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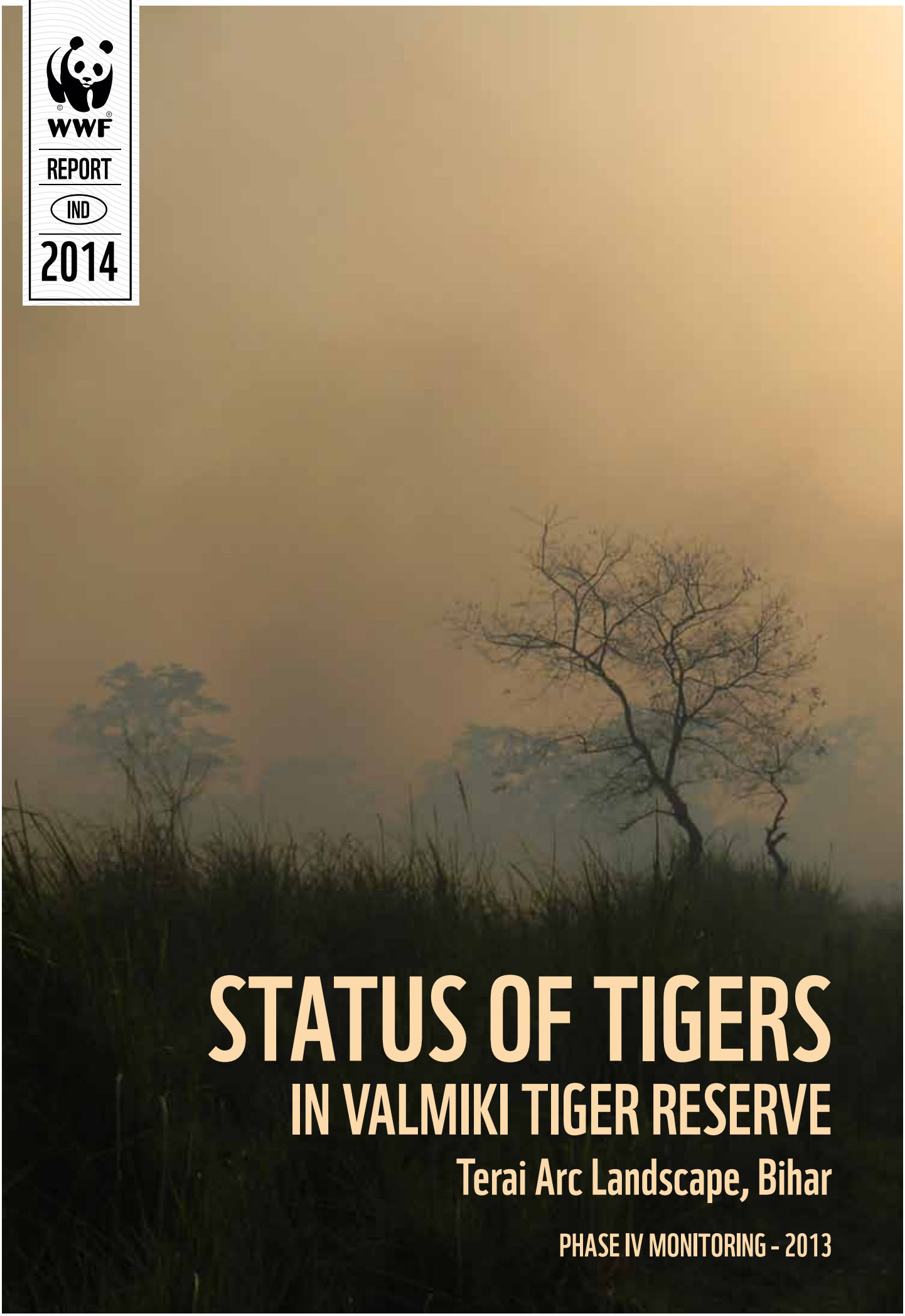

STATUS OF TIGERS

IN VALMIKI TIGER RESERVE

Terai Arc Landscape, Bihar

PHASE IV MONITORING - 2013

Published by WWF-India

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Maurya, K. K. and Borah, J. 2013. *Status of tigers in Valmiki Tiger Reserve,Terai Arc Landscape, Bihar, India*. WWF-India.

Note: This report presents the current status of tigers within Valmiki Tiger Reserve. Here we present minimum tiger numbers based on the camera trapping exercise within Valmiki. Given the contiguity between Valmiki and Chitwan National Park in Nepal, and tiger capture locations from the study, these numbers may not exclusively represent the resident population from Valmiki. Future monitoring will robustly estimate population in this transboundary forest complex.

Cover Picture:
Kamlesh K. Maurya/WWF-India

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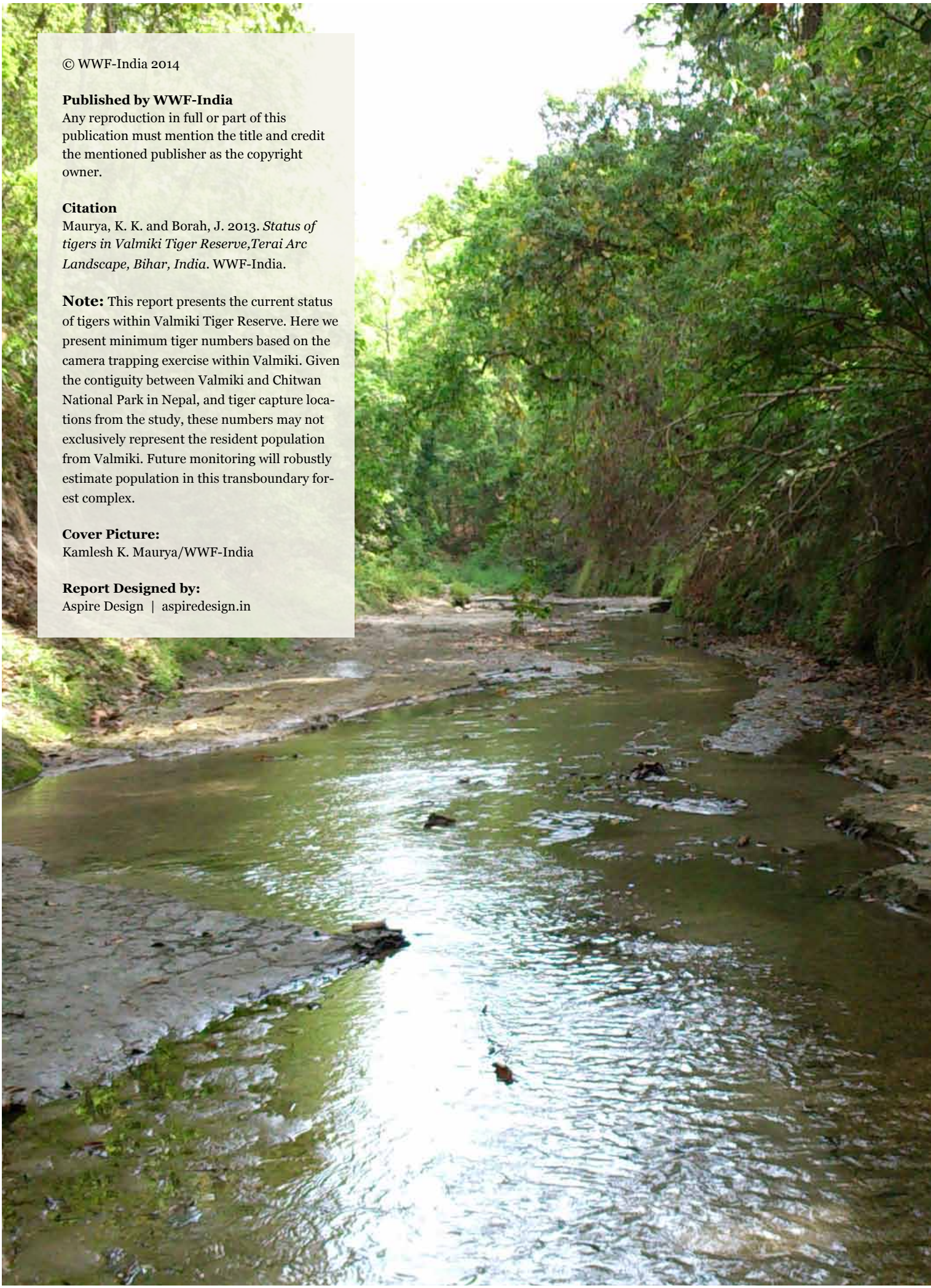


STATUS OF TIGERS
IN VALMIKI TIGER RESERVE
Terai Arc Landscape, Bihar

PHASE IV MONITORING - 2013

FOREWORD

CHIEF MINISTER
BIHAR

PATNA

Foreword

The Valmiki Tiger Reserve (VTR) is the only Tiger reserve in Bihar. It is contiguous with Chitwan National Park of Nepal and intermittently connected with Shohagi Barwa Wildlife Sanctuary in Uttar Pradesh. It forms a part of the Terai Arc Landscape (TAL) having a unique combination of the terai-bhabar vegetation, which harbours rich fauna of several endemic and globally endangered species such as tiger, leopard, gaur and fishing cat.

The Forest department, Government of Bihar carried out the phase IV monitoring exercise for estimation of tigers as per the guidelines of the National Tiger Conservation Authority. This was done in collaboration with the World Wildlife Fund-India. The estimation is based on the camera trapping method. This report presents the results of the exercise which has covered the Valmiki Tiger Reserve in its entirety using photographic capture-recapture method for the first time.

The report indicates that Valmiki Tiger Reserve now has a good population of Tigers which is a sign that the habitat of the reserve is in a healthy state. I congratulate the authorities of Valmiki Tiger Reserve along with their collaborating partners WWF India for this effort. I also convey my best wishes to the officials and staff of the reserve and all other stakeholders who have relentlessly worked for the conservation of wildlife in Valmiki Tiger Reserve.

(Nitish Kumar)

Chief Minister of
Bihar State

Dipak Kumar Singh
Secretary to the Govt.

सत्यमेव जयते

Government of Bihar
Deptt. of Environment & Forest
Sinchai Bhawan, Patna-800015
0612-2217713 (Off.)
0612-2217773 (Fax)
Mob. : 9431815952
E-mail-secretary.forest@yahoo.com
dksingh1992@yahoo.co.in

Date : 03/02/2014

Preface

Valmiki Tiger Reserve (VTR), is the only tiger reserve in the state of Bihar. VTR is contiguous with Chitwan National Park as well as Parsa Wildlife Sanctuary of Nepal and Sohagi Barwa Wildlife Sanctuary of Uttar Pradesh, India. The area falling in Terai Arc Landscape (TAL) represents terai bhabar region having variety of wildlife species including tiger and leopard.

The present report presents the outcome of camera trapping exercise in VTR, by the forest department in collaboration with WWF-India, to determine the tiger status. This was first attempt to estimate the minimum tiger population by covering the whole VTR using photographic capture-recapture method which was carried out as a part of Phase-IV monitoring protocol of National Tiger Conservation Authority (NTCA), Government of India. The results provide insights into the richness and diversity of VTR, which imply that it is a rich ecosystem within the Terai Arc Landscape. Considering the biodiversity-rich habitat of VTR, including presence of breeding tigers, and its connectivity to other important tiger habitats in this landscape, the report presents recommendations which would help tigers in rebounding in unoccupied areas within VTR and provide a wonderful opportunity to increase their numbers.

I extend my appreciation to the officials and staff of Valmiki Tiger Reserve along with their collaborating partners, WWF India, for carrying out this wonderful work. I hope similar initiatives and collaboration would continue in future years so as to conserve and manage this beautiful place.

DKSingh 3/2/14

(Dipak Kumar Singh).

FOREWORD

बी० ए० खान, भा०व०से०
अपर प्रधान मुख्य वन संरक्षक-सह-
मुख्य वन्यप्राणी प्रतिपालक, बिहार, पटना

B. A. Khan, I.F.S.
Addl. Principal Chief Conservator of Forest
-cum-Chief Wildlife Warden, Bihar, Patna

सत्यमेव जयते

बिहार सरकार
पर्यावरण एवं वन विभाग
अपर प्रधान मुख्य वन संरक्षक-सह-
मुख्य वन्यप्राणी प्रतिपालक, बिहार कार्यालय
Government of Bihar
Environment & Forest Department
Office of the Addl. P.C.C.F.-cum-
Chief Wildlife Warden, Bihar, Patna

Valmikinagar Tiger reserve, located at the edge of the Terai Area Landscape, forms a very important part of a large tiger habitat including the Chitwan National Park in Nepal and the Sohagi Barwa Sanctuary in Uttar Pradesh. The reserve has a variety of wildlife with the Tiger as its apex species. Phase-IV monitoring was carried out for the first time in line with the guidelines of the National Tiger Conservation Authority (NTCA) in collaboration with World Wildlife Fund- India. The entire area of the reserve was covered using the camera trap capture- recapture technique to arrive at a reliable figure about the number of tigers in the sanctuary. It is heartening to note that the cameras have captured photographs of 22 tigers. The tiger estimation exercises carried out in 2006 and 2010 placed the number of tigers in the reserve at 10 and 8 respectively.

The increase in number of tigers is indicative of the suitability of the habitat for tigers. It also indicates that the strengthening of the protection and surveillance system with generous support from NTCA has played a part in increase in the numbers. The team at Valmiki Tiger Reserve has also done its best to see that the habitat of the Reserve improves and has succeeded largely in spite of depleted staff strength.

The WWF-India deserves credit for the excellent work done by them in systematically covering the entire 901 sq km of the reserve for Phase-IV monitoring. Earlier estimations were based on part coverage with extrapolation, which may have led to under reporting. Special thanks are due to Sri. Kamlesh Maurya who, under the guidance of Sri Jimmy Borah, camped in the Reserve for long periods and painstakingly collected, collated and analysed the data acquired from the field. Thanks are also due to Sri Ravi Singh, Secretary General , WWF- India for extending support in carrying out this exercise.

This exercise also led to the discovery of three species of animals hitherto not reported from the area namely, Crab Eating Mongoose, Himalayan Serow and Yellow Throated Marten.

I am sure this monitoring report will be of help in Valmiki Tiger Reserve getting recognition as one of the better managed Tiger reserves in the country.

(Basheer Ahmed Khan)

List of Figures and Tables

ACKNOWLEDGEMENTS

We are grateful to Mr. B.A. Khan, Principal Chief Conservator of Forest (PCCF) & Chief Wildlife Warden, Bihar; Mr. Santosh Tewari, Conservator of Forest (CF) & Field Director, Valmiki Tiger Reserve (VTR); Mr. Kamaljeet Singh, Divisional Forest Officer, (DFO)-cum-Deputy Director and Mr. Nand Kishor, DFO-cum-Deputy Director, for inviting WWF-India for Phase IV monitoring. We thank them for their kind support, encouragement and for providing the vital logistic support. Also, we are thankful to the current management team of VTR for sharing the optimism of highlighting VTR as an important tiger conservation area in the world.

We are also grateful to Range Officers Sh. Ramchandra, Sh. Ajay Sinha, Sh. Sadan, Sh. Ajit Jha, Sh. Ranveer Singh, Sh. B.K. Mishra, Sh. Sunil Sinha and Sh. K.K. Choudhary; Foresters, Forest Guards, Tiger Trackers (TT), Patrolling Party (PP) Fire Watchers and Rhino Trackers of VTR for their cooperation and kind assistance. We are also thankful to all office staffs at Bettiah for providing all the required facilities at the Bettiah office.

