Examining large carnivore occurrence, conflict and socio-cultural tolerance in the central Indian landscape

2015-2016

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I would like to make a special acknowledgement to the people living in and around the Kanha-Pench landscape amidst wildlife, who opened their lives and homes to researchers and students, share incredible life stories, and always helped us regain a sense of purpose, when it was most needed.

INTRODUCTION

Protected wildlife reserves have been successful as population refuges for several threatened species. But these reserves constitute a mere 4% of India's land area. Throughout India's recent conservation history, the focus of protection efforts has been somewhat limited to mammals within wildlife reserves. Although several species of large mammals inhabit multi-use unprotected landscapes, conservation research has also largely been directed towards certain charismatic species. Consequently, conservation interventions and policy have been inadequate in addressing the ecological requirements and challenges of relatively widespread species.

Large swathes of multi-use forests, open scrub, and grasslands are severely at risk of conversion for agricultural and industrial purposes, necessitating studies on the ecology of carnivores in human-dominated landscapes. Additionally, since human-wildlife interface is high in such areas, it is also important to understand the nature and extent of human-wildlife interactions, and local peoples' perception of wildlife and conservation.

Figure 1: Image of multi-use forests, interspersed with agricultural areas in the study area

Carnivores like leopards *Panthera pardus* and sloth bears *Melursus ursinus* are highly adaptable and live in heterogeneous landscapes. Nonetheless, they're vulnerable to anthropogenic threats; both species have experienced >30% range contraction over the last 100 years in India. Despite their widespread occurrence, only sparse information is available on their ecology and distribution. Dearth of reliable information has hindered conservation efforts for these species, both for the purpose of assigning conservation status, and for assessing threats to their persistence.

In this context, the aim of the current project is to understand the distribution and status of leopards and sloth bears outside the protected area network in central India. Specifically, the objectives are: (a) to examine the distribution patterns of the focal species in non-protected areas of the Kanha-Pench landscape, (b) to assess the influence of ecological and anthropogenic factors that drive patterns of distribution and space-use, and (c) to determine the extent of human-wildlife conflict, thresholds of human tolerance/acceptance of wildlife and, examine the factors driving these conflicts and perceptions.

METHODS

Study Area

The Kanha-Pench landscape extends to *c.*160 km from 79°30’ to 80° 32’ E to 21°45’ to 22°24’ N in the southern part of the State of Madhya Pradesh, India. This area harbors some of the finest deciduous forests of India, dominated by sal, teak, and bamboo forests, interspersed with grasslands. The region has been recognized as a crucial sink landscape for long-term tiger conservation. Apart from tigers, the forests in such “sinks” serve as important refuges for several carnivore species including leopard, sloth bear, dhole, hyena, jackal and wolf; and herbivores such as the gaur, nilgai, sambar, chital, wild pig, barking deer, blackbuck, and four horned antelope.

The forests in the landscape are interspersed with human habitations. Over 400 villages are located within the landscape, including several ethnic tribes inhabiting the forest interiors. While the major source of livelihood is farming, many communities are also dependent on forest-based resources, small-scale mining, and marginal labor.

Figure 2: Image of unprotected reserve forests and a rural settlement in the study area

Field Surveys

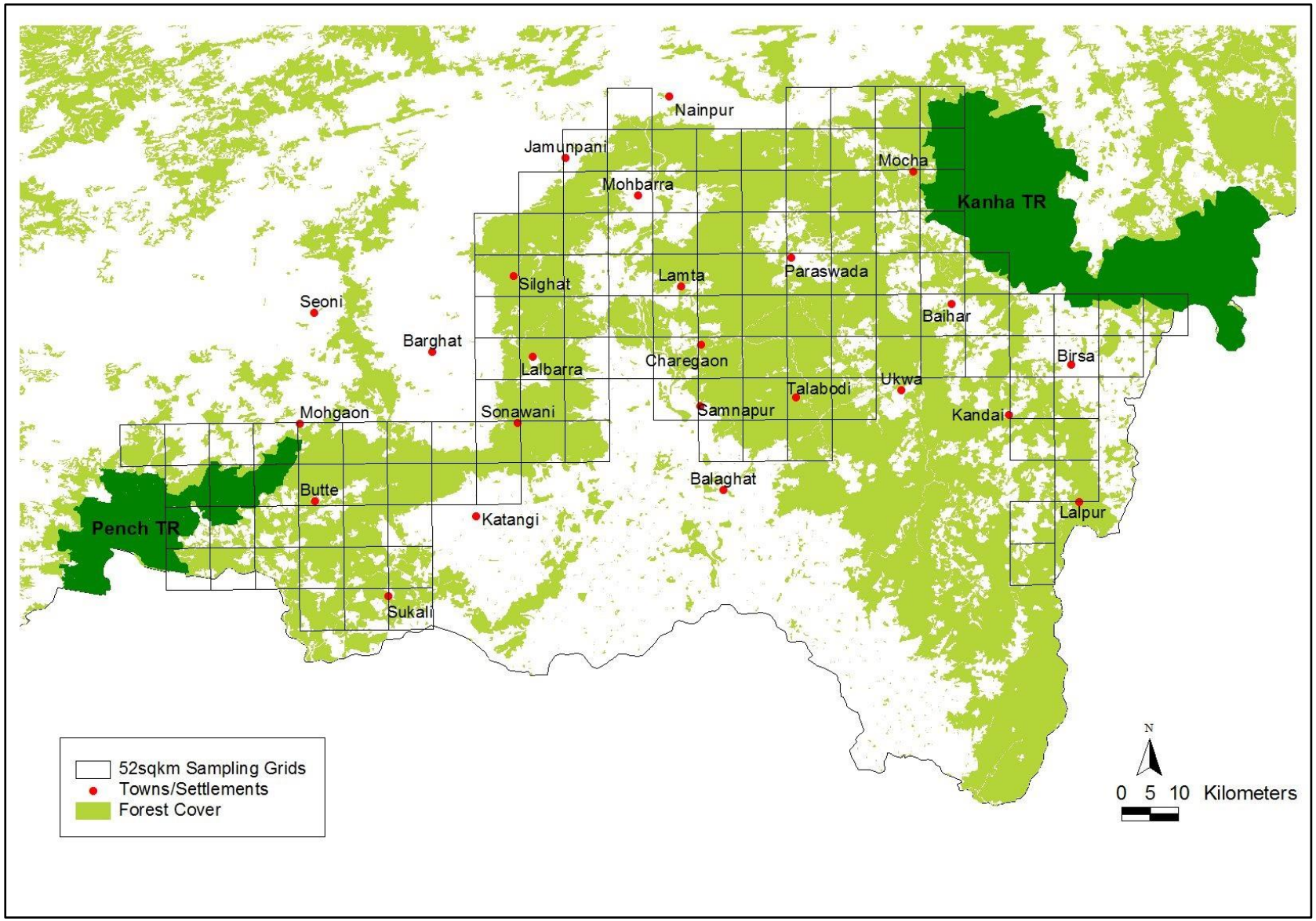
The current study employed a multi-pronged approach, which included indirect sign surveys to assess patterns and determinants of carnivore occurrence, as well as questionnaire surveys of local communities.

