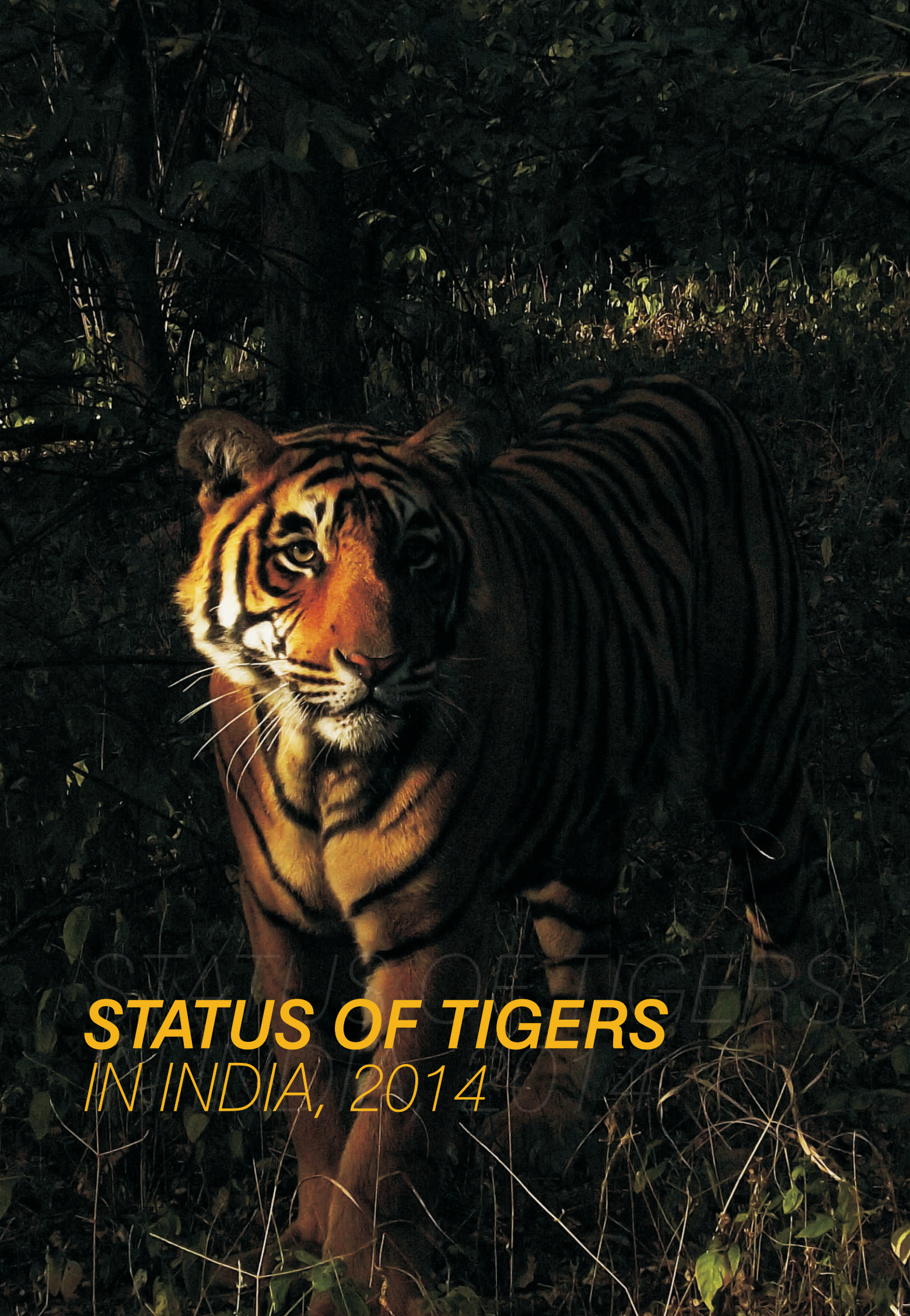


STATUS OF TIGERS
IN INDIA, 2014

Citation

Y. V. Jhala, Q. Qureshi, and R. Gopal (eds) 2015. The status of tigers in India 2014. National Tiger Conservation Authority, New Delhi & The Wildlife Institute of India, Dehradun.

मा वनं छिन्धि सव्याघ्रं मा व्याघ्राः नीनशन् वनात्।
वनं हि रक्ष्यते व्याघ्रैः व्याघ्रान् रक्षति काननम्।।

(महाभारत)

This is the third round of the country level assessment of Tigers, Co-predators and Prey, using the refined methodology. As a country having the maximum number of tigers and their source area, India also has the unique distinction of embarking on this refined methodology across all forested habitats and tiger States within the country. The state of the art technology has been put to use, involving remotely sensed data, geographical information system and camera traps, besides extensive ground survey. The latest computer application have been used for obtaining the results.

This science based monitoring and assessment would further strengthen our efforts to conserve our national animal.

I compliment the tiger States, National Tiger Conservation Authority, Wildlife Institute of India and collaborators outside the goverment system for this commendable effort.

Prakash Javadekar
Minister of State (Independent Charge)
Environment, Forests & Climate Change
Government of India

Introduction 01

By virtue of being the top predator, the tiger functions as an umbrella species for the conservation of biodiversity, ecosystem functions, goods, and services in forest systems of Asia. The "Project Tiger", a pioneering conservation initiative of the Government of India, aims to harness this role of the tiger along with the tigers' charisma to garner resources and public support for conserving representative intact ecosystems. Securing natural systems along with their functions would ensure that their inherent values, goods and services are available for future generations of Indians.

Survival of tigers is critically dependent on conservation and management efforts. Major threats to tigers are poaching driven by an illegal international demand for tiger parts and products, depletion of tiger prey caused by illegal wild meat consumption, and habitat loss due to the ever increasing demand for forested lands. To gauge the success of conservation efforts as well as to have scientific monitoring of tiger populations and their ecosystems, it is important to have information on where the tigers are and how many are there. This information at a population cluster level, is essential for successful management practices. National Tiger Conservation Authority in collaboration with the State Forest Departments, National Conservation NGO's, and the Wildlife Institute of India conducts a National assessment for the "Status of Tigers, Co-predators, Prey and their Habitat" every four years. The methodology used for this assessment was approved by the Tiger Task Force in 2005.In this report, we focus on population change across the three cycles of population monitoring undertaken in 2006, 2010 and in the current cycle of 2014. The data and inferences generated by this system not only serve as a monitoring tool but also as an information base for decision making for managers. Most protected areas in India are too small to sustain tigers in the long-term. This dilemma can be addressed by managing these "small" tiger populations as meta-populations, i.e. several small populations and a few large populations, all connected with each other can ameliorate much of the ill effects of small fragmented populations. Tiger reserves and some Protected Areas serve as source populations of tigers while intervening forested areas act as corridors. By permitting dispersing tigers to move between different tiger populations long-term persistence of individual populations is enhanced. Thus, the "tiger bearing forests" need to be fostered with protection as well as restorative inputs to ensure their source and corridor value for demographic and genetic viability of tiger populations. As we demonstrate in this report, continuous monitoring of tiger populations across the country has yielded information on successful conservation management practices. More importantly, the report also highlights places where immediate intervention is required to recover tiger populations by re-evaluating current management strategies.

02 Methods

The countrywide assessment of tiger status uses a double sampling approach to estimate the distribution and abundance of tigers in India. The first component of the double sampling consists of ground surveys (Phase 1) of all potential tiger occupied forests in 18 States (Table 1) wherein the ground survey data is collected by the State Forest Department personnel:

State & Landscape Complex	Sampled Beat	Tiger occupied Beat	No. of Sampled Trails	Samples Trails with Tiger signs detected
Bihar	31	27	145	94
Uttar Pradesh	315	129	712	244
Uttarakhand	812	361	1810	658
Shivalik Hills & Gangetic Plains	**1158**	**517**	**2667**	**996**
Andhra Pradesh	2409	85	7036	172
Chattisgarh	3562	97	9595	150
Jharkhand	19	0	92	0
Maharashtra	5874	614	17640	1106
Madhya Pradesh	8580	717	25834	1493
Odisha	3299	81	10434	135
Rajasthan	179	84	642	180
Central Indian Landscape & Eastern Ghats	**23922**	**1678**	**71273**	**3236**
Goa	105	7	315	10
Karnataka	2201	506	6819	1106
Kerala	672	208	2025	411
Tamil Nadu	1002	206	3214	506
Western Ghats	**3980**	**927**	**12373**	**2033**
Assam	547	95	851	190
Mizoram	13	3	45	3
Arunachal Pradesh				
North Bengal	45	23	152	52
North Eastern Hills & Brahmaputra Flood Plains	**605**	**121**	**1048**	**245**
Sundarbans	**52**	**31**	**318**	**190**
INDIA	**29717**	**3274**	**87679**	**6700**

** From scat Dna*
 # From Camera trap and scat DNA

1) Trail surveys for ccupancy of habitat patches by tigers and other predators
2) Line transects to estimate prey abundance
3) Sampling plots on the line transects to assess
   a) habitat characteristics,
   b) human impacts and
   c) prey dung density.

and from recent remotely sensed data (Phase 2) following variables

a) landscape characteristics,
b) human "foot-print", and
c) habitat attributes

were used to model tiger abundance and occupancy.

