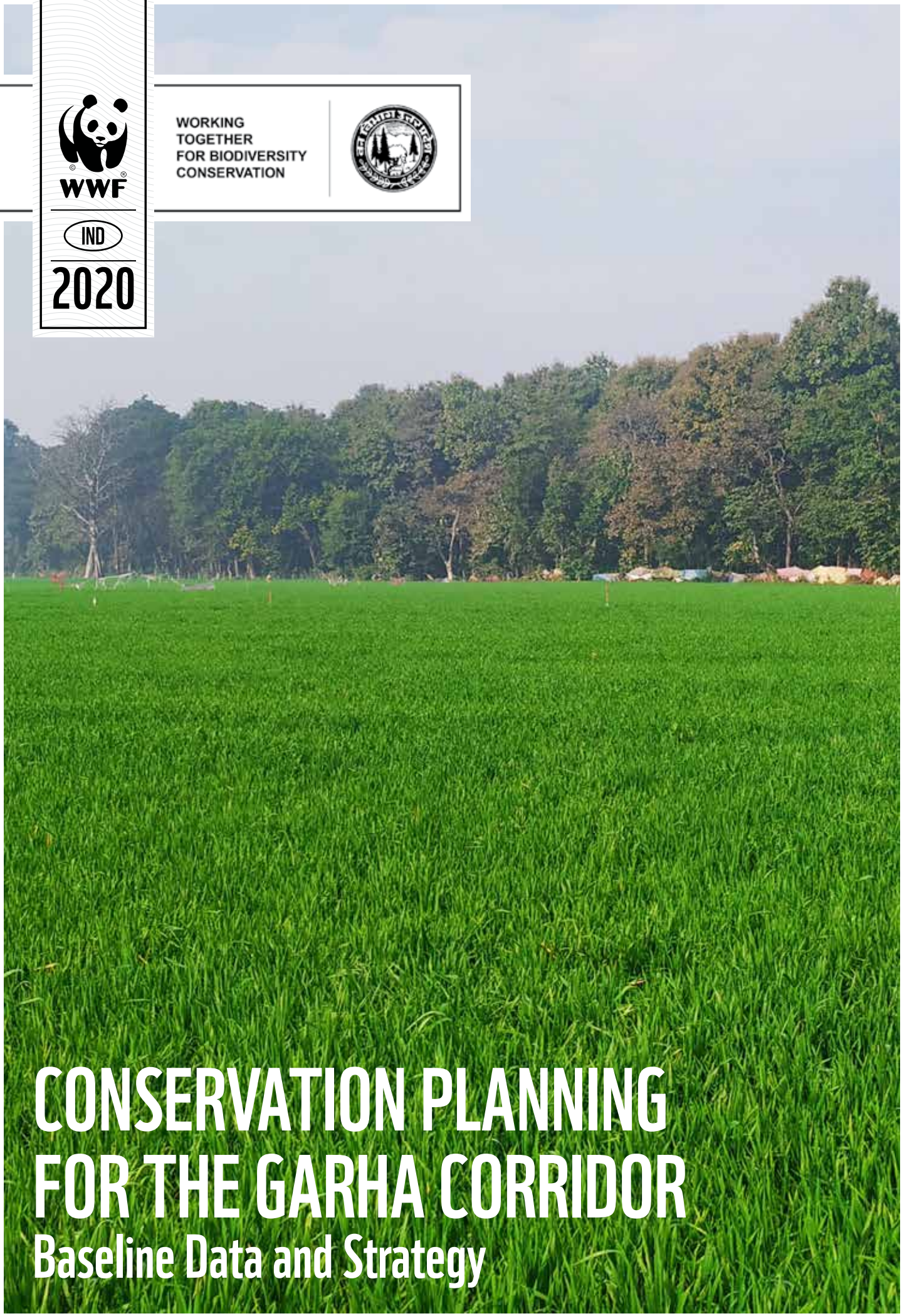
WWF

IND

2020

WORKING TOGETHER FOR BIODIVERSITY CONSERVATION



CONSERVATION PLANNING FOR THE GARHA CORRIDOR

Baseline Data and Strategy

Report written and compiled by Ashish Bista & Pranav Chanchani
Field work (contributors to the report)- Ashish Bista, Pranav Chanchani & Rohit Ravi
Administrative support- Adarsh Kumar (IFS), Naveen Khandelwal (IFS) & H Raja Mohan (IFS)
Logistic support- Naresh Lodhi & Mudit Gupta

Citation
Bista, A., Chanchani, P., Ravi, R., Lodhi, N., Gupta, M., Kumar, A., Khandelwal, N. and Mohan, H. R (2020) *Conservation planning for the Garha corridor: Baseline data and strategy*. Uttar Pradesh Forest Department and World Wide for Nature-India.

CONSERVATION PLANNING FOR THE GARHA CORRIDOR

Baseline Data and Strategy

FOREWORD

Maintaining functional connectivity between habitat patches is mandatory for long term survival of large mammal populations in a given landscape. In fragmented landscapes like the *Terai* in Uttar Pradesh, tiger populations primarily inhabit relatively isolated Protected Areas. Therefore, it is imperative that measures be taken to maintain habitat connectivity within this landscape that allows for dispersal of tigers within and between Pilibhit Tiger Reserve and Dudhwa Tiger Reserve, and adjacent forested habitats.

Various wildlife corridors in Uttar Pradesh are beyond forest boundaries and they comprise of agricultural areas where sugarcane, wheat, and other crops are cultivated. This presents both opportunities and challenges. The opportunity is that with appropriate conservation planning, and community support, this landscape can be managed, so as to keep it permeable for wildlife movement, in the forest – agriculture mosaic. The challenge is to ensure that wildlife should be able to disperse safely in these mosaics.

This report, based on long term studies conducted by WWF India, focuses on wildlife status, land-use, and potential conservation actions for the Garha corridor. This corridor forms the critical connection between the Garha and Lalpur blocks of Mala Range of Pilibhit Tiger Reserve. At its narrowest, this gap in forest cover is 1.5 km, and this space has human settlements and farmlands that are routinely used by wildlife. The report recommends that government-owned land in the corridor, including the wetlands and swampy areas, need to be managed to enhance connectivity.

This report provides essential background information and strategies for restoration of this critical corridor. These measures will help in dispersal of tigers and may also reduce human-carnivore conflict around Pilibhit Tiger Reserve by extending contiguous habitats within the Reserve.

Mr. Sunil Kumar Pandey, IFS

Chief Wildlife Warden, Uttar Pradesh

FOREWORD

This report has been prepared with an aim to secure the Garha corridor, one of the critical connectivity patches within the Terai Arc Landscape. The Garha corridor connects two critical portions of the Pilibhit Tiger Reserve, comprising Mala, Mahof, Barahi, and Haripur ranges with the Deoria block comprising the Lalpur and Ghunghchai part of the Mala range and the entire Deoria range within the same reserve.

The authors have summarised information generated from long-term tiger monitoring exercises conducted between 2011 and 2017 in the Pilibhit Tiger Reserve and surveys undertaken to identify the status of government-owned land in the Garha corridor. The report shows evidence of tiger dispersal from Pilibhit's northern forest ranges to the Deoria patch and indicates the functionality of this corridor. Recommendations to secure this corridor include approaches as a declaration of Eco-Sensitive Zone, working with Gram Sabhas and district administration to regulate land-use change and managing about 100 ha of land for afforestation through community involvement.

This work has been accomplished with substantial efforts put by the officers and field staff of Pilibhit Tiger Reserve and field teams of WWF India. I would like to offer sincere thanks to the senior officials of the Uttar Pradesh Forest Department, institutions, partner NGOs, and individuals who made this work possible. I hope this report will be useful for the restoration of one of the critical corridors in the Terai Arc Landscape.

Mr. Ravi Singh
SG & CEO
WWF India

CONTENTS

ACKNOWLEDGMENT

We express our gratitude to Mr. Sunil Pandey, the Chief Wildlife Warden of Uttar Pradesh, and Mr. Ravi Singh, SG & CEO of WWF-India, for extending their support and interest on the conservation of the Garha corridor. We want to extend our heartfelt appreciation to Ms. Sheetal Verma (IAS), the District Magistrate of Pilibhit District, who facilitated a land-use survey in the Garha farmland.

This document is an outcome of a long-term monitoring exercise that required intensive camera trapping and line transect survey in the Pilibhit TR. Such a programme would not have been possible without the dedication and field support of forest officials of the reserve. Foremost, we would like to thank Mr. V K. Singh (IFS), who encouraged us to develop a restoration plan of this corridor. Subsequently, we would like to thank Mr. Rajiv Mishra (IFS) and Mr. Kailash Prakash (IFS) for their kind support in carrying out field surveys in reserve. We are also thankful to the Range Officers of Mala and Deoria ranges for their valuable support.

Several field staffs (working as foresters, forest guards, and watchers) worked tirelessly to undertake camera trapping exercise and line transect surveys. We are also thankful to the lekhpal who assisted in the land-use survey in Damgarhi Miyunai and Lalpur T Madho Tanda villages.

In WWF India, the efforts of Mr. Kamlesh K Maurya (Landscape Coordinator, TAL Bihar) is highly appreciated. Likewise, Mr. Kandhai Lal has put immense effort into carrying out camera trapping and line-transect surveys, and land mapping exercise. His hard work in data collection has been instrumental in framing this corridor document. We also acknowledge Mr. Anil K Srivastava.

Special thanks to Dr. Sejal Worah (Programme Director) and Dr. Dipankar Ghose (Director, Wildlife and Habitats) and Dr. Anil Kumar Singh (Team Leader, Terai Arc Landscape) for their support.

SUMMARY

Linking isolated forest patches through creation and maintenance of biological corridors is seen as one of the most crucial steps toward conserving populations of endangered large mammals such as the tiger (*Panthera tigris*). Presently several tiger populations in the state of Uttar Pradesh have shrunk, and face many threats, in part because of increasing fragmentation and isolation of their habitats. Uttar Pradesh's most significant tiger population exists in the Pilibhit Tiger Reserve (PTR). Even here, historic habitat fragmentation has impacted the species. The 200 sq. km "Deoria patch" comprises the Deoria range and parts of the Mala range of PTR. It is separated from the Pilibhit "main forest", which consists of the rest of Mala range, Mahof, Barahi and Haripur Ranges (which are also connected with other divisions in Uttarakhand, UP and Nepal). The Garha gap is made up of a mosaic of farmlands and settlements and is bisected by various roads, a state highway and a major canal.