Preparatory work (digitizing road networks and villages located within the study area) as well as a reconnaissance survey was carried out in the months of July – August 2015. The field surveys started on 1st September 2015 and continued till 10th January 2016. A total of 1,033 person-days (including research personnel, volunteers, and forest department staff) and about 19,000 km of drive-effort was invested during the survey period.

The total area surveyed was approximately 7000 sq.km of which over 4000 sq. km is forested. Field surveys were carried out in Balaghat Circle (West Baihar range, East Baihar range, Birsa range, North Lamta range, South Lamta range, Balaghat range, Logur range, Lalbarra range and Katangi range), Seoni Circle (Keolari range, Barghat range, Kurai range and Khawasa range), Mandla Circle (Bamhani range, East Mandla range), Kanha buffer (Khatia range, Khapa range, Samnapur range) and Pench buffer (Ghatkohka range, Rukhad range and Khawasa range). All necessary permits from the Forest Department were obtained from the respective Chief Conservator of Forests and Field Directors.

Ranges south of Ukwa and Balaghat towns could not be covered due to unrest and insurgency problems. Both indirect sign survey and questionnaire survey were not conducted in this region.

Figure 3: Map of Study area overlaid with a 52 sq.km-grid array

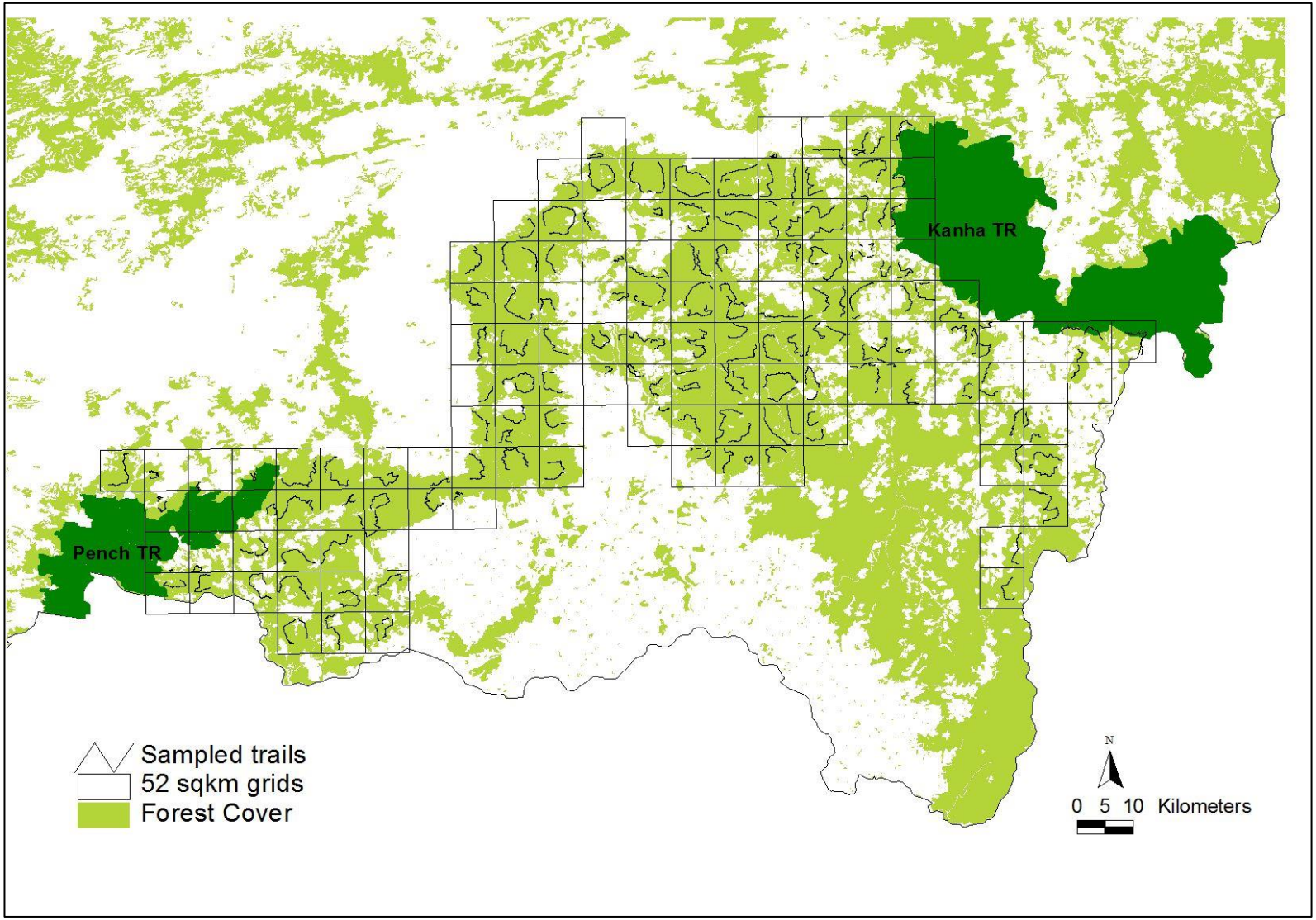


Indirect Sign Surveys

The study area encompasses a heterogeneous landscape matrix of human settlements, non-protected forest areas, and agricultural fields, covering an area of about 7,000 sq. km. We conducted sign surveys over a grid array of 128 grid-cells, with each grid-cell measuring *c.*52 sq. km in area. Within each grid, surveys were carried out by multiple teams of two-three surveyors. Sampling was conducted along forest roads and trails to increase the probability of detecting indirect signs as both leopards and bears are known to use such paths extensively for movement. We used consecutive segments each of 1-km length, which represented our spatial replicates, and data was collected at every 100-m interval. The sampling/walk effort invested in each grid was proportional to the forest cover (range = 2-23 km walk effort). Detections were based on presence of signs such as scats, tracks, or direct observations of the study species. Only unambiguously identified signs were recorded and fresh signs (<7 days old) were used for analysis. Along with detection/non-detection data of the carnivores, we also collected data on the presence of all principal prey species, livestock, and semi-feral/feral dogs. Information related to human presence, such as signs of logging, lopping, NTFP collection, fire, poaching were also noted. Other ecological variables (substrate condition and habitat type) that could potentially influence the detectability and distribution of the species were collected. Sign surveys were conducted in the dry months, from October 2015 – January 2016, which allowed for uniformity in the detection process. Further, we assumed that there would be no change in the distribution patterns for leopards and bears across the landscape during the sampling period.

