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LIFELINE FOR TIGERS

Status and Conservation of the Kanha-Pench Corridor

WWF-INDIA

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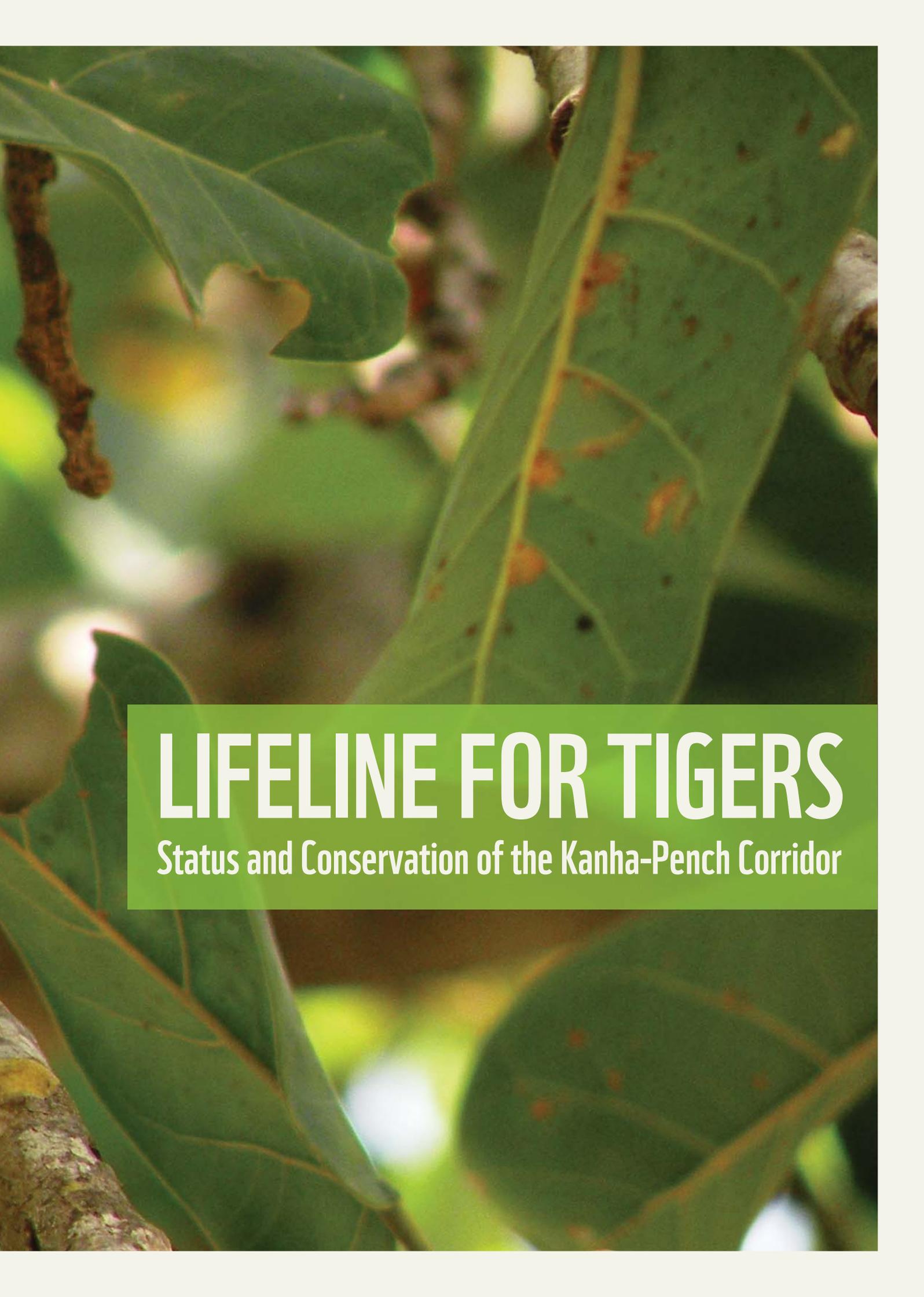
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A close-up photograph of several green leaves, likely from a tree, showing signs of insect damage. The leaves are vibrant green with prominent veins. There are several holes and irregular brown spots on the leaf surfaces, indicating feeding by insects. The background is softly blurred, showing more greenery and a hint of a tree trunk.

LIFELINE FOR TIGERS

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EXECUTIVE SUMMARY

The team of WWF-India's Satpuda Maital Landscape Programme conducted an extensive survey on tigers, co-predators and prey in the Kanha-Pench corridor.

This corridor, by connecting the Kanha and

Pench Tiger Reserves, sustains one of the most important meta-population of tigers in central India. The Kanha-Pench complex harbours around 120 tigers along with several important floral and faunal assemblages. The landscape also supports diverse land use, forest protection regimes and traditional forest dwelling tribal communities. The conservation significance and potential for long term viability of the tiger population in this landscape has been recognized by national agencies such as the National Tiger Conservation Authority (NTCA), Wildlife Institute of India (WII) and by various independent conservation biologists.

Realizing the conservation significance of the landscape and to support the management efforts by state forest departments, it seemed imperative to assess the vast managed forest between Kanha and Pench Tiger Reserves for wildlife usage and occupancy. One of the key objectives was to identify the important forest blocks, which serve as a refuge to dispersing wildlife across the corridor. The field survey was carried out in the late summer of 2010 i.e. in May and June as per the framework suggested in the NTCA-WII guidelines. The survey covered approximately 1700km² of managed forests under five forest divisions in Mandla, Seoni and Balaghat districts of Madhya Pradesh. To systematically sample the forest area between Kanha and Pench, a 10x10km size grid was superimposed over the map of forest cover and each grid cell (100km²) was considered as a sampling unit. Out of 22 such grid cells, 17 were intensively searched during 456 man-days as they formed the crucial corridor connectivity between the two tiger reserves. This area encompassed a total of 82 forest beats, out of which 79 were intensively searched for large carnivore and herbivore signs and indirect evidence. Simultaneously, human presence and disturbance was also assessed in each of these forest beats. The team walked on wildlife trails gathering evidence of wildlife occurrence, their habitat use and anthropogenic pressures.

Out of the 79 forest beats covered, tigers were found in 21 beats, leopards in 59, dholes in 25, sloth bears in 48 and Hyena in 8 beats. The highest sign encounter rate was for sloth bears *i.e.* 0.38 signs/km, followed by leopards (0.15 signs/km), tigers (0.12 signs/km), dhole (0.10 signs/km) and hyena (0.08 signs/km). Tiger occupancy was found to be 76% in the forest corridor. The data suggested the extensive use of this forest corridor by tigers and other co-predators. Dung and pellet count of wild ungulates were encountered in 82 sampled beats, out of which the Chital's pellets were found in 38 beats, Sambar's in 27, Nilgai's in 19 and Barking deer's in 17 beats. The Chaushinga seemed to be present only in two beats whereas very few dung signs of wild pig (only five beats) could be identified in the field.

Since the forest corridor is a multiple-use area, most beats showed direct or indirect human presence as there are more than 440 villages located in and adjacent to it (<5km). Among all anthropogenic pressures, livestock grazing seemed the most extensive as it was reported in 72 beats during this survey. Besides livestock grazing, collection of fuel wood and minor forest produce occurs all along the corridor. Other than community dependence on forest resources, the Forest corporation and production divisions also extract timber from this forest on a regular basis (Mohgaon, Lamta and Barghat Forest corporation areas). In addition to community dependency and legal timber extraction by the government, several linear developmental projects such as broadening of roads and broad gauge conversion of railway lines passing through the corridor are posing greater threats to corridor connectivity. Mushrooming of tourist hotels and resorts adjacent to both Kanha and Pench Tiger Reserves also hamper the movement of dispersing wildlife in the corridor. Increasing human and cattle population along the corridor has also resulted in escalated human-wildlife conflict issues, which affect the socio-political will in stepping up wildlife conservation efforts at the landscape level. However, WWF-India is striving to engage with various stakeholders to showcase and scale up conservation measures for the holistic conservation of tigers and their habitats.

The present study identified two important forest blocks, namely: a) Rukhad and b) Keolari-Kopijhola-Sonkhar, and four critical habitat linkages in the corridor which require immediate attention and management to ensure safe wildlife passage between Kanha and Pench Tiger Reserves. To secure and safeguard corridor connectivity in the long term, WWF-India recommends several measures such as: a) improving the compensation mechanism to the local community for loss of livestock and agricultural crops; b) intensifying patrolling and protection measures especially during summer, and monitoring water holes to prevent poisoning; c) developing an effective livestock management strategy to reduce cattle numbers while improving milk economy; d) engaging the local community in sustainable forest-based livelihoods such as collection and marketing of minor forest produce, ecotourism and Joint Forest Management; e) introducing energy conservation measures to reduce dependency on fuel wood; and f) developing strategies and mechanisms to keep a check on new developmental projects coming up in this area.

Keeping in mind the conservation significance of the Kanha-Pench corridor landscape, the forest department, being a legal custodian of the forest, should attempt to develop an institutional platform to discuss conservation and development concerns and to arrive at a consensus among all the stakeholders in this important corridor.

Below, we summarize our recommendations to mitigate various threats to the tiger and to ensure long-term conservation of this corridor.

Developmental Pressures

- Development projects in and around the corridor need to be planned with minimal impact on the long-term functional viability of the corridor.
- The upcoming roads and railway lines crossing through the corridor should be planned, keeping in mind the safe passage of wildlife. Construction of tunnels or underpasses can be helpful for the safe passage of wild animals. Speed breakers

in crucial areas on the roads will reduce the speed of vehicles, which in turn will minimize road kills. The train line passing through the crucial areas in the corridor should have a low speed limit.

- All developmental activity or construction of resorts and hotels around the tiger reserves should be regulated according to the 'eco-sensitive zone' guidelines issued by the Ministry of Environment and Forests, Government of India. Strict implementation of the necessary regulations is required to reduce the ecological footprint of these resorts.

Human-Animal Conflict

- In the forests of Baihar and Mukki range of the Kanha Tiger Reserve, individual tigresses and a tigress with cubs have often been 'camera trapped' on kills. Efforts should be made to increase protection and regular monitoring in areas like those.
- The Keolari-Kopijhola-Ugli areas harbour a resident female tigress. This block is under the territorial and corporation division. Small scale poaching and poisoning of herbivores has been recorded in this area, making the tigers more vulnerable.
- Wildlife is at its most vulnerable during summer, due to scarcity of resources. Water is the key limited resource in this highland. Special monitoring of water holes should be carried out all along the corridor, to effectively deter the poaching of herbivores and poisoning of tigers and other carnivores.
- The compensation process by the forest department is lengthy and time consuming. Steps should be taken to make the whole process smooth and fast. We suggest that to reduce the time lag in payment of compensations: i) lower forest officials should be authorised to make payments and; ii) local village institutions should be involved and empowered to make compensations from a 'pool fund' vested with them.

Resource Dependency of Local Communities

Our observations indicate that although livestock rearing is a part time livelihood activity, most of the cows are unproductive. Milk economy is not very evident in this region, though the cattle numbers are enormous. At the same time, the negative impact these cattle have on the forest is alarming. We recommend that removal of unproductive cattle should be considered and attempts should be made to improve cattle breeds through artificial insemination. Communities should be motivated to rear good cattle breeds with a 'stall feeding' option, which can provide a good income generation opportunity. Also, the dung can be used as biogas, thus reducing the pressure of fuel wood collection on the forest, while the residue from biogas can be used as a fertilizer.

