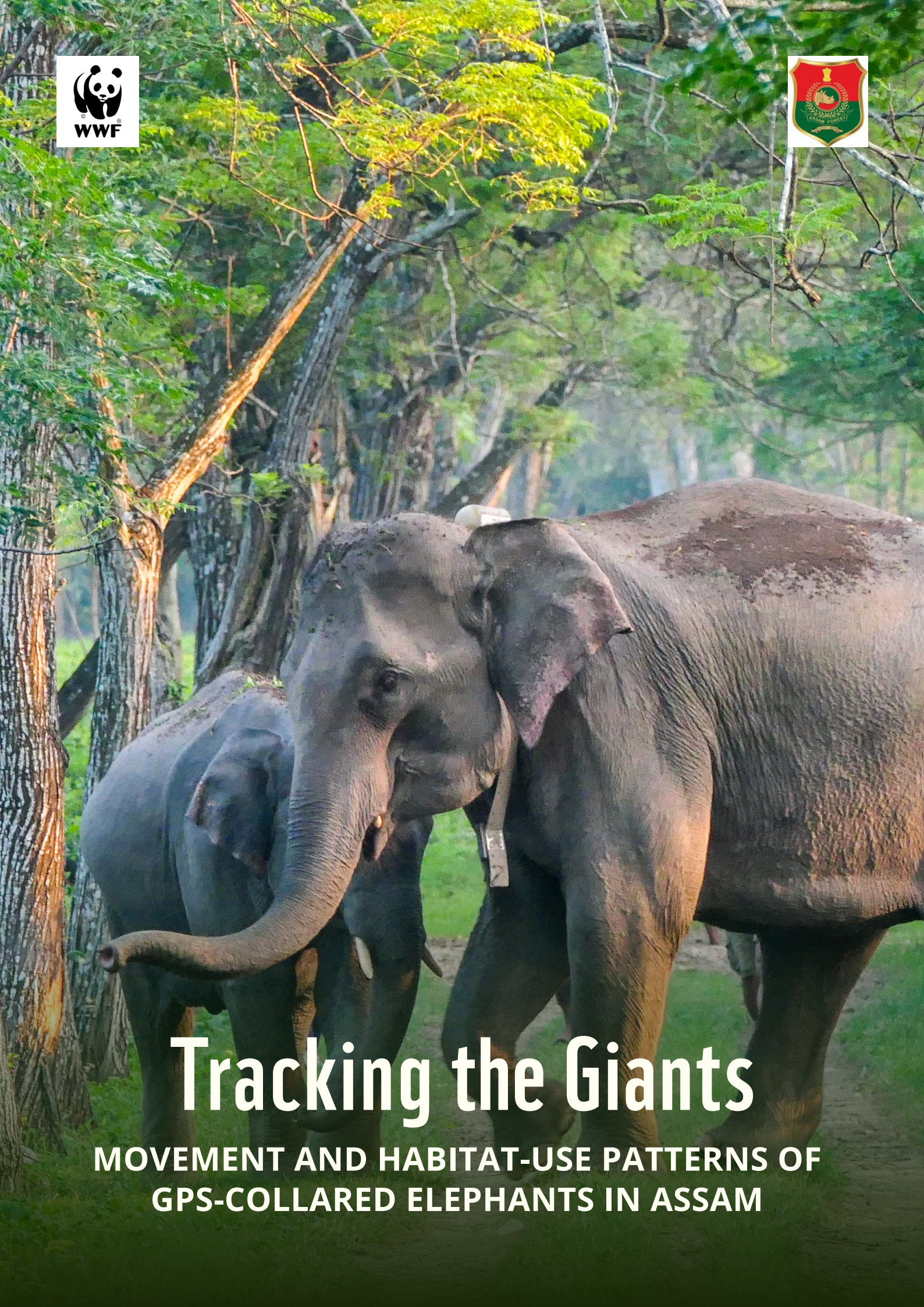


# Tracking the Giants

## MOVEMENT AND HABITAT-USE PATTERNS OF GPS-COLLARED ELEPHANTS IN ASSAM

**Report by**
Report prepared by Department of Environment, Forest and Climate Change, Government of Assam and World Wide Fund for Nature – India (WWF-India)

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**Recommended Citation**
Department of Environment, Forest and Climate Change, Government of Assam and WWF-India. (2026). *Tracking the Giants: Movement and Habitat-Use Patterns of GPS-Collared Elephants in Assam*.

Published in 2026

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# Tracking the Giants

## MOVEMENT AND HABITAT-USE PATTERNS OF GPS-COLLARED ELEPHANTS IN ASSAM

*Bishu reunites with the herd after a successful collaring operation*



*Mynow moves through a tea plantation in Udalguri District*

# FOREWORD

জয়ন্ত মল্লবৰুৱা
মন্ত্ৰী
বিত্ত, পৰিবেশ, বন আৰু জলবায়ু পৰিবৰ্তন,
খনি আৰু খনিজ সম্পদ বিভাগ,
অসম চৰকাৰ

Jayanta Mallabaruah
MINISTER
Finance, Environment, Forest & Climate Change,
Mines & Minerals Departments,
Government of Assam



It gives me immense pleasure to extend my warm greetings on the occasion of the release of *Tracking the Giants: Movement and Habitat-Use Patterns of GPS-Collared Elephants in Assam*.

Assam holds a special place in India's elephant landscape, with approximately 20% of the country's elephant population residing in the state. The conservation of this iconic species, while ensuring the well-being of communities living alongside them, remains an important responsibility.

This study, prepared by the Assam Forest Department, in collaboration with WWF-India, provides valuable scientific insights into the movement, habitat use and home ranges of radio-collared elephants across the districts of Sonitpur, Udalguri and Biswanath in Assam. Its findings underline the need for informed habitat management, protection of elephant corridors and stronger measures to mitigate human–elephant conflict.

The movement of elephants across forests, agricultural landscapes, tea gardens, river islands and beyond national boundaries also highlight the importance of cooperation and a landscape-level approach to conservation.

I congratulate the Assam Forest Department, WWF-India and all field, technical and community stakeholders associated with this pioneering initiative. I hope the knowledge generated through this study will further strengthen science-based wildlife management and contribute to a future of harmonious coexistence between people and elephants.

**Shri Jayanta Mallabaruah**

Hon'ble Minister

Environment, Forest and Climate Change Department

Government of Assam



*Bishu recovers after the collaring operation in Biswanath District*

# MESSAGE

**Mahendra Kumar Yadava, IFS (Retd.)**
Special Chief Secretary
Government of Assam

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Assam is one of the fastest-growing economies in India, where the government is committed to both economic development and wildlife conservation. Effective wildlife conservation requires scientific information on species ecology such as their movements and habitat requirements. This is particularly important for the Asian elephant, whose long-term persistence depends on the availability of interconnected habitats and safe movement routes across a rapidly changing landscape.

The radio-collaring of elephants undertaken by the Assam Forest Department in collaboration with WWF-India is an important advancement in our understanding of elephant ecology in Assam through the use of technology. The study was designed to generate baseline information on the movement patterns, home ranges, and habitat use of elephants in three districts of Assam. This was made possible by the more than 38,000 GPS locations acquired from radio collars of the five elephants between November 2021 and June 2026.

The findings highlight the importance of integrating elephant conservation into broader landscape-level planning through multistakeholder engagement. Such findings have direct implications for policy and management. The identification and securing of fine-scale movement routes, protection of critical corridors, integration of wildlife considerations into infrastructure planning, strengthening of early-warning systems and development of appropriate crop-loss mitigation mechanisms are among the important management directions emerging from this work.

I believe that the information generated through this project will provide a valuable scientific foundation for strengthening elephant conservation and human-elephant conflict management in Assam. It also demonstrates the importance of continuing long-term monitoring and expanding telemetry-based research to other elephant-bearing landscapes of the state. I am confident that the findings will translate into practical conservation action on the ground.

**Shri M. K. Yadava, IFS**
Special Chief Secretary
Department of Environment, Forest and
Climate Change Department
Government of Assam



*Mynow at a tea estate in Udalguri District*

# MESSAGE

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The conservation of Asian elephants in Assam requires a landscape-level approach supported by reliable information on their foraging and ranging behaviour. While field observations provide valuable information, GPS telemetry offers an opportunity to track movements that are otherwise difficult to observe in certain terrains. The GPS radio-collaring programme undertaken by the Assam Forest Department and WWF-Inclia has generated valuable scientific information basis the monitoring of five elephants across highly conflict-prone Sonitpur, Udalguri and Biswanath districts between 2021 and 2026.

The study has demonstrated that elephant movement in Assam is highly dynamic and varies considerably between seasons and landscapes. The identification of specific movement routes and areas provides opportunity for targted conservation interventions. The study has also provided valuable information on the spatial requirements of elephants, with annual home ranges of some elephants exceeding 500 km$^2$. These findings reinforce the need to look beyond individual protected areas and consider the broader landscape in elephant management.

The Assam Forest Department remains committed to strengthening scientific wildlife management and ensuring that conservation interventions are informed by field-based evidence. The successful implementation of such a technically demanding programme demonstrates the value of collaborative conservation. I hope this report will serve as a practical reference for wildlife managers and contribute to strengthening long-term elephant conservation in Assam.

(Sandeep Kumar, IFS)
Principal Chief Conservator of Forests &
Head of Forest Force, Assam



*Tara is successfully revived after sedation and collaring*

# PREFACE

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Assam is one of the leading states in India in elephant conservation and is home to around 5,800 elephants, or about 20% of the country's elephant population. Their historic and widespread presence across the state has fostered a deep-rooted cultural relationship between the people of Assam and the megaherbivore. However, there is a growing need to protect this species, secure its habitat, and ensure coexistence between humans and elephants. Such management imperatives require crucial information on elephant ecology and behaviour, generated through robust scientific application and modern technology.

Towards this purpose, the Assam Forest Department, in collaboration with WWF-India as a technical partner, undertook a pioneering GPS telemetry study of Asian elephants in the state. The study was initiated in three districts of Assam (Udalguri, Sonitpur and Biswanath), considering their vulnerability to human–elephant conflicts. The aim of the study was to understand where elephants move, how they use different habitats and land-use types, and how their movements vary across seasons. The project generated an important body of information from five GPS-collared elephants between November 2021 and June 2026.

Elephant movements indicated strong seasonality and were closely linked with the cropping pattern and the configuration of the landscape. The elephants remained largely within protected forests during much of the year but expanded their range during the post-monsoon period, moving through tea plantations, agricultural areas, and riverbeds towards the Brahmaputra River. In Udalguri, elephants demonstrated movements across the international boundary into Bhutan. The overall home range of the radio-collared elephants was estimated to be within 500–1,000 km$^2$, with variation observed across different individuals and seasons. The study has highlighted the importance of maintaining functional elephant corridors and movement routes, like the Nameri–Sonai-Rupai–Arimora Chapori route. The findings presented in this report will contribute to evidence-based elephant conservation, corridor protection, and human–elephant conflict management, and the prioritisation of future research and monitoring in Assam.

I appreciate the dedicated efforts of the officers and field staff of the Assam Forest Department, WWF-India, and other partners whose cooperation made this challenging exercise possible. This report will serve as a useful reference for wildlife managers, researchers, conservation practitioners and other stakeholders working towards securing a future where people and elephants can continue to share Assam's landscape with greater safety and coexistence.

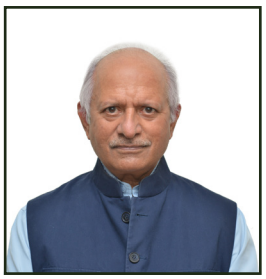
Vinay Gupta

**Dr Vinay Gupta, IFS**
Principal Chief Conservator of Forests, Wildlife and Chief Wildlife Warden
Environment, Forest and Climate Change Department
Government of Assam



*Budhini's herd moves through a tea plantation in Udalguri District*

# MESSAGE



It is my pleasure to present this report titled *Tracking the Giants: Movement and Habitat-Use Patterns of GPS-Collared Elephants in Assam*, a pioneering initiative for monitoring one of the state's most treasured wildlife species.