Figure 4: Example survey route and research personnel during field survey

Figure 5: Spatial distribution of survey effort of 1631 km in the Kanha-Pench landscape



Leopard Scat Collection and Diet Analysis

In order to assess the dietary patterns of leopards in the landscape, and to gauge their dependence on wild versus non-wild prey, we collected leopard scats during the sign surveys. All fresh and old (deposited post-monsoon and remained intact for a period of about 1 month) scats were collected. Scats were stored in airtight sample kits and each scat was assigned a unique specimen number. Ancillary information such as geographic coordinates, secondary signs, substrate condition, scat condition, date, and time of collection were also noted. We washed all scats thoroughly using a mesh-sieve, to remove any soil substrate and foreign matter, sun-dried and stored for further examination.

We identified the prey species primarily on the basis of the hair content in the scats. We also found bone fragments, hoofs of ungulates, paw skin of primates, quills, claws, and teeth in scat samples, which made identification easier during physical examination. From each scat sample, 15-20 hair specimens were randomly extracted and examined for cuticle and medullary patterns. We identified the species using reference slides of hair samples from domestic animals and from reference slides of hair samples of wild animals available with Centre for Wildlife Studies, Bangalore, and manuals published by the Wildlife Institute of India, Dehradun.

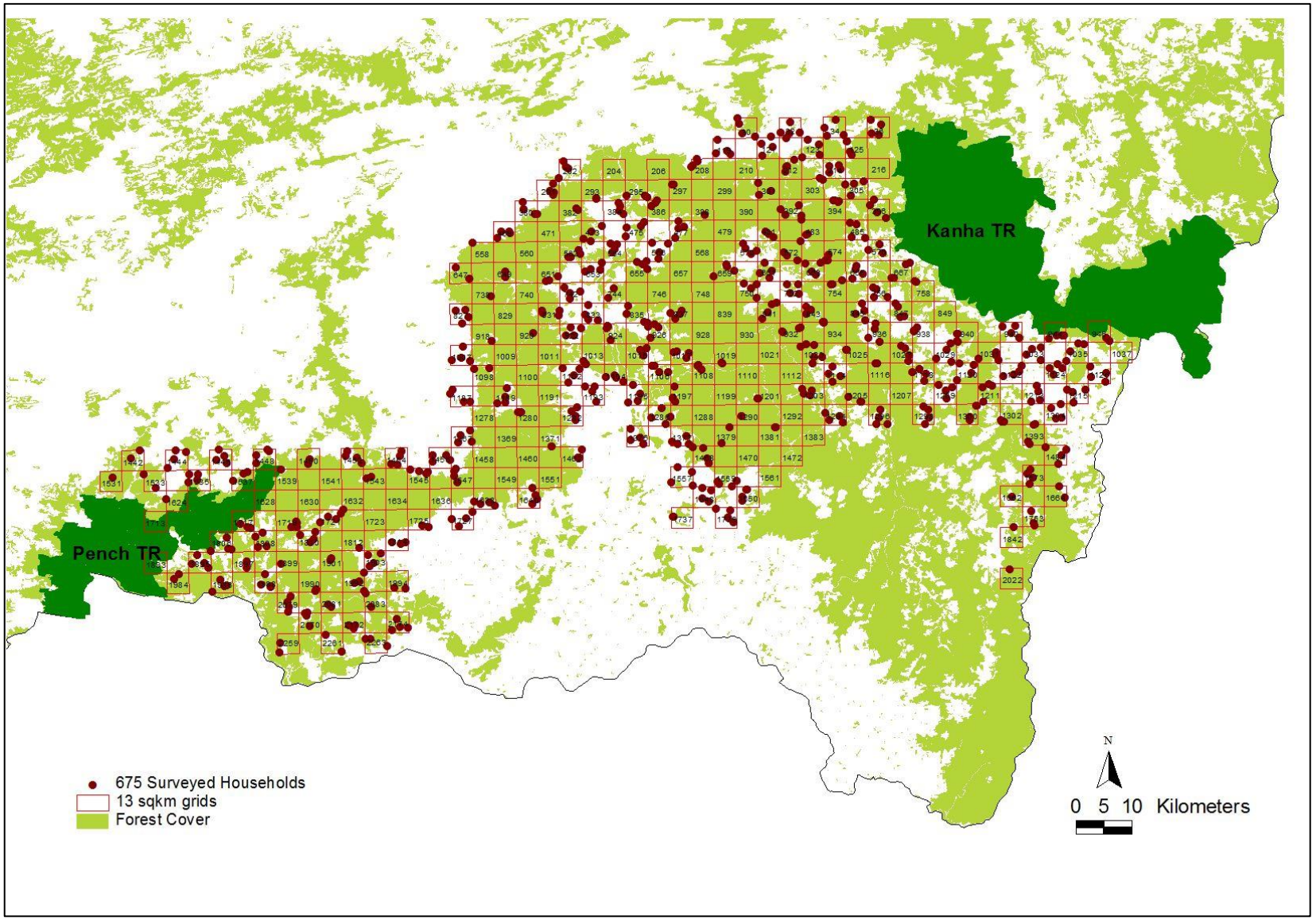
Figure 6: Scat collection protocols developed by Centre for Wildlife Studies, Bangalore were followed to collect genetic samples and scats for diet analysis

Questionnaire-based Social Surveys

We sub-divided the grid array of 128 grids of size 52 sq. km (sampled during the sign surveys) into 496 smaller grids of 13 sq. km each. To enable systematic sampling of the vast landscape, we sampled 50% of the grids in a checkerboard pattern, sampling every alternate grid. Of the 248 grids, we sampled 200 grids, excluding grids with complete forest habitat and no human settlements. We digitized a total of 1155 settlements in the grid network, using Survey of India topographic maps, and Google Earth. Within each grid, by ensuring maximum spatial coverage, we selected at least 4 settlements, and in each settlement 1 household was interviewed. In grids with only one settlement, we interviewed two households. We conducted 675 household surveys, with an average of 3.4 interviews per grid. We interviewed adult male and female members of the household and collected information pertaining to family demographics (age, gender and education), socio-economic indicators (livestock and land holdings, income, institutional access), and dependence on forests. Respondents were also questioned about their interaction with the focal species, specifically in the last one year, livestock losses, adoption of mitigation measures, report and receipt of compensation, and their perception of carnivore presence. Respondents were made to identify species from different photographs, before consequent wildlife-related questions, in order to avoid misidentification. Household surveys were conducted in the months of September 2015 – January 2016.