We suggest that a detailed study be undertaken on land use patterns, socio-economic status and the magnitude of forest dependency by these settlements or villages. Local resources should be identified to plan suitable management strategies for the villagers' livelihood issues and to make them friendlier towards conservation actions as well as motivate them to be a part of conservation. Development projects in and around the corridor need to be planned ensuring minimal impact on the long-term functional viability of the corridor.



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1. THE SATPUDA MAIKAL LANDSCAPE: AN INTRODUCTION

Most Protected Areas (PA) in India are analogous to small islands in a vast sea of ecologically unsustainable land use. Many of these protected areas are too small to sustain viable populations of large mammals in the long term and therefore such species are prone to local extinction (Hanski, 1994; Wikramanayake *et al.*

1998; 2004). Establishment of small isolated pockets of protected areas has not been able to stem the overall decline of the species. However, this can be seen as crucial first step towards creating a network of secure habitat space for certain populations (Weber and Rabinowitz, 1996).

In recent times, conservation biologists have advocated the conservation of wide ranging species such as tiger on a meta-population level (Margules and Pressey, 2000; Jhala *et al.* 2008). Herein, the main idea is to protect breeding populations as a 'source pool' and provide dispersal opportunities by linking habitat patches across the landscape mosaic to maintain a larger population. Tiger reserves and some protected areas serve as source populations for tigers, while intervening forested areas act as connecting corridors. Thus the 'tiger bearing forests' need to be fostered with protection as well as with restorative inputs to ensure the demographic and genetic viability of tiger populations.

1.1 Geographical Location

The Central Indian Highlands are a distinct province within the Deccan Peninsula zone, as per the bio-geographic classification of India by Rodgers and Panwar (1988). These highlands comprise two parallel chains of hills viz., the Satpuda and the Vindhya Ranges, which run almost continuously from east to west and are separated by the river Narmada all along its course. The Satpuda Maikal Landscape (SML) in the Central Indian Highlands is situated along the Satpuda and Maikal hill ranges, between the Melghat Tiger Reserve in Maharashtra and the Achanakmar Tiger Reserve in Chhattisgarh, encompassing an area of over 118,113km² (Figure 1). Administratively, the landscape spans over 15 districts of three states, namely Madhya Pradesh, Maharashtra and Chhattisgarh.

The mean elevation of the Vindhyas in the north varies between 450 and 600m, though a few points rise above 900m (Jaypal *et al.* 2005). In contrast, the Satpudas in the south are characterized by several high peaks, the highest being the Dhupgarh (1348m) near Pachmarhi.

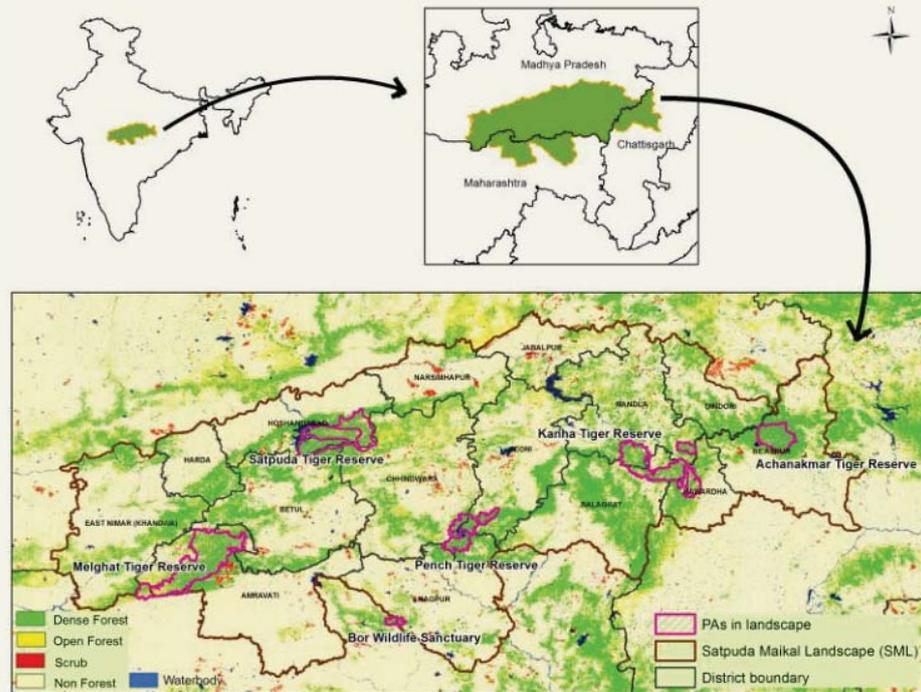
The Central Highlands are primarily covered with tropical dry and moist deciduous forests. While Teak (*Tectona grandis*) dominates the forest in the western and central

parts of the region, an abundance of Sal (*Shorea robusta*) can be found in the moist deciduous forests in the eastern ranges. The northern part of the landscape has forests dominated by stunted Sal, *Anogeisus* sp. and *Acacia* sp. interspersed with several miscellaneous species. The southern half of the landscape has a drier forest association. Some of the natural grasslands, mostly those along river valleys, have now become agricultural lands while some other areas are preserved in the successional stage of anthropogenic grasslands (e.g. old village sites or wastelands) by fire, tree cutting and livestock pressure (Qureshi *et al.* 2006). The Satpuda Maikal watershed comprising the Narmada, Son, Pandu, Kanhar, Rihand, Bijul, Gopad and Banas Rivers, running almost parallel to each other from south to north, is the second largest in India (Gopal and Shukla, 2001).

Whilst much of the central Indian forests have been greatly disturbed by anthropogenic development, the area still contains some of India's finest forests. The majority of the forests are of a deciduous nature, but the hill ranges are more diverse.

FIGURE 1

The Satpuda Maikal Landscape showing Forestcover, Protected Areas and Administrative boundaries. The K-P corridor is distinctly visible as a thin winding strip of forest between the Kanha and Pench Tiger Reserves



1.2 Climate

The climate of the SML can be differentiated into three seasons – extended summer, winter and a short monsoon. The average rainfall varies from 1000mm annually to 1400mm across the landscape. The temperature can range from 0° in winter to as high as 49° in the summer (Gopal and Shukla, 2001).

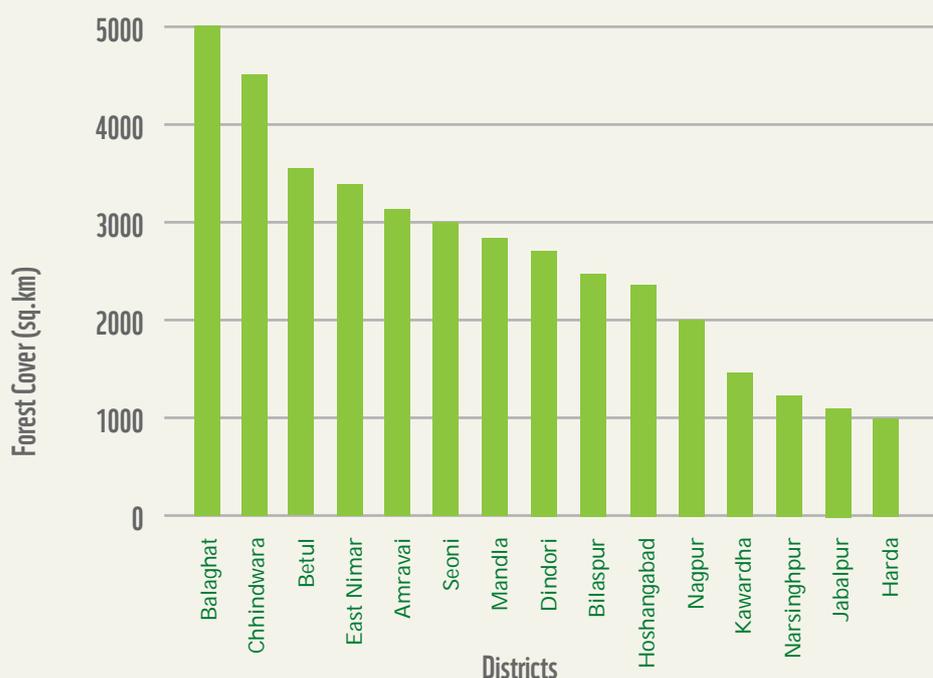
1.3 Forests

The landscape measures 118,113km² out of which 40,837km² (34.6 per cent) is forest cover (Forest Survey of India, 2011). The forest cover in the districts of SML is shown in Figure 2. Recognizing the importance of this landscape for tiger conservation, several Tiger Reserves have been established here. These are Kanha, Satpuda, Pench, Melghat and Achanakmar Tiger Reserves. These tiger reserves have some degree of connectivity in the form of corridors: Kanha-Pench, Pench-Satpuda, Kanha-Achanakmar and Satpuda-Melghat.

Though more than a quarter of SML is still forested, there are growing signs of forest and environmental degradation. The landscape is crucial for securing long-term tiger conservation, as within this landscape there are six tiger reserves and four forest corridors connecting these tiger areas with each other to form a single inter-connected complex of tiger habitat covering more than 40,000km².

FIGURE 2

District-wise forest cover in the Satpuda Maikal Landscape



1.4 People

The forests in the landscape are interspersed with human habitations. There are forest villages as well as revenue villages located within the landscape. Several ethnic tribes inhabit the interiors of these forests. The major ethnic tribes/groups in the landscape are the Baiga, Gond, Baharai, Korku, Ahir, Dhoba and Panka. Besides these tribes, Yadav, Panwar, Banjara, Pardhi and Jharia communities also reside in the landscape. The Baigas (Figure 3) are primarily hunter-gatherers, whereas the Gond and Korku are dependent on farming and livestock grazing. Most of the other communities are

FIGURE 3
Baiga community in
the SML

dependent mainly on farming for their livelihood, while the Yadav are semi-nomadic people who mostly depend on livestock grazing in the forests. The Pardhi are the major traditionally hunting community found in the landscape. While farming is the major livelihood activity, most communities are also dependent on forest-based resources, small-scale mining and marginal labour.



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1.5 Biodiversity

The landscape is rich in biodiversity. Forest diversity is evident in the form of Teak dominated forests, Sal forests and mixed deciduous forests with some areas being mainly grassland (Dadar). The forest corridors between the different tiger reserves not only connect tiger populations but are also important for maintaining biodiversity. The large mammal assemblage consists of large carnivores like the tiger, leopard, sloth bear, dhole, hyena, jackal and wolf; and large bodied herbivores such as the gaur, nilgai and sambar. Chital, barking deer, blackbuck, and four horned antelopes are also found in this forest area. The area also supports a rich avian fauna (Jaypal *et al.* 2005). The landscape is home to two unique species, the hard ground Barasingha (*Rucervus duvaucelii branderi*) which is only found in the Kanha Tiger Reserve and the critically endangered Forest Owlet (*Athene blewitti*), thought to be extinct until re-discovered in 1997 in this landscape (Rasmussen and King, 1998). With about 100 pairs, the Melghat Tiger Reserve holds the largest known population of this rare endemic Forest owlet (Birdlife International, 2013).

Melghat Tiger Reserve in SML is a stronghold of the rediscovered, critically endangered Forest Owlet. This painting was published in 1891, soon after the last known record of the bird in 1884. Though with some inaccuracies, it remained one of the best illustrations of the species for over a century. Illustration by John.G.Keulemans. Published in Sharpe, Bowdler R. (1891) *The Scientific Results of the Second Yarkand Mission: based upon the collection and notes of the late Ferdinand Stoliczka. Aves.* London: Published by Order of Government. of India.