Total Length Trails (km)	No. of Transects Walked	Total Length Sampled (km)	No. Plots Sampled	No of Camera Trap Locations	Individual Tigers Photo - captured/DNA ID
830	118	360	854	235	21
3785	683	2107	828	551	92
9755	1592	3575	3503	806	292
14370	**2393**	**6042**	**5185**	**1592**	**396**
32635	8436	18811	14883	505	37
45309	9664	23165	15720	0	19#
577	224	448	431	0	3*
91920	18577	46692	31116	1466	144#
145627	26556	64410	53614	2459	292
52550	10071	20910	17742	140	6#
3368	482	1003	1690	863	63
371987	**74010**	**175439**	**135196**	**5433**	**558**
1614	348	686	580	0	3*
34910	7200	15676	10620	577	257
11824	2031	4095	3474	399	85
17533	3375	7033	5373	578	189
65881	**12954**	**27489**	**20047**	**1554**	**518**
4405	872	3036	2058	806	136
205	39	78	0	0	3*
				84	15#
1437	164	349	277	0	2*
6047	**1075**	**3462**	**2335**	**890**	**152**
812	**318**	**1031**	**529**	**266**	**62**
459096	**90750**	**213464**	**163292**	**9735**	**1686**

***Table 1**: Country wide effort for ground surveys and camera trap sampling.*

The second component (Phase 3 & 4)of the double sampling consists of scientifically rigorous abundance estimation in select sampling units using a) remote camera trap based capture-recapture technique for estimating tiger and other carnivore abundance and b) line transect based Distance sampling for estimating prey abundance. c) Camera trap based habitat covariates and vegetation quantification on plots at each transect. This sampling was done by trained State Forest Department personnel, competent National Non-Governmental Organizations and the Wildlife Institute of India (Table 1 & Fig 1).

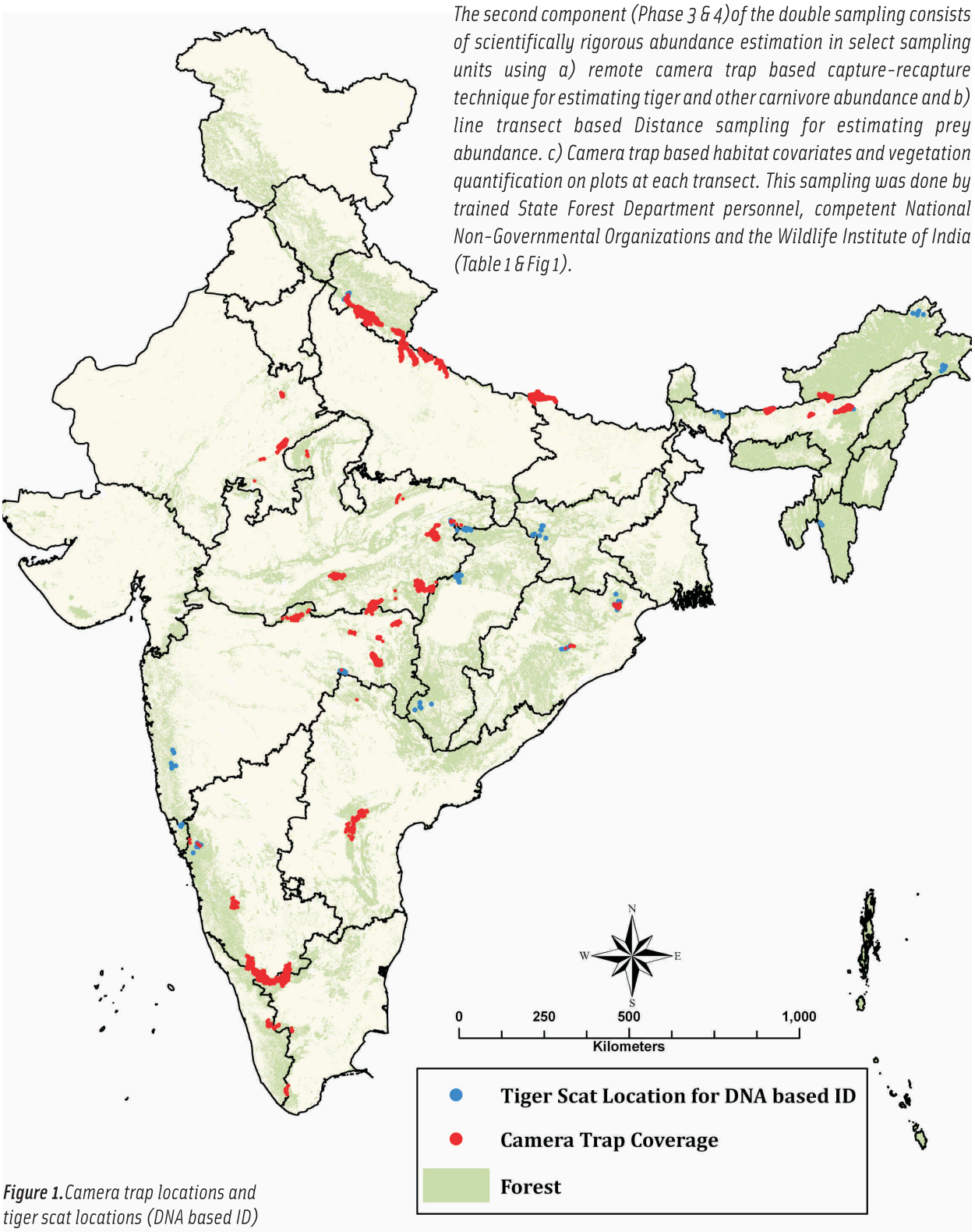


Figure 1. *Camera trap locations and tiger scat locations (DNA based ID) for population estimation.*

03 Data Analysis

Abundance Analysis: *Camera traps were placed in 9735 locations at 51 sites for mark recapture analysis (Table1, Fig1). Tiger photographs obtained from camera traps were digitized and analyzed using the program Extract-Compare, a pattern recognition program specially developed to individually identify tigers from their striped coat pattern. We used likelihood based spatially explicit capture-recapture (SECR) joint likelihood model to estimate tiger abundance. Tiger sign abundance, habitat characteristics, prey availability and human footprint variables obtained from the ground surveys and remotely sensed data were used within SECR as covariates to model tiger density in program R. Covariate based abundance models were developed for each landscape to estimate abundance within tiger occupied forests.*

Genetic Sampling: *At sites where it was not possible to undertake camera trapping due to very low tiger numbers or unfavourable law and order conditions, scat samples of carnivores were collected to estimate minimum number of tigers through genetic analysis. DNA was extracted from samples and then first screened for species identification using a tiger specific cytochrome-b marker that amplifies a 162 base pair fragment. Tiger positive samples were confirmed after samples were run along with a positive and negative control. Tiger positive samples were subsequently identified to individual tigers using a panel of 11 microsatellite markers. To minimize scoring errors, we repeated each marker multiple times and accepted an allele score only if it was amplified in minimum of three replicates. To test the reliability of our individual identification, we calculated the cumulative probability of identity of our marker panel, which is indicative of the power of the selected markers to differentiate between individuals in a population. Scoring of alleles were performed using software Geneious, further, to test the reliability of individual identification, we calculated the cumulative probability of identity of marker panel using GIMLET program. After accounting for scoring errors and the power of markers, individuals in each population were identified.*

