विभाग UTTAR PRADESH FOREST DEPARTMENT QUI COALITION FOR WILDLIFE CORRIDORS 2024 佁 合 **DUDHWA-KISHANPUR** CORRIDOR PROFILE

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DUDHWA-KISHANPUR CORRIDOR PROFILE





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Foreword

Maintaining functional connectivity between Protected Areas (PAs) has become more urgent than beforeas rapid land-use change has fragmented and degraded natural habitat affecting survival of several threatened species. This is especially true in the Uttar Pradesh terai where the Dudhwa National Park and surrounding PAs are embedded in a matrix of human modified landscape.

Conserving wildlife in Dudhwa National Park in a long run would require maintaining the movement of wildlife between Dudhwa National Park and the larger forest complex of Kishanpur Wildlife Sanctuary and Pilibhit Tiger Reserve, through the Dudhwa-Kishanpur corridor. The Tiger Conservation Plan of Dudhwa Tiger Reserve also emphasizes effective management of this corridor for preserving and maintaining of overall health of ecosystem in the terai.

This document is the first profile available on the Dudhwa-Kishanpur corridor detailing characteristics and features of the corridor, and highlights key conservation challenges and threats in the corridor area. It provides valuable information that is required by field staff and managers to plan and implement measures to secure this corridor. I am hopeful that this document will guide corridor conservation planning in a fragmented landscape.

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Foreword

Wildlife corridors are important elements in securing wildlife and their habitat in the fragmented Terai Arc Landscape (TAL). They allow free animal movement from one Protected Area (PA) to another, and such movement is essential to maintain healthy population of wildlife and ensure genetic diversity within a population. In absence of wildlife corridors, there is increased likelihood of inbreeding which can eventually lead to local extinction of a given population.

The Dudhwa-Kishanpur corridor is a significant linkage that connects wildlife habitats in Dudhwa National Park and Kishanpur Wildlife Sanctuary, Protected Areas (PAs) which are separated by a gap of about 25 km aerial distance and comprised of forest patches, farmlands, settlements and other natural features such as rivers and nalas. Although this corridor has been recognised for its ecological importance, a document detailing the features of this corridor was missing. Lack of information on the corridor had hindered ability to take any tangible actions on securement of the corridor.

I am delighted to see this document that describes structural and functional status of alesser-known corridor, and put-forth recommendations/suggestions on potential restoration measures. Dedicated scientific work on this corridor to document connectivity prospects would be helpful in devising long-term conservation plans for this corridor.

> Sunil Chaudhary, I.F.S. Principal Chief Conservator of Forests, M & W.P/ APCCF, Project Tiger Uttar Pradesh Forest Department.

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Corridor Overview

The Dudhwa-Kishanpur corridor connects the Dudhwa National Park (DNP) and Kishanpur Wildlife Sanctuary (KWS) in Uttar Pradesh. Spread over ~1,000 km², the corridor largely comprises agricultural fields (78% of the corridor area) and wetlands and streams that facilitate the movement and dispersal of large mammals, including tigers and swamp deer. Forests, grasslands and sandislands along the Sharda River cover about 20% of the corridor area, and most of these are under the administrative jurisdiction of the North Kheri forest division (a part of the buffer zone of Dudhwa Tiger Reserve). Long-term tiger monitoring exercises carried out in DNP and KWS by the forest department, habitat use surveys carried out in the corridor and information from radio-telemetry of tigers reveal that this corridor is functional and extensively used by tigers and other wildlife. However, linear infrastructure, human-wildlife conflict, and land-use change are some key challenges within this corridor. Maintaining the functionality of the corridor in future depends on maintaining the current permeability of farmlands and conserving wetlands and grasslands embedded within the farmlands. Co-developing land-use management plans involving multiple stakeholders, including the local communities, forest department and district-level governance agencies is necessary to maintain the corridor's permeability and effectively mitigate human-carnivore conflict.



Area of natural habita Low 17%



Threatened species richnes Medium 47



Average human population High 647 persons/km²







Natural habitat fragmentation index Low 0.82



Landscape complexity inde Medium 0.45

Habitat connected: Dudhwa National Park and Kishanpur Wildlife Sanctuary Area of corridor: 1000 km² Focal species: Tiger, Swamp deer Major threats: Land-use change, human-wildlife conflict Coalition for Wildlife Corridors member(s): World Wide Fund for Nature- India (WWF-India)



Kishanpur Wildlife Sanctuary

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DUDHWA-KISHANPUR CORRIDOR

Sugarcane Tigers of Dudhwa-Kishanpur ©Nikhil Pal



Sugarcane Tigers of Dudhwa-Kishanpur ©Nikhil Pal

Swamp Deer ©Raiva Singh

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Sharda river bank ©Rekha Warrier

> Sugarcane farms ©Rekha Warrier

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Sugarcane Tigers of Dudhwa-Kishanpur ©Nikhil Pal

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Rice field with cattle egret ©Rekha Warrier

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Sugarcane Tigers of Dudhwa-Kishanpur ©Nikhil Pal

Mustard field ©Rekha Warrier



Sal and

Homes in the corridor ©Raiva Singh



Crocodile ©Somreet Bhattacharya



Settlements in the corridor ©Raiva Singh

> Nallahs in corridor ©Raiva Singh

White Rumped and Griffon vulture 9 ©Raiva Singh

Sugarcane field post harvest Raiva Sigh

1 Corridor History

The Imperial Gazetteer of India (with information from the period between the late 18th and early 20th centuries) describes the corridor and surrounding landscape (northern part of the then Kheri district) as 'a wild tract of country which practically forms a vast river bed in which the Sarda (river) has worn several channels', beyond which, towards Nepal, stretched large areas of forests. The vast sal dominated forests were reported to support several wild animals. 'Tigers, bears and wolves are not rare', the document says, 'while leopards, wild dogs, hyenas, jungle cats, and jackals are more common'. Swamp deer were noted to be more common among the five species of deer reported from the region (Imperial Gazetteer of India, 1931).