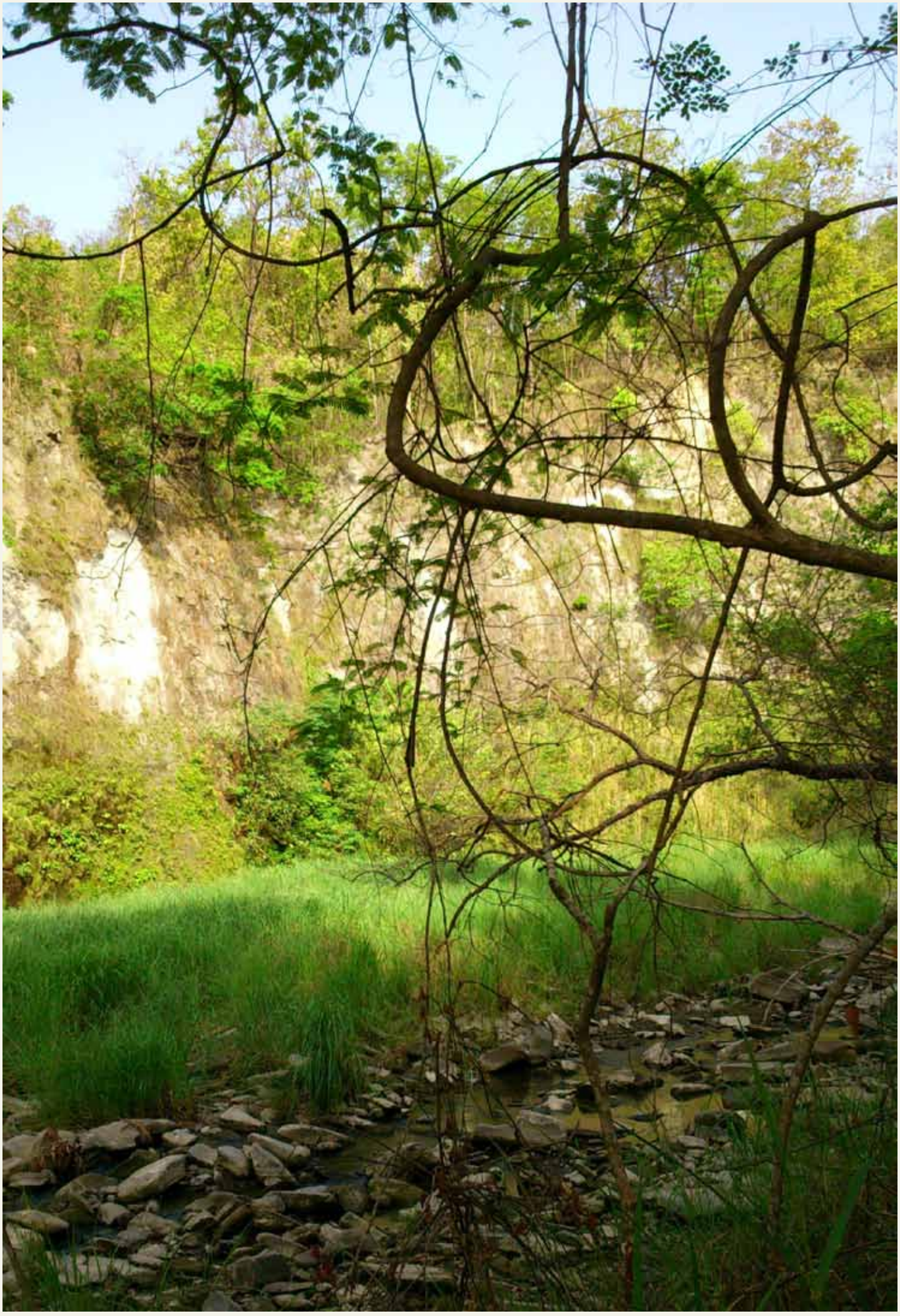
Our field assistants were outstanding. We are grateful to the excellent team of dedicated field technicians who assisted in data collection: Kandhai Lal, Ashok Kumar, Anil Kumar and Mahesh Kumar for their sincere and relentless efforts in the field.

We acknowledge the technical support extended by Dr. Y. V. Jhala at Wildlife Institute of India during report writing and data analysis. We also acknowledge Ujjwal, Nishant, Bopanna and Abhishek Harihar for their assistance in finalizing this report.

We are also grateful to Anil Srivastava, Naresh Lodhi, Dabeer Hassan, Prem Singh and Prem Maurya for their cooperation and kind assistance. Thanks to Tridip Sharma from WWF-India's North Bank Landscape programme office for helping in training staff during the very initial stage.

We thank Dr. Harish Guleria, Head-TAL programme, WWF-India for his support in all forms. Special thanks are due to Dr. Mudit Gupta, Coordinator, TAL-UP, WWF-India, for his constant support and encouragement to undertake tiger monitoring study in VTR. Last but not the least, we remain grateful to Mr. Ravi Singh, SG & CEO, WWF-India; Dr. Sejal Worah, Programme Director, WWF-India; and Dr. Dipankar Ghose, Director, Species and Landscapes Programme, WWF-India for their support and inputs.

This exercise was supported by WWF-Sweden and Environment & Forest Department, Government of Bihar, India.



EXECUTIVE SUMMARY

Reliable estimates of status and population trends are critical for the conservation of large terrestrial carnivores as they play an important role in evaluating effectiveness of conservation efforts and also provide benchmark data for future management decisions. The only tiger reserve in the state of Bihar, the Valmiki Tiger Reserve (VTR) is located in the extreme northeastern corner along the international border with Nepal. It represents one of the last patches of forests having a unique combination of the terai-bhabar vegetation, which harbour rich fauna of several endemic and globally endangered species such as tiger (*Panthera tigris*), Greater one-horned rhinoceros (*Rhinoceros unicornis*), Gaur (*Bos gaurus*), and Fishing cat (*Prionailurus viverrinus*). It is contiguous with Chitwan National Park in Nepal and intermediately connected with Sohagi Barwa Wildlife Sanctuary in Uttar Pradesh, India. This study presents the findings of the first attempt to estimate the tiger population by covering the whole Valmiki Tiger Reserve using photographic capture-recapture method. As part of Phase-IV monitoring protocol to obtain minimum tiger numbers operating in this least known tiger reserve, WWF-India conducted the camera trapping exercise in collaboration with the Field Director of VTR and the Environment & Forest Department, Government of Bihar.

The minimum population of tigers in VTR was estimated in a systematic scientific framework using the camera trapping technique. About 3000 possible camera locations were located across the study area with an unprecedented effort of 6500 man-days. A total of 270 best sites were selected as camera trap stations on the basis of occurrence of tiger signs. There was a total sampling effort of 6688 trap days and it varied from 525 trap days (*i.e.* fifth block) to 1820 trap days (third block). Total 154 pictures of 22 unique individuals (11 males, 8 females and 3 unidentified) were photographed across the study area. We report this figure as the minimum population size of tigers operating in VTR. One adult female (VT11) with two accompanying cubs (<3 month) was photographed frequently in Madanpur Range. The presence of a breeding female and cubs leads us to concur that VTR has a resident tiger population. In addition to tigers and leopards, the study also captured lesser cats like fishing cat, jungle cat and leopard cat, as well as prey and other species. Three of the species — Himalayan Serow, Crab-eating Mongoose and yellow-throated Marten were reported for the first time in VTR from photographic evidence.

These results provide insights into the richness and diversity of VTR, which imply that it is a rich ecosystem within the Terai Arc Landscape. Considering the biodiversity-rich habitat of VTR, including breeding tigers, and its connectivity to other important tiger habitats in this landscape, we recommend enhancing the protection and habitat management in the area, which would help tigers in rebounding in unoccupied areas and provide us with a wonderful opportunity to increase their numbers.

1. INTRODUCTION

Conservation of biodiversity throughout the world is extremely challenging due to expanding human populations and the associated impacts on wildlife. These challenges are particularly acute for large carnivore in a densely populated country like India. Tigers (*Panthera tigris*) have been serving as a flagship species to generate worldwide conservation attention for Asian forest biodiversity. Despite being listed as 'endangered' for over 30 years by the International Union for the Conservation of Nature (IUCN), wild tigers continue to be threatened by poaching, habitat destruction, depletion of prey, diseases and trade in body parts well as conflict with humans (Dinerstein *et al.* 2007). Ironically, tigers are now in peril as their current global population comprises less than 5% of what was estimated just a century ago (Dinerstein *et al.* 2007). The remaining forest patches throughout the tiger's distribution range have been prioritized by their potential contribution to long-term survival of the species. The landscapes of India support about 50% of the world's wild tiger population (Jhala *et al.* 2011) and have been listed as a global priority area for the conservation of this globally endangered species. The Government of India, along with its partner organizations, is playing an important role in tiger recovery by identifying potential sites within the Indian landscape for effective monitoring and conservation measures. Currently tigers occur mainly in 17 states of India, which have good forest covers. The distribution of tigers in most of these states is under severe threat due to human pressures and various developmental activities.

The Terai Arc Landscape (TAL) is one of the most important landscapes in the Indian subcontinent for its assemblage of threatened and endangered wild fauna and is also recognized as one of the 200 globally important eco-regions for wildlife conservation (Johnsingh *et al.* 2004). The TAL is spread over the southern slope of the Himalaya, across India, Nepal, Bhutan and Bangladesh (Fig. 1). In India and Nepal, TAL is represented by a green necklace around the foothills of the Himalaya along the border of the two countries from the river Bagmati in the east to the Yamuna in the west. The total area of the landscape is about 49,500km^2 of which 30,000km^2 lies in India. Despite the human disturbances and habitat fragmentations, this landscape still holds one of the highest populations of tigers. Qureshi *et al.* (2006) indicated that this landscape has 20,800km^2 potential tiger habitat in the Indian side. Within this landscape, is an important tiger reserve that is located in the easternmost corner; namelythe Valmiki Tiger Reserve (VTR). The only tiger reserve in the state of Bihar, VTR is located in the extreme northeastern corner along the international border with Nepal (Fig. 2). It represents one of the last patches of forests having the unique combination of terai-bhabar vegetation (Johnsingh *et al.* 2004), which has a rich fauna of several endemic and globally endangered species. It is connected to the Chitwan National Park in Nepal and also has interrupted connectivity with Sohagi Barwa Wildlife Sanctuary in Uttar Pradesh, India.

Figure 1: The Terai Arc Landscape in India and Nepal with the Indian TAL border (black boundary line), reserve forests (FD, forest division) and protected areas (TR, tiger reserve; NP, national park; WLS, wildlife sanctuary; WLR, wildlife reserve). Forest cover includes all natural forests *(Source: Rajapandian, 2009).*

TAL has come under increasing pressure due to the rapid growth of human population and large-scale land conversion over the past few decades. With large areas under agriculture, it has shaped a landscape with fragmented forest patches embedded in an agricultural landscape. It is known that habitat fragmentation due to unplanned development can cause the decline or local extinction of a species (Crooks, 2002). For example, the tiger has become locally extinct in 29% of the districts of this landscape where it was historically recorded (Jhala *et al.* 2008). These areas also witness human-wildlife conflict frequently. Despite being of high importance and providing connectivity with important tiger populations, information on tiger populations and prey availability is still lacking from the area.

1.1 Tiger Monitoring in Valmiki Tiger Reserve

Determining occurrence and estimates of abundance of animal populations often form the cornerstone of ecological and wildlife management studies (Caughley, 1977). Reliable estimates of status and population trends are critical for the conservation of carnivores as they play an important role in evaluating the effectiveness of conservation efforts and also provide benchmark data for future management decisions and practices (Jhala *et al.* 2011). In the recent past, India has secured many important landscapes for tiger conservation, among which, Valmiki Tiger Reserve was recognized in 1994 as the 18th Tiger Reserve in the country. There is no baseline information regarding the tiger population and their prey base except for a few studies conducted in recent years by Wildlife Institute of India (WII) and Wildlife Trust of

India (WTI) (2010). Earlier attempts and studies to estimate tiger population were mostly confined to small pockets. Jhala et al (2011) estimated tiger occupancy 510km^2 (~50% of VTR) with an estimated population of 10 (7-13) tigers. As a part of the Phase-IV tiger estimation in Bihar, WWF-India carried out sampling at VTR (~1000km^2) using camera traps based on National Tiger Conservation Authority (NTCA) protocol (2012). The study was the first attempt of its kind to cover the entire park and was ably supported by the VTR forest department. The objectives of this study were:

1. To determine the status of tigers and other fauna in the VTR area by photographic capture-recapture using camera traps.
2. To provide the minimum number of tigers operating in and photo-captured from VTR.

2. STUDY AREA

2.1 Brief History

The state of Bihar has a forested area of 6,804 km² constituting 7% of the total geographic area of the state. The state has also one National Park (NP) and 12 Wildlife Sanctuaries (WLS), most of which are restricted to the southern border with Jharkhand. Most of the forest areas were under the local 'Zamindar' till 1952. During the Zamindari period, the present tiger reserve was owned and managed by Bettiah Raj and Ramnagar Raj. The deteriorating condition of the forests under the unscientific management and intensively exploitative felling had led the State Government to take over the management of the forests under the Bihar Private Protected Forest Act, 1947. The Ramnagar Raj Forest was taken over in the year 1950 and the Bettiah Raj forests were taken over in 1953-1954. Consequently, under the Land Reforms Act 1950, these forests become the property of the State and were notified as Protected Forests under section 29 (3) of the Indian Forests Act, 1927. Most of the forest areas were given on lease to Bihar State Development Forest Corporation for development of forestry.

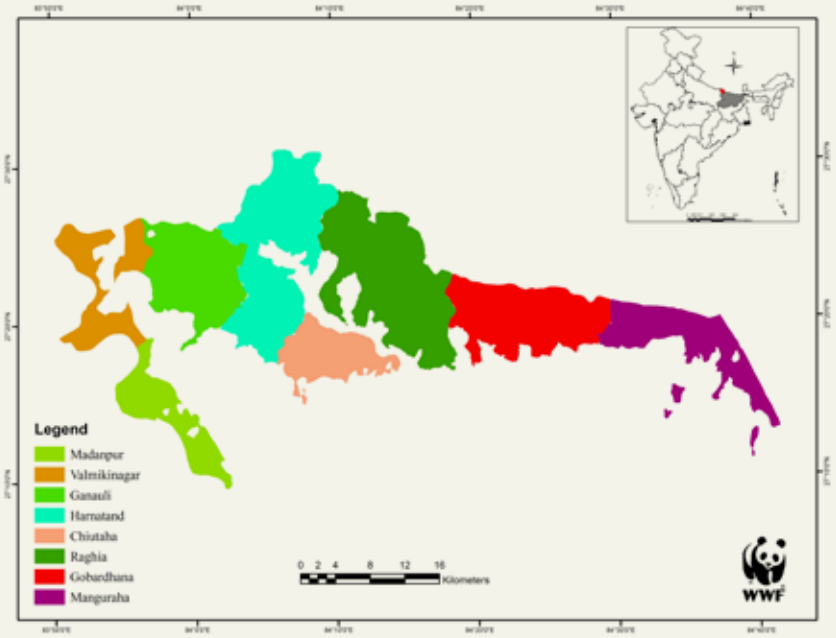
2.2 Location

The only tiger reserve of the state, VTR is located in the extreme northeastern corner along the international border with Nepal. In the west, the reserve is bounded by the Gandak river. Valmiki Tiger Reserve occupies 901.13km² of the northernmost part of West Champaran district in Bettiah taluka (Fig. 2). The area lies between latitude 27° 10' N and 27° 30' N, and longitude 83° 50' E and 84° 10' E. Administratively, this tiger reserve is divided into two forest divisions (Division-1 & Division-2) and managed under eight ranges namely: Manguraha, Gobardhana, Raghia, Chiutaha, Harnatand, Ganuali, Valmiki Nagar and Madanpur, which comprises 65 forest sub-beats known as management units.

2.3 Physical Feature

The topography of VTR is characterized by rocky hills and *doon* valleys drained by numerous rivers and streams which gradually merge with flat alluvial plains in the south (Fig. 3). These rivers and streams are the major sources of water in VTR. The Ganguli River flows almost through the center of the reserve. The soil of the area is alluvial and newer alluvium. Most of the Bhabar portion of the area is covered with older alluvium between Triveni Ghat and Raghia in the west. Sandy soil, laterite soil, variegated clay and loose boulders constitute the older alluvium. The altitude varies from 140 m above msl to the highest point being about 874 m above msl (Someshwar temple) in the Gobardhana Range of Division-1. The westernmost part of the reserved forests has a highly rugged terrain with steeper slopes.

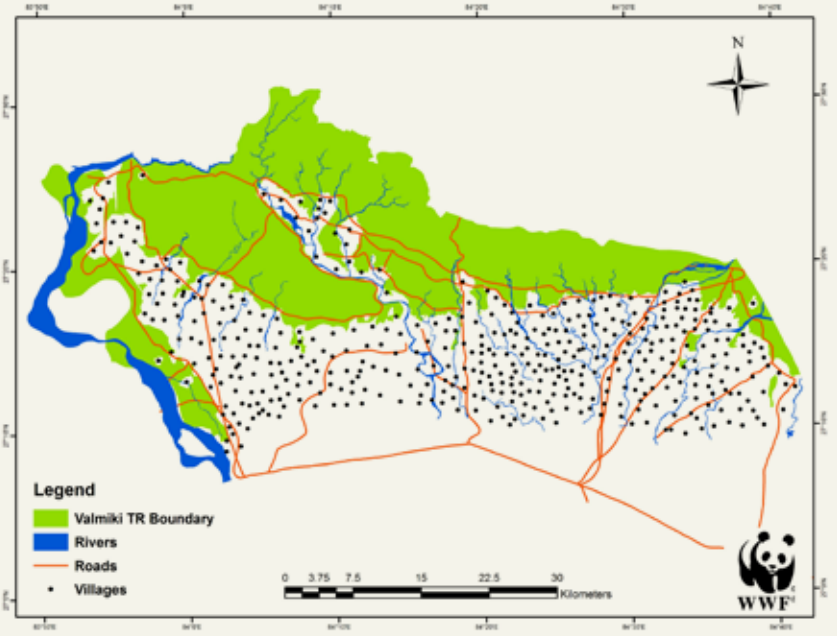
Figure 2:
Location map of Valmiki Tiger Reserve in Bihar with eight different ranges.



2.4 Climate

There are three clearly defined seasons. Winters are accompanied by fog and light winter showers in the month of January. The minimum temperature goes down to 5°C in the reserve. The summer season commences from mid-March and reaches its high in early May due to the hot westerly winds. The monsoon sets in the latter half of June and continues till September. The maximum temperature goes beyond 43°C. The area of VTR receives annual ~1106 mm rainfall (Singh, 2013).

