



# The Survivability And Connectivity Of Bengal Tigers Within Valmiki Tiger Reserve And Its Adjacent Forest Patches In Bihar And Nepal - A Review

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## Abstract

The Valmiki Tiger Reserve (VTR), a crucial habitat for the endangered Bengal tiger (*Panthera tigris tigris*), is situated in Bihar, geographically within the Himalayan Terai region along the Indo-Nepal borderlands. This review explores the factors affecting tiger survival and movement, focusing on habitat suitability, corridor connectivity, and conservation efforts. Habitat fragmentation caused by agriculture, infrastructure, and human encroachment impedes tiger dispersal, affecting genetic diversity and long-term viability. Corridors linking VTR to Nepal's Chitwan and Parsa National Parks are vital but threatened by deforestation and development. The review evaluates tools like GIS modeling and field surveys in identifying suitable habitats and functional corridors. Poaching, human-wildlife conflict, and declining prey populations further threaten tigers. Current conservation efforts—habitat protection, anti-poaching actions, community initiatives, and cross-border collaboration—show promise but require strengthening. The study emphasizes integrated, landscape-level strategies and community engagement to safeguard the Bengal tiger population in VTR and surrounding areas.

**Index Terms** - Bengal tiger, Valmiki Tiger Reserve, connectivity, survivability, conservation, human-tiger conflict.

## Introduction

Valmiki Tiger Reserve (VTR), situated in Bihar within the biodiverse Himalayan Terai bordering India and Nepal, represents a critical yet increasingly fragmented stronghold for the endangered Bengal tiger. The ecological integrity of this transboundary landscape is paramount for the long-term survival of tiger populations, which rely on adequate habitat, prey availability, and crucial connectivity between isolated forest

patches. Growing human pressures, including habitat fragmentation and infrastructure development, pose significant threats by hindering tiger movement and limiting genetic exchange.

This review consolidates existing research on the ecological dynamics of Bengal tigers within VTR and its adjoining forest areas in both Bihar and Nepal. It examines the key determinants of tiger survival, such as habitat quality, prey abundance, and the impact of human activities. Furthermore, it investigates the vital aspect of landscape connectivity, identifying existing wildlife corridors and potential obstacles that either facilitate or impede tiger dispersal across the reserve and its neighboring forest areas.

By critically assessing the current body of knowledge, pinpointing gaps in understanding, and highlighting both the challenges and opportunities for tiger conservation in this complex transboundary region, this review seeks to provide a comprehensive overview. The aim is to inform future research endeavors and guide effective management interventions designed to ensure the long-term viability and interconnectedness of Bengal tiger populations within the Valmiki Tiger Reserve and its broader, interconnected ecosystem spanning India and Nepal. The insights gained from this synthesis will be invaluable for directing conservation strategies and fostering collaborative efforts between the two nations, ultimately contributing to the wider goal of Bengal tiger recovery throughout their range.

### **Connectivity Analysis**

For Bengal tigers to survive long-term in fragmented areas like the Terai Arc Landscape, especially around Valmiki Tiger Reserve (VTR) bordering Nepal, ecological connectivity is essential. This allows movement, maintains genetic diversity, and aids adaptation. However, habitat loss from human activities isolates tigers, raising the risk of inbreeding and local extinctions.

Analyzing connectivity near VTR involves mapping habitats, finding potential corridors (like forest strips), and evaluating landscape resistance (settlements, infrastructure). Techniques like least-cost path analysis and circuit theory quantify this, while field data (camera traps, genetics) confirm the models. The vital VTR-Parsa-Chitwan corridor is threatened by agriculture and infrastructure.

Connectivity analysis guides key conservation: protecting and restoring corridors, lessening infrastructure impacts, managing habitats, involving communities, and fostering cooperation between India and Nepal. Collaborative work and tackling socio-political issues are vital for effective corridor management, particularly with increasing climate change impacts.