Till the mid 1900s, the terai forests and marshes were reported to be uninhabitable, being the haunt of wild animals and breeding grounds for recurring diseases like malaria (People's Union for Democratic Rights report, 1989). Post-independence, the 'malarious' jungles slowly started to be reclaimed. The Government of India started attempting to make the swampy and forested terai areas more habitable. Across the terai within the Uttar Pradesh state, leases were granted to individuals and cooperatives to develop the land and to the refugees who had come to India post-partition from western and eastern Pakistan (People's Union for Democratic Rights report, 1989; Midha and Mathur, 2010). The once extensive alluvial grassland and forest system gradually started getting fragmented. The human population across the Terai increased 130% between 1881 and 1981 and it is currently among the most densely populated regions in the country (Semwal, 2005). The once extensive terai grasslands and forests are now restricted to smaller fragments, most of them protected and managed by the forest department.

Forests and grasslands in the Uttar Pradesh terai were known for tiger hunting and were recognized as important habitats for the swamp deer. In 1958,

a small 64 km² area was declared as Sonaripur Wildlife Sanctuary, which was extended to form the Dudhwa Wildlife Sanctuary in 1968 to conserve the largest population of swamp deer in the Indian subcontinent (Semwal, 2005). Further in 1977 the Dudhwa National Park (DNP) was created and in 1987-88, DNP and Kishanpur Wildlife Sanctuary were together declared as the Dudhwa Tiger Reserve (Semwal, 2005). Katerniaghat Wildlife Sanctuary, east of DNP, was added to the Tiger Reserve in 2003.

Although DNP and Kishanpur wildlife sanctuary were brought under the common management regime of Dudhwa Tiger Reserve, they were and still are geographically separated by a span of 20 - 25 km of predominantly agricultural land, with many settlements, meandering nallahs, ox-bow lakes, rivers, and a network of roads and railway lines. Several studies have established that this agriculture dominated gap between the protected areas (PAs) is an important wildlife corridor, now called the Dudhwa-Kishanpur corridor, vital for tigers and other species (Johnsingh et al., 2004; Kanagraj et al., 2011; Qureshi et al., 2014). However, the importance of agricultural areas for connectivity in this landscape has sometimes been underestimated (Kanagaraj et al., 2013). There is no structural forest connectivity in the east-west direction that can serve as an unbroken conduit for animal movement between the two PAs, and animals occurring in this corridor inevitably need to cross the Sharda River.

Land use change in this region since India's independence has largely been by way of conversion of grasslands and wetlands into agricultural areas where sugarcane, wheat and paddy are cultivated. While these changes have been extensive, the area is still permeable to the movement of many species, and conserving this permeability would be crucial to ensure the persistence of wildlife populations into the future.

2 Corridor Significance

2.1 Importance of core habitats connected

Dudhwa National Park (DNP)

DNP is located in Lakhimpur-Kheri district, Uttar Pradesh, India. DNP has a core area of 490 $\rm km^2$ and a buffer of 190 km² (Tiger Conservation Plan of Dudhwa Tiger Reserve, 2013-14 to 2022-23). DNP has extensive stands of sal (Shorea robusta) forests and large patches of grasslands (including wetlands). These grasslands support diverse fauna that occur primarily in alluvial grasslands, including barasingha (Rucervus duvaucelii duvaucelii), hog deer (Axis porcinus), rhinoceros (Rhinoceros unicornis), and Bengal florican (Houbaropsis bengalensis). Schaaf and Singh (1977) estimated a population of 1200-1600 barasingha in Sathiyana, Kakraha and Banke Taal areas of DNP in 1975. However, recent surveys indicate that the Barasingha population may now be considerably lower in these areas and the surrounding farmlands (Rastogi et al., 2023). Over the past decade, tiger density in the park has been estimated to range between 1.8 animals/100 km² (Chanchani et al., 2014a) to 2.3 animals/100

km² (Jhala et al., 2020). Apart from tigers, megaherbivores including one-horned rhinoceros and elephants are other important species found in this park. The rhino population, with approximately 40 individuals, is contained within two large enclosures in the national park. A small elephant population (likely between 40 - 80 individuals) uses the PA (Dudhwa Tiger Reserve, 2020). Some or all of these individuals also periodically migrate to forests in Nepal, particularly through the trans-boundary Laljhadi and Basanta corridors. Bengal floricans also occur in Dudhwa's grasslands in small numbers (Narwade et al., 2017; Rahmani et al., 2017). Based on Champion and Seth's (1968) classification, the major types of vegetation found in this park include, tropical moist deciduous forest, littoral and swamp, and tropical dry deciduous forest dominated by sal. About 27 species of grass are found in the reserve, and dominant species include Imperata cylindrica, Narenga porphyrocoma, Vetiveria zizanioides, Desmostachya bipinnata and Saccharum spontaneum (Rastogi et al., 2022).