Assam is home to one of the most significant elephant populations in India. The state's diverse ecosystems, ranging from the floodplains of the Brahmaputra to the forested hills and protected areas, serve as a vital habitat for the long-term survival of the species. However, land-use change, habitat fragmentation, and increasing human–elephant interactions continue to pose significant conservation challenges.

This report provides valuable scientific insights that can help guide evidence-based conservation planning and management. Through GPS locations of five radio-collared elephants in three districts of Assam over nearly five years, the study revealed crucial information on elephant movement routes, varied habitat use, seasonal migration, spatial extent, and interaction with human communities. The study highlights the importance of protecting habitats and corridors, strengthening community participation, and fostering collaboration among stakeholders.

I express gratitude to the Assam Forest Department and commend the efforts of all those who contributed to this work. I believe that the findings presented here will serve as a useful resource for advancing elephant conservation and promoting harmonious coexistence between people and elephants in Assam.

**Ravi Singh**

Secretary General & CEO,

WWF-India

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*Phul moves with her herd through a tea estate in Sonitpur District*



*Mynow foraging in a tea plantation in Udalguri District*

# Acknowledgements

We gratefully acknowledge the Project Elephant Division, Ministry of Environment, Forest and Climate Change, Government of India, for granting authorisation for this initiative.

We extend our gratitude to Shri M. K. Yadava, IFS, former Principal Chief Conservator of Forests (Wildlife & Biodiversity) and Chief Wildlife Warden, Government of Assam, for his vision, guidance and support. His contribution has been central to initiating and shaping this project.

**We sincerely acknowledge the guidance and support of senior leadership and frontline personnel of the Assam Forest Department:** Additional Principal Chief Conservator of Forests cum Council Head of Department, Forests, Bodoland Territorial Council; Conservator of Forests, Northern Assam Circle, Tezpur; Divisional Forest Officer, Western Assam Wildlife Division; the forest frontline staff of Sonitpur East, Sonitpur West and Dhansiri Forest Divisions and the staff of the Assam State Zoo.

**We acknowledge the support of other government agencies and personnel:** District Commissioner, Udalguri; District Commissioner, Sonitpur; District Commissioner, Biswanath; Superintendent of Police, Udalguri; Superintendent of Police, Sonitpur; Superintendent of Police, Biswanath; Joint Director Health, Udalguri; Joint Director Health, Sonitpur and Joint Director Health, Biswanath.

**We acknowledge the support of associations, non-governmant organisations and community members:** All Bodo Students Union, Udalguri; Assam Branch Indian Tea Association, Guwahati; Regional News and Media, Assam; Wildlife Trust of India, Assam; Aaranyak, Guwahati; Assam Wildlife Rescue & Rehabilitation Organisation, North-Lakhimpur; Bhorla NGO, Udalguri and local community members.

**We extend our acknowledgement to other individuals who supported this work:** Hiten Baishya, Dr Nitin Sekar, Dr Parikshit Kakati, Arjun Kamdar, Dr Khanin Changmai, Rutwik Kharkar, Rangjalu Basumatary, Dr Abhilasha Sharma, Dr Seema Lokhandwala and Dr Panjit Basumatary for their valuable contributions to the project work.

**We express gratitude to the WWF-India leadership for their guidance and encouragement:** Ravi Singh, Secretary General and Chief Executive Officer; Dr Sejal Worah, Programme Director; Dr Dipankar Ghose, Senior Director, Biodiversity Conservation; Yash Magan Sethia, Director, Wildlife and Habitats and Dr Pranav Chanchani, Head of Species Conservation.

Finally, we gratefully acknowledge the WWF-US for the funding support which enabled this project.

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# List of abbreviations

| Abbreviation | Full form |
|---|---|
| **ADS** | Anti-Depredation Squad |
| **AWT** | Africa Wildlife Tracking |
| **BTC** | Bodoland Territorial Council |
| **CWLW** | Chief Wildlife Warden |
| **DFO** | Divisional Forest Officer |
| **GIS** | Geographic Information System |
| **GPS** | Global Positioning System |
| **HEC** | Human–Elephant Conflict |
| **MCP** | Minimum Convex Polygon |
| **NGO** | Non-Governmental Organisation |
| **NSA Corridor** | Nameri–Sonai Rupai–Arimora Chapori Corridor |
| **RF** | Reserve Forest |
| **TE** | Tea Estate/Tea Garden |
| **VHF** | Very High Frequency |
| **WLS** | Wildlife Sanctuary |
| **WWF** | World Wide Fund for Nature |
| **ABITA** | Assam Branch Indian Tea Association |
| **APDCL** | Assam Power Distribution Corporation Limited |
| **CCF** | Chief Conservator of Forests |
| **CF** | Conservator of Forests |
| **CI** | Confidence Interval |
| **CHD** | Council Head of Department |
| **CWRC** | Centre for Wildlife Rehabilitation and Conservation |
| **DLCC** | District-Level Coordination Committee |
| **DNA** | Deoxyribonucleic Acid |
| **IFS** | Indian Forest Service |
| **IIT** | Indian Institute of Technology |
| **MoEF & CC** | Ministry of Environment, Forest and Climate Change |
| **PCCF** | Principal Chief Conservator of Forests |
| **PE** | Project Elephant |
| **QGIS** | QGIS (GIS software; version 3.2 cited in the report) |
| **SE** | Standard Error |
| **SMS** | Short Message Service |
| **GPS** | Global Positioning System |
| **WTI** | Wildlife Trust of India |
| **WWF-US** | WWF-US/WWF United States |



*Mynow with her calf in Hatigarh Tea Estate*

# Executive summary

India hosts the world's largest wild population of Asian elephants (*Elephas maximus*), estimated at ~22,500 individuals (95% CI: 18,255–26,645), representing approximately 55% of the global population of the species. The population in India may be further subdivided into four subpopulations, with northern India supporting ~2,000 individuals and east-central India hosting ~1,900 individuals. The largest population is found in southern India, with an estimated 12,000 individuals, followed by northeast India, with ~6,500 individuals. In northeast India, Assam remains the stronghold for Asian elephants with an estimated 4,149 individuals (SE ± 390), according to the Synchronised All India Elephant Census, 2025. The elephant population estimation in Assam in 2024 reports 5,828 individuals based on direct sightings and block counts. While DNA-based and direct count-based approaches may yield varying figures owing to differences in methodology and sampling effort, it is beyond refute that Assam holds the highest elephant population in northeast India.

Loss of elephant habitats, both historical and ongoing, has severely impacted both elephant populations and local communities, forcing them to share space with each other in close proximity. Following large-scale deforestation in the early 1900s, when forests were cleared for tea plantations, and more recent forest loss to make room for agriculture and human settlements, elephants have adapted to human-use landscapes dominated by tea plantations and other agricultural land. As elephants increasingly use these human-dominated landscapes, crops such as paddy, maize, banana, sugarcane, and areca-nut have been incorporated into their diets, both for solitary males and female-led herds. As elephants move between fragmented and depleted forests, their ranges increasingly overlap with human settlements and farms, often resulting in crop and property damage, human casualties, and injury or mortality among elephants. Between 2000 and 2023, 1,468 people lost their lives, and 337 people were injured due to accidental encounters with elephants. In the same period, 626 elephants also died due to human-induced reasons such as electrocution, poisoning, railway collisions, etc. (Habib et al., 2025). In addition to the loss of lives, elephants also impact farm-based livelihoods with intense crop losses reported from across the state. A major knowledge gap in evidence-based management of such adverse interactions between people and elephants is the lack of information on elephant presence and movement.

With the emergence of GPS telemetry technology, elephants fitted with GPS collars can be tracked across multiple years leading to an accurate mapping of their seasonal ranging patterns and movements in human-use areas. Between April 2021 and June 2026, Assam Forest Department, in partnership with WWF-India, tracked four female-led herds and one solitary male in three high-conflict districts of Udalguri, Sonitpur, and Biswanath. The exercise enabled the collection of high-resolution information on the seasonal movement ranges of the species across multi-use landscapes. In Udalguri, the two collared elephants and their herds were recorded extensively using tea plantations, along with Bornadi Wildlife Sanctuary (WLS) and the reserve forests of Khalingduar. Between October and January, their ranges increased manifold to include crop fields in and around the tea estates of Barangajuli, Dimakuchi, Paneri, Hatigarh, Orangajuli, etc., between Laokhaitora/ Barnadi River in the west to Dhansiri River in the east. In contrast, the two collared elephants and their herds in Sonitpur largely remained within Sonai Rupai WLS between January and September. However, between October and December, they showed a seasonal range expansion similar to that observed in Udalguri, when they moved through tea estates and settlements in Arimora Chapori. In 2025–26, these elephants did not go to Arimora Chapori after their movement was blocked at the southern boundary of Sonai Rupai as part of a conflict management intervention. The solitary tuskless bull elephant collared in Biswanath in 2024 was found to range between the forests of Behali WLS and the Brahmaputra River islands that form part of the Sixth Addition areas of Kaziranga. Notably, most of the collared elephants were observed to use river channels to move north–south between the forests of the Himalayan foothills and the Brahmaputra grasslands (chaporis).

The findings of the study emphasise the importance of protected areas and reserve forests as core elephant habitats during the non-cropping season, while also highlighting the strategies and movement routes used by female-led herds to access crops during the harvest season. The results also highlight the importance of tea plantations as secondary habitats and refugia for elephants, especially in Udalguri. The near-annual presence of elephants in the tea plantations of Udalguri necessitates proactive steps to reduce the risk of accidental encounters between people and elephants, as well as interventions to prevent electrocutions. Furthermore, the movement routes of the elephants, especially across roads, railways and settlements need to be safeguarded to avoid accidental collisions with trains and vehicles. The study, therefore, presents crucial insights into the movement and seasonal ranging patterns of female-led elephant herds and a solitary male across the high-conflict landscape of Udalguri, Sonitpur, and Biswanath Districts.

# 1. INTRODUCTION

Asian elephants number around 50,000 in the wild today, with approximately 10% of this population found in Assam, India (Fernando & Pastorini, 2011; Leimgruber et al., 2003; Project Elephant, 2017; Shaffer et al., 2019). Over the last three decades, Assam has witnessed widespread loss of forest cover due to socio-political reasons, with a corresponding spike in negative interactions between people and elephants (Mahato et al., 2021). The large-scale fragmentation of elephant habitats, combined with the cultivation of highly palatable paddy in these areas, has increased the spatial overlap between people and elephants. Consequently, elephants are forced to move and forage through tea plantations and agricultural lands to access remnant habitat patches, while local communities depend on the same areas for their livelihoods. This shared dependence on the landscape leads to severe consequences, including the loss of human and elephant lives, and significant economic losses, as well as less visible costs such as fear and psychological trauma associated with such interactions (Barua et al., 2013; Goswami et al., 2014). Between 2017 and 2021, more than 400 people and 200 elephants died in the state due to human–elephant conflict-induced causes (Habib et al., 2025). Economic losses from damage to crops, housing and other structures have also been substantial but remain poorly documented. The magnitude of the problem varies across the state and needs to be addressed from a socio-ecological perspective. While the social dimensions of these interactions are being explored through the long-term engagement of the Assam Forest Department and WWF-India in the state, corresponding ecological information has been lacking for a long time, creating a knowledge lacuna in understanding elephant movement and habitat use. Critical details on where elephant populations spend the year, where and what they forage on, and how they use the landscape remained limited, making it difficult to create robust and evidence-based conservation strategies and interventions.