Figure 7: Questionnaire-based surveys were conducted by teams of 2 people, in settlements located inside the forest and on the periphery

Figure 8: Spatial distribution of 675 households surveyed in the Kanha-Pench landscape



RESULTS

Indirect Sign Surveys

A total walk-effort of 1631 km was invested to obtain a total of 434 detections of leopards and 337 detections of sloth bears. Apart from the focal species, we also detected signs of co-predators and all herbivores. The number of signs detected per species is presented in Table 1.

Carnivores	**Signs Detected**	**Herbivores**	**Signs Detected**
Tiger	195	Gaur	309
Leopard	434	Sambar	1,411
Bear	337*	Nilgai	541
Dhole	21	Chital	1,065
Hyena	15	Blackbuck	23
Wolf	32	Wild pig	686
Fox	54	Muntjac	703
Jackal	222	Four horned antelope	127
-	-	Rhesus macaque	142
-	-	Langur	3,498

Table 1: Number of signs detected (including scats/dung/pellets, tracks and direct sighting) of major mammal species in the Kanha-Pench landscape. * Includes termite mounds damaged by bears.

a) *Leopard and Bear Distribution*

The two focal species of our study, leopard and sloth bear were found to be the most commonly occurring carnivores. Leopards were detected in 94 of the 128 grids (including tracks and scats which were up to a month old), with an encounter rate of 0.27 signs/km. For all further analysis, we will consider only fresh scats and tracks that were detected. Such fresh signs (25 fresh scats of <7 days old and 162 tracks) were detected in 60 of the 128 grids, thus resulting in a **naïve occupancy of 47%** and an **encounter rate of 0.11 signs/km**. Figure 11 shows the naïve distribution of leopards in the study area based on only fresh signs.

Sloth bear signs (including scats, tracks and damaged termite mounds) were detected in 86 of the 128 grid cells. The overall encounter rate for bears was 0.21 signs/per km. However, in order to standardize the detection process, we excluded damaged termite mounds and included only scats and tracks for further analysis. Based on these signs (209 scats and 45 tracks), bears were detected in 74 of the 128 grids, thereby having a **naïve occupancy of 58%** and an **encounter rate of 0.16 signs/km**. Figure 12 shows the naïve distribution of sloth bears in the study area, based on detections of scats and tracks.

Proposed analysis: In order to account for imperfect detection and identifying locations of 'psuedo-absence', we will be analyzing the data further under an occupancy modelling framework to estimate the 'true habitat occupancy' and the proportion of area occupied by leopards and sloth bears. Additionally, species distribution and detectability will be modelled using specific covariates which have been identified as drivers of their distribution in earlier studies. Some of the covariates for which data has been acquired through remote sensing include proportion of forest cover, area under agriculture and human settlements in each grid, terrain heterogeneity, and forest productivity, among others. Leopard distribution will be further modelled with prey availability within the study area. We will also use anthropogenic factors such as cattle grazing, and signs of forest use by people (described below) as possible factors that could negatively influence species occupancy.

Figure 9: Indirect signs of leopard and sloth bear detected during the field survey

b) Human Presence

Intrusive human activities in the form of cattle grazing and fodder collection, lopping of trees and bamboo, illegal logging, NTFP collection and signs of poaching (snares for small mammals and birds) were recorded in the entire study area, with varying degree of use. Over 11,000 signs of livestock dung/pellets and tracks were recorded, along with over 200 signs of dogs. We recorded over 8000 signs of local biomass extraction (specifically illegal logging of trees, lopping for fuelwood and fodder and bamboo extraction), 257 signs of NTFP collection (fruits, leaves, bark, honey, and mushrooms) and 64 signs of poaching. Additionally, approximately 400 signs of organized biomass extraction, in the form of timber and bamboo extraction, operated and managed by the forest department were recorded. Higher levels of human disturbance were recorded in areas closer to settlements and villages.

Figure 10: Heavy grazing pressure and presence of certain illegal activities such as traps for small fauna were detected in the study area

Figure 11: Leopard distribution (naïve occupancy) in the study area, based on detection of fresh scats and tracks