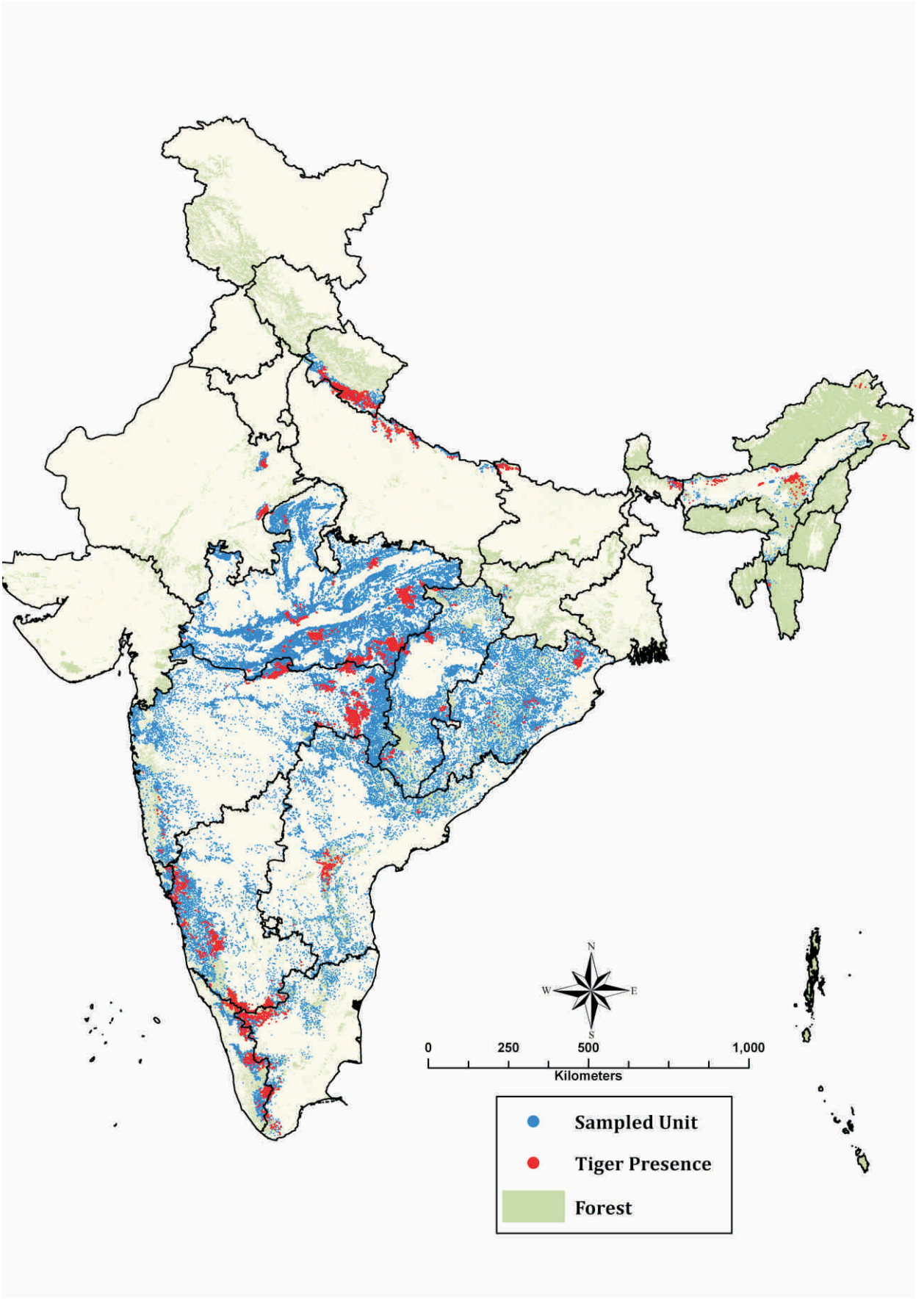
Maximum Entropy Models (MaxEnt): *In the states of Mizoram and Arunachal Pradesh except Pakke Tiger Resreve, we could not sample area with appropriate mark recapture method due to logistic constraints. In these states we used confirmed tiger presence locations from tiger scat (confirmed by DNA profile) and opportunistic camera trap photos to model suitable tiger habitat using program MaxEnt. Minimal tiger density obtained from individually identified tigers within small intensively searched areas was used to provide a crude estimate of tiger numbers in these states.*

Occupancy Analysis : *Data from replicate ground surveys (phase 1) were transferred to 10 x 10 km grids in a geographic information system. Occupancy of a grid by tigers was then modelled to address imperfect detection of tiger signs from spatially replicated surveys. This analysis helps in understanding spatial extent of tiger populations, and habitat connectivity between tiger populations.*

04 Results

A total of 3,78,118 km2 of forests in 18 tiger states were surveyed (Table 1, Fig. 2). An unprecedented effort was invested in camera trapping and scat collection of tigers across India (Fig. 1) by a combined effort of Tiger Reserves, NGO partners and WII resulting in a Photo Capture of 1686 tigers. A total of 419 scats from 12 sites across the country were used for genetic analysis, which yielded about 255 amplifiable scats. Out of these, 85 scats were confirmed to be that of tiger and were identified to 47 unique individuals. The country wide population was estimated to be 2226 (1945-2491).

Figure 2. *Spatial coverage of sampling units for tiger sign, ungulates encounters, habitat characteristics and human impacts. Sites where tiger signs were recorded is shown in red and provides an overview of tiger distribution in India.*



The total number of tigers (>1.5 years of age) estimated in India in 2014 was 2226 (1945 to 2491)

State	Tiger Population			Tiger km^2		
	2006	2010	2014	2006	2010	2014
Shivalik-Gangetic Plain Landscape Complex						
Uttarakhand	178 (161-195)	227 (199-256)	340 (299-381)	1,901	3,476	6,576
Uttar Pradesh	109 (91-127)	118 (113-124)	117 (103-131)	2,766	2,511	2,519
Bihar	10 (7-13)	8	28(25-31)	510	750	922
Shivalik-Gangetic	**297 (259-335)**	**353 (320-388)**	**485 (427-543)**	**5,177**	**6,737**	**10,017**
Central Indian Landscape Complex and Eastern Ghats Landscape Complex						
Andhra Pradesh	95 (84-107)	72 (65-79)	68 (58-78)	14,126	4,495	4,686
Chattisgarh	26 (23-28)	26 (24-27)	46 (39-53)*	3,609	3,514	4,735
Madhya Pradesh	300 (236-364)	257 (213-301)	308 (264-352)*	15,614	13,833	15,156
Maharashtra	103 (76-131)	168 (155-183)	190 (163-217)*	4,273	11,960	11,643
Odisha	45 (37-53)	32 (20-44)	28 (24-32)*	9,144	3,398	3,981
Rajasthan	32 (30-35)	36 (35-37)	45 (39-51)	356	637	1,147
Jharkhand	-	10 (6-14)	3*	1,488	1,180	626
Central India	**601 (486-718)**	**601 (518-685)**	**688 (596-780)**	**48,610**	**39,017**	**41,974**
Western Ghats Landscape Complex						
Karnataka	290 (241-339)	300 (280-320)	406 (360-452)	18,715	14,414	15,896
Kerala	46 (39-53)	71 (67-75)	136 (119-150)	6,168	6,804	7,735
Tamil Nadu	76 (56-95)	163 (153-173)	229 (201-253)	9,211	8,389	8,347
Goa	-	-	5*			533
Western Ghats	**402 (336-487)**	**534 (500-568)**	**776 (685-861)**	**34,094**	**29,607**	**32,511**
North Eastern Hills and Brahmaputra Flood Plains						
Assam	70 (60-80)	143 (113-173)	167 (150-184)	1,164	2,381	3,848
Arunachal Pradesh	14 (12-18)	-	28*	1,685	1,304	1,169
Mizoram	6 (4-8)	5	3*	785	416	100
Northern West Bengal	10 (8-12)	-	3*	596	799	704
North East Hills, and Brahmaputra	**100 (84-118)**	**148 (118-178)**	**201 (174-212)**	**4,230**	**4,900**	**5,821**
Sunderbans	-	**70 (64-90)**	**76 (62-96)**	**1,586**	**1,645**	**1,841**
TOTAL	**1,411 (1,165-1,657)**	**1,706 (1,507-1,896)**	**2,226 (1,945-2,491)**	**93,697**	**81,906**	**92,164**

* *From camera trap data and scat DNA*

Table 2 : *Estimated tiger numbers and area occupied by tigers in 2014 for landscapes and States compared with estimates for 2006 and 2010.*

05 Shivalik-Gangetic Plains Landscape

The state of Uttarakhand has shown a remarkable increase in population and occupancy. Bihar too has recorded a substantial improvement in tiger population. In Uttar Pradesh, Pilibhit Tiger Reserve and adjoining Uttarakhand have improved, while tiger status has showed a slight decline or remained unchanged in Uttar Pradesh terai. (Table 2, Fig 3).