Understanding the movement ecology and habitat use of a wide-ranging species such as the Asian elephant is essential for developing effective strategies for conservation and for managing adverse interactions with humans in shared and fragmented landscapes. Traditional methods of tracking elephants, including tracking on foot, indirect sign surveys and VHF-based technology are constrained by various factors such as dense vegetation, difficult terrain and adverse weather conditions. GPS telemetry overcomes these limitations by transmitting continuous, high-resolution location data regardless of weather, time and terrain, in addition to enabling ground-tracking using VHF.

GPS telemetry provides empirical data on solitary males and female-led herds, enabling robust estimation of home ranges, evaluation of seasonal habitat preferences and mapping of critical movement paths connecting habitats. By overlaying coordinate data onto land-use maps, it is possible to study how elephants navigate a complex mosaic of natural forest habitats and anthropogenic land-use types. Additionally, modern satellite-enabled collars support real-time location fixes, allowing local response units to track herd movements, enabling timely early-warning alerts and targeted mitigation efforts.

The Assam Forest Department and WWF-India undertook the first-ever study to understand the ranging pattern and habitat use of Asian elephants in Assam based on GPS telemetry. The aim of the study was to gather baseline data on the habitat use of elephants in certain high-conflict districts of the state, and relative use of different land-use types in the region (Graham et al., 2009). The study looked at three key questions: (1) What are the seasonal home ranges of female-led herds and solitary males? (2) How do elephants use the landscape, i.e., the areas in which they forage and the paths they use to move between forest patches? (3) How are resources such as food and water distributed across the landscape, and how does their distribution relate to patterns of elephant movement?

For the purpose of this study, one adult male and four adult female elephants were successfully collared between 2021 and 2024. Two females from different herds were collared in Sonitpur District, one in 2021 and the other in 2022, while two females from different herds were collared in Udalguri District in October 2023. In 2024, one male elephant was collared in Biswanath District. It is noteworthy that these districts witness high levels of negative interactions between people and elephants following large-scale habitat loss over the past three decades (Mahato et al., 2021; Habib et al., 2025).

The information obtained from the GPS telemetry study will help design holistic measures to ensure the persistence of elephants in the landscape by minimising risks to both people and elephants.

# 2. STUDY AREA

## SONITPUR DISTRICT

Sonitpur District, located in Assam, India, is geographically positioned between latitudes 26°30'N and 27°01'N and longitudes 92°16'E and 93°43'E. Covering approximately 2,076.70 km², the district is characterised by diverse topographical features, including the northern foothills of the Eastern Himalayas and expansive alluvial flood plains (https://sonitpur.assam.gov.in/about-us/geography, accessed in June 2026). The district is traversed by several significant river systems, most notably the Brahmaputra River, which plays a crucial role in the region's hydrology and ecology. Sonitpur is endowed with rich biodiversity and includes several protected areas such as the Nameri National Park and the Sonai Rupai WLS. These protected areas are habitats for numerous endangered species, including the Bengal tiger (*Panthera tigris tigris*) and the Asian elephant. The district has a predominantly subtropical, highly humid climate, with a monsoon season that strongly influences its agricultural practices and ecological patterns. Sonitpur has a primarily agrarian economy, with tea cultivation being a major economic activity, alongside rice and other crop farming. Recent conservation efforts in the district have focused on mitigating human–wildlife conflicts and promoting sustainable land-use practices to preserve its unique ecological heritage.

## UDALGURI DISTRICT

Udalguri District, situated in Assam, India, is geographically located between latitudes 26°46'N to 26°58'N and longitudes 91°45'E and 92°18'E. The district covers an area of approximately 1,985.68 km² and features diverse topography, including the northern Himalayan foothills and fertile alluvial plains (https://udalguri.assam.gov.in/, accessed in June 2026). The district is traversed by several key river systems, most notably the Dhansiri and Barnadi rivers, which are vital to the region's hydrology and agriculture. Udalguri boasts significant biodiversity, hosting the Bornadi WLS and several other reserve forests. These protected areas are crucial habitats for endangered species such as the Asian elephant, the Bengal tiger and the pygmy hog (*Porcula salvania*). The district experiences a subtropical monsoon climate with high humidity, with the monsoon season playing a pivotal role in shaping its agricultural and ecological dynamics. Udalguri's economy is predominantly agrarian, with tea, rice, and citrus fruits being the major crops. Conservation initiatives in Udalguri have increasingly focused on mitigating human–wildlife conflicts, promoting sustainable agricultural practices and preserving its rich ecological diversity

## BISWANATH DISTRICT

Carved out of Sonitpur District in 2015, Biswanath District lies between longitude 92° 16' E and 93° 43' E and latitude 26° 30' N and 27° 01' N. The district borders the state of Arunachal Pradesh to the north, the Sonitpur and Lakhimpur Districts of Assam to the west and east respectively, and the Brahmaputra River to the south. It is drained by the tributaries of the Brahmaputra River, such as Ghiladhari, Burhigang, Bargang, Behali, Buroi, Solengi, Balijan, Kharoi and Mornoi. The district is largely plain, with a forest cover of 16.11% (Forest Survey of India, 2023) occurring amid a patchwork of tea plantations and croplands. Two divisions, namely the Sonitpur East Forest Division and the Biswanath Wildlife Division, are part of the district. The reserve forests of Biswanath, Behali (now Behali WLS), Singlijan, and Gohpur, covering about 392.87 km² of the district, are managed by the Assam Forest Department. The Sixth Addition areas to the Kaziranga National Park and Tiger Reserve lie within this district, along the northern bank of the Brahmaputra River. The Behali Reserve Forest (RF) was declared a wildlife sanctuary in 2022. The district is known for its population of wild elephants, estimated at about 104 individuals, with 60 in the Biswanath Wildlife Division and 44 in the Sonitpur East Forest Division (Piraisoodan, Vignesh, & Jayshree, 2024). The district is also known for the greater one-horned rhino (*Rhinoceros unicornis*) as well as tigers traversing up north from Kaziranga.

# 3. PRE-COLLARING PREPARATIONS

## SELECTION OF SITES

Five elephants, including four females and one male, were targeted for collaring across three districts of Assam, namely Sonitpur (2021 and 2022), Udalguri (2023), and Biswanath (2024). Since males and females are known to have different ranging and foraging strategies, a combination of males and females was selected. Collaring adult females helped in tracking entire herds while tracking a solitary male helped capture individual movement, given their largely solitary nature. Sonitpur, Udalguri and Biswanath Districts were selected based on high and persistent levels of human and elephant casualties reported across these districts over the past two decades. While instances of adverse human–elephant encounters in Sonitpur and Biswanath have reduced significantly over the past decade, Udalguri has emerged as the new hotspot (Habib et al., 2025). Between 2011 and 2024, Udalguri reported 221 human casualties which included 144 deaths and 77 injuries. In the same period, 96 elephant deaths were also reported from the district. While 14.5% of the elephant mortalities were conclusively assigned to electrocution, a large number of deaths could not be attributed to any specific cause (Sangma et al., 2025).

## PERMISSIONS AND APPROVALS

The collaborative project between the Assam Forest Department and WWF-India to collar elephants and monitor their movements over time was initiated through a joint proposal by the Sonitpur East, Sonitpur West and Dhansiri Forest (Territorial) Divisions. The proposal, titled *GPS Collaring of Elephants to Assess their Migration Paths, Vegetation Preferences, and Behavioural Patterns in and around Sonitpur East and Sonitpur West Division, Assam*, was submitted to the Chief Wildlife Warden (CWLW) Assam. Subsequently, the Assam Forest Department requested approval from the Ministry of Environment, Forest and Climate Change (MoE&FCC), Government of India, vide letter *WL/FG_39(2) Man-Animal Conflict/2017/Part-I*, dated 2 February 2020. The permission was provided by the Ministry, vide letter *F. No. 13-5/2019-PE*, dated 3 March 2020. The Assam Forest Department approved technical collaboration for the project with WWF-India vide letter *WL/FF_39(2) Man-Animal Conflict/2017/Part-I*, dated 5 August 2020. Instructions and approvals were provided by the CWLW, Assam to the respective Divisional Forest Officer (DFO) and the WWF-India team for each capture/collaring operation. The collaring operation was led by the Assam Forest Department, with WWF-India serving as technical partner and project investigator, in accordance with the guidelines issued by the MoE&FCC and WWF International's *Network Standard for Animal Handling and Translocations*.

## OPERATION PLANNING AND ARRANGEMENTS

At the beginning of each collaring operation, the Assam Forest Department, with inputs from WWF-India, constituted a team of expert veterinarians, wildlife biologists, researchers, NGOs, forest officials and field staff. The collaring operation was defined as a period of tracking, darting, fitting and revival of collared individuals. The collaring team was then subdivided into several operational teams, including a tracking team, an immobilisation and collaring team, a monitoring and technical team, a logistics team, and a communication, public liaison and crowd management team.

Based on consultations with the Assam Forest Department field staff, WWF-India, tea estate management, other NGOs, and veterinarians, it was decided that tea plantations would provide the ideal setting for tracking and immobilising elephants. An early attempt to track and dart the elephants inside the forests proved challenging due to low visibility and difficulties in tracking. Hence, the time window for collaring was determined based on when elephants were commonly seen in the tea plantations. Across all three districts, elephants are commonly seen in the tea plantations during the winter months, between October and January. The collaring operations were therefore planned during this period.

Two weeks before the commencement of the collaring operations, the tracking team was deployed to record information on elephant presence in the selected areas. Field staff from the Assam Forest Department, WWF-India and other NGO members, local planters, and local community members provided information on elephant presence. The herds and males were then visually profiled to identify suitable individuals for collaring based on an assessment of physical features, presence of calves, *musth* status, and other criteria, as applicable to male and female elephants. Areas frequented by the herds and solitary males within the tea estates were recorded, and their pros and cons were evaluated to assess the feasibility of collaring in these areas. Regular interactions were held with local village residents and community members to communicate the purpose of this initiative and solicit their on-ground support. Connections were established with the district administration and the police department for maintaining order and safety during the collaring exercise.



*Budhini passing through Majuli Tea Estate*

# 4. COLLARING OPERATION

## PHASE I: SONITPUR

### OPERATION 1 (APRIL 2021)

***First radio collaring attempt of wild elephants in Sonai Rupai WLS***

Initial reconnaissance survey in April 2021 recorded a few subgroups of wild elephants in Sonai Rupai WLS. These elephants were commonly observed emerging from the woodland into grassland patches in both Kherbari and Gelgeli areas. As such, a sedation, collaring and release operation was planned for 24–26 April 2021. Since the elephants were known to be active only in the evenings and before dawn, it was decided that the *kumki* or trained captive elephants would be mobilised and prepared for the operation accordingly. The varied expertise of the team members, including on-ground knowledge, experience with previous sedation and release operations, familiarity with local elephant behaviour and the personalities of the *kumki* elephants, and knowledge of the terrain, was used to plan the operation.

#### DAY 1

The first radio collaring attempt was undertaken in the Kherbari Grassland of Sonai Rupai WLS with six *kumki* elephants. The original strategy was to spread the *kumkis* around a small herd of wild elephants to facilitate successful darting. However, as the *kumki* elephants had been brought from different locations and were not used to working together under these conditions, they were unable to move independently around the wild herd. Consequently, the team approached the elephants in three groups of two *kumkis* each. A female elephant was successfully darted along the grassland forest edge, but the herd immediately retreated into the adjoining forest. Since the tranquillisers require several minutes to take effect, the team attempted to track the darted elephant. However, dense forest cover, thick undergrowth and limited ability of the *kumkis* to independently search the area prevented the team from tracking the animal. During the pursuit, an adult *makhna*, or a tuskless bull elephant, repeatedly nudged the darted female deeper into the forest, apparently helping her move away from the perceived threat (Kamdar et al., 2024).