Almost 5 years of population monitoring in PTR (previously Pilibhit Forest Division) and intermittent corridor monitoring has established that the break in connectivity between these two patches has resulted in a depressed tiger population with unstable dynamics in the Deoria patch, and has lowered the overall potential in Pilibhit Tiger Reserve to support tigers. In this context, this report presents information on a) status of tiger and prey with a focus on the Deoria patch, b) dispersal of tigers among the Deoria patch and the other forests of PTR, and use of farmlands in the corridor by herbivores, and c) identifying key barriers to animal movement in the corridor, and detailing land use by communities residing in this corridor.

Four years of multi-year camera-trap data from surveys in the 2011 - 2017 period reveal that abundance estimate ($\hat{N}$) of tigers in PTR varied between 23 (95% CI 23-28) in 2013 and 38 (95% CI 38-40) in 2017, with the highest number of unique tigers photographed in the Deoria patch in any year being three. Furthermore, 45 line transects sampled across the PTR in the year 2014 revealed that the ungulate density of six herbivores (chital, hogdeer, nilgai, barking deer, wild boar and swamp deer) was 49 animals/sq. km (CV 15.8%) in the Pilibhit forests, excluding Deoria. 32.2 animals/sq. km (CV 28.6%) was the ungulate density estimated in the Deoria patch with eight transects (136 km sampling effort). The Deoria patch thus has sufficiently high prey densities to support several tigers- even though prey densities here are lower than in the other ranges. Nilgai was the most commonly detected ungulate in the Deoria patch.

The high turnover and dispersal of tigers into the Deoria patch (according to 2011 – 2017 camera trap data) makes it evident that the corridor is still functional. Camera traps deployed in 2019 in farmlands within the corridor photo-captured two tigers in the corridor over a 3-month duration. However, sparse use of the patch by tigers, and high probability of local extinction underlines the need for better connectivity and securing dispersal routes for tigers.

There are various impediments to animal movement within the corridor. High traffic volume on the National Highway (NH 730) disrupts the corridor and the lights and noise of vehicular traffic may deter wildlife from approaching it. Scattered human settlements like homesteads, some with high walls or fences, are also obstructions.

While animals can potentially move through many parts of the agricultural matrix between Pilibhit main forest and Deoria patch, areas considered to be the most permeable lay within the

shortest straight-line distance between the two patches, passing through the Damgarhi Miyuna and Lalpur T MadhoTanda villages. Given low housing density, there are still opportunities for animal movement through crop fields. A detailed ground assessment of land records of these two villages revealed that the Gram Sabha owns over 7 hectares in various parcels of land in these villages, including nalas, ponds, rasta (mud roads) and chakroad (metal roads). About 4 hectares of this land has been converted to farmland.

We identify strategies to manage the Garha corridor to ensure it remains permeable to animal movement - through a combination of regulations, habitat restoration and mitigation for key barriers and partnerships with local communities.

SECTION-1

INTRODUCTION

Background

A key conservation goal in the Terai Arc Landscape (TAL), which extends from Bagmati river in the east (Nepal) to Yamuna river in the west (India), is to ensure functional connectivity between forest patches in order to facilitate dispersal and animal movement between wildlife reserves and other habitats, particularly for wide ranging species including tigers, rhinos and elephants. The forests of this region have been severely depleted and fragmented over the past 150 years (Strahorn 2009). The Terai is a unique eco-region which supports diverse floral and faunal assemblages including a number of endangered mammals (Mathur et al. 2011). However, the remaining population of charismatic mammals that include tigers, rhinos and elephants in the Terai now persist only in a few forest fragments. Despite creation of numerous protected areas in the Terai and Bhabhar tracts of the TAL of India and Nepal, large mammals occur in relatively low numbers in several sites, and their growth may be impeded by patch isolation and habitat fragmentation.

While the tiger population in Pilibhit Tiger Reserve is notably large, with 15 or more breeding age females, the discontinuity of the 200 km2 Deoria forest block (nearly 30% of the tiger reserve's overall area) is a major challenge. A point that needs to be noted is that, this patch supports very low tiger densities (<1 tiger/100 km2), possibly because of habitat fragmentation. At its narrowest, the distance between the Pilibhit main forest and Deoria block is 1.5 km. Although areas lying in this gap are largely under agriculture (sugarcane, wheat and rice cultivation), this gap also contains numerous homesteads, scattered villages and provincial towns all connected by roads and state highways. Other human modifications of the landscape

in the 'gap' area include canals, and a British-era narrow gauge railway line that is still in use and being upgraded to a broad-gauge line. Fences and other barriers around homes and farmlands all have the potential to restrict animal movement, and change in future land use could increasingly render this agricultural corridor impermeable to animal movement. Foresight and planning are required to ensure both functional connectivity for wildlife and harmonious associations between humans and wildlife in this region.

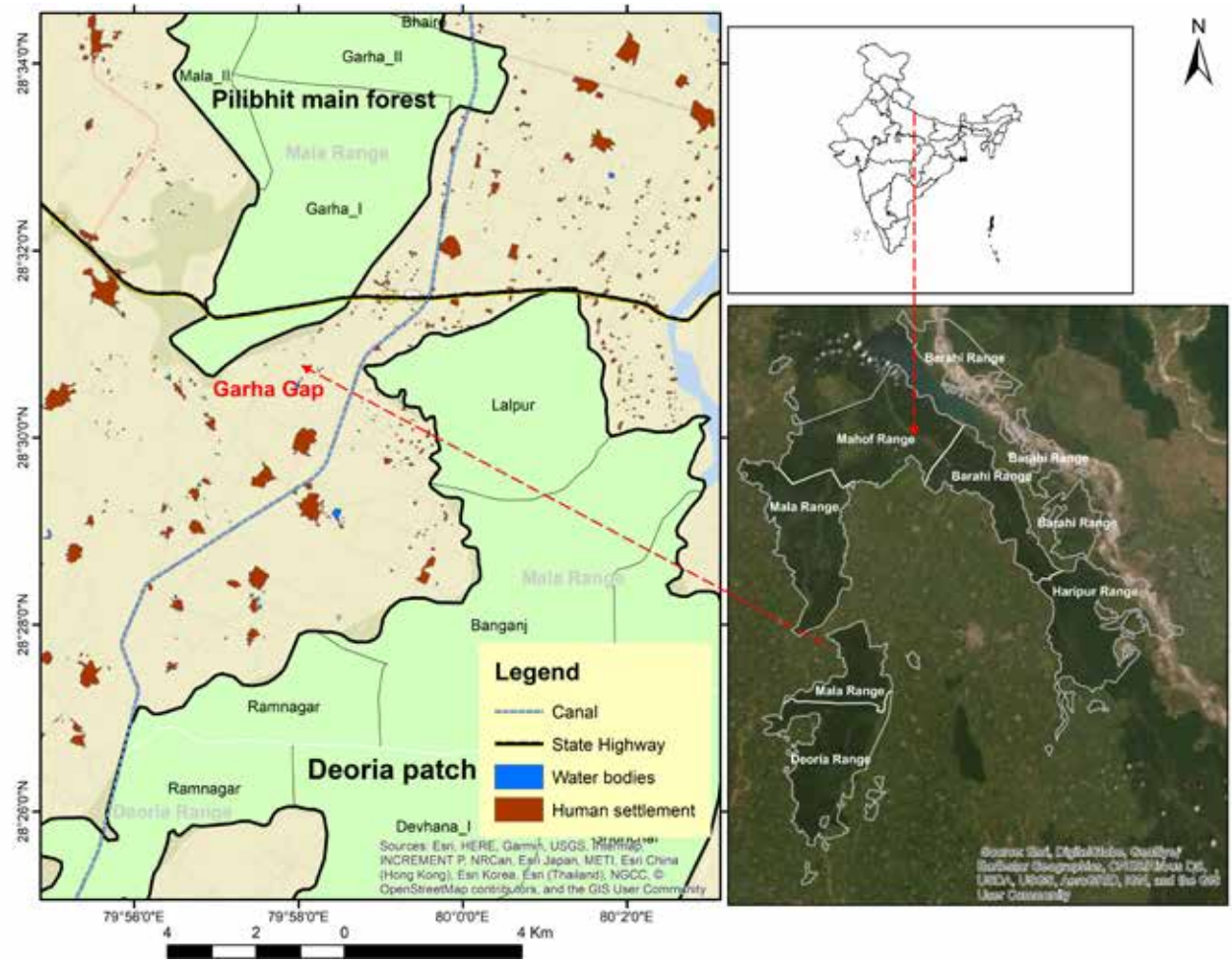


Figure 1: Garha gap lying between Pilibhit main forest and Deoria patch in Pilibhit Tiger Reserve, Uttar Pradesh

Significance of the Garha gap as a wildlife corridor

The Garha gap separates the major (500 km2) portion of the Pilibhit Tiger Reserve (comprising Mala, Mahof, Barahi, and Haripur ranges) from the Deoria block. Administratively, the Deoria block consists of the Lalpur and Ghunghchai part of Mala range and the entire Deoria range (Fig 1). The isolated Deoria block is associated with both low tiger occupancy and density, in comparison to the remaining areas of the Pilibhit forest complex (spanning four ranges) that supports a tiger density of about 4/100 km2 and wild prey (~40/km2) (Chanchani et al. 2014; Bista 2011). Given that this area has varied habitats, including grasslands, and ample perennial water, it has the potential to expand the area of contiguous habitat for tigers, prey and other wildlife within PTR, in the event of better connectivity.

Given that much of the land in the Garha gap is under private ownership or control, land use continues to change with each passing year. The expanding human footprint in the matrix around the patches presents challenges to set aside land for conservation. The complexity of restoring this corridor is compounded by the fact that land areas that facilitate animal movement are largely under private ownership or occupation, with small and scattered parcels under the management of various government departments or village Gram Sabhas. In order to integrate wildlife habitats across Pilibhit Tiger Reserve, it is important to assess how wildlife uses this farmland corridor, and identify strategies for its management and restoration, to ensure that that it remains permeable to animal movement.

Key impediments to animal movement within the Garha gap

Conversion of agricultural land, which is permeable to animal movement, to other land-use types which may impede movement and reduce the frequency with which wild mammals move between the two forest patches.