1.6 Tigers

Tiger Reserves and forest blocks in the central part of India have been globally recognized as important for tiger conservation. Kanha-Pench, Indravati-Navegaon, Melghat, Andhari-Tadoba and Sitanadi-Udanti have been identified as priority Tiger Conservation Landscapes (TCL) of global importance (Wikramanayake *et al.* 1998).

The National Tiger Conservation Authority (NTCA), India, also recognizes this landscape as a priority area for long-term tiger conservation (Jhala *et al.* 2008). The Central India tiger population is estimated to be 601 (515-685) within the forested area (Jhala *et al.* 2011). Of this, SML tiger population is estimated to be more than 300 (Jhala *et al.* 2011). Some of the important tiger population bearing areas in this landscape are: Kanha, Achanakmar, Boramdeo, Pench, Satpuda-Pachmarhi-Bori and Melghat.

2. ASSESSMENT OF TIGER, PREY AND HABITAT STATUS IN THE KANHA-PENCH CORRIDOR

The Kanha-Pench corridor (KPC) area in the Satpuda Maikal hill ranges forms one of the most crucial tiger conservation units of the world, as it is still a contiguous forest patch of 16,000km² (Wikramanayake *et al.* 1998). Besides, out of the 601 tigers in Central India, more than 120 tigers were reported from the Kanha-Pench landscape i.e. Kanha Tiger Reserve, Pench Tiger Reserve and the forested area connecting both these reserves. Kanha has a recorded tiger presence in 2609km², supporting a population of 60 tigers (range 45-75), while Pench has a recorded tiger presence in 1987km², supporting a population of 54 (range 44-65) tigers (Jhala *et al.* 2011). Though tiger abundance is reportedly low in the Mandla, Seoni-Balaghat and Baihar forest divisions intervening the Kanha and Pench landscape (Jhala *et al.* 2011), they can form a viable corridor connecting Kanha and Pench.

Although there have been several studies on the tiger population of Kanha as well as Pench, very little effort has been made to study the meta-population of tigers and the connectivity between these two tiger reserves, which is of critical importance for the continued presence of a healthy population of tigers in this tract. Recent genetic studies have found a continuing gene flow between tiger reserves in the Satpuda–Maikal landscape (Sharma *et al.* 2012, 2013) and recorded tiger presence in KPC.

To assess the distribution of tigers in this corridor, the team surveyed the forest tract falling in five forest divisions namely, Mandla (East and West), Mohagaon Project (Corporation), South Seoni and parts of Balaghat, (Figure 5) which form the Kanha-Pench corridor. The length of this corridor is approximately 160km and it lies between 79°30' 05" to 80° 32' 55" and 21° 45' 15" to 22° 24' 20". The total area covered for this study was 2200km² (Figure 4). The present study was initiated with the goal to ensure connectivity and long-term conservation of the meta-population of tigers in the Kanha-Pench landscape. The study tries to identify vital forest areas that are being used by tigers to move between the two source populations (Kanha and Pench Tiger Reserves) and highlight immediate concerns so to ensure the connectivity between these Protected Areas for a long-term conservation of tigers in a meta-population framework.

2.1 Objectives

The main objectives of the study were as follows:

FIGURE 4

**Kanha-Pench corridor
in the Satpuda
Maikal Landscape of
Central India**

Source: Wildlife Institute
of India

1. To assess the habitat use of tigers and other carnivores in the Kanha-Pench corridor (KPC).
2. To assess the distribution of tiger prey species, extent of human disturbance and connectivity between two existing source populations, i.e. Kanha and Pench Tiger Reserves.
3. To identify critical areas within KPC for immediate as well as long-term conservation measures.
4. To identify and document different wildlife conservation related issues in the corridor.

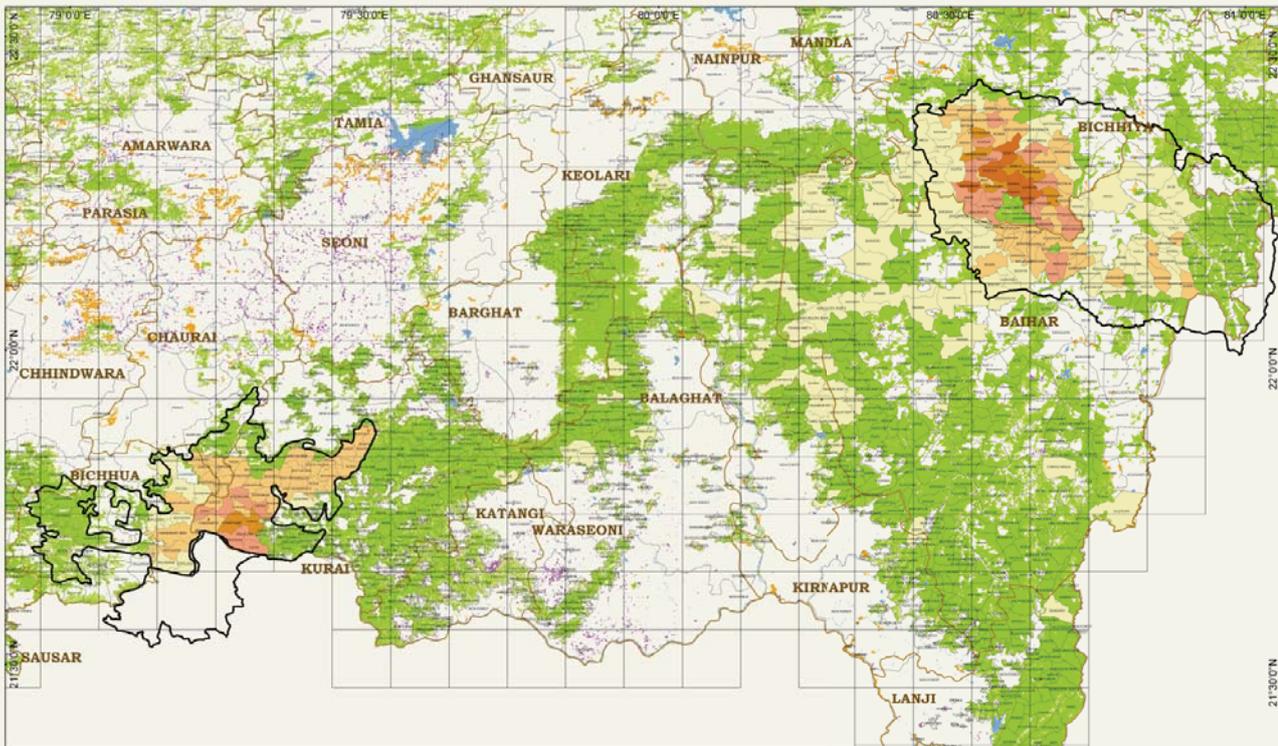
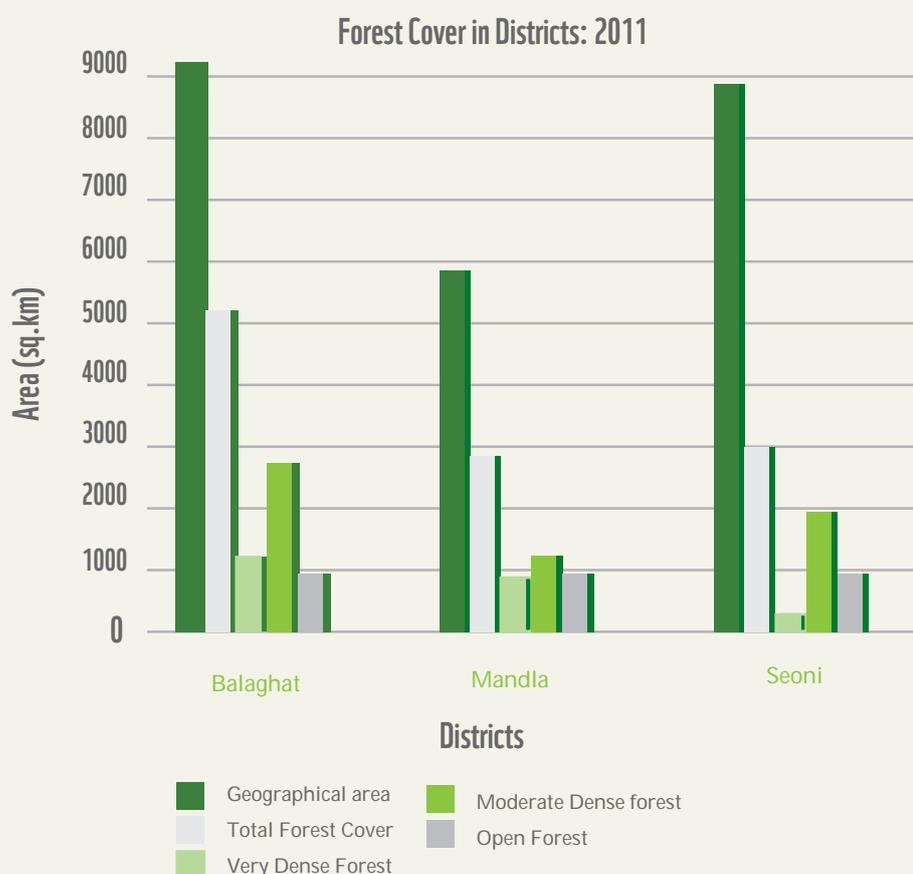


FIGURE 5

Total geographical area and forest cover in Mandla, Balaghat and Seoni districts

Source: Madhya Pradesh Forest department



2.2 The Survey

2.2.1 Survey design

As part of the All India Tiger Estimation exercise of NTCA, we undertook the occupancy survey for tigers in the Kanha-Pench Corridor. The survey was conducted to determine tiger bearing areas in KPC. Fieldwork was carried out during the period of May-June 2010.

10×10km² size grids were superimposed on the land-cover map of KPC, resulting in 22 grids, out of which 17 grids were sampled for tigers and other wildlife occupancy and use. We surveyed for carnivore signs in spatially replicated segments within each of the 17 grids. Following Karanth *et al.* (2011), we excluded grids with less than 10% tiger habitat) and forest fragments less than 10km² from the survey. Tiger presence was assessed with sign detection data generated from the occupancy sampling of the 100km² sized grids. We also surveyed the area for ungulate prey presence, human disturbance and habitat status. These surveys in KPC provided the key data to map tiger distribution so as to identify use of the corridor by tigers and associated mammals.

A total of 1700km², which consisted of 82 beats within the 17 (100km²) grids, was intensively surveyed. The study covered five forest divisions within the KPC namely; South

Seoni, Mohagaon, East Mandla, West Mandla and parts of Balaghat division. Two major linkages have been suggested by Sen (2007, unpublished report) namely: a) the Kanha-Pench direct link via Sarekha ghat-Latgaon-Nainpur-Khatiya-Mocha and b) the Boda-Khapa-Jalgaon-Pandiyachapara link outside the corridor. The latter link could not be surveyed during the present study, due to logistical and insurgency problems in the extensive forest of Balaghat district.

2.2.2 Field protocol

The survey was conducted in the dry season of May and June to minimize variations in animal detection probabilities induced by rainfall. Typically, tigers move along forest trails to hunt or to locate, avoid or deter conspecifics (Karanth and Sunquist, 2000). Their passage is marked by tracks and occasional scat deposits (Sunquist and Sunquist, 1989; Smith *et al.* 1987). Fresh signs of tigers, leopards, dholes and major ungulate prey species in KPC were identified and recorded by trained observers. Only unambiguously identified signs were recorded. Overall, the number of spatial replicates in a grid (sampling effort) varied from 2 to 7, depending on the extent of habitat within the grid. We photographed and recorded signs of tigers, leopards, dholes and ungulate prey species, as well as signs of livestock or human presence.

