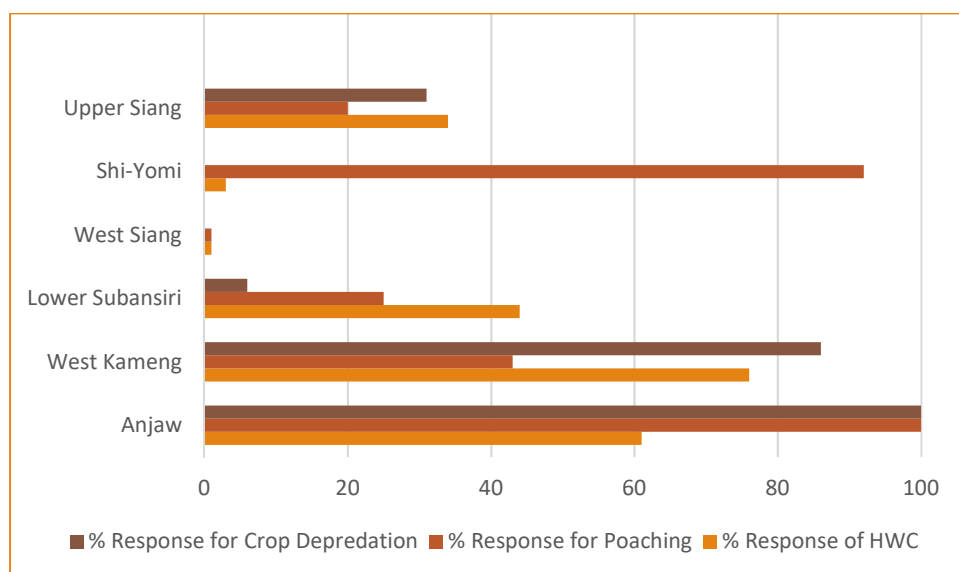


Figure 7.2.13: Tiger Presence reported based on Percentage Response in Arunachal Pradesh



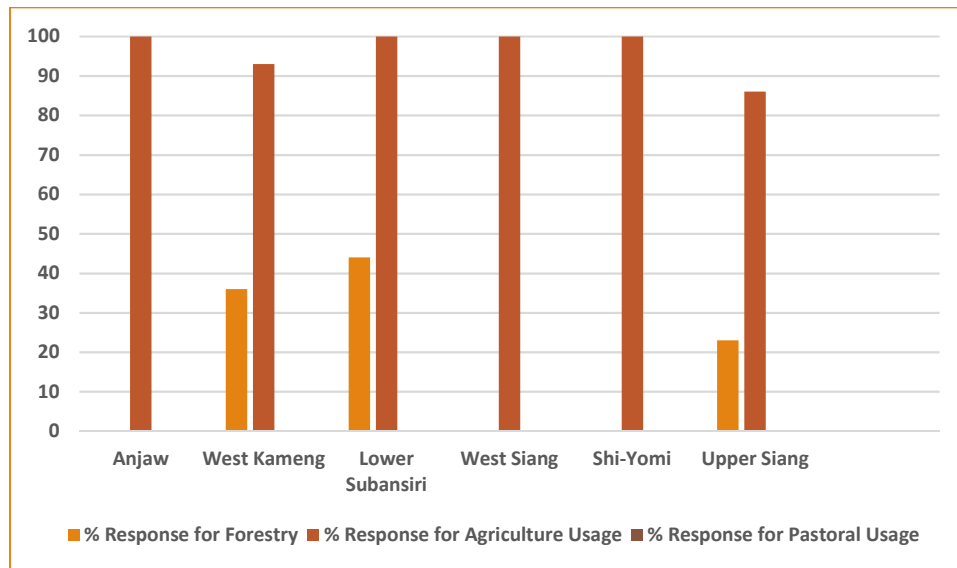
\* Dibang Valley & Tawang districts have been excluded owing to limited responses in this context

**Figure 7.2.14: Comparison of Human-wildlife Conflict to Crop Depredation and Animal Killing in Arunachal Pradesh**

Districts	Dominant Community	% Response for Poaching	Species Mentioned (actual responses)
Tawang	Monpa	0	-
West Kameng	Aka, Monpa	43	Most wild animals, Wild Boar, Deer, Ghoral
Lower Subansiri	Apatani	25	Deer, Macaque, Wild Boar, Birds
West Siang	Adi	1	Not mentioned
Shi-Yomi	Adi	92	Deer, Macaque, Wild Pig, Bear, Serow
Upper Siang	Adi	20	Deer, Birds, Ungulates, Mixed
Dibang Valley	Idu-Mishmi	0	-
Anjaw	Meyor, Mishmi	100	Deer, Barking Deer, Wild Pig, Bear

**Table 7.2.1: Communities involved in Hunting in Arunachal Pradesh based on percentage response**

Hunting is still considered a way of life in Arunachal Pradesh and also a part of the culture of the state in some areas for specific tribes. There are 26 major and more than 100 minor tribes in Arunachal Pradesh. Although hunting is banned by law in Arunachal Pradesh, there are areas wherein hunting is still prevalent to a certain extent, with selective hunting of certain ungulates like deer, wild boar, birds and macaques.



\* Dibang Valley & Tawang districts have been excluded owing to limited responses in this context

Figure 7.2.15: Land-use Patters in Arunachal Pradesh based on Percentage Response



Mithun - *Bos frontalis*



Yellow-throated Marten - *Martes flavigula*



Marbled Cat - *Pardofelis marmorata*



Leopard Cat - *Prionailurus bengalensis*



Asian Golden Cat - *Catopuma temminckii*



A Pack of Dholes / Indian Wild Dog –  
*Cuon alpinus*

Figure 7.2.16: Representative camera trap images from Arunachal Pradesh

## CAMERA TRAP FINDINGS

Details of camera trapping (state wise) are provided below:

**Uttarakhand:** Camera trapping was conducted in forest divisions of Tons, Badkot, Kedarnath and Pithoragarh.

**Sikkim:** Camera traps were deployed in both territorial and wildlife divisions of East Sikkim and the territorial division of North Sikkim.

**West Bengal:** Camera trapping was done in Gorumara and Darjeeling Wildlife Divisions.

**Arunachal Pradesh:** Camera traps were deployed in forest divisions of: Yingkiong, Along, Hapoli, Shergaon, and Bomdila, and Protected Areas including Talley Valley WLS, Eagle Nest WLS and Mouling NP.

## CAMERA TRAPPING FIELD EFFORT

The camera trap deployment details (state wise) are as below:

State	Number of forest divisions with camera traps	Number of camera traps placed
Uttarakhand	4	164
Sikkim	3	31
West Bengal	2	38
Arunachal Pradesh	9	146



## High Altitude Tiger Captures from India

No.	State	Forest Division	Range Name	Beat / Area Name	Date	Time	Elevation (m)
1	Uttarakhand	Kedarnath Forest Division	Ukhimath	Madhmeshwar Beat (Kedarnath Musk Deer Sanctuary)	26-May-19	2:30 AM	3431
2	Sikkim	North Sikkim Territorial Division	Lachen	Lachen Beat 4 (Near Talam area)	29-Jun-19	5:40 PM	3602
3	Sikkim	North Sikkim Territorial Division	Mangan	Mangan Beat 2 (Naga Forest Block area)	11-Jul-19	8:35 PM	2425



*Tiger (Panthera tigris)*

Figure 7.2.17: Representative Images Sikkim

## 7.3 NEPAL

### LITERATURE REVIEW FOR HIGH ALTITUDE

PUBLICATION	AUTHOR & YEAR	TIGER PRESENCE WITH AREA
Fauna and Flora International	Green MJB 1979	1976-77 Himalayan Tahr in the upper section of Langtang Valley. Other herbivores here include Himalayan musk deer and domestic livestock — yak, cattle, sheep and goats. Leopard and wild dog inhabit the lower part of the Valley, along with martens, foxes. Snow leopard and clouded leopard reported in 1977, no recent sightings reported.
<i>Biological Conservation</i>	Oli et al. 1994	Snow leopard predation on livestock in Annapurna Conservation Area
<i>Mammalia</i>	Stoen and Wegge 1996	Tigers in Karnali floodplain of the Royal Bardia National Park, 1990-94
Snow Leopard Network website	Yangzom 1997	Qomolangma National Nature Preserve, Tibet, shares its international border with Nepal and is inhabited by Snow Leopard and Blue Sheep. The plateau portion sustains numerous rare species of wildlife, including the black-necked crane, Tibetan wild ass, wolf, and Tibetan gazelle. The area is contiguous with Nepal's Makalu Barun National Park and Conservation Area, Sagarmatha and Langtang National Park, linking and allowing for genetic interchange between various subpopulations of thinly spaced and widely roaming carnivores like the snow leopard.
Published in (Pages 40-46): Tibet's Biodiversity: Conservation and Management: Proceedings of the Conference	Jackson 1998	Mammal species include the Himalayan tahr, langur, wild pig and goral, along with blue sheep, kiang and Tibetan gazelle, very small populations of Tibetan argali, forest ungulates like the Himalayan tahr, serow, barking deer; distribution of east Himalayan goral and musk deer not very properly documented. Carnivores include the snow leopard, asiatic black bear, tibetan wolf and



		forest leopard, along with some small spotted cats
Status paper of Langtang National Park: Published in Grassland Ecology and Management in Protected Areas of Nepal: Proceedings of a workshop	Karki 1999	Himalayan tahr, musk deer, leopard, black bear, barking deer, serow, goral, wild dog, wild boar.
<i>International Journal of Wilderness</i>	Singh and Jackson 1999	Snow leopard presence confirmed in all but one of the following protected areas- Langtang NP, Shey-Phoksundo NP, Dhorpatan Hunting Reserve, Annapurna Conservation Area, Sagarmatha NP, Kanchenjunga Conservation Area, Manaslu Conservation Area, some portions of Makalu-Barun NP and Conservation Area. Qomolangma Nature Preserve serves as linking corridor between Makalu Barun, Sagarmatha, Langtang, Manaslu and Annapurna
In Riding the Tiger: Tiger conservation in human-dominated landscapes. Cambridge University Press	Smith et al. 1999	Population survey in 1994-97 revealed 48 tigers in Royal Chitwan National Park & Parsa Wildlife Reserve, 36 in Royal Bardia National Park and 16 in Royal Sukhlaphanta Wildlife Reserve
M.Sc. Dissertation thesis on 'Study of Park People Relationship in Royal Sukhlaphanta Wildlife Reserve General report on the royal sukhaphanta wildlife reserve department of national park and wildlife conservation	Joshi, 2002, Balson, 1976	Wild elephant, tiger, one-horned Rhinoceros, blue bull, leopard, wild pig, chital
<i>Ecoprint</i>	Shrestha and Basnet 2005	Shivapuri-Nagarjun National Park: Wild boar, barking deer, Himalayan ghoral, common leopard jungle cat, golden jackal, yellow-throated marten, large civet, himalayan black bear, Himalayan mouse pika, indian hare, chinese pangolin, porcupine and rhesus macaque are some of the common mammals found here (surveyed in 2003-04)
<i>Biological Conservation</i>	Sangay and Vernes 2008	Livestock depredation cases from 2003-2005 suggest tiger presence (along with leopards and snow leopards) in various

		<p>districts representing many high-altitude areas/districts:</p> <p>Trongsa District covering Jigme Singye Wangchuck National Park with more than 20% of the cases relating to livestock depredation by tigers.</p> <p>Wangdue and Zhemgang districts covering parts of Royal Manas and Jigme Singye Wangchuck National Park</p> <p>Jigme Dorji National Park with depredation cases relating to tigers, leopards and snow leopards</p> <p>Sakteng Wildlife sanctuary, Bundeling Wildlife Sanctuary and Jomotsangha Wildlife Sanctuary, where tigers and leopards (majorly) responsible for livestock deaths</p> <p>Wangchuck Centennial National Park and Jigme Kesar Strict Nature Reserve- wildlife depredation cases reported between 2003-05</p>
<i>International Journal of Conservation Science</i>	Aryal and Subedi 2011 Mishra	Musk Deer in Khaptad National Park Himalayan black bear, leopard in the mid altitudinal ranges
The Status of the Nepal Mammals: The National Red List Series	Jnawali et al., 2011	Himalayan Tahr in Annapurna Conservation Area (Mustang), Kanchanjanga Conservation Area, Langtang National Park, Makalu Barun National Park, Western part of Gorkha within the Manaslu conservation area, Sagarmatha National Park, Rara National Park, Khaptad National Park
IUCN The Status of Nepal's Mammals: The National Red List Series	Jnawali et al. 2012	Survey in Chitwan National Park, including Churia (Dec 2009 to March 2010), revealed 125 (range 95 to 185) adult tigers. Estimates of adult tiger populations in the other protected areas taken from the December 2008 to March 2009 camera trap census: Bardia National Park, 18; Parsa Wildlife Reserve, 4; Shukla Phanta Wildlife Reserve, 8
IUCN The Status of Nepal's Mammals: The National Red List Series	Jnawali et al. 2012	Snow Leopards distributed along the northern border with China (Tibet) and occur within seven mountain protected areas: Annapurna Conservation Area, Kanchanjanga Conservation Area, Langtang National Park, Makalu Barun National Park, Manaslu Conservation Area, Sagarmatha

		National Park and Shey Phoksundo National Park.
International Bear News	Yadav et al. 2012	Asiatic Black Bear Killed in Rara National Park
<i>Mammalia</i>	Pokheral, 2013	Genetic analysis of scats gave the tiger number as 6 (2008-11)
<i>Banko Janakari</i>	Karki et al. 2013	Chitwan National Park was camera-trapped from January to March 2010. Sixty-two adult tigers were identified. The study showed the use of Churia by tigers concluding that Chitwan serves as a source to maintain tiger occupancy of the larger landscape comprising Chitwan National Park, Parsa Wildlife Reserve, Barandabhar buffer zone, Someswor forest in Nepal
	Dhakal et al. 2014	Camera trapping in the Terai-Arc Landscape estimated the The total tiger population in Nepal at 198 individuals including 120 in Chitwan NP, 50 in Bardia NP, 17 in ShukhlaphantaWR, 7 in Parsa WR (4-13), and 4 in Banke NP (3-7)
Nepal Journal of Environmental Science	Thapa & Maharjan 2015	Himalayan Tahr and Barking Deer in Rara national park
NTNC Annual Report, 2016		Manaslu Conservation Area has a diverse range of habitats which boasts many rare flora and fauna such as Snow leopard, Lynx, Musk deer, Red fox, Jackle, Brown bear and their prey species such as Blue sheep, Himalayan thar, Himalayan serow, Wooly hare and Himalayan marmot
<i>Integrative Zoology</i>	Thapa and Kelly 2016	Camera trapping survey covering 536 km <sup>2</sup> of Churia and surrounding areas within Chitwan National Park revealed the presence of 31 individual tigers, 28 individual leopards and 25 other mammalian species. Estimated 62.7 prey animals per 100 km <sup>2</sup> with forest ungulate prey (sambar, chital, barking deer and wild pig), accounting for 47% of the total
Springer Science, The Wetland Book	Kumar and Lamsal 2016	Red Panda in Langtang NP and Rara NP Musk deer in Rara, Shey Phoksundo, Sagarmatha and Langtang NP Snow Leopard and Tibetan wolf in Shey Phoksundo NP

		Smooth Otter, Himalayan Black bear in Rara NP
<i>Oryx</i>	Chen et al. 2017	Surveys conducted during 2014 resulted in 7 minimum individual snow leopards
PLoS ONE	Chetri et al. 2017	Preferable prey base consisting of ungulates like Bharals, tahr, Tibetan gazelle, kiang and argali
Management Plan of Shivapuri Nagarjun National Park	2017	Sambar deer, Himalayan serow, goral, leopard, clouded leopard, jungle and leopard cat, Eurasian otter, assam and rhesus macaque, Himalayan black bear, Chinese pangolin
Fauna & Flora International	Lamichhane et al 2017	Parsa Wildlife Reserve, Nepal, camera trapped in 2013, 2014 & 2016. Once believed to be a sink for tigers from Chitwan National Park, it now provides a new hope for tigers. SECR analysis survey tiger density from 0.78 to 1.38 individuals per 100 km <sup>2</sup> from 2013 to 2016. The tiger abundance also increased from 7 to 17 from 2013 to 2016.
Fauna and Flora International	Ghimirey and Acharya 2017	Records of Clouded leopards presence confirmed in Langtang NP, Shivapuri-Nagarjuna National Park, Annapurna Conservation Area, Chitwan NP
PLOS ONE Journal article	Shrestha et al. 2018	2014-16 Scat analysis of Snow leopards revealed components of its diet, which were Himalayan Tahr, Blue Sheep, Goats and Yaks, in the Sagarmatha National Park (SNP), Lower Mustang and Upper Manang (Annapurna Conservation Area) areas of Nepalese Himalaya
Fauna and Flora International	Khanal et al. 2018	Snow Leopard and its prey, bharal, in Api Nampa Conservation Area
Ecoscience	Pokheral and Wegge, 2018	Camera trapping in Shuklaphanta National Park revealed the presence of 11 tigers and 9 leopards (Dec 2008- Feb 2011 during winter dry seasons)
<i>Global Ecology and Conservation</i>	Chetri et al. 2019	Scat analysis of Snow leopards in the Annapurna-Manaslu landscape revealed the presence of atleast 34 individuals in the area, with an average density estimate of 0.95 animals per 100 sq.km
<i>Journal of Threatened Taxa</i>	Lama et al. 2018	First photographic evidence of Snow leopards in the Limi Valley of Humla District in 2015. In addition to this, the Blue Sheep,

		Beech Marten, Pika and bird species were also detected.
<i>Diversity and Distribution</i>	Macdonald et al. 2019	Clouded leopard presence in Langtang National Park

### **TIGER OCCUPANCY (QUESTIONNAIRE SURVEY)**

A total of forty four responses were collated from three divisions of western Nepal focusing on a region with more probability of wild tiger, comprising portions of three divisions: Dadeldhura, Baitadi, and Darchula.

The responses relating to tiger presence were from Dadeldhura (7), Darchula (2; sightings reported in 2003 and 2018) and from Baitadi (1; sighting reported in 2002).