Kishanpur Wildlife Sanctuary (KWS) and Pilibhit Tiger Reserve (PTR)

KWS has a core area of 203 km² and is surrounded by the buffer zone division of the Dudhwa Tiger Reserve. KWS and buffer zone division are contiguous with PTR, forming the largest contiguous forest in Uttar Pradesh. The Sharda River flows towards the north of this sanctuary. Barasingha is known to occur mostly along Jhadi tal, Ull river and Chaltuwa area within KWS. The sanctuary supports the highest tiger density in the state of Uttar Pradesh, between 4.2 and 4.9 animals/100 km² (Chanchani et al., 2014a; Jhala et al., 2020). There are no resident elephants in this sanctuary; however, infrequent movement from Shukhlaphanta National Park in Nepal through PTR and the buffer zone division has been recorded a few times in the recent years. Similar to DNP, vegetation types in this sanctuary include tropical semi-evergreen forest, tropical moist deciduous forest, littoral and swamp, and tropical dry deciduous forest (Champion and Seth 1968).

Contiguous with KWS, Haripur and Barahi ranges of the PTR lie at the North Western end of the corridor. PTR, established in 2014, supports Uttar Pradesh's single largest tiger population. Prior to 2014, Pilibhit forest division was among the most productive areas for the commercial extraction of sal wood in North India. The Barahi and Haripur ranges are dominated by alluvial grasslands along the banks of the Sharda river. These are productive habitats for tigers, hog deer and swamp deer. However, these areas are also used extensively for livestock grazing. These ranges are also connected with Shukhlaphanta National Park in Nepal via the transboundary Lagga-Bagga-Tatarganj corridor (Thapa et al., 2017; Bista et al., 2022).



2.2 Wildlife utilising the corridor

Several studies have highlighted the importance of the Dudhwa-Kishanpur corridor (Johnsingh et al., 2004; Kangraja et al., 2011; Qureshi et al., 2014 and Warrier et al., 2020). Along with published research, reports and unpublished data provide information on the use of the corridor by tigers and other wildlife. A sub-adult male tiger photo captured originally in the Sharda beat of KWS in 2013-2014 subsequently dispersed to the Bhadraula area of DNP, where he was photo-captured in 2016. Additionally, 3-4 tiger individuals were documented to be using the corridor area in 2016, including a female with cubs. A tigress was also documented to have raised cubs in a sugarcane field in the corridor in 2012 (personal observation, Pranav Chanchani). Additional information comes from radio-telemetry data. In the winter of 2022, a radiocollared female translocated to DNP traversed the corridor three times in the span of 10 days, using different movement pathways on each occasion and covering the length of the corridor (stopping just short of KWS in Palia range of North Kheri forest division) in just a few hours (WWF-India and Uttar Pradesh Forest Department, Unpublished data). Also, in 2022, a radio-collared male tiger spent considerable time within the sugarcane plantations in the corridor. This tiger also made a foray to the banks of the Sharda river, covering about half the distance between DNP and KWS, before turning back towards Dudhwa. Both animals were recorded to have killed feral cattle and wild ungulates (nilgai, wild pigs, hog deer) in the corridor.

Apart from tigers, swamp deer, leopards (Panthera pardus), wolves (Canis lupus palippes), hog deer, nilgai (Boselaphus tragocamelus), wild pig (Sus scrofa), jungle cats (Felis chaus), fishing cats (Priomailurus viverinnus) and occasionally elephants (Elephas maximus) are also known to use the corridor (Warrier et al., 2020, DTR and WWF-India 2022).

There is evidence of temporal and spatial variation in the use of the corridor by different species. Some of the species, like hog deer and wild pigs, occur quite widely across the corridor and may be found in the area all year-round, while others like elephants have been documented in the corridor less frequently, and their presence has usually been linked to crop-raiding along the periphery of DNP. Swamp deer were found all along the banks of Sharda river that flows through the corridor



(Internal report WWF-India) and are speculated to spend considerable amounts of time along river banks and farmlands adjacent to the river. The most significant congregations of swamp deer in India were reported from the Ghola area, which lies within this corridor (Schaller 1969), but these tracts of grasslands and wetlands have since been transformed to agricultural land. The occurrence of tigers in the corridor varies by season, with a higher probability of use during winter compared to monsoon and summer (Warrier et al., 2020).



Tiger individual photographed in camera trapping exercise in Kishanpur WLS in the year 2013-14 (left hand side image) and subsequently in Dudhwa NP in the years 2016, 2018 and 2020 (right hand side image).

2.3 Importance for connectivity at a landscape or regional level

Characterised by tall grass and deciduous forests, the lowland Terai habitat stretches along the Himalayan foothills from Uttarakhand, through northern India and southern Nepal, to Bihar. DNP and KWS are positioned approximately at the centre of this more-or-less linear, trans-boundary Terai Arc Landscape (TAL). The TAL has come to be recognized as both a densely populated region of high agricultural productivity and as a region that is critically important for the conservation of threatened mammals, birds, reptiles and plants (Mathur et al., 2011). The central location of the Dudhwa-Kishanpur corridor, within a landscape consisting of an extensive but discontiguous network of PAs and reserve forests, makes it a critical link for maintaining a meta-population of tigers and swamp deer, among other species within the transboundary TAL.

