STRIPES

Best Practices from India's Tiger Reserves: Restoring Habitats, Harnessing Technology, and Empowering Communities for Long-Term Conservation

Cover Photo- Amey Namdeo Thakare

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28th meeting of the National Tiger Conservation Authority

The 28th meeting of the National Tiger Conservation Authority was held on 21 December 2025 at the Sundarban Tiger Reserve, West Bengal, under the chairmanship of the Hon'ble Minister of Environment, Forest and Climate Change. The meeting brought together Members of the Authority to review ongoing conservation initiatives, deliberate on emerging challenges, and chart priorities for the coming year.

A key highlight of the meeting was the release of four NTCA publications, reflecting the Authority's emphasis on documentation, outreach, and science-based conservation. The *Project Cheetah booklet* was released to mark three years of implementation of India's ambitious cheetah reintroduction programme. The publication documents key milestones, management interventions, and learning outcomes from the project, highlighting both national efforts and international cooperation. It captures the evolution of the programme from planning to on-ground execution, underscoring adaptive management, veterinary protocols, and habitat readiness as central pillars of Project Cheetah.

The latest edition of *STRIPES magazine* was also released, with a thematic focus on technology-enabled tiger monitoring. The issue highlights the commencement of the Sixth All India Tiger Estimation and showcases the growing use of digital tools and standardized protocols for large-scale wildlife monitoring.

Another key release was an *NTCA booklet* documenting India's tiger conservation journey, offering a comprehensive account of the country's evolution from crisis-driven intervention to globally recognized conservation leadership. The publication traces major policy milestones, while also highlighting institutional reforms, scientific monitoring advancements, expansion of the tiger reserve network, and steady population recovery.

Tigerverse, an outreach-oriented publication exploring the lesser-known dimensions of India's tiger reserves, was also released as part of the event. Moving beyond a wildlife-centric narrative, the publication showcases the extraordinary biodiversity, unique geological features, historical legacies, and vibrant cultural traditions embedded within these landscapes. By presenting tiger reserves as living, multi-layered ecosystems shaped by both nature and people, Tigerverse seeks to deepen public appreciation and foster broader engagement with conservation.

In addition to the releases, members deliberated on issues such as human–wildlife conflict, infrastructure impacts, invasive species management, frontline staff welfare, governance implications of recent Supreme Court directions, and the need for stronger science-based and coordinated approaches. The discussions reaffirmed the Authority's commitment to strengthening conservation outcomes through improved planning, capacity building, and inter-sectoral collaboration.
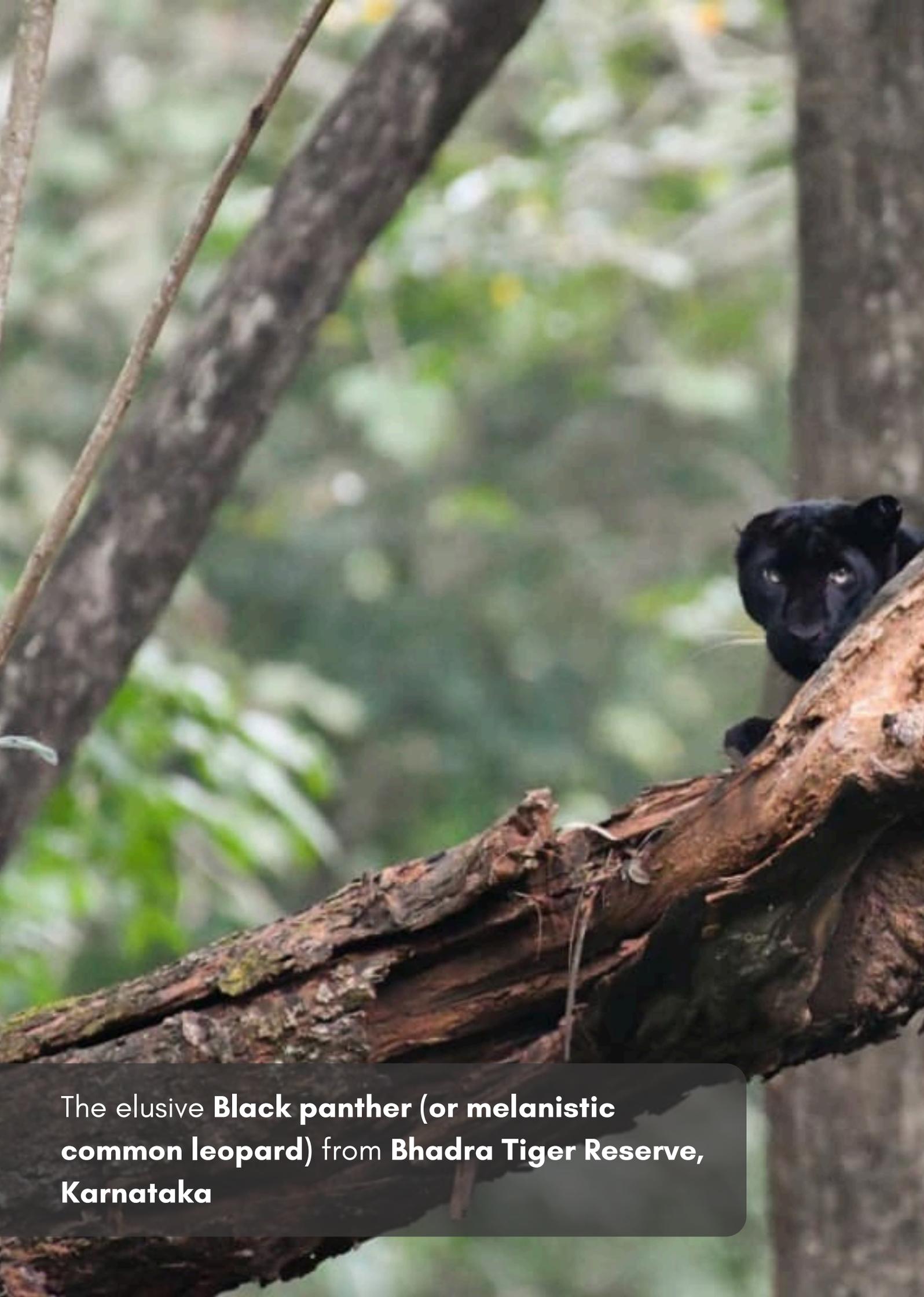
The elusive **Black panther (or melanistic common leopard)** from **Bhadra Tiger Reserve, Karnataka**

Return of Tigers to Sonai Rupai Wildlife Sanctuary, a Satellite Core of Nameri Tiger Reserve: A Story of Recovery, Resolve, and Rewilding

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Sonai Rupai Wildlife Sanctuary, located in the northern foothills of Assam along the Arunachal Pradesh border, was notified as a Wildlife Sanctuary in 1998, encompassing an area of approximately 220 sq km. Historically, Sonai Rupai was recognised as one of the most productive grassland–forest mosaics of the north bank of the Brahmaputra, supporting a remarkable assemblage of flagship species, including the tiger, greater one-horned rhinoceros, wild water buffalo, and Bengal florican.

Archival forest records and local accounts indicate that the sanctuary once functioned as an integral component of the larger Himalayan foothill wilderness, maintaining ecological continuity with the Manas Tiger Reserve landscape to the west and the Nameri Tiger Reserve–Pakke Tiger Reserve landscape to the east. This connectivity historically enabled the movement of wide-ranging species and sustained robust wildlife populations across the region.

However, the late 1990s and early 2000s marked a period of severe ecological decline for Sonai Rupai, closely paralleling the crisis experienced by Manas during the same timeframe. Extensive encroachment exceeding 100 sq km, coupled with habitat fragmentation, degradation of grasslands, drying of wetlands, and prolonged protection challenges, resulted in the local extinction of several key species, including tigers and rhinoceros.

Once-vibrant grassland complexes and wetlands gradually lost their ecological vitality, and Sonai Rupai entered one of the most difficult phases in its conservation history—emerging as a landscape of diminished ecological function despite its inherent potential.
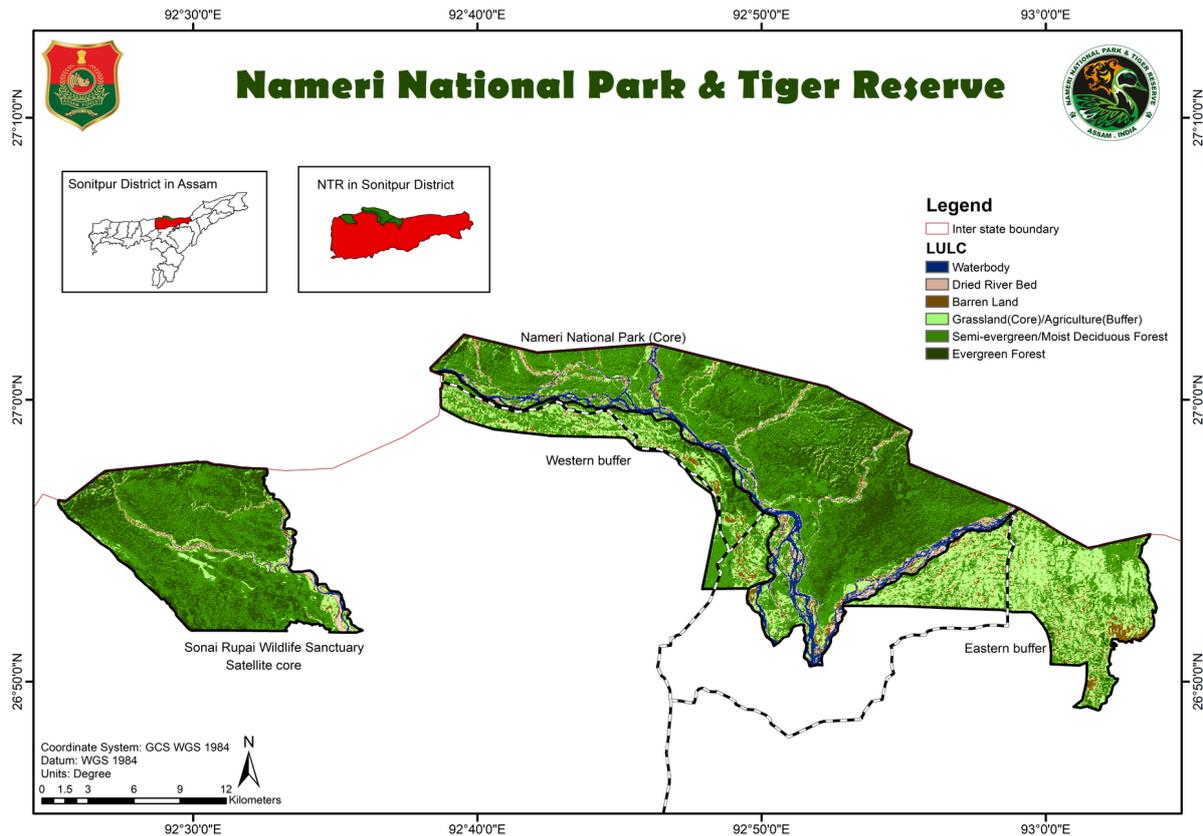
The Turning Point: Early Signs of Recovery and Satellite Core Notification

After years of ecological decline, the first indications of recovery in Sonai Rupai Wildlife Sanctuary began to emerge during 2013–14, when indirect signs of tiger movement, including pugmarks and movement trails, were recorded from within the sanctuary. Although sporadic and limited in extent, these observations carried considerable ecological and managerial significance, indicating that the landscape—despite prolonged degradation—still retained the intrinsic capacity to support wide-ranging carnivores.