#### DAY 2

Based on reports of elephant activity, the capture team resumed searching the Kherbari grassland and adjoining forests by following fresh footprints, dung and other indirect signs. However, no elephants could be located. The operation later shifted to the more open Gelgeli Grassland, where a herd was sighted near the grassland–woodland boundary. While the team was attempting to dart an adult female, a juvenile unexpectedly crossed in front of the target and was struck by the dart. A second dart successfully struck the intended female, after which both elephants moved into the adjoining woodland. According to the lead veterinarian, Dr K.K. Sarma, the immobilisation drugs used were among the safest available, inducing standing sedation and gradually wearing off depending on the animal's physiology.

The darted juvenile was subsequently located under sedation and found to be in good health. However, considering that it was still growing, the team decided against fitting it with a GPS collar. Despite intensive tracking, the adult female could not be located due to dense thorny vegetation, fading daylight and the difficult terrain, which also restricted the movement of the *kumki* elephants carrying personnel and equipment. As darkness approached, the search was discontinued for safety reasons. The team subsequently decided to conduct a combing operation the following day to verify the condition of the darted elephants.

#### DAY 3

A systematic combing operation was carried out in the Kherbari and Gelgeli areas with the support of the Assam Forest Department staff and *kumki* elephants. Although the darted elephants were not sighted, fresh tracks and other indirect signs indicated that they had safely moved away, with no apparent adverse effects. Later, the team responded to reports of two elephants near Sherpa Beel, where the relatively open terrain appeared favourable for another collaring attempt. However, the elephants were identified as two large adult *makhnas*, one of which displayed aggressive behaviour towards the *kumki* elephants. Considering the significant safety risk to both personnel and the captive elephants, the operation was immediately abandoned. A final attempt was made in the Kherbari grassland that evening, but no elephants emerged from the forest. Although the first collaring operation concluded without a successful collaring, it provided key insights to the team.

The experience demonstrated that the greatest challenge lay not in darting an elephant but in tracking the immobilised animal through dense forests with thorny undergrowth. The operation highlighted the importance of favourable terrain, detailed reconnaissance,

experienced and well-trained *kumki* elephants that are capable of working independently, adequate logistical support for the welfare of the *kumkis*, and conducting darting operations during daylight hours. It was also concluded that collaring operations should ideally be completed within two days to minimise fatigue and maintain operational efficiency. Based on these experiences, future collaring efforts were planned in tea estates and agricultural landscapes where elephants periodically emerge from the forest, offering better visibility and access and enabling easier tracking. The operation also provided remarkable insights into the social behaviour of elephants, particularly the observed actions of an adult *makhna* that assisted the darted female by guiding her away from the capture team, demonstrating the strong social bonds and cooperative behaviour of Asian elephants.

## OPERATION 2 (NOVEMBER 2021)

Leveraging insights from the first operation, the team decided to wait until the elephants emerged from the forest into surrounding tea estates and agricultural fields, where visibility and access were significantly better. The WWF-India team conducted comprehensive surveys of various tea estates across Sonitpur for potential sites. Based on the regular elephant presence, Tarajuli and Phulbari Tea Estates were selected for the collaring attempt. The WWF-India team had already established strong connections with local villagers and Anti-Depredation Squad (ADS) members.

On 14 November 2021, two teams comprising WWF-India personnel, forest staff and veterinarians were strategically deployed to their designated estates. While an attempt to sedate an elephant at Phulbari was impeded by a large crowd, the veterinary team later reassembled at Tarajuli and successfully sedated one elephant from a group of four. Although four trained *kumkis* had been brought in to assist, the team opted to dart the elephant on foot. Previous operations had shown that elephant herds in Sonitpur responded evasively when approached by *kumkis*, likely because captive elephants had been known to chase wild herds back into the forest, a long-standing practice in Sonitpur. After obtaining the requisite physical measurements, the team fitted the collar, marking the first successful radio collaring of a wild elephant in Assam. The team named her 'Tara', after the Tarajuli Tea Estate.

## OPERATION 3 (NOVEMBER 2022)

In November 2022, extensive surveys were conducted in various tea estates in Sonitpur District, as forest areas were deemed unsuitable for collaring operations. On 13 November 2022, the presence of a herd of 22–25 elephants was recorded in Phulbari Tea Estate. The team established connections with local forest guards and community leaders to track elephant movements in the area. Two trained *kumkis* were brought in from Orang National Park to assist in the operation. With the area secured by the Assam Forest Department, the veterinarians successfully sedated an adult female elephant, following which the necessary measurements were taken and the GPS collar fitted. Once the collaring was completed and all personnel had vacated the area, reversal medication was administered to the elephant. Building on the lessons from previous collaring attempts, this marked the second successful collaring of a female elephant in Sonitpur District. The team named her 'Phul'.



*Collar installation on Phul*

# PHASE II: UDALGURI

## OPERATION 1 (OCTOBER 2023)

In the second phase of the project, the team minimised previous operational errors by adapting to regional environmental factors. Understanding the local terrain and community dynamics was crucial. The Assam Forest Department and WWF-India team visited multiple potential collaring sites in Udalguri to engage with residents and tea estate management to map local elephant movements. Team members maintained constant contact with local partners and the Assam Forest Department staff, who provided essential logistical and technical support.

Once a connection with the local community was established, local residents directed the team to areas where herd sightings were common. This collaboration enabled the team to monitor movements and conduct an on-site assessment of the local topography. Connections were also forged with local forest guards and tea garden staff, who provided initial confirmations of elephant presence in the tea estates.

The collaring team also maintained strong partnerships with local NGOs, the police department and the district administration, all under the overall supervision of the Assam Forest Department.

Following an extended period of routine tracking, intensive monitoring was undertaken from 25 September to 2 October 2023. Elephant herds were tracked across four separate locations: Dharamjuli, Badlapara, Hatigarh and Majuli Tea Estates. Alternative locations were also monitored to account for possible shifts in herd movements. The Badlapara Tea Estate was initially identified as the most suitable location due to its open spaces. The elephants had been using the interconnected Hatigarh and Majuli Tea Etates for some time, where the relatively even terrain and plantations of Guatemala grass (*Tripsacum andersonii*) provided suitable cover. Although the Dharamjuli Tea Estate hosted the highest number of elephants (over 40 individuals), it was deemed unsuitable due to its proximity to a *hola* (a low-lying drainage system) that connected to a nearby river, which posed a potential risk of animal drowning following sedation.

On the scheduled day of the operation, i.e., 3 October 2023, one of the tracking teams discovered a herd of 25–30 elephants in the nearby Barangajuli Tea Estate. The team swiftly surveyed the location and found it ideal for the operation due to a flat, rectangular patch of shrubland remote from human habitation.

A *kumki* elephant, along with the logistics and communication teams, was deployed to the site. Interestingly, in Udalguri, where *kumkis* were used minimally and only for short durations to drive wild elephants, the wild herds appeared considerably more relaxed in their presence, in sharp contrast to the evasive behaviour observed in Sonitpur. This distinction provided another valuable lesson for future operations. After securing the perimeter, the veterinary team darted the chosen female, named 'Mynow', in a relatively open area. Once the sedative took effect, the team cautiously approached the elephant while keeping the remainder of the herd at a safe distance. Physical measurements were recorded, the collar was secured and reversal medication was administered once the team had cleared the area. Upon reversal, the female quickly rejoined her herd in a nearby thicket.

## OPERATION 2 (OCTOBER 2023)

Given the intensive tracking and monitoring already underway in Udalguri, the presence of elephant herds in the vicinity and the operational logistics already in place for the first collaring, the Hatigarh Tea Estate provided a good opportunity for the second collaring operation. On 4 October 2023, immediately after the previous day's collaring, the ground team was able to successfully sedate and collar another adult female elephant at Hatigarh Tea Estate. She was named 'Budhini'.

# PHASE III: BISWANATH

## OPERATION (OCTOBER 2024)

While exploring opportunities for collaring a male elephant in Biswanath District, the collaring team established strong ties with the local community, tea plantation management, and the local Forest Department staff to secure technical and logistical support. These connections were built through organising radio collaring awareness programmes, engaging community mobilisers and frequent visits to the area. The Assam Forest Department staff, who were well-versed in seasonal elephant migration paths, guided the team in identifying ideal deployment sites.

Bedeti Tea Estate represents the largest contiguous cluster of tea in Biswanath District and adjoins the Behali RF, which was then proposed as a wildlife sanctuary. Elephants frequently traverse between the reserve forest and the adjoining tea gardens bordering paddy fields, particularly in October when the crops ripen. Because crop-raiding is a primary driver of human–elephant conflict, local communities frequently drove elephants back towards the Behali RF to protect their harvests and livelihoods.

In early October, reports confirmed that elephants had begun venturing into the tea gardens. At least three herds were reported to be traversing the region—one moving north from Kaziranga Tiger Reserve, an unidentified herd near the Gingia Tea Estate, and one

in the Bedeti Tea Estate. A joint team from the Bargang Range Office (Sonitpur East Forest Division) and WWF-India visited the Bedeti Tea Estate and confirmed that elephants were taking shelter in the tea plantations during the day. The team surveyed the site to assess the herd's composition, as well as the soil composition, vegetation and terrain within the plantation. The Bedeti herd was targeted for the operation due to highly favourable field conditions, strong ground support from the Assam Forest Department and close collaboration with regional ADS leaders.

On the night of 27 October 2024, a herd of 25–30 elephants crossed into Borajuli Division of Bedeti Tea Estate. On 28 October 2024, one of the two male *makhnas* in the herd was darted for collaring. A combination of medetomidine and ketamine was used to induce partial sedation, allowing the elephant to remain standing rather than collapse. A male *kumki* was brought in to safely confirm that the anesthesia had taken full effect. Once sedation was verified, vital signs, including respiration and pulse rates, were monitored and physical measurements were taken. The collar was fitted around the neck and the reversal dose was administered. About 20 minutes later, the elephant successfully rejoined his herd and was observed mud-bathing in the shade. He was named 'Bishu,' after Biswanath District.

Table 1: Summary table of collared elephants

| Sr. No. | Name | Gender | Age (approx.) | Biodata (approx.) | Herd size (approx.) | Collaring date and make | District |
|---|---|---|---|---|---|---|---|
| 1 | Tara | F | 35 years | Shoulder height: 264 cm<br>Neck girth: 253 cm<br>Length: 395 cm | 50 | 14 November 2021, Vectronics Aerospace 40750 | Sonitpur |
| 2 | Phul | F | 20 years | Shoulder height: 251 cm<br>Neck girth: 236 cm<br>Length: 320 cm | 60–70 | 13 November 2022, Vectronics Aerospace 40751 | Sonitpur |
| 3 | Mynow | F | 25 years | Shoulder height: 245 cm<br>Neck girth: 254 cm<br>Length: 340 cm | 50–60 | 3 October 2023, Africa Wildlife Tracking 5379 | Udalguri |
| 4 | Budhini | F | 25 years | Shoulder height: 215 cm<br>Neck girth: 214 cm<br>Length: 295 cm | 20–45 | 4 October 2023, Africa Wildlife Tracking 5378 | Udalguri |
| 5 | Bishu | M | 25–40 years | Shoulder height: 288 cm<br>Length: 453 cm | 25–30 | 28 October 2024, Africa Wildlife Tracking 6503 | Biswanath |



*Phul being revived after collaring*



*Tara along with a tusker in Tarajuli Tea Estate*

# 5. POST-COLLARING MONITORING

## DATA ACQUISITION AND ANALYSIS

All five collars were programmed to transmit location data at one-hour intervals. This enabled the team to understand fine-scale elephant movements and how they varied across the day, months and even seasons. Data from the collars were directly uploaded to the satellite and retrieved on a desktop computer. In case the collars were unable to transmit the location due to unavailability of signal, the data was stored in the device and was uploaded later when network connectivity was available.