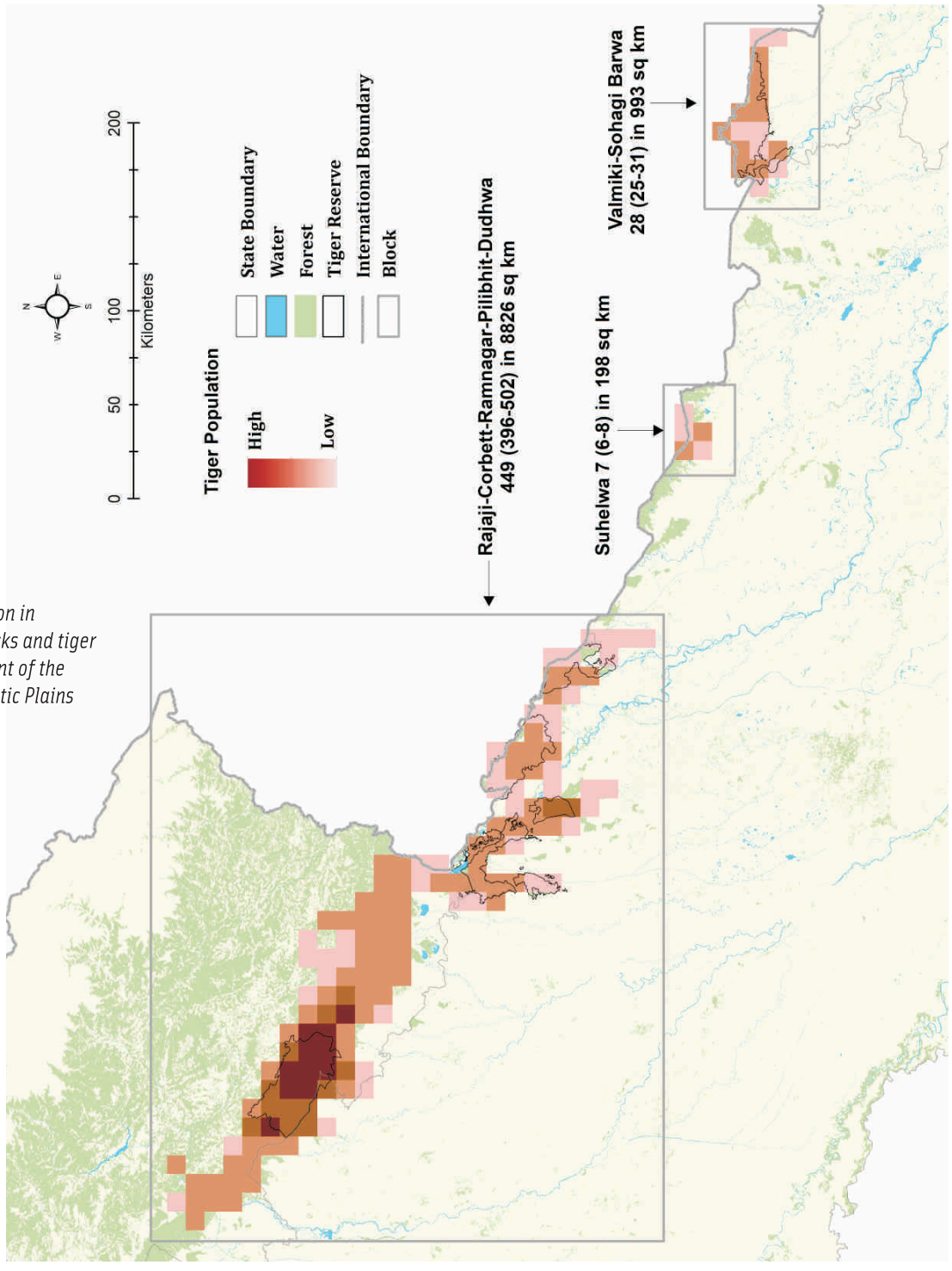


Fig 3. *population in landscape blocks and tiger density gradient of the Shivalik Gangetic Plains Landscape*

There are two significant populations in Uttar Pradesh i.e. Pilibhit & Dudhwa Tiger Reserves. Estimate of Suhelwa tiger population is likely an over estimate.

This landscape has recorded impressive gain in tiger occupancy of about 10,107 sq.km, most of which is contributed by Uttarakhand (Fig 4). Corbett Tiger Reserve has substantially contributed in recovery of tiger population in this landscape. It is crucial to maintain the corridor connectivity which in many areas is in precarious condition. It is equally important to have connectivity of Tiger Resreves of Uttar Pradesh and Bihar with forests in Nepal as in the many places it is not possible to have connectivities restored in Indian part. Any development such as border roads on either sides should be done with adoption of green infrastructure to avoid fragmentation. High human density, intensive agriculture, boulder mining and other developmental activities pose a challenge to tiger conservation. The tiger population west of Ganga in Uttarakhand has rapidly declined, with Dholkhand tiger population in Rajaji National Park on verge of local extinction. Urgent plan and attention is needed to reintroduce tigers in western part of Rajaji national park. It is also crucial to develop plans to deal with human-tiger conflict in this landscape.

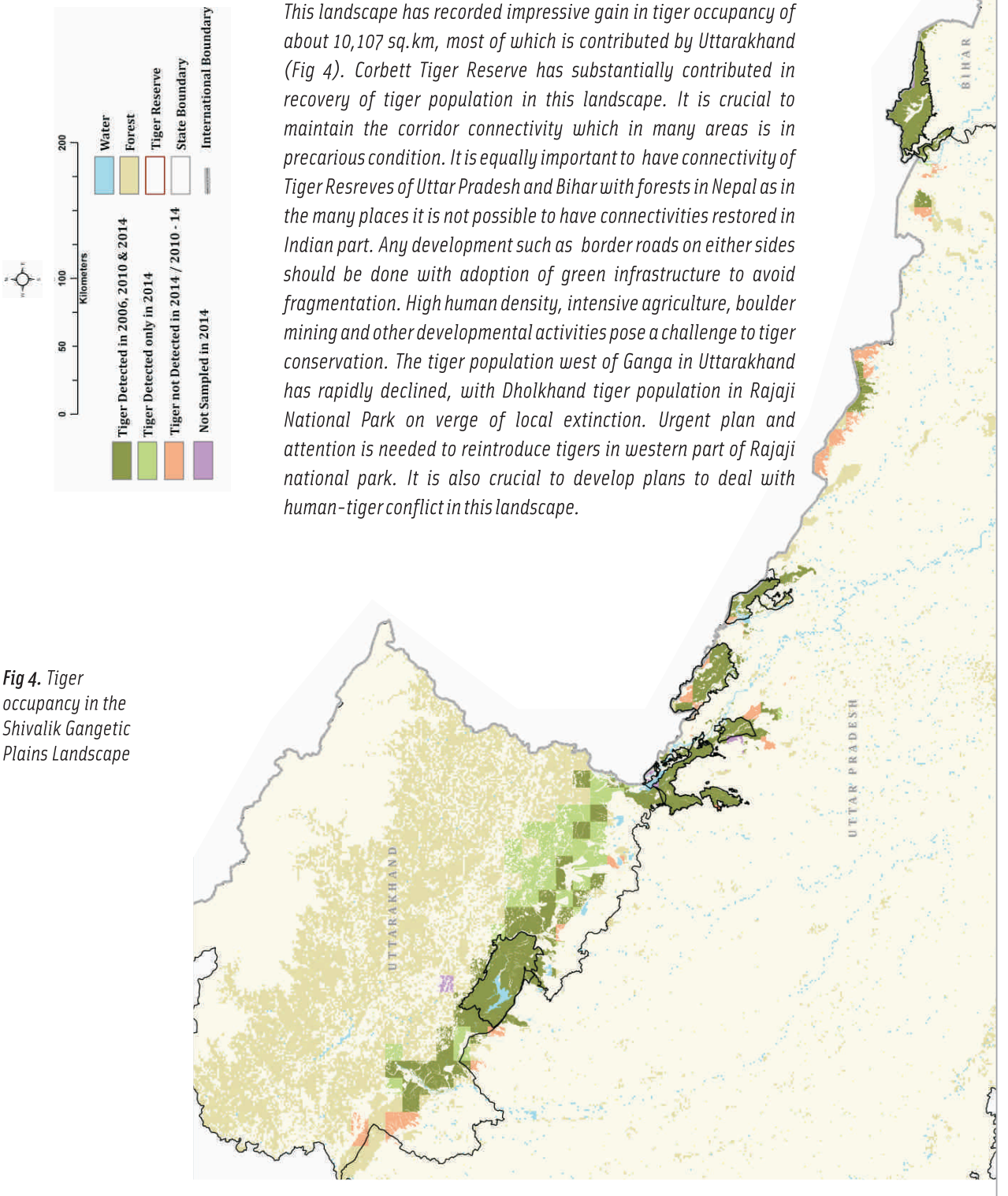


Fig 4. *Tiger occupancy in the Shivalik Gangetic Plains Landscape*

06 Central Indian & Eastern Ghats Landscape Complex

Tiger occupies 41974 sq km area with 688(596-780) individuals in this landscape. Increase was registered in and around tiger reserves where existing habitat contiguity has permitted dispersing tigers to establish territories and reproduce (Fig 5 & Fig 6) . Notable improvements are observed in the state of Madhya Pradesh, while tiger populations of Maharashtra and Rajasthan have marginally increased. However northern Andhra Pradesh, most parts of Odisha and Jharkhand continue to lose tiger habitat and tiger abundance has declined (Fig. 5).