These early indicators coincided with gradual improvements in protection and habitat conditions within the sanctuary, highlighting Sonai Rupai's importance in landscape-level conservation and functional connectivity. The observations underscored its strategic location as a linking landscape between the Manas, Nameri–Pakke, and Kaziranga tiger landscapes, enhancing its role as a potential corridor and dispersal zone for large mammals.

Recognising this ecological potential, and to ensure focused protection and scientific management, the remaining inviolate portion of Sonai Rupai Wildlife Sanctuary—approx. 120 sq km—was formally notified as a Satellite Core of Nameri Tiger Reserve in 2015.

The Satellite Core status brought Sonai Rupai under the enhanced management framework of a tiger reserve, enabling strengthened protection,

Nameri National Park & Tiger Reserve

Sonitpur District in Assam

NTR in Sonitpur District

Legend
Inter state boundary
LULC
Waterbody
Dried River Bed
Barren Land
Grassland(Core)/Agriculture(Buffer)
Semi-evergreen/Moist Deciduous Forest
Evergreen Forest

Nameri National Park (Core)

Western buffer

Sonai Rupai Wildlife Sanctuary
Satellite core

Eastern buffer

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 1.5 3   6   9   12
Kilometers

systematic monitoring, targeted habitat restoration, and alignment with national-level tiger conservation protocols. More importantly, it reaffirmed Sonai Rupai's function as a stepping-stone habitat—capable of facilitating tiger dispersal, supporting transient individuals, and contributing to the long-term ecological viability of the broader Nameri–Pakke tiger landscape.

This notification laid the foundation for a series of focused interventions that, over the subsequent years, progressively restored habitat functionality and ultimately culminated in the confirmed return of tigers to Sonai Rupai after decades of absence.

Habitat Revival and Protection: Foundations of a Comeback

The transformation of Sonai Rupai Wildlife Sanctuary from a degraded remnant into a functional satellite core was achieved through sustained, multi-dimensional interventions focusing on protection strengthening, habitat revival, and community engagement. These measures were implemented in a phased and systematic manner under the management framework of Nameri Tiger Reserve, laying the ecological foundations necessary for the return of tigers.

Key interventions included:
1. Strengthening of Anti-Poaching and Protection Measures

- Effective protection formed the cornerstone of Sonai Rupai's recovery. The Anti-Poaching Camp (APC) network was significantly expanded, with the establishment of new camps in strategic interior locations such as Lakhighat APC, Goranga APC, and Safapani APC, ensuring sustained presence in previously under-protected and vulnerable areas.
- To enhance mobility and inspection efficiency, the fair-weather road network was extended, enabling deeper and more frequent patrolling in interior forest tracts. Protection capabilities were further strengthened through upgradation of the wireless communication system, facilitating real-time coordination among field units.
- Additional measures included procurement of patrolling vehicles, deployment of the 3rd Assam Forest Protection Force for area domination, and focused enforcement drives in encroachment-prone pockets. Collectively, these interventions substantially improved spatial coverage, deterrence, and response time, restoring field-level confidence and control across the sanctuary.

The Greater Scaup (*Aythya marila*) in Serpabeel

© Aman Wilson

2. Wetland Revival – Serpabeel as a Keystone Intervention
- Among habitat restoration efforts, the revival of Serpabeel emerged as a keystone ecological intervention. Once a prominent wetland attracting large congregations of migratory waterbirds, Serpabeel had gradually dried up due to siltation and altered hydrological regimes.
- Targeted restoration was undertaken under the APFBC Phase-II Project, involving approximately 70,000 cubic metres of de-siltation and excavation to revive a portion of the historic wetland. The intervention restored water-holding capacity and ensured perennial water availability, revitalising surrounding habitats.
- The ecological response to the intervention was both rapid and multi-trophic. The revived Serpabeel began supporting elephants, ungulates, resident waterbirds, and migratory species, thereby strengthening the prey base and improving overall habitat suitability for large carnivores.
- Notably, during post-restoration wetland monitoring, the Greater Scaup (Aythya marila) was recorded from Serpabeel in 2025, marking the first documented record of this migratory species from the Sonai Rupai landscape. The occurrence of this rare diving duck underscores the restored wetland's ecological functionality and highlights the broader biodiversity gains achieved through targeted habitat interventions.

3. Grassland Restoration at Scale
- Recognising the central role of grasslands in sustaining prey populations, more than 350 hectares of degraded grassland were recovered and scientifically managed within the Kherbari and Gelgeli grassland complexes. The restoration programme focused on the removal of invasive weeds such as Chromolaena odorata, Lantana camara, and Mikania micrantha, along with the uprooting of woody species including Semul and Jamun. These measures were complemented by regulated habitat management practices, including controlled burning, and the systematic re-establishment of open grassland structure.
- These interventions resulted in a marked improvement in forage availability, grassland productivity, and prey use, thereby enhancing habitat quality across the grassland matrix. The restored grasslands reinstated the structural heterogeneity essential for grassland-dependent species, forming a critical ecological foundation for supporting tiger movement as well as potential residency within the Sonai Rupai landscape.

4. Creation of Artificial Water Pits in Dry Patches
- Given the seasonal aridity of the bhabhar tract, particularly during the lean months, artificial water pits were created at strategically identified dry locations within the interior of the sanctuary. These water sources functioned as critical dry-season refugia,

reducing water stress for herbivores and ensuring a more even spatial distribution of prey across the landscape—an essential prerequisite for sustaining tiger movement and potential residency.

- Notably, the first photographic capture of a tiger from Sonai Rupai Wildlife Sanctuary was recorded at one such artificial water pit during post-intervention monitoring, underscoring the effectiveness of targeted water augmentation measures in restoring habitat functionality and supporting apex predators.

5. Community Engagement and Outreach
- Alongside physical and protection-based interventions, strong emphasis was placed on sustained community outreach and awareness programmes in villages adjoining the sanctuary. Regular engagement initiatives helped rebuild trust, reduce anthropogenic pressures, and foster informed community participation in conservation efforts.
- By positioning local communities as stakeholders in conservation rather than adversaries, these initiatives contributed to improved compliance, reduced conflict, and the development of long-term social support for protection and habitat restoration measures—an essential component in ensuring the sustainability of conservation outcomes in Sonai Rupai Wildlife Sanctuary.

The Return: Tigers Reclaim Sonai Rupai
In 2024, a significant conservation milestone was achieved when a tiger was first camera-trapped in Sonai Rupai Wildlife Sanctuary during wetland monitoring under the APFBC Phase-II project. This constituted the first confirmed photographic record of a tiger from the sanctuary after decades of absence, providing scientific validation of the landscape's ecological recovery.

Subsequently, during the Phase-IV Monitoring (2024–25), the tiger was successfully re-captured, and data analysis validated by the Wildlife Institute of India confirmed the presence of two individual tigers within Sonai Rupai Wildlife Sanctuary, which functions as a Satellite Core of Nameri Tiger Reserve.

The return of tigers coincided with broader faunal recovery within the sanctuary. At present, Sonai Rupai supports more than 25 mammalian

species, including Asian elephant, gaur, leopard, clouded leopard, marbled cat, jungle cat, leopard cat, and binturong, among other meso-carnivores. This assemblage reflects the restoration of trophic integrity and functional habitat conditions across the landscape.

Beyond the return of a single species, the recovery of Sonai Rupai represents a wider restoration of ecosystem processes—from revived wetlands and productive grasslands to strengthened prey dynamics and improved protection regimes. The reappearance of sensitive indicator species, including rare migratory waterbirds such as the Greater Scaup (Aythya marila), highlights the depth and quality of habitat recovery achieved through focused, science-based interventions.

In recognition of sustained field-level commitment, two frontline staff members of Sonai Rupai Wildlife Sanctuary were honoured on Global Tiger Day 2025, acknowledging their critical role in protection, monitoring, and safeguarding the sanctuary during its recovery phase.

A Landscape Reclaimed
The return of tigers to Sonai Rupai Wildlife Sanctuary stands as a compelling demonstration of what sustained protection, science-based habitat restoration, and community partnership can collectively achieve. Once regarded as a severely degraded and fragmented protected area, Sonai Rupai today functions as a revitalised Satellite Core, reinforcing the ecological resilience of Nameri Tiger Reserve and the broader Eastern Himalayan foothill landscape.

More importantly, Sonai Rupai has re-emerged as a critical genetic corridor and stepping-stone habitat, facilitating tiger dispersal and maintaining genetic connectivity between the valley tiger sub-populations of Assam and the hill tiger sub-populations of Arunachal Pradesh. Positioned strategically between the Kaziranga Tiger Reserve and Manas Tiger Reserve landscapes to the west and the Nameri–Pakke Tiger Reserve landscape to the east, Sonai Rupai plays a pivotal role in enabling gene flow across one of India's most important transboundary tiger landscapes.

Its recovery demonstrates that even severely degraded protected areas can be ecologically reclaimed when conservation actions are strategic, sustained, and implemented at a landscape scale. By restoring habitat functionality and reducing fragmentation, Sonai Rupai now contributes meaningfully to the long-term genetic viability and demographic stability of tiger populations across the Brahmaputra valley and adjoining hill eco-systems.

Going forward, management emphasis will remain on maintaining protection intensity, consolidating habitat gains, strengthening scientific monitoring, and deepening community partnerships, ensuring that this recovery trajectory is not only sustained but resilient. The story of Sonai Rupai is therefore not merely one of the return of an apex predator, but of renewed ecological confidence—affirming that long-term commitment to conservation can successfully reclaim lost landscapes and restore their rightful place within India's tiger conservation network.

Garuda: AI–Powered Wildlife Conservation

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G aruda represents a cutting-edge, AI-powered conservation initiative that has successfully deployed advanced surveillance technology within the Nagarahole Tiger Reserve. The project integrates artificial intelligence with real-time monitoring systems to address key challenges related to human–wildlife conflict and protected area security.

Key Achievements

The implementation of the Garuda system has yielded significant, measurable outcomes across several critical areas of Tiger Reserve:

- Wildlife Protection: Enhanced monitoring capabilities have improved tracking and protection of key wildlife species.
- Conflict Management: Real-time data has enabled for proactive responses to potential human-wildlife conflict situations.
- Strategy Refinement: Data generated through the system has supported the refinement instrumental in refinement of long-term conservation and protection strategies.

By leveraging technology, the reserve is moving towards a sustainable model in which advanced surveillanvce acts as a force multiplier for the dedicated forest staff, strengthening protection efforts while ensuring the safety of both wildlife and surrounding communities.

> Project Status: The pilot project's successful deployment of AI-powered cameras and integration of GSM Cameras has demonstrated the potential of technology to revolutionize wildlife conservation.

Objectives for the Pilot Study

The pilot study for the Garuda system was designed with clearly defined, high-impact objectives intended to address the most pressing management challenges in Nagarahole Tiger Reserve. The primary focus was on mitigating human-wildlife conflict and enhancing the intelligence capabilities of the forest department.