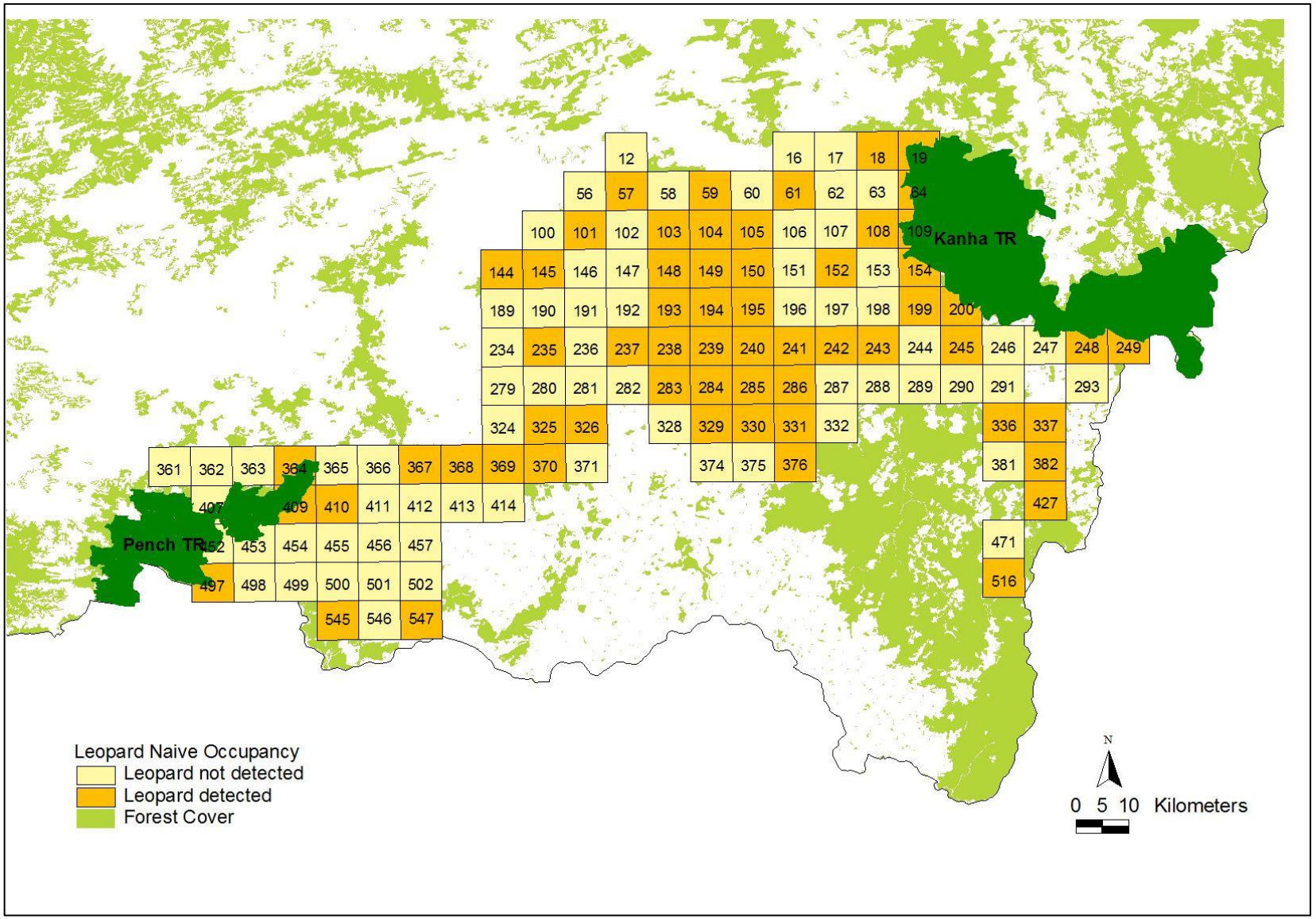
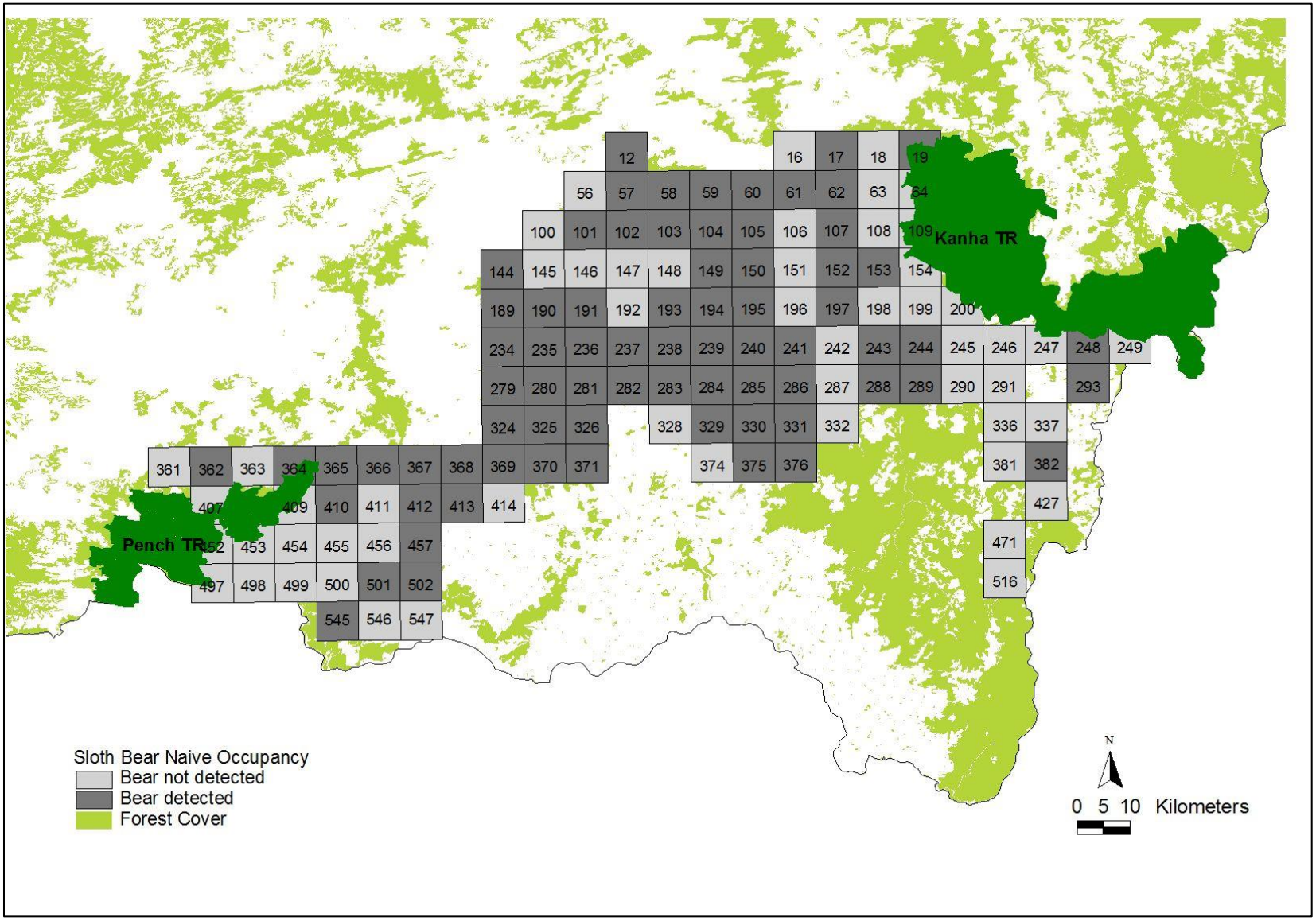


Figure 12: Sloth bear distribution (naïve occupancy) in the study area, based on detection of fresh scats and tracks



Leopard Diet Analysis

A total of 253 leopard scats were collected and analyzed for dietary patterns. Langur and chital hair were most commonly detected in the samples, constituting 34% and 23% of leopard scats, respectively. Domestic cattle constituted 6% of scats, while domestic dogs and goats constituted less than 1% each. We also found one scat sample containing evidence of human hair. Details of prey consumption patterns are provided in Figure 13 below.

Proposed analysis: Further analysis to examine prey preferences and selection by leopards, based on prey biomass, will be undertaken.