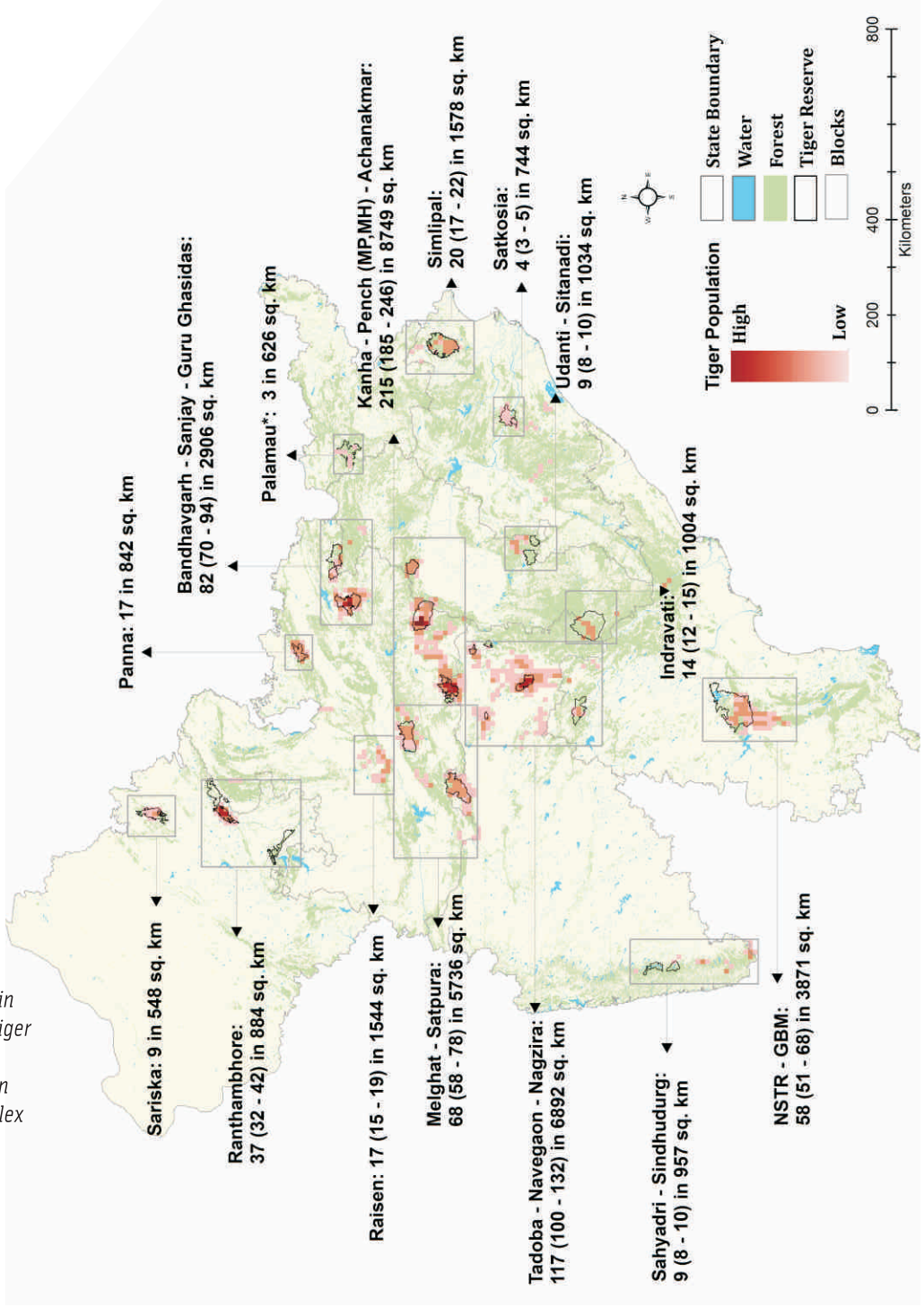


Fig 5. *Tiger population in landscape blocks and tiger density gradient of the Central Indian & Eastern Ghats Landscape Complex*

Chhattisgarh has shown an increase, but this is due to a commendable effort in surveying parts of Indravati Tiger Reserve which was assessed for the first time in 12 years by sign surveys and genetic sampling. This landscape has four significant populations namely Kanha-Pench, Tadoba-Navegaon-Nagzira, Bandhavgarh& Nagarjunasagar. All these populations have crucial corridor connectivity for gene flow but face challenges due to developmental projects like road widening and mining. It is vital and urgent to secure these corridors by adopting better mitigation measures. Simlipal harbours unique population of black tigers and faces challenges due to immense human pressure. This population requires urgent attention as it has shown decline. The places where tiger population can be augmented are Sanjay Dubri, Guru Ghasidas, Palamau, Satkosia and Udanti-Sitanadi Tiger Reserves. Sahyadri-Sindhudurg part of Western Ghats in Maharashtra is showing encouraging trends in tiger occupancy and is contiguous with Goa and Karnataka. Madhya Pradesh has done commendable work in relocating villages to restore habitat as well as providing special attention to the existing corridors. Madhya Pradesh has also successfully experimented with translocation of large herbivores like gaur and barasingha. Due to fragmented nature of Central Indian Landscape corridors are key to the future of tiger survival.

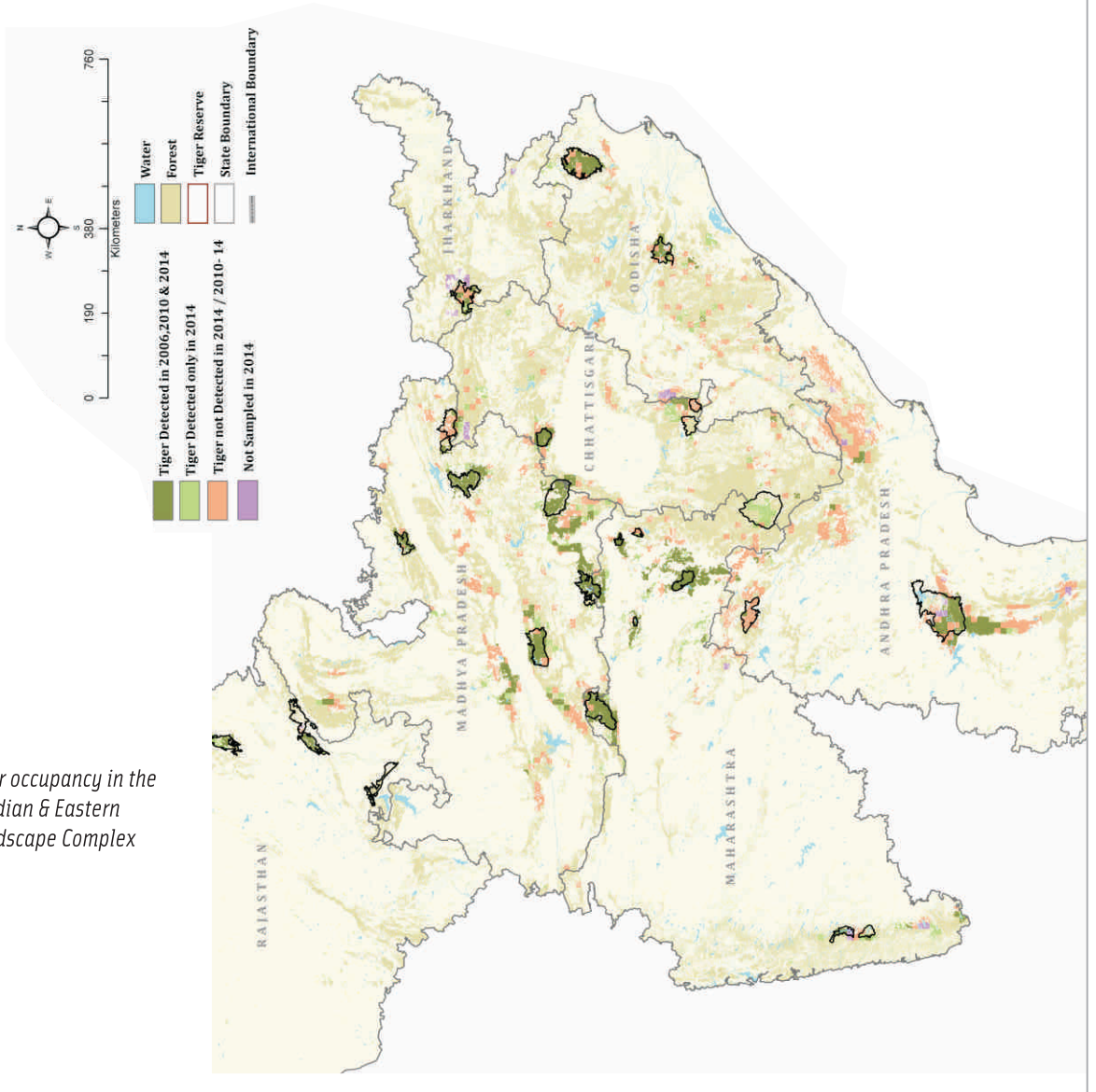


Fig 6. *Tiger occupancy in the Central Indian & Eastern Ghats Landscape Complex*

07 Western Ghats Landscape

Tiger population and occupancy has shown a substantial increase within this landscape. (Table 2, Fig. 7). The landscape has recorded occupancy of tigers in 32511 sq. km (Fig. 8.). States of Karnataka, Kerala and Tamil Nadu have all registered an increase in tiger abundance. Goa now has a persistent tiger presence with about 3-5 tigers. The Nagarhole-Bandipur-Mudumalai-Wayanad-BRT-Satyamangalam complex holds the world's single largest tiger population currently estimated at over 585 tigers and largest tiger occupied landscape block (12,814 km^2) in