Core Objectives

1.*Minimize Crop Damage and Elephant Conflicts*
One of the most significant challenges in the region is conflict arising from elephants straying into agricultural lands. The system aims to provide early warnings to reduce crop destruction and prevent dangerous encounters between elephants and local farmers.

2.*Reduce Man-Animal Conflict with a Focus on Tiger Movement*
Tracking the movement of large predators, specifically tigers, is crucial for public safety. The system monitors tiger pathways and territorial movements to alert forest staff of potential spillover into human settlements, enabling proactive intervention before conflict incidents occur.

3.*Identify Human Crossovers and Illegal Entry*
Protecting the integrity of the reserve requires effective monitoring of unauthorized human entry. The system is designed to identify potential poachers, illegal loggers, and other unauthorized trespassers entering protected forest zones.

4.*Integration of GSM Camera Traps with AI Engine*
A key technical objective was the seamless integration of standalone GSM camera traps with a central AI processing engine, ensuring continuous data flow and real-time analysis across the monitoring network.

Successfully Achieved Pilot Studies

The pilot implementation of the Garuda AI system yielded remarkable results, demonstrating the viability and effectiveness of technology-driven conservation approaches. Key achievement include:

- AI-powered camera deployment: Successful installation and operation of AI-enabled cameras at strategic locations across Nagarhole Tiger Reserve, estabilising a comprehensive surveillance network.
- GSM camera integration: Seamless integration of GSM camera traps with the central AI engine, enabling real-time data

transmission and analysis from remote forest locations.

- Early warning system: Implementation of an effective early warning mechanism to alert forest staff and nearby communities of approaching wildlife, particularly elephants and tigers, significantly reducing conflict incidents.
- Wildlife movement mapping: Generation of detailed movement patterns and corridor maps for key species, providing valuable inputs for conservation planning and habitat management.
- Intrusion detection: Identification and prevention multiple instances of unauthorized human entry into protected areas, strengthening reserve security.
- Data-driven conservation: Creation of robust datasets that support refinement of

Initial data suggests that achieving these objectives leads to a direct reduction in compensation claims for crop damage and a measurable decrease in human-wildlife conflictincidents.

conservation strategies and more efficient allocation of protection and management resources.

Conclusion

The successful pilot study has validated the Garuda system as a transformative tool for wildlifeconservation, demonstrating that AI-powered technology can effectively bridge the gap between conservation needs and ground realities.

Case study: Reduction in conflict cases before and after installation of Garuda system ▶

Anechowkur WLR: Ex-Gratia Heatmap by Village & Damage Type
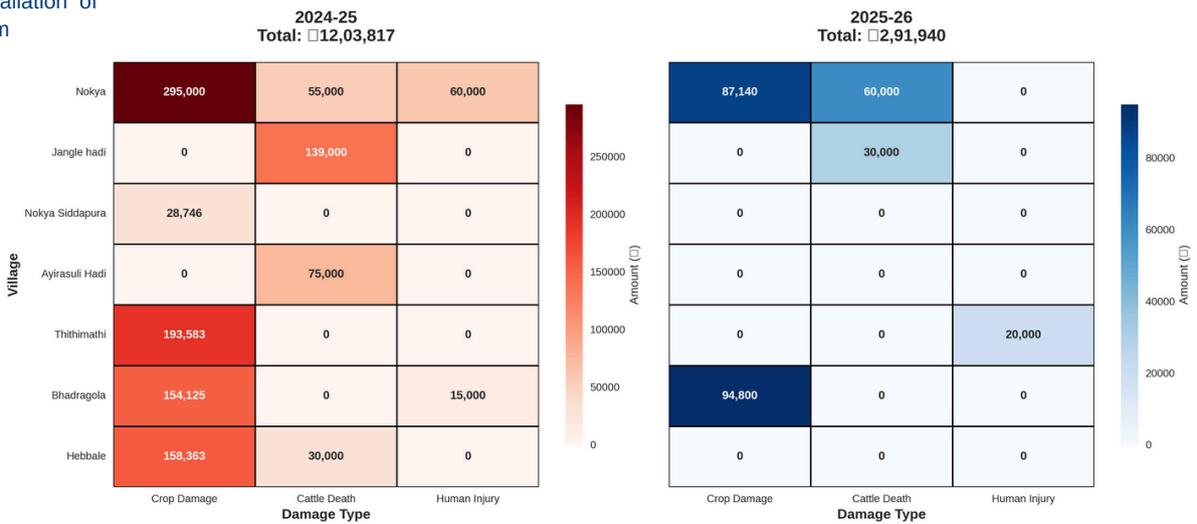
Village-per-Camera Heatmap: Ex-Gratia Payments
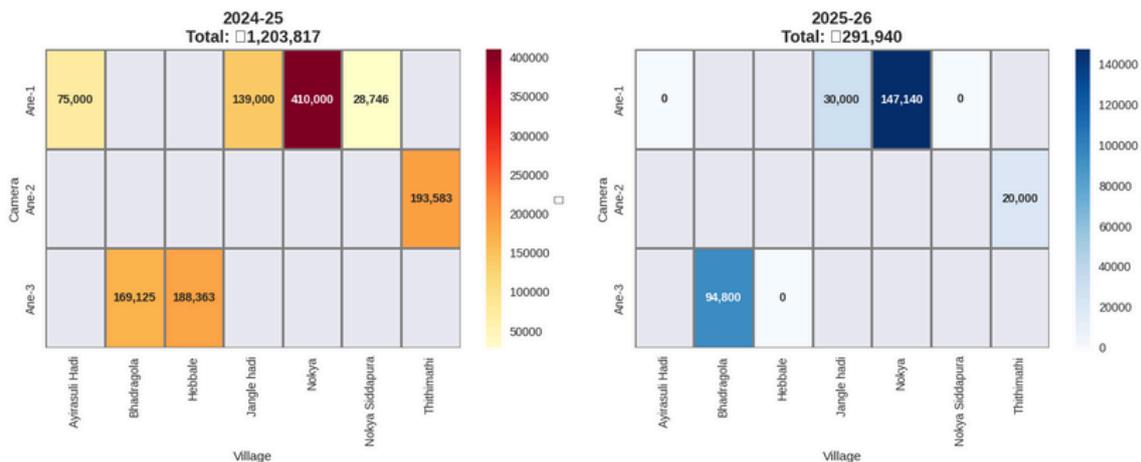
Case study: On 24 April 2025, Garuda cameras detected a herd of 7 elephants approaching farmland. Alert teams responded within 2 minutes, using safe deterrent methods to redirect the elephants back to the forest corridor.

This rapid response demonstrates how early detection technology significantly reduces human-wildlife conflict incidents while protecting both wildlife and community livelihoods.

Early-warning alerts through Garuda-AI system: Elephant and tiger movement alerts

Where the Tiger Roared Again: The Remarkable Revival of Palamau Tiger Reserve

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There was a time when the very name "Palamau" carried a wild resonance, a soundscape of roaring tigers, rustling Sal forests, and echoes of the time-worn stones of Palamau Fort. It wasn't just a place; it was a living pulse in the heart of India's wilderness. From Satyajit Ray's 1970 cinematic masterpiece Aranyer Din Ratri (Days and Nights in the Forest), which captured the poetic silence and splendour of this land, to its inclusion among India's first nine tiger reserves in 1973 under the ambitious Project Tiger, Palamau Tiger Reserve (PTR) was once a jewel in the crown of Indian conservation.

But the story of PTR, like the forests it protects, has never followed a straight path. Like many great landscapes, it too endured years of silence, darkness, and absence. The roar that once echoed through its valleys faded. And yet, today we tell a different story, not of loss, but of renaissance; not of despair, but of hope. Because in PTR, the tiger has roared again.

Before that roar returned, the forest endured decades of silence, its resilience tested by forces far beyond its control. The decline of PTR did not begin with chainsaws or bulldozers, but with fear. In the 1980s, left-wing extremism took root in this landscape, rendering vast stretches of forest inaccessible not just to tourists, but to the very custodians tasked with protecting it. Forest guards and officers were unable to patrol or implement even basic conservation activities. Frequent conflict between extremists and state forces turned what was once a refuge of life into a no-go zone. As silence fell over the sal groves, nature suffered. Prey species such as spotted deer, sambar, and wild boar declined under unchecked poaching and mounting anthropogenic pressure. weight of unchecked poaching and human pressure. Grasslands withered. Wetlands dried. And the tiger—the apex predator that demands peace, seclusion, and prey-retreated. The population, already precarious, dwindled to the point where extinction within the reserve seemed imminent. Yet even in this darkness, hope flickered quietly. And from that fragile hope, a new chapter slowly began to take shape.

The forest did not give up. And neither did the people who had once drew strength and identity from it. I joined Palamau Tiger Reserve in January 2023 as Deputy Director of the North Division, entering a landscape shaped equally by heartbreak and potential. Under the leadership of Field Director Shri Kumar Ashutosh, IFS, and later Shri S. R. Natesha, IFS, and in close coordination with Shri Kumar Ashish, IFS, Deputy Director of the South Division, we embarked on a journey not merely to protect, but to revive. Our mission was clear: bring life back to this forest, and remind the world that PTR still mattered. We began by listening to the forest, to the people, and to the past. We recognised that protection alone would not suffice. The landscape needed healing. It needed trust.

At the same time, it is important to acknowledge that no revival happens in isolation. The story of PTR's resurgence would be incomplete without recognising the tireless efforts of those who served here during its most difficult decades. Officers, frontline staff, and forest workers laboured under immense personal risk, often without recognition, frequently unable even to access core areas due to security threats. Yet they held the line, protected what they could, and kept alive the hope that one day the forest would recover. The progress we see today is not a sudden miracle; it is the outcome of decades of quiet resilience. We walk in their footsteps. Any success we claim is built upon the foundation they preserved. With this legacy behind us, we turned toward regeneration.

Our forest staff during the early days
of Palamau Tiger Reserve

Regeneration through trust, habitat, and community

Our efforts took root across multiple layers. We focused on rebuilding habitats, reviving grasslands, restoring bamboo groves, and constructing check dams to ensure perennial water sources during the parched summer months. Water, after all, is the lifeline of any forest. But habitat without prey is a hollow promise. We therefore turned our attention to prey-base augmentation. Using BOMA capture techniques, traditionally used in Africa but adapted to Indian context, we translocated spotted deer from high-density areas to newly created soft-release enclosures in prey deficient zones. The idea was simple but powerful, let them acclimate, breed, and thrive, and then release them into the wild where tigers may someday return.

But restoring nature is only half the battle. For conservation to truly succeed, communities must walk alongside the forest. In parallel, we confronted one of the most sensitive but necessary actions in conservation, village relocation. Communities living deep within the reserve had long relied on the forest, but sustained pressure from daily grazing, fuelwood collection, and cultivation came at a steep ecological cost. Through sustained dialogue and support from the district administration, we initiated long-pending relocation programmes, providing compensation, secure housing, and dignity to families who chose to move, freeing critical core habitats for wildlife.