Of the 82 forest beats (average area: 20km² approx.), 79 beats were extensively surveyed for carnivore signs. Areas within a beat were systematically sampled and searched for tiger signs, starting with the areas most likely to have a tiger presence.

The field survey, conducted during May to June 2010, had an effort of 456 man-days. We followed the systematic framework as suggested by Jhala *et al.* (2008) to assess the status of other carnivores, prey and their habitat in the Kanha-Pench corridor.

2.3 Findings

2.3.1 Distribution of tigers

We provide the results with 'beats' as a unit, since it is the smallest administrative unit of the forest department. Aggregated to the 100km² grid cells for a large predator like the tiger, it is an appropriate ecological scale of sampling. A total of 391.17km was searched during the carnivore sign survey. Tiger signs in the form of scats and pug-marks were recorded in 21 beats. The overall tiger sign encounter rate was 0.12 signs/km. Direct sightings of tigers were recorded in Kopijhola and Rukhad areas during the survey. Leopard signs were recorded from 59 beats with an overall sign encounter rate of 0.15 signs/km. Dhole signs were recorded from 25 beats with an overall sign encounter rate of 0.10 signs/km. Hyena signs were recorded from 8 beats with an overall encounter rate of 0.03 signs/km. Sloth bear signs were recorded in 48 beats with an overall encounter rate of 0.38 signs/km.

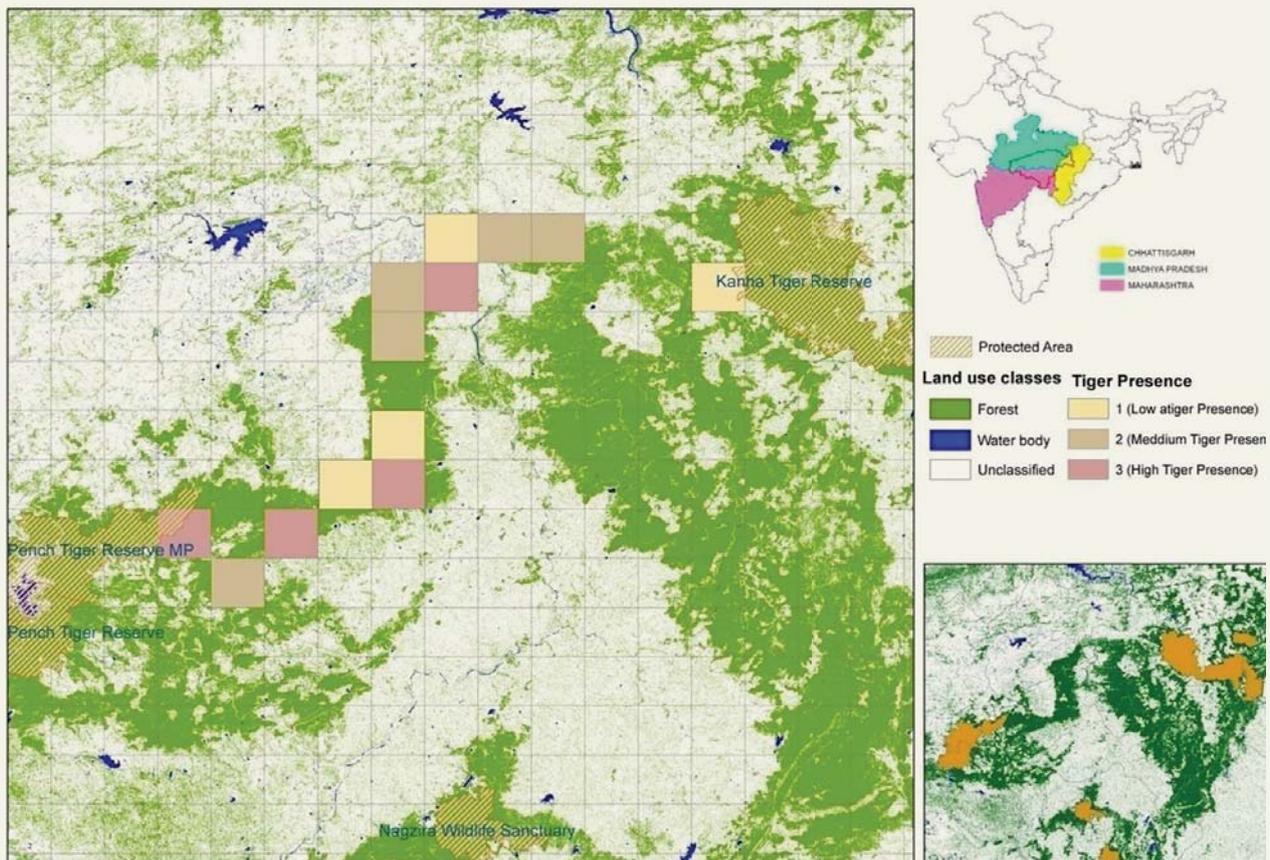
Aggregated to the 100km² grids, we found tiger signs in 13 grid cells out of 17 surveyed (Figure 6), giving a naive occupancy of 76%. Given the limited sample size, we did not pursue detailed statistical occupancy analysis. However, surveys revealed a very high

FIGURE 6

**Tiger presence
(indirect and direct
evidence)
in the study area.**

proportion of the corridor area being used by tigers. Tigers were found to be using more than three-fourths of the forested tract that forms the corridor between Kanha and Pench Tiger Reserves.

Tiger presence was high in South Seoni division, as most of the KP corridor falls in this forest division. Among all the ranges sampled in this division, Rukhad, Kurei and Ugli range indicated a particularly high tiger presence. It is worth mentioning that since



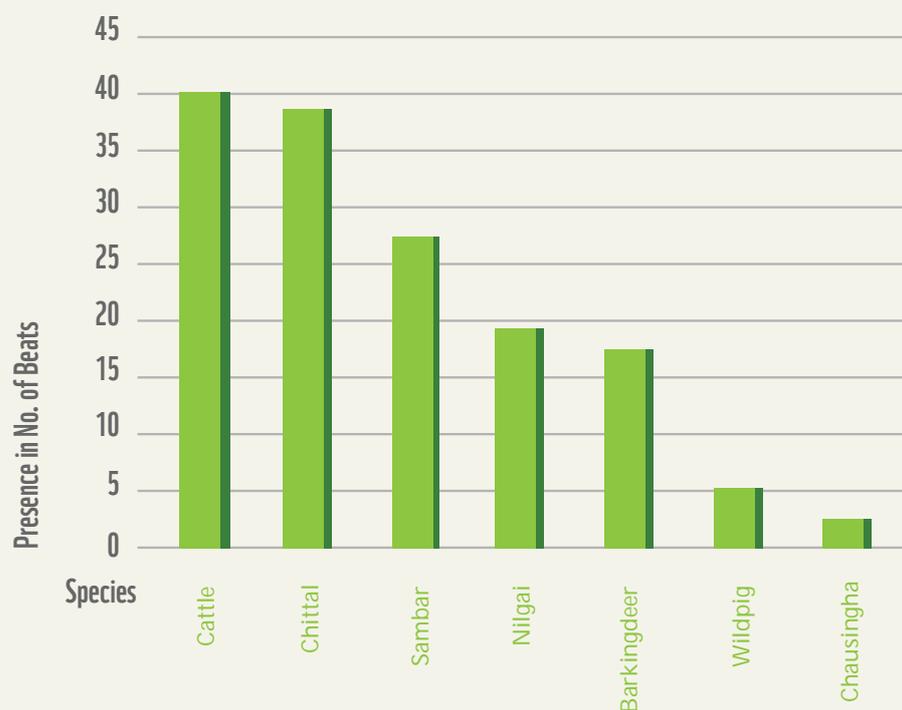
Rukhad and Kurei are adjacent to the Pench Tiger Reserve, the prey density in these areas is likely to be good, and can support a few dispersing tigers venturing out from the Pench Tiger Reserve. There have been several tiger sightings in Rukhad and Kurei ranges, and tiger signs are also frequently found here. A tiger was sighted directly in the Kopijhola beat of Barghat range during the survey period itself.

2.3.2 Wild-prey and livestock distribution

Pellet counts were undertaken to record the presence and absence of prey species in the study area. Out of 82 beats sampled, pellet counts were conducted in 78 beats. Cattle dung was recorded in 40 beats, Chital pellets in 38 (Figure 8), Sambar pellets in 27 (Figure 9), Nilgai pellets in 19 and Barking deer pellets in 17 beats. Wild pig and Chausingha pellets were found in only 5 and 2 beats respectively (Figure 7). The pellet data provided us with information on the presence of different prey species within the study area.

FIGURE 7

Indirect evidence of prey species (pellets/dung) found in sampled beats (n=78 beats)



Among the prey species, Gaur showed a very restricted distribution in the corridor. They were only found close to the Protected Areas. Although there was no any direct sighting of Gaur on the line transect, it was sighted on several occasions in Rukhad and Kurei areas close to Pench. Beyond this, Gaur were not recorded in the entire corridor stretch towards Kanha. Blackbucks and Chausingha too showed patchy distribution and were seen more frequently near Keolari (in the central part of the corridor), whereas Chital, Sambar, Wild pig and Barking deer were found throughout the corridor.