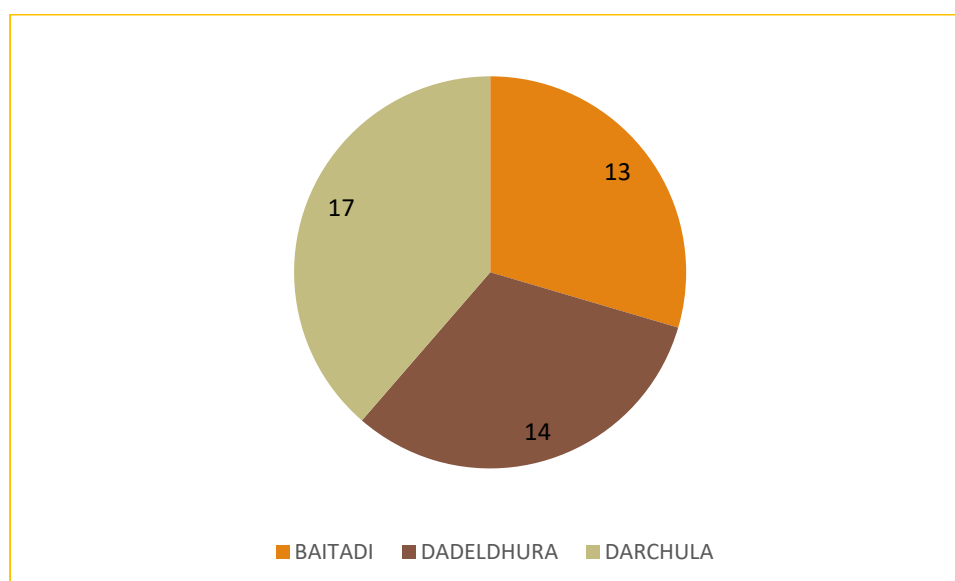


Figure 7.3.1: Villages

In Darchula, human-wildlife conflict with large carnivores was reported (tiger, snow leopard, jackal).

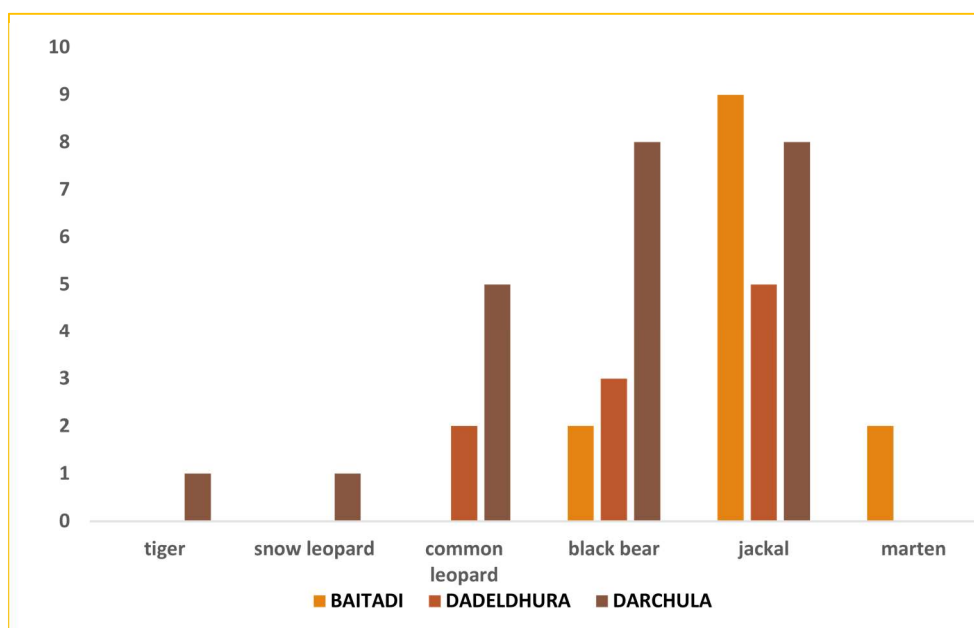


Figure 7.3.2: Carnivore Conflict in Region

Conflict with wild ungulate was also reported (barking deer, wild boar, and porcupine). Response relating to human wildlife conflict due to Sambar, Bharal, Musk deer was reported only from Dadeldhura.

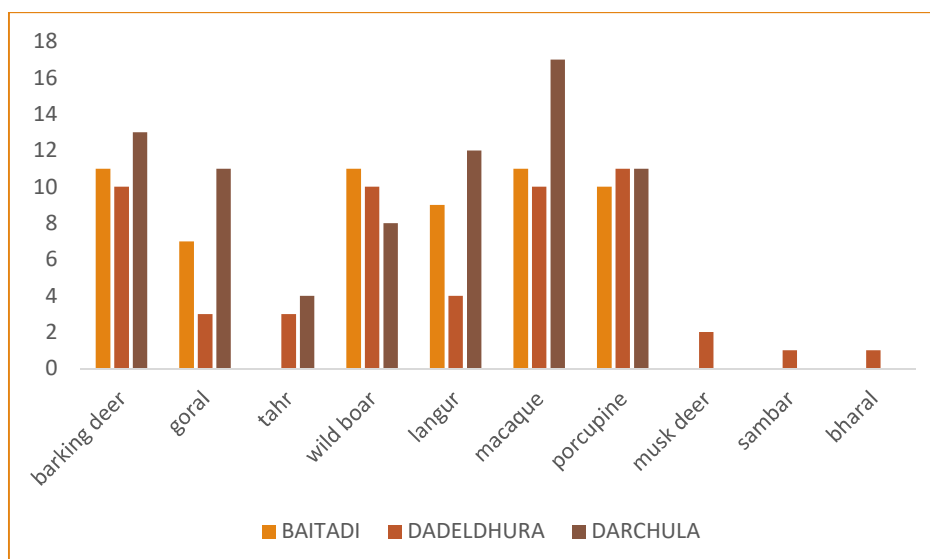


Figure 7.3.3: Ungulate Conflict in the Region



The major land use is agriculture. Local communities consume bushmeat and thus subsistence poaching is prevalent.

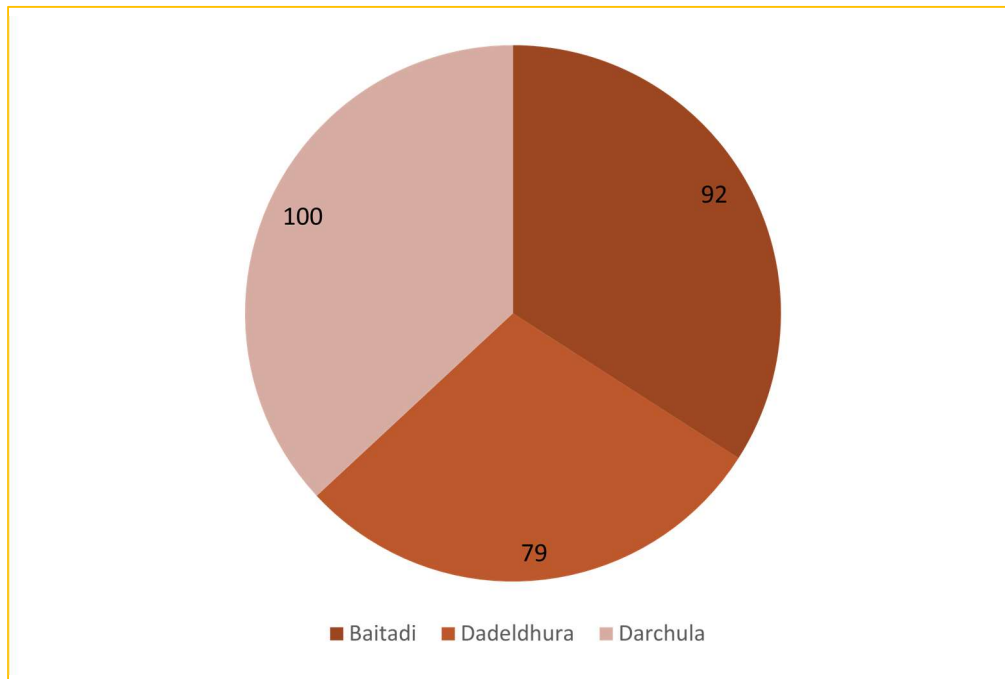


Figure 7.3.4: Bushmeat consumption (%)

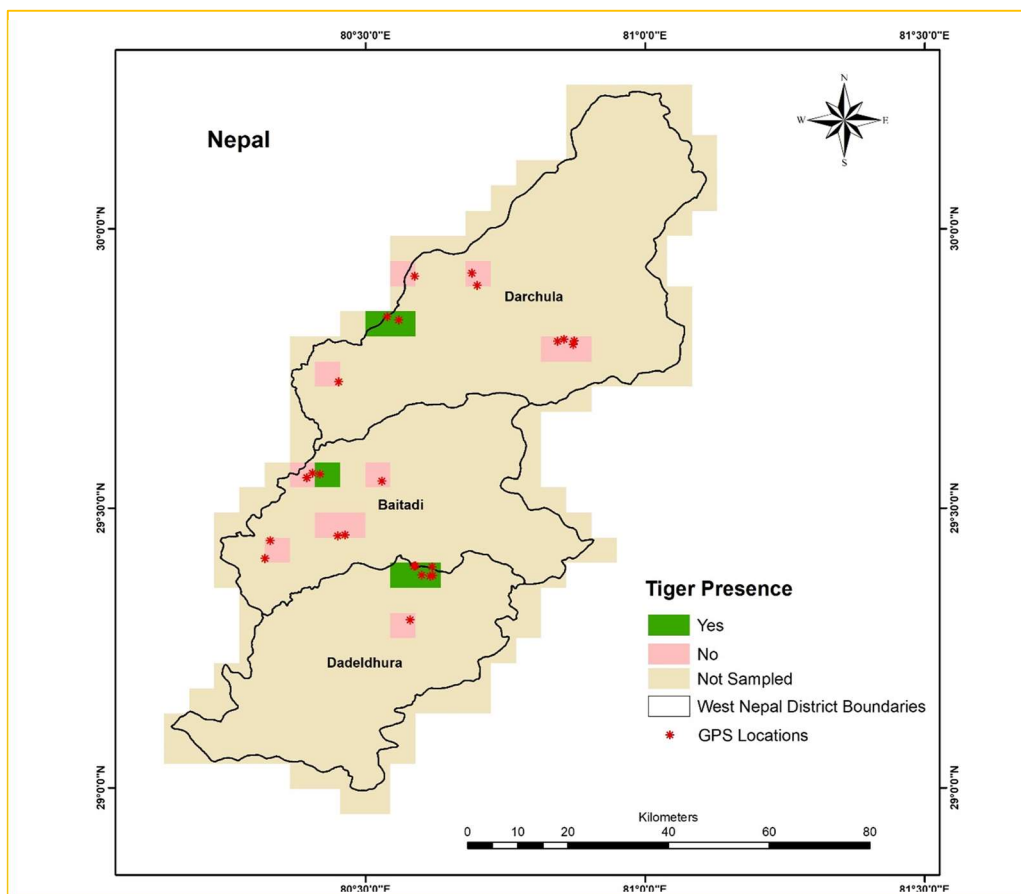


Figure 7.3.5: Questionnaire-based Presence/Absence Survey and Results [Western Nepal]

## CAMERA TRAP FINDINGS

Based on the questionnaire survey done in August 2018, camera trapping was reported done in forest areas between Baitadi and Dadeldhura districts.

A total of 27 camera trap points were identified in Dadeldhura and Baitadi districts where cameras were installed for 5 trap nights at each location in December 2018, as shown in the figure 7.3.6. A total of 7 wild species were captured in the Dadeldhura district, while only one was caught in Baitadi. The camera trapped species include: barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), common leopard (*Panthera pardus*), yellow throated martin (*Martes flavigula*), golden jackal (*Canis aureus*), red fox (*Vulpes vulpes*), and jungle cat (*Felis chaus*). There was no photo capture of tiger. Out of 4896 photographs, there were 1425 independent humans and 26 wildlife captures. In general, the region was subjected to anthropogenic disturbance and lack of larger mammals.

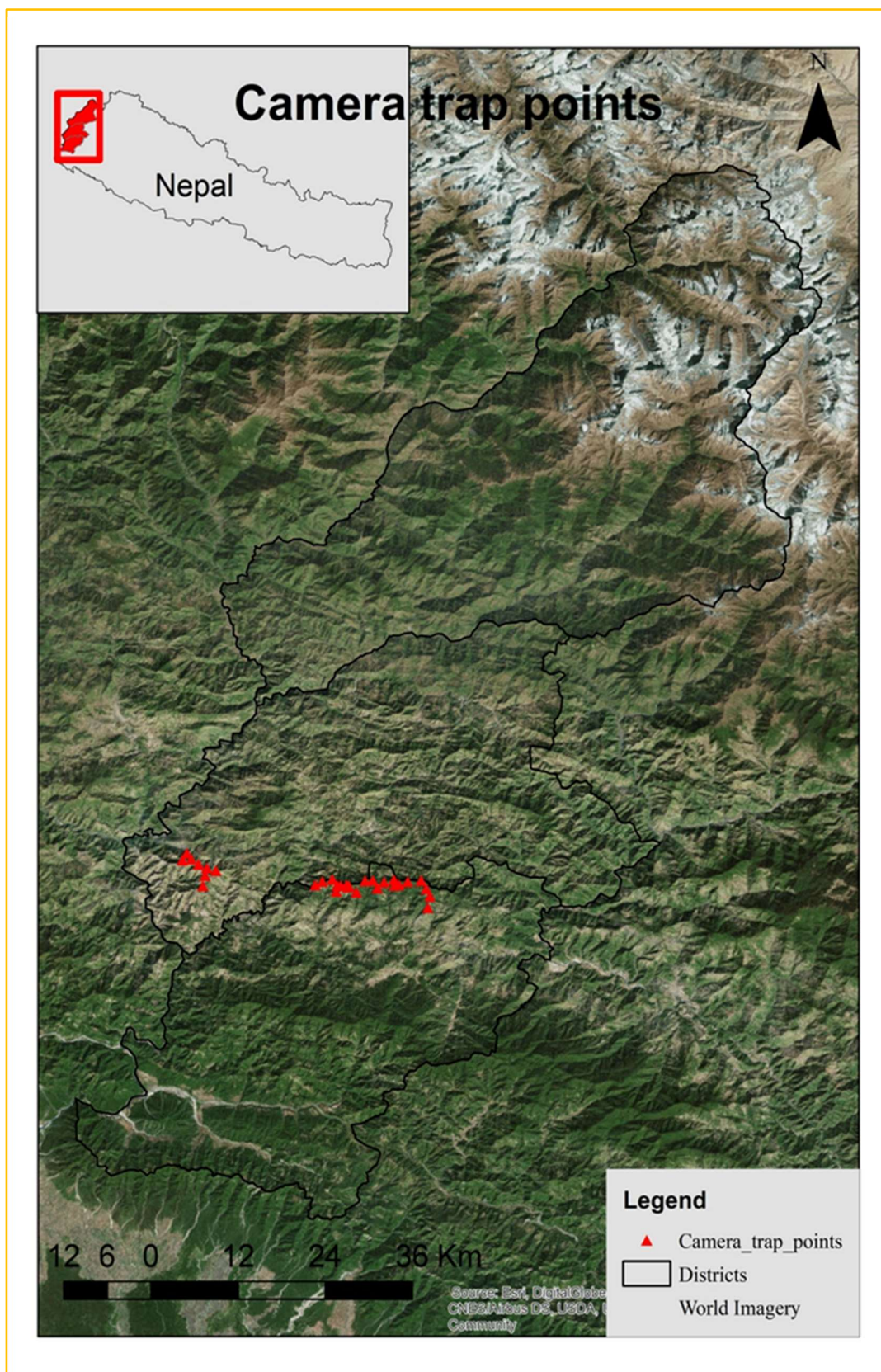


Figure 7.3.6: Map of the area with the camera trap points





Barking Deer (left)



Jungle cat (right)



Leopard (left)



Yellow throated Martin (right)



Jackal (left)



Red Fox (right)



Wild boar (left)



Leopard pugmark sighted during the camera trap survey

Figure7.3.7: Photographs of the camera trap species

## 8. TIGER HABITAT SUITABILITY MAPPING AND CORRIDOR CONNECTIVITY IN EASTERN AND WESTERN HIMALAYAS

### TIGER HABITAT SUITABILITY MAPPING

The data from socio-economic survey was analyzed and the tiger occurrence reported in present or historically was mapped.

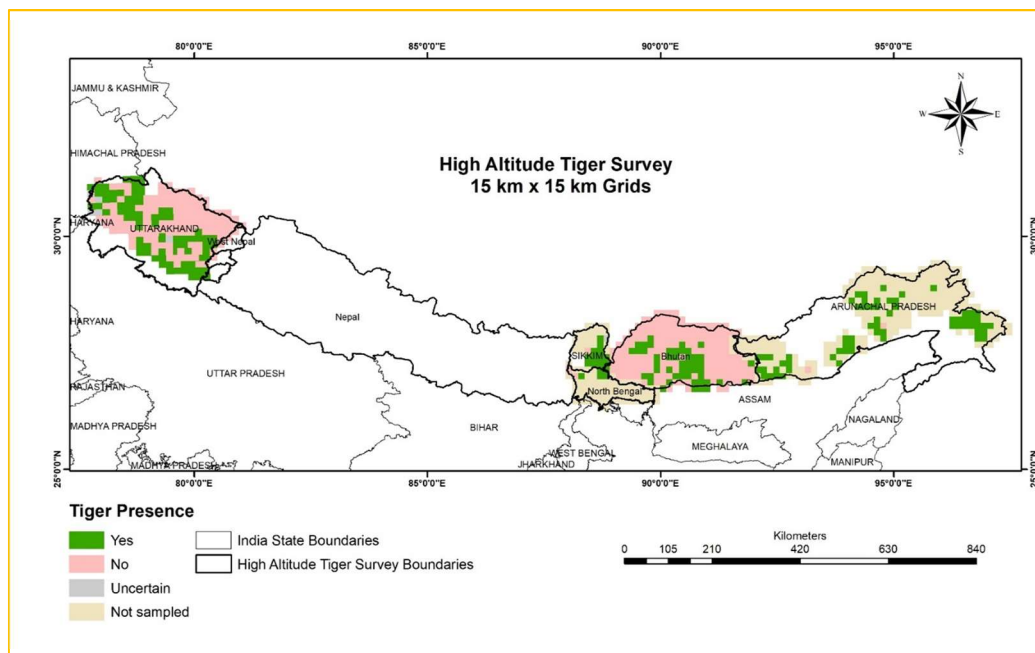


Figure 8.1: Questionnaire-based Presence/Absence Survey and Results [India]