The data from the collars included location information in the form of GPS coordinates and the corresponding time of location acquisition. Additional information, including the animal's speed during the location acquisition and accelerometer data indicating its activity status (e.g. upright, resting, etc.), was also recorded. The data was analysed using QGIS (version 3.2) and *R* to calculate the daily distance moved and net displacement over 12-hour periods (6 am–6 pm and 6 pm–6 am) to understand variations in diurnal and nocturnal movement (R Core Team, 2020) (*see Figure 1*). Further, the land use of the area covered by the animals was classified into broad categories such as forest, tea estate, agricultural fields and settlements to understand the relative use of the different land-use types. Additionally, month-wise minimum convex polygons (MCP) were estimated to understand seasonal variation in activity centres and home ranges.



*Mynow foraging in a tea estate in Udalguri District*

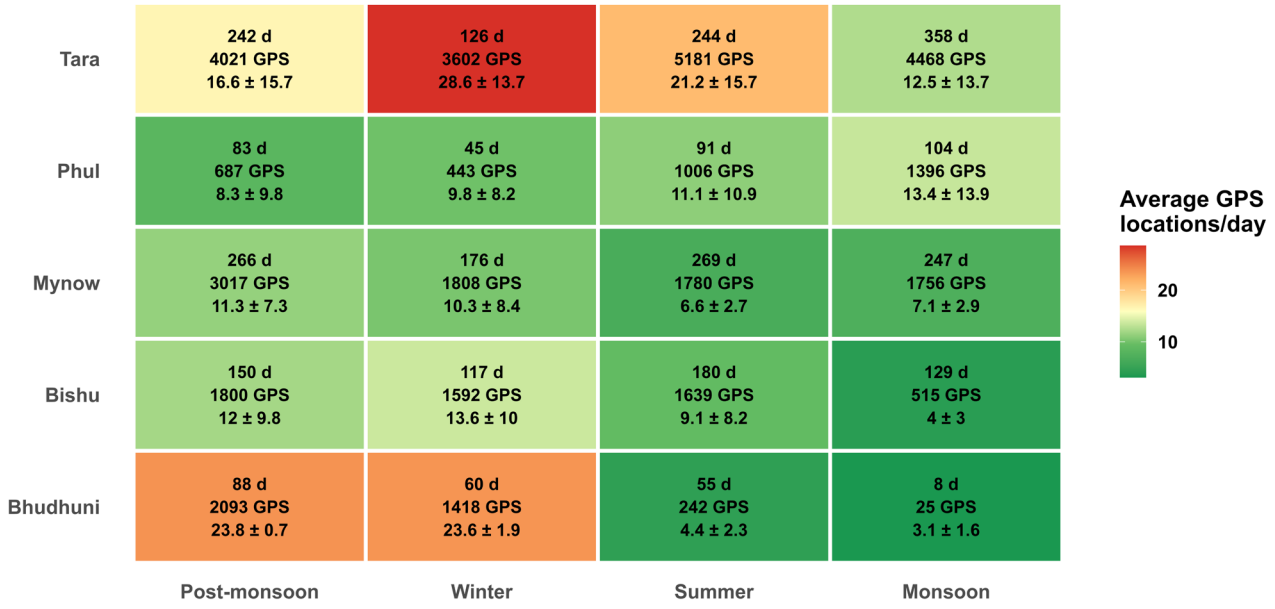



Figure 1: Season-wise data transmission by the GPS collars

# HOME RANGE

## SONITPUR

Satellite telemetry data revealed that the two collared elephants in Sonitpur District, namely Tara and Phul, belong to separate herds with partially overlapping home ranges. Together, the Sonitpur elephants ranged over 500 km² annually. However, there were significant variations in home range across seasons (*see Figure 2*). Between January and September, Tara and Phul ranged from 30–50 km². However, during the post-monsoon months, the range increased to 450–500 km² as the two elephants used the Nameri–Sonai Rupai–Arimora Chapori (NSA) Corridor to reach the Brahmaputra River. During the non-cropping season (January–September), Tara's herd primarily occupied areas along the northern and northeastern reaches of the Jiagabharu River within Sonai Rupai WLS, while Phul's herd utilised the areas along the southeastern parts (*see Figure 2*). Both herds used the tea garden areas of Tarajuli, Amaribari and Adabari Tea Estates to access their shared ground at Sengelimari (*see Figure 3*). Tara's herd, comprising up to 90 individuals, regularly traversed a 0.73 km² patch of the Sengelimari RF. According to collar data, the Sonitpur elephant herd, estimated at 40–80 individuals, was observed spending a significant amount of time in the Singlijan RF within an area of approximately 1 km² during November and December. They spent the day in the dense undergrowth dominated by *Lantana* and *Mikania*, interspersed with teak, sal, and *Lagerstroemia*, and venture out at dusk. Camera trap images along the railway tracks in Sengelimari RF indicate a high probability of the herd using the tracks. Tara's herd exhibited a wider range, moving from Sengelimari RF to Nameri National Park, while Phul's movements were restricted to the former. After leaving Sengelimari RF, Phul's herd was tracked to Arimora Chapori near Tezpur, where they were sighted in a group of 80–90 elephants in November 2023. On their return to the sanctuary, Phul's herd used Rupajuli Tea Estate as a temporary shelter.

Seasonal 100% MCP home ranges for Tara and Phul showed significant differences in area. The home range data was segregated into four seasons based on the Assam State Agriculture Department's classification of seasons. The four seasons were winter (December–February), summer (March–May), monsoon (June–September) and post-monsoon (October–December). Tara's home range was highest during the post-monsoon season (456 km²), followed by summer (62 km²), monsoon (48 km²), and winter (21 km²). The annual 100% MCP for Tara was 522 km². For Phul, the post-monsoon season recorded the highest range (615 km²), followed by monsoon (71 km²), summer (33 km²), and winter (20 km²). Phul's annual 100% MCP home range was 644 km². The expansion in post-monsoon

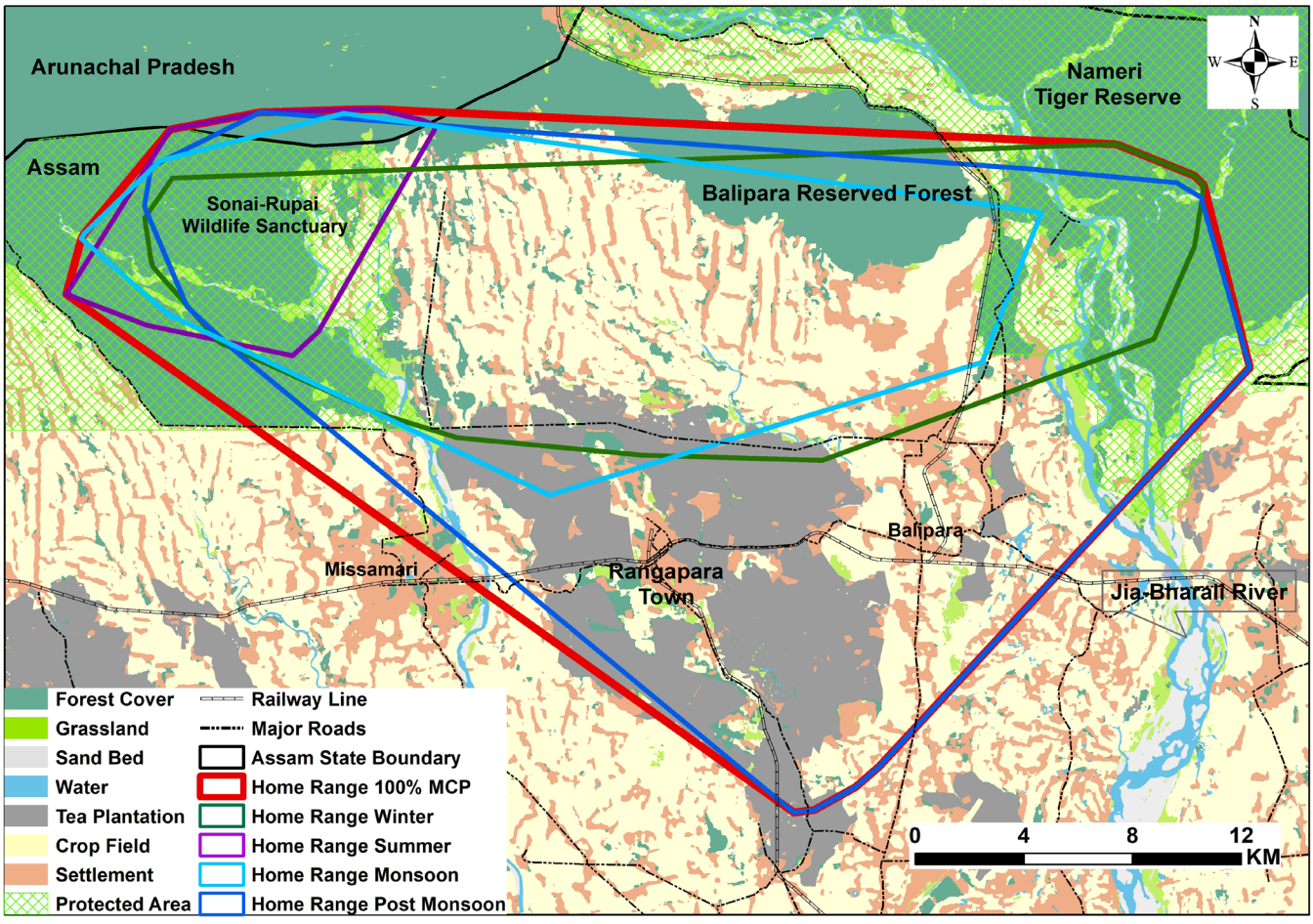



Figure 2: Seasonal home range (100% MCP) of Tara (November 2021–June 2026)