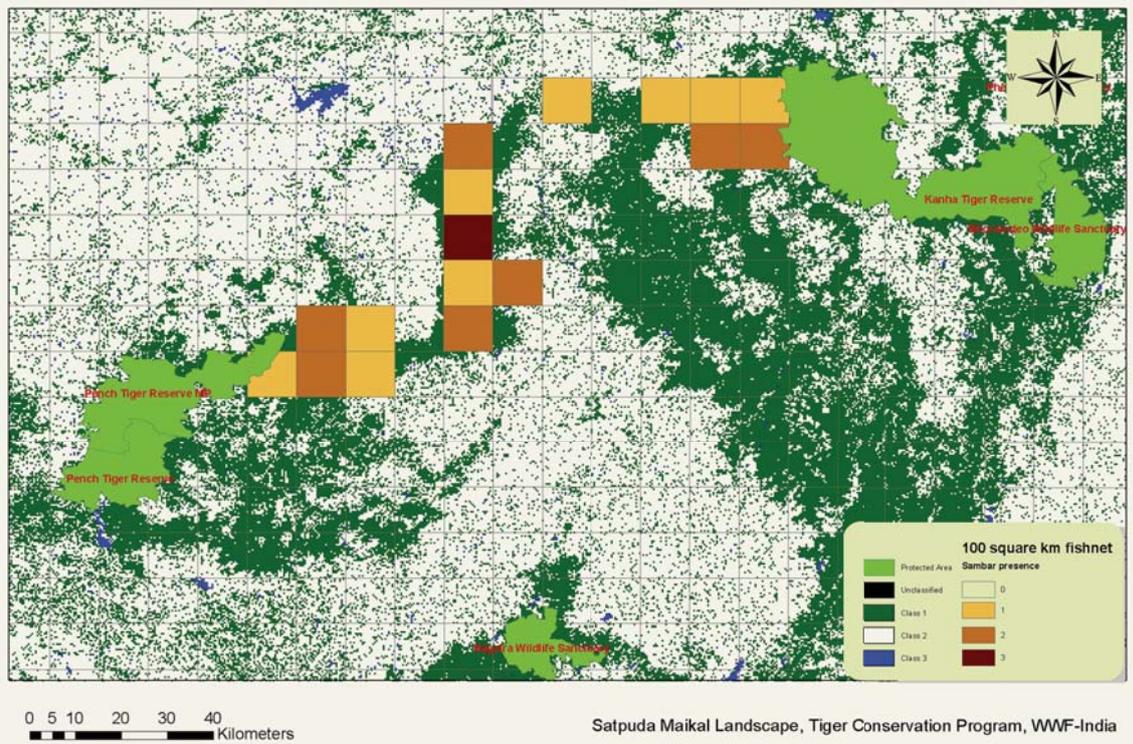
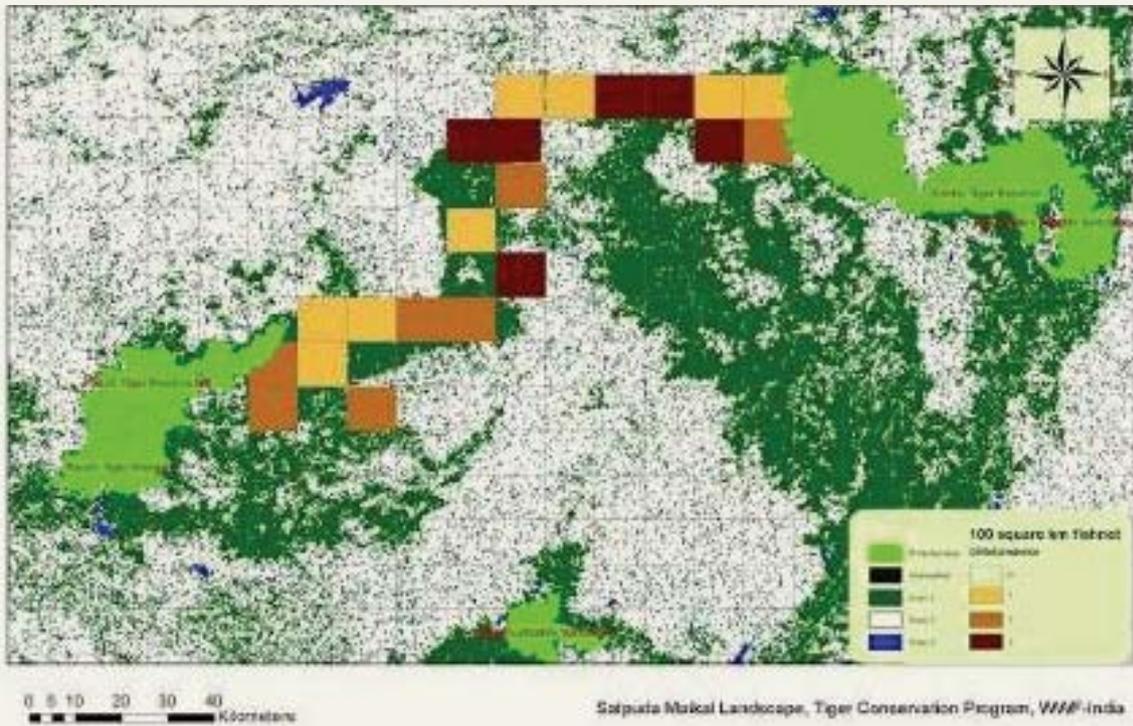


FIGURE 8 | Chital pellet abundance (top)

FIGURE 9 | Sambar pellet abundance (bottom)

2.3.3 Human Disturbance

Out of the 82 beats surveyed, human presence was recorded in 72 beats, in the form of direct sighting, presence of human trails, wood cutting, lopping of trees and bamboo cutting. Livestock was seen in 15 of the beats, while livestock trails were found in 72 beats (Figure 10). Human dependency on the forest was found to be high all along the corridor. While surveying these areas, several local people were found cutting trees or collecting non-timber forest products. Collection of *Diospyros melanoxylon* leaves (tendu patta) was high in these areas during the study period. There are more than 400 villages all along the corridor, and the livelihoods of the villagers are largely dependent on agriculture and forest resource collection. There is also tremendous grazing pressure on the forest from the livestock being reared by the villagers. The majority of their livestock graze in the nearby forests close to human settlements.

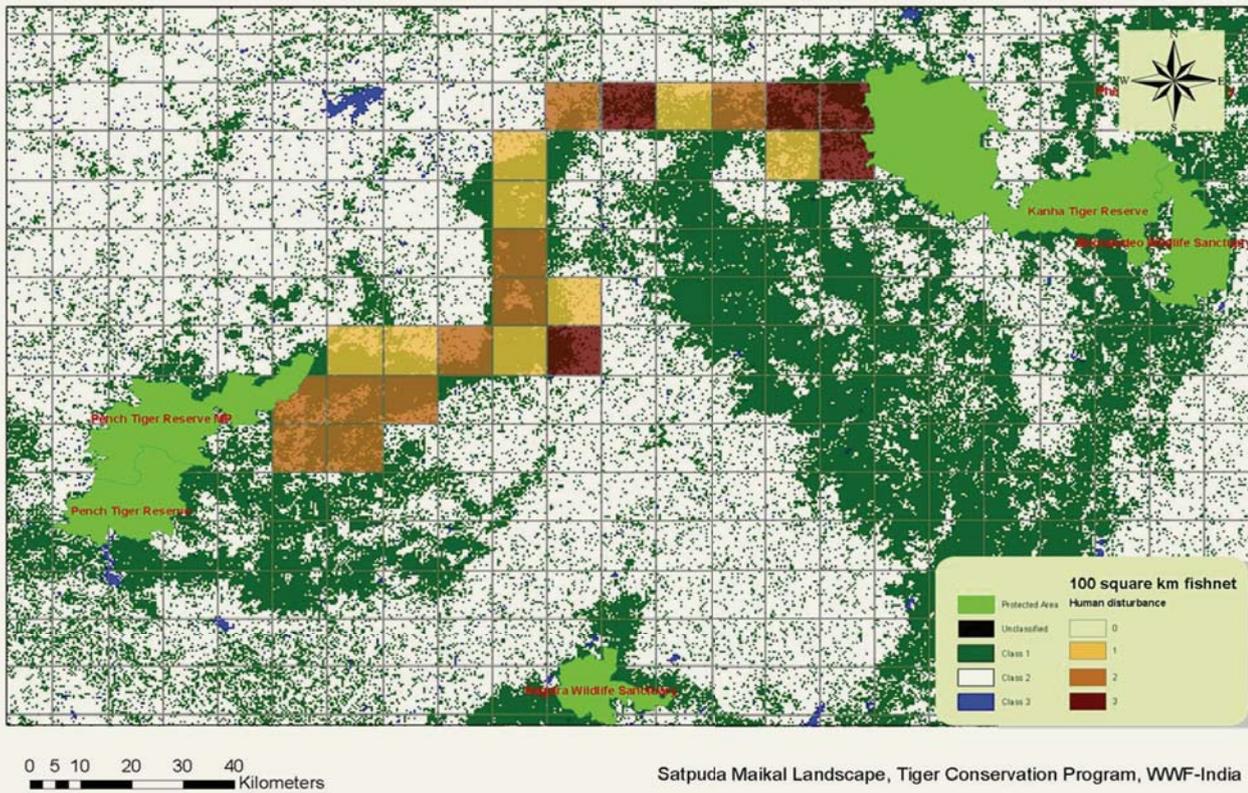


FIGURE 10
Map showing human disturbances in Kanha-Pench corridor

3. CRITICAL HABITAT LINKS AND BLOCKS IN THE KANHA-PENCH CORRIDOR

3.1 Critical Linkages

Though much has been said and discussed about the Kanha-Pench corridor, no systematic effort has been carried out to identify the exact boundary or area of this corridor. The forests which connect the two tiger reserves fall under several territorial divisions, which have different levels of legal protection status, i.e. reserve forest, protected forest and some under the corporation division as well, permitting harvesting of timber and bamboo. To manage and maintain the connectivity, it is essential to have identified corridors with ecological sensitive zones. An unpublished report by Sen (2007) has identified several crucial linkages in this forest corridor. A recent study by WWF-India (Vattakaven, 2010) also recognizes certain developmental threats in this corridor. We therefore emphasize that maintenance of these linkages should be

given immediate priority (Figure 11). In the present study, we have identified major habitat blocks and the weak linkages between them, based on tiger presence, prey base and current human pressure. Our aim is to spur immediate action on the weak linkages so that protection of critical habitat blocks can be ensured, thus securing movement between larger blocks. The linkages (Figure 11) that are crucial for maintaining connectivity in the Kanha-Pench corridor and which need immediate attention have been discussed below.

3.1.1 Sarekha Ghat

The Sarekha ghat linkage is the most crucial connection between the forests of Sonawani and Rukhad and Sakata. At present, it provides a very narrow but vital forest connectivity, crucial for maintaining the functionality of the corridor. It needs to be emphasized that this narrow patch is the only connection for dispersing tigers from Pench to the rest of the corridor. Rukhad and adjacent areas support a good prey as well as tiger presence. This linkage is the major connectivity for tigers moving further towards the Sonawani forests. If this connectivity is lost, the Pench Tiger Reserve will become disconnected from the corridor and hence from the Kanha Tiger Reserve as well.

3.1.2 Latgaon

This linkage connects the Sonawani forest to the Kopijhola-Sonkhar block. It is split into two narrow patches due to the presence of some villages. These villages exert a huge pressure on both the narrow patches. Low tiger presence was recorded in this area, but it is crucial in terms of tiger dispersal and for securing tiger movement between the two larger blocks of Kopijhola-Sonkhar and Rukhad to Sonawani.

3.1.3 Nainpur

The Nainpur linkage connects the Kopijhola-Sonkhar block to the Kota block. Even though the Nainpur linkage is not as narrow as the above two linkages, several recent developmental pressures (roads and railway lines) have caused it to require immediate attention. The broadening of the railway line and a state highway running from Nainpur to Balaghat threatens the safe dispersal of tigers and other wildlife. Areas like Keolari, Ugli and Arjunjhiri, which have registered a healthy presence of tigers and other wild life have also become sensitive. Also, dependency for fuel wood and grazing pressure on the forest from villages is high.

3.1.4 Khatiya Mocha

The Khatiya Mocha link provides important connectivity to the corridor and is vital for its functionality. As this link adjoins the Kanha Tiger Reserve, tigers dispersing from Kanha use this forest patch for dispersal to the corridor as well as to the forests of Balaghat. However, there has been a drastic change in the past few years in terms of land use patterns (personal observation) and rapidly increasing resorts and hotels, which have resulted in loss of connectivity. What remains now are small forest patches. The increase in tourism has resulted in the mushrooming of hotels and resorts in this link, which exerts pressure on forests. Numerous villages are also present on this link. The villagers depend on the forest for the produce and for grazing their livestock. The patchiness of this linkage and disturbance due to tourism activity from resorts and hotels sets a major hurdle in the safe dispersal or movement of tigers and other wildlife, and needs to be addressed immediately.

3.2 Key Tiger Habitat Blocks

In spite of the weak linkages, there are some blocks, which provide a good habitat for tigers. These compact blocks have good forest cover and can potentially support a sufficient prey base for tigers. Though there are settlements and associated pressure on the forests, these blocks, with some degree of protection and management, can provide safe ground for dispersing tigers. The major blocks identified in the Kanha-Pench corridor are:

- A. Rukhad Block
- B. Keolari-Kopijhola-Sonkhar Block

The present study did not cover the forests of the Balaghat division. Hence, details on the linkages in Balaghat have been excluded.