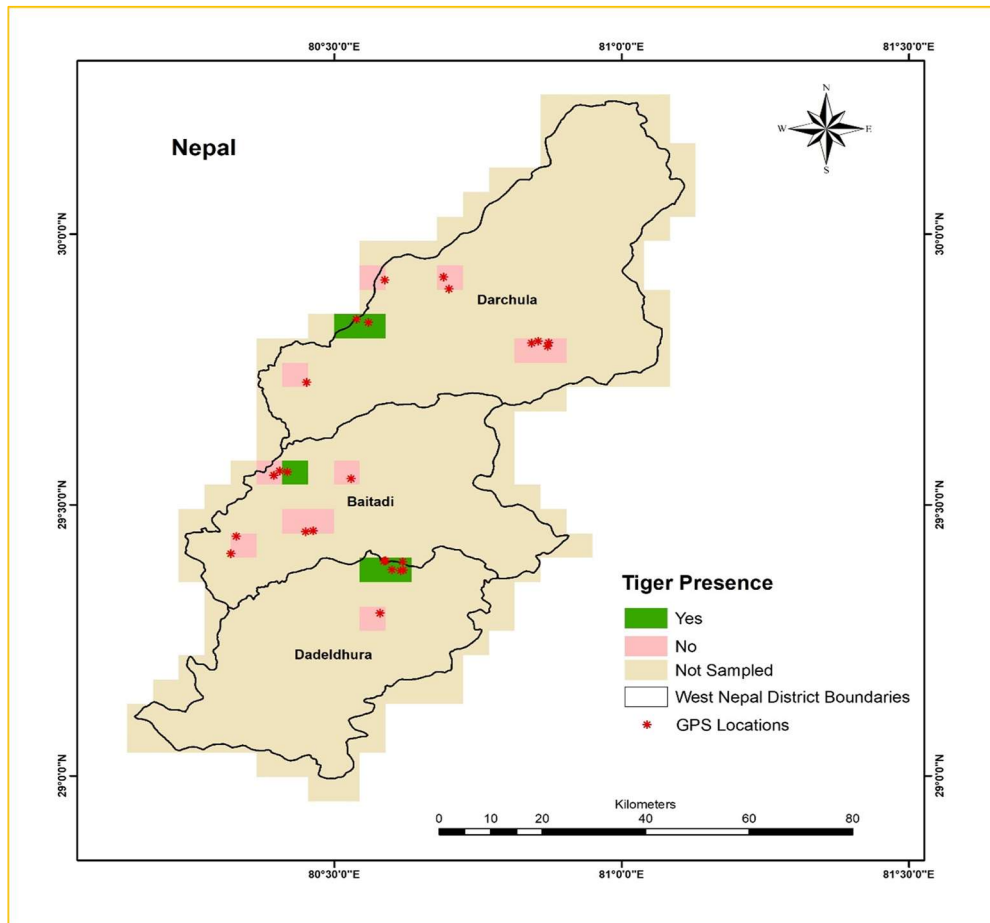


Figure 8.2: Questionnaire-based Presence/Absence Survey and Results [Western Nepal]

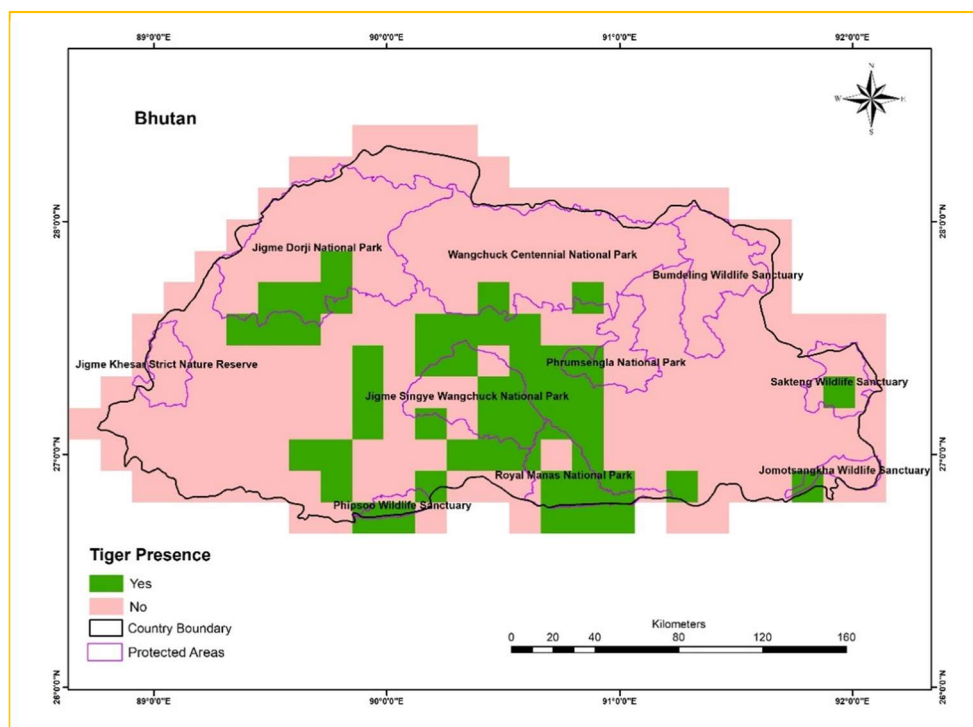


Figure 8.3: Questionnaire-based Presence/Absence Survey and Results [Bhutan]



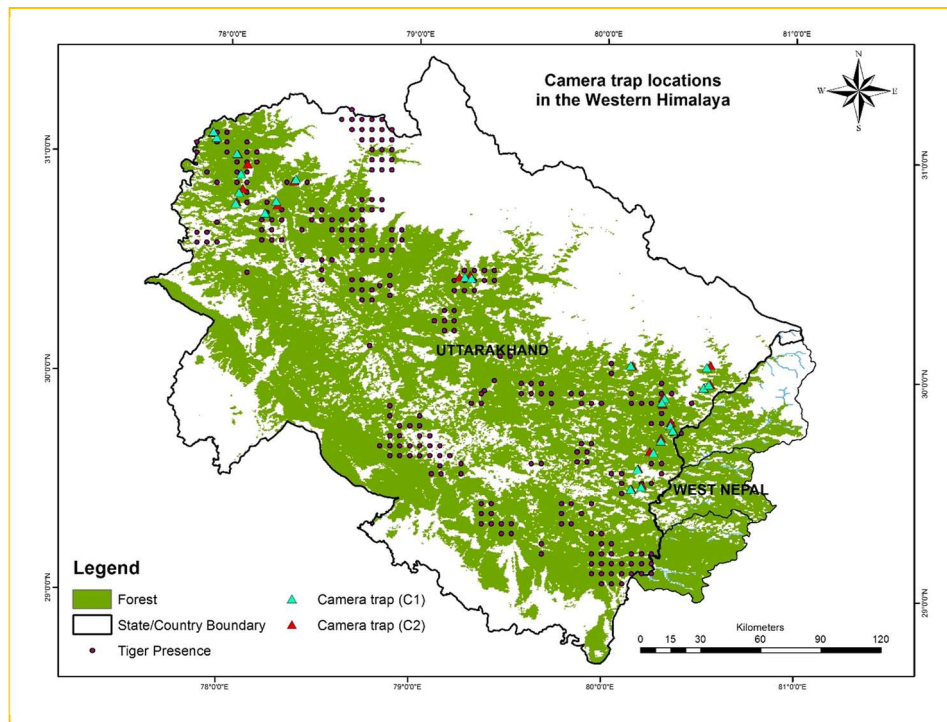


Figure 8.4: Camera trap locations in the Western Himalaya

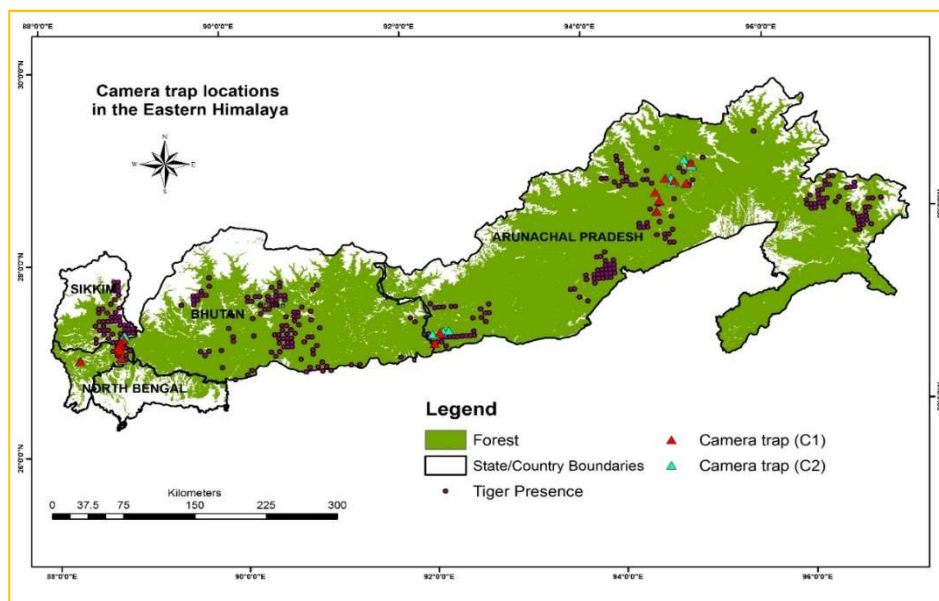


Figure 8.5: Camera trap locations in the Eastern Himalaya

Based on historical and current data, supported by findings of the questionnaire survey, generalized linear model for eastern and western Himalayas were constructed.

## **FACTORS FOSTERING TIGER PRESENCE IN WESTERN HIMALAYAS (UTTARAKHAND AND NEPAL)**

- ✓ Gentle Elevation,
- ✓ High Forest Cover,
- ✓ High Drainage Density,
- ✓ High Temperature Variation and
- ✓ Moderate Dry Condition

## **FACTORS FOSTERING TIGER PRESENCE IN THE EASTERN HIMALAYAS (SIKKIM, NORTH BENGAL, BHUTAN, ARUNACHAL PRADESH)**

- ✓ Moderate Elevation Complexity
- ✓ Moderate Forest Cover
- ✓ Gentle Slope
- ✓ High Drainage Density
- ✓ Low Human Footprint
- ✓ Low Temperature Condition
- ✓ Moderate Dry Condition

## WESTERN HIMALAYA

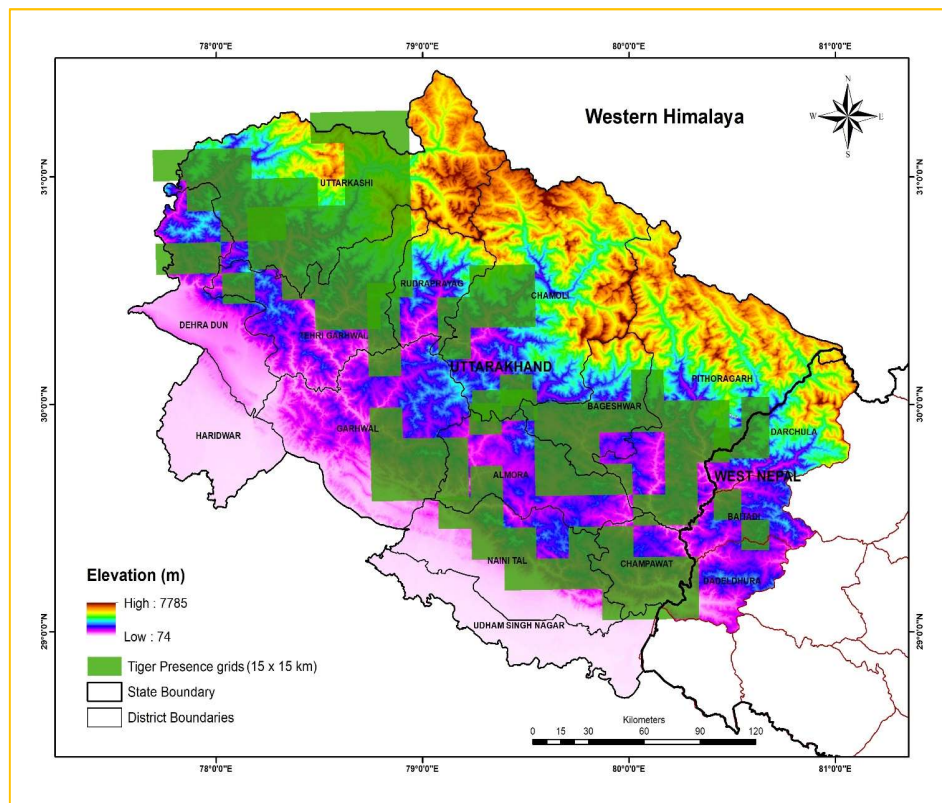


Figure 8.6: Western Himalaya- Elevation

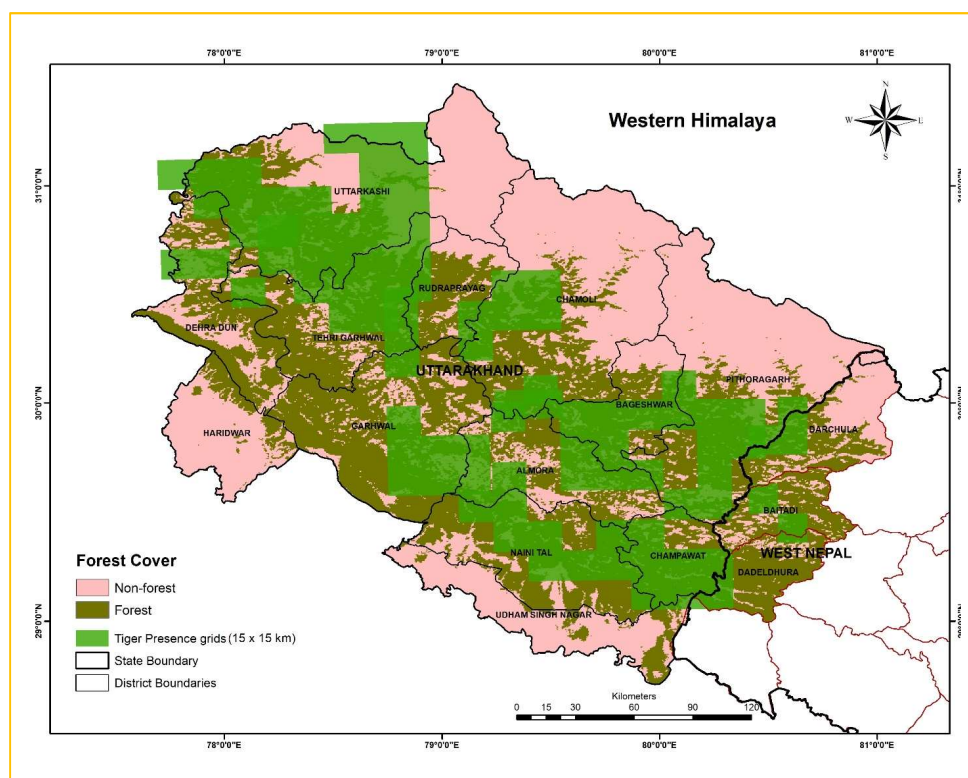


Figure 8.7: Western Himalaya- Forest Cover

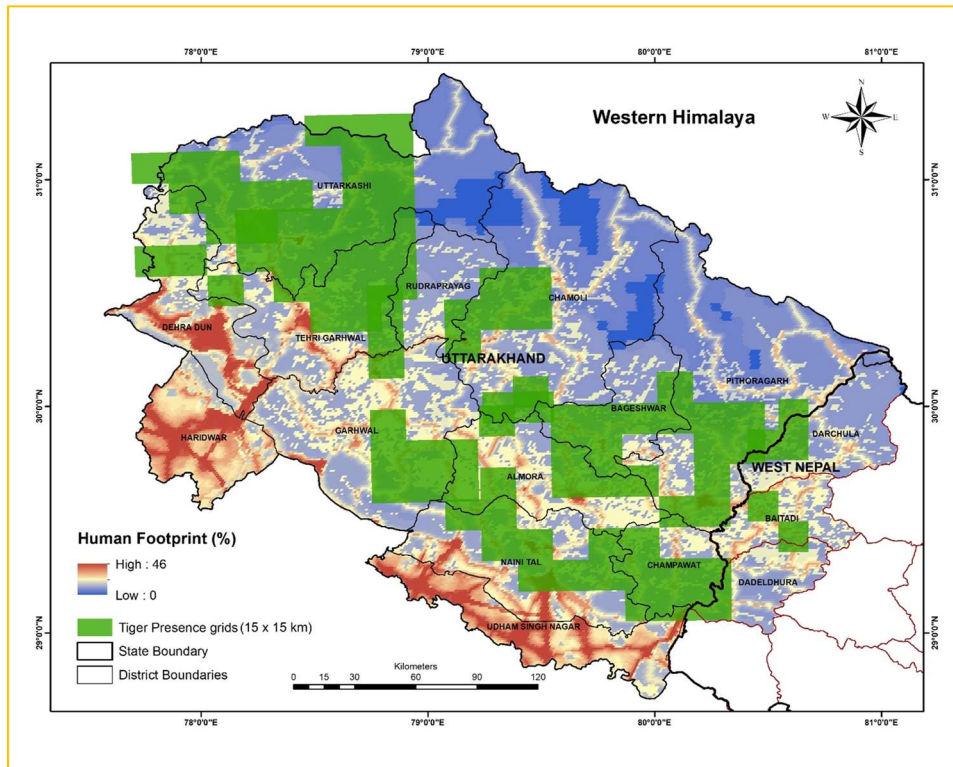


Figure 8.8: Western Himalaya- Human Footprint (%)