Figure 3:
Major rivers, roads and villages in and around Valmiki Tiger Reserve, Bihar



2.5 Flora & Fauna

According to Champion and Seth (1968), the vegetation of VTR has been classified into seven forest types. These vegetation types are (i) bhabar dun sal forest (3C/c2/b (i)), (ii) dry siwalik sal forest (5B/c1/a), (iii) west gangetic moist mixed deciduous forest (3C/c3/a), (iv) khair-sissoo forest (1S/2), (v) cane brakes (1b/e1), (vi) eastern wet alluvial grass land (4d/2s2) and (vii) barringtonia swamp forest (4 d/ss2). Main tree species include *Shorea robusta, Terminalia tomentosa*, *Terminalia belerica*, *Adina cordifolia, Miliusa velutina*, *Trewia nudiflora*, *Mallotus philippensis*, *Lagerstroemia parviflora*, *Salmalia malabarica* and *Acacia catechu*. The vegetation of the study area has been broadly classified into thirteen different habitat classes (Fig. 4). It represents one of the last patches of forests having the unique combination of terai-bhabar vegetation (Johnsingh *et al.* 2004), which harbour rich fauna of several endemic and globally endangered species such as tiger and one-horned rhinoceros. The Asian elephant (*Elephas maximus*) infrequently migrates from Chitwan National Park, Nepal. The forest of VTR also consist of other felids, canids, ursidae, viverridae such as leopard (*Panthera pardus*), fishing cat (*Prionailurus viverrinus*), jungle cat (*Felis chaus*), leopard cat (*Prionailurus bengalensis*), Indian fox (*Vulpes bengalensis*), dhole (*Cuon alpinus*) sloth bear (*Melursus ursinus*), and large Indian civet (*Viverra zibetha*). The important herbivores of the reserve include spotted deer (*Axis axis*), sambar (*Rusa unicolor*), hog deer (*Axis porcinus*), nilgai (*Boselephous tragocamelus*), wild pig (*Sus scrofa*), and gaur (*Bos gaurus*). Due to the presence of human habitation inside the reserve, livestock also occur frequently. The area also harbours 241 species of birds. Some important ones are the red jungle fowl (*Gallus gallus*), *Gyps* Spp., kalij pheasant (*Lophura leucomelanos*) and several other raptors, partridges, quails, pitta and flycatchers (Nand Kishor, personal observation)

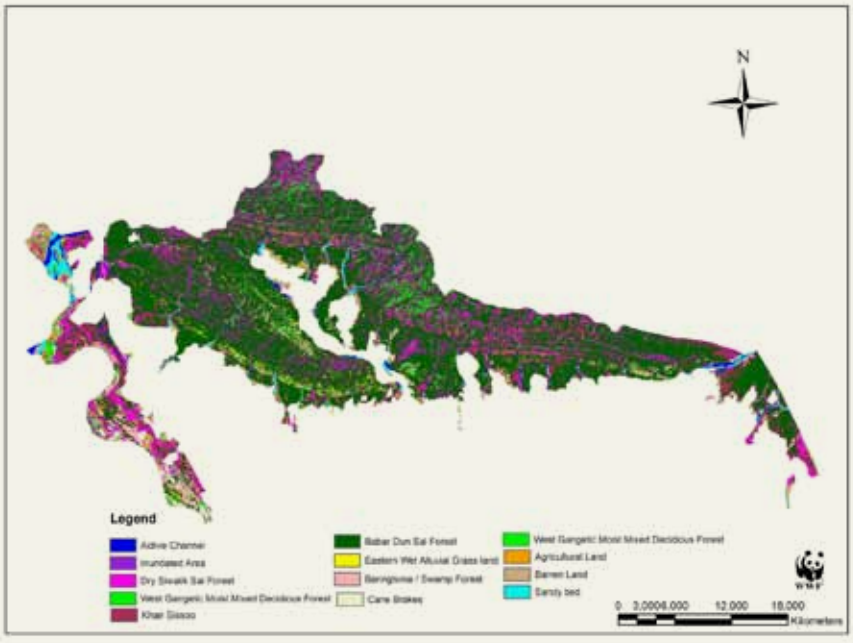


Figure 4: Land use and Land cover map of Valmiki Tiger Reserve, Bihar

2.6 Land Use Land Cover (LULC)

According to Forest Survey of India, Valmiki Tiger Reserve consists of 81 % dense forest, 6.4% open forest, 2 % scrubland, 1.5% agriculture, 2.9% riverbed, 1.1 % water bodies, 5.15% grassland and 0.1% swampy habitat (Fig 4). Most of the grassland patches are found in and around rivers and streams. About 37 species of grasses have been documented in VTR. The largest patch of grassland is only found in Madanpur. Some of the area of VTR is infected by *Phoenix spp*. and highest density (9952 per hectare) is in Manguraha range (WTI, 2012).

2.7 Human Population

The wildlife landscape within VTR is also dominated by human habitation (Fig. 3). There are 26 revenue villages with a population of about 22,000 (within ~45km^2), which are surrounded by the core area, for e.g. Naurangia Doonunder Division-2 (Table 1). Open access to biological resources play an important role in supporting the livelihood of the *tharu, urano* and other communities in these areas. The important towns are Bagha, Ramnagar, Narkatiaganj, Valmikinagar and Bettiah. Agriculture in this valley is the main economic activity but they are also involved in illegal activities like hunting, fuel wood collection and poaching. Their dependence on biodiversity resources ranges from subsistence to commercial exploitation. A recent study showed that the annual consumption of firewood was estimated to be 96,986 kg in a village with a population size of 162 humans (WTI, 2012).

Table 1: List of Villages falling within the areas of the Valmiki Eco-sensitive Zone
Source: Singh 2013

S#	Name of Village	Administrative Block	Area of Village (ha)	Forest Area (ha)	No of Houses	Population
1	Gardi	Shikarpur	262	0.98	568	3288
2	Naurangia	Shikarpur	568	19.77	662	4145
3	Majuraha	Shikarpur	56	5.69	86	429
4	BiriaKalan	Shikarpur	223	32.15	107	555
5	Barwadih	Shikarpur	100	11.16	44	216
6	Gobrahia	Shikarpur	492	38.14	35	1960
7	Jhajhari	Shikarpur	102	24.53	20	127
8	Dhayar	Shikarpur	107	27.15	68	376
9	Bethania	Shikarpur	102	25.8	53	286
10	Bhulbhulaia	Shikarpur	31	2.7	NA	NA
11	Belatandi	Shikarpur	166	3.28	86	442
12	Pipra	Shikarpur	150	4.5	80	469
13	Rupwalia	Shikarpur	158	10.51	74	452
14	Bankatwa	Shikarpur	268	35.28	241	1362
15	Karmaha	Shikarpur	62	43.3	NA	NA
16	Dhobha	Shikarpur	69	NA	NA	NA

S#	Name of Village	Administrative Block	Area of Village (ha)	Forest Area (ha)	No of Houses	Population
17	Sherwa	Shikarpur	285	NA	221	1238
18	Dhokhani	Shikarpur	453	61.47	249	1434
19	Narkatia	Shikarpur	210	5.02	289	1644
20	Katha	Shikarpur	183	27.413	NA	NA
21	Banraha	Shikarpur	92	12.955	NA	NA
22	Raghia	Shikarpur	53	9.87	NA	NA
23	Shitalbari	Shikarpur	495	160.004	270	1591
24	Banwari	Shikarpur	704	261.004	85	540
25	Damrapur	Shikarpur	61	80.846	18	105
26	Hariharpur	Shikarpur	293	160.352	87	497
Total			**5745**	**1063.904**	**3257**	**21156**

3. METHODS

Fieldwork was initiated in January 2013 and extended up to June 2013. In this report, we provide details of the fieldwork carried out over this period, and present the findings of our attempt to determine the status of tigers in the Valmiki Tiger Reserve, Bihar.

3.1 Pre-Field Work

Training workshops on camera trapping and field surveys for deploying cameras were conducted at Gobardhana and Madanpur range offices. Existing data about tiger sightings, predation and frequently-used trails was collected from each range office of VTR for selecting suitable esareas for camera locations.

3.2 Reconnaissance Survey

Reconnaissance surveys were carried out in the months of December 2012 and January 2013 to locate and select suitable trap sites for deploying camera traps. The trap sites were selected based on cues such as scats, scrapes, scent markings, claw marks, pugmarks etc that indicated use of the sites by tigers. The forest guards of the respective beats within the sampling area were also consulted to get a clue of the most extensively used trails such as those near water sources. The whole area of VTR was thoroughly searched for suitable camera locations (Fig. 5). The initial field survey yielded ~3000 potential trap sites with an unprecedented effort of 6500 man-days. These possible camera locations were marked using a handheld Global Positioning System (GPS). These locations were then overlaid on the map of the study area to determine the spatial spread of the trap sites and coverage of the area, especially to detect large gaps without trap sites. Finally 270 trap sites were selected as required by the sampling design.

3.3 Camera Trap Layout

We overlaid 2×2 km sized grids on the map of VTR as recommended by the NTCA protocol (NTCA, 2012) for camera trapping in Phase IV monitoring. The study area was divided into five sampling blocks based on resource availability. The size of blocks varied from 140 to 260 km^2. Camera traps were deployed systematically in each block with at least one pair of cameras deployed within each 4 km^2 grid (Fig. 6). Cuddeback (Attack) digital cameras were used for the exercise. The cameras were placed at a distance of 7-8 meters on both sides from the centre of the trail so as to get full frame pictures of the tigers. The camera delay was kept at the minimum so as not to miss mothers with cubs if and when they happened to pass through. The minimum distance between two camera stations was between 1.5 and 2 km (Fig. 6) to cover well the spatial

distribution of camera traps (NTCA, 2012). Cameras were operated on a 24-hour basis. All the cameras were regularly checked in the field for proper functioning, orientation and status of the battery. Pictures from camera traps were downloaded everyday due to the high probability of camera traps being lost due to theft.

Figure 5: Reconnaissance survey determining suitable camera locations in Valmiki Tiger Reserve, Bihar

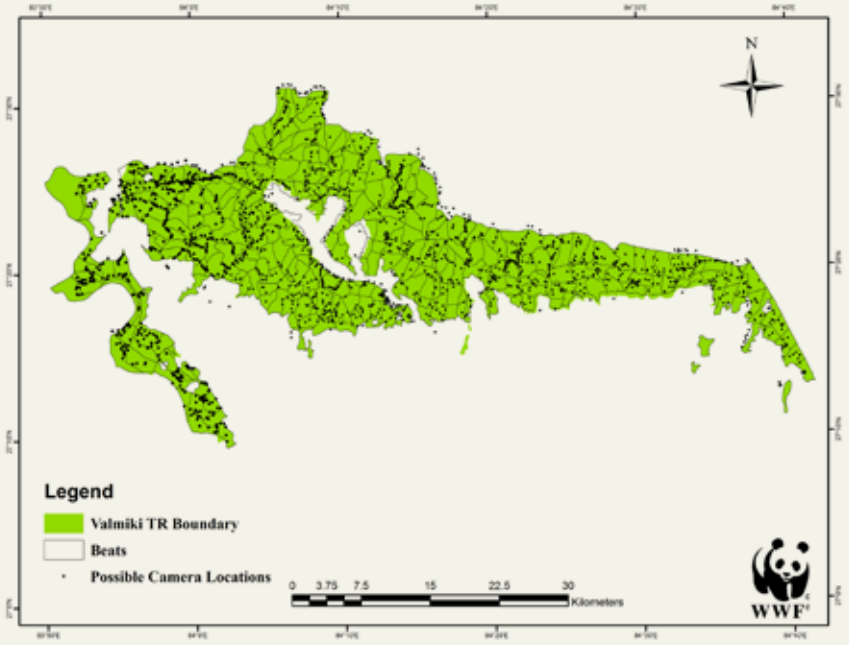
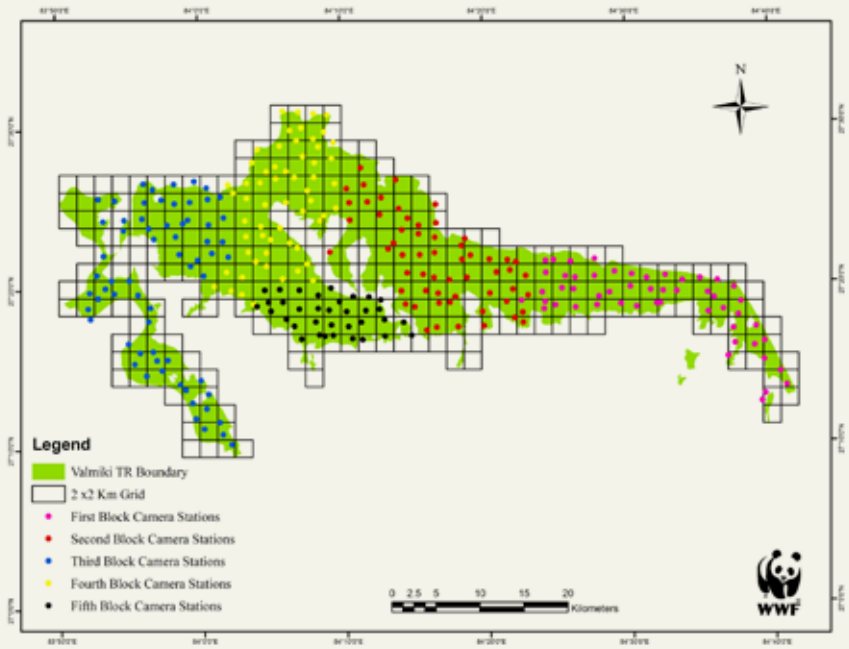


Figure 6: Camera trap layouts in five different blocks of Valmiki Tiger Reserve, Bihar



3.4 Data Analysis

Every photo-captured tiger was given a unique identification number (e.g. VT1, VT2 etc) after carefully examining the pattern of the stripes on the flank, limbs, forequarters and even tail (Schaller, 1967; McDougal, 1977; Karanth, 1995). The sex of the individuals was also ascertained wherever possible, based on camera trap photographs.

Due to logistic constraints, the sampling session was for around 3 months spread over 5 different blocks. We present here the minimum tiger number based on the camera trapping exercise within VTR. However, data collected would also be re-analysed using spatially explicit capture-recapture models (SECR) in a Bayesian analytical framework and software R (package SPACECAP) as well as using the program DENSITY for determining more precise estimates and densities based on closed capture-recapture framework. We hope to deal with and address the different sampling issues through the above mentioned approach. Future monitoring will also robustly estimate population in VTR.

3.5 Activity Pattern and Home Range

The activity pattern of the tiger was assessed from the date and time imprinted on the photographs (Long *et al.* 2008). The percentage of activity level was used to indicate whether large carnivores were nocturnal or diurnal. Assuming that there is a direct correlation between frequency of tiger "captures" in a specific time of the night and activity, we grouped captures data into 12 periods (2 hours in each). Then the number of tiger "captures" for each period was counted. We also attempted to estimate minimum home range size of tigers in VTR for the individuals that were trapped at more than three camera stations. Home range is defined as "that area traversed by the individual in its normal activities of food gathering, mating and caring for young" (Burt, 1943). Minimum convex polygon was used to estimate the home range size of the species (White and Garrot, 1990).

4. RESULTS & DISCUSSION

4.1 Minimum Tiger Numbers

The total sampling effort amounted to 6688 nights of trap effort over five blocks within VTR. In all, we obtained tiger photographs at seventy six camera trap stations (28.1% of total locations). The capture rate of tigers was recorded highest in the first block (44.2%) and lowest in the fourth block (18.6%). We did not obtain any photographs of tigers in the fifth block *i.e.* in Chiutaha and the southern part of Harnatand ranges (Fig. 7). These two ranges are highly disturbed due to anthropogenic pressures and infected by *Phoenix* spp and *Michenia* spp.

A total of 154 captures of **22** unique individuals were obtained across the study area. Out of these, **11** individuals were males, **8** were females, while the gender of **3** could not be identified. ***We report this figure as the minimum number of tigers presently found in the Valmiki Tiger Reserve.*** However, photo-capture locations of the tigers clearly show that some of the individual's home ranges/territories also encompass the adjoining area of the Chitwan National Park in Nepal (Fig. 7). In general, the eastern and western parts of the VTR yielded more pictures of tigers than the central part (Figs. 8 & 9). Interpolation data on count of tiger captures at each camera station indicates that the area being highly used by the tigers is the eastern and western part of VTR (Fig 10). The variation in tiger captures could be related to the presence of a good prey base like chital and sambar (Annexure 6). The western (*i.e.* Madanpur, Valmikinagar and Ganuali ranges) and eastern (*i.e.* Manguraha range) parts consist of substantial grassland, which are suitable for prey base. However, there is no information regarding the prey population in this reserve. One adult female (VT11) with two accompanying cubs (<3 month) was photographed frequently in the Madanpur Range. The presence of the breeding female and cubs leads us to confirm that VTR has a resident tiger population.

4.2 Activity Patterns & Spatial Organisation

Interestingly, there was a high turnover of individuals even between blocks that were adjacent to one another (Fig.11), and only a few adult males seemed to be predisposed to wandering over larger distances - which resulted in their being captured in multiple blocks. For example, Male VT2 and VT9 were trapped in multiple blocks and their home ranges were 130.15 km² and 103.91 km² respectively. Also, capture dynamics revealed that 40% photographs of the total usable captures were contributed by five males. Few individuals were captured only once. The same trend was reported by Azlan & Sharma (2003), and Anwar (2010), where male tigers contributed 66% and 41% of the total usable photographs respectively. Based on their capture-recapture, the average home range of the tiger was estimated to be $52.41_{Mean} \pm 12.83_{SE}$ (N=9) Km².