We did not stop there. Recognizing that conservation cannot be sustained without community participation, we launched our flagship initiative, *Janbhagidari*, a paradigm shift in the conservation ethos, that places the well-being of forest-dependent communities at the heart of conservation efforts. Under this umbrella policy, multiple initiatives were undertaken. Livelihood generation through eco-tourism development at Kechki, Sugga and Lodh falls. Products such as Henar honey, Koyal mustard oil, leaf compost, and Juhi agarbatti were launched, economically empowering indigenous communities while drawing upon their traditional knowledge of the forest.

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Boma enclosure in Betla Range for cheetal capture

Through *"Tiger kid" scholarship program*, bright student from forest villages recieved financial support to pursue education, they otherwise could not afford. A large-scale watershed initiative "Revive the Rivers" mobilised community participation through shram daan to construct small water-harvesting structures. This initiative was recognised by the Hon'ble Chief Minister of Jharkhand and gained renewed momentum, creating a cadre of local youth, water warriors, who are now reviving Palamau's drought-prone landscape through scientific watershed interventions.

The *Eco club initiative* to forge a strong youth cadre has become the eyes and ears of PTR administration, spreading conservation awareness and helping curb illegal activities across the larger landscape. PTR has partnered with the district administration to extend the government services such as medical camps, employment schemes to forest villages. The

"Hunar Se Rojgar " programme, an employment linked residential skill development initiative, has become the lifeline for the unemployed local youth who previously migrated in search of work. The programme equipped them with skills for employment in eco-tourism, forestry operations, hospitality, guiding, and other sustainable vocations.

For the first time in years, the forest began to feel like an ally to the people, not a threat. We revitalised Eco-Development Committees to ensure villagers had an active role in protecting and managing the landscape. Efforts were also initiated to restore the historic Palamau Fort—a magnificent structure dating back to the Chero dynasty and nestled within PTR's forests. With support from the Government of Jharkhand, restoration work began, rekindling local pride and attracting heritage enthusiasts, seamlessly blending history with ecology. Every drop of sweat, every patient step, and every cautious intervention carried a silent question: Would the tiger ever return?

Constructed houses for communities that opted for village relocation

Hon'ble Finance Minister, Government of Jharkhand, Shri Radha Krishna Kishore with the participants of the Hunar Se Rojgar programme

Facilitation of local tribal communities engaged in making furniture from lantana

A Tiger Kid receiving financial assistance from the Deputy Director of Palamau Tiger Reserve

And then, nature responded.

On the morning of March 17, 2023, a camera trap captured a sight no one had seen for years: a tiger. Wild, majestic, unmistakable. It was the forest whispering: "I am still here." In the two years that followed, seven unique tiger individuals have been photo-captured within PTR's boundaries. I have had the honour of directly sighting three of them. Each sighting felt like a miracle. Every paw print etched into the soil is both a message from the past and a promise for the future. The return of the tiger is more than a conservation milestone. It is a cultural and emotional resurrection.

The return of the tiger is more than a conservation milestone; it is a cultural and emotional resurrection. It is a testament to what becomes possible when vision meets persistence. For years, local communities had only stories passed down by elders, of tigers along riverbanks and roars echoing through valleys. Now, they no longer rely on memory alone. They have seen. They have heard. And they believe again.

PTR's ecological significance extends far beyond its own boundaries. Geographically, it occupies a critical junction linking the forests of Central India with those of Eastern India and beyond.

As tiger populations in central reserves such as Kanha, Bandhavgarh, and Satpura exceed their carrying capacities, dispersing individuals seek new territories.

PTR stands ready not as a remnant forest, but as a refuge. Its core areas are intact, its prey base is recovering, and its people are willing. With continued investment and protection, PTR has the capacity to host at least 25 to 30 tigers in the years to come. More importantly, it can function as a secure corridor, a green bridge in India's larger tiger landscape.

Yet to view PTR only through the lens of tigers would be disservice. PTR's ecological significance extends far beyond its own boundaries. Geographically, it occupies a critical junction linking the forests of Central India with those of Eastern India and beyond. As tiger populations in central reserves such as Kanha, Bandhavgarh, and Satpura exceed their carrying capacities, dispersing individuals seek new territories.

While the journey has been uplifting, it is far from complete. Human–wildlife conflict, the legacy of extremism, and climate uncertainty will continue to test us. But we are no longer walking alone. We have partners in the field, in policy, and in every village surrounding the reserve. And we have the tiger walking with us once again.

Our forest tracker sketched the tiger pugmark and is proudly showing it
▼

PTR is not just recovering; it is teaching us something profound. It tells us that no forest is beyond saving, that even after decades of silence, the roar can return. And when people, policy, and passion come together, the impossible becomes inevitable. In a world starved of hope, PTR stands tall, not just as a tiger reserve, but as a testament to the resilience of nature and the indomitable spirit of those who choose to protect it. The next time you hear of PTR, do not think of it as a forgotten forest tucked away in Jharkhand. Think of it as the place where India proved once again that when we care, when we commit, and when we believe, the tiger roars back.

Tiger sighted in March 2023 in Kutku range of PTR
▼

Small Life, Giant determination! Shot of an **Asiatic Weaver Ant (*Oecophylla smaragdina*)** from **Melghat Tiger Reserve, Maharashtra**

Empowering Kaziranga's Women through Circular Economy Initiatives

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K aziranga National Park & Tiger Reserve (KNP&TR), a UNESCO World Heritage Site famed for hosting two-thirds of the world's greater one-horned rhinoceroses and the "Big Five," balances biodiversity and conservation amid Brahmaputra floods and human-wildlife conflicts impacting 184 fringe villages. This article explores Eco-Development Committees (EDCs) and women-led institutions across Eastern Assam, Biswanath, and Nagaon Wildlife Divisions working as vital connectors between park authorities and 50,000 households, promoting resilience via microplanning and sustainable livelihoods.

Central to this are dual skill programs: **SAMARTH Silk Handloom Training (Central Silk Board)** that certified 200+ women in handloom textiles securing employment, financial independence & societal freedom. The Water Hyacinth Upcycling Initiative trained 100 women to transform invasive Eichhornia crassipes into handmade paper, handicrafts and vermicompost, yielding ₹5,000–7,000 monthly incomes, wetland restoration, and SDG alignment.

With women trainees leading zero-waste enterprises, EDCs cut NTFP dependency, boost decision-making, and generate ₹54,000–84,000 annual earnings rectifying policy neglect of women's productive roles. Kaziranga's women warriors emerge as biodiversity stewards, offering a replicable model for India's green economies.

Women empowerment through circular economy initiatives and their linkages to fulfilling the SDG goals and possible convergence with other government initiatives is also discussed.

Kaziranga: Wild Paradise

Kaziranga's conservation journey began in 1905 as a game reserve, evolving into a Reserved Forest in 1908, a game sanctuary in 1916, a wildlife sanctuary in 1950, and finally a national park in 1974, spanning 429.93 sq. km. UNESCO recognized its global importance by declaring it a World Heritage Site in 1985, and it became a Tiger Reserve in 2007. Today, the Kaziranga Tiger Reserve covers 1,302.97 sq. km across Golaghat, Nagaon, Sonitpur, and Biswanath districts in central Assam. This includes Kaziranga National Park and 10 additions, wildlife sanctuaries like Laokhowa and Burhachapori, and several reserved forests.

Renowned for its "Big Five", the One-horned Rhinoceros, Asian Elephant, Royal Bengal Tiger, Asiatic Water Buffalo, and Eastern Swamp Deer; Kaziranga hosts two-thirds of the world's greater one-horned rhinoceroses and boasts one of India's highest tiger densities. The Brahmaputra River has enriched the landscape with alluvial grasslands, wetlands, marshes, swamps, and wet semi-evergreen forests teeming with life. Over 500 bird species thrive here, alongside a growing list of insects, while highly endangered Gangetic River Dolphins grace the Brahmaputra's waters. This biodiversity hotspot stands as one of India's richest, offering visitors thrilling glimpses of iconic wildlife in their natural habitat.

Conservation Challenges and Community Dynamics

Despite its riches, Kaziranga faces significant challenges, especially at the intersection of wildlife protection and human communities. Forest-fringe villages, home to thousands of indigenous families and tribes, face frequent human-wildlife conflicts. Elephants, rhinos, tigers, and buffaloes often stray from the park into farmlands during floods or in search of food, leading to crop raids, livestock losses, and occasional human casualties. The annual Brahmaputra floods exacerbate this, displacing both wildlife and communities while eroding habitats.

Livelihood pressures compound these tensions. Many residents depend on subsistence farming, fishing, and collection of non-timber forest products, but park boundaries and anti-poaching measures restrict access, fuelling resentment and retaliatory actions towards wildlife. Climate change also brings challenges when it intensifies floods and droughts, degrading grasslands and pushing animals outward. Balancing biodiversity conservation with sustainable community development through eco-development committees, skill training, and alternative livelihoods remains crucial for long-term harmony.

Eco-Development Committees: Women Leading Kaziranga's Green Revolution

Eco-Development Committees (EDCs) are empowering women-led engines of change around Kaziranga National Park & Tiger Reserve (KNP&TR), transforming fringe communities into active stewards of this UNESCO World Heritage Site. Operating as village-level bodies, the EDCs spanning across Easter Assam, Biswanath and Nagaon wildlife divisions, place women at the forefront. Through self-help groups (SHGs), they drive microplanning, community mapping, and decision-making forums, shifting from passive victims of floods and wildlife conflicts to confident leaders negotiating livelihoods and conservation. EDCs supercharge women's economic independence via diverse, sustainable livelihood programs, directly tackling the vulnerabilities of 50,000 households reliant on marginal farming, weaving, fishing, and tea gardens. Skill-building workshops which are often women-exclusive target to equip them with high-demand expertise: handloom and handicrafts for wildlife-motif sold at exhibitions and online; mushroom cultivation and vermicomposting, beekeeping and pickle production and other for steady income.

Partnering with forest department initiatives, the EDCs deliver governance training, e-commerce linkages, and skill development projects ensuring women not only survive but thrive. In Kaziranga's wild paradise, EDCs prove that empowered women are the ultimate guardians, weaving sustainable livelihoods into the fabric of biodiversity conservation.

Weaves & Weeds: Crafting Sustainable Livelihood

Empowering women is a critical challenge in developing nations, where they form society's backbone yet face limited participation in decision-making and economic activities. Women's empowerment enables equal access to financial, social, and intellectual resources which

Women on the looms of handloom textile and hyacinth craft
▼

drives bidirectional gains with economic development, fostering self-esteem, autonomy, and social change (Rehman et al., 2015; Pastuszka, 2024). Cross-nationally, higher female societal standing correlates strongly with prosperity, making empowerment both an ethical and growth imperative (Duflo, 2012; Doepke, Tertilt, and Voena, 2012).

Development policies often overlook women's vital role in economic progress, favouring investments in reproductive roles like population programs over their productive capacities, despite women's active participation in income-generating labour worldwide. In Kaziranga National Park's fringe villages, communities battle livelihood insecurity that leaves women economically sidelined. Depending solely on male incomes from fathers, husbands, or sons erodes family stability during socio-economic shifts and curbs women's potential amid new opportunities. These socio-economic vulnerabilities, biodiversity losses, seasonal unemployment, skill deficits, and weak market access are directly addressed through dual skill interventions of Handloom Textile Skill and Hyacinth Craft Skill.

