



STATUS OF CARNIVORES AND OTHER TERRESTRIAL MAMMALS

IN INDERGARH BUFFER OF RAMGARH VISHDHARI TIGER RESERVE, RAJASTHAN

Report by

World Wide Fund for Nature-India (WWF-India)

Citation

Jain A., Panda D., Rajasekar R., Khairva R.K., Jat S.R., Sharma S., Chanchani P. and Maurya K.K (2025). Status of carnivores and other terrestrial mammals in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve, Rajasthan. WWF-India

Published in 2025

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A photograph of a wolf standing in a dry, brushy landscape. The wolf is the central focus, looking towards the right. The background is filled with dry, yellowish-brown grass and bare, dark branches of trees and shrubs. The lighting is natural, suggesting a sunny day.

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IN INDERGARH BUFFER OF RAMGARH VISHDHARI TIGER RESERVE, RAJASTHAN



Foreword



Tiger conservation in the contemporary era has attracted much global attention due to the endangered status of the tiger. Tigers continue to face many threats that challenge their long-term survival including from poaching, habitat loss, non-availability of proper corridors, human-tiger conflict etc. But there is hope as there are solutions. For long-term survival of tiger populations, effective management that considers regular scientific monitoring, protection and enforcement is needed.

The report “*Status of carnivores and other terrestrial mammals in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve, Rajasthan*” focuses on tiger conservation in potential recovery sites in the State. The conservation of tigers in its natural habitat is paramount to the Rajasthan Forest Department. Indergarh area is one such site which is crucial connecting link between Ranthambore Tiger Reserve and Ramgarh Vishdhari Tiger Reserve. The study reveals that the forest of Indergarh has presence of 18 mammalian includes carnivores such as leopard, sloth bear, striped hyena, golden jackal, rusty spotted cat, jungle cat, and desert cat and herbivores like chital, sambar, nilgai, wild pig, Hanuman langur, Indian peafowl, Indian hare, and Indian crested porcupine.

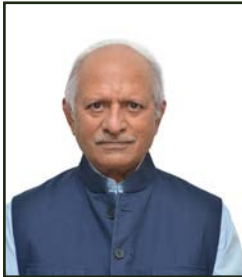
The Rajasthan Forest Department’s commitment for conservation of tigers as an umbrella species is complemented by WWF-India. I extend my appreciation to all the officials and staff of Ramgarh Vishdhari Tiger Reserve along with their collaboration partners, WWF-India and all the stakeholders for supporting tiger conservation in Rajasthan. I hope similar initiatives and collaboration would continue in future years as to conserve and manage this unique ecosystem.

Shikha

(Shikha Mehra)
PCCF & CWLW,
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Foreword



Carnivores play an important role in maintaining healthy and resilient ecosystems. Globally, wild felids, canids, bears and other terrestrial carnivores are under increasing pressure, and many species have been extirpated from vast areas of their historic ranges. The concurrent decline in populations of wild prey has further exacerbated the decline of carnivores, hindering recovery efforts. The persistence of wild carnivores and herbivores depends on managing landscapes that provide productive, safe, and connected habitats, in which adverse human-wildlife interactions are also effectively managed.

In India, there are both significant challenges and opportunities for conserving carnivores. Challenges such as the impacts of land-use change are prevalent across landscapes. They are typically more severe outside Protected Areas, which are also important wildlife habitats. Carnivores, such as tigers, leopards, striped hyenas, and golden jackals, continue to survive in multi-use landscapes across India, moving between forests, agricultural fields, ravines, and even the edges of towns to meet their life history needs.

Rajasthan features a unique mix of semi-arid habitats that support tigers. Once, tigers, along with their co-predators and prey, roamed widely in this state. Today, their strongholds are confined to Ranthambhore and Sariska Tiger Reserves, with Ranthambhore serving as a vital source population for dispersal into nearby habitats. Ensuring connectivity from Ranthambhore is crucial for the future of tigers. An important area for tigers near Ranthambhore is the Ramgarh Vishdhari Tiger Reserve. Within this region, the Indergarh Range serves as a critical corridor connecting Ranthambhore and Mukundara Hills Tiger Reserves. Indergarh has already facilitated tiger movement and continues to support resident populations of other large carnivores, meso-carnivores, and wild herbivores. It has often been overlooked in research and management planning, frequently viewed merely as a buffer zone. This report emphasises the importance of buffers and marginal habitats as vital connecting links that significantly contribute to conservation success.

Through systematic camera-trap surveys and ecological assessments, this report documents the carnivore-prey dynamics of Indergarh. The findings confirm that this range is an important corridor and a functional habitat in its own right—home to resident leopard and striped hyena populations, as well as other diverse carnivores, and a preybase that sustains them. The findings also highlight urgent concerns, including habitat degradation caused by invasive species, the impacts of infrastructure projects, and the pressures of human use. Addressing these challenges requires stronger protection, habitat maintenance and partnerships with local communities through participatory approaches. This report emphasises that Indergarh is a crucial part of Rajasthan's conservation landscape, where interventions are needed to ensure this vital corridor is managed to support wildlife movement, maintain the populations of carnivores, wild herbivores, and other species, and effectively handle the human-wildlife interface to promote coexistence. Strengthening protection measures, restoring habitats, increasing prey stocks, and engaging local communities are urgent steps to enhance connectivity, resilience, and the long-term survival of threatened wildlife across Western India.

I sincerely hope this report encourages collaboration, action, and dedication to preserving Rajasthan's natural landscape for both wildlife and local communities.

A handwritten signature in black ink that reads 'Ravi Singh'.

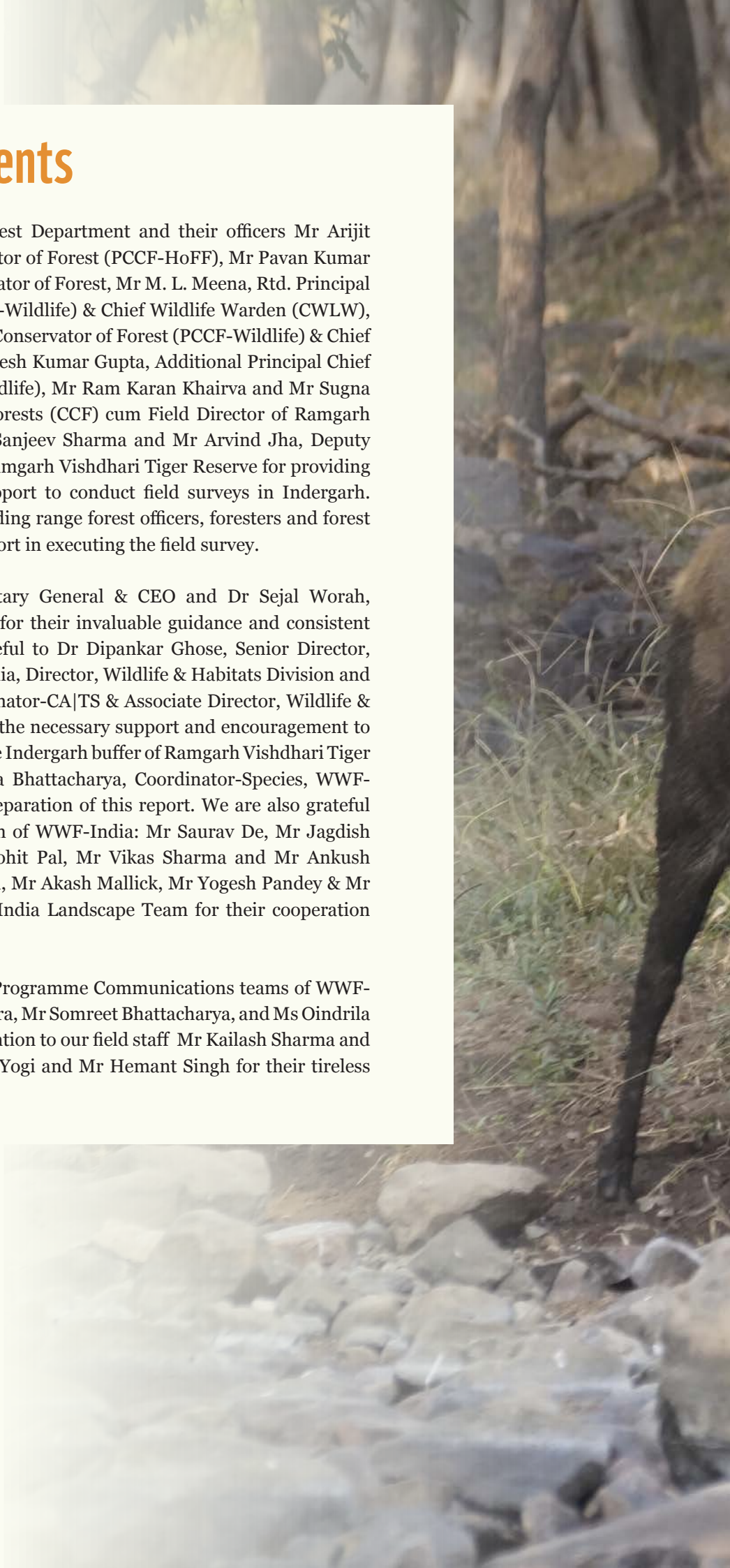
Ravi Singh
SG and CEO, WWF-India

Acknowledgements

We are grateful to Rajasthan Forest Department and their officers Mr Arijit Banerjee, Principal Chief Conservator of Forest (PCCF-HoFF), Mr Pavan Kumar Upadhyay, Principal Chief Conservator of Forest, Mr M. L. Meena, Rtd. Principal Chief Conservator of Forest (PCCF-Wildlife) & Chief Wildlife Warden (CWLW), Ms Shikha Mehra, Principal Chief Conservator of Forest (PCCF-Wildlife) & Chief Wildlife Warden (CWLW), Mr Rajesh Kumar Gupta, Additional Principal Chief Conservator of Forest (APPCF-Wildlife), Mr Ram Karan Khairva and Mr Sugna Ram Jaat, Chief Conservator of Forests (CCF) cum Field Director of Ramgarh Vishdhari Tiger Reserve and Mr Sanjeev Sharma and Mr Arvind Jha, Deputy Conservator of Forests (DCF) of Ramgarh Vishdhari Tiger Reserve for providing the necessary permission and support to conduct field surveys in Indergarh. We also thank the field staff, including range forest officers, foresters and forest guards of Indergarh, for their support in executing the field survey.

We thank Mr Ravi Singh, Secretary General & CEO and Dr Sejal Worah, Programme Director, WWF-India for their invaluable guidance and consistent encouragement. We are also grateful to Dr Dipankar Ghose, Senior Director, WWF-India, Mr Yash Magan Shethia, Director, Wildlife & Habitats Division and Dr Joydeep Bose, Regional Coordinator-CA|TS & Associate Director, Wildlife & Habitats Division, WWF-India for the necessary support and encouragement to undertake species monitoring in the Indergarh buffer of Ramgarh Vishdhari Tiger Reserve. We also thank Dr Ankita Bhattacharya, Coordinator-Species, WWF-India for the inputs during the preparation of this report. We are also grateful to the operations and finance team of WWF-India: Mr Saurav De, Mr Jagdish Upadhaya, Ms Bindu Nair, Mr Rohit Pal, Mr Vikas Sharma and Mr Ankush Kabra, and to Ms Divya Ranu Patel, Mr Akash Mallick, Mr Yogesh Pandey & Mr Hemnat Singh from the Western India Landscape Team for their cooperation and kind assistance.

Our appreciation also goes to the Programme Communications teams of WWF-India, including Ms Dilpreet Chhabra, Mr Somreet Bhattacharya, and Ms Oindrila Sen for their support. A special mention to our field staff Mr Kailash Sharma and Mr Dharmendra Gurjar, Mr Sunil Yogi and Mr Hemant Singh for their tireless efforts in the field.





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Abbreviations

Abbreviation	Meaning
RVTR	Ramgarh Vishdhari Tiger Reserve
RAI	Relative abundance index
SECR	Spatially explicit capture-recapture
D	Density estimates
SE	Standard error
σ	Sigma (movement parameter)
g0	Activity centre
pmix	Sex ratio
Ψ	Psi (occupancy probability)
CI	Confidence interval
\hat{c}	Overdispersion
IDW	Inverse distance weighted interpolation
Mt+1	Minimum number of individuals
lcl	Lower confidence limit
ucl	Upper confidence limit
detectfn	Detection function
npar	Number of parameters
logLik	Log likelihood
AIC	Akaike information criterion
dAICc	Delta akaika information criterion
K	Number of parameters
Cum.Wt	Cumulative weight
LL	Log likelihood

Executive Summary

In Rajasthan, carnivore conservation holds particular significance because the state represents the western most distribution of tigers and associated carnivores in India, within semi-arid habitats where these species occur. Historically, tigers and other large carnivores roamed extensively across eastern Rajasthan. In this context, the adjoining tiger reserve of RTR, the Ramgarh Vishdhari Tiger Reserve (RVTR) provides an important habitat; forming a potential dispersal route between Ranthambore to Mukundara Hills Tiger Reserve. Within the Ramgarh Vishdhari Tiger Reserve, the Indergarh range holds particular importance as a connective link between Ranthambore Tiger Reserve and Ramgarh Vishdhari Tiger Reserve (RVTR), facilitating animal movement across forested habitats. A species monitoring exercise using camera traps by WWF-India during April-May 2024 in the Indergarh Range of Ramgarh Vishdhari Tiger Reserve documented 22 wild mammalian species alongside humans and livestock over 1,696 trap nights, yielding 4,334 independent records. Herbivores such as nilgai, wild pig and Indian hare were the most commonly photo captured species followed by peafowl, porcupine and sambar. A total of 28 adult individuals of leopards were also identified in the Indergarh with an estimated density of 5.76/100 km² (95% CI: 3.81–8.69). Model averaged leopard occupancy (Ψ) was estimated to be 0.66 ± 0.13 (CI 0.11-0.68), strongly associated with

prey availability. Striped hyena $\Psi = 0.43 \pm 0.12$ (CI: 0.21-0.68) showed a positive association with forest cover, golden jackal $\Psi = 0.43 \pm 0.13$ (CI: 0.19-0.68) with human presence, and Indian fox $\Psi = 0.30 \pm 0.13$ (CI: 0.11-0.68) with scrub cover.

Temporal activity analyses revealed leopard and most carnivores to be crepuscular, nocturnal; with leopard displaying a significant difference in activity from striped hyena and ratel. The prey species displayed diverse diel patterns, with sambar and wild pig showing the highest temporal and spatial overlap with leopards.

Indergarh sustains viable populations of leopards and other carnivores, underscoring its ecological significance as a connecting habitat linking Ranthambore and Ramgarh Vishdhari Tiger Reserves. Pressures on wildlife populations and their habitats include highways, railway lines, mining and resource extraction by local communities living in and around the range. Management priorities that have been identified include strengthening corridor connectivity, improving prey distribution through habitat management and *Prosopis juliflora* removal, enhancing protection and field infrastructure, and institutionalising long-term monitoring to support adaptive management of this critical linkage.





1. INTRODUCTION

Carnivores play a vital role in regulating ecosystem processes through scavenging and competitive interactions in human-dominated landscapes (Ripple et al., 2014; Panda et al., 2023). The majority of the world's terrestrial large carnivores have undergone substantial range contractions with either small or isolated populations, and many of these species are currently threatened with extinction (Rangnathan et al., 2008; Yumnam et al., 2014; Rangnathan, 2017; Wolf & Ripple, 2017). Such populations are vulnerable to extinction events caused by environmental and demographic stochasticity (Caughley 1994; Purvis et al., 2000; Cardillo et al., 2004). Large terrestrial carnivores are especially at risk from habitat fragmentation because of their large home ranges and life histories, which often involve dispersal away from natal ranges (Dobson et al., 2006; Crooks et al., 2011; Fonkwo et al., 2011; Ripple et al., 2014).

Large carnivores have been examined as conservation umbrellas for large-scale connectivity planning due to their large spatial requirements (Thorne et al., 2006; Beier et al., 2008; Ripple et al., 2014). As a result, much conservation research has prioritised safeguarding connectivity within and between carnivore populations, with an emphasis on mapping and protecting movement corridors across landscapes increasingly threatened by human development (Morrison & Boyce, 2009; Rabinowitz & Zeller, 2010; Clark et al., 2015; Fattebert et al., 2015; Hilty et al., 2020).

In India, there is growing evidence of the persistence of carnivores in human-modified landscapes (eg., Odden et al., 2014; Warriar et al., 2020; Panda et al., 2022), but there are still many knowledge gaps, both in terms of the spatial coverage of such assessments, of drivers underlying carnivore occurrence and abundance, and of other parameters such as survival, reproduction and movement (Bouchet, et al., 2015; Rosalino et al., 2023). Among the most adaptable large carnivores, leopard (*Panthera pardus*), striped hyena (*Hyaena hyaena*) and golden jackal (*Canis aureus*) have demonstrated the capacity and behavioural plasticity to successfully adapt to and persist in a mosaic of forest patches, agricultural fields, ravines and peri-urban areas (Athreya et al., 2013; Kshetry et al., 2017; Ankit et al., 2021; Panda et al., 2022).

In Rajasthan, carnivore conservation holds particular significance because the state represents the

westernmost distribution of tigers and associated carnivores in India, within semi-arid habitats where these species occur (Jhala et al., 2020). Historically, tigers and other large carnivores roamed extensively across eastern Rajasthan (Singh & Reddy, 2016), but today their persistence is largely restricted to the Ranthambore Tiger Reserve (RTR), Sariska Tiger Reserve and adjoining forest blocks, which act as critical source populations for dispersal into surrounding habitats (Bhardwaj & Sharma, 2013; Jhala et al., 2020; Qureshi et al., 2024). Maintaining connectivity from Ranthambore is vital not only for the long-term viability of tigers but also for sustaining other co-predators such as leopards, hyenas and jackals that thrive in a mosaic of habitats beyond protected areas (Joshi et al., 2013; Sadhu et al., 2017). In this context, the adjoining tiger reserve of RTR, the Ramgarh Vishdhari Tiger Reserve (RVTR) provides an important habitat; forming a potential dispersal route between Ranthambore to Mukundara Hills Tiger Reserve.

Within the Ramgarh Vishdhari Tiger Reserve, the Indergarh range holds particular importance as a connective link between Ranthambore Tiger Reserve and Ramgarh Vishdhari Tiger Reserve (RVTR), facilitating movement across forested habitat, ravines and agricultural mosaics. Over the last decade, there have been records of four tigers' dispersals from RTR to RVTR through Indergarh (Tiger Conservation Plan, Ranthambore Tiger Reserve; Sadhu et al., 2017). Assessing the status of carnivores in Indergarh is crucial, as it provides insights into site use by carnivores, prey availability, and anthropogenic disturbances that can directly influence functional connectivity between Ranthambore which acts as the source population and Mukundara Hills Tiger Reserve. This knowledge is essential for making informed conservation decisions and for maintaining the ecological integrity of connecting routes that underpin the persistence of wide-ranging carnivores in Rajasthan's multi-use landscape.