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These movements and captures were closely correlated with female territories (Figs 12 & 13).

Based on the time recorded in the photographs, tigers showed bimodal peak activities, one after midnight until morning and another just after sunset. The tiger was primarily active at night and exhibited less activity during the day (Fig. 14). In general, large carnivores tend to synchronize foraging with their prey and adapt temporal hunting patterns to the times when their prey is most vulnerable (Sunquist, 1981). In areas where conflicts with humans exist, carnivores also tend to shift their activity in response to human interference. Based on times recorded at photographs, tiger showed bimodal peak activities, one after midnight until morning and another just after sunset. Tiger was primarily active at night and exhibited less activity during the day hours (Fig. 14). In general, large carnivores tend to synchronize foraging with their prey and adapt temporal hunting patterns to the times when their prey is most vulnerable (Sunquist, 1981). In areas where conflicts with human exist, carnivores also tend to shift their activity in response to human interference.

4.3 New Locality Records of Some Wildlife Fauna in Valmiki

Figure 7: Capture and recapture locations of tigers in Valmiki Tiger Reserve, Bihar

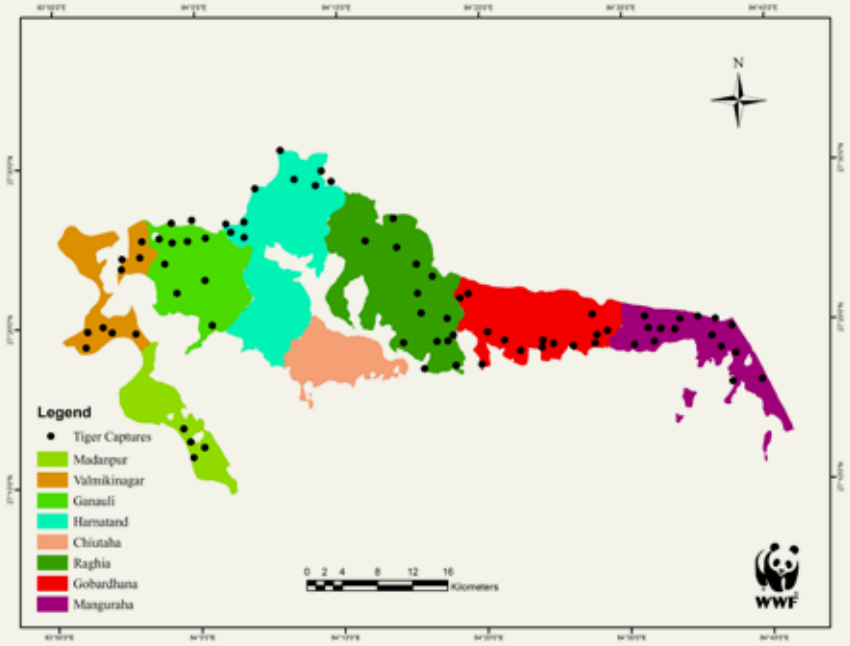


Figure 8:
Frequency of captures and recaptures of tigers in Valmiki Tiger Reserve, Bihar

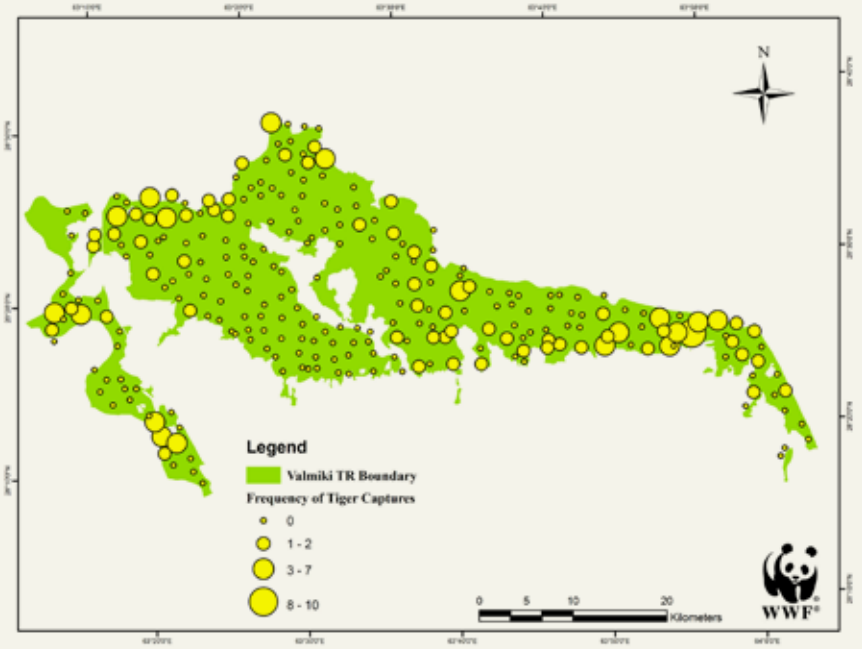


Figure 9:
The capture frequency of unique individual tigers in Valmiki Tiger Reserve, Bihar

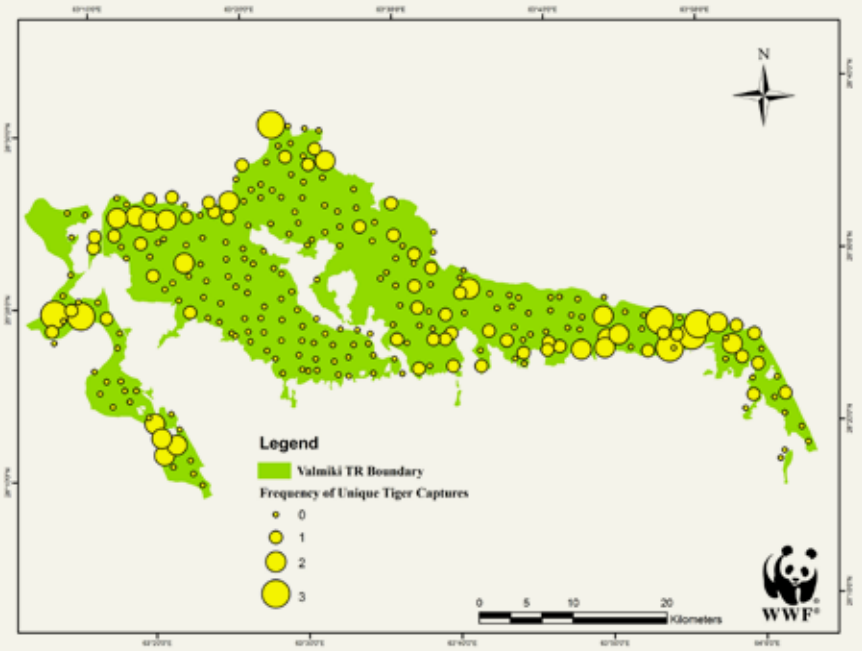


Figure 10:
Interpolation of camera trap captures data (count of tiger captures at each camera station). The green shades are indicative of areas where capture frequencies are expected to be high.

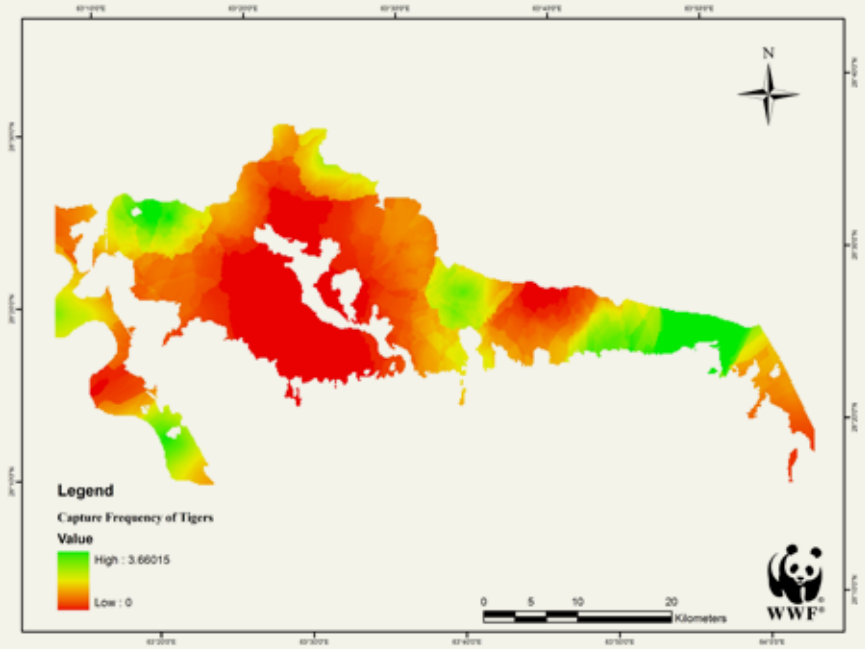


Figure 11:
Spatial organization of tigers in Valmiki Tiger Reserve, Bihar

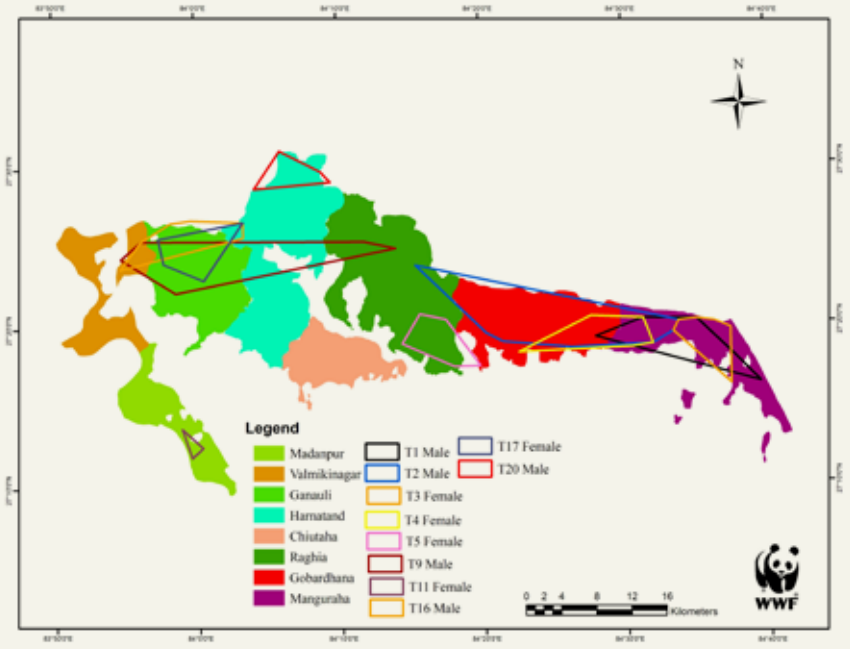


Figure 12:
Capture locations of male tigers in Valmiki Tiger Reserve, Bihar

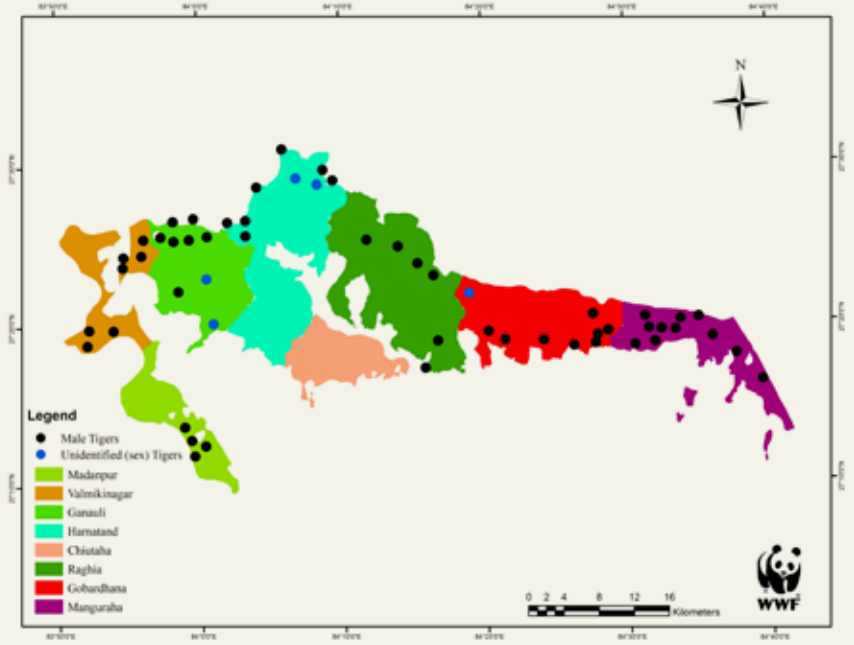


Figure 13:
Capture locations of female tigers in Valmiki Tiger Reserve, Bihar

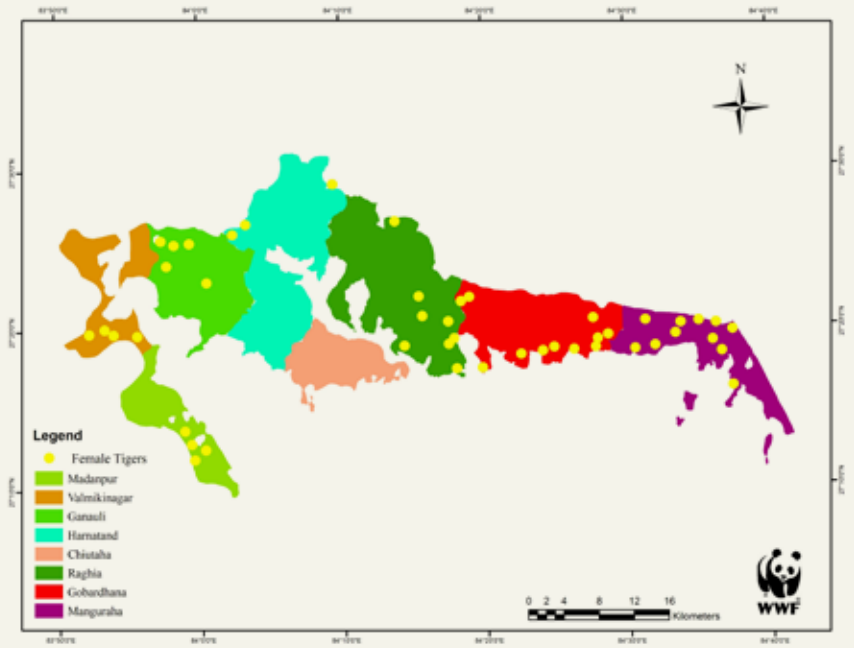
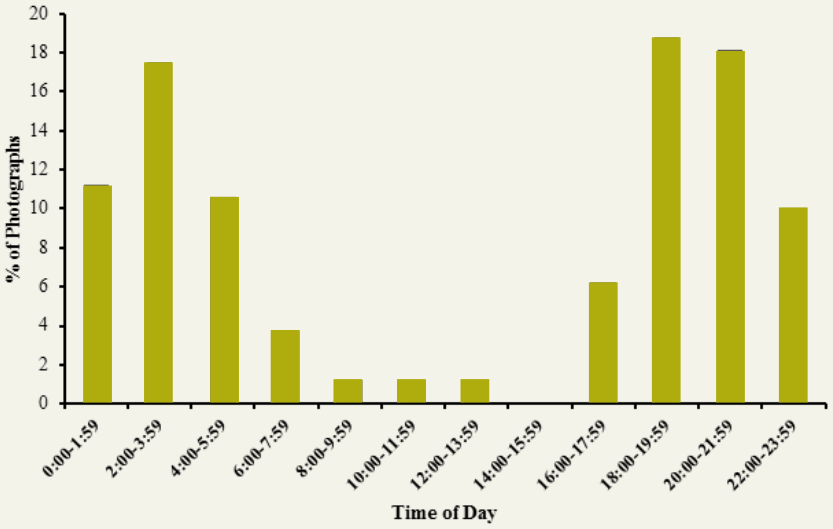


Figure 14:
Temporal activity patterns of tigers in Valmiki Tiger Reserve, Bihar



Tiger Reserve

In addition to tigers and leopards, we recorded pictures of fishing cats, sloth bears, dholes, leopard cats, jungle cats, striped hyenas, Indian fox, golden jackal, sambar, Indian rhino, chital, nilgai, Indian muntjac, wild pig, gaur, porcupine, hare, civets (large Indian, small Indian and common palm), red jungle fowl, kalij pheasant, rhesus macaque and langurs.

We present new locality records of some species in Valmiki Tiger Reserve obtained from the camera trapping survey. These are crab-eating mongoose, yellow-throated marten and Himalayan serow:

Crab-eating mongoose is a member of herpestidae family and listed as 'Least Concern' (IUCN 2010). The species is known to use various habitats ranging from open deciduous forests to evergreen forests and from low to high altitudes (Van Rompaey, 2001). It is also known to occur up to 2,000m above sea level, though it has been rarely found at such high elevations. In India, it is restricted to the northeastern region (Datta *et al.* 2008) and is reportedly fairly common in Assam, Arunachal Pradesh and northern West Bengal (Menon, 2003). The presence of this species in the eastern Terai Arc Landscape is suggestive of a new locality of the crab-eating mongoose.