### **Extinction Risk Assessments**

The Bengal tiger population in Valmiki Tiger Reserve (VTR), Bihar, and its connected forests in Nepal faces increasing extinction risks from habitat loss, fragmentation, poaching, and human conflict. While tiger numbers show promise, long-term survival hinges on habitat integrity and ecological corridors.

The isolated VTR population is susceptible to inbreeding and random events. Fragmentation from development restricts movement and gene flow, raising local extinction risks. Connectivity with Nepal's Chitwan-Parsa and Uttar Pradesh's Sohagi Barwa is vital for dispersal and genetic diversity.

Poaching remains a major threat, amplified by cross-border challenges. Prey scarcity, overgrazing, and encroachment degrade habitat, increasing conflict. Climate change further threatens survival by affecting resources.

Tools like Population Viability Analysis, genetic studies, and corridor modeling assess extinction risks. Effective conservation requires boosting connectivity, strengthening anti-poaching efforts, fostering community coexistence, and building climate resilience. A collaborative, evidence-driven strategy is crucial for securing Bengal tigers in this sensitive transboundary region.

## **Ecological Persistence and Spatial Distribution**

The long-term future of Bengal tigers in the Valmiki-Nepal region hinges on their ecological persistence and spatial distribution. Their ability to thrive within Valmiki Tiger Reserve (VTR) relies on good habitat, consistent prey, and low human disturbance, all currently under pressure from habitat loss and human activities.

The pattern of where tigers live is shaped by habitat characteristics, food sources, and human presence. Although tigers move between India and Nepal, which is essential for genetic health, infrastructure development along the border is disrupting these vital connections. Monitoring tiger distribution using tools like camera traps and habitat models is key to effective conservation planning.

Therefore, successful conservation requires a two-pronged approach: strengthening the ecological conditions within VTR and ensuring functional corridors across the wider landscape. This demands efforts in habitat recovery, protecting movement pathways, reducing human-tiger conflict, and fostering cooperation between India and Nepal to secure the continued existence of these iconic animals in this important area.

## **Connectivity And Corridor identification**

Ensuring habitat connectivity is critical for the survival and genetic resilience of Bengal tigers in the Valmiki Tiger Reserve (VTR) and nearby forested regions of Bihar and Nepal. Tigers, as territorial carnivores with wide-ranging movements, depend on ecological corridors to disperse, find mates, and maintain gene flow. The Terai Arc Landscape (TAL), including VTR and neighboring reserves such as Chitwan and Parsa National Parks in Nepal, forms a crucial transboundary region where such connectivity underpins a stable metapopulation.

Yet, increasing habitat fragmentation from human activities—such as road construction, farmland expansion, and settlement growth—poses serious challenges to tiger movement. Research using GIS mapping, remote sensing, and camera traps has highlighted several important corridors, notably the Gandak River Corridor, the Narkatiaganj-Harnatand forest link, and potential pathways to Sohagi-Barwa Wildlife Sanctuary in eastern Uttar Pradesh.

Sustaining these corridors requires coordinated, landscape-level conservation efforts. Key strategies include restoring degraded habitats, formal recognition of corridor zones, limiting human disturbance, and engaging local communities. Strengthened cross-border collaboration between India and Nepal through TAL initiatives is essential for safeguarding these ecological lifelines and ensuring long-term tiger conservation across the region.

### **1.The VTR-Parsa Corridor: Transboundary Linkage For Bengal Tiger Conservation**

The Valmiki Tiger Reserve (VTR) in India shares a crucial border with Parsa National Park (PNP) in Nepal, forming a significant contiguous forest block within the Terai Arc Landscape (TAL). This transboundary region is home to a substantial Bengal tiger population, and the ecological connectivity facilitated by the VTR-Parsa corridor is paramount for the long-term survival and genetic health of these majestic predators. This section delves into the ecological significance, landscape characteristics, existing challenges, ongoing conservation efforts, and future recommendations for strengthening this vital linkage.