This study investigates the spatial ecology of a carnivore assemblage that includes leopard, striped hyena and golden jackal in the Indergarh Range of Ramgarh Vishdhari Tiger Reserve (RVTR) – a linear human-dominated forested habitat that connects RTR and Mukundara Hills Tiger Reserve. Though tigers are only transient in this region, Indergarh represents an ecologically critical landscape that facilitates the

dispersal and long-distance movement of carnivores. Importantly, this range received little attention in species-monitoring efforts, as it functions mainly as a buffer between RTR and RVTR. By focusing on this overlooked yet critical zone, our study aims to estimate: (1) abundance and density of leopard, (2) habitat use

of major carnivores (leopard, striped hyena, golden jackal and Indian fox), (3) spatio-temporal overlap among these carnivores and their prey. Our findings are intended to support and highlight the conservation value of buffer regions and transitional habitats that sustain diverse carnivore communities in Rajasthan.



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2. STUDY AREA

The Indergarh Range ($\approx 220 \text{ km}^2$) is part of the buffer zone of the Ramgarh Vishdhari Tiger Reserve (RVTR), historically linked to Ranthambore Tiger Reserve (RTR), and was formally incorporated into RVTR after its declaration in 2022. Ecologically, it is a crucial corridor for tiger movement between RTR and RVTR (Sadhu et al., 2017). The rugged, hilly terrain supports dry deciduous forest with species like *Acacia catechu* and *Anogeissus pendula*, along with invasive *Prosopis juliflora*. Its fauna includes leopard, striped hyena, golden jackal, jungle cat, nilgai, and wild pig. However, railway lines, highways, the Delhi–Mumbai–Vadodara Expressway, a cement factory, and mining activities fragment the habitat. These pressures, combined with its role as a linkage, underscore the importance of studying wildlife use patterns in Indergarh.

Ramgarh Vishdhari Tiger Reserve (RVTR) falls in the south-eastern part of Rajasthan, which lies between $240 59'' \text{ N}$ to $250 53'' \text{ N}$ and $750 19''$ to $760 49'' \text{ E}$ in Bundi district with representation of both Vindhyan and Aravalli elements. The total area of the tiger reserve is 1501.88 km^2 ; consisting of a core area of 481.9 km^2 and buffer area of 1019.98 km^2 . The core area of RVTR is Ramgarh Vishdhari Wildlife Sanctuary and National Chambal Gharial Sanctuary, and the buffer area of RVTR consists of the territorial ranges of Bundi (Indergarh) and Bhilwara (Bhopatpura).

The forest type of RVTR is classified as Tropical Dry Deciduous Forest, which is further sub-grouped as 5B Northern Tropical Dry Deciduous Forest & C2 Northern Dry Mixed Deciduous Forest (Champion and Seth, 1968). The slopes of the hills are moderate to steep, but at some places, they become precipitous near the top. RVTR mainly comprises dominant tree species like *Anogeissus pendula* (Dhonk) and *Acacia catechu* (Khair). Apart from Khair and Dhonk, the main vegetation comprises tree species including *Acacia nilotica*, *Acacia leucophloea*, *Butea monosperma*, *Lannea coromandelica*, *Mitragyna parviflora*, *Maytenus emarginata*, and shrub species including *Balanites aegyptiaca*, *Capparis decidua*, *Grewia flavescens*, *Salvadora oleoides*, *Dichrostachys cinerea*, *Zizyphus mauritiana* and *Zizyphus nummularia* (Prasad, 2014; Sharma, 2022). In addition, degraded patches across RVTR are colonised by invasive species such as *Prosopis juliflora*, *Adhatoda vasica* and *Parthenium hysterophorus*, which often alter the native vegetation structure and limit natural regeneration. Ground cover mainly consists of various grass species, such as *Bothriochloa pertusa*, *Cenchrus biflorus*, *Aristida depressa*, *Chrysopogon fulvus*, *Panicum antidotale*, *Andropogon pumilus*, *Chloris barbata*, and *Heteropogon contortus* (Prasad, 2014; Sharma, 2022).

Historically, the Bundi region was part of a princely state well known for its forests and wildlife. In the early 20th century, forests covered nearly half of the state

($\sim 2300 \text{ km}^2$ in 1906), and the landscape supported a rich assemblage of species; particularly tiger, leopard, sloth bear, sambar and chital. The rulers of Bundi had their own forest administration and wildlife laws with shikar areas receiving strict protection. However, tiger hunting by royal and invited dignitaries was intense by the 1940s. Bundi still held about 75 tigers, but heavy hunting pressure, habitat degradation from limestone mining and deforestation, and later, poaching led to drastic decline (Singh and Reddy, 2016).

Ramgarh Vishdhari was first declared a wildlife sanctuary in 1982 and later upgraded to a tiger reserve in 2022 in recognition of its ecological importance and role as a corridor linking Ranthambore with Mukundara Hills Tiger Reserve.

Currently, RVTR is home to the tiger (*Panthera tigris*), Indian leopard (*Panthera pardus fusca*), striped hyena (*Hyaena hyaena*), jackal (*Canis aureus*), Indian fox (*Vulpes vulpes*) and sloth bear (*Melursus ursinus*). Major herbivore species include nilgai (*Boselaphus tragocamelus*), spotted deer or chital (*Axis axis*), sambar (*Rusa unicolor*) and wild pig (*Sus scrofa*). Other mammals inhabiting the forests are chinkara (*Gazella bennettii*), Hanuman langur (*Semnopithecus entellus*), Indian crested porcupine (*Hystrix indica*), small Indian civet (*Viverricula indica*), Asian palm civet (*Paradoxurus hermaphroditus*), honey badger or ratel (*Mellivora capensis*) and caracal (*Caracal caracal*) (Thakar et al., 2025).

The reserve is also home to long-established agrarian and pastoral communities, such as Gujjars, Meenas and other local groups who depend upon the forests for grazing, fuelwood, fodder and other minor forest produce. This close dependence often results in interaction between people and wildlife, ranging from livestock depredation to resource competition, making RVTR a socio-ecological landscape where conservation and community livelihoods are intricately linked.

3. METHODS

3.1. Camera Trapping

Fieldwork was initiated in April 2024 and was extended up to May 2024. Reconnaissance surveys (sign surveys along forest trails and drainage features on foot/vehicle) were carried out over an intensive study area of 200 km² in the Indergarh to select suitable sites for deploying camera traps. Site selection was based on collating indirect evidence such as scats, pellets, scrapes, scent markings, claw marks, pugmarks, etc., that indicated use of the sites by leopards and other wildlife. Camera traps were placed within 2 km² grids, with at least one pair of camera traps deployed in each grid. Finally, a total of 55 locations were selected to place camera traps (Figure 1). The average distance between two camera stations was 1.2 km, which ensured adequate coverage. Paired camera traps were secured to trees or posts, about 7-12 feet from the edges of forest roads, animal trails and dry streams that were intensively used by wildlife (Karanth, 1995; Karanth

and Nichols, 1998; Huerta-Rodriguez et al, 2022). Camera traps were operational for 25-35 days during April–May 2024. The camera traps were monitored every 5-7 days, and batteries and memory cards were replaced when necessary.



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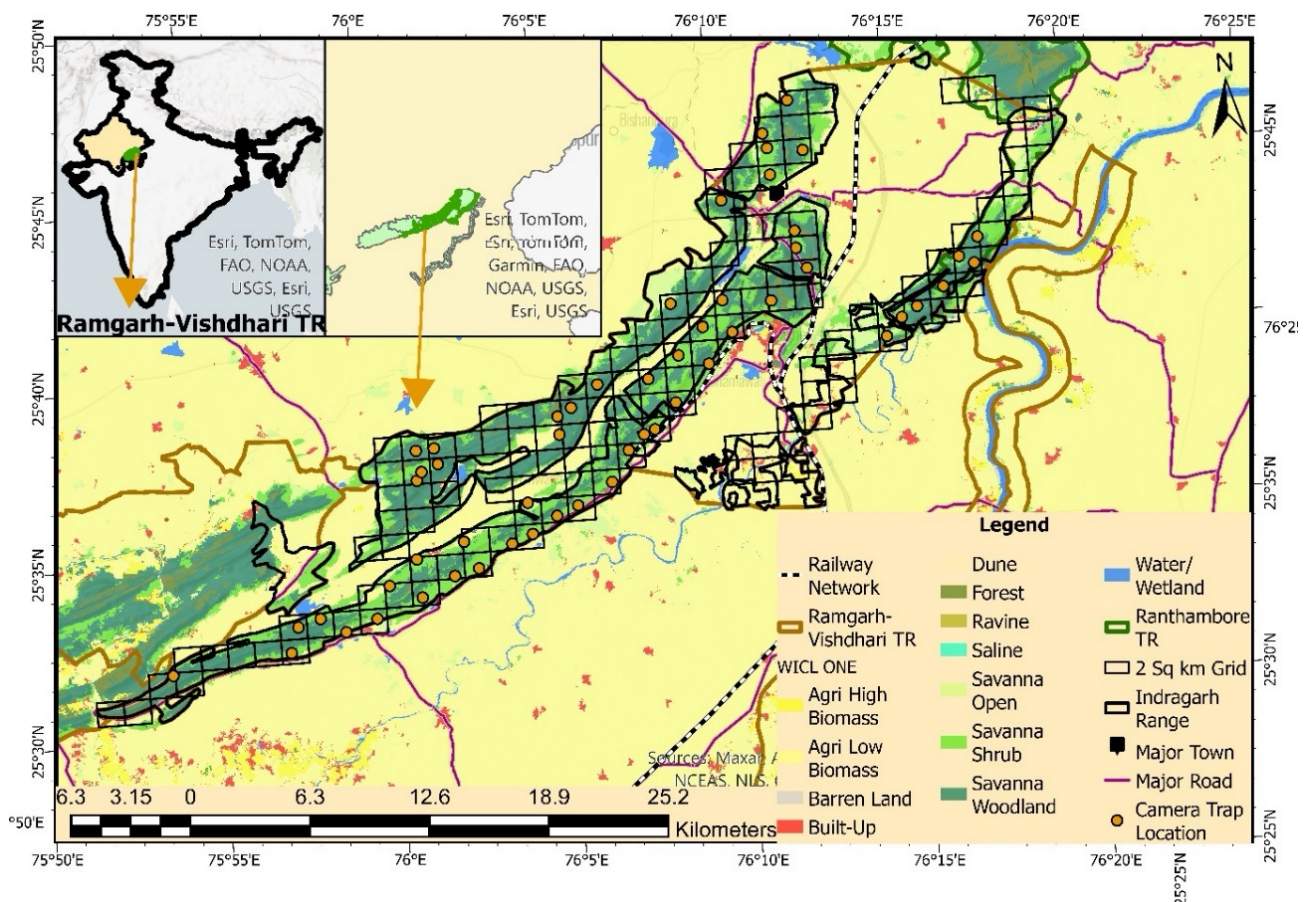


Figure 1: Map showing Ramgarh Vishdhari Tiger Reserve (RVTR) along with the camera trap locations in Indergarh range (Buffer of RVTR)



3.2. Data Analysis

3.2.1. RELATIVE ABUNDANCE INDEX

Captures of 18 mammalian species were tallied to compute relative abundance. As not all species were equally detectable, some present species may have been missed during the survey. For ecological interpretation, carnivores were grouped into three body-size categories: (i) large carnivores (leopard, sloth bear, striped hyena), (ii) meso-carnivores (golden jackal, Indian fox, jungle cat, ratel), and (iii) small carnivores (Asiatic wildcat/desert cat, rusty-spotted cat, small Indian civet). This classification reflects key ecological differences – body size strongly influences prey selection, home-range size, and detectability in camera traps, and thus provides a meaningful framework to assess carnivore assemblages and their coexistence patterns (Karanth & Sunquist, 2000; Ritchie & Johnson, 2009; Carbone et al., 2011; Clements et al., 2014).

Photographic rate is the relative index of the animal's space use and a proxy of abundance estimate (Carbone et al., 2001; O'Brien et al., 2011). Camera-trap photos provided the information on the date and time. Sometimes, individuals were photographed from only one of the two cameras operating at a single camera-trap station. The event of capturing an individual, whether it was photographed by two camera traps or one, was considered to be an independent record of the individual and for analysis, we defined the minimum time between two independent events as 30 minutes (O'Brien et al., 2011).

We calculated Relative Abundance Index (RAI) for each camera-trap location by the formula (Carbone et al., 2001; O'Brien et al., 2003):

$$\text{RAI} = (\text{Total Number of Independent Records}) / (\text{Total Trap Nights}) \times 100$$

The RAI for each species is calculated as the number of photo captures per 100 trap nights (Kalle, 2013).

3.2.2. ESTIMATING DENSITY OF LEOPARD

Leopards were individually identified based on their unique rosette patterns (Karanth, 1995; Edgaonkar, 2008; Kalle, 2011; Chaudhary et al., 2024). To minimise



bias, all photographs were independently examined by three team members, and only clear images were used for identification. Captures of unique individuals were organised in a matrix with the camera-trap station ID and capture occasion (day within the sampling period). Images with distorted perspective or poor clarity were discarded to avoid misidentification (Karanth, 1995; Karanth & Nichols, 1998).

Leopard density was estimated using maximum-likelihood based spatially explicit capture–recapture (SECR) models (Efford, 2004; Borchers & Efford, 2008; Efford, 2018). SECR models conceptualise the population as a set of activity centres distributed across a defined state space, with the probability of detection declining as a function of distance from these centres. Two key parameters describe the detection function: g_0 , the probability of detection at an activity centre, and σ , the spatial scale parameter that describes how detection declines with distance (Efford, 2004). Unlike conventional capture–recapture, SECR explicitly incorporates both detector locations (camera traps) and animal captures, thereby linking encounter histories to activity centres and providing direct density estimates without requiring ad hoc definitions of the effective sampling area. All analyses were implemented in the R package `secr` v5.2 (Efford, 2025; R Core Team, 2023). A buffer width of 6000 m ($\approx 4\sigma$) was applied to define the state space around the trapping array. Animal movements around activity centres were modelled using a half-normal detection function (Ramesh et al., 2012).

Since not all individuals could be sexed reliably, we applied a hybrid mixture model that probabilistically allocated unidentified individuals to sex classes based on their encounter rate (g_0) and movement parameter (σ). To account for heterogeneity in detection, we fitted a set of candidate models:

Table 1: Null, 2 class mixture model and Behavioural Response models used in modelling the density in Spatially Explicit Capture Recapture

Null Model	$D \sim 1 \text{ go} \sim 1 \text{ sigma} \sim 1 \text{ pmix} \sim h2$
2 class mixture model	$D \sim 1 \text{ go} \sim h2 \text{ sigma} \sim 1 \text{ pmix} \sim h2$
	$D \sim 1 \text{ go} \sim 1 \text{ sigma} \sim h2 \text{ pmix} \sim h2$
	$D \sim 1 \text{ go} \sim h2 \text{ sigma} \sim h2 \text{ pmix} \sim h2$
Behavioural Response Model	$D \sim 1 \text{ go} \sim b \text{ sigma} \sim 1 \text{ pmix} \sim h2$
	$D \sim 1 \text{ go} \sim 1 \text{ sigma} \sim b \text{ pmix} \sim h2$

Model support was assessed using the Akaike Information Criterion adjusted for small sample sizes (AICc) (Burnham & Anderson, 2004).

3.2.3. COVARIATE SELECTION

To examine the ecological and anthropogenic factors influencing carnivore occupancy, we selected a combination of remote sensing and ground-based variables that capture landscape characteristics, habitat conditions and human pressures. Although carnivores generally avoid human settlements, they may occasionally be drawn to areas near villages and roads due to the availability of livestock carcasses as an alternative food source (Panda et al., 2022). Accordingly, the distance from each camera trap station to the nearest village (m) was calculated using the Euclidean distance tool in ArcGIS “Spatial Analyst Tools”. Water availability is considered an important determinant, particularly during the peak summer months (April–May) when surface water becomes scarce. Perennial sources such as the Maiz river and abandoned mines around the Indergarh range, which retain water year round, were expected to influence carnivore space use. To represent this, Euclidean distances to drainage lines, water bodies and rivers were calculated for each camera trap point using the “Euclidean distance” tool within the “Spatial Analyst Tools” using ArcGIS Pro.

In addition to distance-based measures, landscape composition was assessed at the camera-trap-grid level to capture habitat structure and resource availability. Proportions of forest cover, scrub cover, and agricultural land within each grid cell were extracted from remote sensing data and incorporated as habitat covariates. Prey availability was accounted for by calculating a

wild prey index, derived from the summed Relative Abundance Indices (RAI) of potential prey species recorded at each station including chital, sambar, nilgai, wild pig, Hanuman langur, porcupine, Indian hare and peafowl. Finally, human and livestock presence (cattle, buffalo, goat and sheep) was quantified using RAI, as these can act as both potential food resources and sources of conflict. Together, these covariates provide a comprehensive framework to assess carnivore habitat use in relation to resource availability, habitat conditions and anthropogenic disturbance.

3.2.4. OCCUPANCY MODELLING

We employed single-season, single-species occupancy modelling to examine habitat use of large- and medium-sized carnivores – specifically leopard, striped hyena, golden jackal, and Indian fox – using the R package *unmarked* (Fiske & Chandler, 2011; Kellner et al., 2023) in R version 4.3.1 (R Core Team, 2023). Repeated surveys with camera traps recorded detections (1) and non-detections (0) across multiple sites. This framework accounts for imperfect detection, providing unbiased estimates of occupancy (Ψ) by explicitly incorporating detection probability (p). The covariates used to model the occupancy probability of the carnivores were forest cover, scrub cover, agriculture cover, distance to village, distance to water, relative abundance of wild prey, humans and livestock. All predictor variables were standardised (mean-centred and scaled to one standard deviation) prior to analysis. To test for collinearity, we performed Pearson’s correlation among predictors and retained

only those with $|r| < 0.60$. As all covariates met this criterion, they are included in the final analysis.

Model selection was based on Akaike's Information Criterion (AIC) and model weights (Burnham & Anderson, 2004). Estimates of Ψ (psi) were averaged across models up to a cumulative Akaike weight of 0.90. Model fit and potential overdispersion (\hat{c}) were evaluated using Pearson's chi-square goodness-of-fit test with 10,000 parametric bootstraps (MacKenzie & Bailey, 2004). When $\hat{c} > 1.1$, we adjusted the dispersion parameter in AIC-based model comparisons. We considered the $p \leq 0.05$ to be significant and $p \leq 0.10$ to be marginally significant. At last, we generated species-specific maps on model averaged site occupancy estimates by inverse distance weighted interpolation (IDW; Liszka, 1984), producing spatial interpolation surfaces of carnivore occupancy probability for Indergarh range.