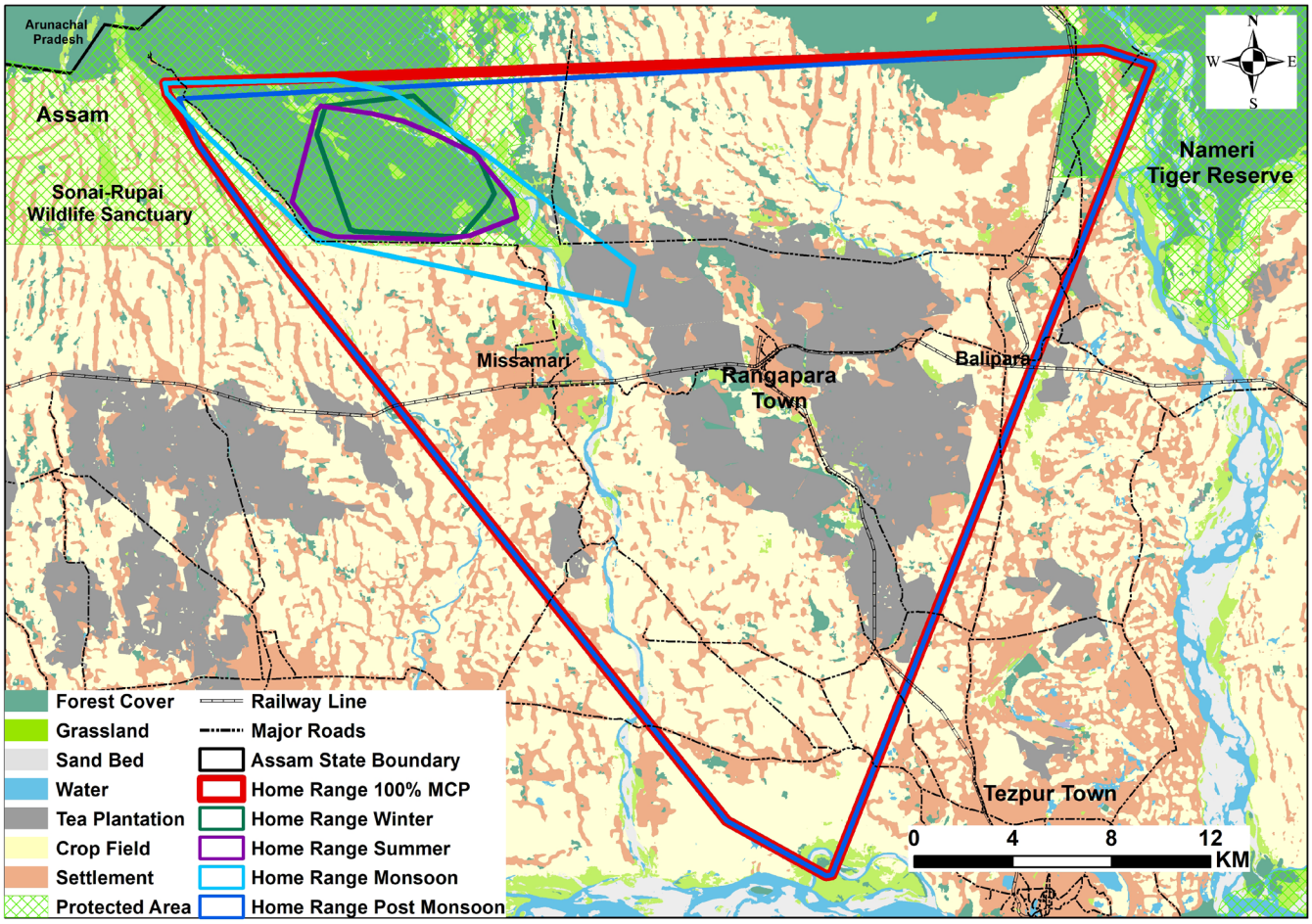



Figure 3: Seasonal home range (100% MCP) of Phul (November 2022–June 2026)

home range for both Tara and Phul may be explained by the presence of paddy crops at the harvest and pre-harvest stages in the landscape, which also coincides with their movement into Arimora Chapori through the NSA Corridor (Nameri–Sonai Rupai–Arimora Chapori).



## UDALGURI

The collared female-led herds in Udalguri exhibited contrasting ranging patterns, although both herds shared a high use of tea plantations and occasionally merged (*see Figure 4)*. Budhini's herd was found to have spent more time in and around the Hatigarh Tea Estate, whereas Mynow's herd traversed a larger area (*see Figure 5*). Mynow left the collaring site immediately after her collaring and travelled approximately 14 km to the southeast and 33 km to the east of the collaring site. In October, both herds were observed to have moved from where the females had been collared, Barangajuli Tea Estate and Hatigarh Tea Estate, to a shared feeding ground in Nonoi RF. Satellite images and collar locations provide strong evidence that during winter these elephants migrate to Bhutan, reaching the areas bordering Udalguri District. Although both collared elephants from Udalguri moved, they did so with separate herds and occupied separate areas in the foothills of Bhutan. The vegetation and landscape characteristics of these areas could not be assessed on the ground, as the team was not permitted to visit the desired location by the Bhutan Border Authority. However, from satellite images, it can be inferred that the vegetation consists of dense forests with sparse human settlements and sufficient water availability, the latter being a limiting factor during the dry winter months in the Bhabar plains of Udalguri.

The seasonal home ranges of the Udalguri herds also showed distinct variation, but the average home ranges were larger than the Sonitpur herds. Mynow's seasonal home range was estimated to be 740 km² during the post-monsoon season, 39 km² in winter, 345 km² in summer and 288 km² during monsoon.

Budhini's post-monsoon range was 240 km², the smallest of the four herds. Her home range decreased to 35 km² in winter and increased to 69 km² in summer. Mynow's annual home range was estimated to be 890 km²; a comparable estimate could not be obtained for Budhini as erratic GPS transmission resulted in too few locations across seasons for a reliable estimation of her annual home range.

## BISWANATH

Bishu's movement across the Biswanath landscape was characterised by a heavy reliance on river networks and riparian channels to traverse north–south between Behali WLS, Singlijan RF, and the lowland grasslands along the Brahmaputra River, particularly within the Sixth Addition areas of Kaziranga Tiger Reserve (*see Figure 6*). His overall ranging area was significantly larger than that of the collared herds in Sonitpur and Udalguri. Encompassing an area of 947 km², his range extended approximately 40 km southeast to

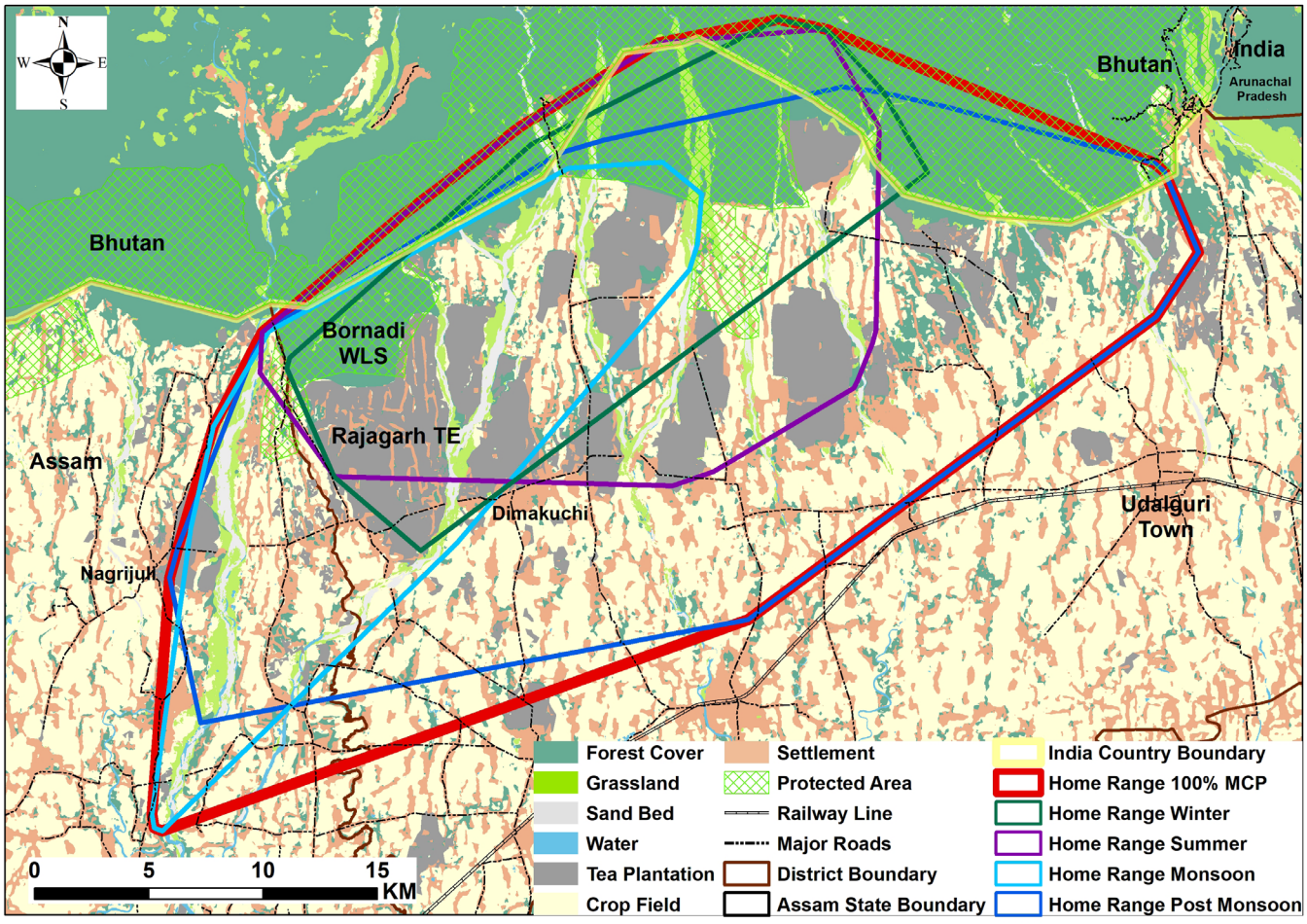



Figure 4: Seasonal home range (100% MCP) of Mynow (October 2023–June 2026)

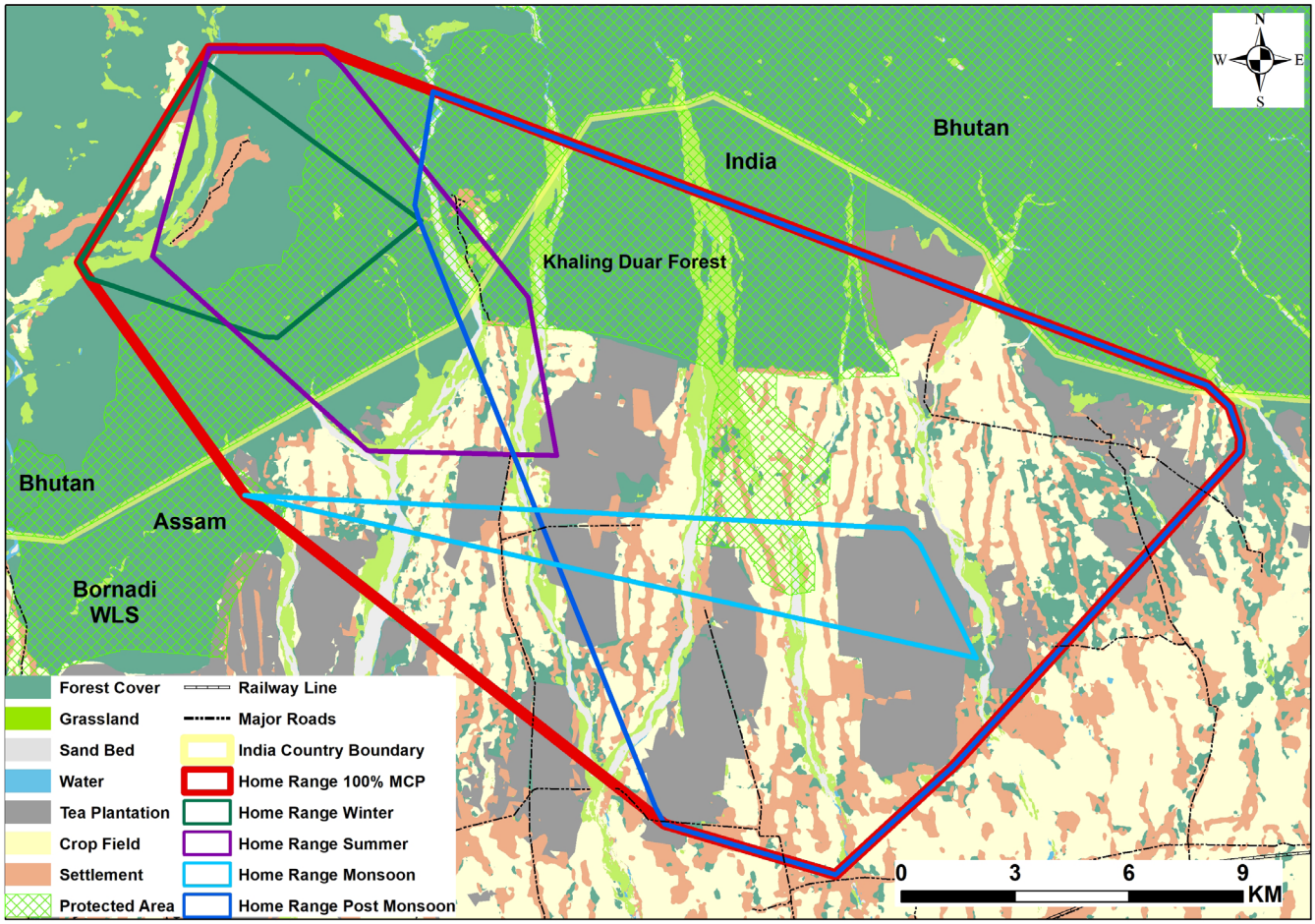



Figure 5: Seasonal home range (100% MCP) of Budhini (October 2023–Sept 2024)

Gohpur, 18 km south and 23 km southwest across the riverine *chaporis* (riverine grasslands/islands) of the Brahmaputra.