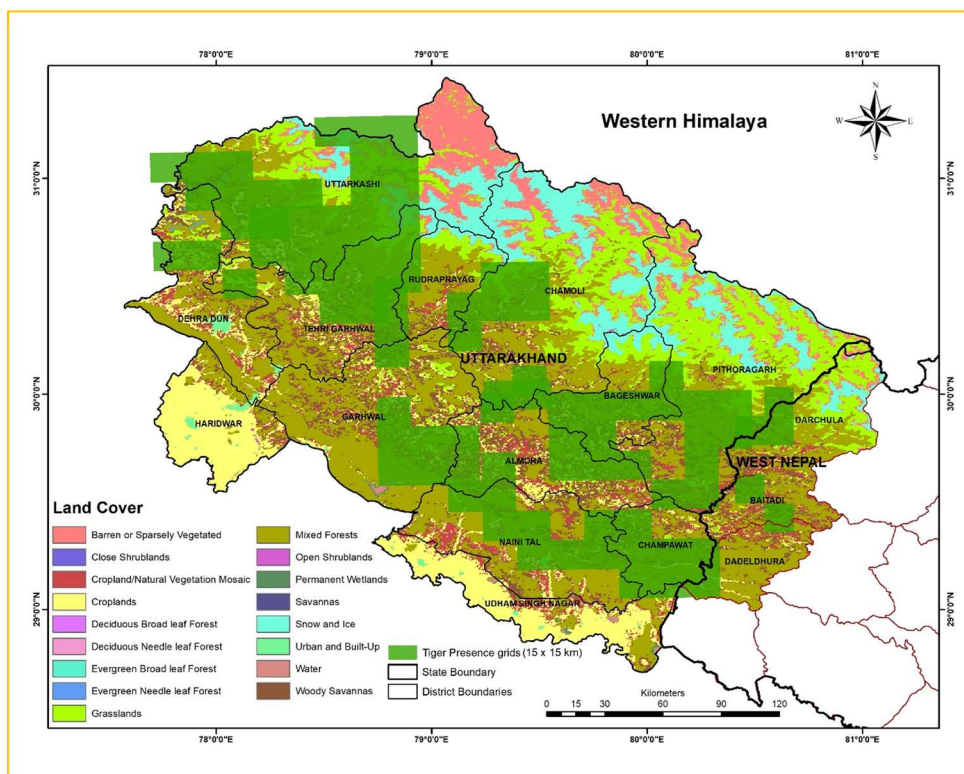


Figure 8.9: Western Himalaya- Land Cover



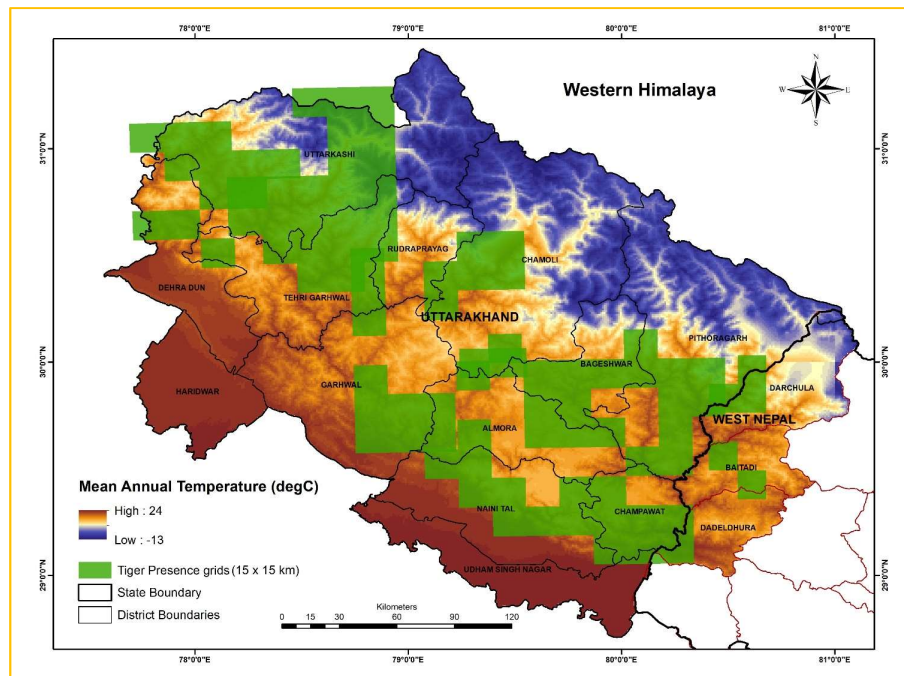


Figure 8.10: Western Himalaya- Mean Annual Temperature (degC)

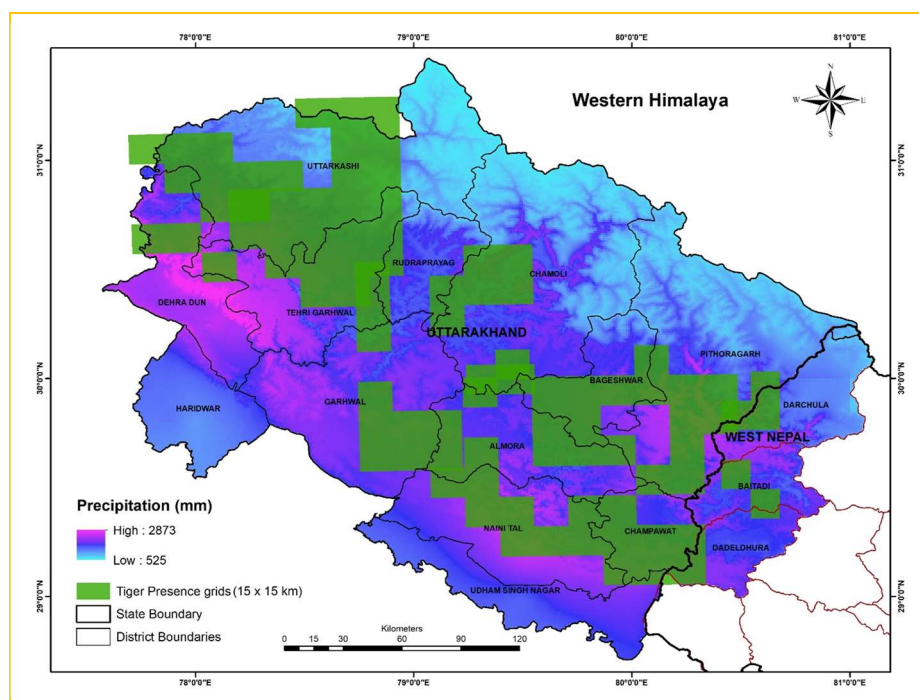


Figure 8.11: Western Himalaya- Precipitation(mm)

## EASTERN HIMALAYA

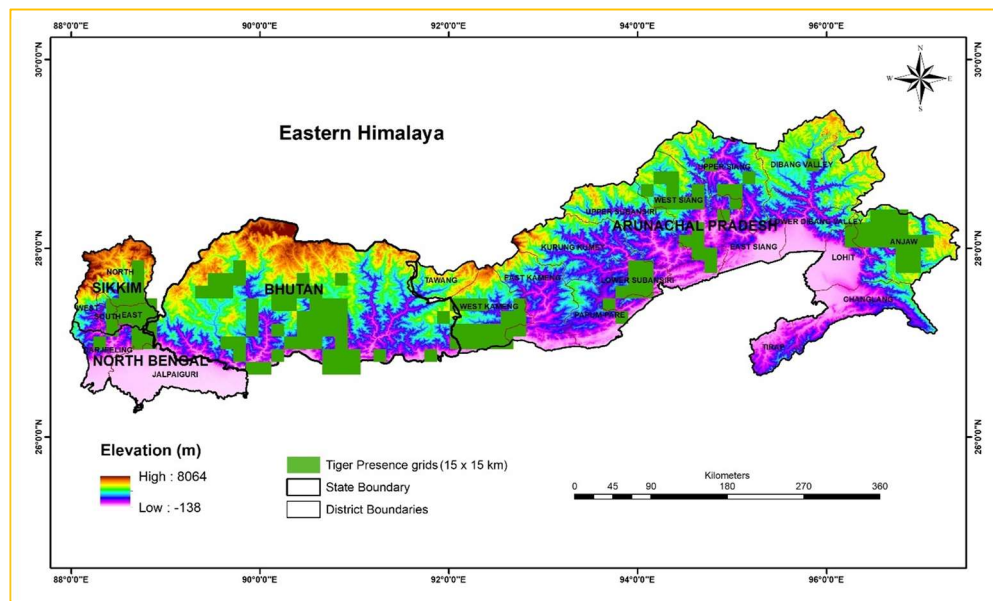


Figure 8.12: Eastern Himalaya- Elevation

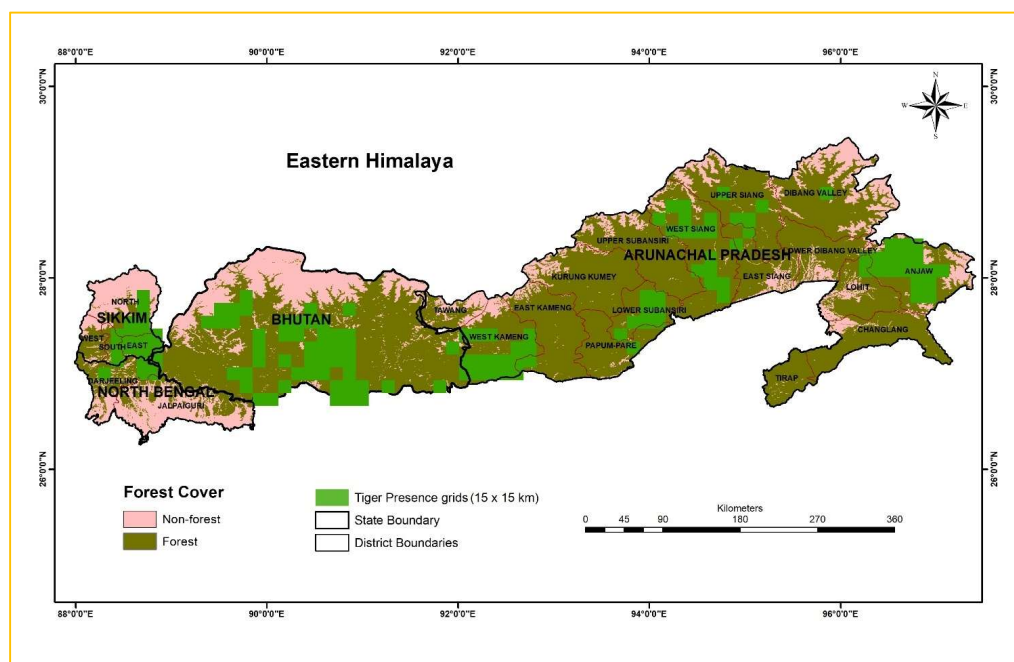


Figure 8.13: Eastern Himalaya- Forest Cover



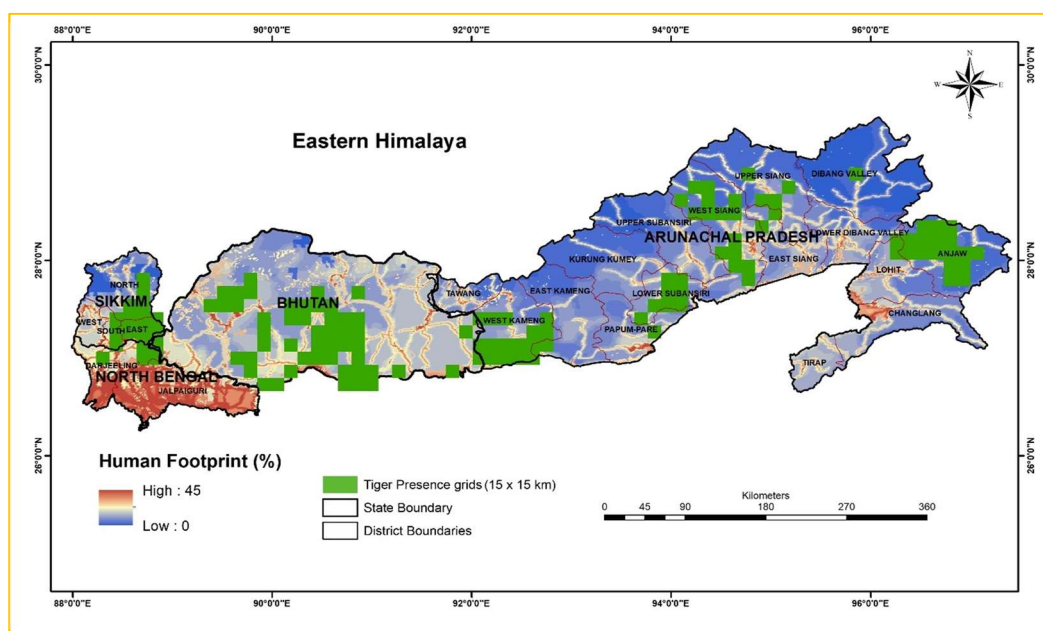


Figure 8.14: Eastern Himalaya- Human Footprint(%)

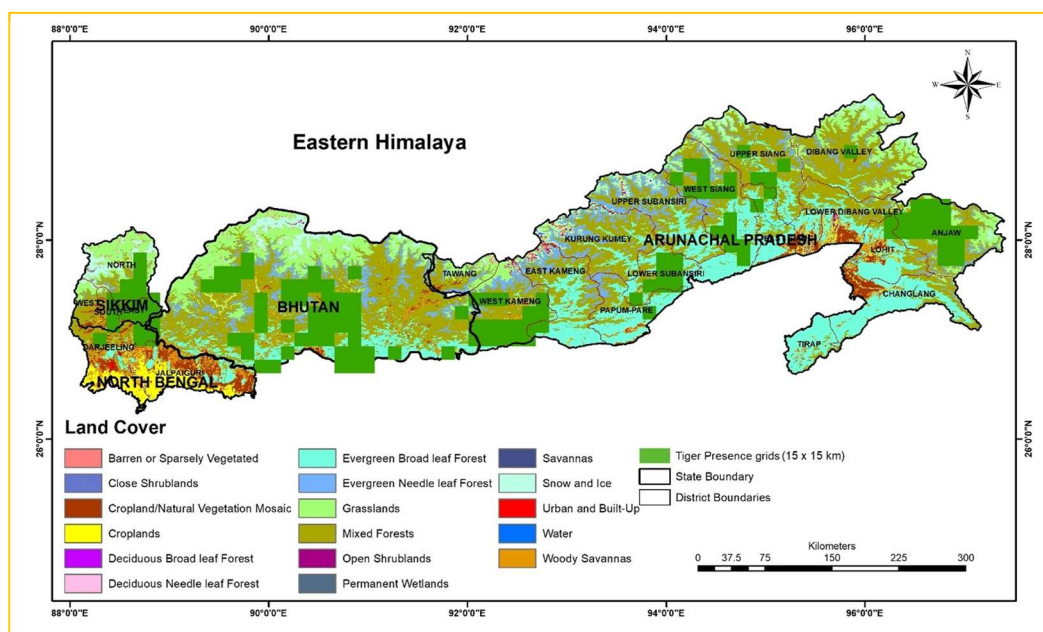


Figure 8.15: Eastern Himalaya- Land Cover

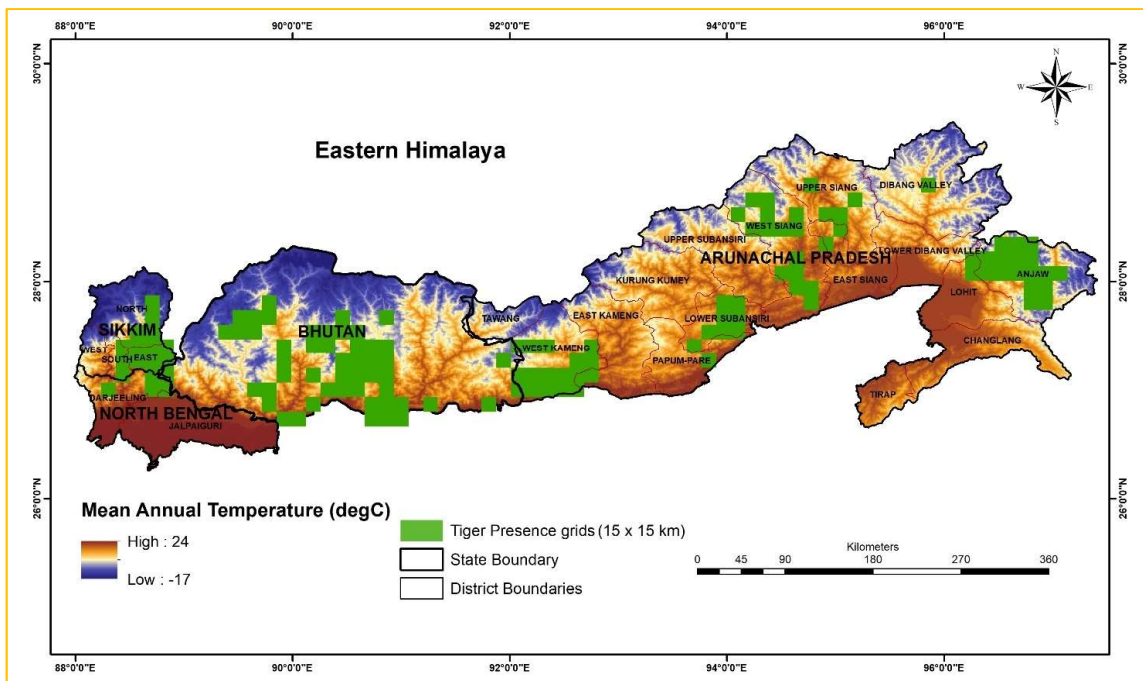


Figure 8.16: Eastern Himalaya- Mean Annual Temperature (degC)

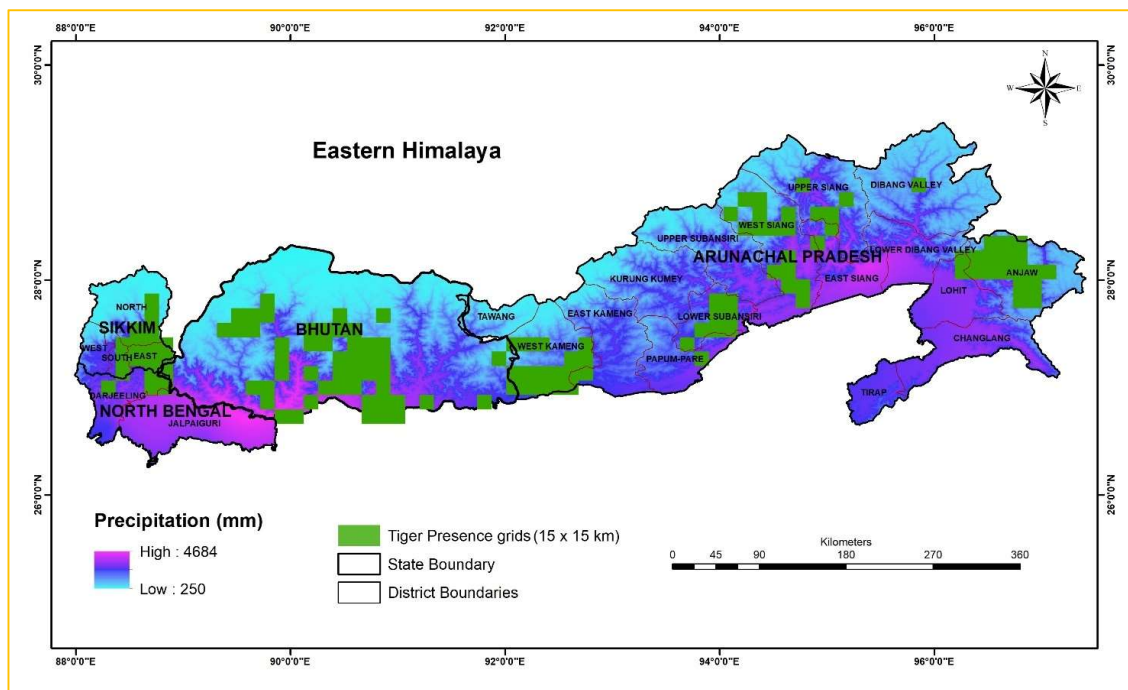


Figure 8.17: Eastern Himalaya- Precipitation(mm)

### **Corridor connectivity:**

Tiger presence locations from the socio-economic survey, human footprint data, drainage and source protected area for tigers were used to predict the least cost pathway for tiger movement.