3.2.5. SPATIO-TEMPORAL ACTIVITY AND OVERLAP

We used time-stamped camera trap images to examine diel activity patterns of photo-captured species. All independent detections were converted into time-of-day value (radians) to allow circular statistical analysis. We categorised activity patterns into three major diel guilds: (a) diurnal activity 07:00-17:59; (b) nocturnal activity 20:00-04:59; (c) crepuscular activity 05:00-06:59 (dawn) and 18:00-19:59 (dusk) (Kyaw et al., 2021); and (d) cathemeral (uniform distribution/activity) (Oliveira-Santos et al., 2013). Circular kernel models using the 'fitact' function was fitted using the 'activity' package (version 1.2; Rowcliffe et al., 2014), estimating mean activity levels (proportion active per day) with 95% confidence intervals. This function relies on the key assumption that all individuals in a population are active at the peak of the circadian rhythm and estimates the activity levels as a proportion of activity over the 24-hour cycle; this method is thus independent of differences in species-specific densities or absolute capture rates (Rowcliffe et al., 2014). The proportional activity levels were multiplied by 24 to estimate the absolute time that a species is active during a 24-hr cycle. As a continuous index of cathemerality, the proportion of activity was used for the less-used phase of the day (irrespective of whether day or night). Thus, 0 denotes an either exclusively diurnal or exclusively nocturnal activity, whereas 0.5 describes a perfectly balanced cathemeral

activity. To test whether two activity patterns could be considered as significantly different, we used *activity* package in R software (Rowcliffe, 2019). With this purpose, a null distribution of 1,000 random overlap indices was created by using bootstrap samples that contained values taken indiscriminately from any of the two density distributions to be contrasted. Then, the observed or "true" overlap index was compared to this null distribution to check the probability that it had arisen by chance (p). The activity patterns of leopard with other carnivores and prey species were significantly different when p value is < 0.05 .

The temporal activity overlaps and overlap coefficient (Δ) were calculated using a non-parametric kernel density estimation method (Linkie and Ridout, 2011) between leopard and carnivores-ungulates using the 'overlap' package (Meredith et al., 2024) in programme R v. 4.0.2 (R Core Team). Specifically, we used the overlap coefficient Δ_1 ($n \leq 50$) and Δ_4 ($n > 50$) estimator based on the available sample sizes. Values of Δ ranged between 0 and 1, where 0 denotes no overlap and 1 denotes complete overlap (Meredith, 2024). We ran 10,000 bootstraps for each species and generated 95% Confidence Interval (CI) for temporal overlap ((Ridout & Linkie, 2009). Spatial overlap was assessed using Pianka's niche overlap index (Pianka, 1973), which quantifies the similarity in resource use between two species. In our case, camera trap detection frequencies across different spatial locations were used as a proxy of space use. The index compares the proportional use of sites by each species and produces values ranging from 0 (no overlap) to 1 (complete overlap). Pianka's index was calculated between leopard and associated carnivores and its prey species to assess the extent of spatial overlap.



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4. RESULTS

4.1. Relative Abundance Index of Photo-captured Species

Camera trapping exercises resulted in a total of 4334 independent captures with an effort of 1696 trap nights. A total of 22 wildlife species were photo-captured along with human beings and livestock, out of which 18 wild species were tallied to compute the Relative Abundance Index. These included carnivores (leopard, sloth bear, striped hyena, golden jackal, rusty-spotted cat, jungle cat, and Asiatic wildcat/desert cat; Figure.

2, 3 & 4) and herbivores (chital, sambar, nilgai, wild pig, Hanuman langur, Indian peafowl, Indian hare and Indian crested porcupine; Figure. 5). Nilgai, wild pig and Indian hare were the most commonly photo-captured species among the herbivores followed by peafowl, porcupine and sambar. Humans and livestock were also commonly photo-captured in the area.

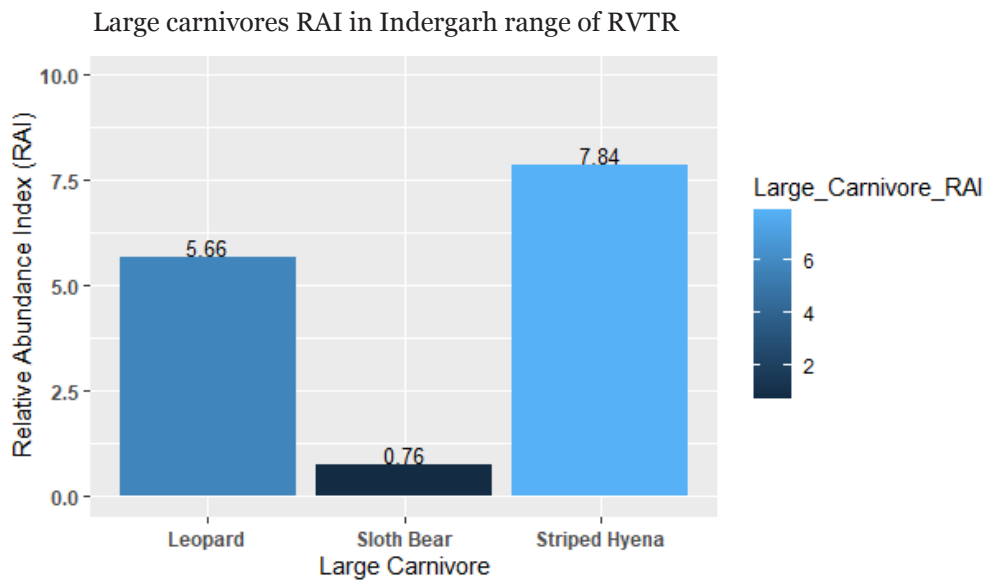


Figure 2: Relative Abundance Index of large carnivores in Indergarh Range

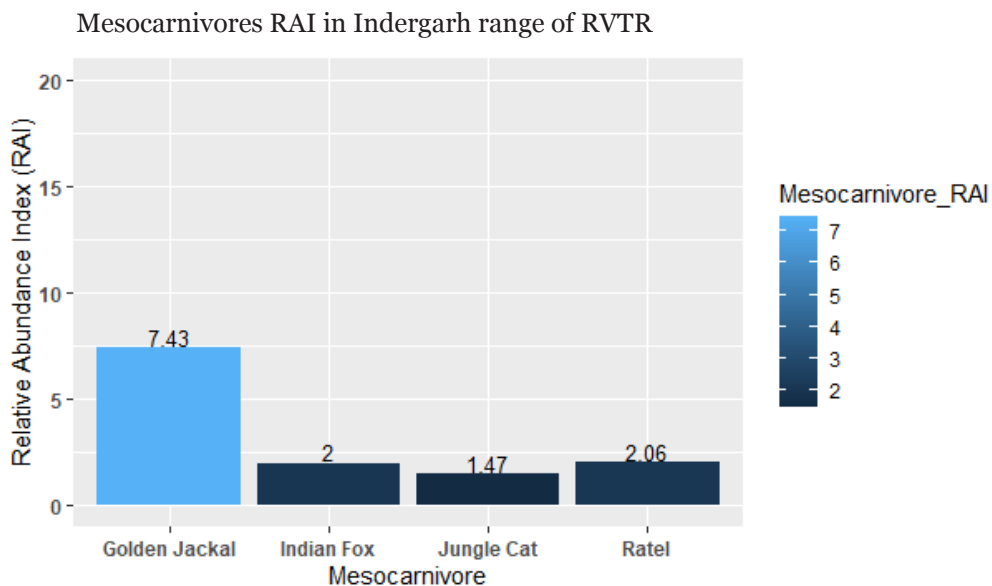


Figure 3: Relative Abundance Index of mesocarnivores in Indergarh Range

Small carnivores RAI in Indergarh range of RVTR

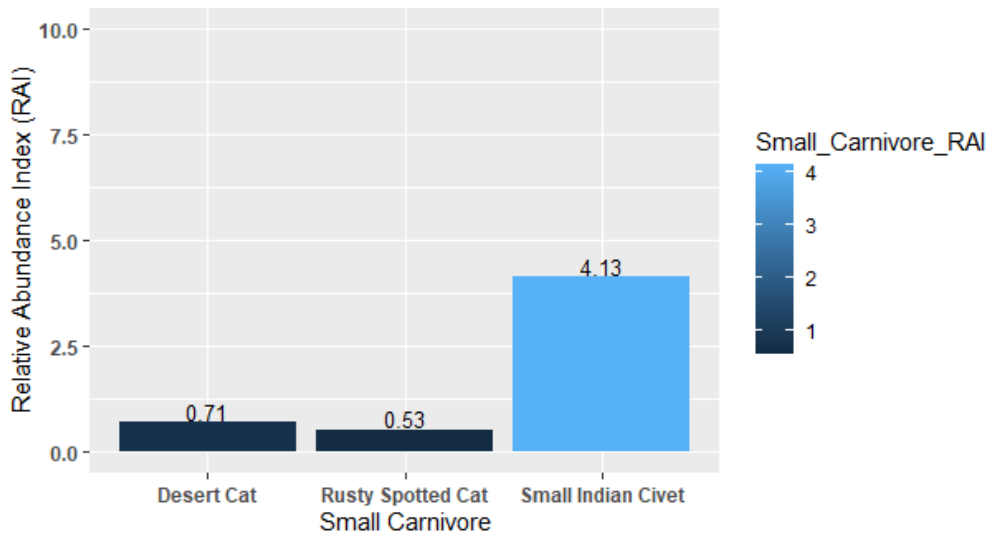


Figure 4: Relative Abundance Index of small carnivores in Indergarh Range

Prey Relative Abundance Index in Indergarh range of RVTR

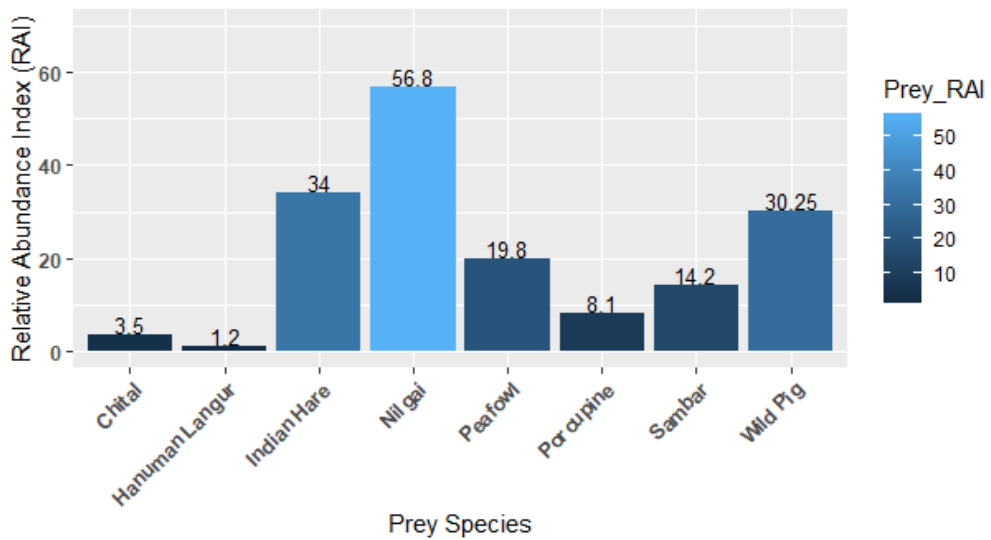


Figure 5: Relative Abundance Index of herbivores in Indergarh Range



4.2. Density Estimates of Leopard

During the sampling period, leopards were detected at 32 of the 55 camera trap sites (58%). A total of 154 photographic captures yielded 28 individually identified adult leopards, comprising 12 males, 12 females, and 4 of unknown sex (Mt+1). Six juveniles were also identified but excluded from density estimation (Appendix A). Notably, 14 adults were recorded only once during the survey. We fitted spatially explicit capture–recapture (SECR) models using a half-normal detection function to account for individual heterogeneity in detection probability ($p_{mix} = h_2$). Candidate model structures (Table 1) allowed g_0 and σ to remain constant or vary with mixture models. Among the fitted models, the heterogeneity model with σ varying by mixture class ($D \sim 1, g_0 \sim 1, \sigma \sim h_2, p_{mix} \sim h_2$) received the strongest support with the lowest AICc value (372.37). Alternative

heterogeneity models, where g_0 or both g_0 and σ varied with mixtures, also received moderate support but had higher AICc values. Behavioural response models incorporating b-effects were less supported (AICc = 376.25) (Table 3).

The model-averaged density of leopards in the Indergarh Range was estimated at 5.76 ± 1.22 SE individuals/100 km² (95% CI: 3.81–8.69; Table 1). Estimates of detection parameters indicated similar baseline detection probabilities for males ($g_0 = 0.051 \pm 0.012$) and females ($g_0 = 0.047 \pm 0.013$), while spatial scale parameters (σ) suggested wider ranging movements for males (1876.71 ± 219.04 m) than females (1623.69 ± 230.51 m) (Table 2).

Table 2: Model average density estimates of leopards in Indergarh range

Model average density estimates				
Parameter	Estimate	SE.estimate	lcl	ucl
D	5.76	1.22	3.81	8.69
g_0 (female)	0.047	0.013	0.027	0.079
g_0 (male)	0.051	0.012	0.032	0.081
σ (female)	1623.69	230.51	1231.01	2141.62
σ (male)	1876.71	219.04	1494.12	2357.26
p_{mix} (female)	0.55	0.12	0.33	0.76
p_{mix} (male)	0.45	0.12	0.24	0.67

Table 3: Summary of AIC values for density estimates of leopards using half normal (HN) detection function from a null, learned response after first detection (b), and the hybrid mixture model (h2) on σ and g_0 in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve.

Model	detectfn	npar	logLik	AIC	AICc	dAICc	AICcwt
$D \sim 1, g_0 \sim 1, \sigma \sim h_2, p_{mix} \sim h_2$	halfnormal	5	-179.82	369.64	372.367	0	0.4013
$D \sim 1, g_0 \sim 1, \sigma \sim 1, p_{mix} \sim h_2$	halfnormal	4	-181.7606	371.521	373.26	0.893	0.2568
$D \sim 1, g_0 \sim h_2, \sigma \sim 1, p_{mix} \sim h_2$	halfnormal	5	-180.8485	371.697	374.424	2.057	0.1435
$D \sim 1, g_0 \sim h_2, \sigma \sim h_2, p_{mix} \sim h_2$	halfnormal	6	-179.7564	371.513	375.513	3.146	0.0832
$D \sim 1, g_0 \sim b, \sigma \sim 1, p_{mix} \sim h_2$	halfnormal	5	-181.7606	373.521	376.248	3.881	0.0576
$D \sim 1, g_0 \sim 1, \sigma \sim b, p_{mix} \sim h_2$	halfnormal	5	-181.7606	373.521	376.248	3.881	0.0576

4.3. Occupancy and Habitat Use of Photo-captured Species

4.3.1. NAÏVE OCCUPANCY

The naïve occupancy estimates reveal distinct patterns of habitat use across four ecological guilds. Among large carnivores, the leopard had the highest occupancy (0.58), indicating broad distribution and adaptability; followed by the striped hyena (0.42), while the sloth bear (0.18) showed restricted presence (Figure 6). Within mesocarnivores, golden jackals had relatively high occupancy (0.42), suggesting generalist behaviour and tolerance to anthropogenic landscapes, whereas the ratel, jungle cat and Indian fox showed values ranging from 0.20-0.25 (Figure 6).

For small carnivores, the small Indian civet stood out with the highest naïve occupancy (0.49), while others like the rusty-spotted cat and Asian palm civet had much lower occupancy (0.13-0.15) (Figure 7), pointing to specialised habitat use or low detection. Prey species exhibited the highest overall occupancies, with nilgai (0.96), Indian hare (0.89) and wild pig (0.87) being the most widespread. In contrast, species like chinkara, chital and langur were associated with lower values (0.02-0.13), (Figure 7).

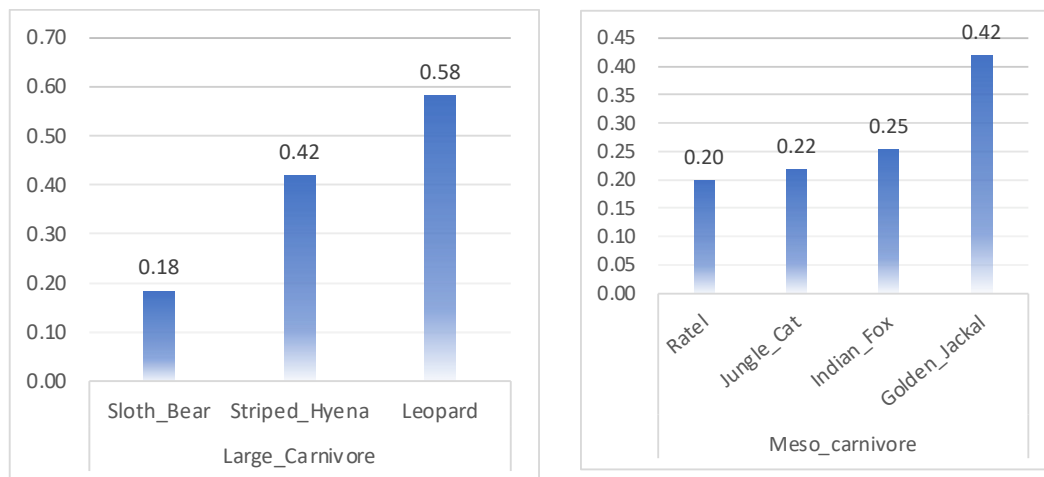


Figure 6: Naïve occupancy of large carnivores and mesocarnivores

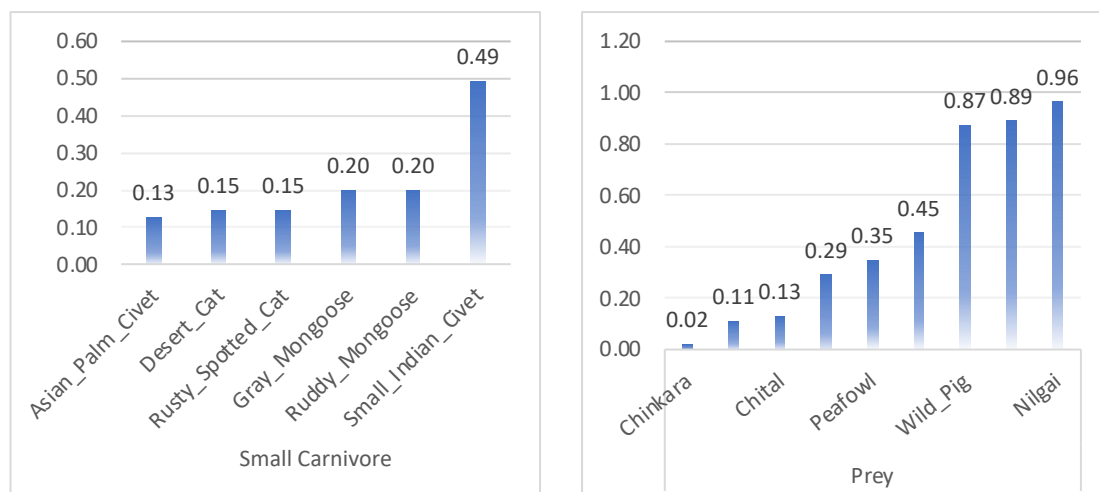


Figure 7: Naïve occupancy of small carnivores and prey species

4.3.2. HABITAT USES OF LEOPARD

The mean detection probability of leopards was estimated at ($p = 0.12$, $SE = 0.02$ [95% CI: 0.09–0.15]). The naïve occupancy of leopards was calculated at $\Psi = 0.58$, whereas the model averaged predicted occupancy was $\Psi = 0.66 \pm 0.13$ (CI 0.11-0.68) (Figure 8). While modelling the site use, a total of seven models best explained the occupancy probability (Ψ) of leopards (Cum.Wt $\leq 90\%$; Table 4). Among these, the top-ranked model identified wild prey availability (all prey RAI) as the most influential factor shaping leopard

occupancy. Leopard occurrence showed a strong positive association with wild prey presence (β all prey = 3.01 ± 1.16 ; Table 5; Figure 9), indicating that sites with higher prey abundance had markedly higher probabilities of leopard habitat use. Competing models that included scrub cover, forest cover, and distance to water alongside prey availability also received support, but with considerably lower weights compared to the prey-only model.