KWS and DNP are connected to a network of PAs on either side. Towards the west of the corridor, KWS, PTR, Surai range of the Terai East forest division, and South Kheri forest division form a contiguous block of habitat and support about 100 tigers

> Dudhwa-Kishanpur corridor ©Rekha Warrier

(~1/6th of the estimated population of TAL). This block is connected to the Shuklaphanta National Park, on the other side of the national boundary, in Nepal, which has an estimated 36 tigers (DNPWC and DFSC 2022). On the eastern end of the corridor, DNP has about 35 tigers (Qureshi et al., 2023). DNP is connected further east through a similar agriculture-dominatedcorridorwith the Katerniaghat Wildlife Sanctuary. Katarniaghat is connected with Bardia and Banke national parks (across the border in Nepal) and the three PAs cumulatively support about 140 tigers (Chanchani et al., 2014b). Shukhlaphanta, Bardia, and Banke national parks are connected through community managed and national forests in the Churia hills of Nepal (Paudel 2011). DNP is connected with these community managed forests in Nepal through forested corridors, and tigers can potentially move to and from Dudhwa to these two PAs in Nepal.

Despite being surrounded by high density tiger populations, the number of tigers within DNP is low, with a male-biased sex ratio (Chanchani et al., 2018). Increasing tiger numbers in Dudhwa requires, among other things, the agricultural corridor connecting Dudhwa to Kishanpur (to the west) and Katerniaghat (to the east) remain ecologically functional.







Figure 1. Map showing Protected Areas (PAs) along the transborder area of India and Nepal.

3 Corridor Characteristics

3.1 Boundaries

Delineating precise boundaries of a corridor is often a challenge. We delineated a crude boundary of this corridor based on multi-species occurrence data from the region (Warrier et al., 2019) and expert-opinion based connectivity modelling data (Chanchani and Noon 2015). While tigers and other wide ranging mammals can likely use pathways to disperse between the PAs outside of this boundary, we believe that it reasonably represents the region within which movements culminating in successful dispersal are more likely and more frequent. The corridor identified by Qureshi et al., (2014) falls within this boundary. Figure 2 represents the crude boundary (delineation details are included in the supplementary information below).



Figure 2. Delineated boundary of Dudhwa-Kishanpur Corridor along with administrative boundaries

3.2 Physical characteristics

This corridor is situated in the central part of TAL, with the northern part of the corridor lying along the Indo-Nepal border. The total area of the corridor is approximately 1,000 km² (about 60 km in length and between 13 and 25 km in width). Given that the corridor lies within the Sharda and Suheli river flood plains, almost in its entirety, the terrain is flat, with a mean elevation of 119 m. These rivers flood annually during monsoons, inundating large portions of the corridor while also depositing alluvial soil. The surface soil is mostly sandy near river banks, loamy in the uplands and clayey in lowland areas. Additionally, these rivers also benefit local people

by providing irrigation water to farmers. Barrages have been constructed upstream on the Sharda, with irrigation water being supplied across several districts of Uttar Pradesh. The Suheli barrage is near the southeastern end of DNP. Seepage from these rivers likely recharges streams and several wetlands in the corridor that are either perennial or seasonal in nature. Invasive species such as water hyacinth are widespread in several of these streams and wetlands. The river banks have stands of *Saccharum spontaneum*, *Phragmites karka* and other grasses that have largely been replaced by farmlands.



3.3 Hydrology

The corridor lies in the Upper Ganga basin. The Sharda river is the major river passing through this corridor; the river originates in the Pithoragarh district of Uttarakhand and travels through the western boundary of Nepal before entering the corridor. Seventy kilometres of the river is in the corridor and drains into the Ghaghara, a tributary of the river Ganga which lies 110 km south of the corridor. The Sharda river is a Himalayan perennial river and the banks of the river are prone to floods in the monsoon. The flow in the river is regulated upstream, not in the corridor region, by the Banbasa barrage. Headwaters of small tributaries of Ghaghara and small water bodies also lie within the corridor. The average annual rainfall in the region is 1059 mm.





Figure 3. River network and water bodies located within the Didhwa-Kishanpur Corridor and the surrounding areas

3.4 Land use within corridor

Nearly 80% of the corridor area is under human use, primarily under agriculture (78%) and human habitation (2%). Forests, grasslands and sand islands along the Sharda River cover about 20% of the corridor area, most of which are under the administrative jurisdiction of North Kheri forest division (a part of the buffer zone of Dudhwa Tiger Reserve). A railway line and a network of roads crisscross the corridor.

Lakhimpur-Kheri district, which holds nearly 90% of the corridor, is sometimes referred to as the "sugar bowl" owing to its large-scale sugarcane production. In 2014-15, sugarcane was cultivated in about 2.1 lakh hectares in the district, and the average yield was 601 quintals/ha (https://lakhimpurkheri.kvk4. in/district-profile.html). Sugarcane is the most preferred crop of the local farmers for several reasons. It is a cash crop that requires relatively little care after plantation; the high water table of terai favours its cultivation and there are several sugar mills in the region. The typical sugarcane crop cycle is 13 months long and is harvested in winter, between November and March in the succeeding year. Second most grown crop is paddy. It was grown in 1.7 lakh hectares in the district in 2014-15. Apart from these crops, wheat, maize, mustard, and ground nuts are other crops grown by farmers. Watermelon and carrots are grown along the river banks of Sharda after the monsoon recedes.

~ 80% Corridor is under human use 78% Agricultural land ~ 20% Forest land (forests, grasslands and sand islands) ~ 1.3% Permanent water bodies 16.85 km National highways Π 32.65 km State highways 22.8 km Railway line intersects



19

with the corridor

3.5 Critical corridor areas

Field observations suggest that the Sharda river and various drainage features, including remnant ox-bow lakes, are important for the occurrence of large mammals (Warrier et al., 2020). However, anthropogenic pressures along the banks of the river may reduce the quality of available natural habitats over time. Understanding these pressures and taking appropriate conservation measures would be critical to ensure wildlife use and functional connectivity are maintained in this corridor.