The growth of linear development along NH-730, including commercial enterprises like dhabas (roadside eateries) and petrol pumps, within the corridor along an arterial state highway, are detrimental for animal movement.

The presence of a National Highway (i.e. NH 730) is an impediment. This highway passes through the corridor area, and has extensive day and night traffic, including many trucks and heavy vehicles. Vehicles plying in this section of the highway typically traverse at high speeds (in excess of 60 kmph). Vehicular traffic can deter and alter animal movement patterns because of volume, speed, noise and light.

Similarly, broad canals with fast flowing water may act as a barrier. This is a concern as the Nibohi branch of the Sharda canal bisects this corridor.

There is an ongoing degradation of natural micro-habitats within the corridor. The Mala river, which most likely serves as a movement route between the two forest patches, is fringed by tall grasslands, fields and several ponds. Dense vegetation along its banks provides cover for wildlife to shelter in. However, such habitats are rapidly being degraded by pressure from grazing, resource harvest and land-use change.

There is lack of formal protection for wildlife once it enters the farmland. Agricultural areas in the corridor lie beyond the purview of the forest department, and wildlife using such areas are especially vulnerable – to road traffic, dogs and occasional poaching.

Anecdotal information on use of farmlands by tiger

Tigers are known to make forays deep into agricultural areas, as is evident from cases of the tigress in Amariya and the tiger in Rehmankheda (located close to Lucknow), who were both documented as undertaking long journeys through Uttar Pradesh's farmlands. In 2012-2013, the aforementioned tigress with three cubs was discovered to have taken up residence in farmlands of Amariya, 15-20 km away

from her territory in Mahof Range of Pilibhit Tiger Reserve. Once established there, she began to wander extensively, often following little drainage features and rivers in the agricultural matrix. Similarly in 2012, a tiger travelled from Dudhwa NP to Rhemankheda, covering a distance of over 180 km. More recently in 2018, a radio-collared male tiger released in Dudhwa spent extensive periods in farmlands, and revealed that tigers do not avoid such areas in the Terai, contrary to the observations of Smith (1980). Moreover, tiger presence is frequently recorded in the farmlands of Pilibhit, Lakhimpur and Bharaich districts, often along river courses, and sometimes at considerable distances from forests.

Increasingly, important wildlife areas are being compromised by habitat loss, fragmentation and isolation (DeFries et al. 2005). The fact is being increasingly recognised that it is essential to maintain connectivity to enable the persistence of a tiger metapopulation in the Terai Arc Landscape (Thapa et al., 2017). For this, PAs, Reserve Forests and other elements of the landscape must be managed synergistically to maintain connectivity and to foster population persistence (Smith et al. 1998; Shrestha 2004; Wikramanayake et al. 2004; Chanchani et al., 2016). The conservation focus has hereto been centred on forested corridors, with agricultural corridors receiving less attention. Our surveys in the agricultural matrix lying between significant tiger habitat areas provide evidence for the presence and movement of tigers in an agricultural corridor. It is imperative, therefore, that conservation schemes in working landscapes account not only for Protected Areas and Reserve Forests, but also for the agricultural areas near forests as well.

Objectives

The broad goal of the report is to identify strategies and actions to maintain structural and functional connectivity between the Pilibhit main forest and the Deoria patch. Its specific objectives are:

- Collate biological information pertaining to the tiger and its prey in PIlibhit TR (in forest tracts at either end of the Garha corridor).
- Understand the status of government-owned land in the Garha gap.
- Identify key challenges and opportunities for corridor management and restoration.

SECTION-2

BUILDING SCIENCE-BASED KNOWLEDGE ON TIGER AND PREY OCCURRENCE AND ABUNDANCE

Any corridor management or restoration plan demands long-term and intensive conservation efforts, and it is therefore important that a science-based understanding of ecological dimensions be incorporated into the planning process. Key ecological dimensions include a thorough understanding of the occurrence and abundance of tigers and their prey, the potential effects of fragmentation on populations, and a grasp on dispersal dynamics. It is equally important to assess habitat use of tigers and prey in corridors – including farmlands – to assess whether, and if so, the degree to which these are functional and to identify actions for their protection and conservation.

In this section of the report, we present information on two aspects underpinning our first objectives, which are, describing the status of both tiger and prey in PTR, their occurrence in the Garha gap and assessing habitat connectivity for these species. Tiger distribution and population estimates within PTR are drawn from systematic camera trap surveys. We also use this information to determine the annual turnover of tigers in the Deoria forest patch. Thereafter, we provide an assessment of the abundance of wild prey in these patches to establish whether they currently support as many tigers as they potentially can. Additionally, we provide evidence for the use of farmlands within the Garha gap by both tigers and wild prey. Finally, we identify areas that may be prioritized for restoration, management and other interventions to secure passageways for wildlife.

Status of the tiger in PTR and Deoria forest patch

Intensive deployment of camera traps (see Table 1; Annex 1) has been carried out for four consecutive years in PTR between 2011 and 2017. Surveys were carried out using standard camera trapping methods and field procedures, and the extent of habitats was consistent across years (Karanth & Nichols 1998). Camera-trap images were collated for four years, and the minimum number of unique individuals for each year was collated based on stripe patterns. A trap operational matrix (containing 1s and 0s indicating whether the camera was active or not on each survey occasion) and capture matrix (indicating captures of individual tigers with respect to site and occasion) were generated for spatially-explicit capture-recapture analysis. Estimates of abundance and density were computed in secr package in R ver 3.1.3 (Efford et al., 2015). A 15-km habitat mask was used to estimate density to ensure that the activity centres of all animals photo-captured lay within the integration region (state space). The region.N function was used to obtain abundance estimate of tigers within the boundary of Pilibhit Tiger Reserve. We did not attempt to separately estimate tiger abundance/ density for Deoria because very few individuals were captured there in any given year.

Chanchani et al., (2014) estimated population abundance and density of tigers in Pilibhit TR, and reported tiger abundance (N̂) as 23 (95% CI 23-28) in 2013 and estimated a density of 3.44 tigers/ 100 km2, suggesting it to be one of the largest tiger populations in Uttar Pradesh. In 2017, the estimated abundance was 38 individuals (38-40). While Mahof, Mala and Haripur ranges of Pilibhit TR supported most of these individuals, Deoria forest patch held a small proportion. No tiger was photo-captured in the year 2013, while three tigers were captured both in 2010 and 2017. The low densities of tigers in Deoria appears to be on account of it being disjunct from the rest of PTR.

Table 1: Summary on camera stations, trap nights, unique individuals and density estimate

S#	Year	Sampling Period	Camera stations		Trap nights		Mt+1		Density (sd)
			Pilibhit TR	Deoria patch	Pilibhit TR	Deoria patch	Pilibhit TR	Deoria patch	Pilibhit TR
1	2011	20th Dec 2010 to 30th May 2011	157	26	2739	421	30	3	4.22 (1.17)
2	2013	15th April 2013 to 15th June 2013	171	29	2814	495	23	No captures	3.44 (0.58)
3	2014	29th April 2014 to 28th June 2014	175	24	4471	477	23	1	3.09
4	2016-17	Dec 2016-Feb 2017	199	27	5625	759	38	3	4.2

Dispersal and Turnover of tigers

Evidence of tiger movement between the Pilibhit main forest and Deoria patch was recorded using cameras traps in 2016-17 (Fig 3). An adult male tiger photo-captured in Mala range of PTR in 2014 made its way across the corridor and was subsequently photo-captured in the Deoria patch in 2016-17. While we are not able to similarly match other individuals photo-captured in the Deoria patch, it is highly likely that they may also have dispersed out of other areas of PTR in years when camera trapping was not conducted.

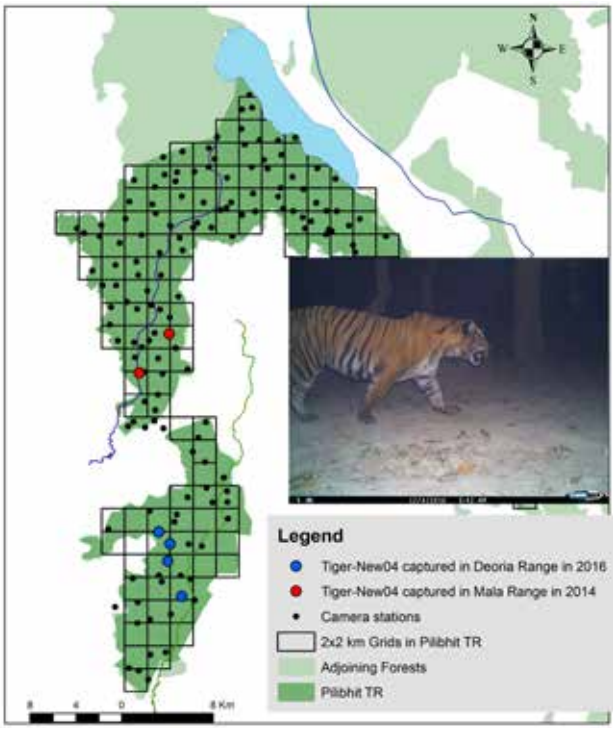


Figure 2: Adult male tiger that dispersed from Pilibhit main forest to Deoria patch

The Deoria patch appears to be associated with frequent colonization and extinction events, and tenure periods for adult males are low. For instance, three adult individuals captured in 2011 were not detected in the year 2013 in Deoria or elsewhere. Of the four tigers cumulatively photo-captured in 2011, 2013 and 2014, one female was captured over a 2-year period. Notably, despite the presence of adult females, no cubs were detected in Deoria over the sampling period. The high population turnover seems to attest to the

fact that tigers disperse into this patch from other areas (presumably other ranges of PTR). The fates of tigers dispersing from Deoria is largely unknown as these individuals have not subsequently been captured elsewhere in the UP Terai thus far. It is also not known why cubs have not been detected in the Deoria forest patch.

Status of wild prey in Pilibhit TR

The population status of ungulates was estimated using variable distance line transect sampling and distance analysis (Thomas et al 2010, Buckland et al 2012).

A total of 45 straight line transects (length varying from 1 to 2.5 km) were established and surveyed in 2014. Eight (136 km survey effort) of these transect lines were in the Deoria patch of Pilibhit Tiger Reserve, whereas 37 transect lines (244 km survey effort) were located elsewhere in the reserve. Surveys were undertaken in morning and evening hours to increase detection probability of ungulates. 2-3 observers carried out surveys 4-7 times per transect line and recorded observations of ungulate species encountered, including cluster size and composition, radial distance, angle, location coordinates and broad habitat attributes.