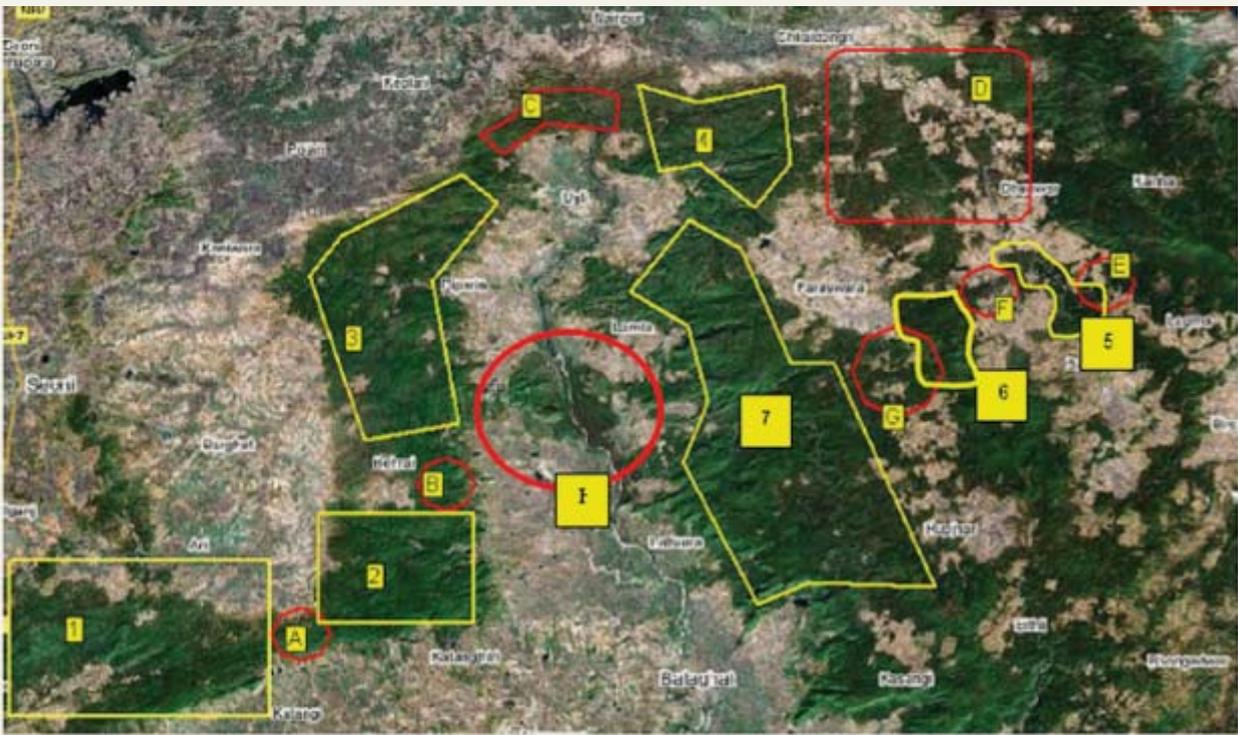


FIGURE 11

Linkages in Kanha-Pench corridor

Source: Sen 2007, unpublished report

- A.** Sarekha Ghat
- B.** Latgaon Corridor
- C.** Nainpur Corridor
- D.** Khatiya-Mocha Patch
- E.** Boda link
- F.** Khapa Link
- G.** Jalgaon–Amwahi link
- H.** Pandiyachhapara link

- 1.** Proposed Rukhad Sanctuary
- 2.** Sonawani Block (120 sq. km)
- 3.** Kopijhola Block (182 sq. km)
- 4.** Kota Block (148 sq. km)
- 5.** Tatighat Block (15 sq. km)
- 6.** Sarekha Block (67 sq. km)
- 7.** Loghur Block (500 sq. km)



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4. THREATS IN THE KANHA-PENCH CORRIDOR

This study was instrumental in documenting the immediate threats in the corridor, which are summarized below.

The entire corridor area comes under several territorial forest division jurisdictions, with varying degrees of effective protection. However, there are several permanent

human settlements (revenue as well as forest villages) all along the corridor. There are approximately 440 villages in the forest corridors between Kanha and Pench and the population is ever increasing. The human population of Mandla, Balaghat and Seoni districts has increased by 14.66, 13.56 and 18.20 per cent respectively in the past ten years (Census of India, 2011). The major threats within this corridor are the growing population, developmental activities, unplanned land use development and increase in the number of cattle, resulting in loss of habitat contiguity as well as increase in human-animal conflicts..

4.1 Development Pressure

Several developmental activities in the Kanha-Pench corridor pose a great challenge in managing the wildlife habitat. Among these, the most severe threats are the upcoming roads and railway lines. Although there are several roads running through the corridor, two major roads pose the foremost threat to the corridor; namely the road connecting Keolari to Balaghat via Ugli, and the road connecting Nainpur to Balaghat that runs parallel to the Nainpur-Balaghat railway line. A study by Vattakaven (2010) has highlighted the impact of these roads on the dispersing animals. While conducting the present study, several wild animal road kills were recorded on both the roads, which runs through the corridor at several points.

Besides these two roads, the National Highway-7 (NH-7) is a major barrier for animals near the Pench Tiger Reserve (Figure 12). Already numerous road kills have been documented and its impact on the wildlife population is not yet fully understood. Recent plans for broadening this highway are bound to further adversely affect the dispersal of animals.

FIGURE 12

**Road kill along NH-7
passing through the
Kanha-Pench corridor**



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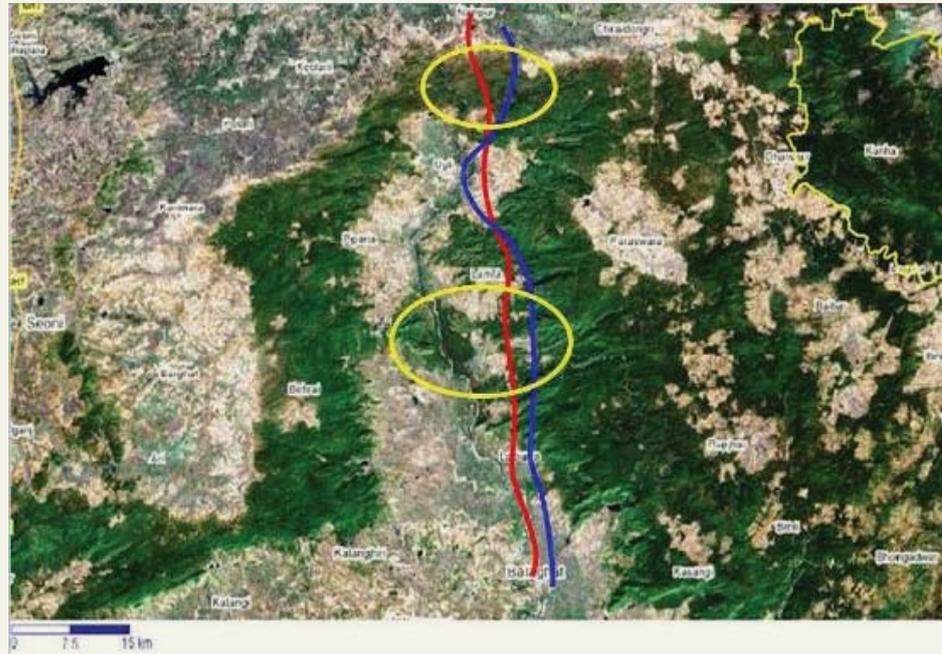
The proposed broadening of the railway track from Nainpur to Balaghat will severely impact the corridor. The length of the track is 74.9km, out of which 17.9kms run through the Kanha-Pench corridor (Figure 13). The line cuts the corridor into two halves at two crucial linkages i.e. the Nainpur and Pandiyachapara sections. The broadening of this line requires 69.75 hectares of additional land. Currently, the narrow gauge line supports a maximum speed limit of 40km per hour. Once the railway line is broadened, the maximum limit will be 100km per hour, which may increase the chances of animals being killed.

Besides roads and railway lines, a serious developmental threat to this corridor is the mushrooming of hotels and resorts near the Kanha and Pench Tiger Reserves. These two tiger reserves act as the source population of tigers and the corridor connectivity supports the safe genetic exchange between the two populations. But in the recent past, tourism has flourished and several new resorts have come up around these tiger reserves. Many of these resorts are in Mocha, Khatiya and towards Baihar. All these areas are key parts of the corridor. Unregulated construction of hotels and resorts breaks the safe connectivity of Kanha from the rest of the corridor (Figure 14). At present, more than 50 resorts exist near the Khatiya gate of the Kanha Tiger Reserve. The presence of these resorts will have a long-term impact on tiger dispersal in terms of crowding

FIGURE 13

The railway line (in red) passing through the K-P corridor affecting two crucial linkages: Nainpur link and Pandiyachapara link (in yellow); the adjoining road (in blue) from Nainpur to Balaghat. (Lines are approximate representation)

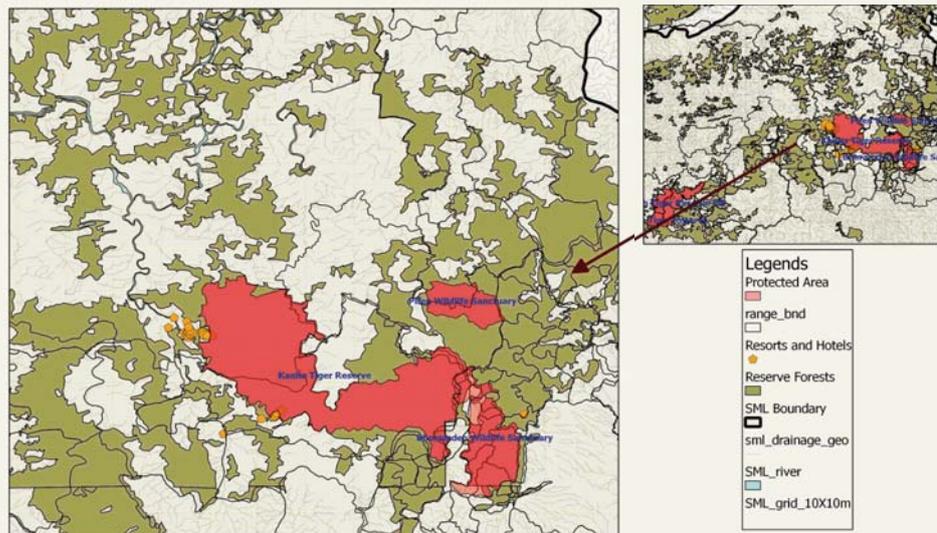
Source: Vattakaven, 2010



activity, vehicular movement, night light as well as pressure on the forest. Also, there is no clear-cut policy to monitor the ecological impacts of these resorts. This needs immediate attention if the connectivity is to be secured.

FIGURE 14

Location of resorts and hotels around Kanha Tiger Reserve



4.1.1 Recommendations

Development projects in and around the corridor need to be planned in a manner that ensures minimal impact on the long-term functional viability of the corridor. The upcoming roads and railway lines crossing through the corridor should be planned, keeping in mind the safe passage of wild life. Construction of tunnels or underpasses can be helpful for safe wild animal passage. Also, speed breakers in crucial areas on the roads will reduce the speed of vehicles, thus minimizing the death of wildlife through road kill. The train line passing through the crucial areas in the corridor should have a low speed limit.

All developmental activities or construction of resorts and hotels around the tiger reserves should be regulated according to the 'eco-sensitive zone' guidelines issued by the Ministry of Environment and Forests (MoEF), Government of India. Strict implementation of the necessary regulations is required to reduce the ecological footprint of these resorts.

4.2 Human-Animal Conflict

The human-animal conflict is a challenging issue in the Kanha-Pench corridor. Conflict arises mostly due to crop raiding by wild ungulates and cattle lifting by carnivores in the corridors. The crop raiding intensity is high all along the corridor and cattle lifting cases in the forest divisions are common within the area. Due to the absence or low presence of their natural preys, tigers and leopards tend to prey on livestock. Uncontrolled grazing by livestock in these areas makes the cattle more vulnerable to predation. In retaliation, tigers are sometimes poisoned by the local communities.