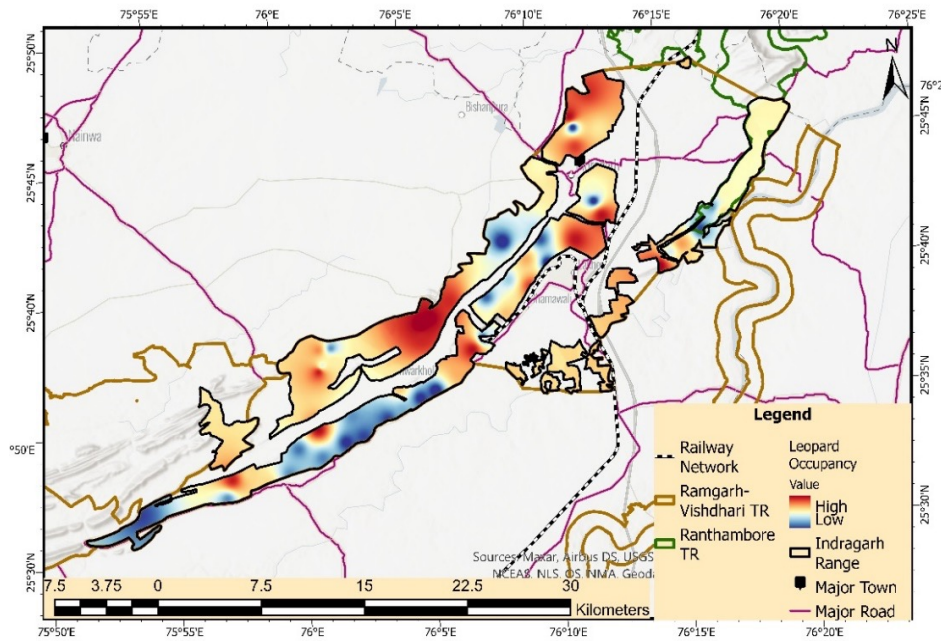


Figure 8: Leopard occupancy map in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

Table 4: Model selection results; role of ecological and anthropological covariates in determining probability of leopard habitat-use (ψ) in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

S. no	Model	K	AICc	Delta_AICc	AICcWt	Cum.Wt	LL
1	p (.) ψ (all prey)	3	677.83	0	0.37	0.37	-335.68
2	p (.) ψ (scrub cover + all prey)	4	679.81	1.98	0.14	0.51	-335.5
3	p (.) ψ (forest cover + all prey)	4	679.91	2.07	0.13	0.64	-335.55
4	p (.) ψ (distance to water + all prey)	4	680.12	2.29	0.12	0.75	-335.66
5	p (.) ψ (human)	3	681.18	3.35	0.07	0.82	-337.36
6	p (.) ψ (forest cover + scrub cover + all prey)	5	682.21	4.38	0.04	0.86	-335.5
7	p (.) ψ (distance to water + forest cover + all prey)	5	682.30	4.47	0.04	0.90	-335.54

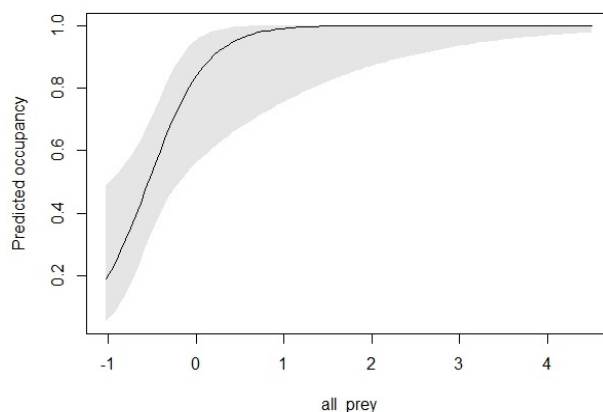


Figure 9: Predicted occupancy response curve showing the relationship between all prey and the probability of species occupancy. The solid black line represents the mean predicted occupancy, while the shaded grey area indicates the 95% CI

Table 5: β -coefficients (SE) from most-supported models used to assess the effect of variables on ψ (habitat-use) of the leopard in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

Model	β all prey (SE)	β scrub cover	β forest cover	β distance to water	β agriculture cover	β human RAI	β livestock
p (.) ψ (all prey)	3.01 (1.16)	-	-	-	-	-	-
p (.) ψ (scrub cover + all prey)	2.97 (1.14)	- 0.24 (0.41)	-	-	-	-	-
p (.) ψ (forest cover + all prey)	2.98 (1.16)	-	0.18 (0.37)	-	-	-	-
p (.) ψ (distance to water + all prey)	3.07 (1.21)	-	-	0.09 (0.46)	-	-	-
p (.) ψ (human)	-	-	-	-	-	3.47 (2.41)	-
p (.) ψ (forest cover + scrub cover + all prey)	2.96 (1.15)	- 0.19 (0.55)	0.07 (0.50)	-	-	-	-
p (.) ψ (distance to water + forest cover + all prey)	3.03 (1.21)	-	0.18 (0.37)	0.07 (0.45)	-	-	-



4.3.3. HABITAT USES OF STRIPED HYENA

The mean detection probability of striped hyenas was estimated at ($p=0.11$, $SE = 0.01$ [95% CI 0.09-0.13]). The naïve occupancy of striped hyena was calculated at $\Psi = 0.42$, whereas the predicted model averaged occupancy was $\Psi = 0.43 \pm 0.12$ (CI: 0.21-0.68) (Figure 10). While modelling the site use, a total of 17 models best explained the occupancy probability (Ψ) of striped

hyenas (Cum.Wt $\leq 90\%$); Table 6) with one significant site-use covariate, such as forest cover. Among the site-use covariates, forest cover emerged as the most influential factor, with hyena occurrence showing a positive association with forest cover ($\beta_{\text{forest cover}} = 0.48 \pm 0.31$; Table 7; Figure 11).

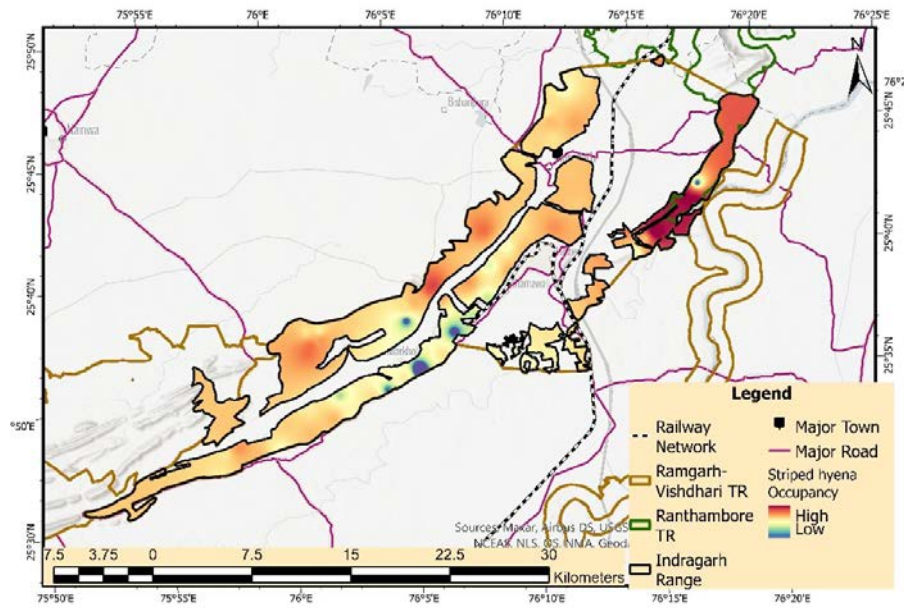


Figure 10: Striped hyena occupancy map in Indergarh range of Ramgarh Vishdhari Tiger Reserve



Table 6: Model selection results; role of ecological and anthropological covariates in determining probability of striped hyena habitat-use (ψ) in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

S. no	Models	K	AICc	Delta_AICc	AICcWt	Cum.Wt	LL
1	p (.) ψ (forest cover)	3	598.1	0	0.12	0.12	-295.81
2	p (.) ψ (.)	2	598.61	0.51	0.09	0.22	-297.19
3	p (.) ψ (agriculture cover)	3	598.73	0.63	0.09	0.31	-296.13
4	p (.) ψ (forest cover + scrub cover)	4	598.79	0.69	0.09	0.39	-294.99
5	p (.) ψ (distance to water + forest cover + scrub cover)	5	599.24	1.14	0.07	0.46	-294.01
6	p (.) ψ (distance to water + agriculture cover)	4	599.66	1.55	0.06	0.52	-295.43
7	p (.) ψ (distance to water + forest cover)	4	599.77	1.67	0.05	0.57	-295.49
8	p (.) ψ (distance to water)	3	600.33	2.23	0.04	0.61	-296.93
9	p (.) ψ (forest cover + all prey)	4	600.36	2.26	0.04	0.65	-295.78
10	p (.) ψ (distance to village)	3	600.56	2.46	0.04	0.69	-297.04
11	p (.) ψ (livestock)	3	600.6	2.5	0.03	0.72	-297.07
12	p (.) ψ (agriculture cover + livestock)	4	600.66	2.56	0.03	0.75	-295.93
13	p (.) ψ (all prey)	3	600.7	2.6	0.03	0.79	-297.11
14	p (.) ψ (scrub cover)	3	600.83	2.73	0.03	0.82	-297.18
15	p (.) ψ (human)	3	600.85	2.75	0.03	0.85	-297.19
16	p (.) ψ (agriculture cover + human)	4	601.04	2.94	0.03	0.88	-296.12
17	p (.) ψ (forest cover + scrub cover + all prey)	5	601.19	3.09	0.03	0.9	-294.98

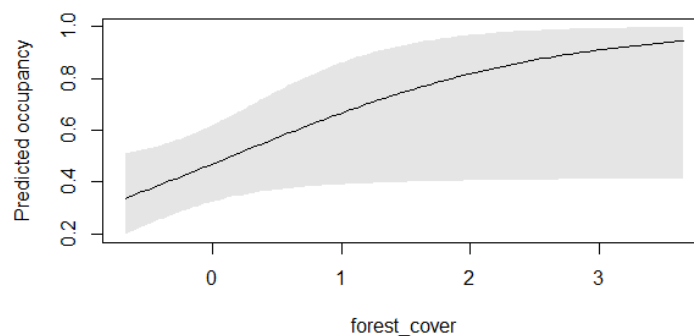


Figure 11: Predicted occupancy response curve showing the relationship between forest cover and the probability of striped hyena occupancy. The solid black line represents the mean predicted occupancy, while the shaded grey area indicates the 95% CI

Table 7: β -coefficients (SE) from most-supported models used to assess the effect of variables on ψ (habitat-use) of striped hyena in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

Models	β forest cover (SE)	β agriculture cover (SE)	β scrub (SE)	β distance to water (SE)	β all prey (SE)	β distance to village (SE)	β livestock (SE)	β Human (SE)
p (.) ψ (forest cover)	0.48 (0.31)	-	-	-	-	-	-	-
p (.) ψ (.)	-	-	-	-	-	-	-	-
p (.) ψ (agriculture cover)	-	- 0.45 (0.32)	-	-	-	-	-	-
p (.) ψ (forest cover + agriculture cover)	0.81 (0.42)	-	0.50 (0.41)	-	-	-	-	-
p (.) ψ (distance to water + forest cover + scrub cover)	1.01 (0.47)	-	0.75 (0.46)	- 0.48 (0.30)	-	-	-	-
p (.) ψ (distance to water + agriculture cover)	-	- 0.58 (0.36)	-	- 0.39 (0.34)	-	-	-	-
p (.) ψ (distance to water + forest cover)	0.51 (0.32)	-	-	- 0.24 (0.30)	-	-	-	-
p (.) ψ (distance to water)	-	-	-	- 0.21 (0.29)	-	-	-	-
p (.) ψ (forest cover + all prey)	-	0.48 (0.31)	-	-	- 0.08 (0.29)	-	-	-
p (.) ψ (distance to village)	-	-	-	-	-	- 0.15 (0.28)	-	-
p (.) ψ (livestock)	-	-	-	-	-	-	0.14 (0.28)	-
p (.) ψ (agriculture cover + livestock)	-	- 0.47 (0.33)	-	-	-	-	0.18 (0.29)	-
p (.) ψ (all prey)	-	-	-	-	- 0.11 (0.29)	-	-	-
p (.) ψ (scrub cover)	-	-	- 0.03 (0.28)	-	-	-	-	-
p (.) ψ (human)	-	-	-	-	-	-	-	0.002 (0.28)
p (.) ψ (agriculture cover+ human)	-	- 0.45 0.32)	-	-	-	-	-	- 0.04 (0.28)
p (.) ψ (forest cover + scrub cover + all prey)	0.81 (0.42)	-	0.50 (0.41)	-	- 0.04 (0.31)	-	-	-

4.3.4. HABITAT USES OF THE GOLDEN JACKAL

The mean detection probability of the golden jackal in the Indergarh Range was $p = 0.12$ (SE = 0.01). Naïve occupancy was $\Psi = 0.42$, while model-averaged occupancy was predicted at $\Psi = 0.43 \pm 0.13$ (CI: 0.19-0.68) (Figure 12). While modelling the site use, a total of fifteen models best explained the occupancy probability (Ψ) of the golden jackal (Cum.Wt $\leq 90\%$;

Table 8) with human presence emerging as the most important covariate ($\beta_{\text{human}} = 0.72 \pm 0.42$; $p = 0.$; Table 9; Figure 13). The positive association suggests that jackals preferentially occupied areas with human presence, likely due to the availability of anthropogenic resources such as livestock carcasses, garbage or crop fields.

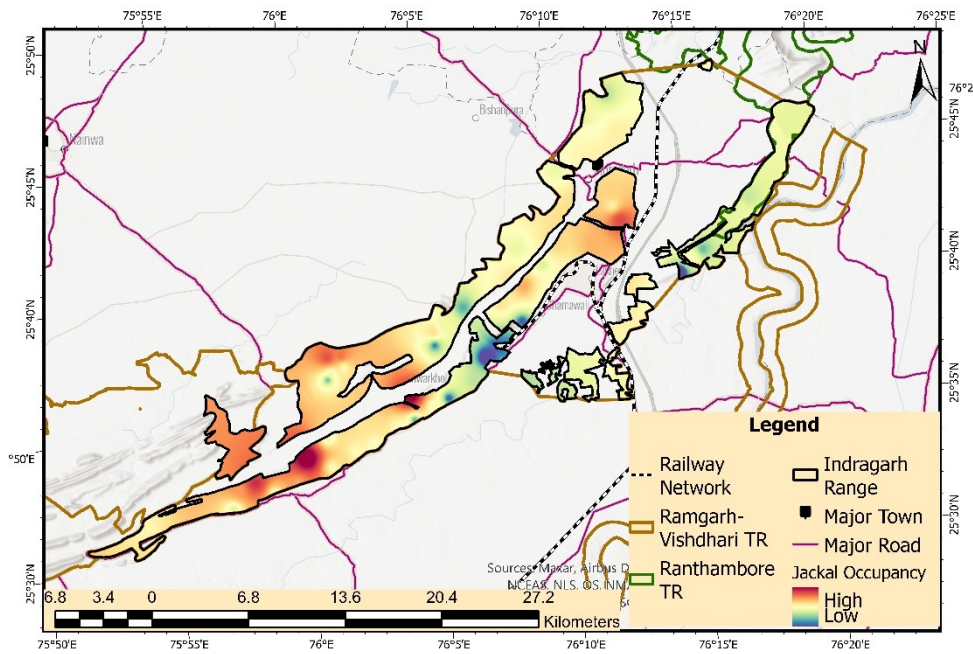


Figure 12: Golden jackal occupancy map in Indergarh range of Ramgarh Vishdhari Tiger Reserve



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Table 8: Model selection results; role of ecological and anthropological covariates in determining probability of golden jackal habitat-use (ψ) in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

S. no	Models	K	AICc	Delta_AICc	AICcWt	Cum.Wt	LL
1	p (.) ψ (human)	3	618.28	0	0.15	0.15	-305.9
2	p (.) ψ (livestock)	3	618.86	0.58	0.12	0.27	-306.19
3	p (.) ψ (agriculture cover + livestock)	4	619.31	1.03	0.09	0.36	-305.25
4	p (.) ψ (human + livestock)	4	619.61	1.34	0.08	0.44	-305.41
5	p (.) ψ (agriculture cover + livestock)	4	619.69	1.41	0.08	0.52	-305.44
6	p (.) ψ (all prey)	3	620.34	2.06	0.06	0.57	-306.93
7	p (.) ψ (distance to village + livestock)	4	620.36	2.08	0.05	0.63	-305.78
8	p (.) ψ (scrub cover + all prey)	4	620.57	2.29	0.05	0.68	-305.88
9	p (.) ψ (.)	2	620.57	2.3	0.05	0.73	-308.17
10	p (.) ψ (scrub cover)	3	620.73	2.46	0.05	0.77	-307.13
11	p (.) ψ (agriculture cover)	3	621.43	3.16	0.03	0.81	-307.48
12	p (.) ψ (distance to village)	3	621.58	3.31	0.03	0.83	-307.56
13	p (.) ψ (forest cover + all prey)	4	622.34	4.06	0.02	0.86	-306.77
14	p (.) ψ (distance to water + scrub cover)	4	622.52	4.24	0.02	0.87	-306.86
15	p (.) ψ (distance to water + all prey)	4	622.58	4.3	0.02	0.89	-306.89