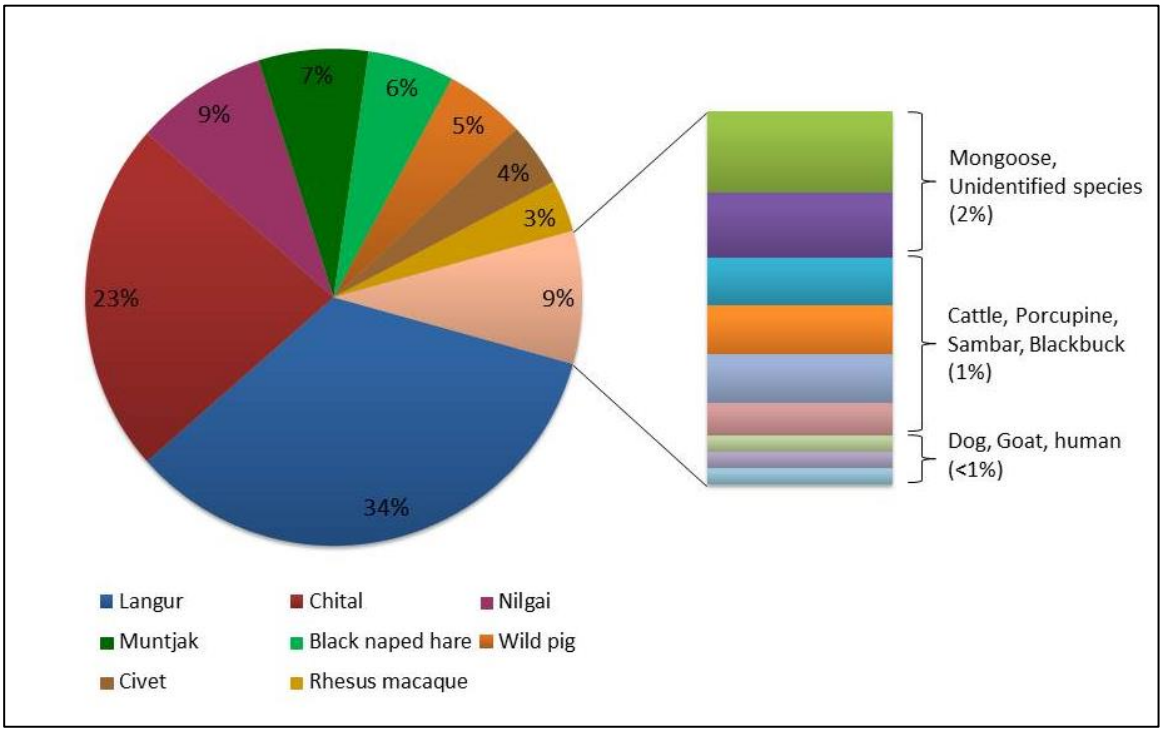


Figure 13: Prey composition in a sample of 253 leopard scats

Questionnaire-based Social Surveys

a) Family Demographics and Socio-Economic Characteristics

Of the 675 households interviewed, 67% of the respondents were male, of which 30% had completed education higher than the 8th grade. The average respondent age was 39 years. The average household size was about 6 members per family, 52% being women. Overall, 57% of the population was between the ages of 18 to 59 years and 23% of the household members were uneducated.

A large majority of the respondents are settled farmers. Around 51% of the respondents claimed to be only subsistence/marginal farmers, not making any income from agriculture, while 17% managed to earn Rs. 10,000-50,000 from farming. Additionally, many families and household members were engaged in some form of marginal labour, with nearly 44% people earning between Rs. 10,000-50,000. Dependence on forest produce as a source of income was found to be negligible with nearly 55% households reporting less than Rs. 5,000 as income from sale of *tendu* and *mahua*, among other forest products.

Rearing livestock (cows, buffaloes, and goats) and poultry was a common practice across the study area. 83% of the households reported owning either cows and/or buffaloes, with an average of 4 cattle-heads per household. 34% respondents reported owning goats (with average 2 goats per household) and 41% owned poultry (average 2 per household).

b) Resource Extraction and Forest Dependence

Forests were found to be utilized by the communities for different purposes. The most common activity was related to animal husbandry, with 64% households reporting grazing livestock in the forests, while only 7% collected fodder from forests (70% relying on fodder collected from private land holdings). Despite households reporting marginal incomes from NTFP collection and sale, 64% engaged in collection of *tendu*, *mahua*, bamboo, fruits, and mushrooms. Reliance on forests to meet daily fuelwood requirement was found to be the highest, with 84% household reporting extraction (either as a daily, weekly, monthly or yearly activity). A small percentage of people (13%) also reported to taking meat or fish from inside forests.

c) Interaction with Wildlife and Reported Losses

Among the respondents interviewed, 89% correctly identified leopard from photographs, of which 19% people reported encountering a leopard in the past one year. In terms of losses, in the past one year, the highest percentage of livestock loss due to various reasons was reported for cows. The most common reason for loss was disease (63%), while predation was a cause for 18% cases. Of this 18%, approximately 15% (a total of 6 cases) was attributed to predation by leopards. Similarly, the main reason for loss of goats (reported by 12% respondents) was disease as well (52%), with predation contributing to 38% of the loss. However, most predation cases were attributed to wild canids, with leopards causing a little over 1% loss. Four separate cases of leopards stealing dogs were also reported. None of the respondents reported human injury or death due to leopards in their household over the past year, although 7 cases were reported at the scale of the settlement.

In the case of sloth bears, 97% respondents correctly identified the species, with 32% of them reporting an encounter in the past one year. Among these, only 4 respondents reported human injury or death in their household, caused during an encounter with sloth bear. However, a total of 38 respondents reported human injury or death by bears within their settlement.

Proposed Analysis: We will be undertaking detailed analysis to examine the reported interactions and losses due to leopards and bears, and assess the factors contributing to the same. We will also be examining people's perception and attitude towards carnivores and the factors influencing these perceptions.

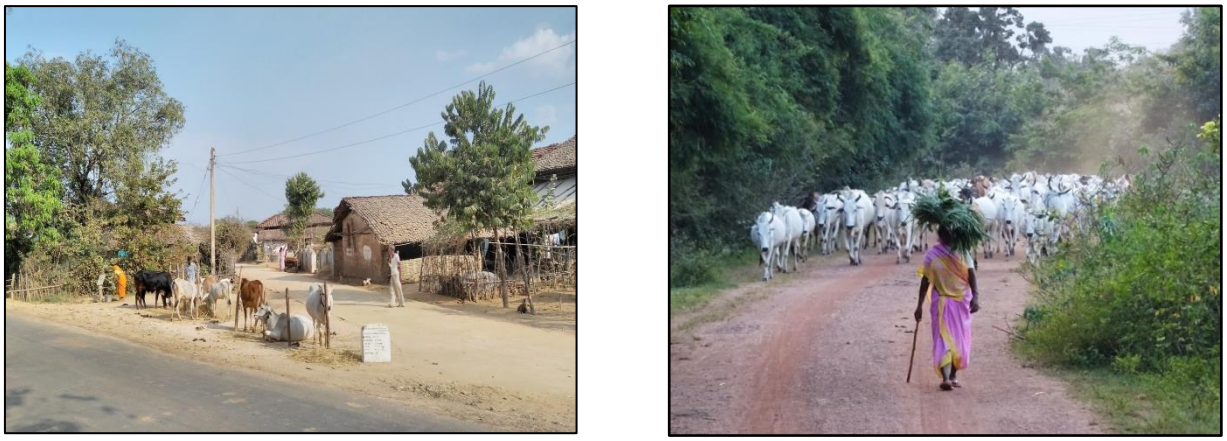


Figure 14: Local communities living within the Kanha-Pench landscape and on its periphery are dependent on the reserve forests for varied resource needs, including grazing and fodder collection

CAPACITY BUILDING

In order to carry out the sign surveys and questionnaire surveys across the large geographic extent of the study area, we involved civil society members to assist with collection of field data. These citizen scientists included students (mostly aspiring young scientists) as well as people from other backgrounds such as doctors, engineers, bankers and architects. A total of 43 volunteers participated in the surveys. Relevant training related to identification of animal signs, scat collection protocols, and conducting questionnaire surveys was provided to all participants. Participants were also trained in map reading and navigation skills using topographic maps and GPS. All new volunteers were accompanied by at least one researcher or completely trained volunteers.