These two forest patches, Behali WLS, and Singlijan RF, served as the herd's primary core area throughout the year, with Bishu exhibiting a marked preference for Behali over Singlijan. Following his collaring in October 2024, Bishu headed towards the *chaporis*, navigating south via the Buroi River. By December, tracking data showed movement as far as Gohpur along the channels of the Brahmaputra River. Between November and January, his home range analysis revealed significant residence in the chapori grasslands (150 km²). This spatial preference was driven by the proximity to adjacent agricultural fields where the herd raided crops at night, using the dense grassland patches as a daytime refuge. In the first year of radio collaring, Bishu continued to utilise these chaporis with a small herd of 6–10 individuals through March. Data from the second year showed continued use into May and June; however, the drivers of this extended seasonal movement remain to be explored. In addition to riverine habitats, Bishu spent substantial time in the Bedeti and Gingia Tea Estates, including the Borajuli Division, using an area of 20 km² that provided critical daytime shade adjacent to crop fields during the peak paddy harvest.



*Budhini passing through Orangajuli Tea Estate*

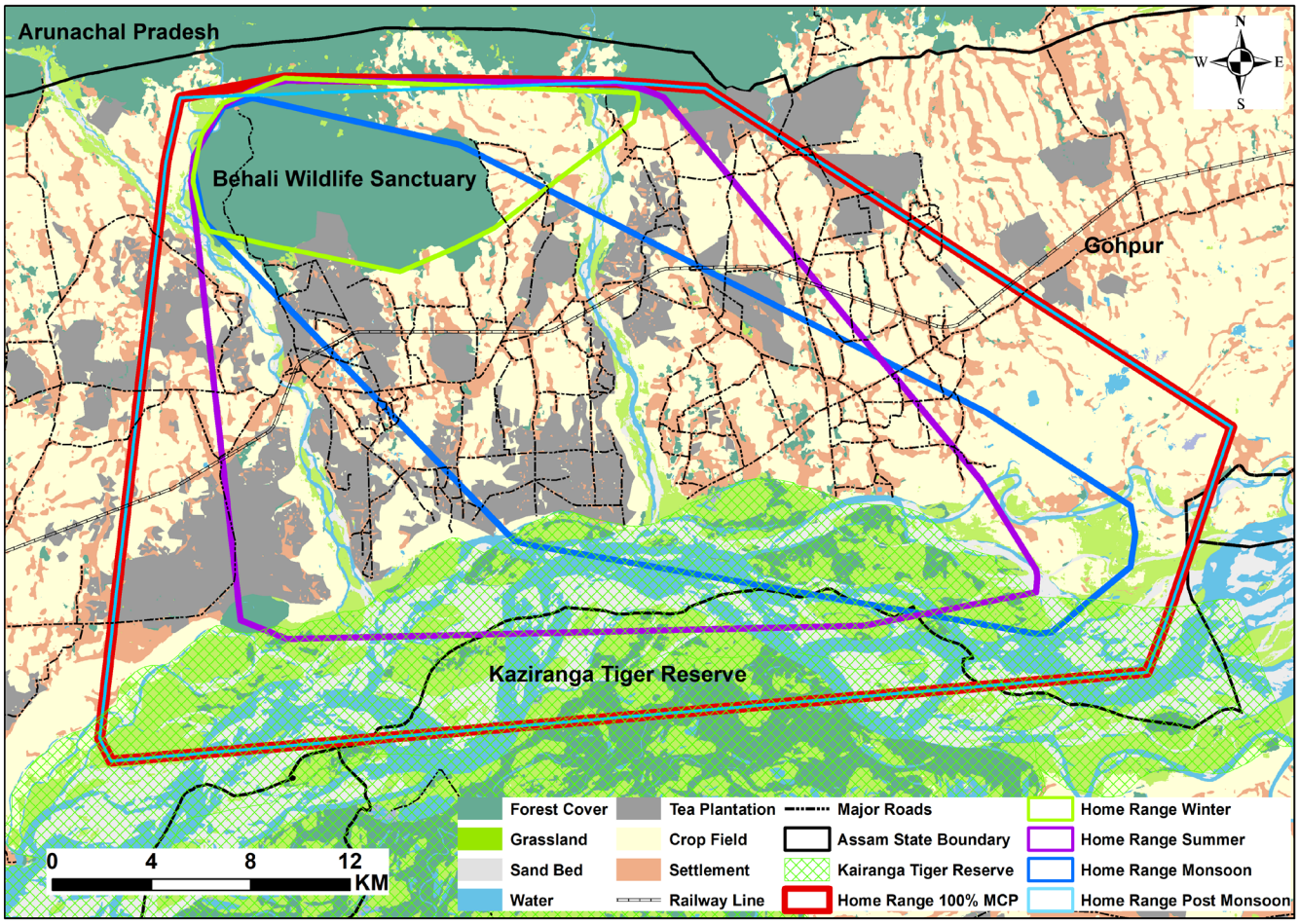



Figure 6: Seasonal home range (100% MCP) of Bishu (October 2024–June 2026)

## SEASONAL VARIATION IN MOVEMENT

In the wild, elephants move to access food and water and to seek mating opportunities. With seasonal variation in resource availability, home ranges and movement rates also change. Movement rates may further vary between day and night depending on land use, with elephants potentially showing greater nocturnal movement through human-use areas compared to more diurnal movement in natural habitats. We tested these hypotheses by quantifying diurnal and nocturnal movement rates across seasons for all the collared individual elephants. Net diurnal displacement was calculated for each 12-hour period beginning at 6 am, based on the first and last locations recorded during that period. The same approach was used for the 12-hour period beginning at 6 pm to calculate net nocturnal displacement. The data was divided into 12-hour periods, beginning at 6 pm on the first day, to assess variation between diurnal and nocturnal movement. Similarities were observed in the movement patterns of the two elephants in Sonitpur, which contrasted markedly with the two Udalguri elephants. To examine both individual and cluster-wise variation, the data was analysed separately for each elephant and collectively for the two collared elephants in each district. Finally, data from all five collared elephants were pooled and analysed for landscape-scale inferences (*see Figure 7*).

For the Sonitpur elephants, net displacement ranged from 0.01 km to 3 km across all seasons except the post-monsoon months of October, November and December, when it reached up to 11.67 km. There was no statistically significant difference observed in the net displacements between day and night. However, the range of night-time displacement was found to be higher for Sonitpur elephants compared to the Udalguri elephants (*see Figure 8 and 9*). Further, the range of displacement was higher at night compared to day in the post-monsoon season. This period also coincides with an abundance of standing paddy at the pre-harvest and harvest stages. As elephants predominantly raid these crop fields at night, this may explain the greater range of nocturnal displacement compared with diurnal displacement.

The net daily displacement analysis for Bishu showed that he moved more extensively at night (1.21 km to 6.75 km) than the day (0.78 km to 1.86 km). The mean night-time displacement in November (6.75 km) was more than twice that of December (2.98 km). This is during the period when the elephant traversed between

forests, tea plantations, and croplands to feed on ripening paddy in November and part of December, until the crop was harvested (*see Figure 10*). Movement was significantly lower during January (1.21 km at night and 0.78 km during the day), when the elephant restricted its movement to Singlijan RF (*see Figures 11–13*).



*Bishu approaches a herd in Biswanath District*

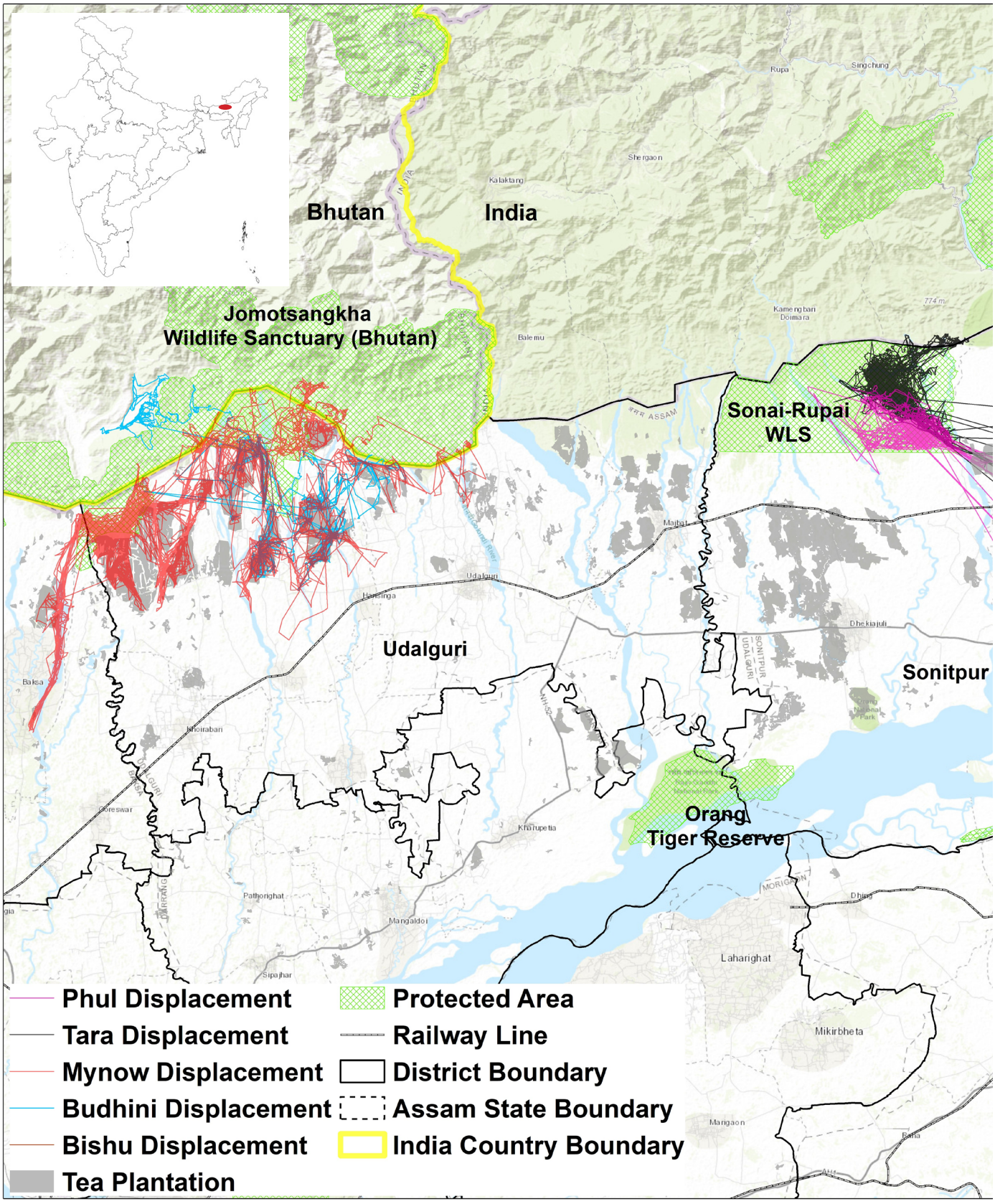
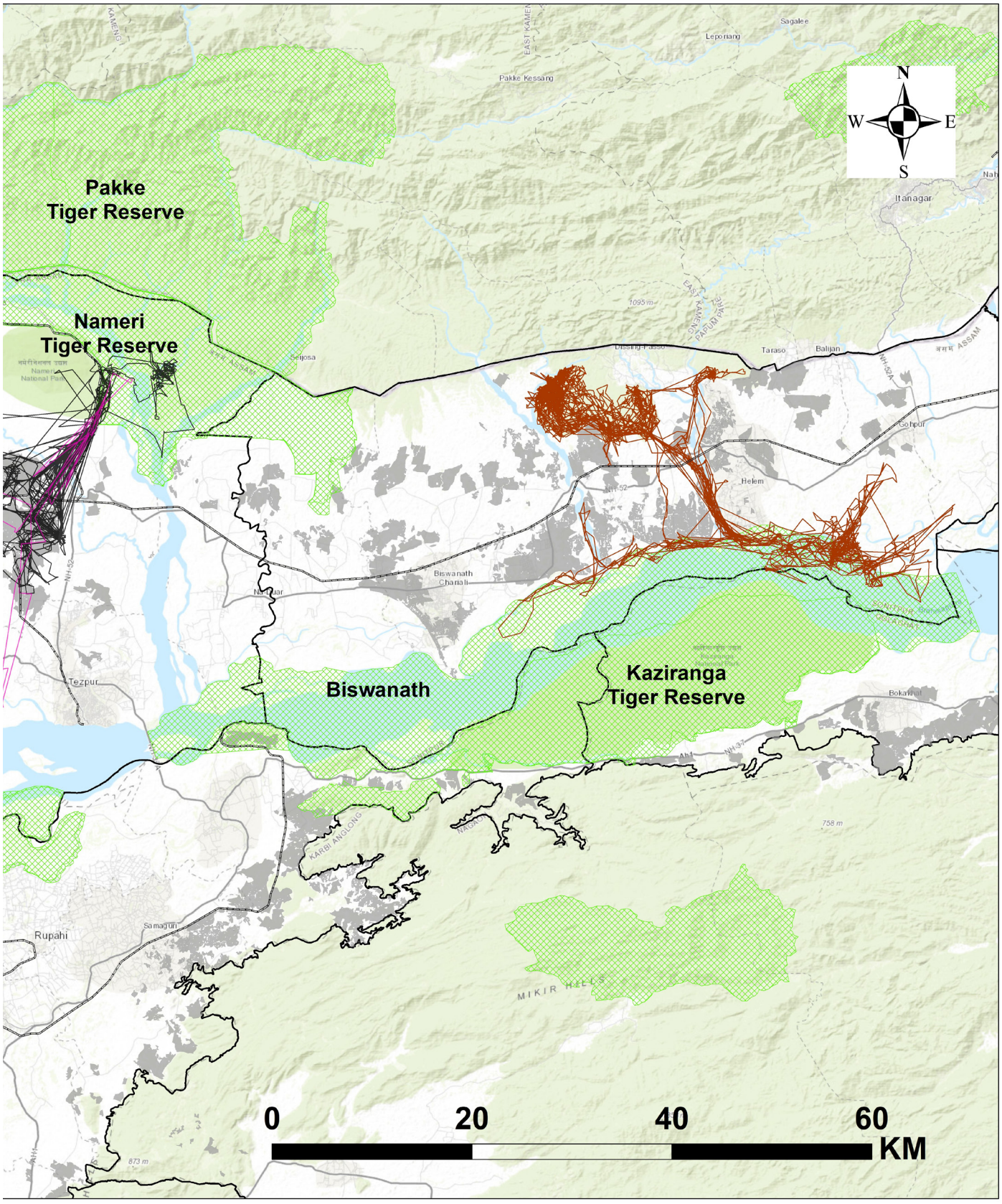