In Kaziranga National Park & Tiger Reserve (KNP&TR), Eco-Development Committees (EDCs) embody this through women-led skill training in handloom textiles and water hyacinth crafts, turning fringe village women from flood-threatened farmers into market-savvy entrepreneurs. Across the EDCs, self-help groups (SHGs) receive targeted workshops on handloom weaving of crafting vibrant wildlife-motif fabrics like rhino and tiger patterns from local cotton and silk that are exhibited, sold online, and tied to e-commerce. Complementing this, water hyacinth

training transformed the invasive wetland weed into durable handicrafts such as mats, bags, and home decor, clearing Brahmaputra floodplains while generating livelihoods. This proves that handloom and hyacinth crafts not only sustain households but weave women into Kaziranga's conservation leadership that safeguards a UNESCO legacy with resilient, income-generating autonomy.

The Water Hyacinth Initiative's circular economy model trained 100+ women in upcycling invasive biomass into handmade paper, handicrafts and compost, while SAMARTH handloom training equipped 200+ women across the wildlife division fringes with weaving expertise. Together, these programs convert ecological liabilities into economic assets generating sustainable incomes through tourism sales & eco-market linkages transforming both environmental threats and skill gaps into women-led prosperity.

SAMARTH Silk Weaver Training: Reviving Tradition

India's textile industry, a global powerhouse, desperately needs skilled hands while millions of women in villages and small towns hunger for jobs that honour their craft. Here comes SAMARTH, the government's game-changing skill revolution, born from the 12th Five-Year Plan and supercharged to empower women like never before.

Dubbed the Scheme for Capacity Building in Textile Sector (SCBTS), SAMARTH isn't just training, it's a lifeline. It pumps demand-driven, job-guaranteed skills into organized textile hubs and revives traditional weaving through the Ministry of Textiles. For women, it's magic: from rural looms to urban markets, they're learning

high-value techniques, launching home-based businesses, and claiming economic freedom.

The mission is to train people (with women leading the charge), partnering with industry associations and chambers. Factories hum with fresh talent, age-old crafts bloom, and women who were once sidelined is now sustain families. In places like Kaziranga's fringe villages, SAMARTH-trained silk weavers are already turning threads into prosperity. Skills are getting sharpened, futures are being woven and the women are the new face of India's textile triumph.

Objectives of the SAMARTH Scheme

The SAMARTH scheme equips participants primarily women in batches of about 30 with core silk handloom expertise through Central Silk Board's curriculum, covering weaving history, basic weaves (plain, twill, satin), warping methods, pirn winding, advanced shedding mechanisms (tappet, dobby, jacquard), loom maintenance, defect identification, and soft skills like safety and industry norms. Prioritizing female empowerment, 88.3% of 3.27 lakh trainees are women, with 79.5% securing employment; since 2021-22, over 7,985 silk sector beneficiaries many rural women have gained high-value skills in raw silk qualities, yarn types, and GI-tagged products, fostering entrepreneurship, productivity, and sustainable livelihoods in traditional clusters.

The SAMARTH Scheme, through Central Silk Board (Scheme for Capacity Building in Textile Sector), delineates three primary objectives designed to address skill deficits and foster inclusive economic growth within India's textile ecosystem:

- *Delivery of Demand-Driven, Placement-Oriented Skilling Programmes*: To furnish National Skills Qualifications Framework (NSQF)-compliant training initiatives that incentivize and augment industry efforts in generating employment across the organized textile and allied sectors. This encompasses the complete textile value chain, excluding spinning and weaving segments, thereby enhancing workforce readiness and sectoral competitiveness.
- *Advancement of Skilling and Skill Upgradation in Traditional Sectors*: To bolster capacity enhancement in heritage-driven domains such as handlooms, handicrafts, sericulture, and jute. These interventions

preserve cultural practices while equipping artisans predominantly women in rural contexts with contemporary techniques for market viability.
- *Facilitation of Sustainable Livelihood Opportunities*: To enable enduring income generation through wage employment or self-employment for diverse societal strata nationwide. This objective particularly empowers marginalized women by integrating skill development with entrepreneurial pathways.

These objectives align with national priorities for inclusive development, emphasizing gender equity in skill ecosystems and sustainable livelihoods in traditional sectors

Kaziranga & SAMARTH Implementation

Sericulture, a women-centric agro-based cottage industry, supports 9.48 million livelihoods nationwide through production of India's four commercial silk varieties (Mulberry, Tasar, Eri, Muga), integrating cultural heritage with economic viability. The Central Silk Board's SAMARTH Silk Handloom Weaving Training program launched October 2024 at Kohora Convention Centre, Kaziranga National Park & Tiger Reserve (KNPTR) upheld enthusiastic women of the Kaziranga fringe villages ready to be skilled.

The training was conducted all three divisions of Kaziranga: Eastern Assam Wildlife, Biswanath Wildlife, and Nagaon Wildlife. To date, 200+ women have completed certification via Central Silk Board examinations, with 100+ in active cohorts. Implementation spans 10+ Eco-Development Committee (EDC) centers including Rangalu, Panbari, Dhuba Ati-Beloguri, Tamulipathar, Bochagaon, Sohola, Bagori, Bahbari, Sutirpar, Barbheta, delivered by master & assistant trainers.

The SAMARTH Silk Weaver Training Programme in Kaziranga National Park & Tiger Reserve (KNPTR) encompassed 34-day intensive modules across three divisions and showcased exceptional scale and impact, with about 200

women successfully trained and over 100 undergoing training across 13 batches spanning three wildlife divisions: Eastern Assam Wildlife (8 batches), Biswanath Wildlife (3 batches), and Nagaon Wildlife (2 batches). Currently, 174 women have completed training while 128 are undergoing active cohorts, creating over 300 success stories in handloom and textile excellence. This robust implementation being evident in the balanced distribution across divisions correlates directly with enhanced employability and economic empowerment in forest-fringe Eco-Development Committees (EDCs). The ongoing training momentum signals accelerating community transformation, linking skill acquisition to diversified production of market-ready crafts. These metrics underscore SAMARTH's role as a scalable model, converting traditional sericulture knowledge into sustainable livelihoods while reducing economic vulnerability in Kaziranga's 10+ fringe villages.

Program graduates produce diversified, market-ready items: traditional wrapping attire, scarves, embroidered vests, ethnic stoles, handkerchiefs, woolen hats, dining table sets, floor mats, and tea coasters. These outputs generate sustainable revenue streams for fringe communities. The Bagori Weaving Studio exemplifies enterprise integration, featuring professionally equipped looms (KNPTR-provided) for live tourist demonstrations, enhancing cultural tourism and direct sales.
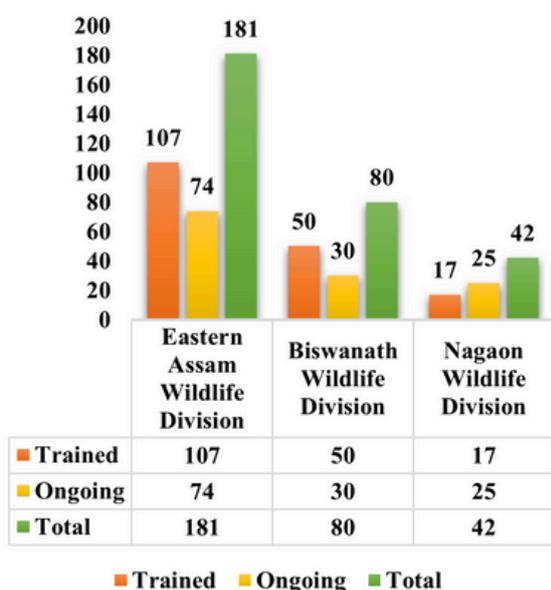
Hyacinth Initiative: Turning Crisis into Opportunity

The Kaziranga Water Hyacinth Upcycling Initiative implements a circular economy framework through systematic harvesting and value addition of invasive Eichhornia crassipes biomass, yielding three synergistic product streams that generate diversified income while facilitating ecosystem restoration. This tri-stream model transforms ecological liabilities into scalable economic assets, directly addressing fringe community vulnerabilities while restoring wetland functionality.

Water Hyacinth Transformations: Products with Purpose
- Handmade Paper - Chemical-free, biodegradable sheets featuring Kaziranga Big-Five motifs and Assamese cultural designs, produced via traditional hand-laid

Products produced by women: Textile, paper, handicrafts and compost produced by the women

techniques augmented by semi-mechanized equipment. Offers high per-unit value with scalable, year-round market demand.

- Artisanal Handicrafts – Range includes bags, purses, hats, table mats, baskets, coasters, bottle holders etc, targeting eco-conscious urban consumers, tourism markets, and institutional gifting. Competitive advantages encompass natural fibre durability, cultural authenticity, and full biodegradability, capitalizing on rising global sustainable handicraft demand with direct-to-consumer and export potential.
- Organic Compost – Nutrient-rich vermicompost derived from processing residues, accessible to local farmers, gardeners, and institutions. Features zero-waste production, low entry barriers for household collectors, and cost-competitive positioning against chemical fertilizers, enabling high-volume community participation.

Economic & Ecological Gains of Water Hyacinth initiative

Synergistic Conservation-Economy Model
This circular framework exemplifies dual

- benefits: ecological restoration (quantified biomass reduction, biodiversity recovery) and also economic benefits that directly funds women-led enterprises, reducing NTFP/forestry dependence while fostering climate-resilient livelihoods (Heriyati et al., 2023). Zero-waste processing and local raw material access eliminate sourcing costs, positioning the initiative as a scalable template for invasive species management and gender-inclusive development in India's protected areas (Harun et al., 2021).
- The Water Hyacinth Initiative achieves quantifiable ecological restoration by systematically harvesting invasive Eichhornia crassipes biomass. This intervention enhances wetland functionality through improved water quality (elevated dissolved oxygen, stabilized pH, reduced turbidity), restored light penetration enabling photosynthesis of native macrophytes, and habitat recovery for migratory waterbirds, fish populations, and the Greater One-horned Rhinoceros. Siltation reduction maintains navigable water depths, mitigating flood risks while bolstering biodiversity metrics essential to Kaziranga National Park & Tiger Reserve

(KNPTR). Additionally, tree-free paper production eliminates conventional forest pulp demand, preventing deforestation emissions and chemical bleaching processes.

Triple Bottom Line Impact: People, Planet, Profit

The Kaziranga Water Hyacinth Initiative exemplifies the 3Ps framework—People, Planet, Profit—while advancing multiple Sustainable Development Goals (SDGs) through women-led circular economy transformation.

People (Social Equity): Empowers 100+ fringe women via comprehensive skilling (paper production, handicrafts, vermicomposting) & financial literacy, generating ₹5,000–7,000 monthly household income (+40–60%) and ₹60,000–84,000 annualized artisan earnings. EDC-integrated cooperatives enhance bargaining power, leadership, and market access such as urban eco-markets, souvenir shops, fostering economic independence and reducing NTFP/forestry dependence.

Planet (Climate Mitigation): Harvesting invasive biomass restores wetlands, produces tree-free paper averting deforestation emissions, employs chemical-free processing (90% water savings), and yields biodegradable products, directly supporting less water usage and fully biodegradable outputs.