Volunteers and interns participated for a minimum period of one week, up to a maximum of 3 months. At the end of the surveys, each volunteer/intern was provided with a Certificate of Participation from Centre of Wildlife Studies, Bangalore. We also collected written feedback from the participants on a regular basis, to improve and meet participant expectations during the survey period. Details of the participants and a few selected feedback responses are provided below.

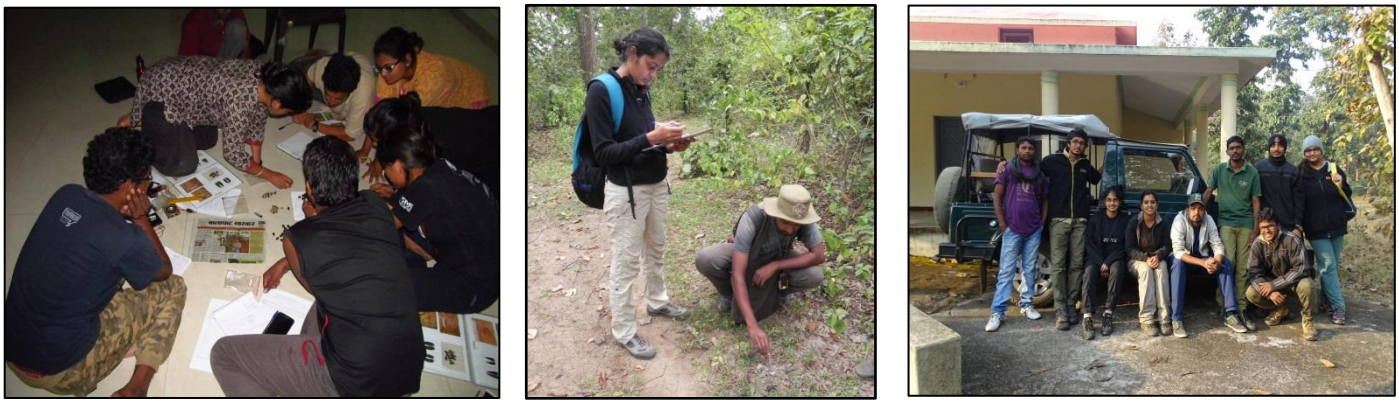


Figure 15: Volunteer training and participation during field surveys

Figure 16: Details of participants based on duration of participation

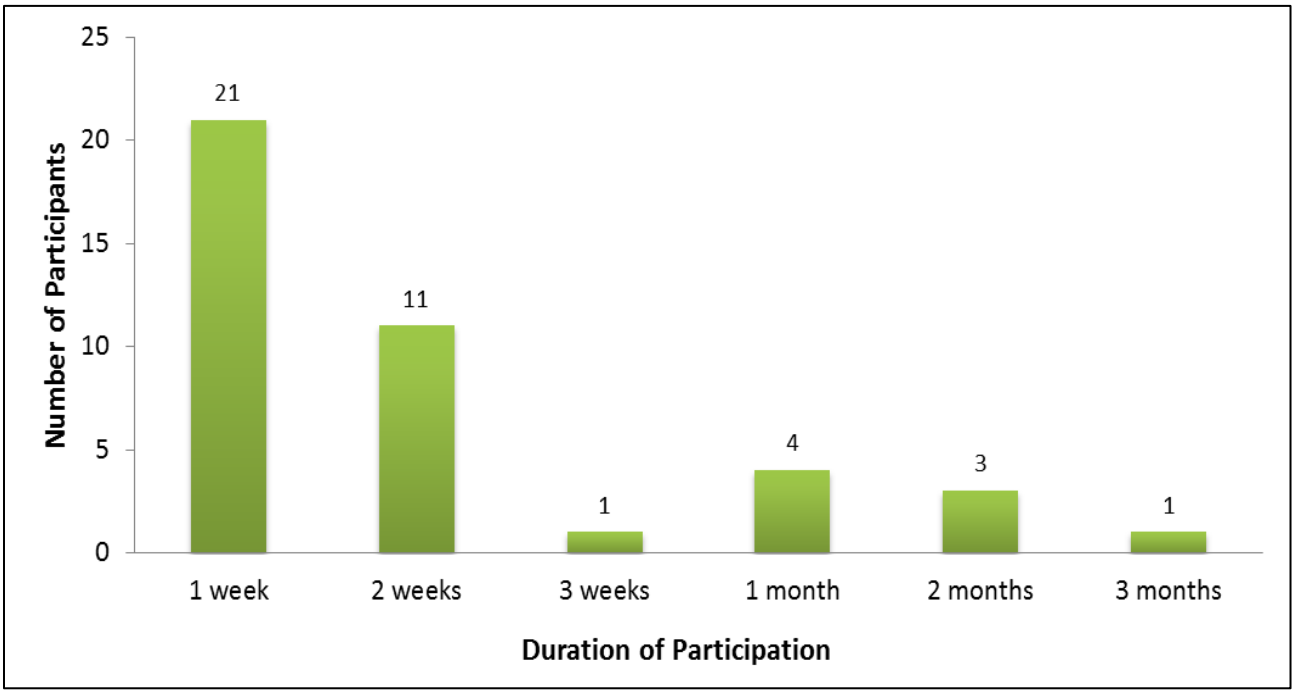
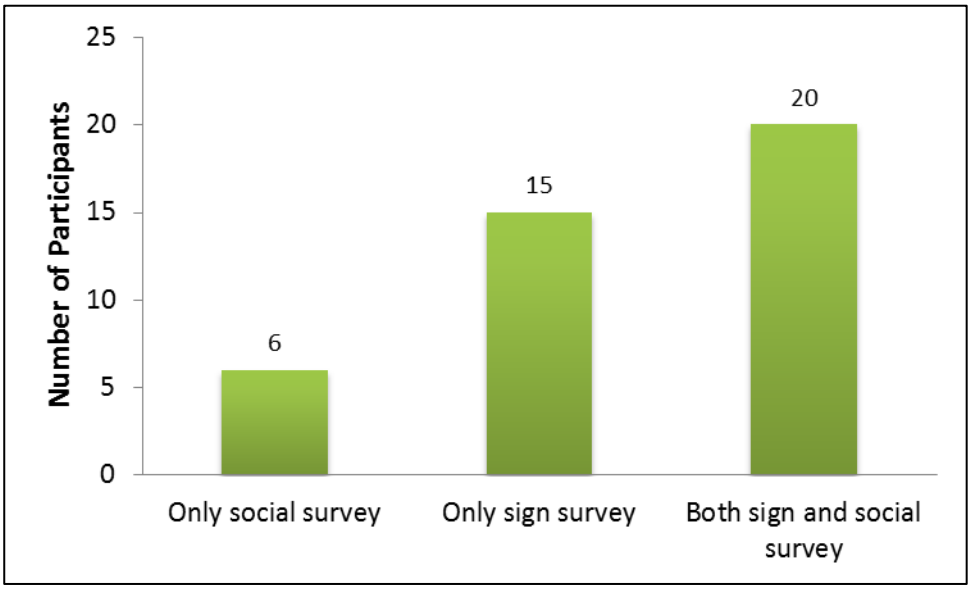