Himalayan serow is a nocturnal, forest-dwelling ungulate and 'Near Threatened' (IUCN 2010). It is very sparsely distributed and confined to a few scattered, isolated populations within its former geographical range — eastern part of the river Jamuna in Bangladesh, northern India, Tibet and Nepal (Grubb, 2005). The Himalayan serow is known to be locally present between 700 to 4000m above mslin all Himalayan states (Bhattacharya *et al.* 2010; Paudela and Kindlmann, 2012). The occurrence of the Serow in Valmiki Tiger Reserve suggests a continuous distribution with the northern part of

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the Nepal hills and highlights a need to assess their current status and distribution, to develop conservation strategies in hilly areas.

Yellow-throated marten is a member of the Mustelidae family of carnivora order and is listed as 'Least Concern' (IUCN 2010). It has a wide distribution from Pakistan and Afghanistan in the west to Russia in the Far East and Indonesia in the east (Corbet & Hill, 1992). In India, the species is reported to occur in the foothills of the Himalaya (Hussain, 1999). This is the first record of this species in the easternmost corner of Terai Arc Landscape *i.e.* Valmiki Tiger Reserve. The presence of this species was recorded in Raghia and Gobardhana ranges of Division-I. The area where they were photographed is hilly and riverine.

CONCLUSION

The intensive camera trapping in Valmiki Tiger Reserve was a pioneer effort to cover the entire reserve, which helped in identifying twenty two (22) tiger individuals using and operating in the area. The finding of this study indicates that tiger numbers in the Valmiki Tiger Reserve is at par with some of the better-managed parks. The healthy tiger numbers in VTR could be attributed to the contiguous landscape extending to the Chitwan National Park in Nepal (Karki, 2011), and also to dedicated conservation and management efforts made by concerned managers and the forest department. However, the tiger's population in VTR is lower than other protected areas in Terai Arc Landscape (Jhala *et al.* 2011). Our camera trapping exercise and field assessment of tiger populations indicates that VTR has the potential to sustain good tiger populations, and this can be enhanced by providing better law enforcement strategies, habitat management, reducing anthropogenic pressures and by securing corridors. With above mentioned factors, tigers can easily rebound in unoccupied areas within VTR and it has the potential to hold more tigers than it currently does. It is worth noting that, the existing 26 revenue villages inside VTR and the other villages in the important Naurangiadoon, exert a lot of pressure on VTR including the core area (see Fig.3). It is important to initiate proper strategies and programmes to reduce the pressure on the forest; even relocation of some villages can be considered as an option. This study also accounted for the presence of various ungulates in the study area such as chital, sambar, muntjac, nilgai, gaur, wild pig and Himalayan serow. The presence of Himalayan serow, yellow-throated marten and crab-eating mongoose were uncertain before this study and is probably the first record from VTR, extending its distributional range. In addition to continuation of the long-term prospects for tiger management and other associated species in this vast landscape, future studies should also address connectivity issues between habitats and a coordinated monitoring across the border between India and Nepal.

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ANNEXURES

Annexure 1

Photo-captured tigers (22 Individuals)

VT1 (Left)

VT1 (Right)

VT2 (Left)

VT2 (Right)

VT3 (Left)

VT3 (Right)

VT4 (Left)

VT4 (Right)

VT5 (Left)

VT5 (Right)

VT6 (Left)

VT6 (Right)

VT7 (Left)

VT7 (Right)

VT8 (Left)

VT8 (Right)

VT9 (Left)

VT9 (Right)

VT10 (Left)

VT10 (Right)

VT11 (Left)

VT11 (Right)

VT12 (Left)

VT12 (Right)

VT13 (Left)

VT13 (Right)

VT14 (Left)

VT14 (Right)

VT15(Left)

VT15 (Right)

VT16 (Left)

VT16 (Right)

VT17 (Left)

VT17 (Right)

VT18 (Left)

VT18 (Right)

VT19 (Left)

VT19 (Right)

VT20 (Left)

VT20 (Right)

VT21 (Left)

VT21 (Right)

VT22 (Left)

VT22 (Right)

Annexure 2

Leopard *(Panthera pardus)*

Indian fox *(Vulpes bengalensis)*

Dhole or wild dog *(Cuon alpinus)*

Striped hyena *(Hyena hyena)*

Golden jackal *(Canis aureus)*

Fishing cat *(Prionailurus viverrinus)*

Jungle cat *(Felis chaus)*

Large Indian civet *(Viverra zibetha)*

Leopard cat *(Prionailurus bengalensis)*

Small Indian civet *(Viverricula indica)*

Yellow throated marten *(Martes flavigula)*

Palm civet *(Paradoxurus hermaphrodites)*

Sloth bear *(Melursus ursinus)*

Gaur *(Bos gaurus)*

Crab eating mongoose *(Herpestes urva)*

Greater one-horned rhinoceros *(Rhinoceros unicornis)*

Indian porcupine *(Hystrix indica)*

Himalayan serow

Sambar *(Rusa unicolor)*

Wild boar *(Sus scrofa)*

Chital *(Axis axis)*

Nilgai *(Boselaphus tragocamelus)*

Indian muntjac *(Muntiacus muntjak)*

Indian hare *(Lepus nigricollis)*

Rhesus macaque *(Macaca mulatta)*

Indian peafowl *(Pavo cristatus)*

Hanuman langur *(Semnopithecus entellus)*

White-throated kingfisher *(Halcyon smyrnensis)*

Red junglefowl *(Gallus gallus)*

Kalij pheasant *(Lophura leucomelanos)*

Annexure 3

Visit of the Hon'ble Chief Minister of Bihar at Valmiki Tiger Reserve

The preliminary findings of the camera trapping exercise were presented to Sh. Nitish Kumar, Chief Minister of Bihar, at the Valmikinagar rest house during his visit to VTR on 17 February 2013 and 18 April 2013. These meetings was organized by the forest department to discuss various conservation issues and the status of tigers in VTR. *"I wish to congratulate WWF-India on these important findings and hope that WWF-India continues its support in conserving the rich biodiversity of Valmiki Tiger Reserve",* said Sh. Nitish Kumar.

Sh. Nitish Kumar, Chief Minister of Bihar, on his visit to VTR along with forest officials.

Discussing tiger monitoring work with WWF-India Team

Annexure 4

Successful rescue of Tigers from human habitation

Within three months of the study period, a total of three events of straying tigers were recorded from Valmiki Tiger Reserve. During the month of February 2013, an adult tiger was sighted in Udaipur WLS near Bettiah and stayed there for about 2 months. On 22 March 2013, a tiger was reported from village Shahpur jungle at around 15:00 hrs. On the same night, the tiger moved in and around the Padarauna town. Forest officials of UP and Bihar kept a track of the animal regularly and our monitoring of tiger signs indicated that it had returned to VTR along the Gandak flood plain. The WWF-India team deployed camera traps in Udaipur WLS to monitor the movement patterns of the stray tiger. Meanwhile, another adult male tiger was seen straying in Sirisiya villages near Bettiah (15 April 2013), after villages heard it roaring in a wheat field. A team of experts from Patna Zoo along with dedicated forest officials arrived on the scene and anesthetized the tiger so that it could be released back to VTR.

Habitat loss, degradation and fragmentation due to human population growth and unplanned use of natural resources has altered the landscape, accelerated the decline of the carnivore population and also sometimes forced them to move outside the Protected Area. The western and southern boundary of Valmiki Tiger Reserve is roofed by several villages while the magnitude of anthropogenic pressure is much higher than expected. which leads to such human-carnivore conflict. The rescued tiger was photographed twice in our camera trapping exercise in Valmikinagar range and it indicates that the animal is doing well.