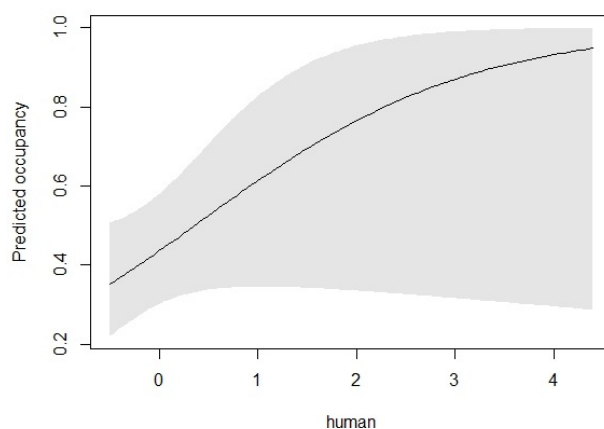


Figure 13: Predicted occupancy response curve showing the relationship between livestock presence and the probability of golden jackal occupancy. The solid black line represents the mean predicted occupancy, while the shaded grey area indicates the 95% CI

Table 9: β -coefficients (SE) from most-supported models used to assess the effect of variables on ψ (habitat-use) of the golden jackal in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

Models	β human (SE)	β livestock (SE)	β agriculture cover (SE)	β all prey (SE)	β scrub cover (SE)	β distance to village (SE)	β forest cover (SE)	distance to water (SE)
p (.) ψ (human)	0.72 (0.42)	-	-	-	-	-	-	-
p (.) ψ (livestock)	-	0.63 (0.37)	-	-	-	-	-	-
p (.) ψ (agriculture cover + livestock)	-	0.69 (0.39)	- 0.48 (0.34)	-	-	-	-	-
p (.) ψ (human + livestock)	0.50 (0.44)	0.37 (0.40)	-	-	-	-	-	-
p (.) ψ (agriculture cover + livestock)	0.69 (0.43)	-	- 0.29 (0.32)	-	-	-	-	-
p (.) ψ (all prey)	-	-	-	- 0.51 (0.36)	-	-	-	-
p (.) ψ (distance to village + livestock)	-	0.61 (0.38)	-	-	-	- 0.27 (0.29)	-	-
p (.) ψ (scrub cover + all prey)	-	-	-	- 0.53 (0.37)	0.43 (0.31)	-	-	-
p (.) ψ (.)	-	-	-	-	-	-	-	-
p (.) ψ (scrub cover)	-	-	-	-	0.42 (0.30)	-	-	-
p (.) ψ (agriculture cover)	-	-	- 0.35 (0.31)	-	-	-	-	-
p (.) ψ (distance to village)	-	-	-	-	-	- 0.32 (0.29)	-	-
p (.) ψ (forest cover + all prey)	-	-	-	- 0.52 (0.36)	-	-	- 0.17 (0.29)	-
p (.) ψ (distance to water + scrub cover)	-	-	-	-	0.48 (0.32)	-	-	- 0.23 (0.31)
p (.) ψ (distance to water + all prey)	-	-	-	- 0.09 (0.30)	-	-	-	- 0.50 (0.36)

4.3.5. HABITAT USE BY THE INDIAN FOX

Overall, the mean detection probability of the Indian fox was ($p=0.06$, $SE= 0.01$). The naïve occupancy of the Indian fox was calculated at ($\Psi = 0.25$), whereas the model averaged occupancy probability was $\Psi= 0.30 \pm 0.13$ (CI: 0.11-0.68) (Figure 14). While modelling the site use, a total of five models best explained the occupancy probability (Ψ) of the Indian fox (Cum.Wt \leq

90%; Table 9) with scrub cover as the most important covariate (Table 11). As the response curve shows, site use of the Indian fox was positively associated with scrub cover ($\beta_{\text{scrub cover}}=1.36 \pm 0.58$; $p=0.02$), as occupancy probability increased from near zero in areas with low scrub cover to sites dominated by scrub (Table 12; Figure 15).

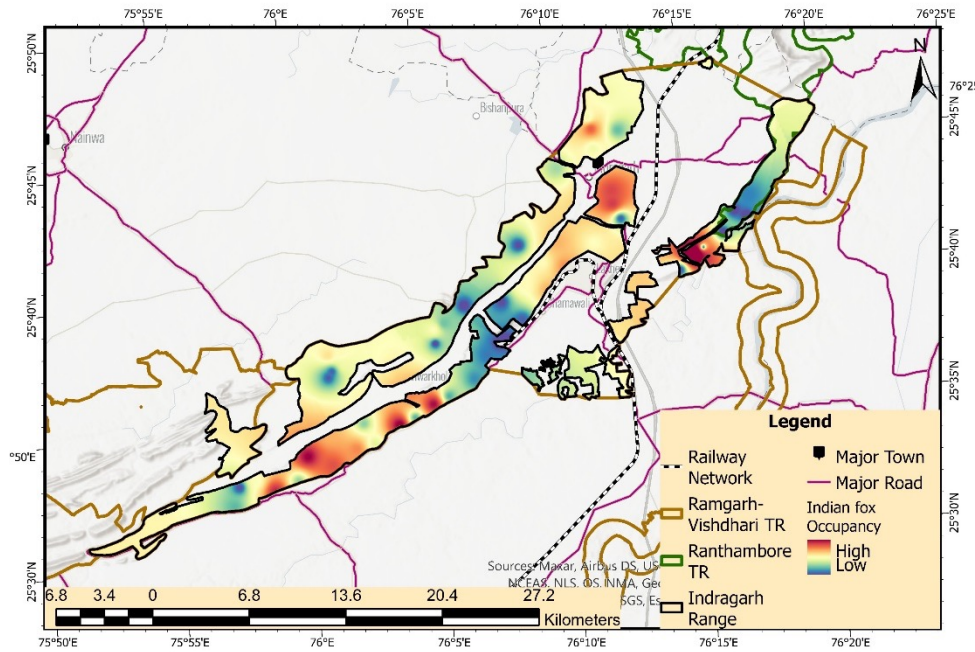


Figure 14: Indian fox occupancy map in Indergarh range of Ramgarh Vishdhari Tiger Reserve

Table 10: Model selection results; role of ecological and anthropological covariates in determining probability of Indian fox habitat-use (ψ) in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

S. no	Models	K	AICc	Delta_AICc	AICcWt	Cum.Wt	LL
1	$p(\cdot) \psi$ (scrub cover)	3	280.43	0	0.3	0.3	-136.98
2	$p(\cdot) \psi$ (scrub cover + small prey)	4	280.6	0.17	0.27	0.57	-135.9
3	$p(\cdot) \psi$ (forest cover)	3	281.52	1.09	0.17	0.74	-137.52
4	$p(\cdot) \psi$ (distance to water + forest cover)	4	283.34	2.92	0.07	0.81	-137.27
5	$p(\cdot) \psi$ (distance to water + forest cover + small prey)	5	283.42	2.99	0.07	0.88	-136.1

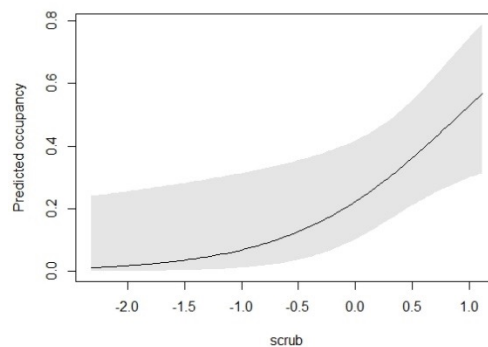


Figure 15: Predicted occupancy response curve showing the relationship between livestock presence and the probability of Indian fox occupancy. The solid black line represents the mean predicted occupancy, while the shaded grey area indicates the 95% CI

Table 11: β -coefficients (SE) from most-supported models used to assess the effect of variables on ψ (habitat-use) of Indian fox in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

Models	β scrub (SE)	β small prey (SE)	β forest cover (SE)	β distance to water (SE)
p (.) ψ (scrub cover)	1.36 (0.58)	-	0	0.3
p (.) ψ (scrub cover + small prey)	1.53 (0.63)	- 0.54 (0.40)	0.17	0.27
p (.) ψ (forest cover)	-	-	1.09	0.17
p (.) ψ (distance to water + forest cover)	-	-	2.92	0.07
p (.) ψ (distance to water + forest cover +small prey)	-	- 0.62 (0.45)	2.99	0.07



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4.4. Temporal and Spatial Overlap of Leopard with Major Carnivores and Prey Species

4.4.1. TEMPORAL ACTIVITY OF THE LEOPARD WITH OTHER CARNIVORES AND PREY SPECIES

Leopards in the study area exhibited crepuscular to nocturnal activity with an absolute activity time of 9.97 hrs (SE = 1.38, CI 6.97-12.24). Other large carnivores such as striped hyenas (6.25 hrs, SE = 1.05, CI 5.67-9.66), showed primarily nocturnal and crepuscular activity.

Among mesocarnivores, golden jackals were crepuscular with an absolute activity time of 8.54 hrs (SE = 1.42, CI 7.87-13.47), while those of jungle cats (6.79 hrs, SE = 1.63, CI 3.98-10.17) and porcupines (7.55 hrs, SE = 0.81, CI 6.55-9.64) were largely nocturnal–crepuscular. While Indian fox (8.53 hrs, SE = 1.19, CI 5.15-9.55) and ratels showed nocturnal activity (6.71 hrs, SE = 1.01, CI 4.28-8.24).

Herbivore prey species showed diurnal, nocturnal and cathemeral tendencies. Sambar displayed nocturnal to crepuscular activity with an absolute activity time of 10.33 hrs (SE = 0.89, CI 8.57-12.03), while nilgai were found to be cathemeral with the highest activity time of 12.05 hrs (SE = 0.89, CI 11.62-15.07). Chital were predominantly crepuscular (6.36 hrs, SE = 1.18,

CI 4.34-8.91), while wild pigs exhibited cathemeral tendencies (8.53 hrs, SE = 0.71, CI 8.13-11.00). Among smaller prey, peafowl were strictly diurnal (5.65 hrs, SE = 0.47, CI 5.05-6.90), langurs were crepuscular–diurnal (6.84 hrs, SE = 1.23, CI 3.58-8.58), and Indian hares showed nocturnal–crepuscular activity (8.53 hrs, SE = 1.35, CI 5.79-10.85).

In large carnivores, the striped hyena ($p = 0.03$) and the ratel ($p = 0.05$) exhibited significant temporal differences in activity compared to leopards, while jungle cats ($p = 0.13$) and Indian foxes ($p = 0.42$) showed no significant differences. Among mesocarnivores, the golden jackal ($p = 0.47$), jungle cat ($p = 0.13$), and Indian fox ($p = 0.42$) all showed no significant temporal differences relative to leopards. In prey species, the chital ($p = 0.05$) and peafowl ($p = 0.0025$) demonstrated significant temporal activity differences with leopards, whereas the sambar ($p = 0.82$), nilgai ($p = 0.19$), wild pig ($p = 0.35$), Hanuman langur ($p = 0.09$), porcupine ($p = 0.12$), and Indian hare ($p = 0.45$) exhibited no significant differences (Appendix C; Table 14).

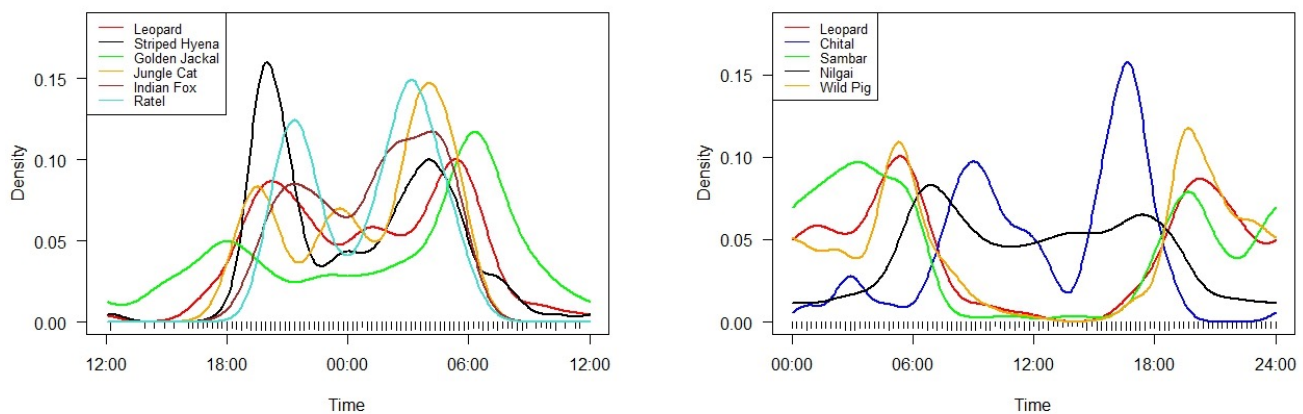


Figure 16: Activity patterns of leopards with sympatric carnivores and prey

4.4.2. TEMPORAL AND SPATIAL OVERLAP OF LEOPARDS WITH OTHER PHOTO-CAPTURED SPECIES

Temporal overlap was estimated between leopard and its associated species. To avoid subjective interpretations of the overlap in activity periods between species, we used the classification as low overlap ($\Delta \leq 0.5$), moderate overlap ($0.5 < \Delta < 0.75$), and high overlap ($\Delta > 0.75$) (Monterroso et al., 2014). Leopard activity exhibited a predominantly nocturnal and crepuscular rhythm, with peaks in the early evening and before dawn. Striped hyena showed high temporal overlap with leopards ($\Delta_4 = 0.80$, 95% CI 0.71-0.88) but low spatial overlap (0.26), suggesting avoidance in space despite temporal similarity. Golden jackal displayed moderate temporal overlap ($\Delta_4 = 0.68$, 95% CI 0.59-0.77) and low spatial overlap (0.32), while jungle cat ($\Delta_1 = 0.77$, 95% CI 0.62-0.89) and Indian fox ($\Delta_1 = 0.75$, 95% CI 0.63-0.86) exhibited relatively high temporal overlap but low spatial overlap (0.14 and 0.17, respectively), indicating fine-scale niche partitioning. Ratels showed moderate temporal overlap ($\Delta_1 = 0.69$, 95% CI 0.57-0.79) and spatial overlap (0.35), reflecting partial overlap in both

dimensions. Among prey species, the sambar ($\Delta_4 = 0.85$, 95% CI 0.76-0.92; spatial = 0.43) and wild pig ($\Delta_4 = 0.91$, 95% CI 0.84-0.97; spatial = 0.50) exhibited the highest overlap with leopard activity, highlighting them as key prey. Porcupine ($\Delta_4 = 0.68$, 95% CI 0.58-0.77) and Indian hare ($\Delta_4 = 0.79$, 95% CI 0.71-0.88) showed medium to high temporal overlap but were not well represented spatially. In contrast, chital ($\Delta_4 = 0.25$, 95% CI 0.15-0.36; spatial = 0.30) and nilgai ($\Delta_4 = 0.47$, 95% CI 0.40-0.55; spatial = 0.41) displayed low to medium overlap across both dimensions due to their predominantly diurnal activity. Peafowl also exhibited low spatial overlap (0.28), consistent with strong temporal partitioning. Collectively, these patterns reveal that while leopards share time with several sympatric carnivores and prey, spatial segregation remains an important mechanism of coexistence, with wild pig and sambar emerging as the most spatially and temporally associated prey species (Figure 17 & 18).