To analyse this data, we ran combination of models with three alternate detection functions, namely Uniform, Half-normal and Hazard rate, and three alternate adjustment parameterizations - Cosine, Simple Polynomial and Hermite Polynomial. We fitted detection functions using these models and selected the best-fit model to derive estimates of density and other relevant parameters. Model fit was assessed using AIC scores, chi-square, p value and visual inspection of shape of detection function curve.

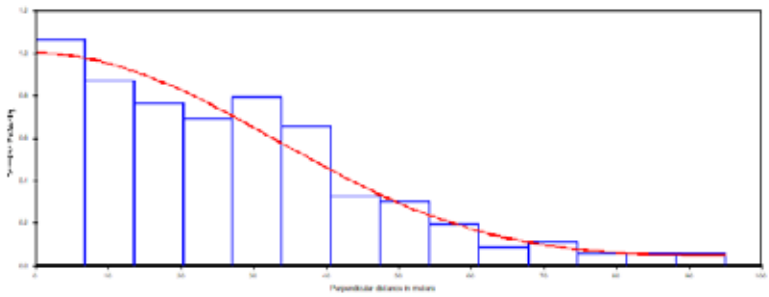


Figure: Detection function fitted with ungulate data from Pilibhit TR in the year 2014.

Transect surveys yielded 228 detections of six ungulate species: Chital Axix axis, Nilgai Boselaphus tragocamelus, Wild boar Sus scrofa, Swamp deer Rucervus duvaucelii, Hog deer Axis porcinus and Barking deer Muntiacus muntjac. While the Deoria patch contributed 24% of the overall detections of ungulates, remaining observations were obtained from the Pilibhit main forest. No ungulates were detected on three of the 45 transect lines. In the Deoria patch, amongst four ungulates (nilgai, chital, barking deer and wild boar), nilgai contributed the highest number of observations (n=39). Of six ungulates, chital (n=109) was the most frequently detected species followed by nilgai (n=28) in the Pilibhit main forest.

Overall, prey population in Pilibhit TR was estimated at 49.05 animals/sq. km (CV 15.8%). The estimated ungulate density in the Pilibhit main forest was 58.4 animal/sq. km (CV 16.5%), and in the Deoria patch it was 32.2 animal/sq. km (CV 28.6%) (Table 2). It is notable that the Deoria forest patch supports reasonable-sized wild prey, and thus has potential to support large number of tigers. This ungulate density is similar to ungulate population in several Protected Areas (PAs) in India.

Table 2: Summary on estimates of ungulate density in Pilibhit main forest and Deoria patch in 2014

Strata	No. of detections (Km)	Group Density (CV)	Mean cluster size (CV)	Density (CV)	95% CI (Density)	Model
Deoria patch	52 (136)	4.67 (27)		32.25 (28.6)	17.1 - 60.56	Uniform Cosine
Pilibhit main forest	168 (244)	8.47 (13.5)		58.47 (16.5)	42.2 - 80.98	Uniform Cosine
Pilibhit TR	220 (380)	7.10 (12.6)	7.73 (9.58)	49.05 (15.8)	35.9 - 66.9	Uniform Cosine

Movement of the Tiger in farmlands of Garha gap (based on camera trap data)

With an objective of assessing the extent of use of farmlands by tigers and other large mammals, we carried out camera trapping exercises in the Garha gap in 2019. A fine-scale (500 x 500 m) grid was overlaid in the Garha gap spanning an area of 5 km² of farmland (Fig 3). 32 camera traps were deployed in 24 stations in the month of March 2019 and June 2019, constituting a total survey effort of 3,388 trap nights. Cameras were installed on trails passing through agricultural fields, which were mostly under paddy cultivation during the survey period.

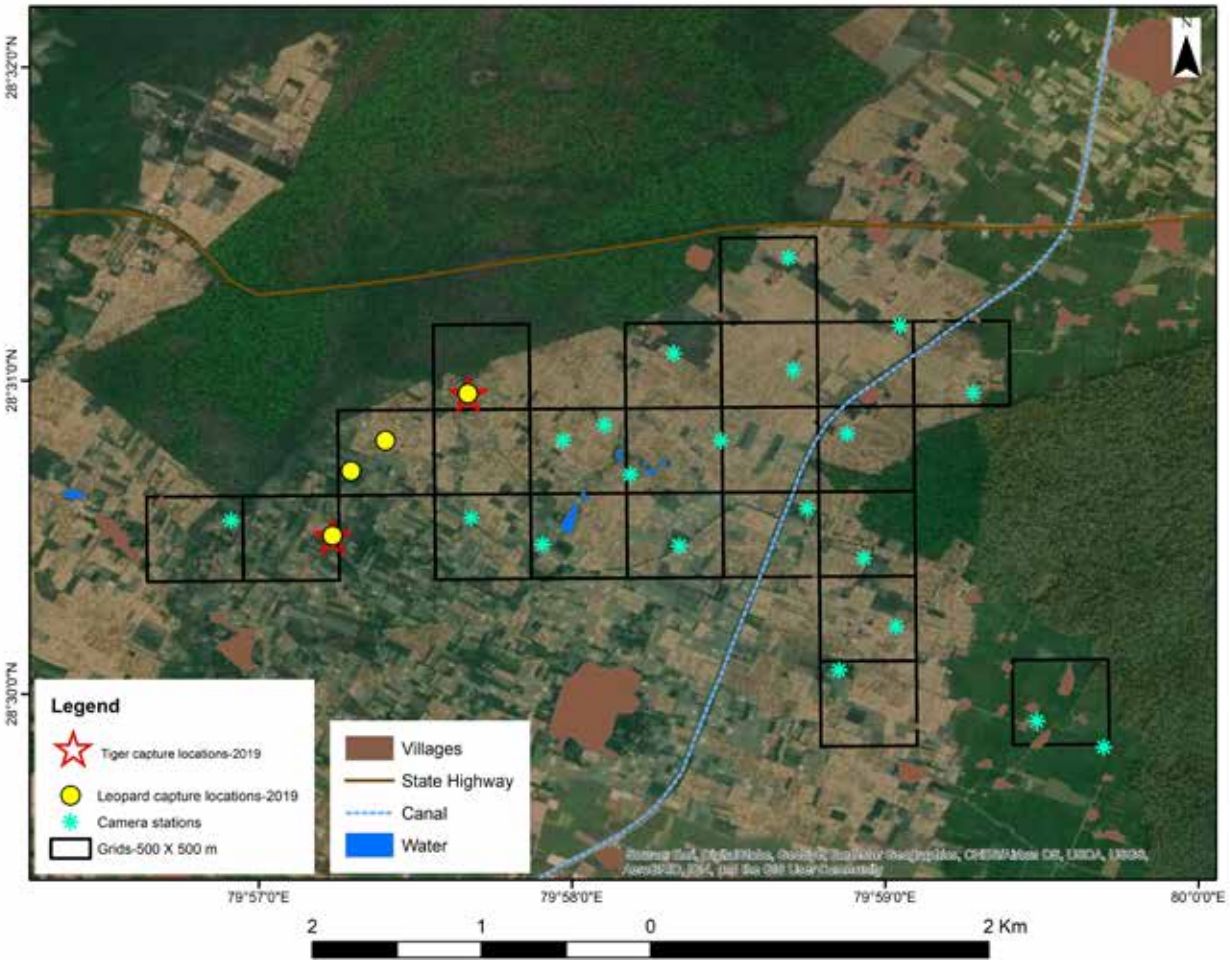


Figure 3: Map showing a) camera stations deployed, b) tiger capture locations and c) leopard capture locations in Garha farmland between March and June 2019

We documented the presence of tigers, leopards, sloth bears, jungle cats, jackals, small Indian civets, nilgai, chital, wild pig, hog deer, rhesus macaques and sarus cranes in the Garha gap. Two tigers, one adult male and an adult female, were photo-captured 0.5 km from the forest edge. The female was recaptured in farmlands within the Garha gap on two occasions. Tigers were captured after sundown (late evening) and during the night when there was minimal human movement. Interestingly, tigers were captured in the Garha gap even when crop cover was low. This happened in the post-harvest season in December-January, when the paddy crop was still immature, and there was very little sugarcane in the area.

Vehicular movement in the State Highway

Between 13 April and 22 June 2019, an observer counted vehicles passing through the National Highway for 61 days. Counting of vehicles was done for an hour each day, either pre-noon or afternoon.

On an average, 497 (SD 42.5) vehicles went by each hour. Given that the highway bisects a 3-kilometre stretch of the forest immediately adjacent to the Garha gap, it is likely to deter wildlife use of the area, and also be hazardous for wildlife attempting to cross the road (Kerley et al., 2002).

Key findings from the biological surveys:

1. Tiger abundance varied from 23–38 in PTR between 2011 and 2017. The highest number of adult tigers captured in the Deoria patch was three, and there were no tigers recorded in 2013. No cubs were detected in the Deoria patch over the entire survey period.

2. High inter-annual turnover of individual tigers was observed in the Deoria patch indicating periodic movement into this patch from surrounding forests. The tigers here did not stay on from one survey year to the next.

3. The recorded dispersal of one adult male tiger from Pilibhit main forest to the Deoria patch provided evidence for functionality of Garha gap as a corridor.

4. The estimated number of wild ungulates in the Pilibhit main forest was 58.4 animal/sq. km (with CV 16.5%), and it was 32.2 animal/sq. km (with CV 28.6%) in the Deoria patch. Wild prey exists in adequate numbers to support more tigers than are currently present. Population densities may be limited because of restricted connectivity.

5. The presence of tigers, leopards and sloth bears in farmlands of the Garha gap suggests that the matrix in the Garha gap is used by wildlife species, either as areas where they forage, as extensions of their natural habitats or to move between habitat patches.

6. High vehicular movement at the rate of an average of 497 vehicles per hour was reported on the National Highway that passes through the forests.

SECTION-3

STATUS OF LAND IN THE GARHA CORRIDOR

In this section, we describe the status of government-owned land within parts of the corridor that were identified as being highly permeable in section 2. Recording spatial extent and distribution of government-owned land along the corridor was crucial to determine opportunities and plan strategies for corridor conservation and restoration. Through consultation with the District Magistrate and Sub-District Magistrate of Pilibhit District, land survey was done with the Lekhpal (field-level revenue officer) in the year 2014. The key objective of this survey was to map parcels of lands and identify those owned by Gram Sabhas. These surveys were primarily conducted within and around Damgarhi Miyuna and Lalpur villages.