We collected data on cattle predation by large carnivores in the past three years from the forest department. Such secondary data, however, has limitations as it only includes those cases that have been registered or recorded by the forest department. In the North Balaghat division, cattle predation by tigers was the highest (Figure 15). In 2009-2010, more leopards than tigers seem to have preyed on livestock in South Seoni and Mohgaon divisions (Figure 16). Interestingly, there is no record of livestock predation by leopards between 2007-2010 in North Balaghat and East Mandla divisions.

Such conflicts are a major problem for communities living in corridor areas, as livestock are a source of livelihood for them. Sometimes, people have also been killed by large predators.

To manage the human-tiger conflict, one of the measures that WWF-India has undertaken, is to provide an immediate interim monetary relief to villagers who have lost livestock to tigers. This helps to lessen the initial anger and hostility of people and pacifies them before the forest department provides the appropriate compensation. Although this does not address the root cause of the conflict, it is an effective and important conservation strategy, at least to reduce or stop retaliatory killing of tigers.

FIGURE 15

Livestock killed by tigers
(2007 to 2010)

Source: Forest Department

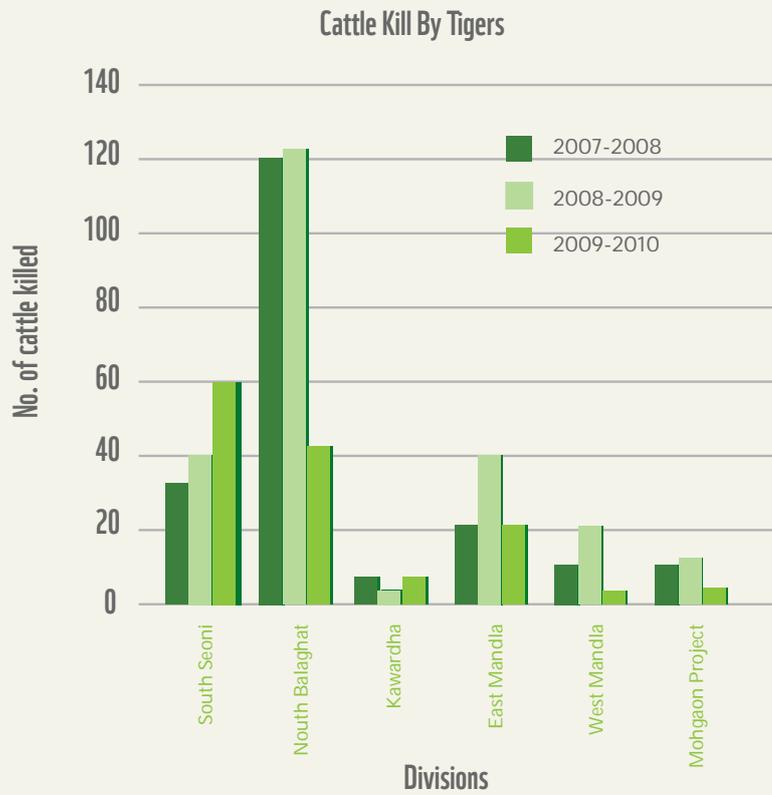
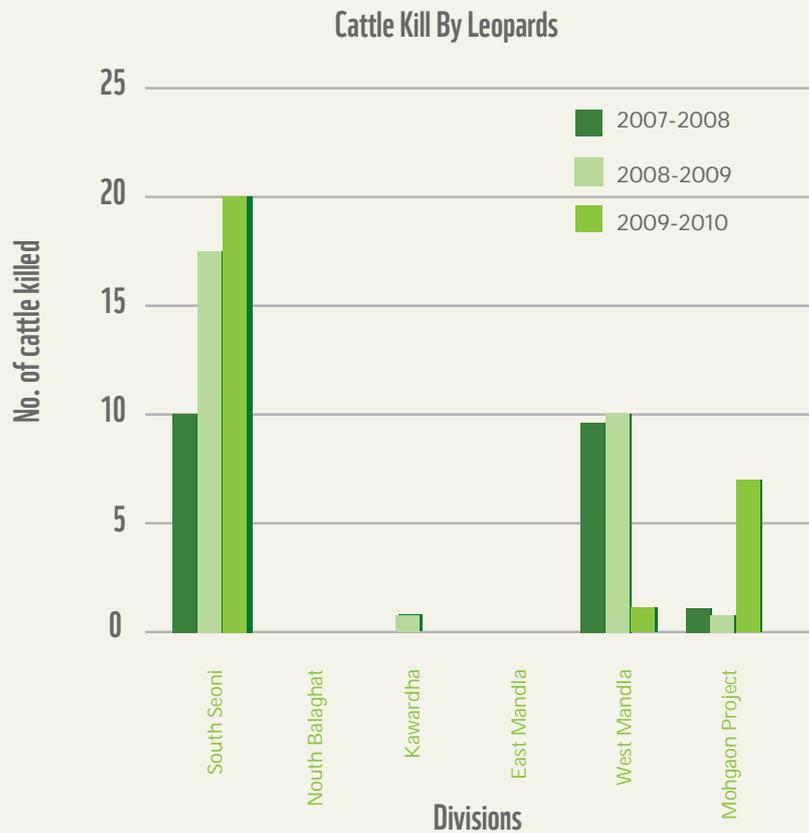


FIGURE 16

Livestock killed by leopards
(2007 to 2010),

Source: Forest Department.



4.2.1 Cattle killing by large predators

From July 2010, WWF-India's field staff started gathering information on cattle kill along the corridor from the Forest department and the local people. Payment of interim relief and camera trapping of the kill was started from January 2011. Collecting information on cattle kills for conflict mitigation is an ongoing WWF-India's activity in the landscape.

Below, our findings from the cattle kill data recorded during July 2010-May 2012 are presented.

4.2.1.1 Monitoring of livestock kills and predators

To understand the magnitude and spatial distribution of the conflict, each conflict site was plotted on a map and attempts were made to photograph dispersing tigers or other animals, using camera traps.

Whenever information about a kill was received, our field team would conduct a primary spot inspection. GPS positions, additional information from cattle owners and signs or evidence of the carnivore were collected. After confirming the kill, interim relief was paid to the cattle owner immediately (Table 1). On the same kill, two motion-cum-thermo sensor cameras were fixed to photo trap the carnivore revisiting the kill. Care was taken to secure the kill from poisoning by involving the cattle owner and local volunteers who kept a vigil on the area. The cameras were fixed for one or two days depending upon the situation. Data analysis is based on the number of cases we recorded.

A total of 181 cases of cattle kills were reported in 22 months (July 2010 to May 2012). The actual number of cases could possibly be higher since it is unlikely that all the information about cattle kills reached us or were reported by the villagers. Out of 181 cases, on 130 occasions (72%) the cattle owners were provided interim relief by WWF-India. For the rest of the 51 cases (28%), interim relief could not be paid, either due to the cases being reported too late or due to issues related to permissions from the concerned authorities regarding payment of interim relief. A total sum of INR 94,950.00 was paid as interim relief against cattle depredation cases.

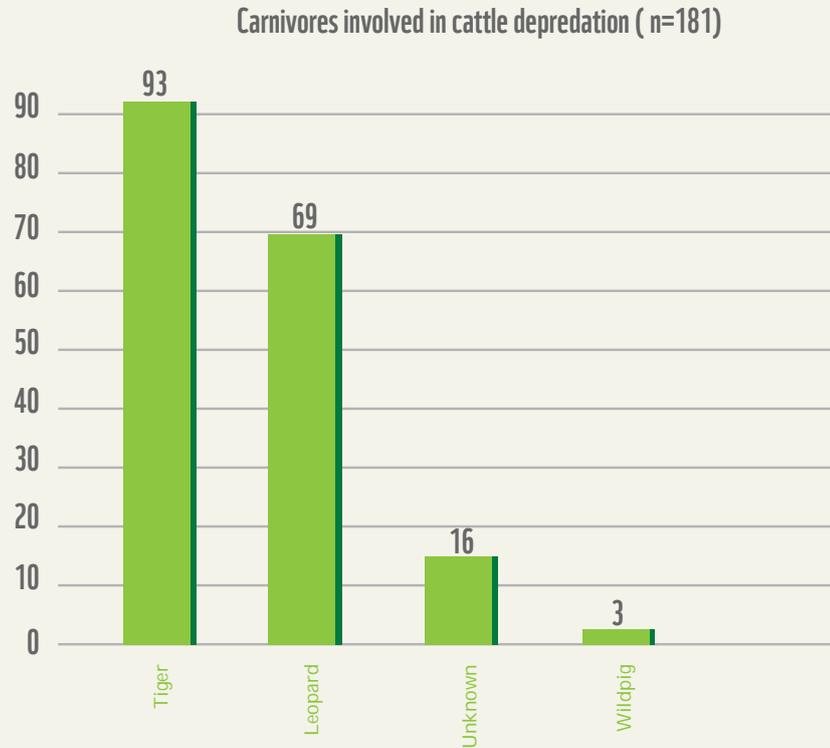
TABLE 1
Net amount paid by WWF-India for loss of different livestock

Species	Size and Age Class	Amount paid as interim relief (INR)
Calf (Cow/Bufalo/Ox)	Up to 2 and a half years	500
Cow	More than 3 years	1000
	Milking	1000
Buffalo	More than 3 years	1000
Ox	More than 3 years	1000

It was found that of the 181 cases reported, 93 kills (51.4%) were made by tigers, 69 kills (38.1%) by leopards and in 16 cases (8.8%) it was difficult to identify the carnivore involved (Figure 17). Dhool rarely preyed on cattle (only 3 incidents) and mostly killed goats and small cattle calf. Though other carnivores like hyenas and jackals are com-

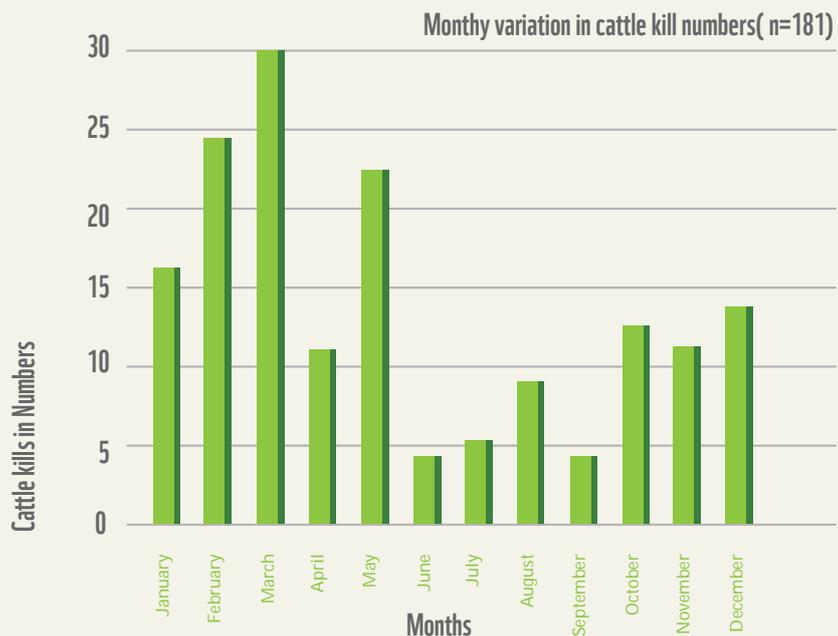
mon in this corridor, they mostly remain confined to scavenging the carcass, as was evident in the photographs from the camera trap on kills.