Profit (Financial Returns): Diversified revenue streams about ₹300/day collection, ₹10/paper unit (200–250 daily), ₹350–400/handicraft, ₹300–350/compost that ensure economic viability with zero raw material costs, high-volume scalability, and export potential, delivering sustained security for vulnerable households.

This integrated model demonstrates how invasive species management catalyses holistic development, positioning Kaziranga as a replicable blueprint for gender-inclusive green economies across protected area fringes.

Strategic Alignment with Sustainable Development Goals

The Kaziranga Water Hyacinth Initiative demonstrates comprehensive alignment across multiple Sustainable Development Goals (SDGs), integrating ecological restoration, women's economic empowerment, and circular economy

principles.

Core SDG Contributions

- SDG 9 (Industry, Innovation & Infrastructure): Pioneers invasive species management through technology transfer, sustainable production infrastructure, and SME development for fringe communities.
- SDG 11 (Sustainable Cities & Communities): Reduces natural resource pressure via alternative livelihoods, enhancing water quality, ecosystem services, and climate resilience in Kaziranga's fringe settlements.
- SDG 12 (Responsible Consumption & Production): Delivers chemical-free, tree-free, biodegradable handmade paper and handicrafts via circular economy model— waste-to-wealth transformation with zero-waste vermicompost production.
- SDG 13 (Climate Action): Mitigates methane emissions from decomposing biomass, preserves carbon-sequestering forests, supports climate-adaptive livelihoods, and achieves avoided emissions through local, chemical-free processing.
- SDG 14 (Life Below Water): Restores aquatic biodiversity via invasive removal, improving dissolved oxygen, water quality, and habitats for fish, migratory birds, and Kaziranga's wetland fauna.
- SDG 17 (Partnerships for the Goals): Multi-stakeholder model uniting Assam Forest Department/KNPTR, technical partner Kumbhi Kagaz, EDC cooperatives, fair trade networks, and e-commerce platforms for knowledge dissemination.
- Cross-Cutting Impacts: Advances SDG 5 (Gender Equality) and SDG 8 (Decent Work) through women-led skilling generating ₹54,000–78,000 annual artisan incomes; supports SDG 1 (No Poverty) via diversified revenue streams for 100+ beneficiaries.

Transformative Vision: Catalyst for Women's Empowerment

The Kaziranga Water Hyacinth Initiative exemplifies a transformative model that synergistically advances ecosystem restoration, women's economic empowerment, and sustainable development through circular economy innovation. By converting invasive Eichhornia crassipes into valuable handicrafts, paper products, and compost, the initiative

Water Hyacinth choking wetlands ▶

Removal, bundling & laying of water hyacinth ▼

Drying of hyacinth stems ▼

creates replicable pathways for strengthening women-led enterprises in India's protected area fringes, redefining invasive species management through community ownership and achieving Sustainable Development Goals alignment. Through multi-stakeholder partnerships such as the government administration, Kumbhi Kagaz technical expertise, EDC cooperatives, and market networks making this model position 100+ women artisans as central agents of environmental restoration and livelihood security, offering a scalable blueprint for gender-inclusive green economies across wetland ecosystems.

Key lessons learnt for scaling up

Converging and leveraging government welfare schemes, such as the Ministry of Textiles' SAMARTH program, has proven transformative for Kaziranga's forest fringe communities. Similarly, tapping into CSR initiatives for sustainable livelihoods—like water hyacinth upcycling—offers substantial benefits. Starting small and scaling across EDCs through active engagement with such departmental schemes can therefore drive a robust circular economy.

From invasive weeds to woven wonders, the alchemy of water hyacinth handicraft upcycling and SAMARTH silk handloom mastery sparks a quiet revolution, threading women's empowerment through the fabric of Kaziranga's forest-fringe villages. These twin pursuits of transforming choking biomass into biodegradable treasures and breathing new life into ancestral looms and also elevate women from silent margins to vibrant architects of destiny, dismantling barriers of dependence with threads of self-reliance and skill.

Kaziranga EDCs have been a support structure of the socio-economic development of the fringe communities. These skill trainings produce outputs that are beyond mere craft, they kindle inner fires of agency, where hands once bound by circumstance now weave cooperative legacies, lead eco-enterprises and steward wetlands back to life, blending heritage with innovation in a dance of resilience.

This is no fleeting spark but a perennial bloom: women as guardians of ecosystems, custodians of culture, and pioneers of prosperity, their looms and looms echoing a creed that true wealth lies in empowered hands reshaping both earth and equity.

Income through Handloom & Hyacinth

	Annual Revenue (Approx.)	Monthly Revenue (Approx.)
Handloom Textile	2,16,000	18,000
Water Hyacinth Paper	3,24,000	27,000
Water Hyacinth Craft	2,52,000	20,900

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Role of MSTrIPES application in protection of forest and wildlife in the state of Uttarakhand

—— **Koko Rose** [1]

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MSTrIPES (Monitoring System for Tigers – Intensive Protection and Ecological Status) is India's flagship, technology-enabled framework to convert routine frontline patrolling into verifiable, management-ready intelligence and to standardise ecological monitoring across tiger landscapes. At its core, MSTrIPES was conceived to address a persistent operational challenge: although tiger reserves carried out intensive field-level patrolling, the information generated often remained ad hoc and rarely reached field managers in a form that could support informed, evidence-based, and responsive decision-making.

MSTrIPES was designed as a unified platform to support effective patrolling, assess ecological status, and record and analyze human–wildlife conflict in and around tiger reserves.

Its value lies not merely in recording patrols, but in enabling an evidence-led protection cycle: plan patrols → record verified tracks and observations → visualize coverage and hotspots → correct gaps and redeploy resources. The MSTrIPES Patrol module maintains a spatial database of patrol track logs with geo-tagged photographs and field observations recorded by frontline staff. It supports real-time visualisation where network connectivity exists and ensures reliable use in remote areas through GPS-enabled functionality and preloaded base maps. Desktop analytics further process raw GIS data into actionable management intelligence.

The adoption of MSTrIPES in Tiger Reserves, mandated by the National Tiger Conservation Authority (NTCA), has fundamentally transformed wildlife management from a reactive practice to a proactive, data-driven science. The system integrates three core components - Standardized

Field Protocols, GPS-enabled data collection that logs patrol tracks and geo-tags observations in real-time and Desktop Analytics that process raw GIS data into actionable intelligence.

In 2025, the full maturation of this system in Uttarakhand became evident. The transition from "Ghost Patrols" (unverified diary entries) to geo-verified Patrolling has been completed. Every kilometre reported in patrolling records is now backed by a digital GPS track log, significantly enhancing accountability and transparency in resource utilisation. This article draws upon MSTrIPES patrolling data for the year 2025 to present an objective assessment of the state of protection in Corbett Tiger Reserve (CTR) and Rajaji Tiger Reserve (RTR).

Corbett and Rajaji Tiger Reserves together form the central artery of the Terai Arc Landscape. These reserves are not isolated islands of biodiversity but dynamic, living landscapes characterised by rugged terrain, deep ravines (raus), dense Sal forests, and extensive alluvial grasslands. While ecologically rich, this terrain presents formidable protection challenges. Porous boundaries, proximity to dense human habitation, and intersecting linear infrastructure such as highways and railways create a high-threat environment that demands constant vigilance.

Historically, management of these vast landscapes relied on legacy systems—paper logbooks and beat diaries. While still in use, these methods suffered from critical information gaps. Managers operated with limited clarity on the spatial fidelity of patrols (the "spatial void"), delays in information availability (the "temporal void"), and an inability to analyse long-term patterns (the "analytical void"). With the transition to MSTrIPES app-based patrolling, managers now have an accessible tool to optimise resource deployment, analyse spatial and temporal patrol coverage, and direct field staff efforts towards priority and vulnerable areas.

Importantly, MSTrIPES has relevance beyond Tiger Reserves. It is directly applicable to Protected Areas and territorial forest divisions because: the beat remains the foundational administrative unit for field protection in India, and MSTrIPES is built around this operational reality.

Moreover, threats such as illegal extraction, snaring, poisoning, and disturbance are often displaced into buffer areas, corridors, and adjoining territorial forests. When deployed in territorial divisions adjoining tiger reserves, MSTrIPES can function as a corridor-security and landscape-monitoring backbone, supporting landscape-level wildlife management.

In recognition of this, efforts are underway to expand MSTrIPES use in territorial forest divisions, with staff from Corbett and Rajaji Tiger Reserves actively training personnel from adjoining divisions.

System-level implementation outputs in Uttarakhand's two Tiger Reserves

MSTrIPES patrolling data from Corbett and Rajaji Tiger Reserves for 2025 (January-December) demonstrates sustained, high-volume, multimodal patrol efforts. Foot patrols formed the core of protection activities, supplemented by vehicle patrols, boat patrols, and monsoon patrols conducted using elephants.

MSTrIPES does not force a "one mode fits all" patrolling template, rather it documents and enables optimization of multimodal patrolling aligned to threat geography and habitat structure. From the data, it is clear that foot patrolling is the primary pillar of protection in Uttarakhand's tiger reserves, accounting for ~ 680,973 km (approx. 70% of the total effort). This "foot-first" strategy ensures that forest guards can penetrate deep-forest and rugged Shivalik escarpments where vehicles cannot reach. Motorized patrolling (four-wheelers and motorcycles) provide a critical rapid-response layer covering ~ 276,596 km, while specialized assets like elephant-back patrols and boat patrols (unique to Corbett's Ramganga reservoir) secured niche habitats.

## MSTrIPES maps enable "supervision at a glance"

A central benefit of MSTrIPES is that it converts track logs into maps that allow managers to verify which areas were actually patrolled and where gaps (or repeatedly patrolled "easy routes") may exist. Patrolling Coverage maps below demonstrate how MSTrIPES supports supervisory review of coverage distribution at the reserve scale.

COMPARATIVE PATROL EFFORT BY MODE (ANNUAL 2025)
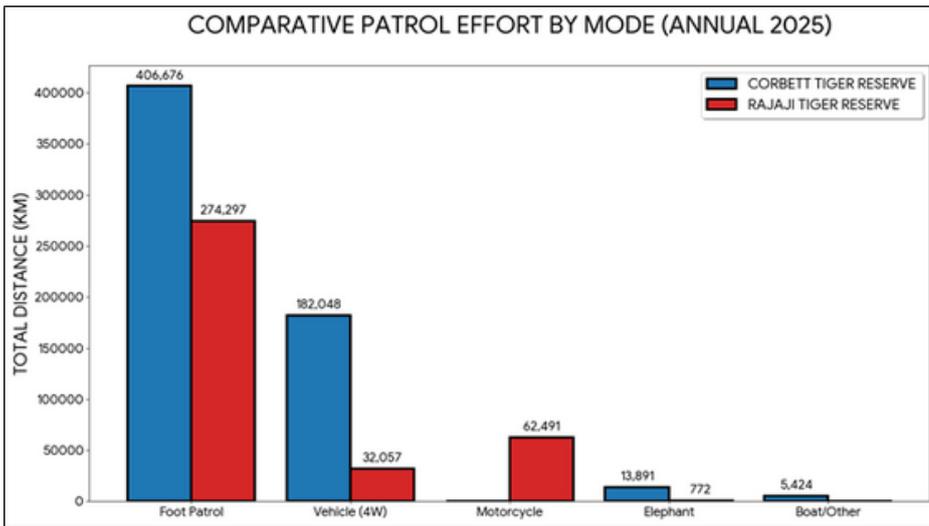
Mode-wise patrol distance recorded through MSTrIPES in CTR & RTR: Foot patrol dominates in both reserves; Rajaji shows substantial motorcycle patrolling reflecting interface and linear-infrastructure monitoring needs; Corbett uniquely records boat patrols supporting reservoir/riverine surveillance.