The area earmarked for prioritized conservation encompasses land within Damgarhi Miyuna and Lalpur T. Madho Tanda villages. The cumulative area of land under these villages is approximately 4.6 km2 with a density of approximately 150 households/km2. Although this density appears to be high, spatially these households are aggregated into one or two large clusters, and >80% of the total area is under cultivation. Notably these large clusters of homes don't fall along identified dispersal routes (areas of high current flow) in the Garha gap. Based on the 2011 Census, 19 and 672 families reside in Damgarhi Miyuna and Lalpur T. Madho Tanda villages, respectively, with houses scattered and embedded within sugarcane farmland. 1215 people (33% of the total population) in Lalpur T. Madho Tanda village were listed as Schedule Caste (SC) while there were no SC households in Damgarhi Miyuna village.

There are several other villages proximate to the two villages within the identified restoration zone of the corridor. These villages- Binaur, Pachpera Garha, Jari, Grant no. 2 Urf and Bidhipur – have similar settlement patterns and household densities as Damgarhi Miyuna and Lalpur T. Madho Tanda and the land around them is also predominantly under agriculture (Table 4). While it is likely that wildlife also uses these areas, dispersal pathways (between Deoria patch and Pilibhit main forest) through these villages will be considerably longer. Sugarcane is the dominant crop in the entire area, interspersed with wheat and paddy that are grown seasonally in some lots.

Table 4: Summary on village demography based on Census of India 2011

S No	Name of villages	Area of village (ha)	Total household	Total population			Scheduled castes
				Person	Male	Female	Person
1	Binaur	216	36	201	96	105	26
2	Pachpera Garha	225	63	363	196	167	13
3	Jari	76	42	215	115	100	77
4	Grant no 2 Urf Bishanpur	291	136	598	298	300	116
5	Lalpur T. Madho Tanda	357	672	3611	1935	1676	1215
6	Damgarhi Miyuna	102	19	119	58	61	0
7	Bidhipur	174	245	1229	620	609	286

Status of Land along corridor

Damgarhi Miyuna village:

Land records suggest that 5.7 ha of land in this village is categorized as government-owned in the form of barren land, nala, rasta, chakmarg, pond and jhari (Table 5; Fig 6). Land surveys revealed that 0.6 ha of land is classified as nala and 0.3 ha as ponds. Notably >90% of these nala and ponds have been converted to agricultural farmland. Additionally, 2.6 ha of available land is classified as rasta and chakroad. About 0.3 ha of land is categorized as "agriculturally barren" under ownership of the Gram Sabha. Overall >2.8 ha of land classified as either nala, pond, rasta or chakroad has been converted to agricultural purpose.

Table 5: Summary on status of government-owned land in Damgarhi Miyuna village in Garha corridor

S No	Khet No.	Khasra No.	Land category	Village name	Status of land in 2014	Status of land in 2019	Area in Ha
1	339	230	Banjar				0.016
2	342	100	Banjar				0.162
3	312/365	230	Banjar				0.024
4	14	230	Banjar/ nala				0.016
5	18	230	Banjar/ nala	Dhamgari Myuna	Nala	Cultivated	0.032
6	335	230	Banjar/Nala				0.081
7	49	234	Chakmarg	Dhamgari Myuna	Rasta	Cultivated	0.182
8	52	234	Chakmarg				0.024
9	66	234	Chakmarg				0.012
10	68	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.146
11	81	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.097
12	139	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.061
13	147	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.065
14	160	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.02
15	167	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.045
16	173	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.182
17	182	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.036
18	184	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.024
19	192	234	Chakmarg				0.125
20	209	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.016

S No	Khet No.	Khasra No.	Land category	Village name	Status of land in 2014	Status of land in 2019	Area in Ha
21	215	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.077
22	225	234	Chakmarg				0.016
23	232	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.028
24	237	234	Chakmarg	Dhamgari Myuna	Gram Sabha	Cultivated	0.016
25	245	234	Chakmarg	Dhamgari Myuna	Rasta	Cultivated	0.016
26	263	234	Chakmarg	Dhamgari Myuna	Rasta	Cultivated	0.15
27	288	234	Chakmarg	Dhamgari Myuna	Rasta	Cultivated	0.109
28	289	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.008
29	320	234	Chakmarg	Dhamgari Myuna	Rasta	Cultivated	0.012
30	359	234	Chakmarg				0.024
31	374/364	234	Chakmarg	Dhamgari Myuna	Cultivated	Cultivated	0.028
32	195/366	234	Chakmarg				0.012
33	1	230	Jangal Jhari				0.146
34	31/4	230	Jangal Jhari				1.084
35	88/5	224	Jangal Jhari				0.243
36	113/4	231	Jangal Jhari Aabadi				0.178
37	4	233	Nala				0.022
38	8	233	Nala	Dhamgari Myuna	Nala	Cultivated	0.016
39	15	233	Nala	Dhamgari Myuna	Nala	Cultivated	0.259
40	17	233	Nala	Dhamgari Myuna	Nala	Cultivated	0.044
41	19	233	Nala				0.093
42	302	233	Nala	Dhamgari Myuna	Nala	Cultivated	0.231
43	340	232	Pond	Dhamgari Myuna	Talab	Cultivated	0.259
44	345	232	Pond	Dhamgari Myuna	Rasta	Cultivated	0.105
45	21	235	Rasta	Dhamgari Myuna	Rasta	Cultivated	0.316
46	25/2	230	Rasta	Dhamgari Myuna	Rasta	Cultivated	0.223

S No	Khet No.	Khasra No.	Land category	Village name	Status of land in 2014	Status of land in 2019	Area in Ha
47	30/2	230	Rasta	Dhamgari Myuna	Rasta	Cultivated	0.053
48	32	235	Rasta				0.064
49	114	29	Rasta				0.206
50	323	235	Rasta				0.295
51	354	235	Rasta	Dhamgari Myuna	Rasta	Cultivated	0.032

Lalpur T. Madhotanda village:

About 15 ha of land was found categorized as government-owned land in various forms (Table 6; Fig 6). Based on the Lekhpal survey, at least 4.2 ha land was found available as ponds, but on ground visit of these ponds they were found to be converted into farmland. A large volume of conversion has taken place between 2014 and 2019. Additionally, about 8.5 ha of land was categorized as rasta/chakroad, a majority of which has been cultivated. 0.14 ha of land was categorized as "barren" land.

Table 6: Summary on status of government-owned land in Lalpur T. MadhoTanda village in Garha corridor

S No.	Khet no.	Khasra no.	Land category	Village name	Status of land in 2014	Status of land in 2019	Area in Ha
1	56	436	Banjar				0.032
2	77	437	Banjar	Lalpur	Cultivated	Cultivated	0.028
3	322	436	Banjar	Lalpur	Banjar Kheti	Jangal ki boundary	0.028
4	353	437	Banjar	Lalpur	Cultivated	Cultivated	0.04
5	364	437	Banjar				0.012
6	100	443	Chakroad				0.113
7	112	443	Chakroad	Lalpur	Cultivated	Cultivated	0.085
8	127	443	Chakroad	Lalpur	Cultivated	Cultivated	0.02
9	136	443	Chakroad	Lalpur	Cultivated	Cultivated	0.134
10	148	443	Chakroad	Lalpur	Cultivated	Cultivated	0.101
11	158	443	Chakroad	Lalpur	Cultivated	Cultivated	0.02
12	178	443	Chakroad	Lalpur	Cultivated	Cultivated	0.008
13	180	443	Chakroad	Lalpur	Cultivated	Cultivated	0.073
14	186	443	Chakroad	Lalpur	Cultivated	Cultivated	0.057
15	207	443	Chakroad	Lalpur	Cultivated	Cultivated	0.105
16	213	443	Chakroad	Lalpur	Rasta	Cultivated	0.032
17	241	443	Chakroad	Lalpur	Cultivated	Cultivated	0.008
18	247	443	Chakroad	Lalpur	Cultivated	Cultivated	0.062
19	263	443	Chakroad				0.02
20	264	443	Chakroad				0.012
21	266	443	Chakroad				0.38
22	288	443	Chakroad	Lalpur	Cultivated	Cultivated	0.032
23	293	443	Chakroad	Lalpur	Cultivated	Cultivated	0.105

S No.	Khet no.	Khasra no.	Land category	Village name	Status of land in 2014	Status of land in 2019	Area in Ha
24	305	443	Chakroad				0.069
25	373	443	Chakroad	Lalpur	Cultivated	Cultivated	0.069
26	384	443	Chakroad	Lalpur	Cultivated	Cultivated	0.121
27	388	443	Chakroad	Lalpur	Cultivated	Cultivated	0.065
28	402	443	Chakroad	Lalpur	Cultivated	Cultivated	0.098
29	416	443	Chakroad				0.089
30	228	436	Jangal/ Gram sabha	Lalpur	Cultivated	Cultivated	0.138
31	310	445	Kabristhan				0.263
32	119	438	Nali	Lalpur	Nali	Cultivated	0.093
33	170	439	Nali	Lalpur	Nali	Cultivated	0.081
34	234		Nali	Lalpur	Nali	Cultivated	0.02
35	286	439	Nali	Lalpur	Nali	Cultivated	0.081
36	299	439	Nali				0.099
37	227	434	new parti	Lalpur	Cultivated	Cultivated	0.056
38	351	434	new parti	Lalpur	Cultivated	Cultivated	0.073
39	253	443	Pakki Sadak				0.028
40	32	438	Pond				0.369
41	61	438	pond				0.274
42	68	438	pond	Lalpur	Talab	Cultivated	0.223
43	78	438	pond	Lalpur	Talab	Cultivated	0.96
44	85	124	pond	Lalpur	Talab	Cultivated	0.64
45	326	438	pond	Lalpur	Kheti	Cultivated	1.198

S No.	Khet no.	Khasra no.	Land category	Village name	Status of land in 2014	Status of land in 2019	Area in Ha
46	328	438	pond	Lalpur	Talab	Cultivated	0.607
47	53	435	Purani Parti	Lalpur	Purani Parti	Cultivated	0.93
48	99	442	Rasta	Lalpur	Rasta	Cultivated	2.699
49	225	442	Rasta				
50	276	442	Rasta				0.093
51	311	442	Rasta	Lalpur	Rasta	Cultivated	4.006

Summarisation of land survey

- In Damgarhi Miyuna village, 5 ha of land is available in the form of nala, ponds, rasta and chakroad under ownership of the Gram Sabha, which can be brought under conservation. >2.8 ha of Gram Sabha land has been converted for agricultural purposes.
- Similarly, in Lalpur T. Madho Tanda, 15 ha of land was classified nala, ponds, rasta and chakroad though a large amount of this land is used for farming.