FIGURE 17
Carnivores involved in cases of cattle depredation



Monthly segregation of all the cattle kill incidents shows that depredation cases were highest during the months of February and March. The graph (Figure 18) shows a gradual increase from the month of January, reaching the peak in March while June-July are the lean period for the number of incidents recorded.

FIGURE 18
Monthly variation in cattle kill numbers recorded



It was found that cows are more preyed upon than buffalo and ox, by both tiger and leopard. This may be due to the herd structure of cows, which makes them easier prey than buffalo. Also, it was found that smaller sized prey (cattle calf and goat) were mostly attacked by leopards while larger animals like the buffalo were mostly killed by tigers (Figure 19).

FIGURE 19
Different species of livestock killed by tigers and leopards



Attempts were made to put camera traps in all the cattle kill incidents reported; however logistical problems permitted us to camera trap only in 77 (43%) occasions. Delay in getting the information and logistical problems were the major challenges that prevented installation of camera traps in the rest of the cases. However, the camera trapping exercise led to some interesting observations about the elusive carnivores involved. Eleven different tiger individuals and seven leopards have been photo-captured within the Kanha-Pench corridor. Besides tigers and leopards (Figure 20), other carnivore like dhole, hyena, jackal and jungle cat were also photo-captured in the camera traps.



FIGURE 20

Tiger and leopard on different cattle kill

As is evident from the observations, the tiger is the major carnivore involved in livestock kills in the Kanha-Pench corridor, followed by the leopard. Hyenas and jackals only scavenge the cattle remains of tiger or leopard kills. In one interesting occasion, a leopard and a hyena were photo-captured fighting over a kill (Figure 21 & 22). Dhool were reported killing goats and cattle calves, but they were only photo-captured in camera traps while scavenging on tiger kills. On several occasions, camera trap photos revealed tiger kills being scavenged by several other carnivores like hyenas, jackals (Figure 23) and sometimes by raptors. This phenomenon of scavenging is ecologically important as it shows how different carnivore species share the same resources (Figure 24) and also provides an insight into the utilization of leftover carcasses by large carnivores such as the tiger.

FIGURE 21

Hyena and leopard fighting over the same kill





FIGURE 23

Series of photographs that captured tiger, domestic dog and jackal on the same kill at different times



FIGURE 24

A kill shared by tigers and dholes at different time periods

Long term conservation of tigers in central India or elsewhere depends on conservation at the landscape scale than over small isolated pockets of tiger habitats. The landscape approach for large meta-populations of tiger can only be possible if there is secured connectivity among the tiger reserves for exchange between populations. Kanha-Pench corridor is one of the vital corridors supporting tiger dispersal in the central India landscape. However, successful movement or dispersal in this corridor depends upon the available prey and secure passage. This corridor is full of human settlements and their livestock herds, which graze inside the forest. This in turn results in depredation of livestock by large carnivores as well as increased grazing competition.

Frequent loss of livestock to large carnivores causes anger and negative attitudes towards not only tigers, but towards all wildlife. Hence effective and timely compensation towards cattle loss is necessary to reduce chances of retaliation.

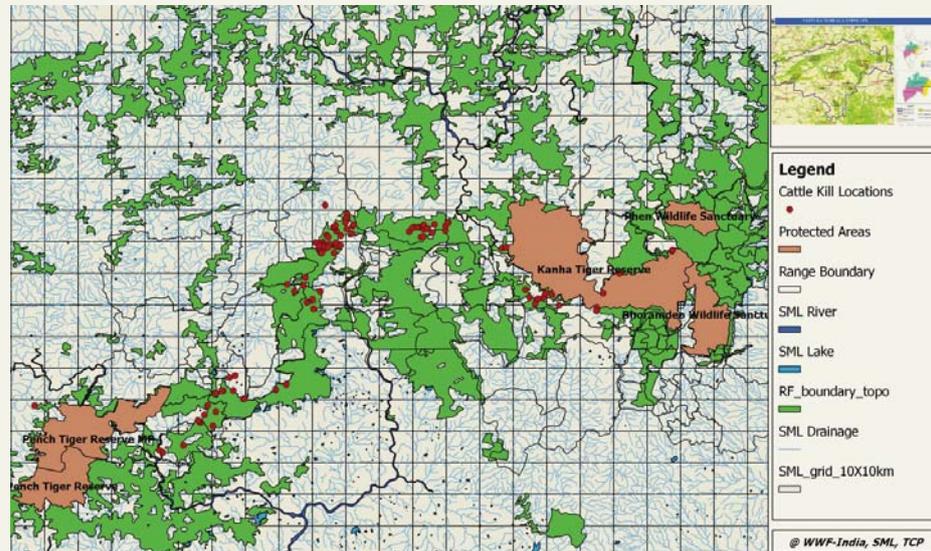
As mentioned earlier, the existing compensation scheme by the Forest department is a time taking process and in many instances, is not likely to cover the actual loss. It has been found that providing quick immediate relief reduces the chances of retaliation, even though the amount paid is small (Bose et al, 2011).

4.2.1.2 Areas vulnerable to livestock predation

Cattle killings by large carnivores were recorded from most areas of the Kanha-Pench corridor. But in a few places, the occurrence of cattle kill was more frequently recorded. These places are the Baihar-Bhaisanghat range, Keolari-Ugli and Rukhad-Kurei-Ari area (Figure 25). In Baihar-Bhaisanghat, three females and two tiger cubs have been camera trapped. Males were mostly photo-captured in the Rukhad-Kurei-Ari range. In an interesting observation, a tigress was photo-captured multiple times in the Keolari-Kopijhola-Ugli area, which suggests that the tigress might be a resident of this area for the past one and a half years. This suggests that not only do tigers use the forest for dispersal but some may hold territory in the corridor as we

FIGURE 25

Cattle kill locations in Kanha-Pench corridor



Unlike the Kanha-Achanakmar corridor, where leopards are the major carnivores involved in cattle killing (Ahmed *et al.* 2012); in the Kanha-Pench corridor, it is tigers who are the major species involved in cattle killing. A study in the Terai Arc landscape (Bose *et al.* 2011) documents the highest predation on cattle during June-July (rainy season), but in Central India this happens in March. This could be due to the onset of summer, a resource crunch period when cattle venture more and more into the forest searching for food and water, thus exposing themselves to predation by tigers.

4.2.2 Recommendations

Based on these observations, the following measures should be taken for safeguarding the tigers of the Kanha-Pench corridor:

- In the forest of Baihar and Mukki range of the Kanha Tiger Reserve, individual females and female with cubs have been very often camera trapped on kills. Efforts should be made to provide increased protection and regular monitoring in those areas.
- The Keolari-Kopijhola-Ugli areas harbour a resident female tigress. This block is under the territorial and corporation division. Small scale poaching and poisoning of herbivores has often been recorded in this area, making tigers more vulnerable. A better protection regime is advisable for the area.
- Wildlife is at its most vulnerable during summer, due to scarcity of resources. Water is the key limited resource in this highland. Special monitoring of sources like water holes should be undertaken in a regular and effective manner all along the corridor, to deter the poaching of herbivores and poisoning of tigers and other carnivores.
- The compensation process by the forest department is lengthy and time consuming. Steps should be taken to make the whole process smooth and fast.

4.3 Resource Dependence of Local Communities

The forests of this corridor have numerous human settlements. Most of these villagers depend on the forest for their cattle grazing and other resource needs such as fuel and small timber (Figure 26). High cattle population leads to overgrazing in several areas, degrading pastureland and inhibiting forest regeneration, which in the long run is harmful both to wildlife and to the human communities dependent on these forests. Within the Kanha-Pench corridor, a large number of livestock venture into the forests for grazing. As they become the easiest prey for large carnivores such as tigers, leopards and dholes, in retaliation villagers sometimes poison the livestock carcass to kill the carnivores.

4.3.1 Recommendations

Our observations indicate that although cattle rearing is a part time livelihood activity, most of the cattle are unproductive. Milk economy is not very evident in this region, though the cattle numbers are enormous. At the same time, the negative impact these cattle have on the forest is alarming. We recommend that removal of unproductive cattle should be considered and attempts should be made to improve cattle breeds through artificial insemination. Communities should be motivated to rear good cattle breeds with a 'stall-feeding' option, which can provide a good income generation opportunity. Also, the dung can be used as biogas, thus reducing the pressure of fuel wood collection on the forest while residue from the biogas can be used as fertilizer.

We suggest that a detailed study be undertaken on land use patterns, socio-economic status and the magnitude of forest dependency by these settlements or villages. Local resources should be identified to plan suitable management strategies for the villagers' livelihood issues. Steps should also be taken to make them friendlier towards conservation actions and to motivate them to be a part of conservation.

FIGURE 26

Forest dependency for fuel wood and collection of non timber forest produce (Tendu leaf)



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5. DISCUSSION & CONCLUSION

The present study was focused on the potential of the Kanha-Pench corridor to support dispersing tigers and identify the threats the tigers encounter in the corridor areas. It identified the areas being used by

tigers and suggested strategies to manage the areas that need immediate attention. The findings of this study have several implications for forming a long-term conservation plan, and we hope that it will serve as an important baseline for the future monitoring of the Kanha-Pench corridor.

The study proved that the forest area of Kanha-Pench corridor is in use by dispersing and/or resident tigers. As concluded by Sharma *et al.* (2013) based on genetic data, the two major source populations, i.e. Kanha and Pench Tiger Reserves, exchange individuals through this corridor. Tigers are known to disperse long distances and studies suggest that tiger dispersal through the forested corridor connecting the tiger reserves in this landscape has maintained gene flow and prevented genetic subdivision (Sharma *et al.* 2012; 2013).

The evidence of tiger signs throughout the forest area from Kanha to Pench Tiger Reserves suggests that the tigers are using this corridor for dispersal. There were instances during the survey when evidence of a female tigress with cubs was detected in areas like south Seoni division and Kopijhola. It is noteworthy that besides tigers, other sympatric carnivores such as leopards, dholes and hyenas were also recorded from the study area. Sloth bear presence was documented all along the corridor indicating that there is a good population of sloth bear in these forest areas.

Though the study could not reliably estimate the density of prey species due to low sample size, indirect evidence in the form of pellet counts revealed that prey species are patchily distributed in the corridor.

The study highlights the importance of the Kanha-Pench corridor as an important dispersal and breeding ground for tigers between two source populations. To ensure long-term survival of tigers in the Kanha-Pench landscape, the current connectivity must be maintained and ensured for the future. This needs a strong understanding of socio-economic and land use issues and a shared vision of tiger conservation by all the stakeholders involved in wildlife conservation, management and planning in this landscape.

5.1 Conclusion

The quality of the forest complex between protected areas is important for large and wide ranging animals like tigers. It is now known that the functional status of various corridors within central India is rapidly declining (Jhala *et al.* 2011; Rathore *et al.* 2012; Sharma *et al.* 2013). Our study suggests that in spite of the presence of tigers and other wildlife in the Kanha-Pench corridor area, the threat to tigers is ever increasing due

to different factors including habitat fragmentation, developmental pressures as well as the changing socio-economic status of the local communities. It therefore becomes imperative that the status of such corridors is maintained and secured. Securing the Kanha-Pench corridor is critical for the long-term conservation of the tiger population within this landscape. Engagement with local communities, supporting the Forest Department and continuous monitoring of the tiger population in these corridors are some of the major activities, which would ensure that the functionality of the corridor is maintained in this politically sensitive area.

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