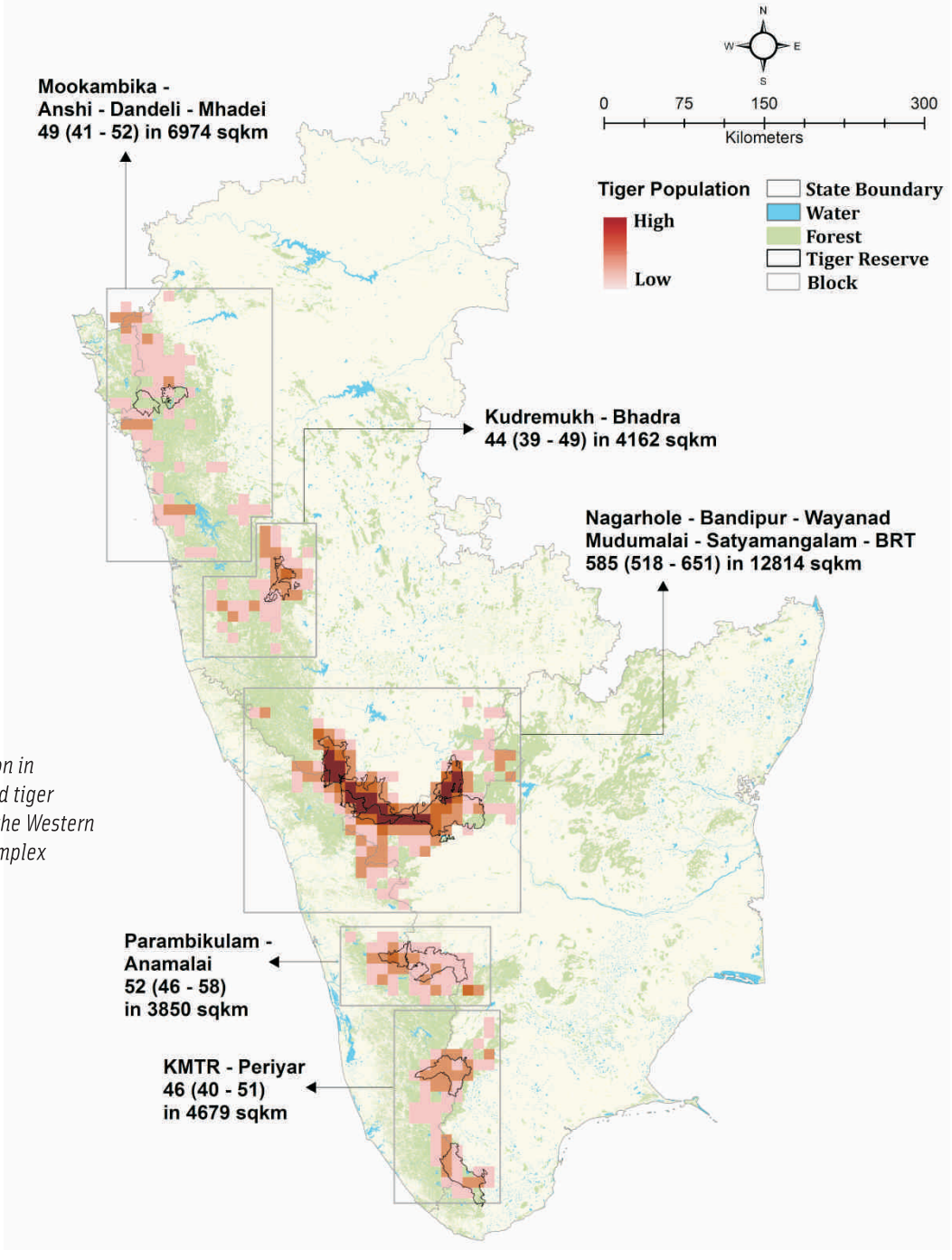


Fig 7. *Tiger population in landscape blocks and tiger density gradient of the Western Ghats Landscape Complex*

the country. The other important populations are Parambikulam, Periyar and Bhadra Tiger Reserves. In Western Ghats Landscape. Western Ghats terrain provides excellent connectivity and tigers have spread over most of the landscape. The Sahyadri Tiger Reserve has 7 tigers (based on scat DNA) which is although part of Westren Ghats Landscape is accounted for in Maharasthra (Central Indian Landscape). The Connectivity between populations are threatened by infrastructure development, plantations and industrialization and require ecologically sensitive developmental planning. Karnataka has done exemplary work in the relocation of villages from tiger reserves which has improved tiger habitat.