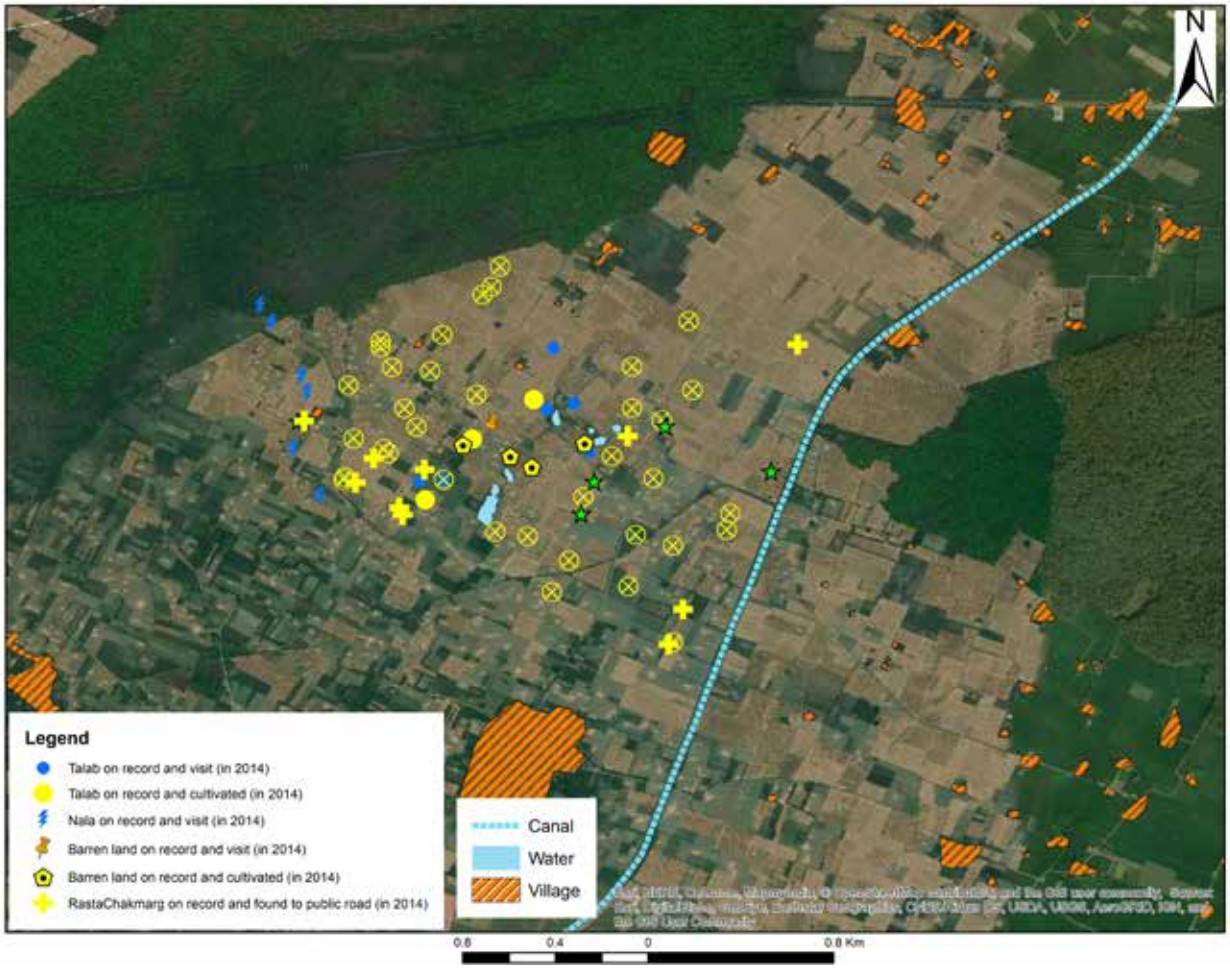


Figure 4: Status of Gram Sabha-owned land in Damgarhi Miyuna and Lalpur T. MadhoTanda villages along the Garha corridor

SECTION-4

CONSERVATION STRATEGIES

Based on findings of biological surveys and land records, we put forward two broad categories of strategies that can be adopted singly or in combination to conserve the Garha corridor and facilitate animal dispersal: a) the regulatory approach (focusing on maintenance of current land-use practice), and b) land procurement for restoration purposes. Continued functionality of this corridor in the future can only be ensured by collective actions implemented by multiple stakeholders including the District Administration, various government departments (including Revenue, Agriculture, Forest, Highways, Irrigation) and local communities.

Regulatory approach

The land-use pattern greatly determines the use of a given area by a species of interest. Since vegetation cover is an essential pre-requisite for animals, the nature and extent of land cover has great significance to determine space use by tigers (Sunarto et al 2012, Chanchani et al 2016). As suggested by camera trap data, there is evidence that present land-use practices have facilitated the dispersal of tigers in the studied area. The maintenance of present land-use pattern and practices through strict regulation of policy and provision is crucial in safeguarding this corridor.

Provision on Acts

One of the great challenges to this endeavour is rapid conversion of land-use practice. Discouraging conversion of farmland to other land use can be viewed as one important step toward safeguarding dispersal route of tigers. Legislation provides a legal framework for protection of farmland in the state of UP. Section 143 of the U.P. Zamindar Abolition and Land Reforms Act 1950 regulates change in the status of agricultural land into non-agricultural. Under Section 143, the Assistant Collector/SDM is authorized to regulate the change of status of agricultural land. The significance of privately-owned agricultural land, or land owned by the revenue department of the Gram Sabha, may be little understood by authorities who are involved in this regulation process. Involvement with the Lekhpals (operative in corridor areas), or the SDM/Assistant Collector will remain important to effectively conserve corridors and regulate/check unregulated development activities in corridor areas.

Eco-sensitive Zone:

The Ministry of Environment, Forests and Climate Change, Government of India has issued a notification for declaration of “Eco-sensitive Zones” around Protected Areas in order to regulate and manage activities in these areas (http://moef.gov.in/wp-content/uploads/2017/07/22e.pdf). PTR has proposed an eco-sensitive zone (ESZ) of 1 km that encompasses the Garha corridor.

Within the ESZ, activities that shall be prohibited are - setting up new wood based industries and saw mills, commercial mining, and establishment of hydroelectric projects. In addition, activities that shall be regulated include felling of trees, setting up hotels and resorts (given that no restriction on animal movement is made), drastic change in agriculture system, commercial use of natural water resources, fencing of hotels and lodges and others.

Role of Gram Sabhas

Gram Sabhas' role in preservation of natural resources in this corridor is crucial. Generally, wildlife conservation in farmlands is an ignored aspect in the Work Plan of Gram Sabhas. Inclusion of a section on corridor conservation and protection of wildlife in the Work Plan of Damgarhi Miyuna and Lalpur T. MadhoTanda village would be a positive step. To this end, there should be active engagement with the Pilibhit district administration and Gram Sabha representatives.

Land procurement for restoration purpose

Land within Damgarhi and Lalpur villages still provides opportunities for animal dispersal for two reasons: a) It is relatively unoccupied by large clusters of houses with pre-dominant farmlands, b) there is an availability of government-owned land in these villages which provides small pockets of trees and grass for animals to take temporary shelter in.

A conservative estimate of the dimensions of land required to create structural connectivity and to provide safe passage for wildlife movement is 2000 X 500 m (or 100 ha). This would provide safe passage for animals and maintain a viable structural connectivity. At least 3 ha of land under the ownership of the Gram Sabha can be readily used for wildlife conservation. Meanwhile, another 3 ha of Gram Sabha land, which has been illegally occupied and diverted to other land-use types, can be lawfully reclaimed to strengthen corridor conservation. Thus, if active restoration through land procurement is pursued, about 95 ha of privately owned land may need to be acquired, following all relevant legal processes and compensation procedures.

Post land-procurement, wildlife-friendly vegetation cover can be regenerated via two modes, i) planting by forest department, for instance, Social Forestry Division, Pilibhit, and ii) through partnerships with local communities, including identifying whether and when they may access these forests/ harvest resources. Engaging local communities in afforestation programs will be advantageous on two fronts: a) local communities will have a stake in corridor conservation, and b) success of afforestation will be ensured through their active participation.

Since land acquisition may only be a long-term solution, there is an immediate need to develop a plan with the district administration and concerned Gram Sabhas to protect wetland/marshes and afforest lands that are presently owned by Gram Sabhas in this corridor. Concurrently, specific measures also need to be put in place to mitigate impacts of human-wildlife conflict on local communities living within the corridor.

REFERENCES

1. Buckland, S. T., Anderson, D. R., Burnham, K. P. & Laake, J. L. (2012) Distance sampling: estimating abundance of biological populations. Springer Science & Business Media.

2. Chanchani, P., Bista, A., Warrier, R., Nair, S., Sharma, R., Hassan, D & Gupta, M. (2014) Status and Conservation of Tigers and their Prey in the Uttar Pradesh Terai. WWF-India, New Delhi.

3. Chanchani, P., Noon, B. R., Bailey, L. L. & Warrier, R. A. (2016) Conserving tigers in working landscapes. Conservation Biology, 30(3), 649-660.

4. DeFries, R., Hansen, A., Newton, A. C. & Hansen, M. C. (2005) Increasing Isolation of Protected Areas in Tropical Forests over the Past Twenty Years. Ecological Applications, 15, 19-26.

5. Efford, M. G., Dawson, D. K., Jhala, Y. V. & Qureshi, Q. (2015) Density-dependent home-range size revealed by spatially explicit capture-recapture. Ecography, 39, 676–688.

6. Karanth, K. U. & Nichols, J. D. (1998) Estimation of tiger densities in India using photographic captures and recaptures. Ecology, 79(8), 2852-2862.

7. Kerley, L. L., Goodrich, J. M., Miquelle, D. G., Smirnov, E. N., Quigley, H. B. & Hornocker, M. G. (2002) Effects of roads and human disturbance on Amur tigers. Conservation Biology, 16(1), 97-108.