Key Indicator (Jan–Dec 2025)	Corbett Tiger Reserve	Rajaji Tiger Reserve
Total patrol distance (five modes)	606,766 km	369,617 km
Monthly average	50,564 km/month	30,801 km/month
Daily average (aggregate across all patrol teams)	1,663 km/day	1,012 km/day
Dominant mode share (Foot)	67.00%	74.20%
Secondary mobility layer	Four-wheeler/Vehicle	Motorcycle & Four-wheeler
Specialized modes visible in Patrolling report	Elephant + Boat	Elephant (low), no boat

RTR MSTrIPES patrol coverage map (Jan–Dec 2025): Patrol track density map generated from MSTrIPES logs. The map supports rapid identification of high-coverage zones and potential thin-coverage pockets for redeployment.
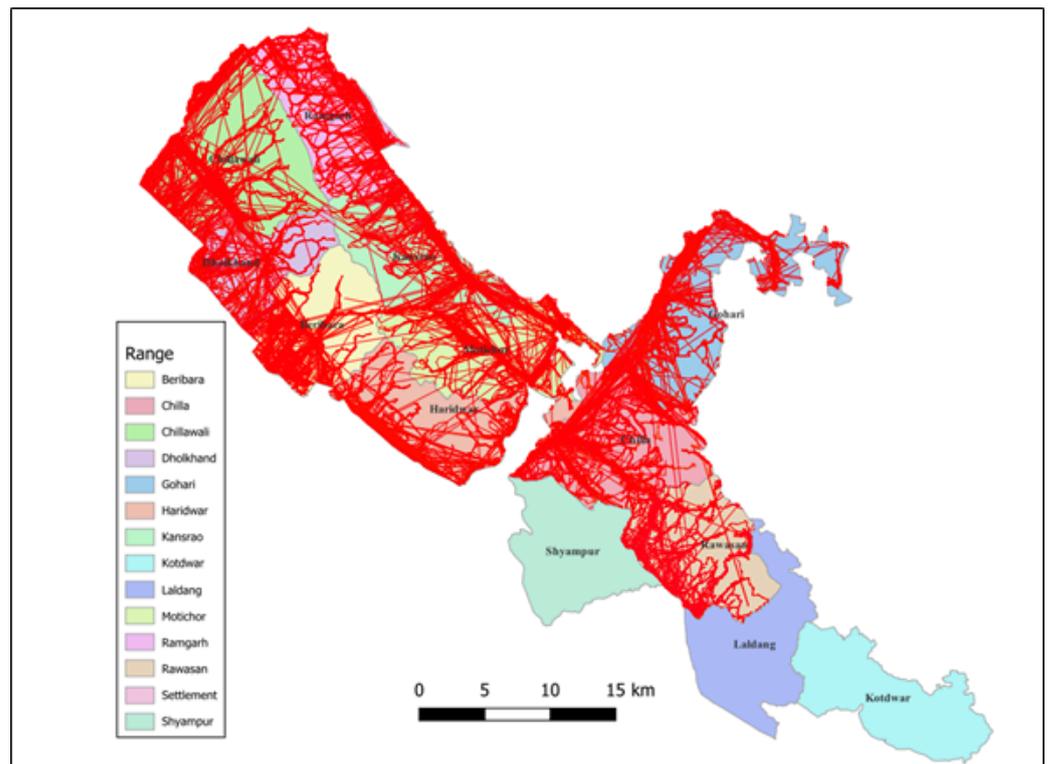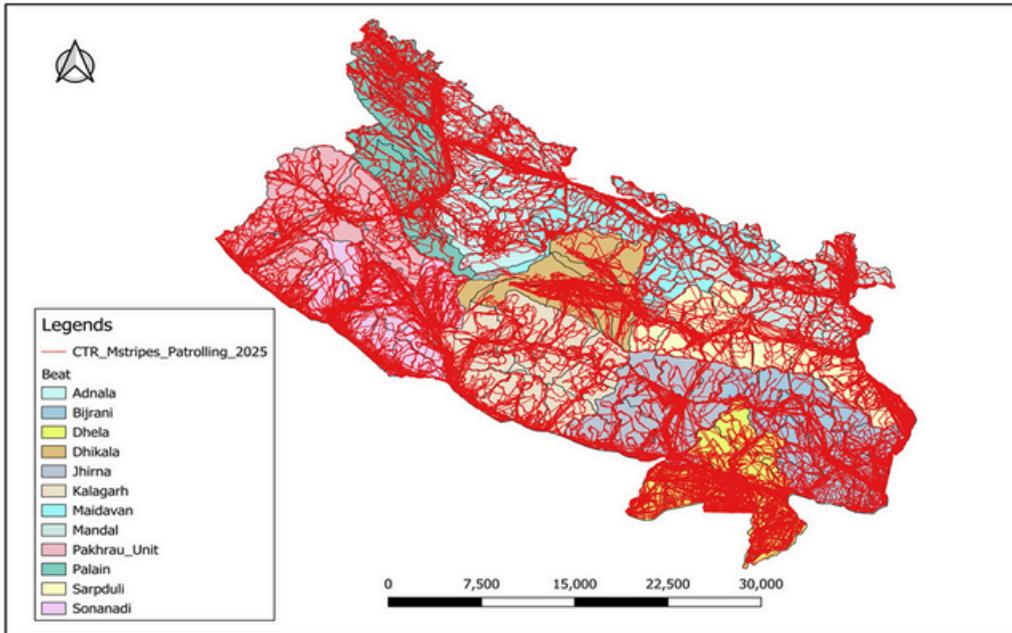
Beat-level distribution: converting effort totals into deployable management insight

Beat-wise foot and vehicle patrol distributions (visible in Corbett's Patrolling Coverage Maps) indicate where patrol effort was concentrated. In 2025, major beats such as Bijrani and Dhela appear among the highest by foot patrol totals, reflecting intensive surveillance coverage in high-use/high-sensitivity sections.

This beat-level visibility in MSTrIPES patrolling system is precisely where this application improves management as opposed to traditional paper logs. Supervisors can compare coverage across beats and question anomalies (e.g., a drop in patrol distance or consistent route bias) using objective track-based evidence.

Wildlife observation mapping: protection patrols become ecological intelligence inputs

Wildlife Sighting Maps also demonstrate MSTrIPES' integrated protection–ecology utility: sightings recorded during patrols can be mapped to support adaptive planning. M-STrIPES integrates wildlife sighting data with patrol tracks, enabling inferences to be drawn of animal occurrences across the reserves. In 2025, the tiger sightings (and signs) in Corbett were concentrated in ranges like Dhikala, Bijrani, Jhirna and Dhela – core areas known for high tiger densities. Rajaji's tiger presence was lower and mostly in the Eastern ranges (Chilla, Gohri, Rawsan) that connect to the larger Lansdowne forest corridor.

Corbett: Tiger sightings map derived from patrol observations: Spatial distribution of tiger sightings/records logged through MSTrIPES field observations, supporting habitat-use inference and focused protection in high-use zones.
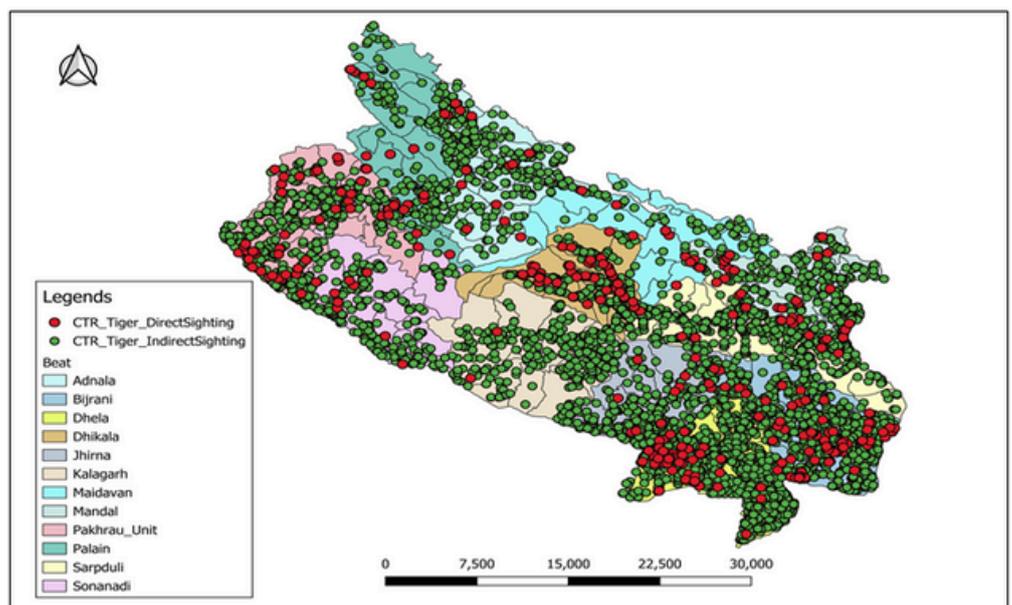
RTR Elephant sightings map derived from patrol observations: Elephant sightings/records logged through MSTrIPES observations; these outputs help flag interface zones and distribution patterns relevant for conflict prevention and patrol deployment.
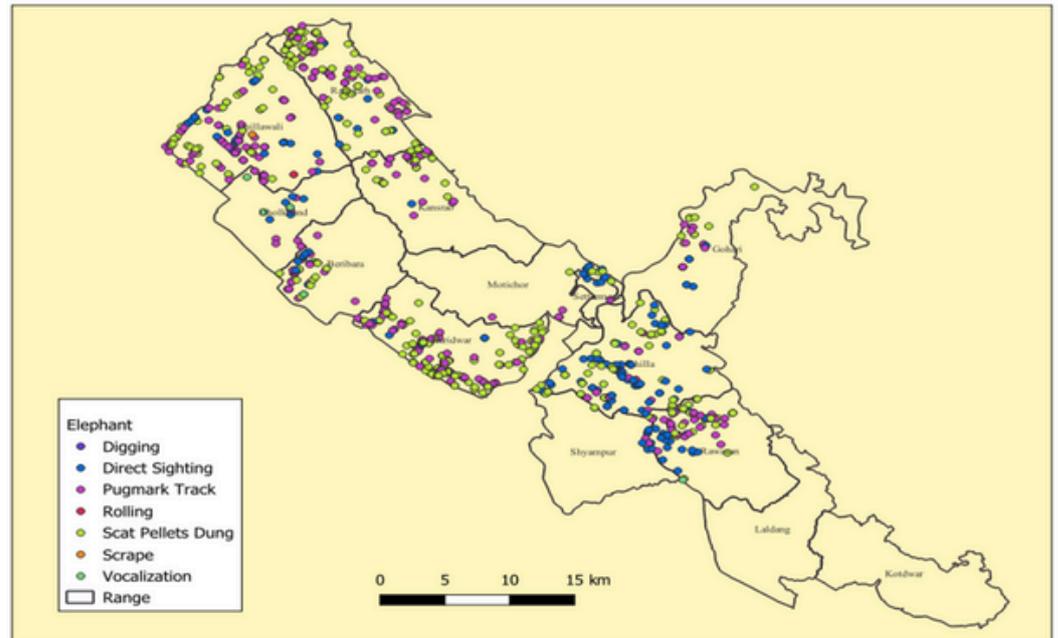
Elephant sightings were frequent in Rajaji (especially in Chilla, Haridwar & Chillawali ranges) and also in Corbett's Sonanadi range and southeastern boundary. Leopards were spotted across virtually all ranges in both reserves, being adaptable and occurring even in fringe areas; patrol data showed leopard signs in both core forest and edge habitats. These wildlife distribution maps help officers identify key habitat use areas and potential human-wildlife conflict zones for focused protection.