Global datasets were used for analyzing connectivity between different protected areas, as well as between tiger reserves and protected areas. Published information (Dutta et al., 2015) in the context was used for deriving habitat (land use and land cover) and anthropogenic (human footprint) variables from multiple data layers in the GIS (ArcGIS v10.5, Esri, Redlands, CA, USA).

Since tiger movement is critically influenced by the available habitat quality and quantity, the global MODIS land cover data was used. The said data provides a suite of global land cover types that are mapped using the spectral and temporal information derived from MODIS. The maps are produced using a supervised classification algorithm, and a database of high quality land cover training sites at 500m spatial resolution. There are 16 land cover types which were reclassified into seven broad categories of habitat that are relevant for tiger by merging the similar classes. Such classes include forest, degraded forest, water bodies, settlements, croplands and barren lands.

For the anthropogenic variable, the Global Human Footprint Dataset, 2009, at 1 km spatial resolution, was used, which represents the relative human influence in each terrestrial biome expressed as a percentage (Sanderson et al., 2002). The final layer is obtained from nine global data layers covering human population pressure, human land use and infrastructure (built-up areas, night-time lights, land use/land cover), and human access (coastlines, roads, railroads, navigable rivers). These pressures are weighted according to estimates of their relative levels of human pressure and then summed together to create the standardized human footprint. The data was further reclassified into four categories namely absent, low, medium and high using equal intervals in ArcGIS environment.

The habitat categories were assigned resistance values as per the published resistance values to derive the resistance surfaces. The resistance values and weighting schemes were adopted

from Dutta et al., 2015 - Table 2. The final resistance layer was derived by summing the weighted resistances from individual layers (land use/land cover and human footprint) and adding one (to account for Euclidean distance).

The existing connectivity between different protected areas in eastern and western Himalaya were mapped using the program Linkage Mapper to get the least-cost path between pairs of adjacent protected areas. To model the connectivity from tiger reserves to different protected areas, the least-cost path was derived in ArcGIS environment using Distance toolbox.

**Table 2** Resistance values used for this study

Layer (weight)	Category	Resistance score
LULC (0.44)	Forest	0
	Degraded	2
	Scrub	2
	Barren	6
	Water	6
	Agriculture	49
	Settlement	100
Road (0.13)	Absent	0
	Other Roads	50
	Highways	100
Population density (0.33)	Absent	0
	Low	30
	Mod	60
	High	100
Railway (0.09)	Absent	0
	Present	100

*Source: Dutta et al., 2015*

## WESTERN HIMALAYAS

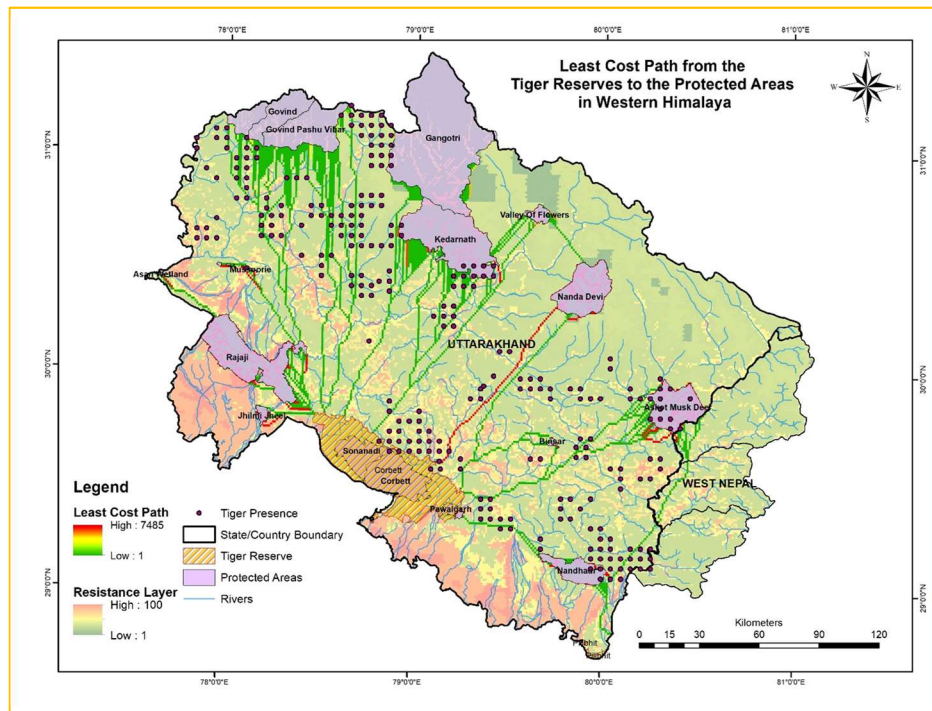


Figure 8.18: Least Cost Path from the Tiger Reserves to the Protected Areas in Western Himalaya

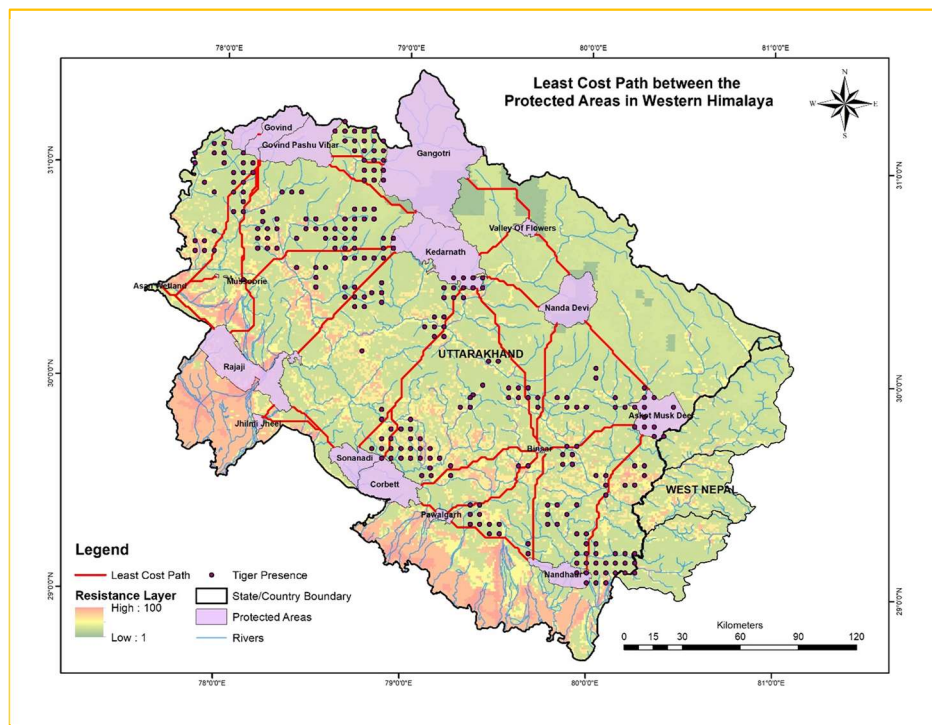


Figure 8.19: Least Cost Path between the Protected Areas in Western Himalaya



## EASTERN HIMALAYAS

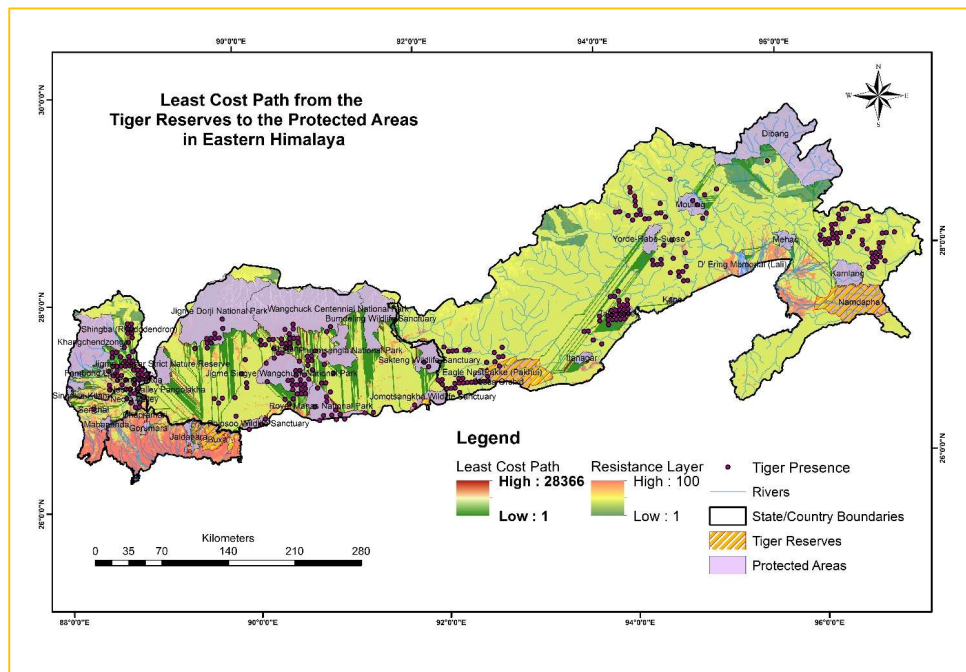


Figure 8.20: Least Cost Path from the Tiger Reserves to the Protected Areas in Eastern Himalaya

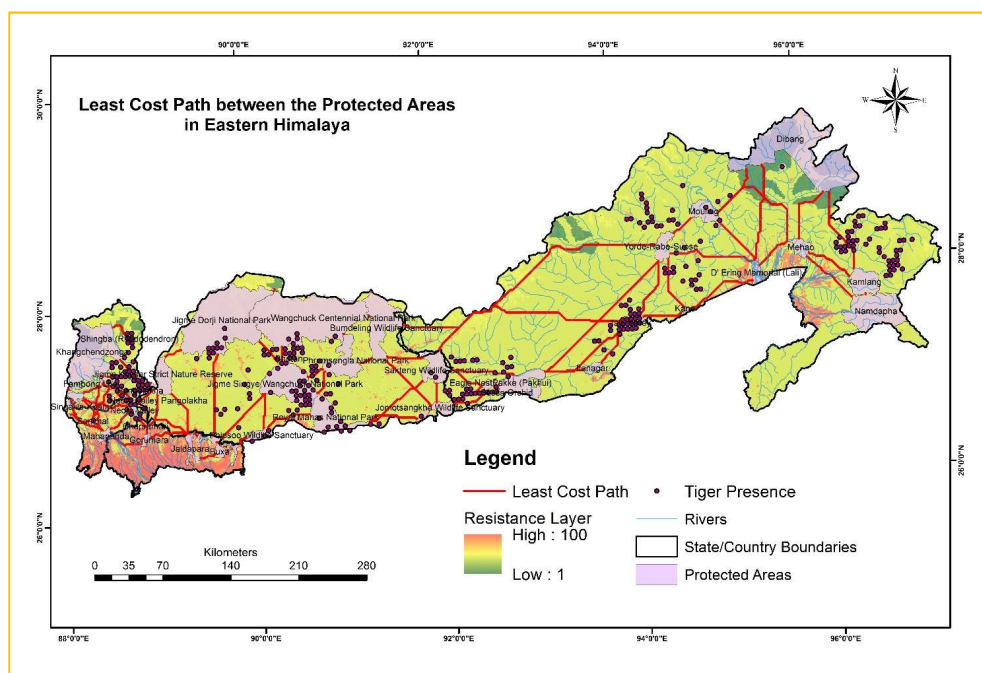


Figure 8.21: Least Cost Path between the Protected Areas in Eastern Himalaya



## *9. Contours of High Altitude Tiger Action Plan for Bhutan, Nepal and India*

---

Landscapes are subjected to transformation over time, and the Himalayan habitats are no exception. Broadly, an in-situ approach for conserving tiger in the high altitude warrants a landscape approach, comprising of:

- wildlife management in protected areas
- ecosystem management in other portions to engage with stakeholders with a focus on local people

The instant situation analysis study has depicted habitat suitability for tigers across two distinct Himalayan zones, viz. Eastern and Western Himalayas, spread over three countries (Bhutan, India and Nepal).

### **Major Attributes of High Altitude Tiger Landscapes**

- Rugged and mountainous habitat
- Mosaic: forests, protected areas, cultivation, settlements, crop land, orchards, hydel projects, surface infrastructure
- Sensitive to intensive land use
- Subjected to environmental stochasticity and man-made disasters
- Human – wildlife conflict ranging from severe to moderate
- Tremendous forest resource dependency
- Ecological significance: glacial health, river flow, and water provisioning for millions of human beings, ecosystem services
- Evolution of traditional practices – agro-pastoral practices

In order to evolve a suggestive roadmap, it is crucial to understand the traditional practices and threats relating to Himalayan ecology, such as:

- Inaccessibility, marginalization, unsustainable development
- Need for fostering water resources, glacial health

- Loss of biodiversity habitat loss, overexploitation, wetland drainage, sprawling of settlements, overall landscape transformation owing to urbanization introduction of exotics, river valley projects, surface infrastructure, industries, agro-pastoral customs, forest fires , mining , natural calamities , poaching and trafficking

Several tiger habitats in such high altitude have connectivity to tiger source areas in the foothills and plains. While the study gives a brief insight into such linkages, in-depth appraisal is required for understanding tiger movement and adaptation in high altitude, vis-à-vis habitat shrinkages in plains, possible tree line progression, luring of carnivores due to pastoral movements, availability of extended habitat at high altitude owing to changes in forest cover.

## **CONTOURS OF SUGGESTED HIGH-ALTITUDE ROADMAP**

The action strategy calls for a high altitude tiger master plan, with gainful portfolio for local communities and ensuring centrality of tiger conservation in development, through an effective coordination mechanism, involving stakeholders and line departments operating within the landscape. In the Indian context, it is pertinent to mention that preparation of a master plan for the Ecologically Sensitive Zone (ESZ) identified under the Environmental legislation is a statutory requirement. Format and advisories issued in the said context would be helpful.

The approach to develop a master plan would necessitate compilation of background information on land use attributes (within and outside protected areas), status of protection, mapping landscape features and incidences of human wildlife interface, assessing resource dependency, identifying line departments and build structured partnerships through MoUs with agencies, including Agriculture, Health and Family welfare, Animal Husbandry, Development Authorities, Revenue, Irrigation, Horticulture, Disaster Management, Electricity and Hydel power Corporation, Infrastructure, Surface Transport, Border Roads Organizations, Business and Industries.

Suggestive actions at each level are indicated below:

- Landscape level:
  - Defining scale and limit
  - Identifying administrative architecture
  - Landscape level monitoring mechanism: steering committee/landscape authority
  - Resource mobilization
  - Intensive monitoring of tigers (deployment of more camera traps, monitoring teams, carrying out seasonal assessments for carnivores and prey)
- Local level:
  - Evolving local microplans
  - Strengthening community stewardship and agreed actions on quid pro quo basis, with gains through Payment for Ecosystem Services – for wildlife monitoring, protection, reporting
  - Training and capacity building of frontline and community stewards
- State level:
  - Enabling regime – ensuring political will and synergies with existing state and central Government schemes/ongoing programmes
  - Funding support
- National level:
  - Linkages with Federal schemes
  - Support and policy
  - Hot spot safeguarding
  - Involving army in sensitive areas
  - Border prosecuting agencies
  - Ecological appraisal
  - Green development
- International:
  - Bilateral cooperation
  - Regional cooperation
  - Transborder protection and Joint Assessments

The suggested high altitude tiger landscapes and linkages to source sites for master planning and implementation of the above actions are:

- a. Valmiki-Chitwan-Annapurna (India-Nepal)
- b. Manas-Royal Manas-Jigme Dorji (India-Bhutan)
- c. Neora Valley – Torsa - Buxa -Phibsu (India-Bhutan)
- d. Askot-Pithoragarh-Nandhaur- Suklaphanta (India-Nepal)
- e. Arunachal-Sikkim-bordering PAs of Bhutan (India-Bhutan)

## 10. Appendices

### Appendix 1: Camera trap results for Uttarakhand

Sr. No.	Date Deployed	District	Forest Division	SUB-GRID ID	Location No.	Elevation (m)	Species Photocaptured	Human Disturbance
1	17/05/19	Rudraprayag	Kedarnath FD	UK17I	1	1813	Humans	Yes
2	17/05/19	Rudraprayag	Kedarnath FD	UK17I	2	1815	Porcupine, Himalayan Black Bear	No
3	18/05/19	Rudraprayag	Kedarnath FD	UK17I	3	1827	Himalayan Langur	No
4	14/05/19	Rudraprayag	Kedarnath FD	UK18G	4	3509	Red Fox, Himalayan Monal, Musk Deer	No
5	15/05/19	Rudraprayag	Kedarnath FD	UK18G	5	3431	Red Fox, Yellow-Throated Marten, Himalayan Monal, Common Leopard, Tiger, Himalayan Serow, Sambar, Humans	Yes
6	5/11/2019	Rudraprayag	Kedarnath FD	UK33G	6	1908	Goral, Barking Deer, Himalayan Black Bear, Wild Boar, Humans	Yes
7	16/05/19	Rudraprayag	Kedarnath FD	UK25E	7	2397	Common Leopard, Sambar, Leopard Cat, Himalayan Langur, Barking Deer, Cattle, Himalayan Black Bear, Dog, Humans, Wild Boar, Red Fox,	Yes
8	5/11/2019	Rudraprayag	Kedarnath FD	UK33H	8	1154	Masked Civet, Yellow-Throated Marten	No
9	5/12/2019	Rudraprayag	Kedarnath FD	UK26G	9	3130	Sambar, Himalayan Monal, Common Leopard	No
10	5/12/2019	Rudraprayag	Kedarnath FD	UK26G	10	2844	Sambar, Himalayan Monal, Mountain Weasel, Common Leopard, Red Fox	No
11	18/05/19	Rudraprayag	Kedarnath FD	UK25I	11	2339	Cattle, Barking Deer, Himalayan Langur, Sambar, Leopard Cat, Wild Boar, Porcupine	No
12	18/05/19	Rudraprayag	Kedarnath FD	UK25I	12	2496	Common Leopard, Cattle, Barking Deer, Sambar, Himalayan Langur, Himalayan Serow, Kalij Pheasant, Rhesus Macaque, Leopard Cat, Yellow-Throated Marten, Wild Boar, Goral, Himalayan Black Bear	No
13	30/04/19	Rudraprayag	Kedarnath FD	UK33A	13	2413	Sambar, Humans, Porcupine, Leopard Cat, Red Fox, Common Leopard, Barking Deer, Himalayan Langur	Yes
14	30/04/19	Rudraprayag	Kedarnath FD	UK33A	14	1787	Humans, Cattle, Sambar	Yes
15	5/1/2019	Rudraprayag	Kedarnath FD	UK33B	15	1812	Himalayan Black Bear, Leopard Cat, Barking Deer, Sambar, Yellow-Throated Marten, Wild Boar, Porcupine, Kalij Pheasant	No