8. Mathur, P.K., Kumar, H., Lehmkhhul, J. F., Tripathi, A., Sawarkar, V. B. & De, R. (2011) Mammal indicator species for protected areas and managed forests in a landscape conservation area of northern India. Biodiversity and Conservation, 20, 1-17.

9. Shrestha, M. K. (2004) Relative ungulate abundance in a fragmented landscape: Implications for tiger conservation. University of Minnesota.

10. Smith, J. L. D., Ahern, S. C. & McDougal, C. (1998) Landscape analysis of tiger distribution and habitat quality in Nepal. Conservation Biology, 12, 1338-1346

11. Strahorn, E. A. (2009) An environmental history of Postcolonial North India. Peter Lang, New York.

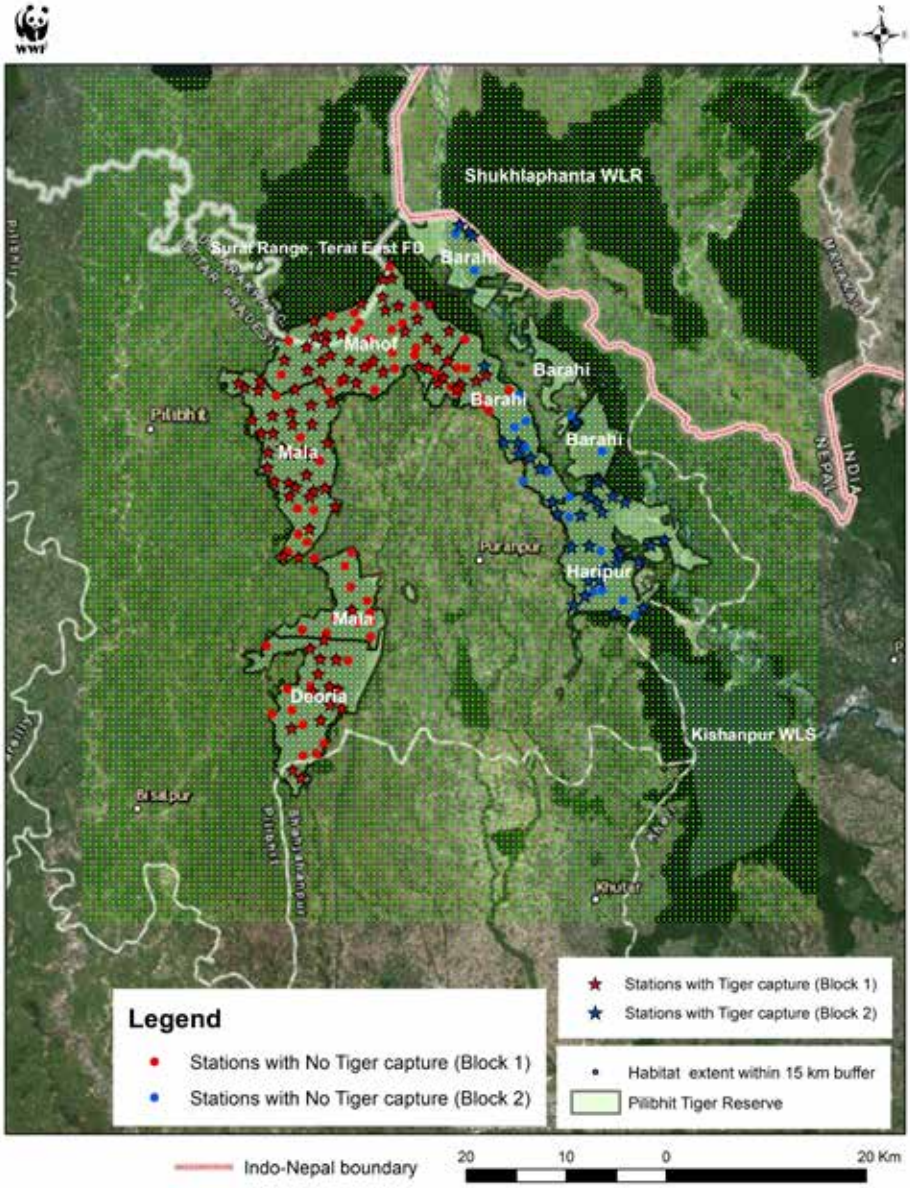
12. Sunarto, S., Kelly, M. J., Parakkasi, K., Klenzendorf, S., Septayuda, E. & Kurniawan, H. (2012) Tigers need cover: multi-scale occupancy study of the big cat in Sumatran forest and plantation landscapes. Plos one, 7(1), e30859.

13. Thomas, L., Buckland, S. T., Rexstad, E. A., Laake, J. L., Strindberg, S., Hedley, S. L., Bishop, J. R.B., Marques, T. A. & Burnham, K. P. (2010). Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology, 47(1), 5-14.

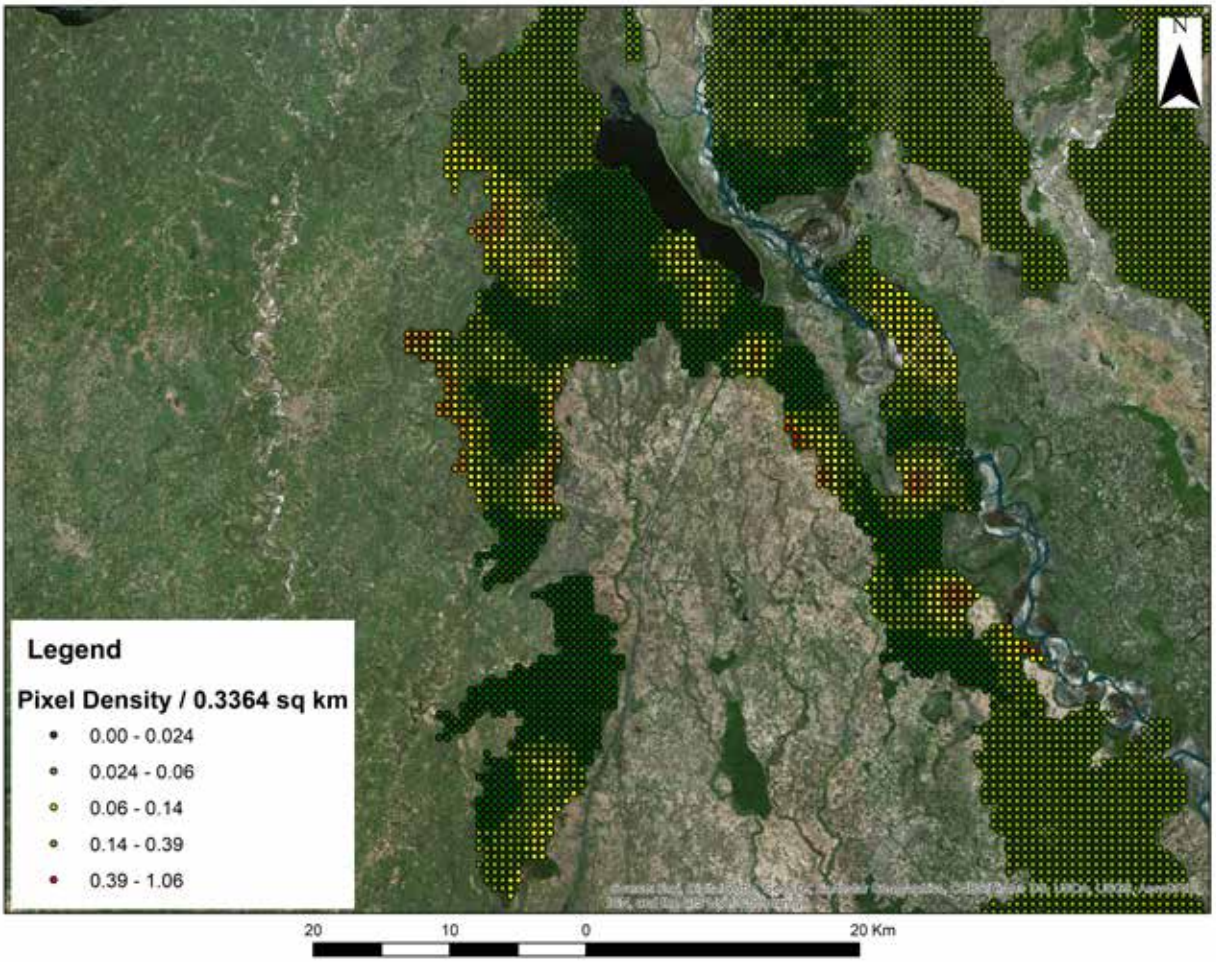
14. Wikramanayake, E., McKnight, M., Dinerstein, E., Joshi, A., Gurung, B. & Smith, D. (2004) Designing a conservation landscape for tigers in human dominated environments. Conservation Biology, 18(3): 839-844

ANNEX-1

a. Camera stations showing capture/non-capture of tigers in Pilibhit TR in 2017, and the 15 km buffer used for computation of density estimation