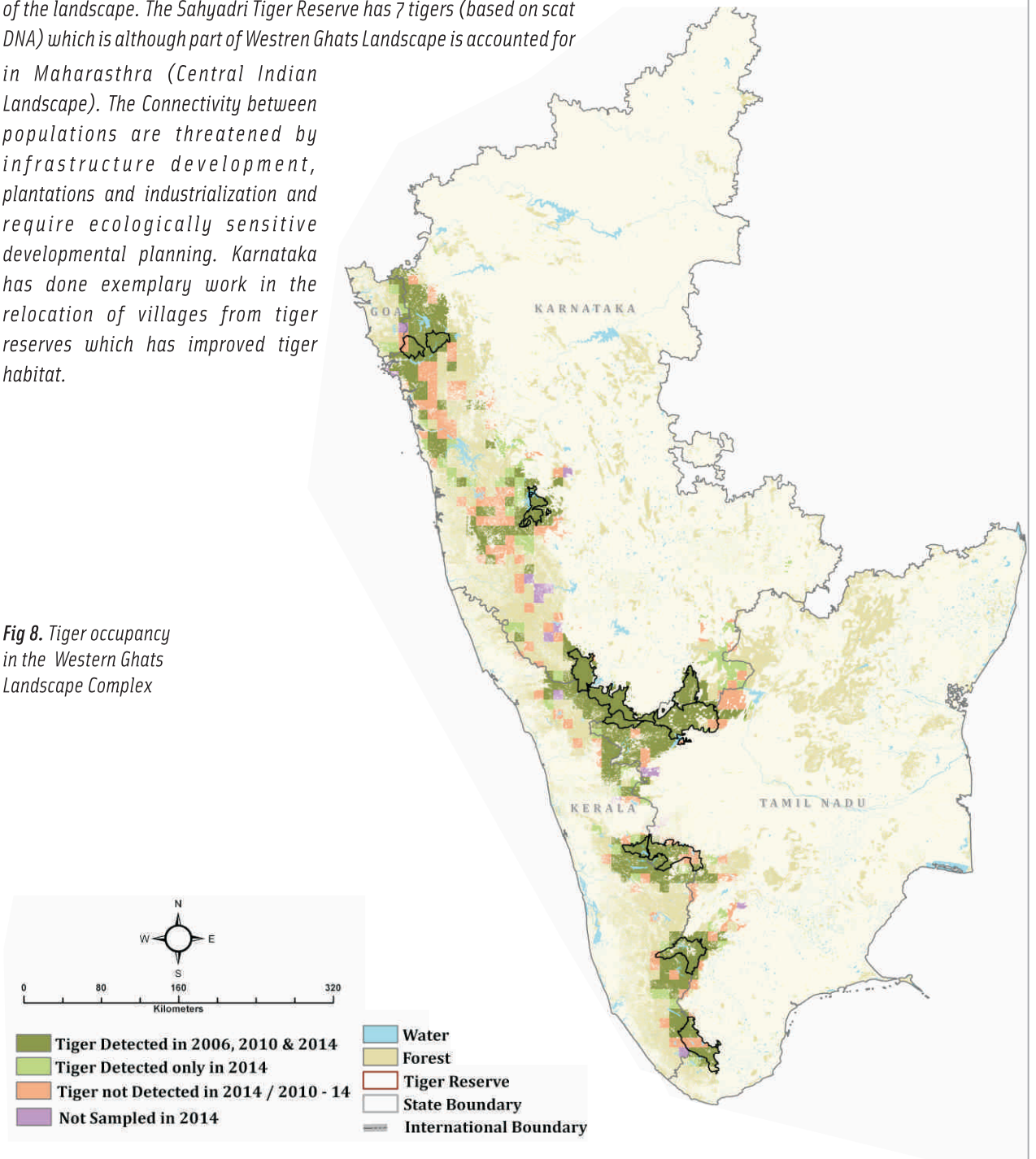


Fig 8. *Tiger occupancy in the Western Ghats Landscape Complex*

08 North Easteran Hills and Brahmaputra Flood Plains

Tiger population status has shown improvement in the State of Assam with Kaziranga having the maximum number of tigers in the landscape(Table 2, Fig. 10 & fig. 11). Evidence of tiger occurrence in the Karbi-Anglong (Assam), Dibang valley and Namdapha Tiger Reserve (Arunachal Pradesh) are encouraging. On the basis of genetic sampling minimum 5 tigers were recorded in Dibang valley and 4 tigers in Namdapha, Tiger Reserve, based on this count within search area density was estimated to be 0.77(SE 0.1) tiger/100 sq km. Extrapolating this density to tiger habitat estimated by MaxEnt gave a potential tiger population of about 17 in

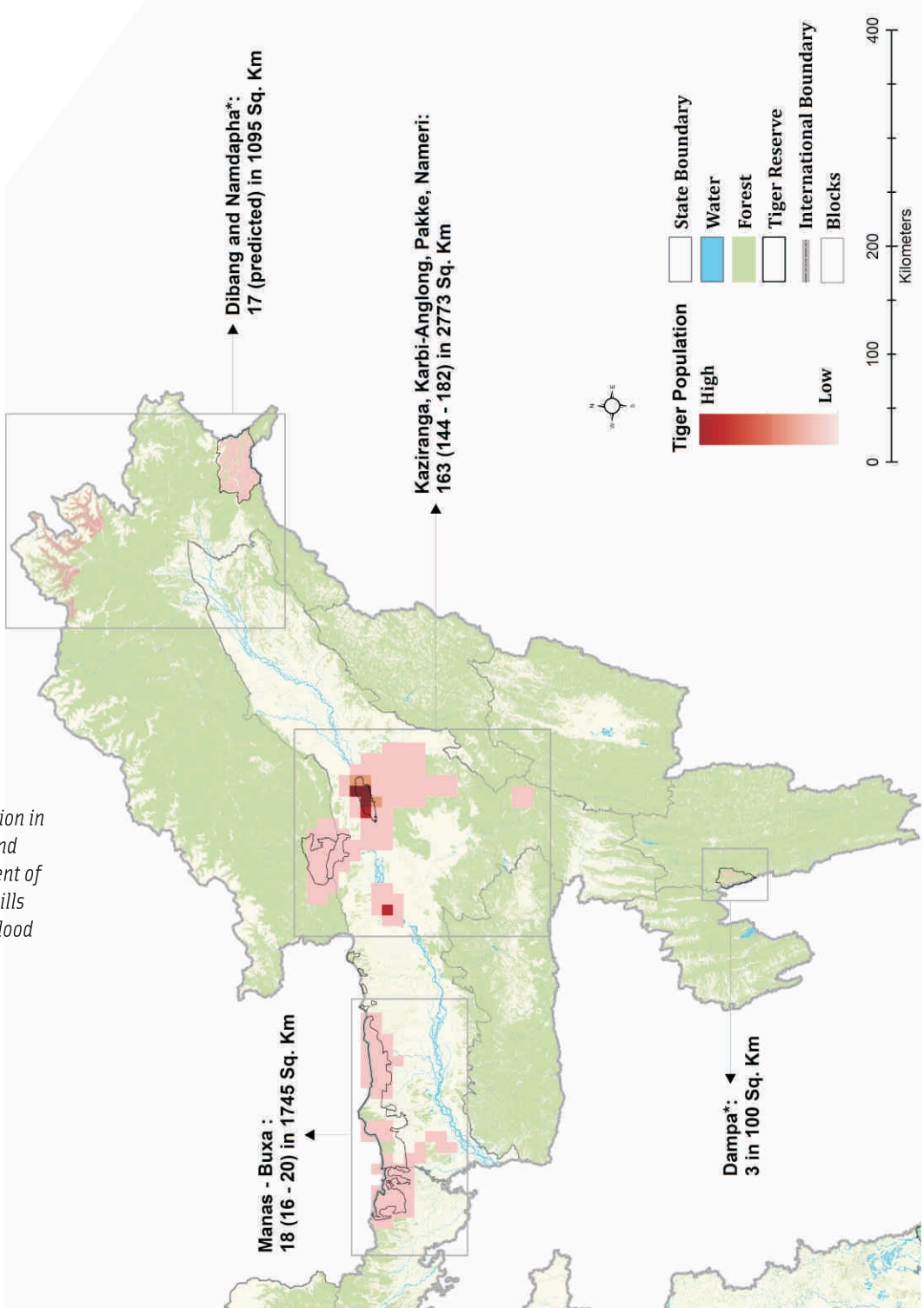


Fig 9. *Tiger population in landscape blocks and tiger density gradient of the North Eastern Hills and Brahmaputra Flood Plains*

Namdapha and Dibang landscape block. Kaziranga landscape (2773 sq km) holds 163 tigers and is one of the most important conservation unit not only for tigers but also for one horned rhinoceros, barasingha, wild buffalo, pygmy hog and Bengal florican. This area is connected with Karbi-Anglong in south, Nameri in the north and Orang on its west. Kaziranga gets flooded every year by Brahmaputra and Karbi hills provide an important refuge. It is crucial to manage traffic on the highway passing through Kaziranga by using green infrastructure and modern technology. Namdapha has remained a low density area, while Dibang has recently recorded breeding females. Two tigers were identified in Buxa on the basis of scat based DNA. Our research team has found no tiger sign in Buxa. The Buxa tiger population is declining and needs special attention. The other important populations in this landscape are Pakke in Arunachal Pradesh, Nameri and Manas in Assam, all these populations are low density areas and are potential sites needing support and assistance for better conservation.