The adoption of MSTrIPES has brought a paradigm shift in patrolling accountability and effectiveness compared to the old paper-based system. In terms of accountability, traditional patrolling relied on diary entries and had no way to verify a guard's actual route or presence which allowed critical gaps and so-called "ghost patrols" (patrols reported on paper but not truly performed). With MSTrIPES, every patrol's GPS track is recorded and timestamped, providing verifiable proof of coverage. Field staff are now fully accountable as supervisors can confirm that each beat was genuinely walked and even replay patrol routes on the digital dashboard. On data quality, the difference is equally stark: the traditional logbooks captured minimal data (often just narrative notes) and missed spatial details, whereas MSTrIPES yields rich, geo-referenced data in real time. Patrolling observations (wildlife sightings, illegal activities etc.) are logged with coordinates and photos, creating a digital evidence chain that is far more accurate and actionable.

Regarding operational efficiency, MSTrIPES dramatically improves field supervision and response. In the past, collating monthly diary reports from dozens of patrol camps was slow and took too much time to organize and draw information from; now managers have an instant GIS-based view of patrol intensity across the reserve. This means if a certain range shows a drop in patrolling or an emerging threat, the Field Director can respond immediately (reallocating patrols, investigating lapses etc.).

M-STrIPES has significantly improved wildlife management, ensuring patrolling is transparent, data-driven and proactive. This improved accountability and supervisory control is not a "theoretical" benefit: it is directly evidenced in the MSTrIPES reports by monthly and range/beat breakups, patrol intensity and sighting maps that are impossible to produce consistently with register-based systems.

Way Forward: Replication in territorial divisions, and the case for landscape-level expansion

Uttarakhand's tiger conservation outcomes depend on protection of forests beyond Tiger Reserve boundaries – the buffers, corridors and territorial divisions that influence connectivity, conflict dynamics and the opportunity structure for wildlife crime. A landscape approach to MSTrIPES would deliver three strategic benefits:

- *Corridor security:* consistent patrol intelligence and coverage verification in movement corridors reduces edge-vulnerability and supports connectivity-

MSTrIPES versus traditional patrolling: a structured performance comparison

Dimension	Traditional record of patrolling (diary/register system)	MSTrIPES app-based patrolling
Coverage verifiability	Patrol claims recorded, but verification is difficult	GPS-logged track trails provide auditable spatial–temporal record of where patrols actually occurred
Supervisory oversight	Diary review is time-consuming and retrospective	Patrol logs can be visualized; supervisors can identify patrol gaps, concentrated routes, and under-covered pockets
Evidence for enforcement	Field notes may lack coordinates and photo documentation	Important observations can be recorded with geo-tagged photographs and coordinates
Timeliness of management action	Often delayed until compilation/review	Supports near-real-time visualization when network exists and reliable offline use with preloaded maps
Analytical readiness	Records difficult to aggregate and time taking	Data can be summarized, mapped, and compared across beats/ranges and time periods with much ease
Integration of protection and ecology	Typically separate processes	Patrol + ecological monitoring + conflict recording exist within a single platform architecture

focused management.

- *Threat displacement prevention*: poachers and illegal extractors tend to exploit territorial forests in the vicinity of protected areas; extending MSTrIPES into these areas will enhance supervision and bring the monitoring and planning of protection measures at par with the protected areas.
- *Unified monitoring language*: comparable metrics across Tiger Reserves and territorial divisions (effort, coverage, incident rates) improve state-level oversight and allow landscape-level performance monitoring.

The Wildlife wing of the state has been actively pushing forward this initiative to territorial forest divisions adjacent to Corbett & Rajaji, which have responded positively to adoption of MSTrIPES patrolling in their areas. Ramnagar and Terai Forest divisions in the periphery of Corbett and Haridwar Forest division adjacent to Rajaji Tiger Reserve have voluntarily trained their staff in MSTrIPES based patrolling and are on track to internalize and roll out this innovative patrolling regime for their respective areas. The successful institutionalization of M-STrIPES across Corbett and Rajaji Tiger Reserves marks a definitive paradigm shift in Uttarakhand's conservation history, transitioning from reactive policing to proactive, intelligence-led patrolling. However, the true potential of this application lies in its scalability and the current effort to extend its usage to critical territorial divisions like Ramnagar, Terai West and Haridwar is a testament to the adaptability of MSTrIPES and underscores its immense potential as a handy tool for managers to secure, monitor, plan and review managerial decisions.

Tiger Translocation in Sahyadri Tiger Reserve: Rebuilding a Western Ghats Tiger Population through Scientific intervention

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Tiger conservation in India has reached a stage where recovery in historically important but low-density landscapes has become both a challenge and an opportunity. The Sahyadri Tiger Reserve (STR), located in the northern Western Ghats of Maharashtra, represents one such landscape where scientific intervention through tiger translocation is being used to restore ecological balance and long-term conservation resilience.

The Sahyadri Tiger Reserve spans 1,165.56 sq km, comprising Chandoli National Park and Koyna Wildlife Sanctuary, with a core area of 600.12 sq km and a buffer of 565.45 sq km. Despite its vast forest cover, perennial water sources, and connectivity with adjoining landscapes, tiger presence in Sahyadri had remained sporadic for decades due to historical local extinctions, low prey densities, and landscape-level fragmentation.

Recognising Sahyadri's ecological potential, the National Tiger Conservation Authority (NTCA), Ministry of Environment, Forest and Climate Change, Government of India, approved a structured tiger recovery programme for the reserve. This programme is guided scientifically by the Wildlife Institute of India (WII) through the Tiger Recovery Strategy and Long-Term Monitoring Plan for Sahyadri Tiger Reserve.

The decision to undertake tiger translocation was preceded by extensive groundwork, including habitat quality assessments, prey-base augmentation, strengthening of protection infrastructure, capacity building of frontline staff, veterinary preparedness, and

Soft release Enclosure at Sonarli in Chandoli National Park @STR

community outreach formed the backbone of readiness in Sahyadri. These preparatory measures ensured that translocation would be a conservation tool rather than a risk.

The translocation initiative in Sahyadri has been implemented under **Operation TARA (Tiger Augmentation and Range Expansion)**. This programme aims to re-establish a breeding tiger population in the Sahyadri landscape using a carefully phased, welfare-oriented and science-driven approach.

A key feature of the Sahyadri strategy has been the adoption of the soft release protocol. Translocated tigers are initially placed in specially designed acclimatisation enclosures within the reserve. This allows them to adapt gradually to local terrain, prey species, climate and human-free forest conditions while enabling close veterinary and behavioural monitoring.

Under Operation, the first tigress STR 04, was translocated to Sahyadri, followed by tigress STR 05 from Tadoba-Andhari Tiger Reserve. Both were captured in Nov-December 2025 and soft released into the Sonarli acclimatisation enclosure in Sahyadri Tiger Reserve. Comprehensive veterinary examinations confirmed their fitness, natural hunting behaviour, and readiness for eventual release into the open forest.

Post-release monitoring in Sahyadri is being carried out through a combination of GPS satellite telemetry, VHF tracking and intensive ground-based field verification. Given the rugged terrain of the Western Ghats, technology is complemented by experienced frontline staff who interpret movement patterns, kill sites, resting behaviour and corridor use in real time.

Human–wildlife coexistence remains central to the Sahyadri recovery effort. Community awareness programmes, village-level communication systems, rapid response teams and transparent information sharing have been strengthened to ensure public confidence and reduce conflict risks. The objective is to ensure that tiger recovery progresses alongside social acceptance and safety.

Early indications from Sahyadri suggest encouraging movement patterns, habitat use and adaptation by translocated tigresses. The presence of resident male tigers in the landscape further enhances the possibility of future breeding and population establishment, provided sustained protection and prey stability.

The Sahyadri experience highlights important lessons for tiger recovery landscapes across India. Scientific preparedness, soft release protocols, robust monitoring, and community-centric management are essential components

Post release monitoring by STR Staff

STR 04 released in Sahyadri Tiger Reserve

© Sachin Dhaigude

for successful translocation. Assisted recovery, when implemented responsibly, can accelerate conservation outcomes in landscapes with high ecological potential.

Tiger translocation in Sahyadri Tiger Reserve is not a one-time intervention but a long-term ecological commitment. With continued guidance from NTCA, scientific support from WII, and the dedication of Maharashtra Forest Department's frontline staff, Sahyadri is poised to emerge as a vital stronghold for tiger conservation in the northern Western Ghats.

Vijay - mascot of Guwahati-hosted edition of the Khelo India Youth Games 2020

Bengal Warriors in Pro Kabaddi use a tiger-inspired logo

Shakti - official mascot for the Women's Premier League in 2023

Indian national football team is popularly nicknamed the "Blue Tigers"

Shera - official mascot of the 2010 Commonwealth Games

Chand - official mascot of 2025 Men's Asia Cup Hockey

The Tiger Effect: Why Sports Keep Roaring Back to Strength's Ultimate Symbol

Across stadiums, jerseys, and mascots, one animal keeps prowling into the spotlight- the tiger. Fierce and agile, the tiger has become one of sport's most powerful visual symbols, especially in Asia, where it also represents national pride and unity.

The appeal is instinctive. Tigers embody strength, dominance, and fearlessness sharpened by control. These qualities mirror what athletes and teams strive to project: power paired with precision.

Indian sport offers some of the most striking examples. From kabaddi teams like the Bengal Warriors, whose tiger-inspired emblem reflects aggression and resilience, to the Indian national football team proudly carrying the nickname "Blue Tigers," the animal has become shorthand for competitive identity. Even in hockey, Chand the

tiger reinforces how deeply rooted the symbol is in sporting culture, bridging tradition with modern competition.

Mascots bring the symbolism to life. Shera, the cheerful yet confident tiger of the 2010 Commonwealth Games, balanced approachability with strength, while Vijay at the Khelo India Youth Games connected youthful energy with sporting ambition. More recently, Shakti, the tiger mascot of the Women's Premier League, reframed the symbol for a new generation- celebrating power, athleticism, and female strength on the biggest stage.

Ultimately, the tiger endures because it works, visually, emotionally, and culturally. For teams seeking an identity that roars before a match even begins, the tiger remains unmatched.

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