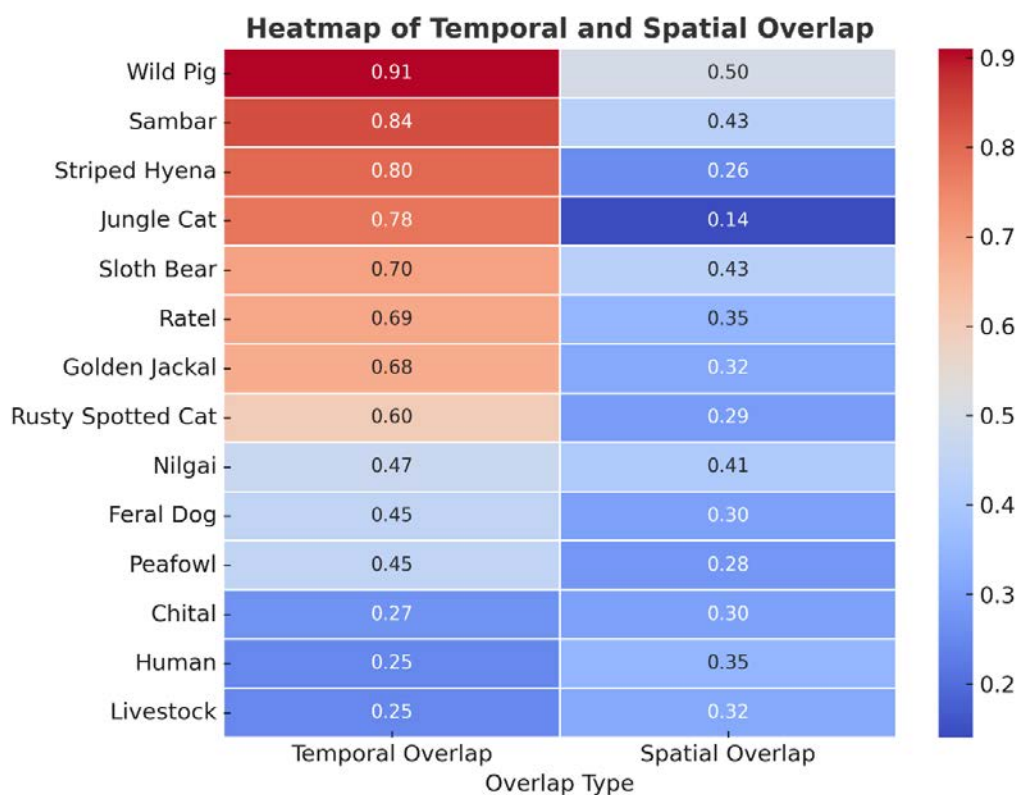
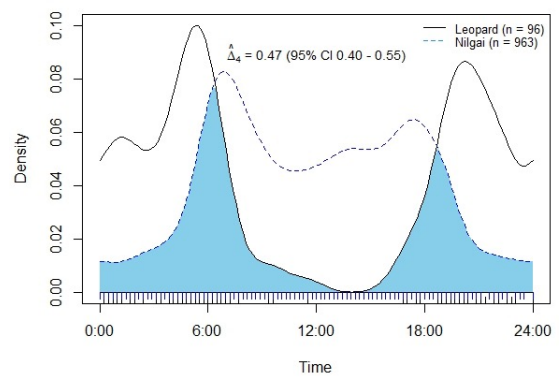
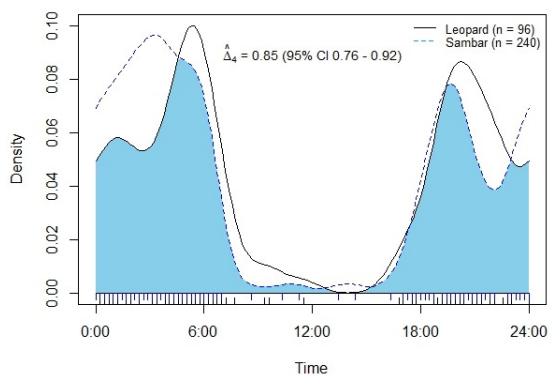
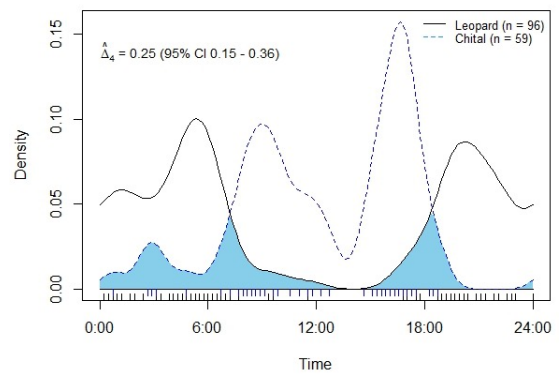
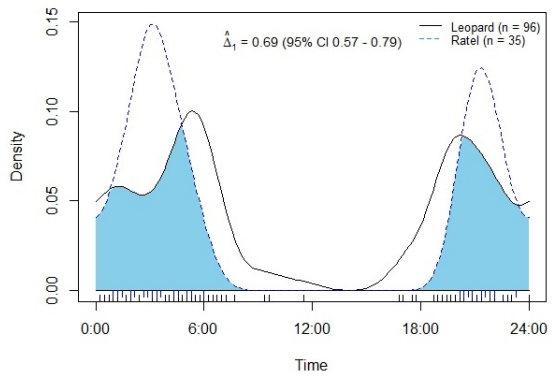
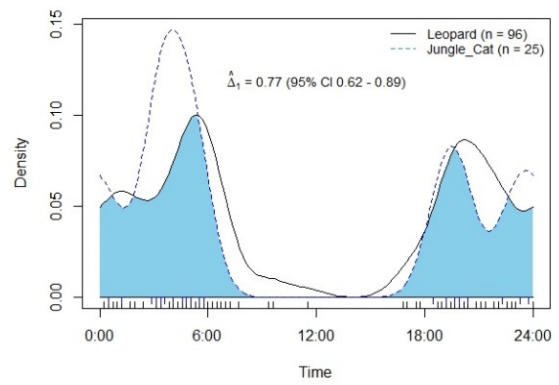
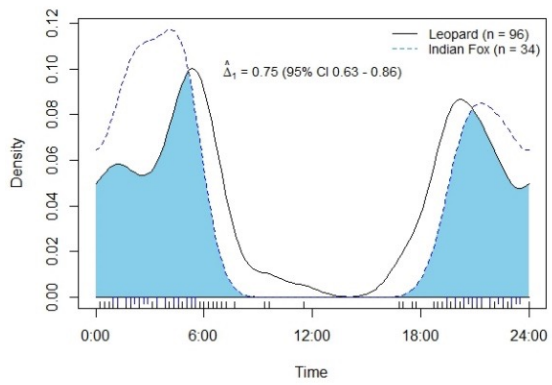
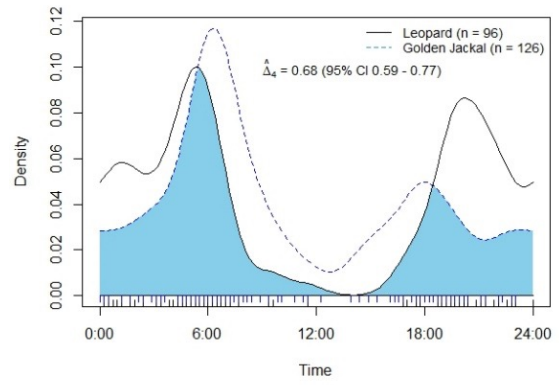
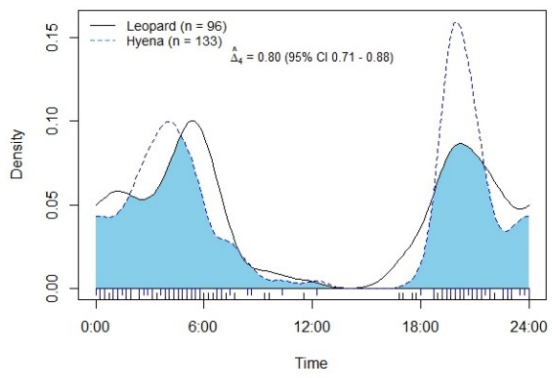


Figure 17: Heatmap showing the degree of temporal and spatial overlap between the leopard and sympatric carnivores and prey. The colour gradient represents the magnitude of overlap, with values displayed in each cell. Higher values indicate high overlap



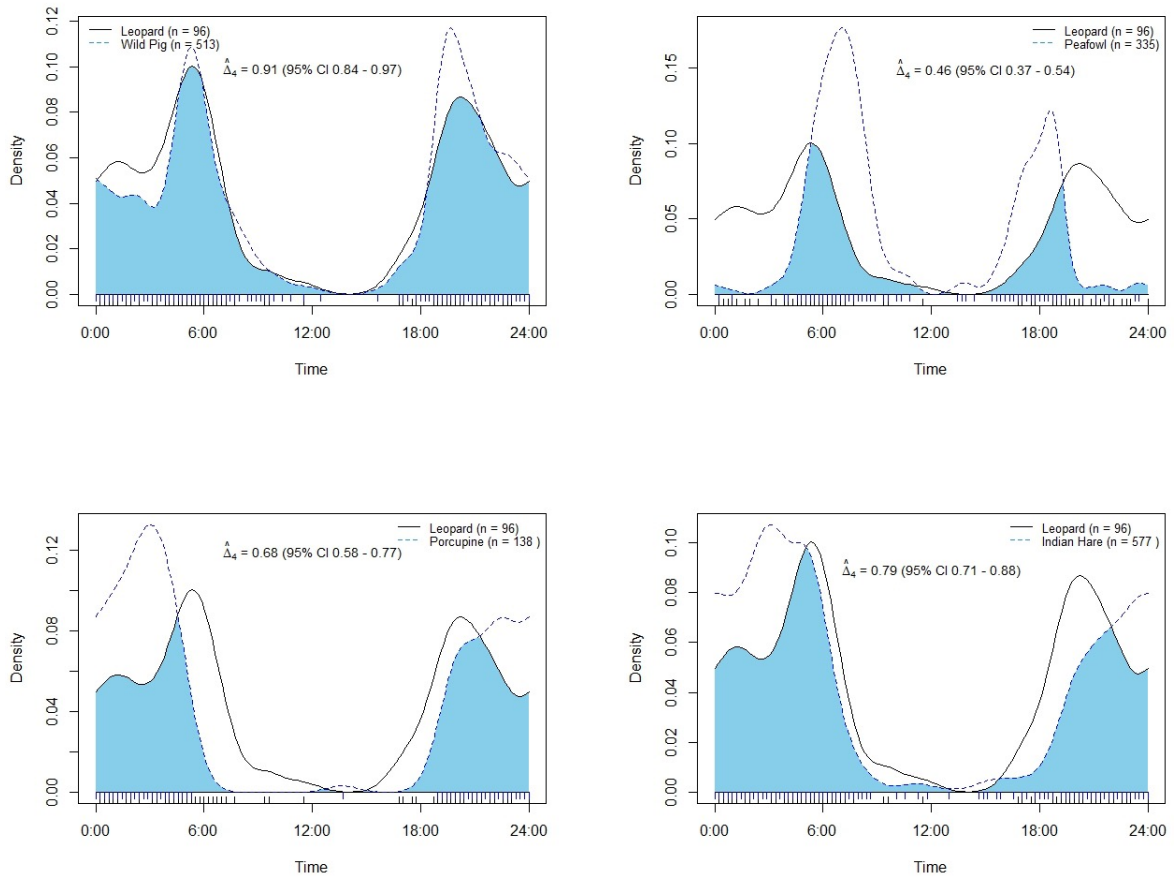


Figure 18: Temporal overlap of leopard with sympatric carnivores and prey



5. CONCLUSION AND MANAGEMENT RECOMMENDATIONS

5.1. Conclusion

The camera trap survey in the Indergarh Range of Ramgarh Vishdhari Tiger Reserve provides valuable insights into carnivore-prey dynamics in a semi-arid landscape. A total of 22 wild mammalian species were documented alongside humans and livestock, underscoring the ecological significance of this buffer region. Herbivores such as nilgai, wild pig and Indian hare were photo-captured most frequently relative to other species, indicating their local abundance and likely importance in sustaining predator populations.

Leopard density was estimated at 5.76 individuals/100km², confirming a resident population within Indergarh range. Our results indicate that leopards persist at moderate densities within the Indergarh buffer, with occupancy estimates showing a broad use of the landscape. The striped hyena, golden jackal and Indian fox also showed substantial occupancy, reflecting their frequent use of the habitat and raising the possibility of co-occurrence with leopards under shared conditions.

Temporal activity analyses revealed that leopard and most other carnivores were primarily nocturnal or crepuscular, consistent with patterns reported across landscapes (Harmsen et al., 2011; Ramesh et al., 2012, Chatterjee et al., 2023). Significant activity differences were detected between leopard and striped hyena, and between leopard and ratel, whereas other carnivores showed broadly similar activity rhythms. Prey species exhibited diverse diel patterns, with chital and peafowl differing significantly from leopard; while sambar, nilgai, wild pig, langur, and smaller prey overlapped more closely. When considered alongside temporal overlap indices, these results indicate that leopards share activity peaks with several sympatric species, yet maintain coexistence through spatial segregation and selective overlap with key prey such as sambar and wild pig. Species may temporally segregate within the 24-hour cycle, possibly a mechanism to reduce interference, avoid direct encounters or respond to prey/human activity (Gerber et al., 2012). Temporal partitioning could be the potential mechanism that

facilitates coexistence although prey activity and anthropogenic disturbance may also play roles.

Notably, our findings demonstrate that the Indergarh range continues to sustain a viable population of leopards and other carnivores despite being embedded within a matrix of human settlements, national highways and expressways, railway lines, mining activity, and other anthropogenic pressures. The persistence of leopards in Indergarh underscores the ecological importance and resilience as the connecting link between Ranthambore and Ramgarh Vishdhari Tiger Reserve, while also highlighting its vulnerability to increasing fragmentation and disturbance. Conserving such multifunctional landscapes is therefore crucial, not only to maintain carnivore populations and their ecological interactions, but also to secure long-term connectivity between tiger reserves across the broader Western India Tiger Landscape.



5.2. Management Recommendations

5.2.1. CORRIDOR CONNECTIVITY

The presence of a resident leopard population along with striped hyena and other carnivores in the Indergarh range highlights its critical role as a functional habitat and connecting link between the Ranthambore and Ramgarh Vishdhari Tiger Reserves. Key areas like Balwan and Sakhawda form an important linkage with the Qualji area of Ranthambore Tiger Reserve, enhancing east-west landscape connectivity. However, existing linear infrastructure, namely Delhi-Mumbai Expressway, Mega highway and railway line are dissecting the Sakhawada block with Lakheri and Indergarh blocks, which threatens the corridor functionality and movement of the large carnivores. Strengthening connectivity requires urgent monitoring of wildlife movement across these barriers and coordination with infrastructure agencies to integrate ecological safeguards into future upgrades.

5.2.2. PREY BASE IMPROVEMENT

Prey base management is of utmost importance to sustain and enhance a carnivore population. Camera trap data and utilisation distribution maps reveal that chital are only limited to Sakhawda and Garhwala blocks (Appendix-D; Figure 19) while Sambar occur mainly in Ajitgarh, Talwas and Sakhawda blocks (Appendix-D; Figure 20). In contrast, generalist species like nilgai and wild pig show broader distribution across the Indergarh range (Appendix-D; Figure 21 & 22). This spatial disparity suggests that species-specific prey augmentation is required to improve prey availability in Sakhawada and Talwas blocks. Efforts should focus on habitat management.

5.2.3. HABITAT IMPROVEMENT IN DEGRADED AREAS

Habitat degradation due to *Prosopis juliflora* poses a significant threat to native plant species like dhonk, khair, etc. in the Indergarh range. This invasive species is particularly dominant in the lower valley areas adjoining the Sakhawda, Indergarh, Lakheri, Talwas and Kotdi blocks; and these areas also coincide with

the limited distribution of key prey species like chital and sambar. Since these ungulate species are habitat specialists, dependent on open woodland and mixed forest conditions, targeted habitat improvement programmes such as phased removal of *Prosopis*, restoration of grasslands should be prioritised in these blocks. This would not only support prey recovery but also improve habitat quality.

5.2.4. STRENGTHENING PROTECTION AND FIELD INFRASTRUCTURE DEVELOPMENT FOR LEM

Given the presence of a resident leopard population along with a diverse assemblage of other carnivores and prey species, Indergarh range deserves stronger protection measures and improvement in field infrastructure. Areas like Balwan, Talwas, Lakheri and Kotdi blocks, exhibiting high occupancy of leopards and other carnivores, should be prioritised for intensive foot-based patrolling using tools like M-STrIPES, to ensure effective protection and early threat detection. Simultaneously, anthropogenic disturbances in these areas must be regulated through regular patrolling and monitoring. Building of new chowkis or upgradation of existing camps, particularly in ecologically rich blocks, is essential to facilitate the rapid response of forest teams.

5.2.5. COMMUNITY ENGAGEMENT AND ECO-DEVELOPMENT INITIATIVES

Indergarh serves as a crucial buffer to the Ramgarh Vishdhari Tiger Reserve, and integration of local communities into conservation efforts is vital. Strengthening Eco-Development Committees (EDCs) or forming new participatory groups as village wildlife volunteers can enhance trust and cooperation between local communities and the forest department. Engaging local community members in habitat restoration and awareness drives not only provide livelihood opportunities but also fosters a sense of ownership in the conservation. Such inclusive conservation approaches are key to sustaining long-term conservation success in this landscape.

5.2.6. LONG-TERM MONITORING AND RESEARCH

Long-term monitoring is essential to track changes in carnivore populations, prey availability and habitat conditions across the Indergarh range. Regular camera trap surveys, line-transect-based herbivore population

estimation should be institutionalised annually or biannually given the presence of a leopard population and varied prey distribution. These surveys should be coupled with studies on carnivore diet and corridor usage for better understanding of prey preferences and species interactions. This will ensure adaptive data-driven management of this important area.



Appendix

1. Leopard Profile – Indergarh Range



L1 (Adult Male_Right)



L1 (Adult Male_Left)



L2 (Adult Male_Right)



L2 (Adult Male_Left)



L3 (Adult Male_Right)



L3 (Adult Male_Left)



L4 (Adult Female_Right)



L4 (Adult Female_Left)



L5 (Adult Female_Right)



L5 (Adult Female_Left)



L6 (Adult Male_Right)



L6 (Adult Male_Left)



L7 (Adult Female_Right)



L7 (Adult Female_Left)



L8 (Adult Female_Right)



L8 (Adult Female_Left)



L9 (Adult Female_Right)



L9 (Adult Female_Left)



L10 (Adult Male_Right)



L10 (Adult Male_Left)



L11 (Adult Male_Right)



L11 (Adult Male_Left)



L12 (Adult Male_Right)



L12 (Adult Male_Right)



L13 (Adult Male_Right)



L13 (Adult Male_Left)



L14 (Adult Female_Right)



L14 (Adult Female_Left)



L15 (Adult Female_Right)



L15 (Adult Female_Left)



L16 (Adult Male_Right)



L16 (Adult Male_Left)



L17 (Adult Female_Right)



L17 (Adult Female_Left)



L18 (Adult Male_Right)



L18 (Adult Male_Left)



LEFT FLANK NOT CAPTURED

L19 (Adult Female_Right)



LEFT FLANK NOT CAPTURED

L20 (Adult Female_Right)



LEFT FLANK NOT CAPTURED

L21 (Adult Female_Right)



LEFT FLANK NOT CAPTURED

L22 (Adult Unknown_Right)



LEFT FLANK NOT CAPTURED

L23 (Adult Female_Right)



LEFT FLANK NOT CAPTURED

L24 (Adult Unknown_Right)



LEFT FLANK NOT CAPTURED

L25 (Adult Male_Right)



LEFT FLANK NOT CAPTURED

L26 (Adult Female_Right)

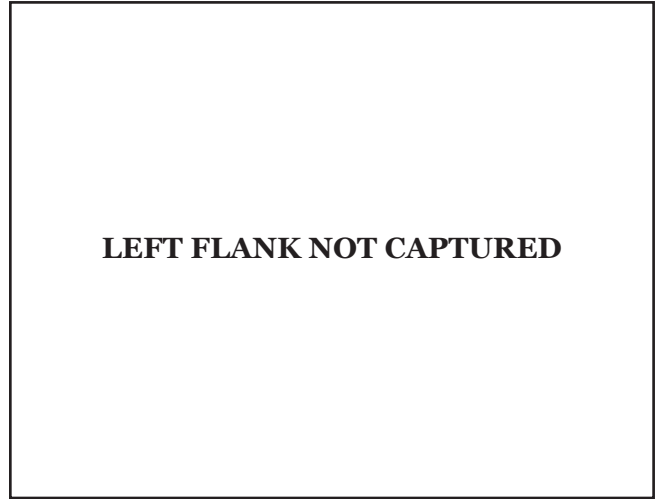


LEFT FLANK NOT CAPTURED

L27 (Adult Unknown_Right)



L28 (Adult Male_Right)