16	5/19/2019	Rudraprayag	Kedarnath FD	UK25B	16	1788	Himalayan Black Bear, Himalayan Serow, Yellow-Throated Marten, Leopard Cat, Porcupine	No
17	21/05/19	Rudraprayag	Kedarnath FD	UK16H	17	2470	Sambar, Humans, Cattle, Barking Deer, Kalij Pheasant, Wild Boar, Porcupine, Himalayan Black Bear, Leopard Cat, Red Fox	Yes
18	21/05/19	Rudraprayag	Kedarnath FD	UK16G	18	2616	Common Leopard, Cattle, Humans, Red Fox, Wild Boar, Dog	Yes
19	22/05/19	Rudraprayag	Kedarnath FD	UK16H	19	1968	Kalij Pheasant, Humans, Porcupine	Yes
20	22/05/19	Rudraprayag	Kedarnath FD	UK16E	20	2661	Cattle, Sambar, Wild Boar	No
21	22/05/19	Rudraprayag	Kedarnath FD	UK16E	21	2581	Humans, Cattle, Red Fox, Kalij Pheasant, Himalayan Black Bear, Leopard Cat, Wild Boar, Barking Deer, Sambar, Porcupine	Yes
22	22/05/19	Rudraprayag	Kedarnath FD	UK16E	22	2599	Humans, Cattle	Yes
23	22/05/19	Rudraprayag	Kedarnath FD	UK16E	23	3136	Leopard Cat, Himalayan Monal, Yellow-Throated Marten, Goral, Himalayan Langur, Sambar, Himalayan Black Bear, Himalayan Tahr, Wild Boar	Yes
24	20/05/19	Rudraprayag	Kedarnath FD	UK25B	24	2602	Red Fox, Yellow-Throated Marten, Humans, Cattle, Porcupine, Masked Civet, Himalayan Langur, Wild Boar	Yes
25	25/05/19	Rudraprayag	Kedarnath FD	UK46H	25	1373	Humans	Yes
26	25/05/19	Rudraprayag	Kedarnath FD	UK46H	26	1243	Cattle, Leopard Cat, Porcupine, Leopard, Humans, Wild Boar, Red Fox	
27	25/05/19	Rudraprayag	Kedarnath FD	UK46H	27	1144	Cattle, Humans	Yes
28	26/05/19	Rudraprayag	Kedarnath FD	UK46B	28	1697	Humans	Yes
29	26/05/19	Rudraprayag	Kedarnath FD	UK46B	29	1721	Goral, Sambar, Serow, Black-naped Hare, Porcupine, Red Fox, Rhesus Macaque, Himalayan langur, Barking Deer,	No
30	28/05/19	Rudraprayag	Kedarnath FD	UK47D	30	1650	Common Leopard, Humans, Rhesus Macaque, Sambar	Yes
31	27/05/19	Rudraprayag	Kedarnath FD	UK43I	31	2522	Serow, Cattle, Humans, Himalayan Black Bear, Wild Boar, Himalayan Langur	Yes
32	27/05/19	Rudraprayag	Kedarnath FD	UK43I	32	2880	Sambar, Goral, Himalayan Langur, Himalayan Black Bear, Cattle, Humans, Wild Boar	Yes
33	6/1/2019	Rudraprayag	Kedarnath FD	UK32F	33	2380	Cattle, Humans	Yes
34	6/1/2019	Rudraprayag	Kedarnath FD	UK32F	34	2058	Cattle, Humans, Goral	Yes
35	30/05/19	Rudraprayag	Kedarnath FD	UK32H	35	2151	Barking Deer, Sambar, Wild Boar	No



36	6/4/2019	Rudraprayag	Kedarnath FD	UK39F	36	1711	Red Fox, Cattle, Common Leopard, Humans, Goral, Macaque, Porcupine, Wild Boar	Yes
37	6/2/2019	Rudraprayag	Kedarnath FD	UK26H	37	3115	Sambar, Humans, Dog, Himalayan Langur, Leopard Cat	Yes
38	6/2/2019	Rudraprayag	Kedarnath FD	UK26H	38	2209	Humans, Dog, Barking Deer, Sambar	Yes
39	6/1/2019	Rudraprayag	Kedarnath FD	UK26I	39	3568	Humans	Yes
40	6/1/2019	Rudraprayag	Kedarnath FD	UK26I	40	3655	Himalayan Langur, Red Fox, Yellow-Throated Marten, Himalayan Tahr, Humans, Sambar, Cattle, Wild Boar	Yes
41	6/7/2019	Rudraprayag	Kedarnath FD	UK39I	41	2046	Cattle, Wild Boar, Barking Deer, Humans, Himalayan Black Bear, Leopard Cat, Sambar, Porcupine	Yes
42	6/7/2019	Rudraprayag	Kedarnath FD	UK39I	42	1952	Wild Boar, Yellow-Throated Marten, Himalayan Black Bear, Common Leopard, Cattle, Humans, Barking Deer	Yes
43	6/7/2019	Rudraprayag	Kedarnath FD	UK43B	43	2387	Humans	Yes
44	6/6/2019	Rudraprayag	Kedarnath FD	UK43B	44	2444	Himalayan Black Bear, Sambar, Wild Boar, Cattle, Humans, Common Leopard, Red Fox, Barking Deer	Yes
45	6/6/2019	Rudraprayag	Kedarnath FD	UK43E	45	1847	Masked Civet, Humans	Yes
46	31/05/19	Rudraprayag	Kedarnath FD	UK33C	46	2354	Humans, Cattle, Barking Deer, Common Leopard	Yes
47	31/05/19	Rudraprayag	Kedarnath FD	UK33C	47	2612	Humans, Cattle, Himalayan Langur, Goral, Yellow-Throated Marten, Humans, Common Leopard, Himalayan Black Bear, Wild Boar	Yes
48	28/05/19	Rudraprayag	Kedarnath FD	UK25E	48	2612	Common Leopard, Sambar, Himalayan Langur, Barking Deer, Himalayan Black Bear, Leopard Cat, Cattle, Wild Boar, Humans	Yes
49	27/05/19	Rudraprayag	Kedarnath FD	UK25F	49	3790	Sambar, Red Fox, Himalayan Monal, Domestic goats	No
50	27/05/19	Rudraprayag	Kedarnath FD	UK25F	50	3816	Humans, Dog, Cattle	Yes
51	28/05/19	Rudraprayag	Kedarnath FD	UK25C	51	3217	Sambar, Cattle, Humans, Wild Boar, Common Leopard	Yes
52	24/05/19	Rudraprayag	Kedarnath FD	UK25I	52	2762	Leopard Cat, Sambar, Himalayan Langur, Barking Deer, Cattle, Wild Boar, Humans	Yes
53	24/05/19	Rudraprayag	Kedarnath FD	UK25I	53	2677	Porcupine, Cattle, Himalayan Langur, Barking Deer	No
54	6/8/2019	Rudraprayag	Kedarnath FD	UK39I	54	2095	Common Leopard, Humas, Kalij Pheasant, humans	Yes
55	6/8/2019	Rudraprayag	Kedarnath FD	UK39I	55	1996	Monitor Lizard, Red Fox, Goral, Common Leopard	No

1	3/10/2019	Yamunotri	Tons FD	UY1I	1	1959	Leopard Cat, Masked Civet, Goat, Humans	Yes
2	3/19/2019	Yamunotri	Tons FD	UY4E	2	1534	Yellow Throated Marten, Masked Civet, Humans, Cattle	Yes
3	3/10/2019	Yamunotri	Tons FD	UY4G	3	1660	Common Leopard, Cattle, Humans, Red Fox	Yes
4	3/10/2019	Yamunotri	Tons FD	UY4G	4	1435	Common Leopard, Cattle, Humans, Jackal, Porcupine, Himalayan Black Bear	Yes
5	3/17/2019	Yamunotri	Tons FD	UY16A	5	1530	Goral, Goat, Humans, Himalayan Langur, Porcupine	Yes
6	3/16/2019	Yamunotri	Tons FD	UY16C	6	2102	Masked Civet, Cattle, Humans	Yes
1	3/9/2019	Pitthoragarh	Pitthoragarh FD	UNSK77A	1	1876	Cattle, Humans, Dog	Yes
2	3/9/2019	Pitthoragarh	Pitthoragarh FD	UNSK77A	2	1880	Leopard Cat, Barking Deer, Humans, Kalij Pheasant, Common Leopard, Cattle, Black-naped Hare	Yes
3	3/12/2019	Pitthoragarh	Pitthoragarh FD	UNSK77D	3	2166	Wild Boar, Sambar, Common Leopard, Barking Deer, Black-naped Hare, Goral, Humans, Cattle	Yes
4	3/12/2019	Pitthoragarh	Pitthoragarh FD	UNSK77D	4	2040	Masked Civet, Humans, Barking Deer, Kalij Pheasant, Wild Boar, Himalayan Langur, Cattle	Yes
5	3/16/2019	Pitthoragarh	Pitthoragarh FD	UNSK76F	5	1676	Red Fox, Rhesus Macaque, Cattle, Jackal, Jungle Cat, Masked Civet, Porcupine, Humans, Common Leopard	Yes
1	4/26/2019	Yamunotri	Badkot FD	UY12G	1	2465	Porcupine, Cattle, Red Fox, Barking Deer, Yellow-Throated Marten, Humans	Yes
2	4/26/2019	Yamunotri	Badkot FD	UY12G	2	2465	Humans, Cattle, Mule, Horse, Dog, Red Fox, Yellow Throated Marten	Yes
3	4/26/2019	Yamunotri	Badkot FD	UY12G	3	2239	Cattle, Humans, Barking Deer	Yes
4	4/26/2019	Yamunotri	Badkot FD	UY12G	4	2239	Cattle	No
5	4/27/2019	Yamunotri	Badkot FD	UY16D	5	1480	Humans, Cattle, Mule, Leopard, Red Fox, Dog, Rhesus Macaque, Bird	Yes
6	4/27/2019	Yamunotri	Badkot FD	UY16D	6	1480	Humans, Cattle, Mule, Leopard, Red Fox, Dog, Rhesus Macaque, Porcupine, Horse, Jungle Cat	Yes
7	4/27/2019	Yamunotri	Badkot FD	UY16D	7	1320	Leopard, Cattle, Human, Rhesus Macaque	Yes

8	5/2/2019	Yamunotri	Badkot FD	UY17E	8	2283	Red Fox, Human, Cattle, Wild boar, Bird, Dog, Himalayan Langur	Yes
9	5/2/2019	Yamunotri	Badkot FD	UY17E	9	2283	Human, Dog, Cattle, Horse, Red Fox, Leopard, Himalayan Black Bear, Mule, Himalayan Langur, Macaque, Indian Wolf, Yellow Throated Marten, Jungle Cat	Yes
10	5/2/2019	Yamunotri	Badkot FD	UY17E	10	2088	Red Fox	No
11	4/28/2019	Yamunotri	Badkot FD	UY17G	11	2260	Humans, Cattle, Kalij pheasant	Yes
12	4/28/2019	Yamunotri	Badkot FD	UY17G	12	2260	Humans, Cattle, Mule	Yes
13	4/28/2019	Yamunotri	Badkot FD	UY17G	13	2212	Humans, Cattle, Kalij pheasant, Dog, Red fox, Horse, Mule	Yes
14	4/28/2019	Yamunotri	Badkot FD	UY17G	14	2212	Humans, Cattle, Red Fox	Yes

## Appendix 2: Camera Trap Results for Sikkim

Sr. No.	Date Deployed	District	Forest Division	Sub-Grid ID	Location No.	Elevation (m)	Species Photocaptured	Human Disturbance
1	29-04-2019	East Sikkim District	East Sikkim TD (Territorial Division)	SE7D	1	2393	Red Panda, Masked Palm Civet, Large India Civet, Assamese Macaque, Steppe Eagle, Cattle, Barking Deer, Yellow Throated Marten, Humans	Yes
2	14-04-2019	East Sikkim District	East Sikkim WLD	SE7I	2	2624	Musk Deer, Barking Deer, Himalayan Serow, Wild Boar, Yellow Troated Marten, Marbled Cat, Satyr Tragopan, Wild Dog,	?
3	14-04-2019	East Sikkim District	East Sikkim WLD	SE7I	3	2439	Black Bear, Barking Deer, Yellow Throated Marten, Spotted Lingsang, Marbled Cat	Yes
4	13-04-2019	East Sikkim District	East Sikkim WLD	SE8G	4	2718	Yellow Throated Marten, Barking Deer, Mithoon, Marbled Cat, Satyr Tragopabn	?
5	10-04-2019	East Sikkim District	East Sikkim WLD	SE8G	5	2265	Wild Boar, Golden Cat, Barking Deer, Goral, Human	?
6	20-04-2019	East Sikkim District	East Sikkim WLD	SE12C	6	2039	Cattle, Human, Himalayan Serow, Masked Palm Civet, Porcupine, Black Bear, Leopard Cat	?
7	20-04-2019	East Sikkim District	East Sikkim WLD	SE12C	7	2264	Golden Cat, Barking Deer, Cattle, Humans, Marbled Cat, Golden Cat	?

### Appendix 3: Camera Trap Results for West Bengal

Sr. No.	Date Deployed	District	Forest Division	SUB-GRID ID	Location No.	Elevation (m)	Species Photo captured	Human Disturbance
1	11-04-2019	Kalimpong	Gorumara WLD	WD14F	1	961	Wild Dog, Human, Dog, Cattle, Assamese Macaque	Yes
2	11-04-2019	Kalimpong	Gorumara WLD	WD14F	2	900	Cattle, Barking Deer, Masked Palm Civet, Assamese Macaque, Human, Wild Boar	Yes
3	17-04-2019	Darjeeling	Darjeeling WLD	WD11E	3	2341	Barking Deer	?
4	17-04-2019	Darjeeling	Darjeeling WLD	WD11E	4	2307	Common Leopard, Barking Deer, Kalij Pheasant, Leopard Cat, Masked Palm Civet, Large Indian Civet	?
5	24-04-2019	Kalimpong	Gorumara WLD	WD7F	5	2936	Mithun, Barking Deer, Cattle, Satyr Tragopan	?
6	24-04-2019	Kalimpong	Gorumara WLD	WD7F	6	3015	Mithun, Human, Cattle	Yes
7	30-04-2019	Kalimpong	Gorumara WLD	WD7I	7	2298	Barking Deer, Human, Himalayan Serow	Yes
8	30-04-2019	Kalimpong	Gorumara WLD	WD7I	8	2320	Wild Boar, Yellow Throated Marten	?
9	01-05-2019	Kalimpong	Gorumara WLD	WD7E	9	2643	Barking Deer, Human, Dog, Masked Palm Civet	Yes
10	01-05-2019	Kalimpong	Gorumara WLD	WD7E	10	2474	Barking Deer, Human, Yellow Throated Marten, Satyr Tragopan, Leopard Cat	Yes

### Appendix 4: Camera Trap Results for Arunachal Pradesh

Sr. No.	Date Deployed	District	Forest Division	SUB-GRID ID	Location No.	Elevation (m)	Species Photo captured	Human Disturbance
1	19-03-2019	Upper Siang	Yingkiong FD	AY34H	1	1202	Wild Boar, Mithun, Barking Deer, Large Indian Civet, Cattle, Human	Yes
2	19-03-2019	Upper Siang	Yingkiong FD	AY34G	2	1254	Wild Boar, Mithun, Barking Deer, Marbled Cat, Dog, Cattle	Yes
3	26-03-2019	Upper Siang	Yingkiong FD	AY46G	3	1117	Mithun, Human	Yes
4	26-03-2019	Upper Siang	Yingkiong FD	AY46G	4	1383	Large Indian Civet, Leopard Cat, Yellow Throated Marten, Mithun	?
5	28-03-2019	Upper Siang	Yingkiong FD	AY40F	5	1109	Mithun, Yellow Throated Marten, Wild Dog, Large Indian Civet, Leopard Cat, Kalij Pheasant, Marbled Cat, Golden Cat, Dog, Human	Yes

6	28-03-2019	Upper Siang	Yingkiong FD	AY40F	6	2003	Mithun, Large Indian Civet, Pack of Wild Dogs	Yes
7	28-03-2019	Upper Siang	Yingkiong FD	AY40C	7	2094	Mithun, Asiatic Black Bear, Asiatic Golden Cat, Human	Yes
8	28-03-2019	Upper Siang	Yingkiong FD	AY40C	8	2117	Mithun, Barking Deer, Human	Yes
9	05-04-2019	Upper Siang	Yingkiong FD	AY45E	9	1453	Mithun, Wild Dog, Kalij Pheasant, Yellow Throated Marten, Leopard Cat, Large Indian Civet, Barking Deer, Porcupine, Wild Boar, Human	Yes
10	23-04-2019	Upper Siang	Yingkiong FD	AY45D	10	1230	Wild Boar, Golden Cat, Human	Yes
11	25-04-2019	Upper Siang	Yingkiong FD	AY44B	11	1607	Mithun, Barking Deer, Human	Yes
12	25-04-2019	Upper Siang	Yingkiong FD	AY44B	12	1507	Mithun, Asiatic Black Bear, Yellow Throated Marten	?
1	05-04-2019	Upper Siang	Mouling WLD	AY45E	1	1782	Mithun, Pack of Wild Dogs, Asiatic Black Bear, Masked Civet, Golden Cat, Clouded Leopard, Human	Yes
2	23-04-2019	Upper Siang	Mouling WLD	AY45A	2	1680	Spotted Linsang, Golden Cat	?
1	22-04-2019	West Siang	Along FD	AAL35I	1	521	Mithun, Barking Deer	Yes
2	22-04-2019	West Siang	Along FD	AAL35I	2	508	Mithun, Barking Deer, Porcupine	Yes
3	23-04-2019	West Siang	Along FD	AAL40I	3	1127	Asiatic Black Bear, Asiatic Wild Dog	Yes
4	23-04-2019	West Siang	Along FD	AAL40I	4	1192	Mithun, Asiatic Black Bear	Yes
5	24-04-2019	West Siang	Along FD	AAL35C	5	626	Mithun, Barking Deer, Yellow throated Marten, Himalayan Palm Civet	Yes
6	24-04-2019	West Siang	Along FD	AAL35C	6	850	Porcupine, Mithun, Leopard Cat, Kalij Pheasant	Yes
7	26-05-2019	West Siang	Along FD	AY45F	7	1497	Sambar Deer, Barking Deer, Human	Yes
8	26-05-2019	West Siang	Along FD	AY45F	8	1417	Barking Deer	?
9	04-06-2019	West Siang	Along FD	AAL20D	9	2627	Dog	Yes
10	06-06-2019	West Siang	Along FD	AAL19F	10	2389	Mithun, Cattle	Yes
11	06-06-2019	West Siang	Along FD	AAL19F	11	2416	Mithun, Cattle, Human	Yes
12	06-06-2019	West Siang	Along FD	AAL43B	12	2089	No animals captured	Yes
13	09-06-2019	West Siang	Along FD	AAL14D	13	2474	Red Panda, Mithun, Cattle	Yes
14	09-06-2019	West Siang	Along FD	AAL14D	14	2733	Wild Boar, Kalij Pheasant, Dog, Human	Yes
15	10-06-2019	West Siang	Along FD	AAL14G	15	2315	Dog, Human	Yes
16	11-06-2019	West Siang	Along FD	AAL21A	16	1733	Masked Palm Civet, Kalij Pheasant	Yes
17	11-06-2019	West Siang	Along FD	AAL21A	17	1496	Barking Deer	Yes



1	02-05-2019	West Kameng	Shergaon FD	AS8G	1	2370	Barking Deer	Yes
2	02-05-2019	West Kameng	Shergaon FD	AS7H	2	2288	Barking Deer	Yes
3	02-05-2019	West Kameng	Shergaon FD	AS7H	3	2187	Barking Deer	Yes
4	02-05-2019	West Kameng	Shergaon FD	AS7I	4	2087	Mithun, Large Indian Civet, Leopard Cat, Yellow Throated Marten, Cattle	Yes
5	03-05-2019	West Kameng	Shergaon FD	AS6I	5	979	Leopard Cat, Wild Boar, Barking Deer, Bat	Yes
6	12-05-2019	West Kameng	Bomdila FD	AB13G	6	2894	Barking Deer	?
7	12-05-2019	West Kameng	Bomdila FD	AB13G	7	3280	Barking Deer, Yellow Throated Marten, Red Panda	?
8	15-05-2019	West Kameng	Bomdila FD	AB12C	8	2717	Barking Deer, Goral, Human	?
9	15-05-2019	West Kameng	Bomdila FD	AB12C	9	2547	Barking Deer	?
10	16-05-2019	West Kameng	Bomdila FD	AB20A	10	3361	Red Panda, Barking Deer	?
11	04-06-2019	West Kameng	EagleNest WLS	AE5D	11	750	Barking Deer	Yes
12	26-05-2019	West Kameng	Shergaon FD	AS9D	12	2772	Yellow Throated Marten, Barking Deer, Asian Elephant	Yes
13	26-05-2019	West Kameng	EagleNest WLS	AE2G	13	2536	Mithun	Yes
14	04-06-2019	West Kameng	EagleNest WLS	AE4C	14	956	Mithun	?