Human-carnivore conflict in Valmiki Tiger Reserve

People gathered during tiger straying incident

Captured tiger

Preparation of field equipment

Camera trap placement for monitoring

Tranquilization program

Strayed tiger photographed twice in camera traps

Captured tiger

Annexure 5

Study a glance

Grassland habitat

Training workshop for Camera & GPS

Ridges and Mountain

Camera traps ready to be deployed

Selecting suitable camera locations

Camera Monitoring

Regular data downloading in field

Camera protection from infrequent rain

Team with field equipment

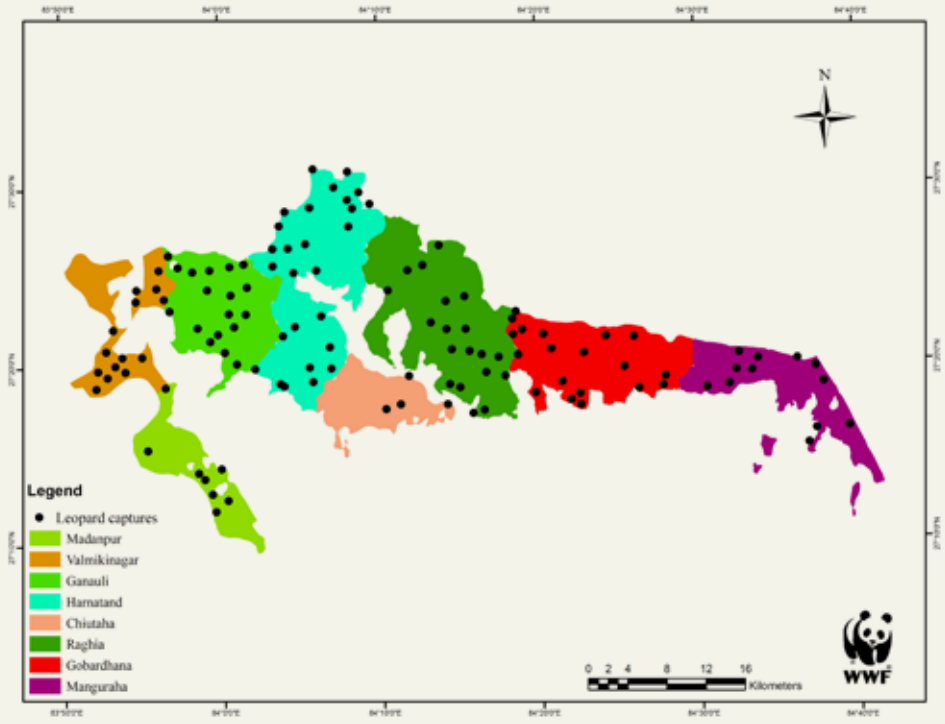
Compilation of data

Camera damaged due to fire

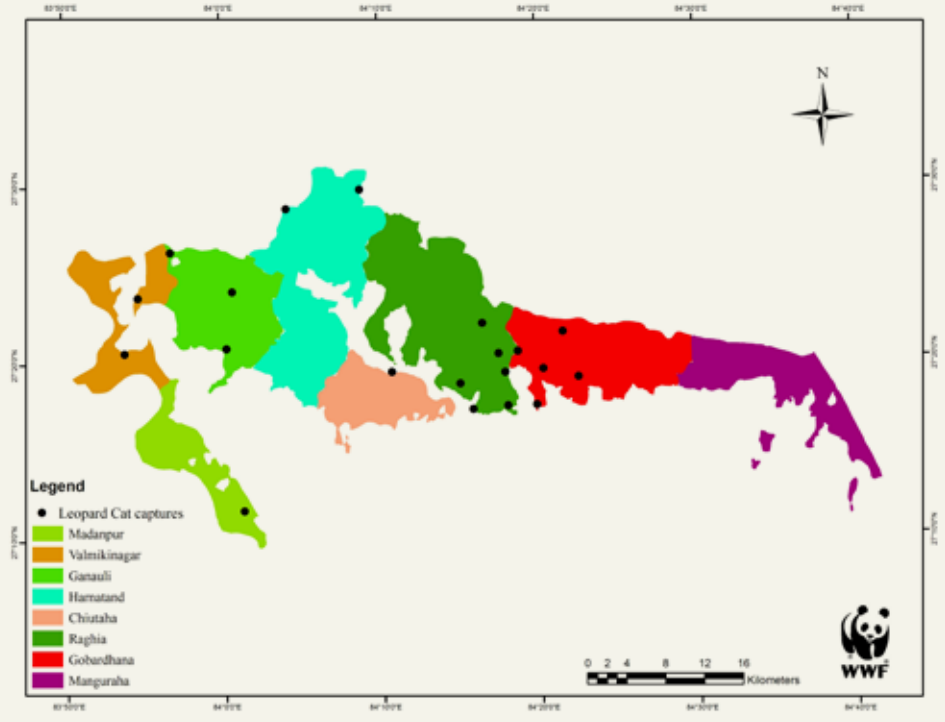
Annexure 6

Capture locations of other wildlife species in Valmiki Tiger Reserve

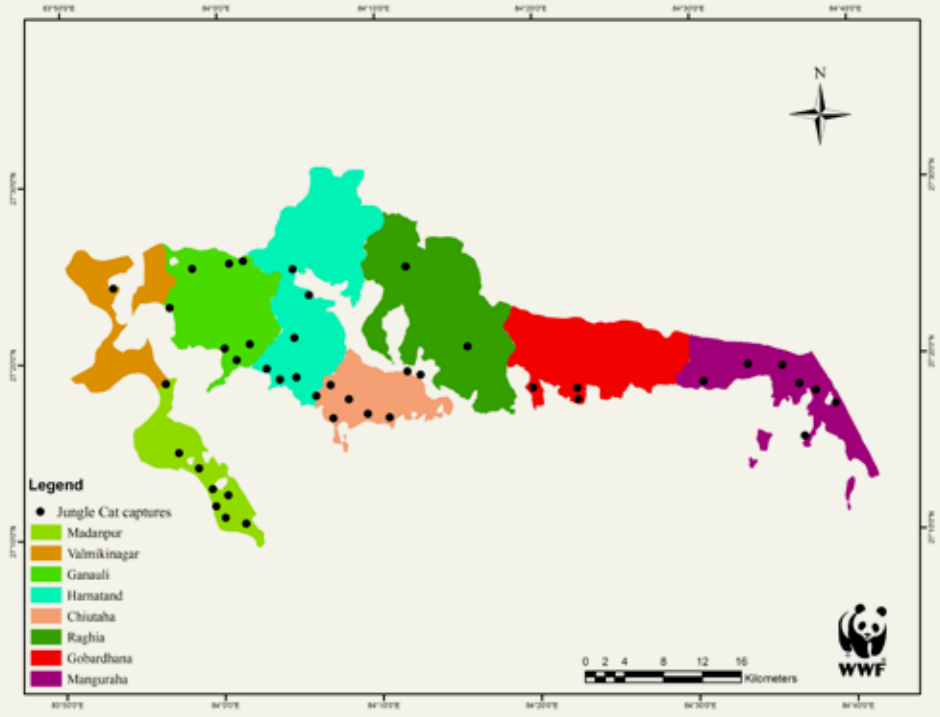
Distribution of Leopard captures



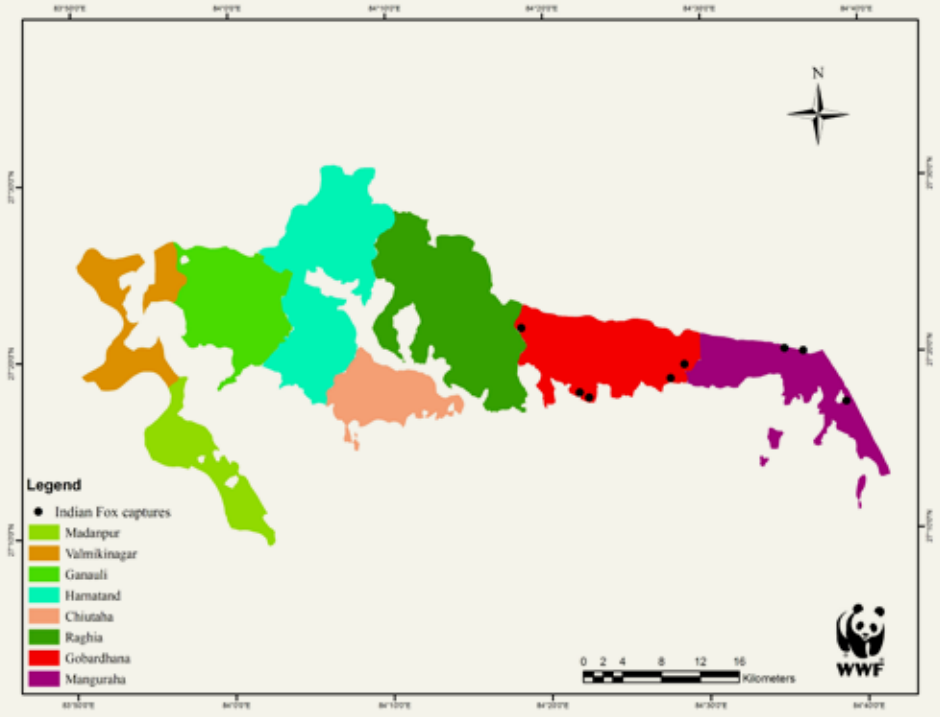
Distribution of Leopard Cat captures



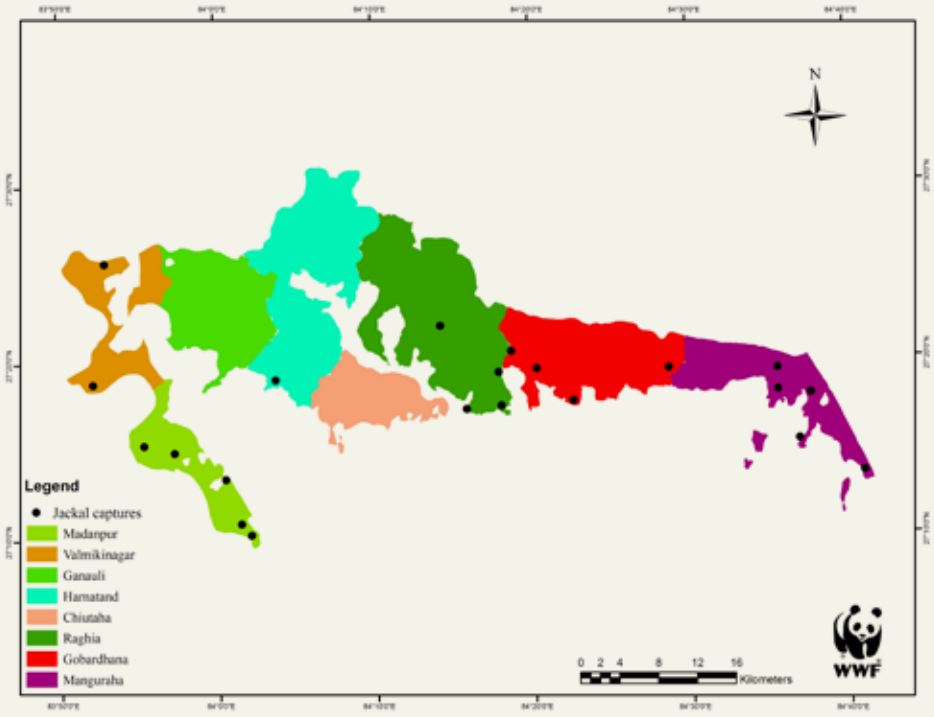
Distribution of
Jungle Cat captures



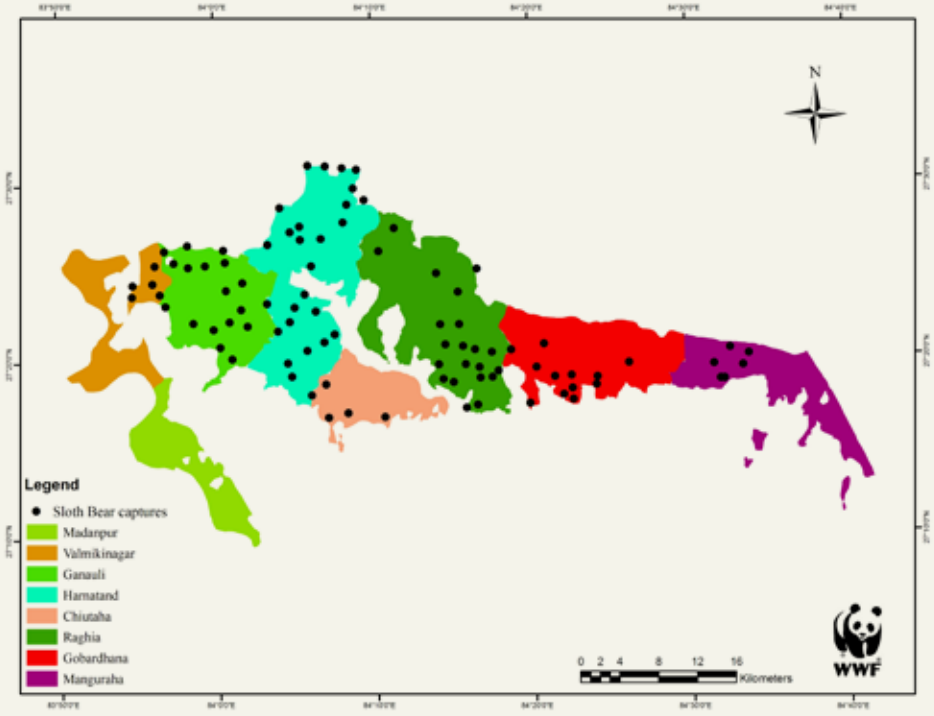
Distribution of
Indian Fox captures



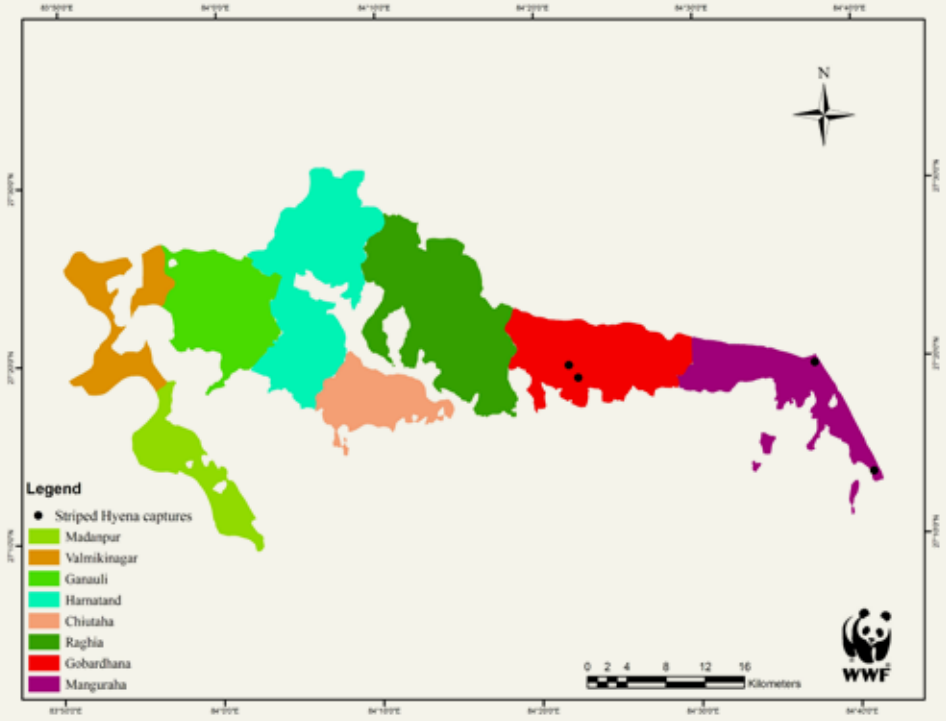
Distribution of Jackal captures



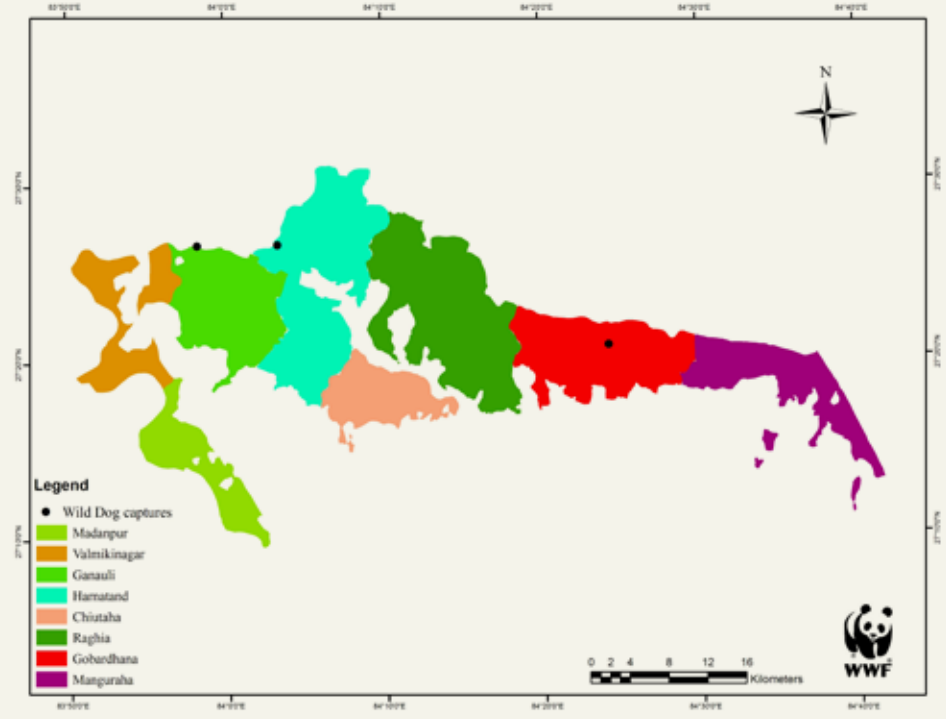
Distribution of Sloth Bear captures



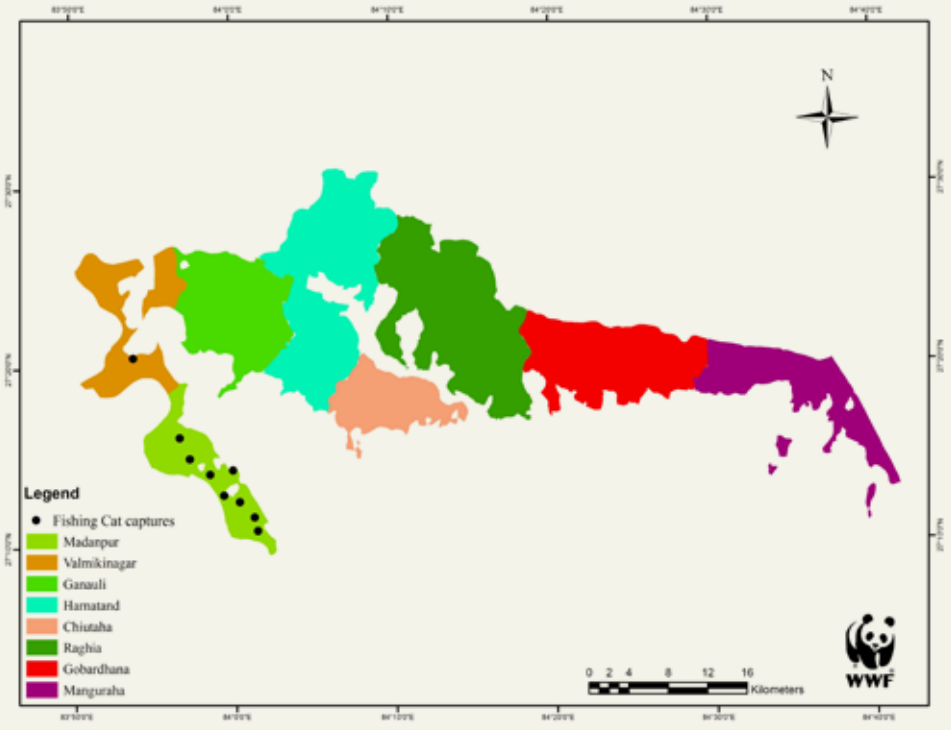
Distribution of
Striped Hyena captures



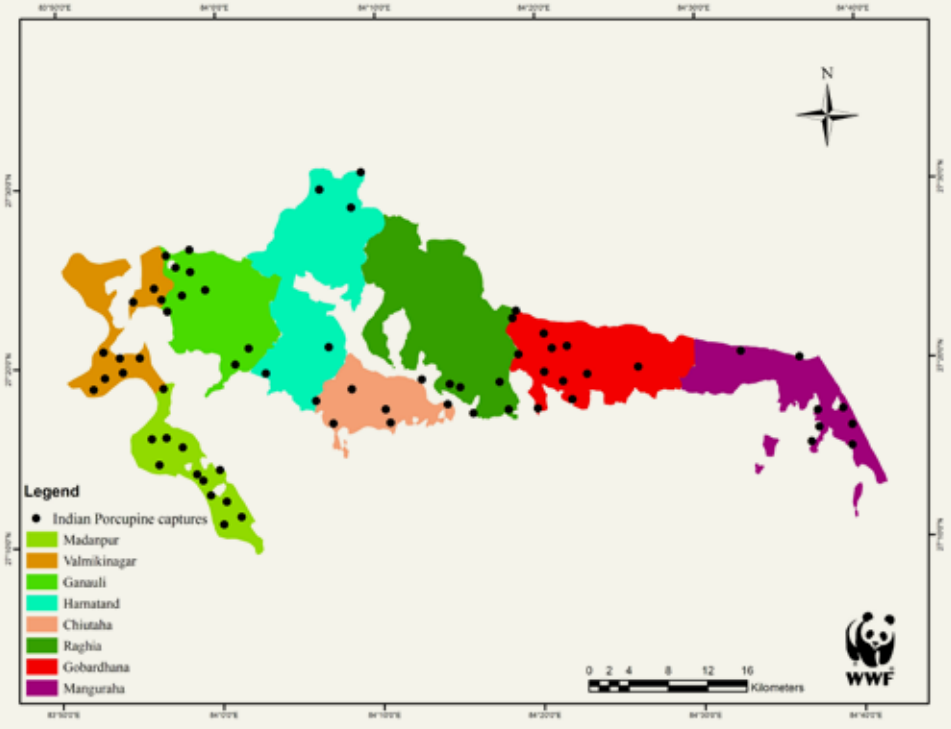
Distribution of
Wild Dog captures



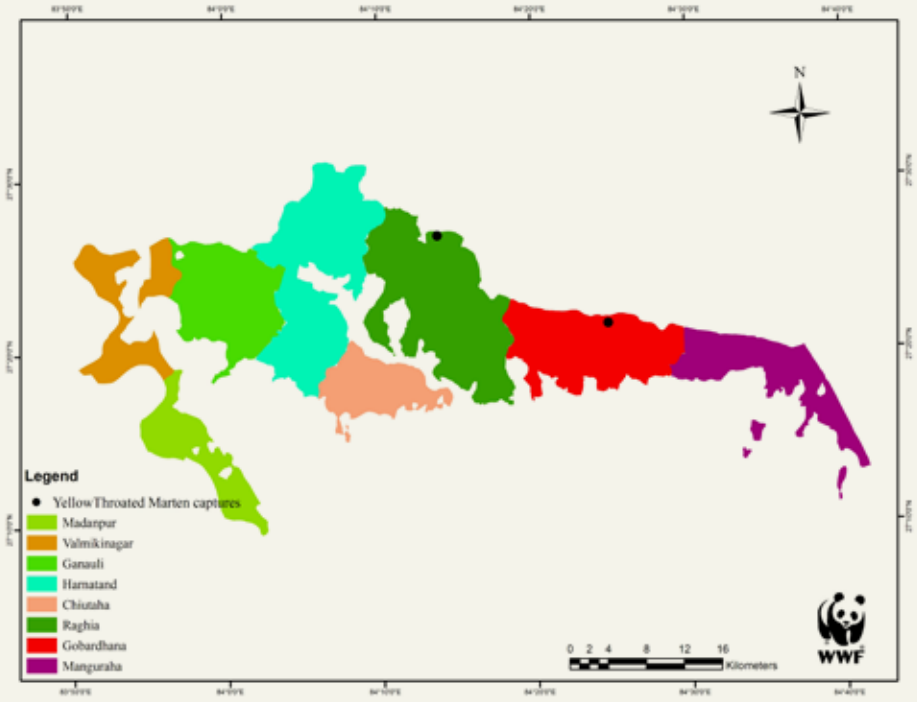
Distribution of Fishing Cat captures



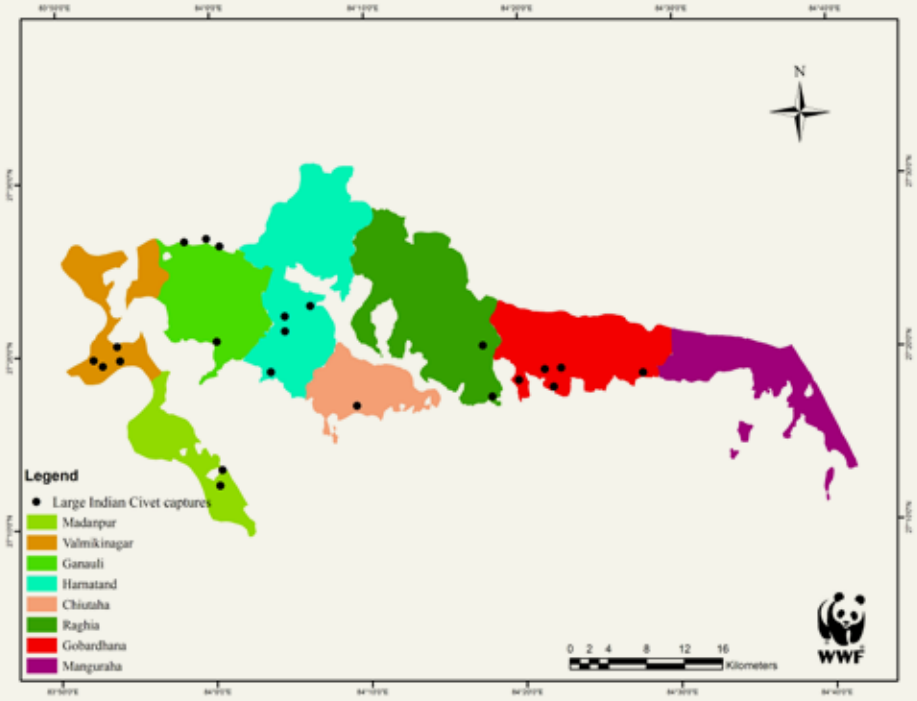
Distribution of Indian Porcupine captures