Gray wolf (Canis lupus)

4 Stakeholders and Management

4.1 Land tenure and holding

All villages within the corridor are revenue villages managed under Gram Sabhas/ Gram Panchayats. Agriculture fields are privately owned by individuals. Preliminary surveys suggest that the average land holding size in the area is about 2 acres (Rekha Warrier, unpublished data). There are small patches of forests that lie within the corridor, managed by the buffer zone division of the Dudhwa Tiger Reserve (Sampurnanagar, Palia and Magjia ranges). There are streams, wetlands and marshes in the corridor area, which likely come under the jurisdiction of government agencies. A periphery of 1 km around DNP and KWS, which encompass the corridor, has been proposed to be notified as an Eco-Sensitive Zone (ESZ). Declaring the corridor as an ESZ can help regulate land use change within the corridor and prohibit developmental activities that are likely to impact wildlife movement negatively.

4.2 Settlements and Communities

The average human population density in the corridor area is 648 persons/ km². There are about 178 villages in this corridor with an average population of 2373 people/ village. Many of these villages are located in low-lying areas which get flooded annually, especially those which are located along the Sharda and Suheli rivers. In some areas, rainwater remains stagnant throughout the year, forming perennial wetlands and nallahs. Towns such



as Palia, Sampurnanagar, Bhira, and Nighasan are the regional economic centres. Small businesses, and the presence of sugar mills and refineries in these towns provide livelihood support for nearby villages. Of the total human population in the corridor, approximately 0.5% belong to Scheduled Tribes (ST) and 26% to Scheduled Castes (SC) (Census of India, 2011).

Village located along the Shardarive ©Raiva Singh



Figure 4. Settlements and major roads passing through the Dudhwa-Kishanpur corridor



5 Challenges

5.1 Infrastructure

Linear infrastructure:

The average density of large linear features (highways, railways and canals) in the corridor is 59 m/km². Two state highways, the two-lane Bhira-Palia-Dudhwa (SH90) and Dhanuraghat-Palia-Nighasan (SH101), and one district road pass through this corridor. Numerous village roads join these highways. In addition to these existing highways, a new Sashastra Seema Bal (SSB) border road is under construction, passing through the northern part of the corridor close to the Indo-Nepal border. Most sections of these highways have relatively higher traffic during day hours and remain largely unused at night. It is speculated that presently these roads have minimal effect on animal movement owing to low vehicle traffic in night hours. However, these roads may impede animal movement, given the probability of an increase in night traffic in the near future. The death of a tiger occurred along the Bhira-Mailani road passing through KWS owing to a vehicle collision in 2011. Herbivores and other lesser known species also face vehicle collisions, however data recording is sparse.

A meter-gauge railway track links Mailani and Bahraich towns. The 23 km railway track passes through the corridor with a main junction at Palia- a small town which is located at the centre of the corridor. Mortality of 8 tigers, 5 elephants, 35 spotted deer and other mammals had been reported in the Dudhwa Tiger Reserve between 1987 and 2019. A Public Interest Litigation (PIL) has been filed in the Honourable Allahabad High Court, Lucknow Bench, requesting directions to minimise the effect of this railway track on wildlife in Dudhwa Tiger Reserve. A committee of secretaries under the chairmanship of the Cabinet Secretary, Government of India, including the State of Uttar Pradesh, was set up to provide inputs on the management of this railway track. Based on the recommendation of the committee, the Indian Railways had decided to close the railway track. The Indian Railways stopped operation on the said line, but some PILs were filed against the closure. On the intervention of the Honourable Court, the services were resumed, but

5.2 Human-wildlife conflict

Seventeen cases of human-tiger conflict were reported between 2008 and 2020 in the corridor (Chatterjee et al., 2022). As compared to other areas in the landscape, reported conflict in the corridor is relatively low in terms of human deaths and injuries. For instance, about 8-9 human deaths and injuries were reported per year on an average between 2008 and 2020 in and around PTR owing to tigers. Of 17 conflict cases, 10 tiger attacks resulted in fatalities and the other 7 victims were injured. The majority of victims (n=14) were male. Most of these conflict cases (n=14) occurred within farmlands when people were working in farmlands. There are also a few instances where tigers were captured and relocated after they were perceived as a threat to local people. In 2016-17, a tigress was captured from Palia range of buffer zone division of DTR after being sighted near human settlements and sent to a zoo. Similarly, another tigress was captured near Nighasan after it was nearly killed by people and subsequently sent to a zoo. A tigress was captured in 2022 after it attacked a boy in Marocha village, near Palia town and was released in DNP following Standard Operating Procedures of NTCA after fitting a radio-collar.

Given human-tiger conflict is one of the most underpressing conservation issues in the landscape, identification of potential areas that have higher probability of conflict occurrence was crucial. A preliminary analysis by Bista et al., (in prep) predicted potential areas with the likelihood of conflict occurrence (Figure 5) by fitting a Resource Selection Function (RSF) model to a 11 year spatial dataset of conflict events (1's), that were compared against randomly generated points (0's). Variables included in the model were human settlement, water occurrence, extent of forest, extent of cropland, nightlight, distance to forest and presence of drainages. Variable Inflation Factor (vif) was used to test for multicollinearity, and covariate that showed high multicollinearity (r> 0.6) was omitted from the analysis and regression model was developed with remaining covariates. A generalised linear model was fitted in RStudio ver 1.3.959. The model predicted that areas closer to forest edges are more likely to experience humantiger conflict.