## Appendix 5: Camera Trap Deployed in Forest Divisions of Nepal

Serial no.	Date Deployed	District	Municipality	Location no.	Elevation	Capture Species	Human Disturbance
1	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	1	2205	Barking Deer	No
2	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	2	2103	Wild boar	Yes
3	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	3	1987	Jungle Cat, Yellow Throated Martin, Wildboar, Common Leopard	Yes
4	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	4	2139	Golden Jackal, Fox	Yes
5	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	5	2282		Yes
6	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	6	2217		Yes
7	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	8	2320		Yes
8	15/12/2018	Dadeldhura	Amargadi Municipality-7	9	1989	Barking Deer, Jungle Cat	Yes
9	15/12/2018	Dadeldhura	Ajayameru Rural Municipality-2	10	2194	Wild boar	Yes
10	15/12/2018	Dadeldhura	Amargadi Municipality-7	11	2250	Barking Deer	Yes
11	15/12/2018	Dadeldhura	Amargadi Municipality-7	12	2075	Barking Deer	Yes
12	17/12/2018	Baitadi	Shivnath Rural Municipality-5	13	2012		Yes
13	17/12/2019	Baitadi	Pancheshwar Rural Municipality-4	14	1492		Yes

14	17/12/2020	Baitadi	Pancheshwar Rural Municipality-4	15	1738		No
15	17/12/2021	Baitadi	Shivnath Rural Municipality-5	16	1882		Yes
16	17/12/2022	Baitadi	Pancheshwar Rural Municipality-3	17	1887		Yes
17	17/12/2023	Baitadi	Pancheshwar Rural Municipality-3	18	1816		Yes
18	17/12/2024	Baitadi	Shivnath Rural Municipality-5	19	1898	Red Fox	Yes
19	17/12/2025	Baitadi	Shivnath Rural Municipality-5	20	1860		Yes
20	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-3	20B	2171		Yes
21	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-3	21	2051	Wild boar	Yes
22	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	22	2049		Yes
23	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	23	1919		Yes
24	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	24	1848		Yes
25	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	25	1725	Golden Jackal	Yes
26	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	26	1929		Yes
27	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-3	27	2042		Yes
28	22/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	28	2063		Yes
29	23/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	29	2098	Barking Deer	Yes
30	23/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	30	2084		Yes
31	23/12/2018	Dadeldhura	Ajayameru Rural Municipality-4	31	2047		Yes

## Appendix 6: Camera Trap Deployed in Forest Divisions of Bhutan

Sr No.	Date Deployed	District	Municipality	Location no.	Elevation (m)	Capture Species	Human Disturbance
1	30/08/2018	Paro	Paro	1	4111	Blue Sheep, Himalayan Black bear, Snow Leopard	Yes
2	29/08/2018	Paro	Paro	2	3519	Lost the Camera	
3	31/8/2018	Paro	Paro	3	3044	Lost the Camera	
4	30/8/2018	Paro	Paro	4	2684	Mountjack, Himalayan Serow	Yes
5	30/08/2018	Paro	Paro	5	3116	Leopard Cat, Marble Cat,	Yes
6	29/08/2018	Paro	Paro	6	2305	Barking Deer, Himalayan Serow, Sambar, Wild boar, Yello Throated Martin	Yes
7	30/8/2018	Paro	Paro	7	3026	Barking Deer, Himalayan Serow, Sambar, Wild boar	Yes
8	09-01-2018	Paro	Paro	8	2307	Barking Deer, Common Loepard, Marble cat, Musk deer, Yellow Throated Martin, Fox Himalayan Serow, Sambar, Wild boar, Dhole. Jungle cat	Yes
9	09-02-2018	Paro	Paro	9	3822	Barking Deer, Himalayan Serow, Sambar, Wild Boar	Yes
10		Paro	Paro	10	3370	Lost the Camera	
11		Paro	Paro	11	3326	Barking Deer, Dhole Himalayan Serow, Yellow Throated Martin	Yes
12	26/08/2019	Paro	Paro	12	2747	Harking deer, Wild Boar	Yes
13	27/8/2018	Paro	Paro	13	2289	Barking Deer, Himalayan Black Bear, Wild Boar	Yes
14	27/8/2018	Paro	Paro	14	2309	Barking Deer, Himalayan Black bear, Wild Boar, Yellow Throated Martin	Yes
15	28/8/2018	Paro	Paro	15	2307	Dhole, Hialayan Serow, Wild Boar,	Yes

16	30/8/2018	Paro	Paro	16	2368	Barking Deer, Samber, Musk Deer, Himalayan serow	Yes
17	29/08/2018	Paro	Paro	17	2309	Barking Deer, Dhole, Samber, Himalayan Serow, Jungle Cat, Marble Cat, Fox, Wild Boar, Yellow Throated Martin	Yes
18	09-05-2018	Paro	Paro	18	2938	Barking Deer, Samber, Himalayan Black Bear, Dhole, Golden Cat, Wild Boar, Yellow Throated Martin.	No
19	09-05-2018	Paro	Paro	19	3076	Dhole, Golden Cat, Himalayan Serow, Samber, Wild Boar, Himalayan Black Bear. Marble Cat	No
20	09-06-2018	Paro	Paro	20	2871	Marble Cat, Himalayan Black Bear, Wild Boar.	Yes
21	09-06-2018	Paro	Paro	21	2196	Fox, Wild Pig.	Yes

Sr. No.	Date Deployed	District	Municipality	Location	Location no.	Elevation (m)	Capture Species	Human Disturbance
1	02-11-2019	Wangdi	Wangdi	WCNP&JSWNP Corridor	1a	4038	Golden Cat, Tiger	Yes
2	02-11-2019	Wangdi		WCNP&JSWNP Corridor	1b	4034	Golden Cat, Tiger	Yes
3	18/2/2019	Wangdi		WCNP&JSWNP Corridor	3	3559	Bear, Himalayan Serow, Tiger	Yes
4	02-06-2019	Wangdi		WCNP&JSWNP Corridor	3	3706	Bear	Yes
5	17/2/2019	Wangdi		Phobjilha	5	4027	Musk Deer	Yes
6	23/2/2019	Wangdi		Phobjilha	2	3802	Dhole	Yes
7	15/2/2019	Wangdi		Gogona	6	4067	Musk Deer, Himalayan Serow	Yes
8	19/2/2019	Wangdi		Phobjilha	9	3679	Nil	Yes
9	20/2/2019	Wangdi		JSWNP Buffer	8	3717	Golden Cat, Red Panda, Himalayan Serow, Marble cat	Yes
10	27/2/2019	Wangdi		JSWNP Buffer	14	3039	Bear, Himalayan Serow, Tiger, Red Panda, Wild Boar	No

## Appendix 7: Areas with historic or recent tiger presence (Questionnaire Survey)

Sr No.	CIRCLE	DIVISION	NEW_RANGE
1	Bhagirathi Circle	Narendranagar Forest Division	Maniknath Range
2	Bhagirathi Circle	Tehri Forest Division	Bhilangana Range
3	Bhagirathi Circle	Tehri Forest Division	Paukhal Range
4	Bhagirathi Circle	Tehri Forest Division	Lambgaon Range
5	Bhagirathi Circle	Uttarakashi Forest Division	Dharasu Range
6	Bhagirathi Circle	Tehri Forest Division	Balganga Range
7	Bhagirathi Circle	Uttarakashi Forest Division	Dunda Range
8	Bhagirathi Circle	Uttarakashi Forest Division	Mukhem Range
9	Bhagirathi Circle	Uttarakashi Forest Division	Badahat Range
10	Bhagirathi Circle	Uttarakashi Forest Division	Taknaur Range
11	Bhagirathi Circle	Gangotri National Park	Gangotri National Park
12	Bhagirathi Circle	Uttarakashi Forest Division	Gangotri Range
13	Garhwal Circle	Garhwal Forest Division	Diba Range
14	Garhwal Circle	Garhwal Forest Division	Pokhra Range

15	Garhwal Circle	Badrinath Forest Division	Pindar Central Range
16	Garhwal Circle	Garhwal Forest Division	Pauri Range
17	Garhwal Circle	Rudraprayag Forest Division	Rudraprayag Range
18	Garhwal Circle	Rudraprayag Forest Division	South_Jakholi Range
19	North Kumaon Circle	Champawat Forest Division	Dogadi Range
20	North Kumaon Circle	Champawat Forest Division	Boom Range
21	North Kumaon Circle	Champawat Forest Division	Bhingrara Range
22	North Kumaon Circle	Champawat Forest Division	Champawat Range
23	North Kumaon Circle	Champawat Forest Division	Debidhura Range
24	North Kumaon Circle	Champawat Forest Division	Kali Kumaon Range
25	North Kumaon Circle	Pithoragarh Forest Division	Gangolihat Range
26	North Kumaon Circle	Pithoragarh Forest Division	Pithoragarh Range
27	North Kumaon Circle	Almora Forest Division	Mohan Range
28	North Kumaon Circle	Almora Forest Division	Almora Range
29	North Kumaon Circle	Civil Soyam Almora	Jageshwar Range
30	North Kumaon Circle	Almora Forest Division	Jaurasi Range
31	North Kumaon Circle	Civil Soyam Almora	Kanarichina Range
32	North Kumaon Circle	Bageshwar	Bageshwar Range
33	North Kumaon Circle	Pithoragarh Forest Division	Askot Range
34	North Kumaon Circle	Pithoragarh Forest Division	Didihat Range
35	North Kumaon Circle	Almora Forest Division	Dwaraghat Range
36	North Kumaon Circle	Bageshwar	Dharamgarh Range
37	North Kumaon Circle	Bageshwar	Kapkot Range
38	North Kumaon Circle	Pithoragarh Forest Division	Berinag Range
39	North Kumaon Circle	Bageshwar	Bajinath Range
40	North Kumaon Circle	Bageshwar	Garhkheth Range
41	North Kumaon Circle	Pithoragarh Forest Division	Munsyari Range
42	South Kumaon Circle	Nainital Forest Division	Barhon Range
43	South Kumaon Circle	Nainital Forest Division	Manora Range
44	South Kumaon Circle	Nainital Forest Division	Bhowali Range
45	South Kumaon Circle	Nainital Forest Division	South Gola Range
46	South Kumaon Circle	Nainital Forest Division	Naina Range
47	Nanda Devi Circle	Kedarnath Wildlife Division	Lohba Range
48	Nanda Devi Circle	Kedarnath Wildlife Division	Dhanpur Range
49	Nanda Devi Circle	Kedarnath Wildlife Division	Nagnath Range
50	Nanda Devi Circle	Kedarnath Wildlife Division	Gopeshwar Range
51	Nanda Devi Circle	Kedarnath Wildlife Division	Ukhimath Range
52	Yamuna Circle	Chakrata Forest Division	River Range
53	Yamuna Circle	Upper Yamuna Barkot Forest Division	Mugarsanti Range
54	Yamuna Circle	Upper Yamuna Barkot Forest Division	Naugaon Range
55	Yamuna Circle	Tons Forest Division	Purola Range
56	Yamuna Circle	Chakrata Forest Division	Bawar Range
57	Yamuna Circle	Upper Yamuna Barkot Forest Division	Kuthnaur Range
58	Yamuna Circle	Chakrata Forest Division	Deoghar Range
59	Yamuna Circle	Tons Forest Division	Devta Range
60	Yamuna Circle	Tons Forest Division	Singtoor Range

61	Yamuna Circle	Tons Forest Division	Kotigard Range
62	Yamuna Circle	Tons Forest Division	Sandra Range

## Appendix 8: Project related Capacity Building Workshops conducted by WWF-India

States	Forest Divisions	Personnel Trained for Questionnaire Survey	Personnel Trained for Field Survey	No. of Divisions wherein Field Survey was conducted
Uttarakhand	17	457	NA	NA
Uttarakhand	4	NA	144	4
Sikkim	8	65	65	3
North Bengal	2	79	79	2
Arunachal Pradesh	9	88	88	9



## Appendix 9: Survey Forms

### High Altitude Tiger Project: Questionnaire Survey for traditional and expert knowledge on tiger presence

(to be collected by forest staff/project personnel)

Country: State/Province:

District/Division: Team & Organization:

Date: Village name: Name of respondent:

Age: Gender: Position/Designation:

Human population in the village: Livestock population in the village:

Dominant Community:

Human wildlife conflict: Y/N If Y then with what species:

Poaching: Y/N If Y then with what species

Dominant land use: Agriculture/Forestry/Pastoral

If Agriculture, then dominant crop: Pastoralists have shepherd dogs? Y/N

Whether tiger has been recorded historically?

When was the tiger evidence (direct or indirect sign) obtained? In Month or in Year

Has there been any evidence of tiger breeding? Seen with cubs?

How often the evidence has been found? Occasionally/Regularly

What are the other wildlife species that are found in this area? Mark tick for all relevant species.

Carnivores	Snow leopard	Common leopard	Black Bear	Brown Bear	Wolf
	Jackal	Red Fox	Yellow Throated Marten		
Ungulates	Sambar	Chital	Barking Deer	Goral	Himalayan Tahr
	Bharal	Wild Pig	Serow	gaur	
Other Mammals	Himalayan Langur	Rhesus Macaque	Porcupine		

Do people in this village consume meat? Y/NO

What are the sources of meat? Domesticated animals or Bushmeat

What is general awareness of wildlife in the area?

[Signature]

### **High Altitude Tiger Project: Data Sheet for Tiger, Co-Predator, and Prey Occupancy Survey**

Country:

State/Province:

District/Division:

Grid ID:

Locality Name:

Name of the Trail:

Team & Organization:

Date:

Start time:

End time:

Trail Segment (km)	Latitude (DD)	Longitude (DD)	Tiger	Leopard*	Black Bear	Brown Bear	Other Carnivore	Sambar	Barking Deer	Wild Pig	Serow	Goral	Langur	Macaque	Other Prey	Remarks
0.0																
0.5																
1.0																
1.5																
2.0																
2.5																
3.0																
3.5																
4.0																
4.5																
5.0																

\* If the identity of Common leopard or Snow leopard could be made, it can be mentioned as CL or SN. Otherwise, mark presence/absence.

Whether there has been any past record/report of tiger in the locality? Yes or No

When was the last record of tiger?

What was the season?

Any other information on the potential or actual presence of tiger in the locality:

## High Altitude Tiger Project: (B) Data Sheet for Habitat Assessment during Occupancy Survey

Country: \_\_\_\_\_ State/Province: \_\_\_\_\_  
 District/Division: \_\_\_\_\_ Grid ID: \_\_\_\_\_  
 Locality Name: \_\_\_\_\_ Name of the Trail: \_\_\_\_\_  
 Team & Organization: \_\_\_\_\_

Date: \_\_\_\_\_ Start time: \_\_\_\_\_ End time: \_\_\_\_\_

Train Segment ID	Elevation	Slope	Aspect	Dominant Vegetation	Canopy Cover %	Tree Cover %	Shrub Cover %	Grass Cover %	Disturbance	Remarks
0.0										
0.5										
1.0										
1.5										
2.0										
2.5										
3.0										
3.5										
4.0										
4.5										
5.0										

Disturbance: L = Livestock/Goat/Sheep      C = Wood Cutting/Lopping      H = Human

Note: Record finer details of around tiger presence if encountered (both direct and indirect signs) during the survey and collect GPS coordinates for each of the observation.