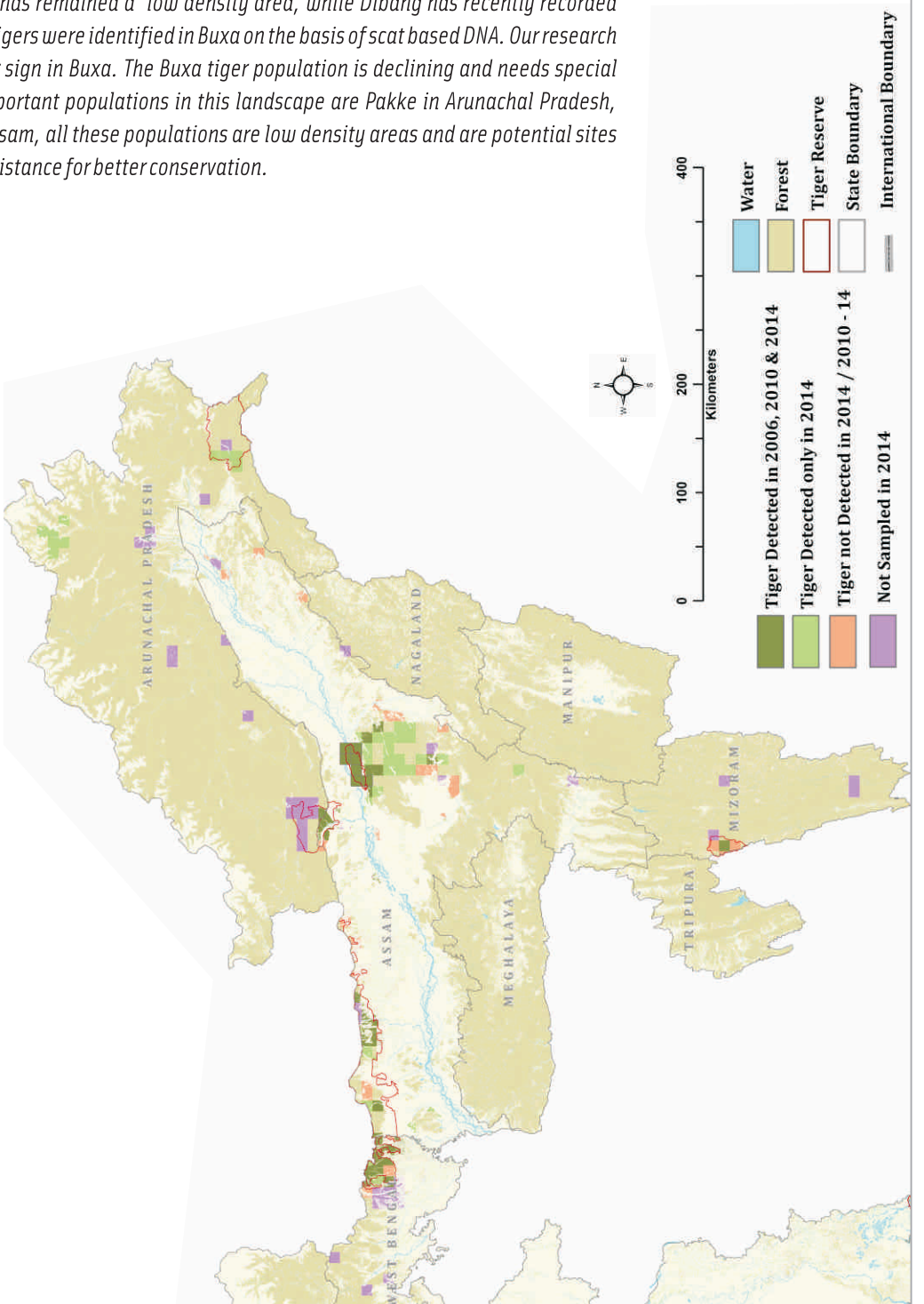
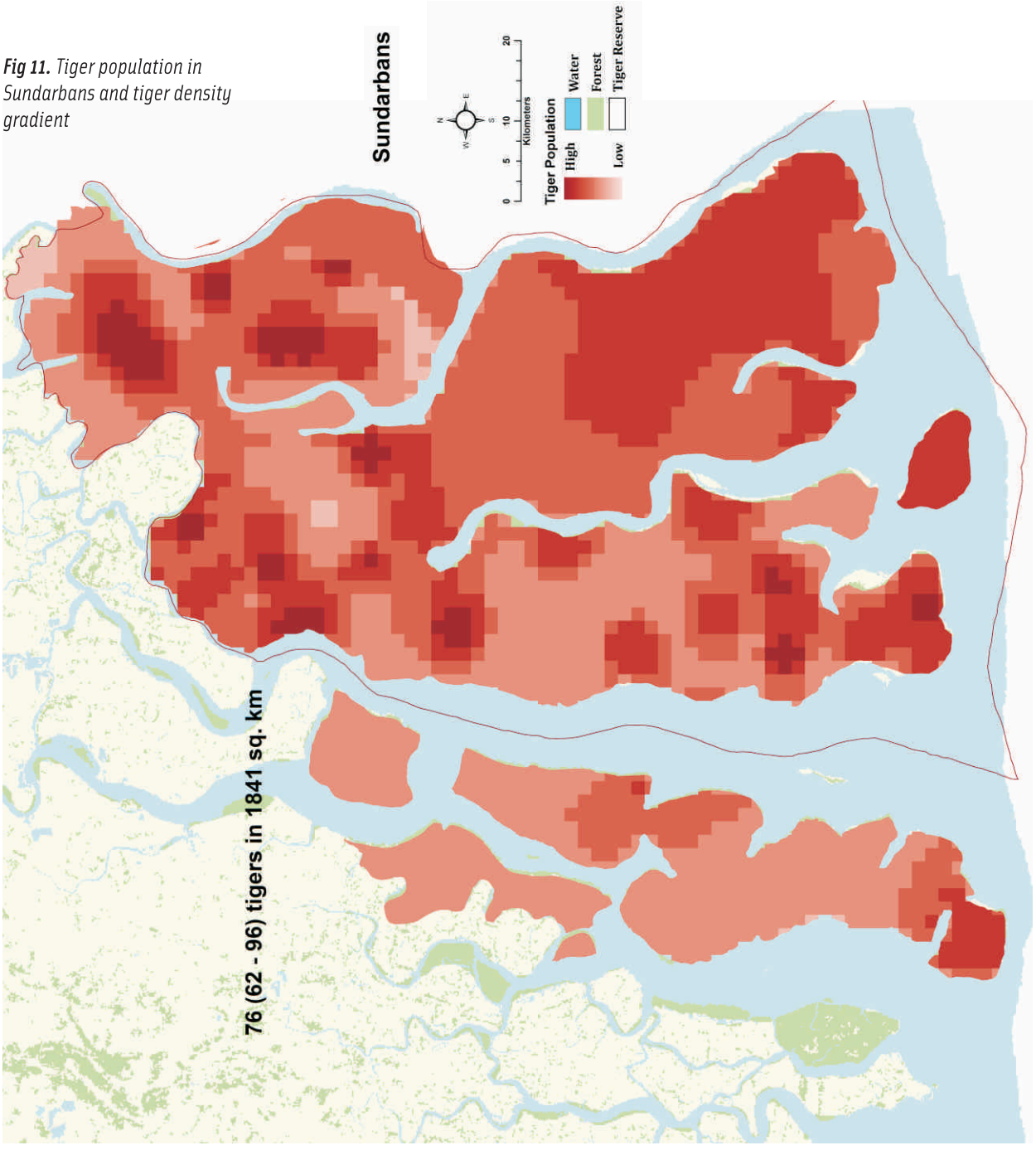


Fig 10. *Tiger occupancy in the North Eastern Hills and Brahmaputra Flood Plains*

09 Sundarbans

Tiger population in the Sundarbans has remained stable and is estimated to be about 76 (62 to 96) tigers (Fig. 9). Major part of the Sundarbans has now been camera trapped. The Indian Sundarbans are contiguous with the Bangladesh, together they form an important population of high conservation significance. Both countries have to ensure that the tiger habitat connectivity will be secured for long term survival of these unique tigers.

Fig 11. *Tiger population in Sundarbans and tiger density gradient*



Conclusions 10

An unprecedented effort of camera trapping and field surveys across tiger occupied habitats was undertaken for this assessment . This effort has resulted in the photo-capture of 1686 individual tigers, constituting over 75% of the total estimated population of 2226 tigers. Currently 921,164 sq km of forest has been occupied by tiger, recording an 11% increase in occupancy. Tiger populations have increased in several states. Notable amongst these are the states of Uttrakhand, Karnataka, Tamil Nadu, Kerala and Madhya Pradesh. There are 6 populations which are sufficiently large enough to hold a self sustaining population, these are, Nagarhole-Bandipur-Wayanad-Mudumalai-BRT-Styamangalam, Corbett-Dudhwa, Kanha-Pench, Tadoba-Navegaon-Nagzira, Kaziranga-Pakke and Sunderbans. However all populations depend on intervening corridors and surrounding reserve forests for continued survival.

It is now clear from three cycles of country wide assessment that tiger populations, indicative of intact functioning ecosystems, respond well to reduction in human pressures, protection, prey availability and habitat restoration. Strong political will, commitment to conservation by wildlife managers and improved protection have paid dividends.

Areas where there is a potential to further increase tiger populations are Sanjay-Guru Ghasidas landscape shared by Madhya Pradesh and Chhattisgarh, Kawal and Srisailam Tiger Reserve in Andhra Pradesh and Telangana, Simlipal and Satkosia Tiger Reserves in Odisha, Manas Tiger Reserve in Assam, Buxa Tiger Reserve in West Bengal, Palamau Tiger Reserve in Jharkhand, Achanakmar and Indravati Tiger reserves in Chhattisgarh. These Protected Areas would benefit from conservation inputs that would restore habitat, prey populations and in extreme cases supplementation of tigers.

Future of tigers in India depends on maintaining inviolate core habitats for breeding tiger populations, habitat connectivity for genetic exchange and protection from poaching of tigers and their prey.

11 Training & Research teams

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Wildlife Institute of India Team:

Dr. V.B. Mathur, Director, Dr. P.K. Mathur, Dean and Dr. K. Shankar, Research Coordinator are acknowledged for support and facilitation.

Faculties involved in Phase I training: *Dr. K. Sankar, Dr. S. A. Hussain, Dr. Bivash Pandav, Dr. Aseem Srivastava, Dr. Gopi G.V., Dr. P. Pal, Dr. Bilal Habib, Shri Salvador Lynghdoh, Shri Qamar Qureshi, Dr. Y. V. Jhala.*

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मा वनं छिन्धि सव्याघ्रं मा व्याघ्राः नीनशन् वनात्।
वनं हि रक्ष्यते व्याघ्रैः व्याघ्रान् रक्षति काननम्।।
(महाभारत)

"Don't destroy the forest where tigers live. Without the forests, there is no existence of tigers. Forest is protected by the tiger and the forest too protects the tiger!"
(The Mahabharat)

सत्यमेव जयते

प्रकृतिः रक्षति रक्षितः
Nature Protects if She is Protected

National Tiger Conservation Authority
राष्ट्रीय व्याघ्र संरक्षण प्राधिकरण

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