Figure 5. Spatial prediction of human-tiger conflict (HTC) in Dudhwa Kishanpur Corridor and surrounding areas from a resource selection function model for field data from 2008 to 2018.



Human-elephant conflict in the form of crop raiding is common along the southern boundary of DNP. Villages close to Sathiyana, Dudhwa, South Sonaripur and Belrayan ranges of DNP experience crop raiding by elephants.

Human-wolf conflict is also reported from this corridor, but such reports are rare. Banks of the Sharda river provide a favourable habitat for wolves, and villages closer to the river are likely to experience conflict with wolves. In 2018, a wolf attacked 3 people sleeping outside their homes in Bijuwa village. In retaliation, the wolf was killed by local people.

The government of Uttar Pradesh has developed a compensation mechanism for wildlife-related conflict, however, considerable delay in payment of compensation is reported by villagers. For livestock depredation events that occur outside PAs, affected individuals are entitled to receive a partial market price of the killed livestock as compensation. Similarly, in cases involving tiger, leopard, and elephant attacks on humans outside PAs that result in an individual's death, the victim's family is entitled to a compensation of 5 lakh rupees. Compensation schemes currently do not cover crop losses resulting from depredation by wild herbivores other than elephants, even though this is the more insidious and spatially extensive type of conflict in the corridor. Farmers employ various types of fencing (electric, razor-wire and fladry) to protect their crops, besides more traditional methods such as the use of night watchmen and scarecrows. Fencing is not deployed extensively enough to cause fragmentation of the landscape; however, electric and razor-wire fences may be responsible for wildlife mortalities in the corridor.

5.3 Land-use change over time

Field observations suggest that some level of conversion of wetlands into farmlands and expansion of built-up areas are taking place in the corridor. However, the extent and intensity of wetland conversion and expansion of built-up areas is not known.





6 Recommendations

Given the limited research on the corridor, some broad recommendations and some actionable points are outlined. It is suggested that specific actions be identified guided by research on connectivity, social dimensions and animal ecology in farmlands.

- This corridor has been included in the Tiger Conservation Plan (TCP) of DTR, approved by the National Tiger Conservation Authority (NTCA). In its present form, the TCP provides a basic description of the corridor and outlines some key measures. However, there is a need to develop a comprehensive corridor management plan guided by scientific assessments to identify focal areas for restoration, strengthening protection, and managing human-wildlife conflict, among other things.
- **2.** Most of the corridor area falls under the category of private farmland. Considering notification

of the corridor as a 'Community Reserve', provisioned under the Wildlife Protection Act 1972, can be a way of recognizing and conserving this corridor. This would require prior alignment of local community goals with conservation objectives with full and equal participation of the local communities.

- **3.** The Uttar Pradesh Forest Department has proposed to declare an Eco-Sensitive Zone of 1000 metres around DNP and KWS. Given that tigers and swamp deer, species of global conservation importance, occur in farmlands within the corridor extensively, it is advisable that the existing boundary of ESZ be reviewed and extended suitably, if possible, to cover larger areas overlapping with the corridor.
- **4.** Small patches of natural habitat (forests, grasslands and wetlands) are embedded within this farmland-dominated corridor. Restoring and maintaining

Crocodile (Crocodylus palustris) these natural habitat patches within the corridor should be a priority as small patches contribute to short and long-term species persistence, as well as provisioning of in situ to global ecosystem services, but are often the most vulnerable to land clearing (Decocq et. al., 2016; Tulloch et al. 2016). Within this corridor, conversion of wetlands and grasslands into farmlands (for sugarcane cultivation) and other land uses remains one of the biggest threats.

- Despite being more sensitive to hydrological and climatic conditions and more vulnerable to agriculturalization and urbanization, small wetlands are largely excluded from water management planning in most agro-ecosystems (Xu et al., 2023). In order to understand their importance and devise a management plan, the first step would be to map and characterise the wetlands within the corridor.
- Several of the forest patches and wetlands within the corridor are degraded. Hence, restoration of native vegetation in the forest patches and removal of aquatic weeds from the wetlands would be crucial to ensure that these patches of natural habitat continue to provide ecosystem services. The forest patches are a part of the buffer division of DTR and most of the wetlands are either under the ownership of the Gram Sabhas or the forest department. The forest department and district-level governance agencies can focus on examining and implementing policies and plans that are focused on protecting these crucial ecosystems in farmlands.
- Recent surveys with communities living along the boundaries of Dudhwa and Kishanpur suggest that they continue to depend on forests and grasslands for fuelwood for cooking and thatch for roofs. In recent years government schemes such as Pradhan Mantri Awas and Ujjwala Yoajana have endeavoured to provide households with access to cooking fuel and funds for constructing permanent houses. While the schemes are known to have high village-level penetration, communities in the corridor still depend on natural resources. Exploring sustainable energy-security measures in the corridor is hence essential.
- 5. Tigers and leopards routinely use the corridor for movement between PAs and also as an extension of their habitat. Although rare within this corridor, wildlife conflict can sometimes lead to loss of human life. The Uttar Pradesh government pays ex-gratia in case of such a loss through the Disaster Relief Fund and the state funding of the forest department. In some parts of the state, through the Bagh Mitra programme, representatives of the local communities, the Bagh Mitras, facilitate the filing of claims for ex-gratia. Extending such community based programmes to this corridor and expanding their mandate to include monitoring of large cat movement within farmlands may be useful towards maintaining coexistence in the landscape.