[Signature]

## Appendix 10: References

- Adhikarimayum, A.S., Gopi, G.V. (2018). First photographic record of tiger presence at higher altitude of Mishmi Hills in Eastern Himalaya biodiversity hotspot, Arunachal Pradesh, India. *Journal of Threatened Taxa*, 10(13):12833-12836
- Aiyadurai, A. (2012). Bird hunting in Mishmi Hills of Arunachal Pradesh, North Eastern India. *Indian Birds Volume*, 7(5): 134-137
- Aiyadurai, A. (2016). Tigers are Our Brothers' Understanding Human-Nature Relations in the Mishmi Hills, Northeast India. *Conservation and Society*, 14(4): 305-316
- Aiyadurai, A., Sing, N., Milner, E.J. (2010). Wildlife Hunting by indigenous tribes: A case study from Arunachal Pradesh. *Oryx*, 1-9
- Arunachalam, A. *et.al.* (2004). Anthropogenic threats and biodiversity conservation in Namdapha nature reserve in the Indian Eastern Himalayas. *Current Science*. 87(4): 447-453
- Aryal, A., Subedi, A. (2011). Conservation and potential habitat of Himalayan musk deer *Moschus chrysogaster* in the protected areas of Nepal. *International Journal of Conservation Science*, 2(2):127-141
- Balson, W. (1976). Survey of the Royal Suklaphanta Wildlife Reserve.
- Bhattacharya, A., Bilal, H. (2016). Highest elevation record of tiger presence from India. *CATnews*, 64, 24
- Bhutia, K.D. (2018). Foxes, Yetis, and Bulls as Lamas: Human-Animal Interactions as a Resource for Exploring Buddhist Ethics in Sikkim. *Journal of Buddhist Ethics*, 25: 45-69 ISSN 1076-9005
- Centre for Inter-disciplinary Studies of Mountain and Hill Environment (2005). Carrying Capacity study of Teesta Basin in Sikkim. Biological Environment - Terrestrial and Aquatic Environment, VI: 250
- Chen, P.J., Gao, Y.F., Wang, J., Pu, Q., Lhaba, C., Hu, H.J., Xu, J., Shi, K. (2017). Status and conservation of the endangered snow leopard *Panthera uncia* in Qomolangma National Nature Reserve, Tibet. *Oryx*, 51(4):590–593
- Chetri, M., Odden, M., Sharma, K., Flagstad, Ø., Wegge, P. (2019). Estimating snow leopard density using fecal DNA in a large landscape in north-central Nepal. *Global Ecol. Conserv.*, 17, e00548
- Chetri, M., Odden, M., Wegge, P. (2017). Snow leopard and Himalayan wolf: food habits and prey selection in the central Himalayas, Nepal. *PLoS One*, 12(2): e0170549
- Chutia, P., (2010). Studies on Hunting and Conservation of Wildlife Species in Arunachal Pradesh, *Sibcoltejo* 5:56-67
- Dash, A.J. (1947). Bengal District Gazetteers Darjeeling

Datta, A. (1998). Hornbill abundance in unlogged forest, selectively logged forest, and a forest plantation in Arunachal Pradesh. *Oryx*, 32: 285-294

Datta, A., et al. (2008) Occurrence and conservation status of small carnivores in two protected areas in Arunachal Pradesh, North-east India. *Small carnivore conservation*, 39: 1-10

Datta, A., et.al (2008). Empty forests: Large carnivore and prey abundance in Namdapha National Park, north-east India. *Biological Conservation*, 141: 1429-1435

Datta, A., Goyal, S.P. (2008). Responses of diurnal tree squirrels to selective logging in Western Arunachal Pradesh. *Current Science*, 95(7): 00113891

Devi Prasad Gupta (1982). Working plan for East Almora FD, Kumaon Circle, U.P.(1980-81 to 1989-90), 41.

Dhakal, M., Karki, M., Jnawali, S.R., Subedi, N., Pradhan, N.M.B., Malla, S. et al. (2014). Status of Tigers and Prey in Nepal. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal

Dhendup, T. (2017, July 27) High hopes for the Mountain Tigers of Bhutan. Retrieved from <https://www.iucn.org/news/species/201707/high-hopes-mountain-tigers-bhutan> on 16<sup>th</sup> June, 2019

Dutt, S.K. (2007). Management Plans for the Almora Forest Division, North Kumaon, U.P.(2006-07 to 2015-16), 90

Dutta, T., Sharma, S., McRae, B. H., Roy, P. S., & DeFries, R. (2016). Connecting the dots: mapping habitat connectivity for tigers in central India. *Regional Environmental Change*, 16(1), 53-67

Dwivedi, B.N. (1978). Working plan for the Nainital Forest Division, Kumaon Circle, U.P. (1978-79 to 1987-88), 54

Ghimirey, Y., Acharya, R. (2018). The Vulnerable clouded leopard *Neofelis nebulosa* in Nepal: an update. *Oryx*, 52(1): 166-170

Gopi, G.V., Jhala, Y.V., Qureshi, Q. (2014). The rapid survey of Tigers and prey in Dibang valley district, Arunachal Pradesh, India. Technical Report. National Tiger Conservation Authority, New Delhi. TR 2014/001: 32

Green, M.J.B. (1993). *Nature reserves of the Himalaya and the mountains of Central Asia*. IUCN, Cambridge and Gland.

Karki, J. (1999). Status Paper of Langtang National Park *Grassland Ecology and management in Protected Areas of Nepal*, 3: 121-132

Gupta, A.C. (1958). Gorumara Game Sanctuary. *Journal of the Bengal Natural History Society*, 29(4): 134-138

Gupta, R.D. (1971). Working Plan for the Pithoraghar Forest Division, Kumaon Circle, U.P.(1968-69 to 1977-78), 50.

Holeyachi, B.S. (2014). Management Plan of Singalila National Park 2013-14 to 22-23, Divisional Forest Officer, Darjeeling Wildlife Division, Wild Life Circle (North), Government of West Bengal.

Important Bird Areas (IBA). Important bird areas in West Bengal. 1095, 1099, 1100 1101, 1106

Jackson R., Ahlborn G. (1998). Observations on the ecology of snow leopard (*Panthera uncia*) in west Nepal. In: H. Freeman editor. Proceeding International. Snow Leopard Symposium. Pp 65–87

Jackson, R. (1998). People-Wildlife Conflict Management in the Qomolangma Nature Preserve, Tibet. Pages 40-46. In: Tibet's Biodiversity: Conservation and Management. Proceedings of a Conference, August 30-September 4, 1998. Edited by Wu Ning, D. Miller, Lhu Zhu and J. Springer. Tibet Forestry Department and World Wide Fund for Nature. China Forestry Publishing House. 188 pages.

Jamtsho, Y., Katel, O. (2019). Livestock depredation by snow leopard and Tibetan wolf: Implications for herders' livelihoods in Wangchuck Centennial National Park, Bhutan. *Pastoralism: Research, Policy, and Practice*, 9(1): 1-10

Jnawali, S.R., Baral, H.S., Lee, S., Acharya, K.P., Upadhyay, G.P., Pandey, M., Shrestha, R., Joshi, D., Laminchane, B.R., Griffiths, J., Khatiwada, A. P., Subedi, N., and Amin, R. (compilers). (2011). *The Status of Nepal Mammals: The National Red List Series*, Department of National Parks and Wildlife Conservation Kathmandu, Nepal.

Johnsingh, A.J.T. (2018). Jim Corbett's trail and other tales from the jungle. Natraj Publishers, 5-29

Joshi, P.D. (2002). *Study on Park-People relationship in Royal Suklaphanta Wildlife Sanctuary*. Masters Dissertation thesis, Tribhuvan University, Nepal.

Kandel, P., Gurung, J., Chettri N., Ning, W., Sharma, E. (2016). Biodiversity research trends and gap analysis from a transboundary landscape, Eastern Himalayas. *Journal of Asia-Pacific Biodiversity*, 9(1): 1-10

Karki, J.B., Jhala, Y.V., Pandav, B., Jnawali, S.R., Shrestha, R., Thapa, K., Thapa, G., Pradhan, N.M.B., Lamichane, B.R., Barber-Meyer, S.M. (2013). Estimating tiger and its prey abundance in Bardia National Park, Nepal. *Banko Janakari*, 26(1): 60-69

Khanal, G., Laxman Prasad Poudyal, L.P., Devkota, B.P. Ranabhat, R. (2018). Status and conservation of the snow leopard *Panthera uncia* in Api Nampa Conservation Area, Nepal. Conservation Area, Nepal. *Oryx*, 1-8



Kumar L., Lamsal P. (2018) High Altitude Wetlands of Nepal. In: Finlayson C., Milton G., Prentice R., Davidson N. (eds) *The Wetland Book*. Springer, Dordrecht

Kumar, A., Solanki, G.S. (2009). Cattle-Carnivore conflict: A case study of Pakke Tiger Reserve, Arunachal Pradesh, India. *International journal of Environmental and Sciences*, 35(1): 121-127

Lachungpa, G., Usha (1998). On the occurrence of the tiger *Panthera tigris* in Sikkim. *Journal of The Bombay Natural History Society* 95(1): 109

Lama, R.P., Ghale, T.R., Suwal, M.K., Ranabhat, R., Regmi, G.R. (2018). First photographic evidence of Snow Leopard *Panthera uncia* (Mammalia: Carnivora: Felidae) outside current protected areas network in Nepal Himalaya. *Journal of Threatened Taxa*, 10(8): 12086-12090

National Trust for Nature Conservation. (2016). Annual Report 2016. Retrieved from [https://ntnc.org.np/sites/default/files/doc\\_publication/2018-11/NTNC Annual%20Report 2016.pdf](https://ntnc.org.np/sites/default/files/doc_publication/2018-11/NTNC%20Report%202016.pdf)

Lamichhane, B.R., Pokheral, C.P., Poudel, S., Adhikari, D., Giri, S.R., Bhattarai, S., Bhatta, T.R., Pickles, R., Amin, R., Acharya, K.P., Dhakal, M., Regmi, U.R., Ram, A.K., Subedi M. (2018). Rapid recovery of tigers *Panthera tigris* in Parsa Wildlife Reserve, Nepal. *Oryx*, 52(1): 16-24

Lamsal, P., Kumar, L., Atreya, K. (2017). Historical evidence of climatic variability and changes, and its effect on high-altitude regions: insights from Rara and Langtang, Nepal. *Int. J. Sus. Dev. World Ecol.*, 24: 471-484

Leki, L., Thinley, P., Rajaratnam, R., Shrestha, R. (2018). Establishing baseline estimates of blue sheep (*Pseudois nayaur*) abundance and density to sustain populations of the vulnerable snow leopard (*Panthera uncia*) in Western Bhutan. *Wildlife Research*, 45:38-46

Lister, Lt. Colnel (1939). The Journal of The Bombay Natural History Society. *Journal of The Bombay Natural History Society*, XL(3,4):553

Macdonald, D. W., Bothwell, H. M., Kaszta, Ž., Ash, E., Bolongon, G., Burnham, D., ... & Hearn, A. J. (2019). Multi-scale habitat modelling identifies spatial conservation priorities for mainland clouded leopards (*Neofelis nebulosa*). *Diversity and Distributions*.

Mallick, J.K. (2010). Past, present status of the Indian Tiger in Northern West Bengal, India: an overview. *Journal of Threatened Taxa*, 2(3): 739-752

Mallick, J.K. (2010), Neora Valley - A new short-listed World Heritage Site. *Tigerpaper*, 37(3): 12-16

Mallick, J.K. (2010). Past and present status of the Indian Tiger in northern West Bengal, India: an overview. *Journal of Threatened Taxa*, 2(3): 739-952

Mallick, J.K. (2012). Mammals of Kalimpong Hills, Darjeeling District, West Bengal, India. *Journal of Threatened Taxa*, 4(12): 3103–3136

- Mallick, J.K. (2012). Mammals of Kalimpong Hills, Darjeeling District, West Bengal, India. *Journal of Threatened Taxa*, 4(12): 3103-3136
- Mazumdar, S.D. (1954). The Vanishing fauna of North Bengal. *Bengal Natural History Society*, (26)4 :158-160
- McDougal, C.W., Tshering, K. (1998). Tiger Conservation Strategy for the Kingdom of Bhutan. Nature Conservation Division, Department of Forests, Thimphu, Bhutan.
- Mishra, C., Madhusudan, M.D., Datta, A. (2006). Mammals of High Altitude of Western Arunachal Pradesh, eastern Himalaya: an assessment of threat and conservation needs. *Oryx*, 40(1): 29-35
- Mishra, N. Status paper of Khaptad National Park. *Grassland Ecology and management in Protected Areas of Nepal*, 3: 146-148
- NCD 2018. Tiger Action Plan for Bhutan (2018-2023): A landscape approach to tiger conservation. Nature Conservation Division, Department of Forests and Park Services, Ministry of Agriculture and Forests, Thimphu, Bhutan.
- Oli, M. K. (1994). Snow leopards and blue sheep in Nepal: densities and predator prey ratio. *Journal of Mammalogy*, 75(4):998-1004.
- Perry, R. (1981). Mountain Wildlife. Croom Helm, London, 74
- Pokheral, C.P. (2013). *Ecology and conservation of tiger Panthera tigris and leopard Panthera pardus in a Subtropical lowland area, Nepal*. PhD thesis, University of Ferrara, Italy
- Pokheral, C.P., Wegge, P. (2018). Coexisting large carnivores: spatial relationships of tigers and leopards and their prey in a prey-rich area in lowland Nepal. *Écoscience*, 1-10
- Riley, L., Riley W. (2005). *Nature's Strongholds: The World's Great Wildlife Reserves*. New Jersey, Princeton University Press
- Sanderson, E. W., Jaiteh, M., Levy, M. A., Redford, K. H., Wannebo, A. V., & Woolmer, G. (2002). The human footprint and the last of the wild: the human footprint is a global map of human influence on the land surface, which suggests that human beings are stewards of nature, whether we like it or not. *BioScience*, 52(10), 891-904
- Sangay, T., Vernes, K. (2008). Human–wildlife conflict in the Kingdom of Bhutan: Patterns of livestock predation by large mammalian carnivores. *Biological Conservation*, 141(5):1272-1282
- Selvan, K.M., *et.al.* (2013). Losing threatened and rare wildlife to hunting in Ziro valley, Arunachal Pradesh, India. *Current Science*, 104(11):1492-1495
- Sen K., Mandal, R. (2017). Present Status of Terai and Duars Region Biodiversity. *International Journal of Science and Research (IJSR)*, 7(4): 1509-1511

Shah, R. (2007). Management Plan for the Civil and Soyam, North Kumaon, Uttarakhand (2009-10 to 2018-2019): Part – II, 294

Shah, R. (2009). Management Plan for the Bageshwar Forest Division, North Kumaon, Uttarakhand (2009-10 to 2018-19): Part III, 357

Shah, R., Sinah, A.R. (2010). Management Plan for the Mussoorie Forest Division, Yamuna Circle, Uttarakhand (2011-2012 to 2020-21): Part-I, 465

Sherpa, M., Wangchuk, S., & Wikramanayake, E.D. (2004). Creating biological corridors for conservation and development: A case study from Bhutan. pp. 128- 134. In: Harmone, D, Worboys G.L. (eds.) *Managing Mountain Protected Areas: Challenges and Responses for the 21st Century*. Andromeda Editrice, Italy

Shivapuri Nagarjun National Park and Buffer Zone Draft Management Plan (2017) Fiscal Year 074/075-078/079 (2017-2021). Government of Nepal, Kathmandu

Shrestha, B., Basnet, K. (2005). Indirect methods of identifying mammals: A case study from Shivapuri National Park, Nepal. *Ecoprint: An International Journal of Ecology*, 12: 43-57

Shrestha, B., Aihartza, J., Kindlmann, P. (2018). Diet and prey selection by snow leopards in the Nepalese Himalayas. *PLoS ONE* 13(12): e0206310

Sinah, A.R. (2012). Management Plan for the Champawat Forest Division, North Kumaon, Uttarakhand (2011-12 to 2020-2021): Part – I, 38

Singh, B.S.M.P. (2012). Uttarakhand State of Environment Report, 45

Singh, J.J., Jackson, R. (1999). Transfrontier Conservation Areas: creating opportunities for conservation, peace and the snow leopard in Central Asia. *International Journal of Wilderness*, 5(2),7- 12

Singh, R., Chauhan, D.S., Mishra, S., Krausman, P.R., Goyal, S.P. (2014). Tiger density in a tropical lowland forest in the Eastern Himalayan Mountains. *Springer Plus*, 3:462

Singh, R., et.al. (2014). Tiger density in a tropical lowland forest in the Eastern Himalayan Mountains. *Springer Plus*, 20143:462

Smith, J.L.D., Ahearn, S.C., McDougal, C. (1998). Landscape Analysis of Tiger Distribution and Habitat Quality in Nepal. *Conservation Biology*, 12:1-9

Srivastava, K.B. (1971). Working plan for East Almora FD, Kumaon Circle, U.P. (1970-71 to 1979-80), 42.

Stoen, O. G., Wegge, P. (1996). Prey selection and prey removal by tiger (*Panthera tigris*) during the dry season in lowland Nepal. *Mammalia*, 60(3): 363–374

Thapa, C., Maharjan, M. (2015). Parasitic burden in high altitude wild ruminants: Himalayan Tahr (*Hemitragus jemlahicus* Smith, 1826) and Barking Deer (*Muntiacus vaginalis* Boddaert, 1785) of Rara National Park, Nepal. *Nep J Environ Sci*, 3:1-6

Thapa, K., Kelly, M.J. (2017). Density and carrying capacity in the forgotten tigerland: Tigers in the understudied Nepalese Churia. *Integrative Zoology*, 12(3):211-227

The Gazetteer of Sikkim (1895). 235

Thinley, P., Lassoie, J.P., Morreale, S.J., Curtis, P.D., Rajaratnam, R., Vernes, K., Leki, L., Phuntsho, S., Dorji, T., Dorji, P. (2017). High relative abundance of wild ungulates near agricultural croplands in a livestock-dominated landscape in Western Bhutan: Implications for crop damage and protection. *Agriculture, Ecosystems & Environment*, 248(1): 88-95

Tigers return to forests in Bhutan. Retrieved from <http://tigers.panda.org/news/bhutan-tigers-return/> on 22<sup>nd</sup> June, 2019

Wang, S.W. (2008). *Understanding ecological interactions among carnivores, ungulates and farmers in Bhutan's Jigme Singye Wangchuck National Park*. PhD dissertation, Cornell University, Ithaca, NY, USA

Wang, S.W., Macdonald, D.W. (2009). Feeding habits and niche partitioning in a predator guild composed of tigers, leopards and dholes in a temperate ecosystem in central Bhutan. *Journal of Zoology*, 277(2009):275–283

Wang, S.W., Macdonald, D.W. (2009). The use of camera traps for estimating tiger and leopard populations in the high altitude mountains of Bhutan. *Biological Conservation*, 142(3): 606-613

Wangchuk, S. (2007). Maintaining ecological resilience by linking protected areas through biological corridors in Bhutan. *Tropical Ecology*, 48(2): 176-187

Wood, H.S. (1937). Observations on the Tiger and its Shikar. *Journal of Bengal Natural History Society*, 12(2): 66-68

Yangzom, Drolma. (1997). Qomolangma National Nature Preserve in Tibet. Pages 216-217 In: R. Jackson and Ashiq Ahmad (Eds). *Proceedings of Eighth International Snow Leopard Symposium*. International Snow Leopard Trust and WWF-Pakistan, Lahore. 237 pages

NOTE	

NOTE	