### ***Ecological Importance***

The VTR-Parsa corridor serves as an indispensable conduit for the movement of tigers and other wildlife across the international border. This unrestricted movement allows for essential ecological processes such as seasonal migrations in response to resource availability and crucial dispersal of young individuals seeking new territories. By enabling the exchange of genetic material between the tiger populations of VTR and PNP (which is contiguous with the larger Chitwan National Park), the corridor plays a pivotal role in mitigating the risks associated with genetic isolation, such as inbreeding depression and reduced adaptive capacity. Furthermore, this interconnectedness contributes to a more resilient metapopulation structure, where the overall stability of the regional tiger population is enhanced by the potential for recolonization following localized extinctions due to natural or anthropogenic disturbances. Scientific evidence, including telemetry data and camera trap records gathered by organizations like WWF, the National Trust for Nature Conservation (NTNC), and the Wildlife Institute of India (WII), substantiates the functional use of this corridor by tigers, leopards, and elephants, particularly across the Gandak River and into the foothills of the Chure range.

**Landscape Features and Human Influence:** The geographical terrain encompassing the VTR-Parsa corridor is characterized by a mosaic of valuable habitats, including riverine woodlands, dominant sal forests, and fertile alluvial floodplains, with the significant Gandak River bisecting the landscape. While the Nepalese side generally exhibits lower human population densities and boasts several continuous forest blocks like Madanpur and Harnatand that facilitate wildlife movement, the corridor is increasingly susceptible to alterations in land use patterns. The expansion of agricultural land, often encroaching upon forest areas, coupled with the detrimental impacts of unregulated sand mining activities and the linear barriers created by infrastructure development such as roads and irrigation canals, are emerging as significant threats to the corridor's integrity.

### ***Conservation Challenges***

Despite its ecological significance, the VTR-Parsa corridor faces a multitude of challenges that hinder its optimal functionality. The construction of linear infrastructure, including roads, railway lines, and irrigation canals, acts as physical barriers, impeding the natural movement of wildlife. The persistent threat of poaching and the escalating instances of human-wildlife conflict, particularly in areas where forest edges meet human settlements, pose direct risks to tiger survival within the corridor. Furthermore, the presence of international political and administrative boundaries complicates the implementation of cohesive and unified conservation strategies. The lack of standardized joint monitoring protocols and efficient mechanisms for data sharing between the forest departments of India and Nepal further impedes effective corridor management. Finally, the increasing anthropogenic pressures stemming from expanding human settlements and the intensification of agricultural practices within the corridor region exacerbate habitat fragmentation and degradation.

### ***Conservation Initiatives And Direction***

Recognizing the critical importance of the VTR-Parsa corridor, several positive conservation initiatives are underway. These include collaborative transboundary agreements facilitated by the Terai Arc Landscape (TAL) program, joint patrolling efforts conducted by Indian and Nepali forest personnel, and community-based engagement programs aimed at promoting sustainable eco-development and effective buffer zone management. To further strengthen the functionality of this vital corridor, several key recommendations warrant consideration. Formalizing a comprehensive transboundary conservation protocol that outlines procedures for joint monitoring, coordinated anti-poaching operations, and collaborative habitat management is essential. Prioritizing habitat restoration through active afforestation and promoting natural regeneration in degraded forest patches within the corridor can enhance its suitability for wildlife movement. Implementing wildlife crossing structures, such as overpasses and underpasses, along major transportation arteries can mitigate the fragmenting effects of linear infrastructure. Expanding community-based conservation initiatives by incentivizing local communities to act as stewards of the forest and providing alternative livelihoods to reduce their dependence on forest resources is crucial for long-term success.

### **2. VTR- Suhelva Corridor : Linkage With Untapped Potential For Bengal Tiger Dispersal**

The Valmiki Tiger Reserve (VTR) in Bihar also shares a southern boundary with forest areas that, if effectively connected, could link it to the Sohelwa Wildlife Sanctuary (SWS) in Uttar Pradesh. Although currently less established as a functional tiger corridor compared to the VTR-Parsa linkage, the VTR-Suhelva corridor holds significant potential for maintaining ecological continuity between the Terai and the Vindhya landscapes within India. This section examines the ecological significance, current status, existing impediments, potential conservation opportunities, and recommended strategies for realizing the latent connectivity of this interstate linkage.