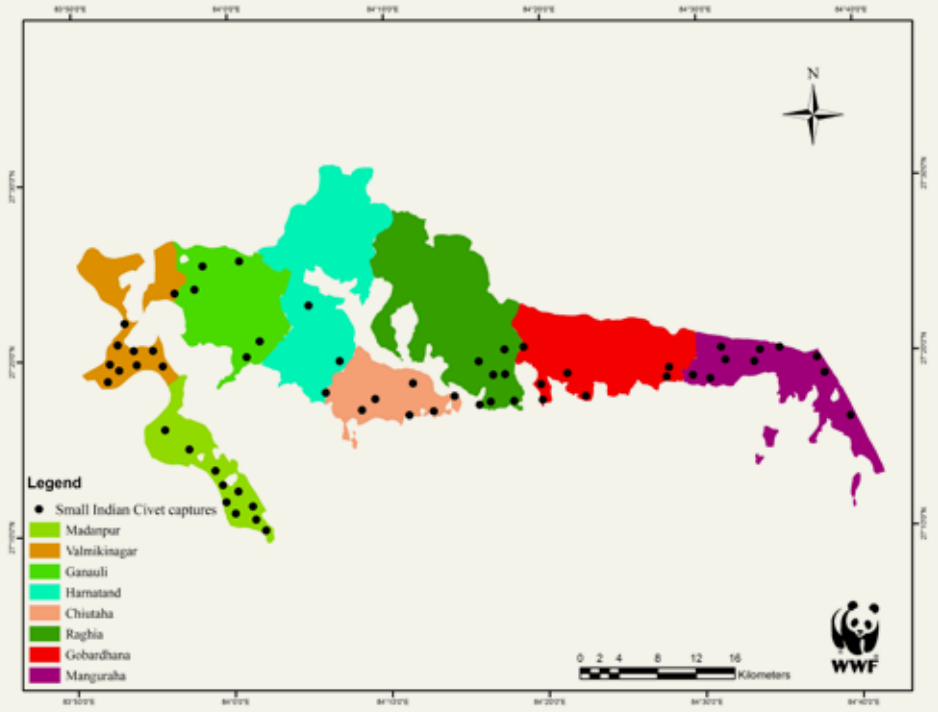
Distribution of Yellow Throated Marten captures



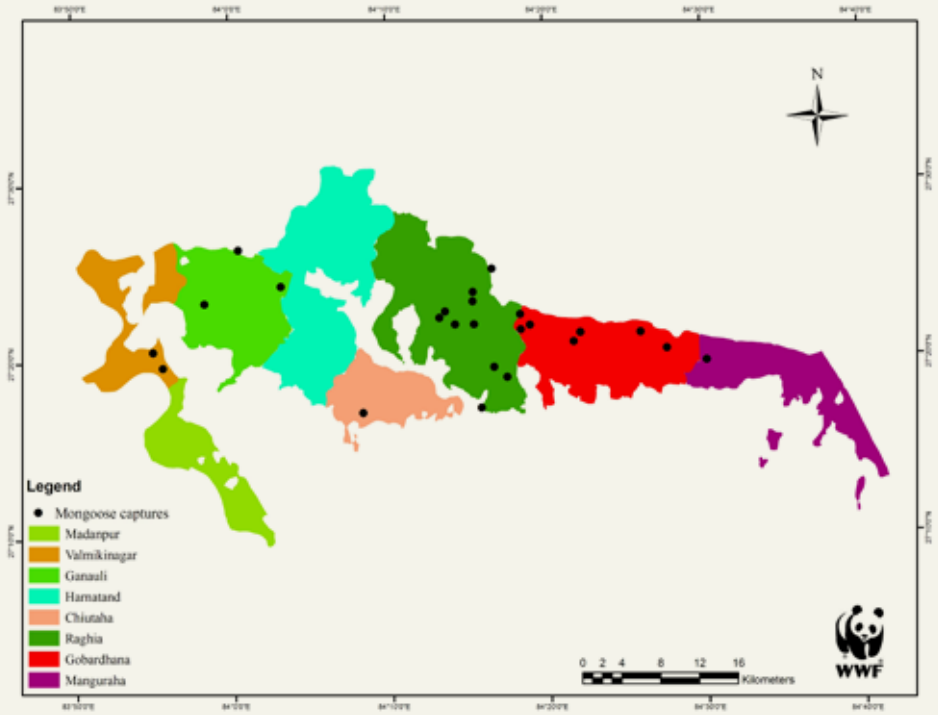
Distribution of Large Indian Civet captures



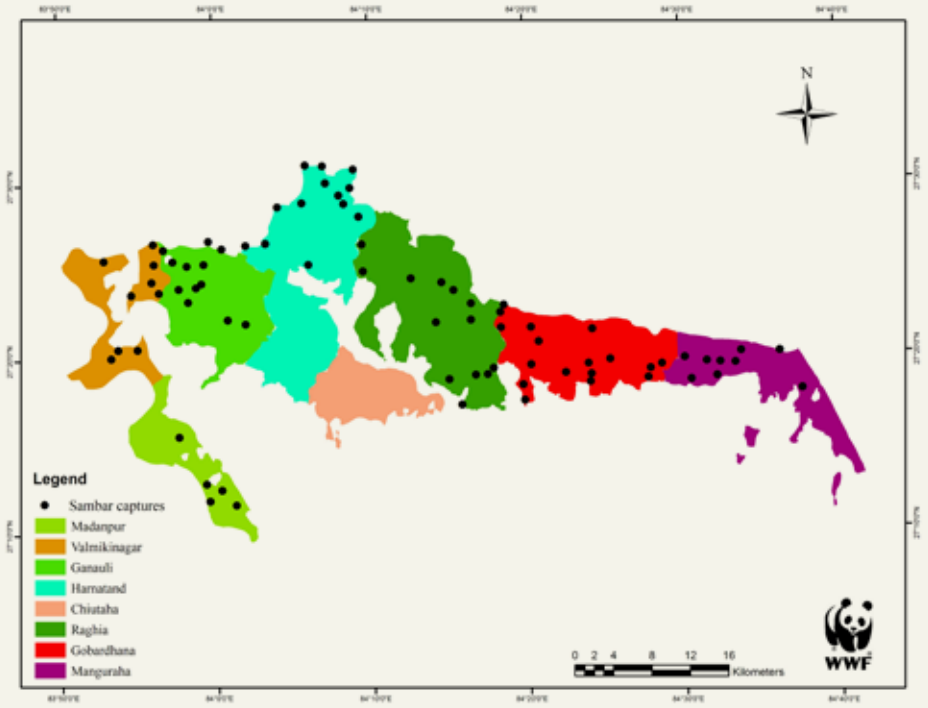
Distribution of Small Indian Civet captures



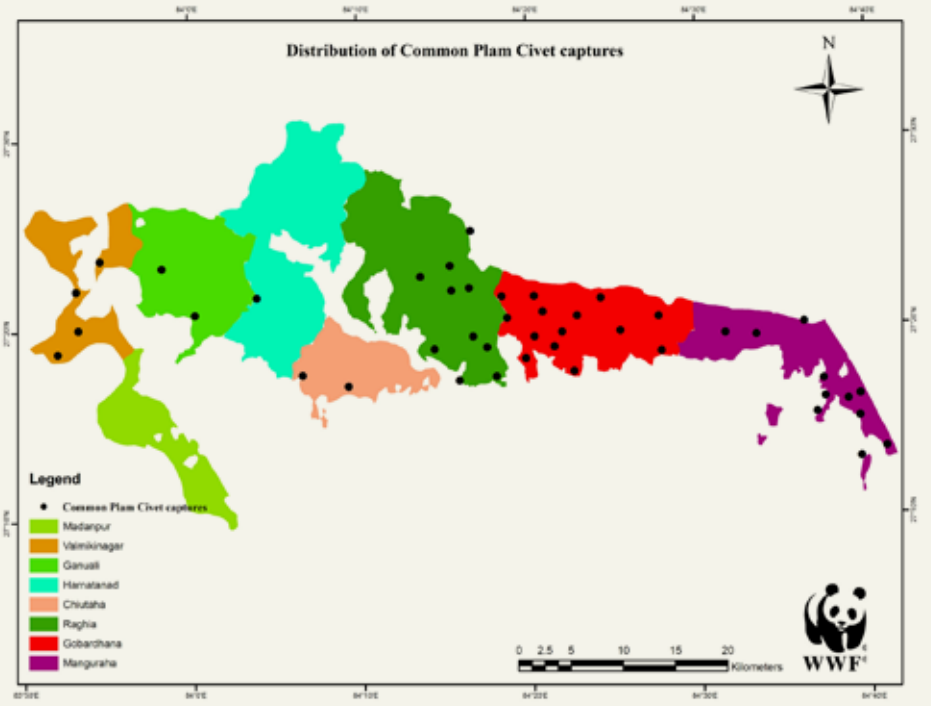
Distribution of Mongoose captures



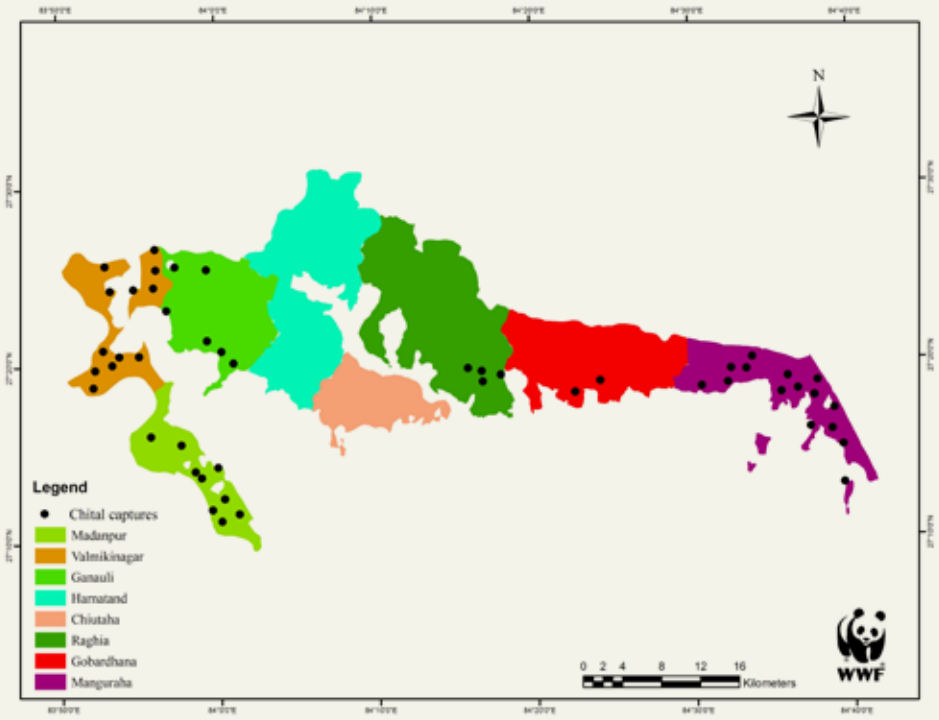
Distribution of Sambar captures



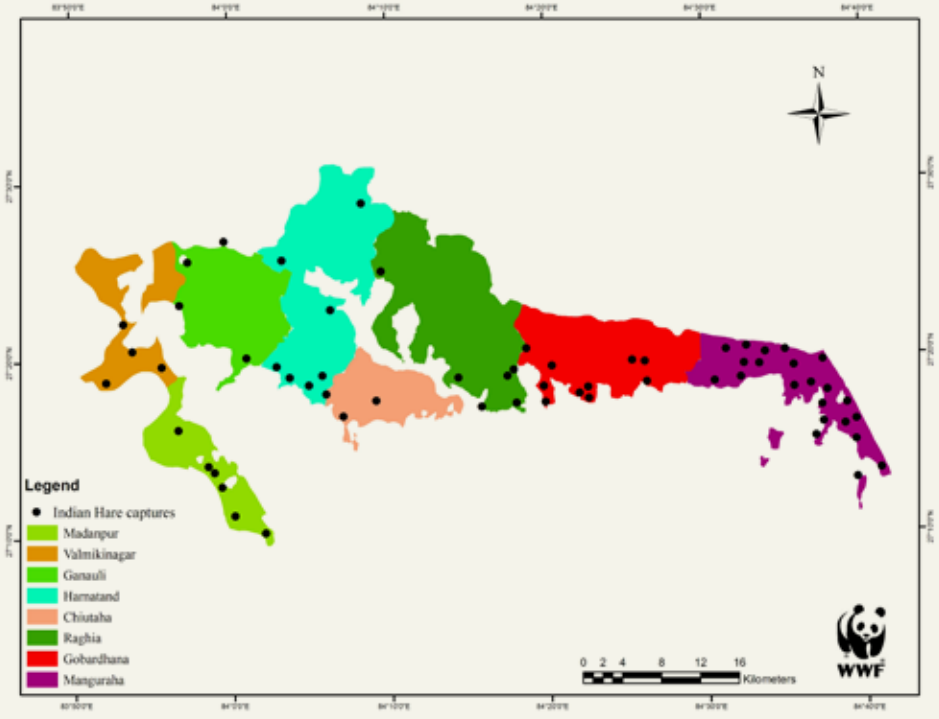
Distribution of Common Plam Civet captures