**Juvenile-1 (Female_Right)
(Cub of L-7 Female)**



**Juvenile-1 (Female_Left)
(Cub of L-7 Female)**



**Juvenile-2 (Male_Right)
(Cub of L-7 Female)**



**Juvenile-2 (Male_Left)
(Cub of L-7 Female)**

RIGHT FLANK NOT CAPTURED



**Juvenile-3 (Male_Left)
(Cub of L-7 Female)**



**Juvenile-4 (Male_Right)
(Cub of L-9 Female)**

LEFT FLANK NOT CAPTURED



**Juvenile-5 (Unknown_Right)
(Cub of L-9 Female)**

LEFT FLANK NOT CAPTURED



**Juvenile-6 (Unknown_Right)
(Cub of L-17 Female)**



**Juvenile-6 (Unknown_Left)
(Cub of L-17 Female)**



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2. Parameter Estimates of Different Models Used in the Density Estimation of Leopard Using the SECR

Table 13: Parameter estimates using candidate models to estimate density of leopards using SECR in Indergarh buffer of Ramgarh Vishdhari Tiger Reserve

Model	Parameter	Estimate	SE.estimate	Lcl	ucl
D~1 go~1 sigma~h2 pmix~h2	D	5.89	1.25	3.90	8.90
	go	0.050	0.011	0.033	0.076
	σ (female)	1471.97	181.03	1157.72	1871.51
	σ (male)	1995.55	226.57	1598.57	2491.13
	pmix_female	0.59	0.11	0.38	0.78
	pmix_male	0.41	0.11	0.22	0.62
D~1 go~1 sigma~1 pmix~h2	D	5.60	1.17	3.74	8.40
	go	0.049	0.010	0.032	0.074
	σ (female)	1770.12	153.20	1494.41	2096.69
	pmix_male	0.50	0.10	0.31	0.69
D~1 go~h2 sigma~1 pmix~h2	D	5.71	1.20	3.79	8.59
	go (female)	0.035	0.011	0.019	0.066
	go (male)	0.060	0.016	0.035	0.099
	σ	1786.26	158.37	1501.84	2124.55
	pmix_female	0.55	0.11	0.34	0.74
	pmix_male	0.45	0.11	0.26	0.66
D~1 go~h2 sigma~h2 pmix~h2	D	5.91	1.26	3.91	8.95
	go (female)	0.045	0.016	0.022	0.089
	go (male)	0.053	0.015	0.031	0.090
	σ (female)	1502.46	208.41	1146.29	1969.32
	σ (male)	1973.68	232.34	1568.27	2483.91
	pmix_female	0.60	0.11	0.38	0.78
	pmix_male	0.40	0.11	0.22	0.62
D~1 go~b sigma~1 pmix~h2	D	5.60	1.17	3.74	8.40
	go	0.049	0.010	0.032	0.074
	σ	1770.24	153.22	1494.50	2096.86
	pmix_female	0.50	0.10	0.31	0.69
	pmix_male	0.50	0.10	0.31	0.69

D~1 go~1 sigma~b pmix~h2	D	5.60	1.17	3.74	8.40
	go	0.049	0.010	0.032	0.074
	σ (female)	1770.22	153.22	1494.48	2096.83
	σ (male)	1770.22	153.22	1494.48	2096.83
	pmix_female	0.50	0.10	0.31	0.69
	pmix_male	0.50	0.10	0.31	0.69

3. Spatio-temporal Interaction of Leopard with Sympatric Carnivores and Prey

Table 14: Summary of activity levels of species in 24-hr cycle and activity difference of leopard with sympatric carnivores and prey using Wald test statistics (p value < 0.05 = significant difference)

Species	Activity difference with leopard	SE	W	P value	Activity level/day (hours)	Activity_SE	LCI	UCI	Temporal overlap	Spatial overlap
Leopard	-	-	-	-	9.97	1.38	6.97	12.24	-	-
Hyena	0.15	0.07	4.80	0.03	6.25	1.05	5.67	9.66	0.8	0.26
Golden jackal	0.06	0.08	0.53	0.47	8.54	1.42	7.87	13.47	0.68	0.32
Jungle cat	0.13	0.09	2.26	0.13	6.79	1.63	3.98	10.17	0.78	0.14
Indian fox	0.06	0.07	0.64	0.42	8.53	1.19	5.15	9.55	0.75	0.17
Ratel	0.14	0.07	3.74	0.05	6.71	1.01	4.28	8.24	0.69	0.35
Chital	0.15	0.08	3.80	0.05	6.36	1.18	4.34	8.91	0.27	0.3
Sambar	-0.02	0.07	0.05	0.82	10.33	0.89	8.57	12.03	0.84	0.43
Nilgai	-0.09	0.07	1.68	0.19	12.05	0.89	11.62	15.07	0.47	0.41
Wild pig	0.06	0.06	0.89	0.35	8.53	0.71	8.13	11.00	0.91	0.5
Peafowl	0.18	0.06	9.17	0.0025	5.65	0.47	5.05	6.90	0.45	0.28