Dudhwa Kishanpur Corridor ©Raiva Singh

7 Conservation Activities

In order to understand the movement patterns of tigers in the farmland system, Dudhwa Tiger Reserve and WWF-India jointly radio-collared two tigers (a male and a female) between 2021 and 2023. While the male tiger intermittently used only some parts of the corridor, the tigress moved extensively between DNP and KWS through farmlands and nalas lying between Palia and Khajuria. Tigress spent considerable time in the farmlands - preying upon wild ungulates (nilgai, wild pig and hog deer), and barely entered the forest. Her behaviour flagged the need to assess the status of wild ungulates in these farmland systems. Understanding the status of wild ungulates can help managers prepare plans and devise conservation measures to protect tigers and other wildlife in the farmland. Keeping this in mind, WWF-India is testing new unmarked methods using camera traps to estimate the density of wild ungulates in the corridor area. Furthermore, WWF-India is also carrying out occupancy surveys in the corridor to assess the habitat use of tigers and the factors governing the use of tigers in farmland systems.

WWF-India has installed a solar fence over a stretch of 7 km near Bhagwantanagar village near South Sonaripur range to help farmers protect their cropland from elephants. This solar fence is being managed by local farmers, and it is perceived that the fence has offered some level of protection in helping reduce instances of crop raiding.



Community members clearing vegetation for maintenance of the solar fence



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8.2 News articles



डा. मदित गुप्ता आशीष तिस्टा वरिष्ट समन्वराक वरिष्ठ परियोजना अधिकारी, उप्र, उत्तर प्रदेश, डक्स्यूडक्सूएफ-उक्त्रुउक्त्रूएफ इडिया

विभ एवं वन्य जीवीं का संरक्षण भारतीय सभ्यता का एक अभिन्न अंग रहा है, परंतु बढ़तो जनसंख्या एवं इसके कारण बहते जैविक दबाव को पुरा करने के लिए पिछले दशकों में वनों का दोहन भी खुब हुआ है। भारत में बन तथा बन्यजीवीं को बचाने तथा इनके संरक्षण के लिए संरक्षित क्षेत्रों की व्यापना को गई है। वर्ष 2020 तक भारत में कुल 104 राष्ट्रीय उद्यान तथा 566 वन्य जोव अभयारण्य की स्थापना की जा चुको थी। भारत के पहले राष्ट्रीय उद्यान 'हेली राष्ट्रीय उद्यान' (इसे आज कार्बेट राष्ट्रीय उग्रान के नाम से जाना जाता

है) को स्थापना वर्ष 1936 में हुई थी, परंतु सही मायने में वर्ष 1973 में भारत सरकार की 'वाध परियोजना' लागू होने के वाद संरक्षित क्षेत्रों के तंत्र में अधिक मजबूती आई। 1972 में भारत में वन्य जोव (संरक्षण) अधिनियम लागू किया गया जिसमें देश के संरक्षित क्षेत्रों एवं वन्यजीवों को पूर्ण सुरक्षा प्रदान की गई है। देश के संरक्षित क्षेत्र जैविक संसाधनों के भंडार है। ये संपूर्ण मानव जाति के लिए आवश्यक प्राकृतिक सेवाएं जैसे-हवा तथा जल का शुद्धीकरण, वर्षा, बाढ़ तथा तापमान नियंत्रण और फसलों का परागण इत्यादि करते हैं।

भारत में अधिकांश संरक्षित क्षेत्रों का क्षेत्रफल लगभग 400 से 500 वर्ग किलोमीटर हो है। संरक्षित क्षेत्रों का आकार में कम होना कुछ वन्यजोवों जैसे-वाघ तथा हाथी के संरक्षण के दृष्टिगत चिंता का विषय है, क्योंकि इन जोवों को अपने जीवन चक्र को पूर्ति के लिए बड़े क्षेत्रों की आवश्यकता होती है।

वन क्षेत्र में एक वयरक नर बाघ के रहने के लिए आवश्यक क्षेत्र की सीमा लगभग 200 वर्ग किमी तथा एक वयस्क नर हाथी के लिए यह सीमा क्षेत्र 400 वर्ग किमी तक हो सकती है। अर्थात इन चन्यजीवीं को अपने देश में संरक्षित करने के लिए हमें और अधिक तथा चड़े वन क्षेत्रों को आवश्यकता है। अपने छोटे आकार के अतिरिक्त कुछ संरक्षित क्षेत्र अन्य संरक्षित क्षेत्रों से आशिक अथवा पूर्ण रूप से पूथक हैं जिससे इन क्षेत्रों में पाए जाने वाले जीवीं का दीर्घकालीन संरक्षण चुनौतीपूर्ण प्रतीत होता है।

वन एवं वन्य जीवों का संरक्षण

विश्व बाध दिवस एक महत्वपूर्ण अवसर है जब हम वन क्षेत्रों के समीप रहने वाले समुदायों तक

विभिन्न विखडित संरक्षित क्षेत्रों के मध्य वन्यजीवीं के आवागमन को सुगम एवं सुरक्षित बनाने के लिए इन क्षेत्रों को जैविक गलिवारीं के माध्यम से जोड़े जाने की आवश्यकता है। जैविक गलियारे दो अथवा अधिक वन प्रखंडों के मध्य वन्यजीवों के आवागमन तथा विचरण के लिए प्राकृतिक मार्ग है। ये मार्ग विभिन स्वरूपों में हो सकते है। उदाहरण के तौर