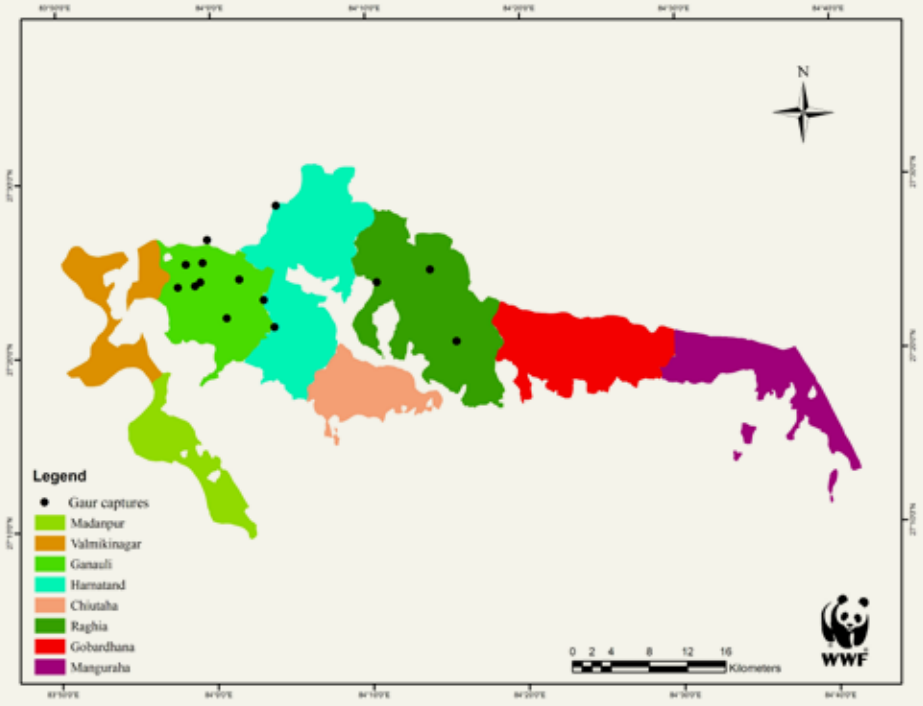
Distribution of
Chital captures



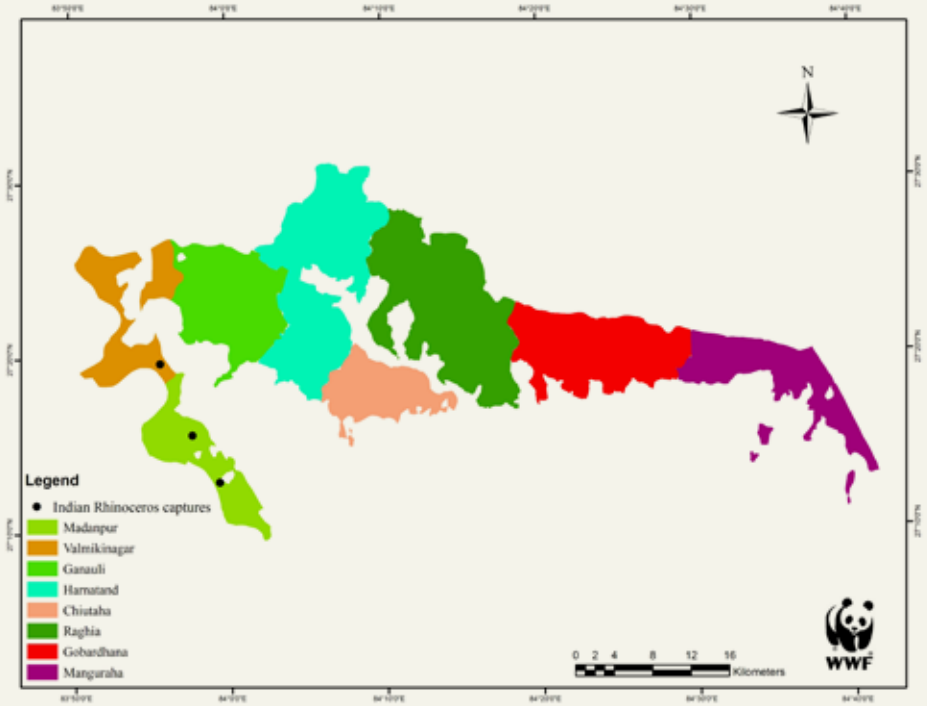
Distribution of
Indian Hare captures



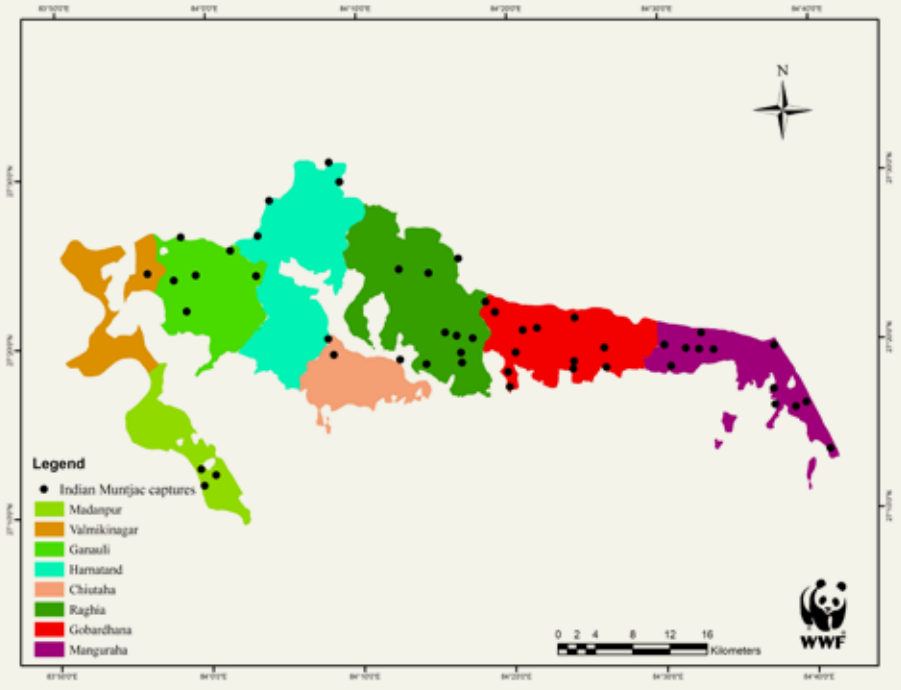
Distribution of Gaur captures



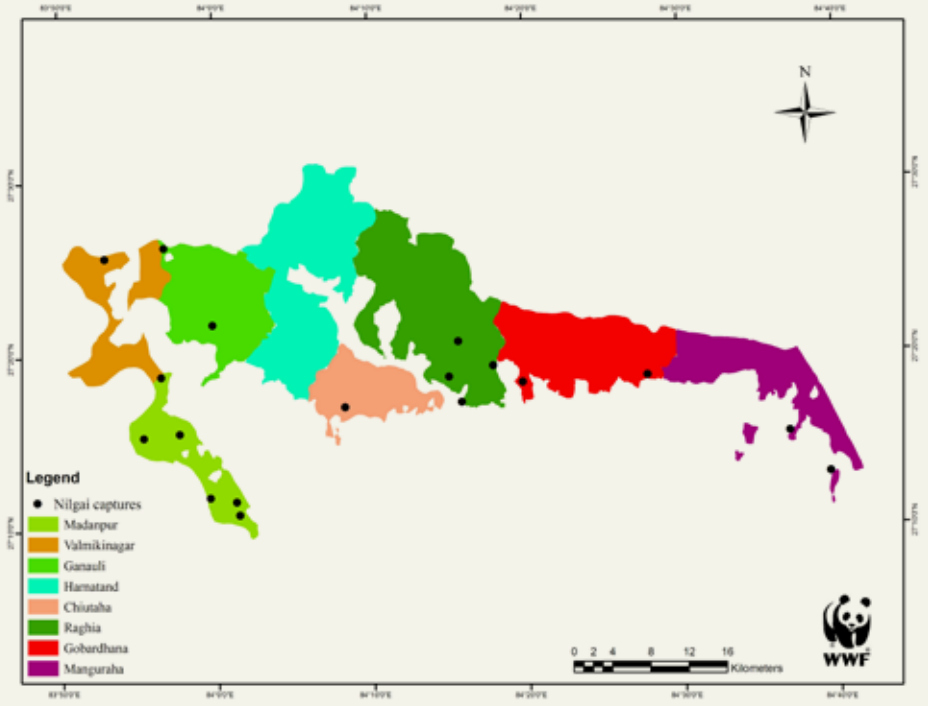
Distribution of Indian Rhinoceros captures



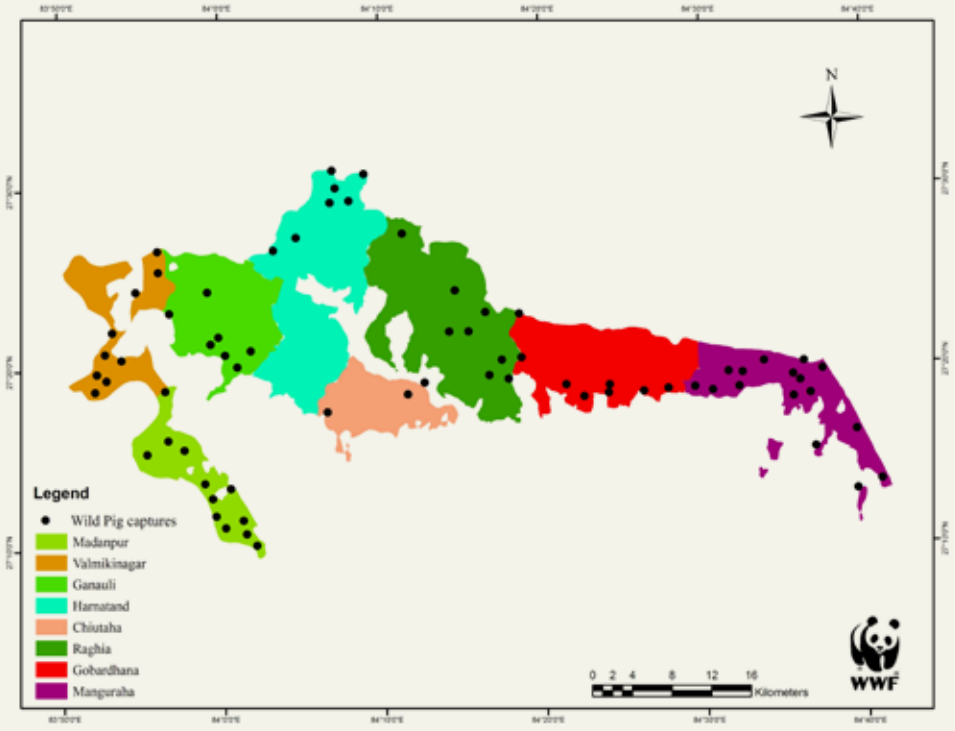
Distribution of
Indian Muntjac captures



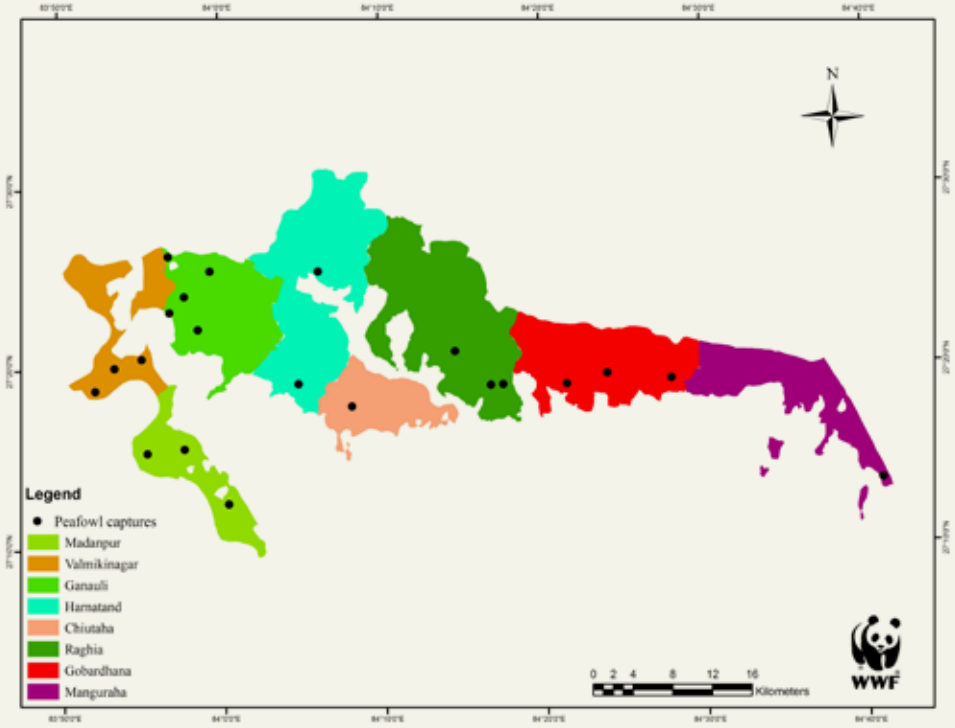
Distribution of
Nilgai captures



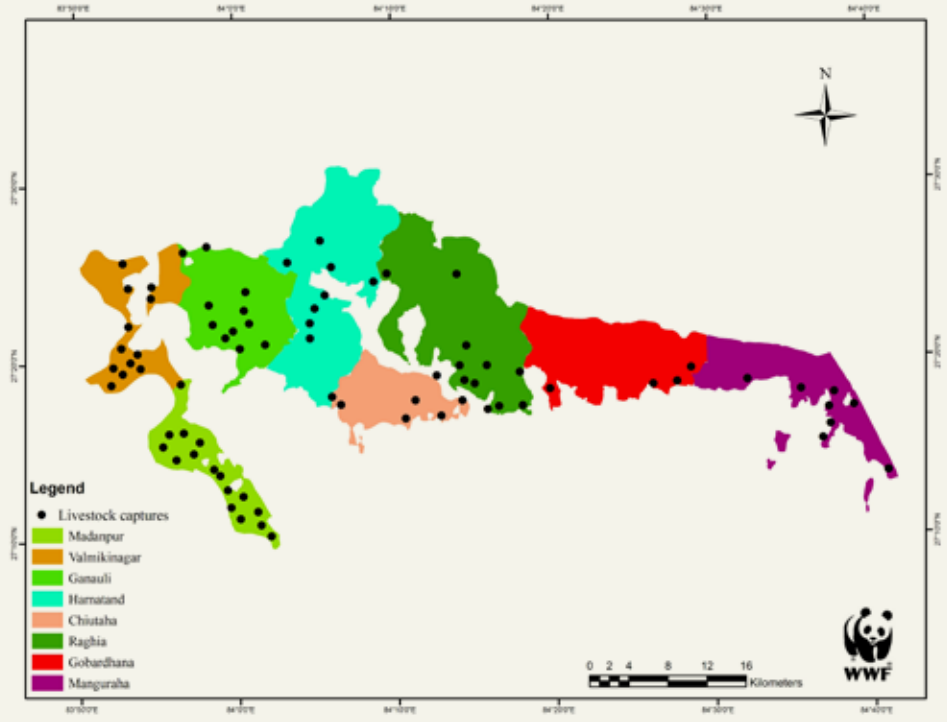
Distribution of Wild Pig captures



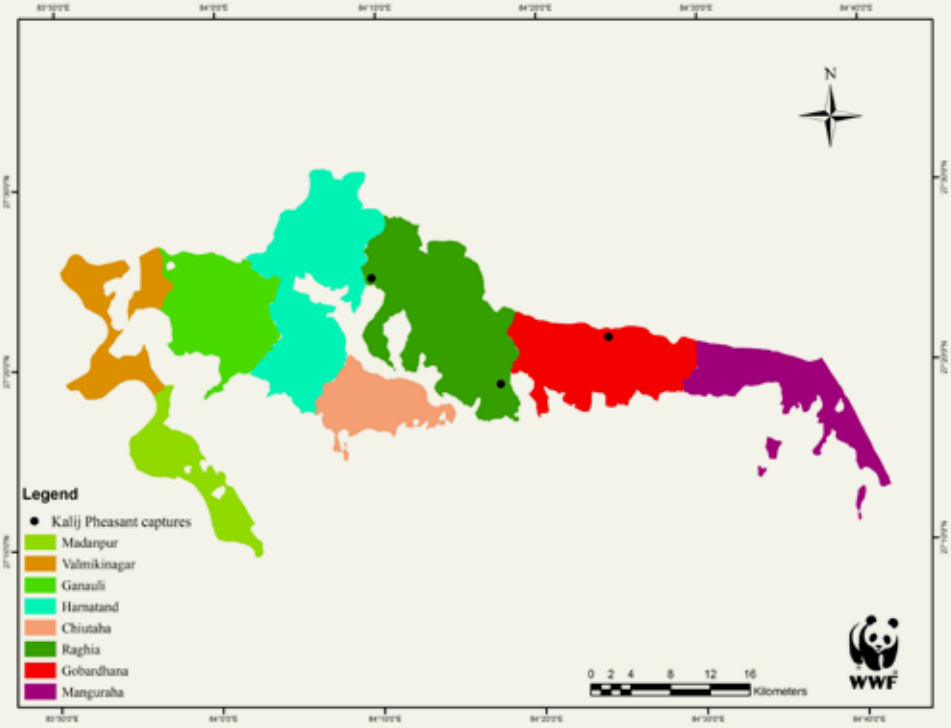
Distribution of Peafowl captures

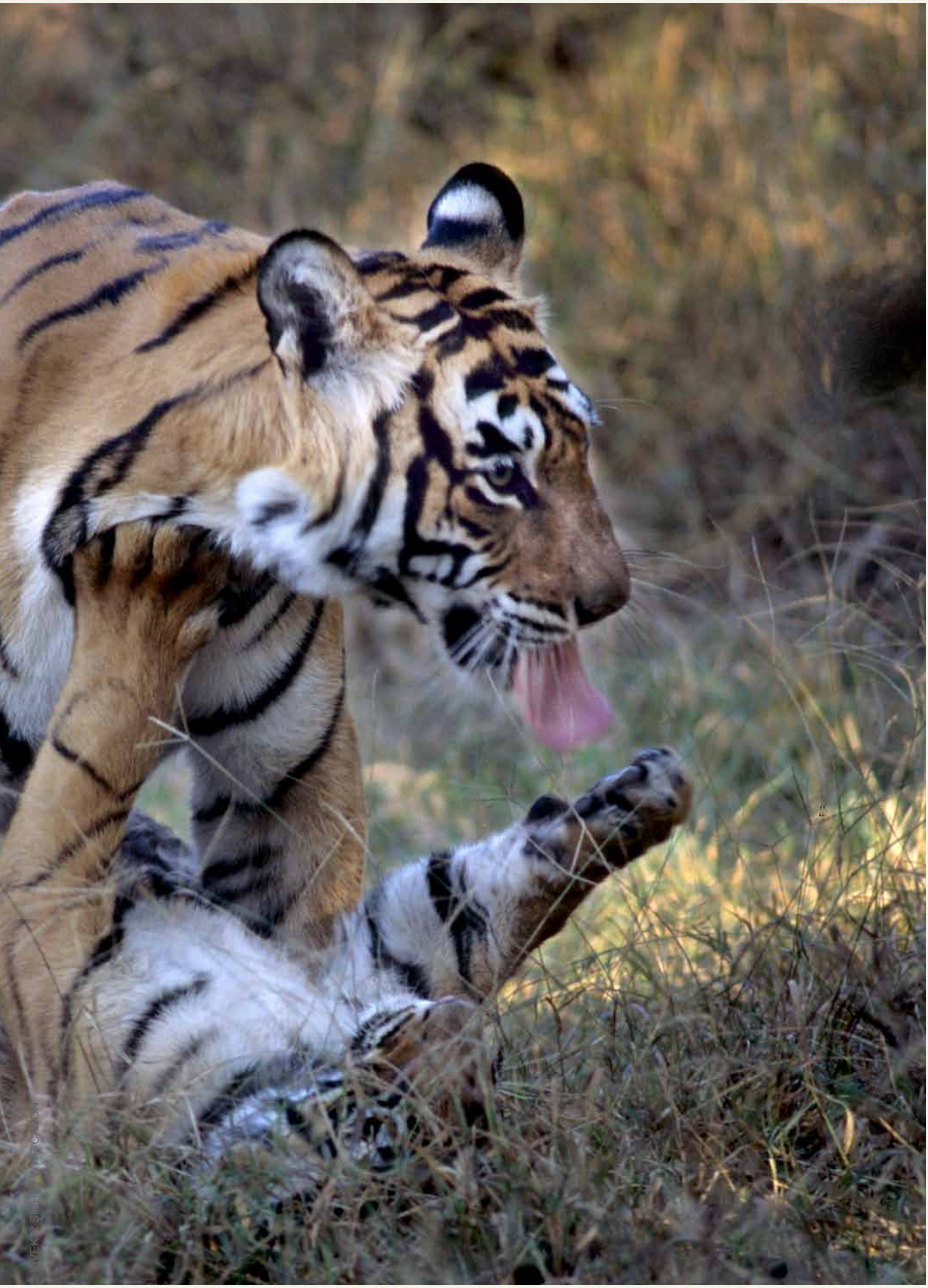


Distribution of
Livestock captures



Distribution of
Kalij Pheasant captures





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Number of individual tigers camera trapped

+ 901

Total area of Valmiki Tiger Reserve in sq. km.

+ 6500

Total number of man days spent for the sampling effort

270

Number of camera trap sites used for the study

Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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WWF-India Secretariat
172-B Lodi Estate
New Delhi 110003
Tel: 011 4150 4814 Fax: 011 4150 4779

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