4. Utilisation Distribution Maps of Photo-captured Species

CHITAL

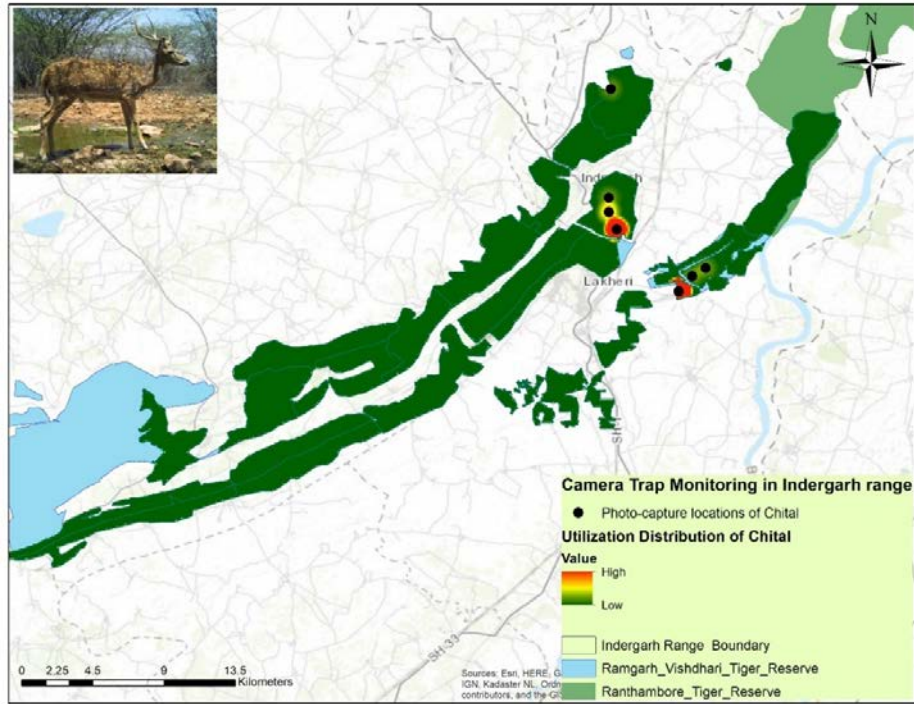


Figure 19: Utilisation distribution map of chital

SAMBAR

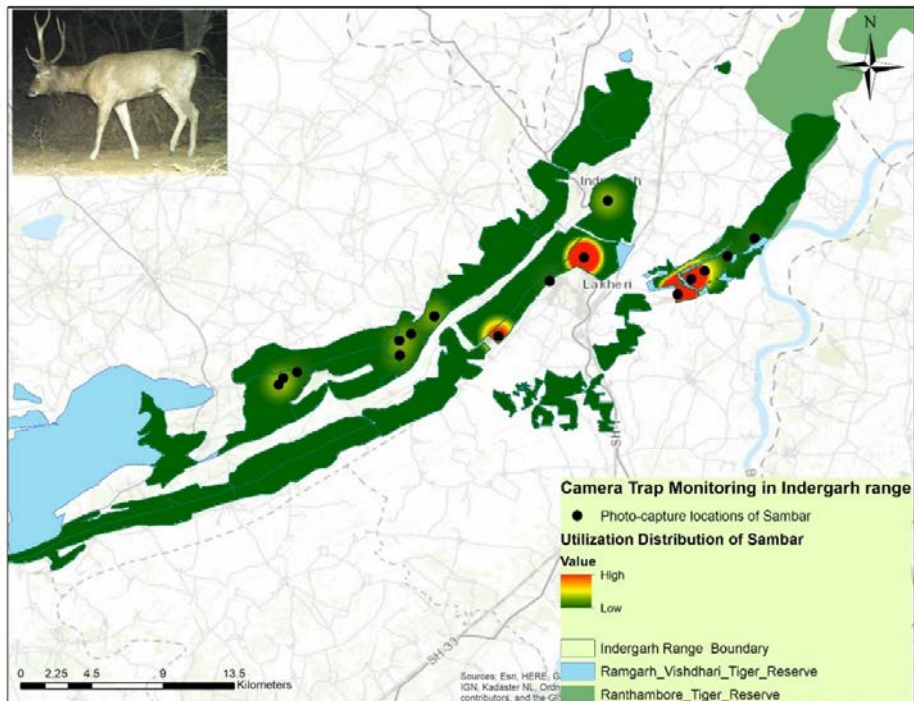


Figure 20: Utilisation distribution map of sambar

NILGAI

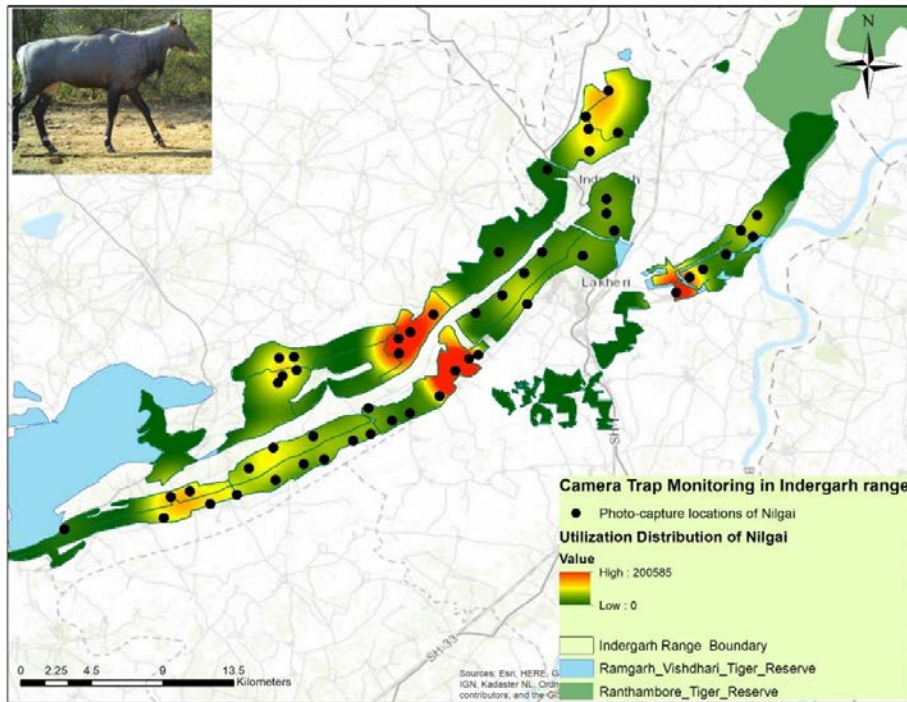


Figure 21: Utilisation distribution map of nilgai

WILD PIG

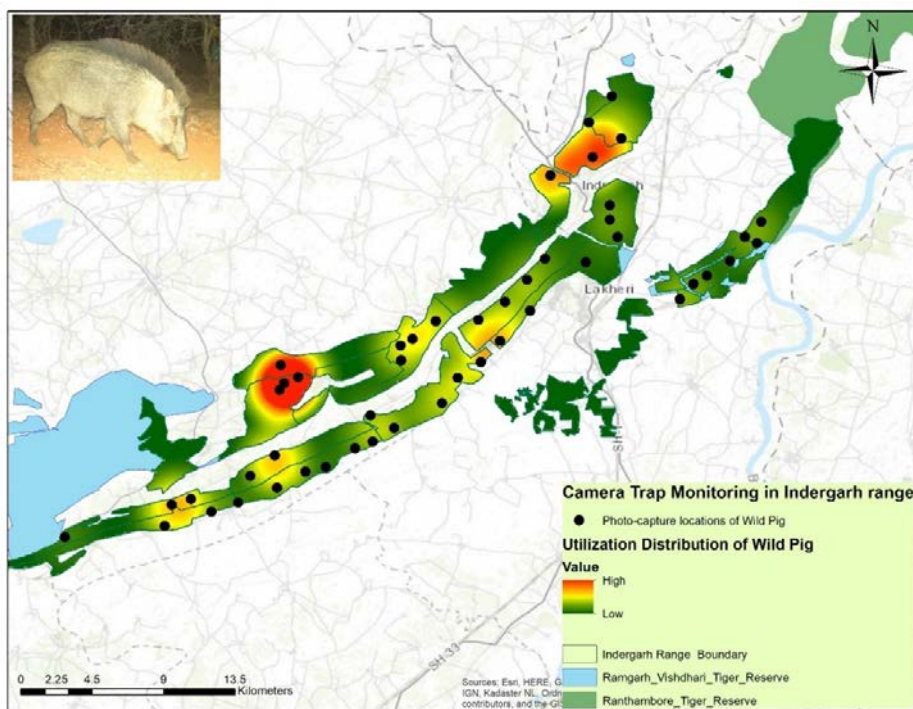


Figure 22: Utilisation distribution map of wild pig

JUNGLE CAT

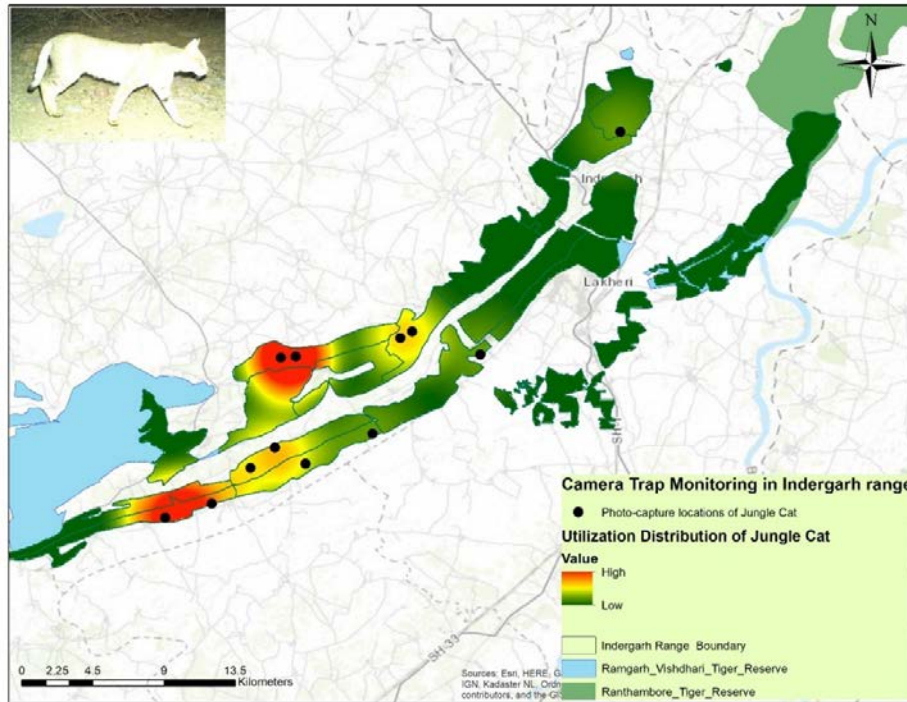


Figure 23: Utilisation distribution map of jungle cat

RATEL

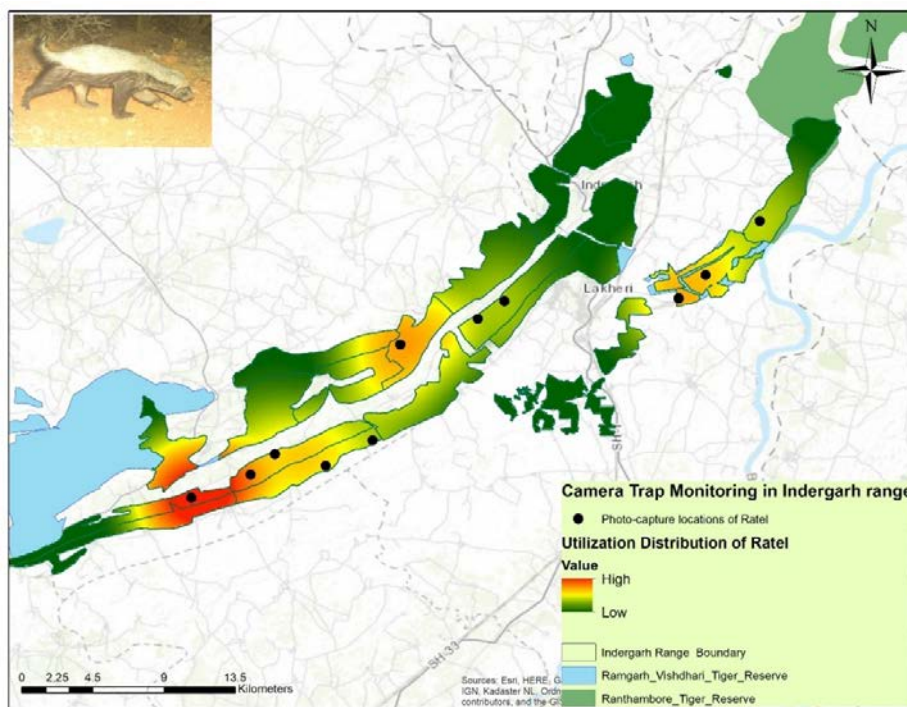


Figure 24: Utilisation distribution map of ratel

INDIAN FOX

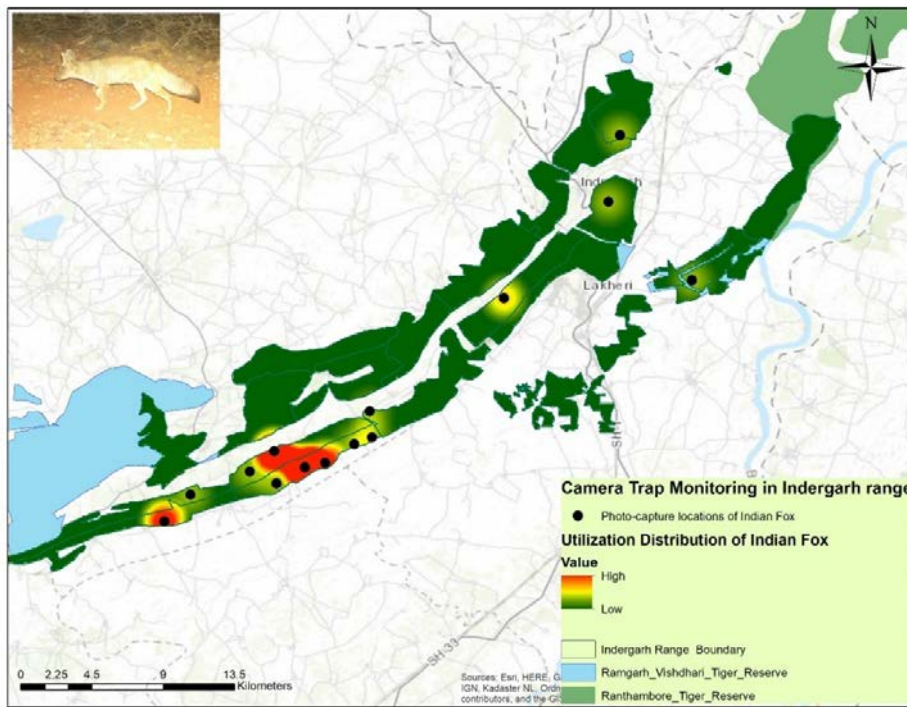


Figure 25: Utilisation distribution map of Indian fox

RUSTY SPOTTED CAT

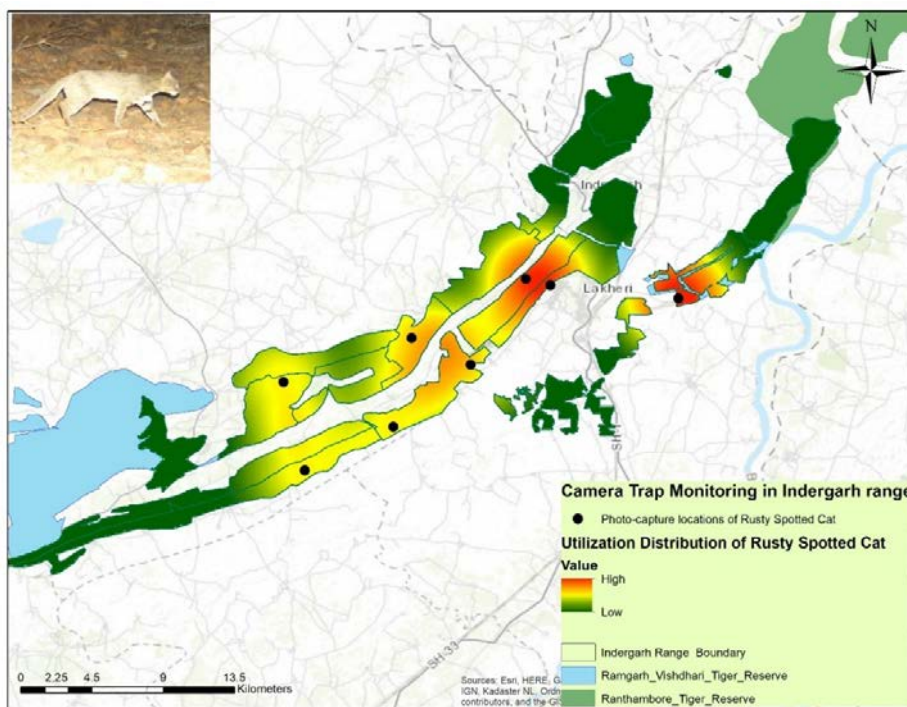


Figure 26: Utilisation distribution map of rusty spotted cat

SLOTH BEAR

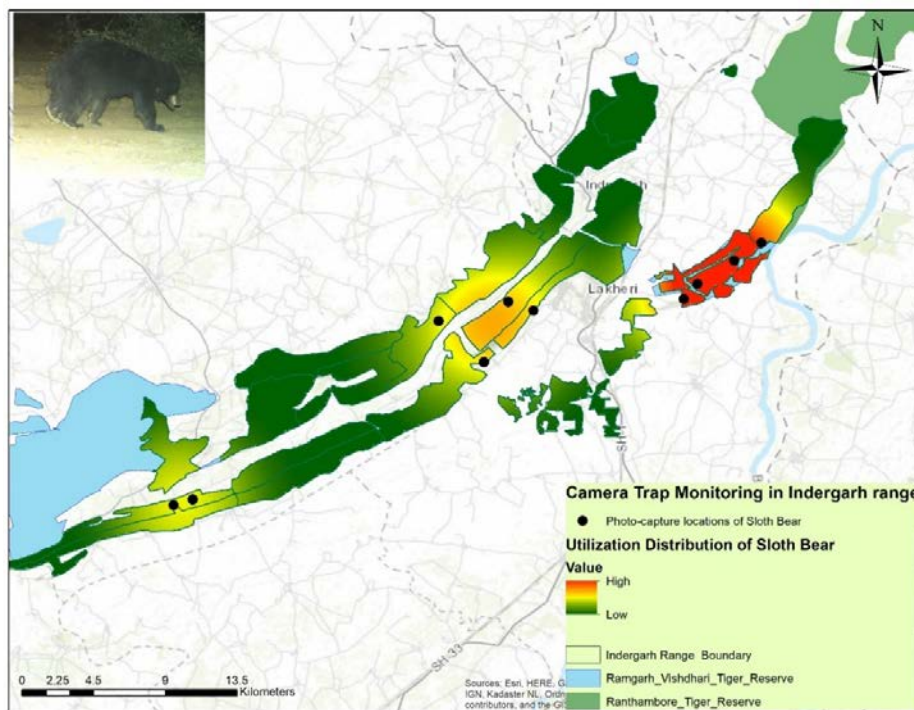


Figure 27: Utilisation distribution map of sloth bear

PEAFOWL

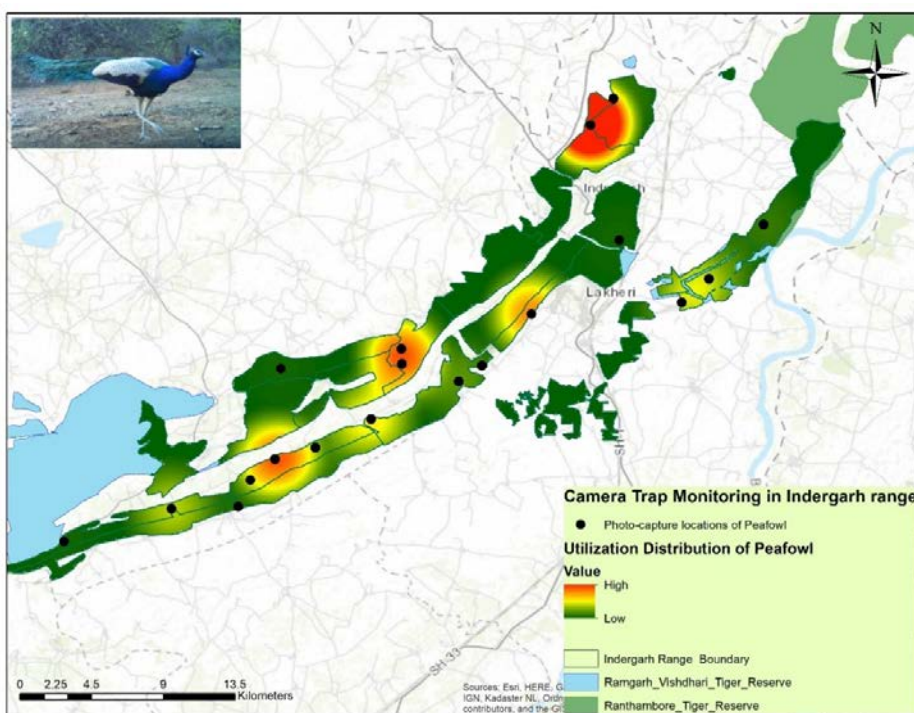


Figure 28: Utilisation distribution map of peafowl

SMALL INDIAN CIVET

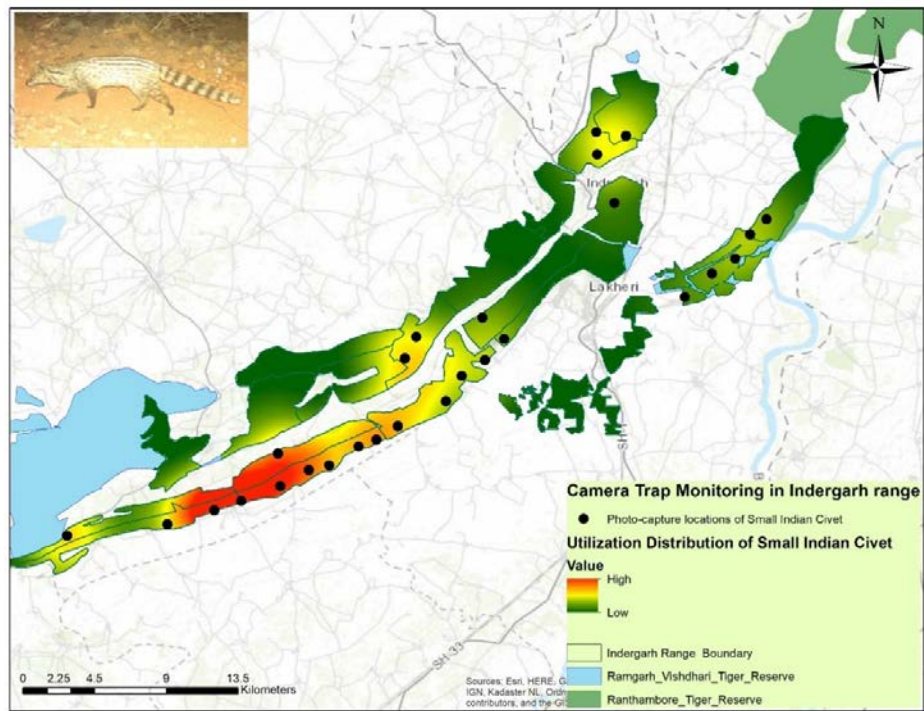
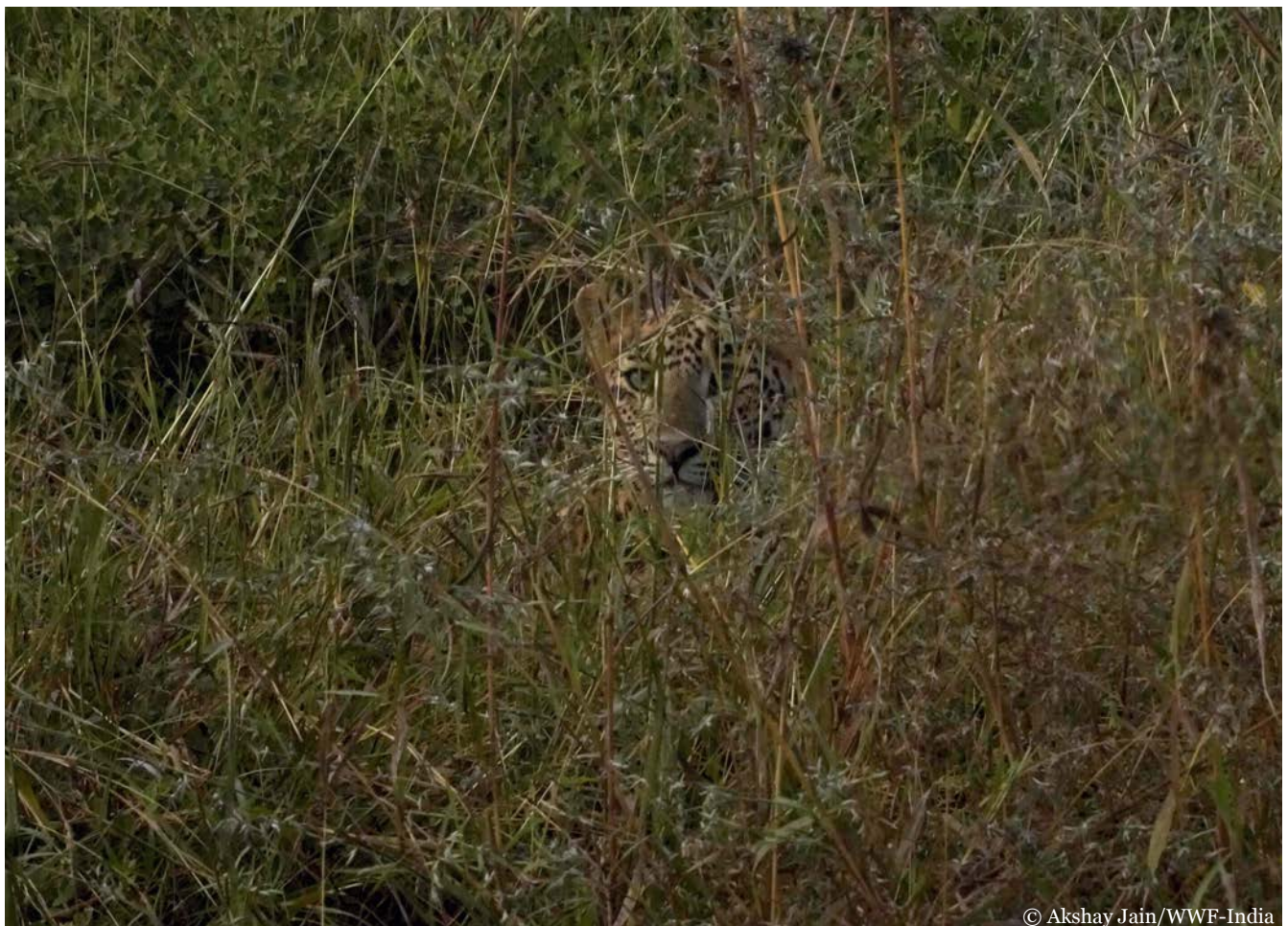


Figure 29: Utilisation distribution map of small Indian civet



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Annexure

1. Strengthening Tiger Conservation in Ramgarh Vishdhari Tiger Reserve (RVTR)

RVTR, being one of India's newly designated tiger reserves, required immediate strategic interventions to strengthen its protection and monitoring framework. To strengthen the law enforcement efforts in Ramgarh Vishdhari Tiger Reserve, WWF-India has been providing equipment and infrastructure support. Following a comprehensive security assessment and a series of consultative meetings with the Deputy Conservator of

Forests (DCF), critical gaps were identified in patrol capacity, field infrastructure, staff safety and digital monitoring systems. To address these gaps, a multi-pronged support approach was developed, focusing on three key areas: capacity building of frontline staff, provision of essential field gear, and upgrading equipment and infrastructure to enhance wildlife monitoring and law-enforcement efficiency.

Table 12: Description of support items provided to Ramgarh Vishdhari Tiger Reserve during 2024-2025

Type of support	Item/training	Quantity/no. of staff	Time period
Capacity building	M-STrIPES Patrol Training (PATROL App)	90 staff members	Jul-24
Field gear support	Field shoes	190 staff members	Feb-24
	Winter jackets, winter caps, bottles, field bags	277 staff members	Dec-24
Equipment & infrastructure support	Mobile phones (M-STrIPES use)	90 units	Aug-Sept-2024
	Camera traps	50 units	Apr-24
	First-aid boxes	80 units	May-24 & May-25
	Field torches	70 units	Dec-24
	Deep Search Metal Detectors (DSMD)	2 units	Mar-25
	4WD vehicles (Tata Yodha & Bolero Camper)	2 units	Jun-24
	Computer systems (desktop, monitor, CPU & UPS)	2 sets	Mar-25
Radio collars & receivers	3 Sets	2023-2025	

2. Photo-captured Species in Indergarh Range



Asian palm civet
(*Paradoxurus hermaphroditus*)
Least Concern



Asiatic wildcat
(*Felis lybica*)
Least Concern



Chinkara
(*Gazella bennettii*)
Least Concern



Chital
(*Axis axis*)
Least Concern



Golden jackal
(*Canis aureus*)
Least Concern



Hanuman langur
(*Semnopithecus entellus*)
Least Concern



Indian crested porcupine
(*Hystrix indica*)
Least Concern



Bengal fox
(*Vulpes bengalensis*)
Least Concern



Indian grey mongoose
(*Herpestes edwardsii*)
Least Concern



Black naped hare/Indian hare
(*Lepus nigricolis*)
Least Concern



Jungle cat
(*Felis chaus*)
Least Concern



Common leopard
(*Panthera pardus*)
Near Threatened



Nilgai
(*Boselaphus tragocamelus*)
Least Concern



Indian peafowl
(*Pavo cristatus*)
Least Concern



Ratel
(*Mellivora capensis*)
Least Concern



Ruddy mongoose
(*Urva smithii*)
Least Concern



Rusty spotted cat
(*Prionailurus rubiginosus*)
Near Threatened



Sambar
(*Rusa unicolor*)
Vulnerable



Sloth bear
(*Melursus ursinus*)
Vulnerable



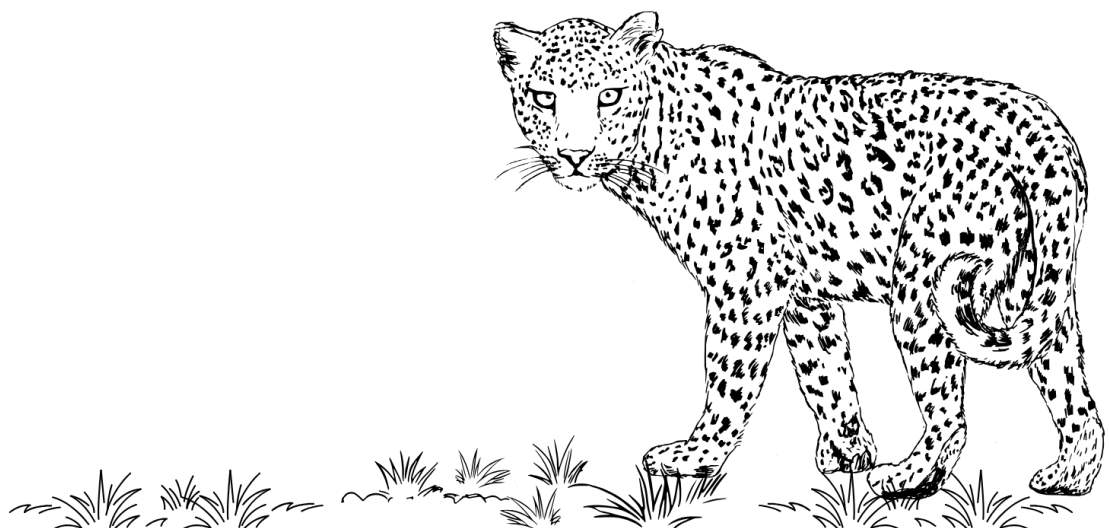
Small Indian civet
(*Viverricula indica*)
Least Concern



Striped hyena
(*Hyena hyena*)
Near Threatened



Wild pig
(*Sus scrofa*)
Least Concern





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