#### ***Ecological Significance***

The VTR-Suhelva corridor, while not currently a primary route for regular tiger movement, represents a potentially crucial north-south ecological connection. Establishing a functional link between VTR and SWS could facilitate the dispersal of tigers and other wildlife, contributing to the genetic health and long-term viability of tiger populations within India. Sohelwa Wildlife Sanctuary, although experiencing sporadic tiger presence confirmed through occasional sightings and indirect evidence like pugmarks and scat, possesses suitable habitat and prey species such as chital and sambar that could support a resident or transient tiger population. Given the increasing tiger density within VTR and the inherent limitations in territorial expansion within the reserve's boundaries, the southern dispersal route towards Suhelva could become strategically important for accommodating dispersing young tigers in the future. Currently, the connectivity between VTR and SWS is fragmented, with forest patches in areas like Ramnagar, Bagaha, and Gobindganj potentially serving as stepping-stone habitats that might facilitate occasional, albeit limited, wildlife movement.

**Impediments For Connectivity**

The development of a functional VTR-Suhelva corridor faces substantial and complex challenges. The landscape southeast of VTR is characterized by severe habitat fragmentation primarily driven by the expansion of agricultural lands, the dense network of railways and roads, and unplanned urban development, particularly in northwestern Uttar Pradesh. Weak forest protection measures and limited systematic wildlife monitoring efforts within the Suhelva Wildlife Sanctuary itself further compound the issue. The relatively low and sporadic tiger presence in SWS currently provides limited impetus for implementing tiger-centric conservation initiatives in the region. Moreover, significant encroachment on forest lands and pervasive logging pressures, especially in community-managed and revenue forests situated outside formally protected areas, degrade potential corridor habitats. A lack of awareness and limited support for the importance of corridor protection among local communities and stakeholders also presents a considerable hurdle. Finally, the need for effective inter-state coordination and collaboration between the administrative bodies of Bihar and Uttar Pradesh adds another layer of complexity to the establishment and management of this interstate corridor.

**Conservation Opportunities And Recommendations**

Despite the significant challenges, the VTR-Suhelva corridor presents several conservation opportunities that can be leveraged through proactive and strategic planning. Conducting a comprehensive corridor feasibility and habitat suitability analysis utilizing advanced tools like GIS, coupled with ground-based surveys such as camera trapping and scat collection, is a crucial first step. Strengthening the protection and patrolling mechanisms within Sohelwa Wildlife Sanctuary and the intervening forest divisions in both Bihar and Uttar Pradesh is paramount. Designating Eco-Sensitive Zones (ESZs) or establishing Conservation Reserves in the buffer areas surrounding protected forests can help regulate land use and minimize further habitat degradation. Implementing targeted corridor restoration programs, including assisted natural regeneration of native vegetation and the removal of physical barriers like unnecessary fencing, can enhance habitat connectivity. Engaging local communities through the development of community-based ecotourism initiatives and alternative livelihood projects can create economic incentives for corridor preservation and foster local stewardship. Furthermore, integrating the VTR-Suhelva corridor into broader conservation frameworks, such as the Landscape Management Plans (LMPs) under India’s Project Tiger or as a strategic extension within the National Wildlife Action Plan, can provide the necessary policy support and financial resources for its effective management and restoration.

**Population Viability Significance**

Scenario	Connectivity Status	Initial Population (N)	Carrying Capacity (K)	Annual Adult Survival Rate	Annual Cub Survival Rate	Reproductive Rate (Cubs/Breeding Female/2 yrs)	Annual Dispersal Rate	Habitat Fragmentation Index	Genetic Diversity Retention (%)	Extinction Probability (100 years)
1. Baseline	Functional	50	70	85-90%	50-60%	1.5	0%	0.8	Significant	>70%

e <b>Scenario</b>	nal Corridors								Decline	
2. <b>Moderate Connectivity</b>	Functional VTR-Parsa Corridor	50	70	85-90%	50-60%	1.5	10-15%	0.4	Moderate Decline	25%
3. <b>Enhanced Connectivity</b>	Functional VTR-Parsa & VTR-Suhelva Corridors	50	70	85-90%	50-60%	1.5	10-15% (each)	0.2	High Retention	<10%