यह अपील पहुंचा सकते हैं कि वन तथा वन्यजीवों का संरक्षण संपूर्ण मानव जाति के हित में है पर-कृषि भूमि, नदी और बहुउद्देशीय वन। विभिन्न क्षेत्रों के मध्य वन्यजीवों का आवागमन कई कारणों से होता है। पहला, इससे प्रजातियों में अंतः प्रजनन को संभावना कम होती है। अंतः प्रजनन से वह प्रजाति हमेशा के लिए विलुप्त भी हो सकती है। दूसरा, चन्यजीव प्राकृतिक आपदाओं जैसे-बोमारी का फैलाव, बाइ, अग्नि इत्यादि से अपना बचाव कर सकते है। जाहिर है ये जैविक गलियारे महत्वपूर्ण हो जगहर हे व जावक गोलवार महत्वपूर्ण पारिस्थितिकीय क्षेत्र हैं, परंतु कभी-कभी इनका संरक्षण एक अत्यधिक दुरुह कार्य भी होता है, क्योंकि सामान्य तौर पर जैविक गलियारे चन तथा संरक्षित क्षेत्रों के बाहर पाए जाते हैं। ऐसी स्थिति में वन अधिकारियों तथा कर्मचारियों द्वारा इनका संरक्षण दुष्कर हो जाता है।

उत्तर प्रदेश में भारत सरकार के राष्ट्रीय बाघ संरक्षण प्राधिकरण एवं भारतीय वन्यजीव संस्थान द्वारा संचालित अखिल भारतीय बाघ गणना वर्ष 2018 के अनुसार कुल 173 बाघ है। इनमें से बाधों की



बाप जैसे वन्य जीव हमारी संस्कृति तथा जीवन का अभिन्न हिस्सा रहे हैं।

अधिकांश आवादी पीलीभीत तथा दुधवा टाइगर रिजर्व में विचरण करती है। जैसे एक अवयस्क वाच जिसको सर्वप्रथम किशनपुर वन्य जीव विहार में पाया गया था। यहँ वाघ कुछ समय बाद दुधवा राष्ट्रीय उशान में देखा गया। किशनपुर वन्य जीव विहार तथा दुधवा राष्ट्रीय उद्यान आपस में 30 किलोमीटर की दूरी पर है। इसी तरह दुधवा-कर्तानयाधार जैविक गलियारा विगत वर्षों में कई बार गैडों के द्वारा प्रयोग किया गया है। उत्तर प्रदेश में कृषि भूमि से होकर वन्यजीवों का यह आवागमन टीईकालीन चन्द्र जीव संरक्षण को दिशा में अत्यंत महत्वपूर्ण है। संरक्षण को प्रक्रिया में स्थानीय समुदाय भी एक महत्वपूर्ण साझीदार है। विश्व

वाच दिवस एक महत्वपूर्ण अवसर है

जब हम वन क्षेत्रों के समीप रहने वाले समुदायों तक वह अपील पहुंचा सकते हैं कि वन तथा वन्यजीवों का संरक्षण संपूर्ण मानव जाति के हित में है। पृथ्वी को प्रत्येक जोवित प्राणी एक विशाल जीवन चक्र का हिस्सा मात्र है तथा सभी प्रजातियों का अस्तित्व एक दसरे पर निर्भर है। जैविक गलियारों के संरक्षण के लिए स्थानीय समुदाय को अपनी भागीदारी सुनिष्टिित करनी होगी तथा सरकार एवं वन विभाग के साथ मिलकर सभी प्राकृतिक संरचनाएं जैसे नदी, तालाव तथा कृषि भूमि को इसके वर्तमान स्वरूप में बनाए रखना होगा। वन्य जीव हमारी संस्कृति तथा जीवन का अभिन्न हिस्सा रहे हैं। इस तंत्र को संरक्षित करने को जिम्मेदारी हम सभी की है।

9 Supplementary Information

Delineation of the crude corridor boundary:

Circuit theory-based modelling approach was used to identify the corridor based on resistance surface generated using expert opinion (Chanchani and Noon., 2015; Figure S1). The cumulative current output values were classified into 10 quantiles, and the top four quantiles were chosen. Warrier et al., (2019) carried out multi-season tiger occupancy estimation in the areas between Dudhwa and Kishanpur using a 2.5 km² grid. We selected grids that had tiger occupancy estimates of > 0.5 for at least one season and grids that had more than one detection of species other than tigers. The two outputs (top quantiles from circuitscape output and occupancy and species occurrence data) were overlaid and merged into a combined vector layer along with the least-cost-corridor identified in (Qureshi et al., 2014) to get potential movement areas. A 1 km x 1 km grid was overlaid on the combined vector, and grid cells that overlapped with the identified potential movement areas were selected in QGIS using the 'Extract by location' algorithm in the Vector Selection toolbox and dissolved to get the final boundary represented on the map (Figure 1).



Figure S1. Tiger connectivity in the Dudhwa-Kishanpur region. The connectivity map was generated using a circuit theory based approach and a resistance map parameterized based on expert opinion (adapted from Chanchani and Noon., 2015). Grey regions depict the areas most likely used by dispersing tigers and the red regions with low probability of movement.

Estimation of principal indicators:

Seven principal indicators, namely area of natural habitat, area under forest department, threatened species richness, average human population, human modification index, landscape complexity index, and natural habitat fragmentation index, were calculated to provide the overall status of the corridor. The method of estimating the value of each indicator is available online at http:// corridorcoalition.org/CWC/about.htm

> Dudhwa Kishanpur Corridor ©Raiva Singh









COALITION FOR WILDLIFE CORRIDORS The Coalition for Wildlife Corridors is a collaborative network of people and organizations working to advance connectivity conservation in India.

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