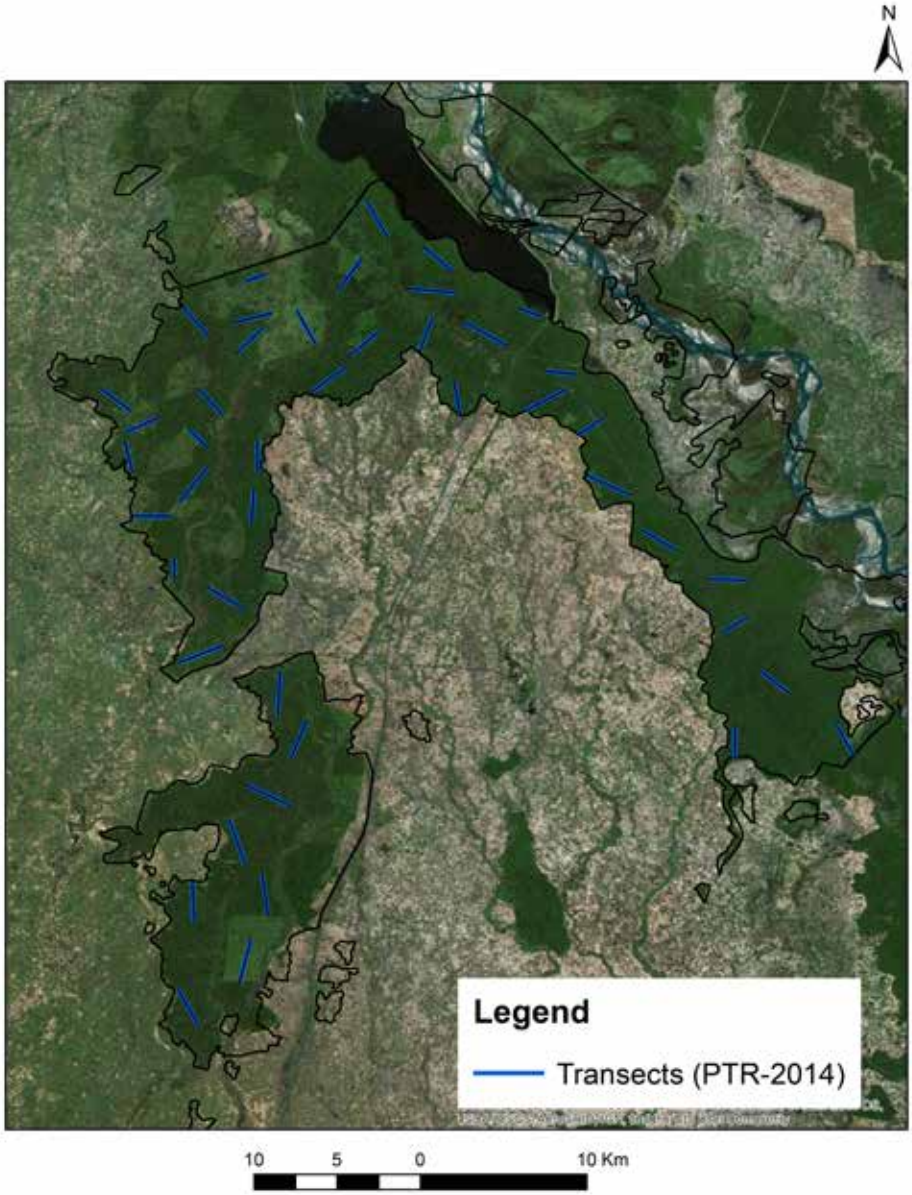


b. Pixel densities showing local tiger hotspots in Pilibhit TR (in 2017). “Red” color depicts high pixel density and “green” shows low pixel density.



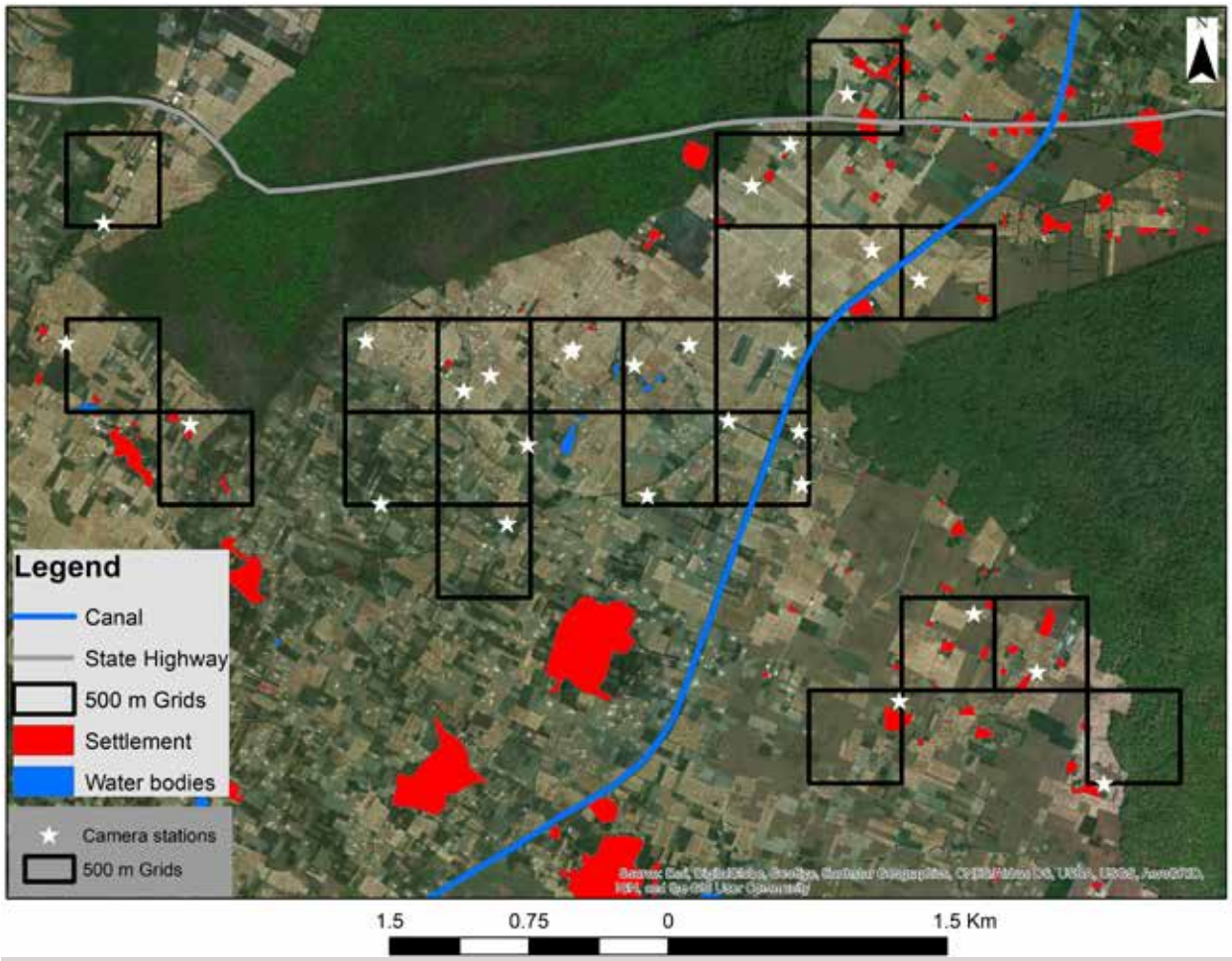
ANNEX 2

Distribution of line transects in Pilibhit TR in the year 2014



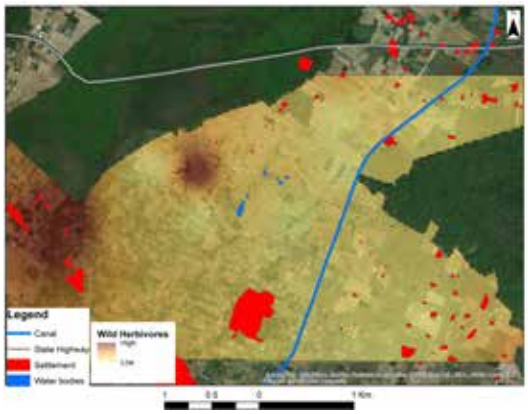
ANNEX-3

a. Camera stations deployed in farmlands of Garha gap in the year 2016

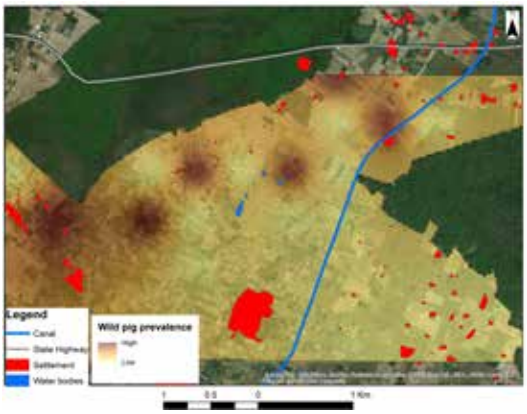


42 camera traps (in 21 grids of sizes 500 X 500 meters) were deployed between May and July 2016 in farmlands of Garha gap and adjoining areas. Single camera traps were deployed with the intent to photo-capture wild animals that use farmlands.

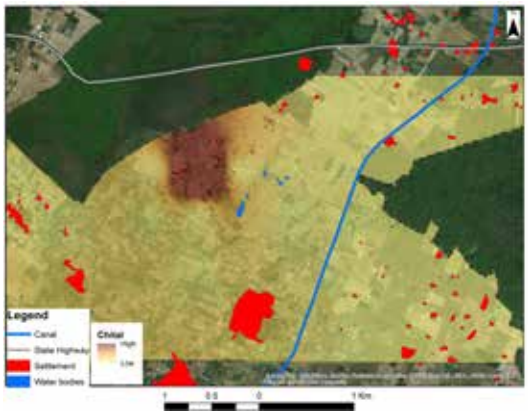
Camera trap images revealed that several wild herbivores use farmlands in the Garha gap. Four wild herbivores were photographed in camera traps, namely nilgai, wild pig, chital and hog deer. Nilgai was the most common herbivore captured in Garha. Notably cameras were placed in periods when crop was harvested and there was no standing crop. Use of farmland by wild animals is expected to be frequent in the rainy and winter seasons when these farmlands hold substantial sugarcane patches. Intensity of use by animals in Garha gap can be found in Annex 3b, c, d & e.



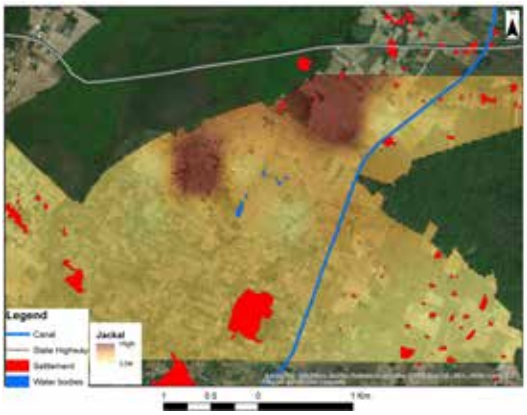
3b Prevalence of wild herbivores in Garha gap



3c Prevalence of Wild pigs in Garha gap



3d Prevalence of Chital in Garha gap



3e Prevalence of Jackal in Garha gap

ANNEX 4

Tiger individuals captured in Garha farmland during March - June 2019

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.

www.wwf.panda.org

WWF-India Secretariat
172 B, Lodhi Estate
New Delhi- 110003
Tel: +91 11 4150 4815

WWF • CONSERVATION PLANNING FOR THE GARHA CORRIDOR

IND

WWFINDIA.ORG