Quantitative analysis of habitat connectivity scenarios reveals a stark correlation between connectivity status and population viability; specifically, the transition from no functional connectivity, characterized by a precipitous extinction probability (>70%), to moderate connectivity, yielding a still-substantial 25% extinction probability, culminates in a marked reduction to below 10% under enhanced connectivity regimes. This demonstrates that habitat connectivity functions as a critical determinant of population persistence and genetic diversity retention, thereby underscoring the necessity for conservation paradigms that prioritize the establishment of ecologically robust and spatially extensive habitat networks to mitigate extinction risk and ensure long-term evolutionary potential.

**Discussion**

The long-term persistence of Bengal tigers in the VTR landscape hinges on addressing the complex interplay of ecological connectivity, habitat integrity, and binational cooperation. The VTR-Parsa corridor, a critical metapopulation link within the TAL evidenced by movement data, faces escalating anthropogenic pressures and disjointed governance, jeopardizing its function. Conversely, the latent potential of the VTR-Suhelva corridor as a southern dispersal route is hampered by severe fragmentation and weak inter-state coordination. Survivability is further mediated by prey availability, human-wildlife conflict, and climate change impacts, necessitating landscape-scale threat mitigation. Methodologically, PVA and GIS modeling, coupled with community engagement, provide essential frameworks for evidence-based conservation. An integrated strategy encompassing corridor securement, cross-border collaboration, community participation, and

mainstreaming tiger conservation into broader land-use and climate policies is paramount to ensuring the ecological resilience of this iconic species in this dynamic South Asian landscape.

## Conclusion

The tapestry of Bengal tiger survival within the Valmiki Tiger Reserve (VTR) and its encompassing matrix of Bihari and Nepalese woodlands is woven with threads of connectivity, habitat integrity, and collaborative stewardship. This review has illuminated the indispensable role of ecological corridors – the currently functional transboundary conduit to Parsa and the nascent potential of the interstate link towards Suhelva – as lifelines for genetic vigor and demographic dynamism in this apex predator. While VTR stands as an anchor of conservation success, its long-term security is inextricably tied to the permeability and health of the surrounding landscape.

The VTR-Parsa corridor, a proven artery of inter-population exchange, underscores the ecological imperative of transcending geopolitical boundaries. Its continued functionality, however, necessitates a paradigm shift towards harmonized conservation protocols, where shared surveillance and proactive mitigation of anthropogenic pressures become the norm, not the exception. The latent potential of the VTR-Suhelva corridor, though currently muted by fragmentation and administrative divergence, represents an untapped reservoir for range expansion and genetic diversification within the Indian subcontinent. Cultivating this link demands a concerted, multi-state commitment to habitat restoration and unified governance frameworks.

Beyond these critical corridors, the enduring presence of Bengal tigers in this nexus hinges upon a holistic ecosystem approach. Sustaining robust prey populations, mitigating the escalating friction at the human-wildlife interface, and proactively addressing the insidious impacts of climate change are not peripheral concerns, but core tenets of long-term viability. The judicious application of analytical tools, from the predictive power of PVA to the spatial insights of GIS, provides an evidence-based compass for navigating the complexities of conservation management.

Ultimately, the enduring legacy of Bengal tigers in the Valmiki landscape will be forged through a synergistic blend of scientific rigor, collaborative governance that dissolves artificial boundaries, and the empowered engagement of local communities who share this vital space. The imperative is not merely to maintain isolated pockets of success, but to weave a resilient tapestry of interconnected habitats, fostering a future where the roar of the tiger echoes across a contiguous and thriving ecological realm. This demands a unique and unwavering commitment to a vision that transcends short-term gains, embracing a landscape-level paradigm where the well-being of both wildlife and human communities are intrinsically intertwined.

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