Figure 17: Details of participants based on survey type



List of participants

Imran Patel (Research Assistant); Shashikiran Hegde; Rohit Singh; Subhasmita Patro; Ankita Sharma; Het Patel; Ankur Singh Chauhan; Marsha Sara Babu; Priya Anna James; Aditi Sivaraman; Huzaifa Dahodwala; Niyati Bhatt; Sangram Gupta; Chetan Bhatt; Anuj Raina; Sushma Sharma; Niveditha Salian; Nikita Sarangdhar; Vijay Patel; Hardip Singh; Prakasamma Sneha; Ekant Sharma; Arjun Vaidyanathan; Noorafsha Abdulla; Ashish Agrawal; Shubham; Jasraj Kalaskar; Dinesh; VT Ravi; Shubham Gupta; Arjun Menon; Tarun Menon; Vaishali Rawat; Surabhi Tanwar; Dhaval Bhatt; Akash Patil; Pankhuri Chaudhary; Rashmi Singh; Krunal Trivedi; Sanjog Sahu; Vinni Munjal; Hitesh Kataria; Koundinya Ummadipolu; and Swapna Rao

Select Feedback

Ankita Sharma - "…I was not aware about the seriousness on the conflicts between human and wildlife and never knew that there are people working on it with full dedication. I learnt a lot about wildlife and its need for conservation …I am glad that I got a chance to start with you guys which created such a very beautiful image about wildlife in my mind and I developed my interest in conserving wildlife in a very positive way…Inspite of having losses almost every day, it was good to see that some of them [local communities] still understood the meaning of conservation and were still willing to save wildlife. Understanding their lifestyle, their problems, and how they deal with it was a great learning and it actually changed my mindset towards life. The interview format also helped in understanding a lot about these wild animals, their habitat preferences, their movement and religious beliefs and customs followed by villagers…"

Sangram Gupta – "It [the study] helped widen my perspective and how I view the society. The social surveys provided me an insight of how callous my nature was towards the neglected part of my country, those in the rural parts who were many yet voiceless. I also got to know how to lead a life in a frugal manner, I earlier had this false belief that surveys such as this get a load of funding and for them it is a kind of excursion but I got to know that it was contrary. How difficult it was to cope up with limited funds the Government agencies sanctions for philanthropic actions like these. I understood the purpose of life was not to chase money blindly but pursue something that you truly find interesting, I actually am on the verge of changing my stream of career to what I enjoy and want to do."

Arjun Menon – “It was the first time I got to work in Central India…The landscape itself was a treasure trove filled with knowledge. I learnt how to identify the signs of carnivores and herbivores very well. Learning how to use a GPS was also a very important thing for me. When I spoke to the villagers in the areas where they said leopards or any other large carnivores do not exist, we were able to find signs of the same - this shows how secretive these beings are. I learnt how man and animal can leave closely without causing much harm to each other…”

Priya Anna James – “This project gave me a very realistic idea of what the life of a researcher is. It has helped give me perspective on what challenges I should be ready to face, how to handle situations as you can't predict and be prepared for everything that happens on field and on how to deal with people…My interest in and willingness to work harder for wildlife conservation have amplified after being part of this research.”

CONCLUSION

While our analysis is not yet complete, it is evident from our preliminary assessments that both our focal species, the leopard and the sloth bear, occupy and use a significant proportion of the Kanha-Pench landscape. We aim to map and examine the species' distribution patterns in the study area using probabilistic occupancy models, identifying areas with high and low occurrence. Further, we will examine specific ecological and anthropogenic drivers of species distribution within the landscape, based on data gathered during indirect sign surveys as well as remotely acquired data.

With over 400 villages inside and on the periphery of the Kanha-Pench landscape, the pressure on forests and wildlife is immense. Local communities are highly dependent on forest lands in order to meet their requirement of fuelwood, fodder, and minor forest produce. In addition, these common areas are extensively utilized for cattle grazing. While human pressure is high on this fragile landscape, through our questionnaire surveys, we obtained evidence of interactions between wildlife and people as well as the consequent losses. People resort to varying strategies to deal with losses due to wild carnivores, however, claims for compensation was noted only for loss of cattle and/or human life. Compensation for losses of goats and poultry due to leopards and canids remains a major problem. People's dependence on forests, coupled with their intrinsic cultural association with flora and fauna seems to have maintained a delicate balance. However, people's tolerance and acceptance of wildlife hinges on effective management of people's resource needs as well as managing wildlife intrusion into human spaces. We will investigate human-wildlife interactions in greater detail, determine hotspots of high conflict with the focal species, as well as identify their drivers.

Capacity building and involvement of citizen scientists was an integral component of this study. Right from the inception of this project, we had identified the need to involve both short-term and long-term volunteers/interns in the study. The project proved to be an invaluable experience for many young scientists for whom this was the first fieldwork experience. People benefited from the intense learning experience, with insights on the importance of the landscape, ecology of the wildlife it harbors as well as the ground realities of wildlife persisting in a human-dominated landscape, with semi-nomadic tribal

communities and settled farmers. The community of wildlife researchers, ecologists, and social scientists is a small constituency, always having to deal with justifiable questions of balancing environment versus development. Involving citizens, especially students, provides us with a unique opportunity to share our experiences and concerns with a larger audience, which possibly may increase the impact of our groundwork and studies.