Figure 7: Overall movement tracks of elephants in Udalguri, Sonitpur and Biswanath Districts in Assam


Pakke
Tiger Reserve
Nameri
Tiger Reserve
Biswanath
Kaziranga
Tiger Reserve
N
W
E
S
Sagalee
Leporiang
Pakke Kessang
Itanagar
Seijosa
Dissing-Passo
Taraso
Balijan
Gohpur
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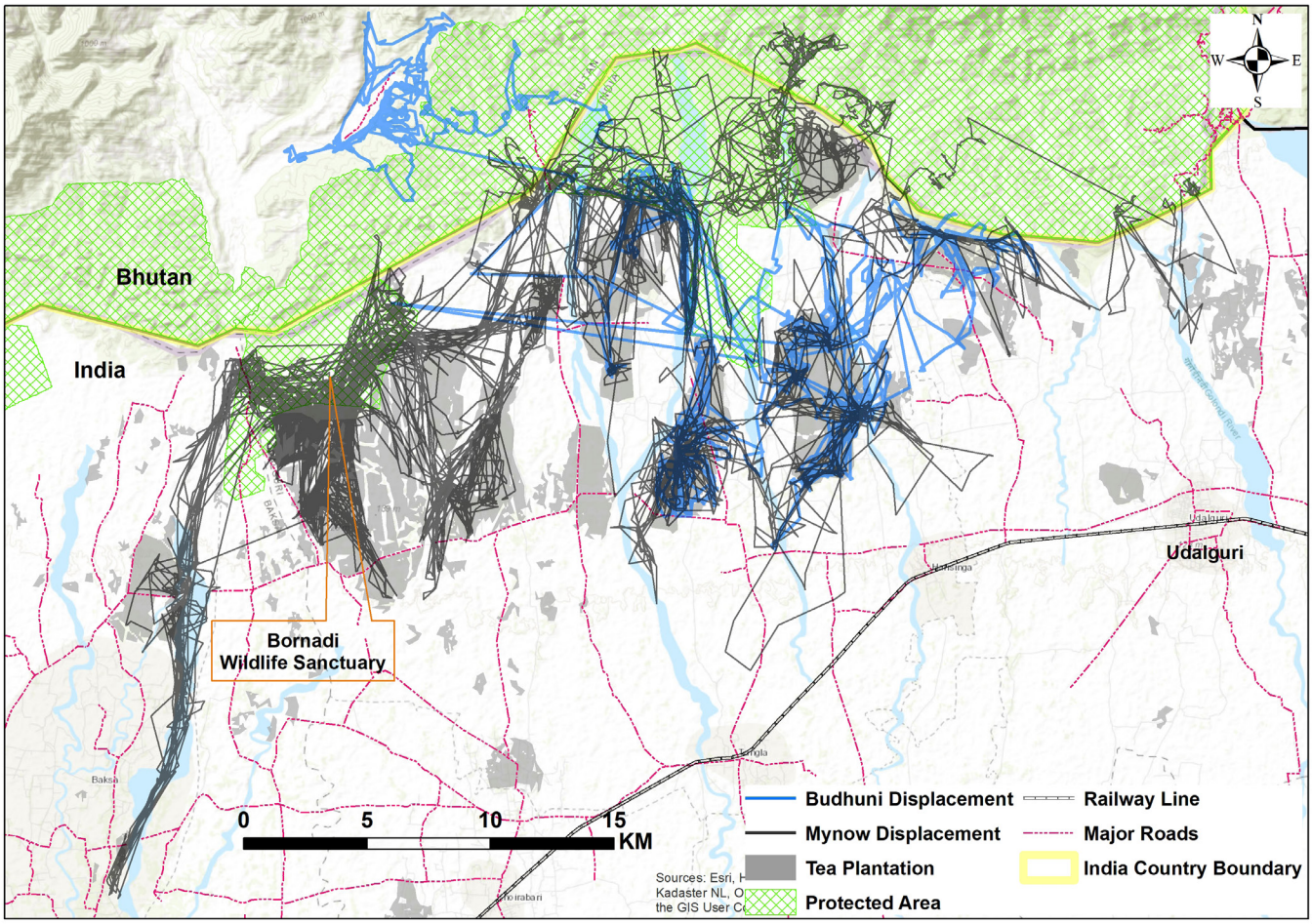



Figure 8: Movement tracks of elephants, Mynow and Budhini, in Udalguri

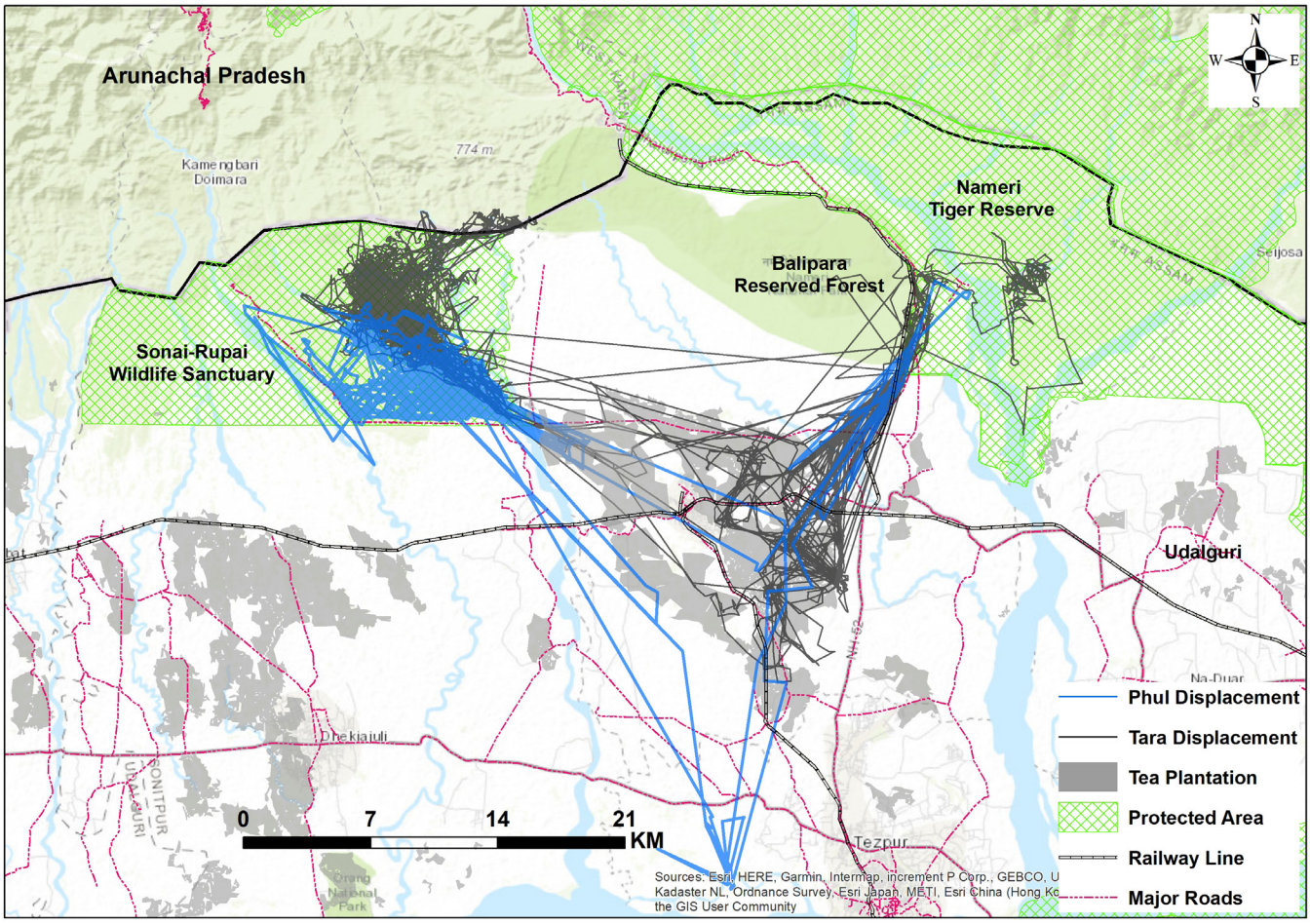



Figure 9: Movement tracks of elephants, Tara and Phul, in Sonitpur

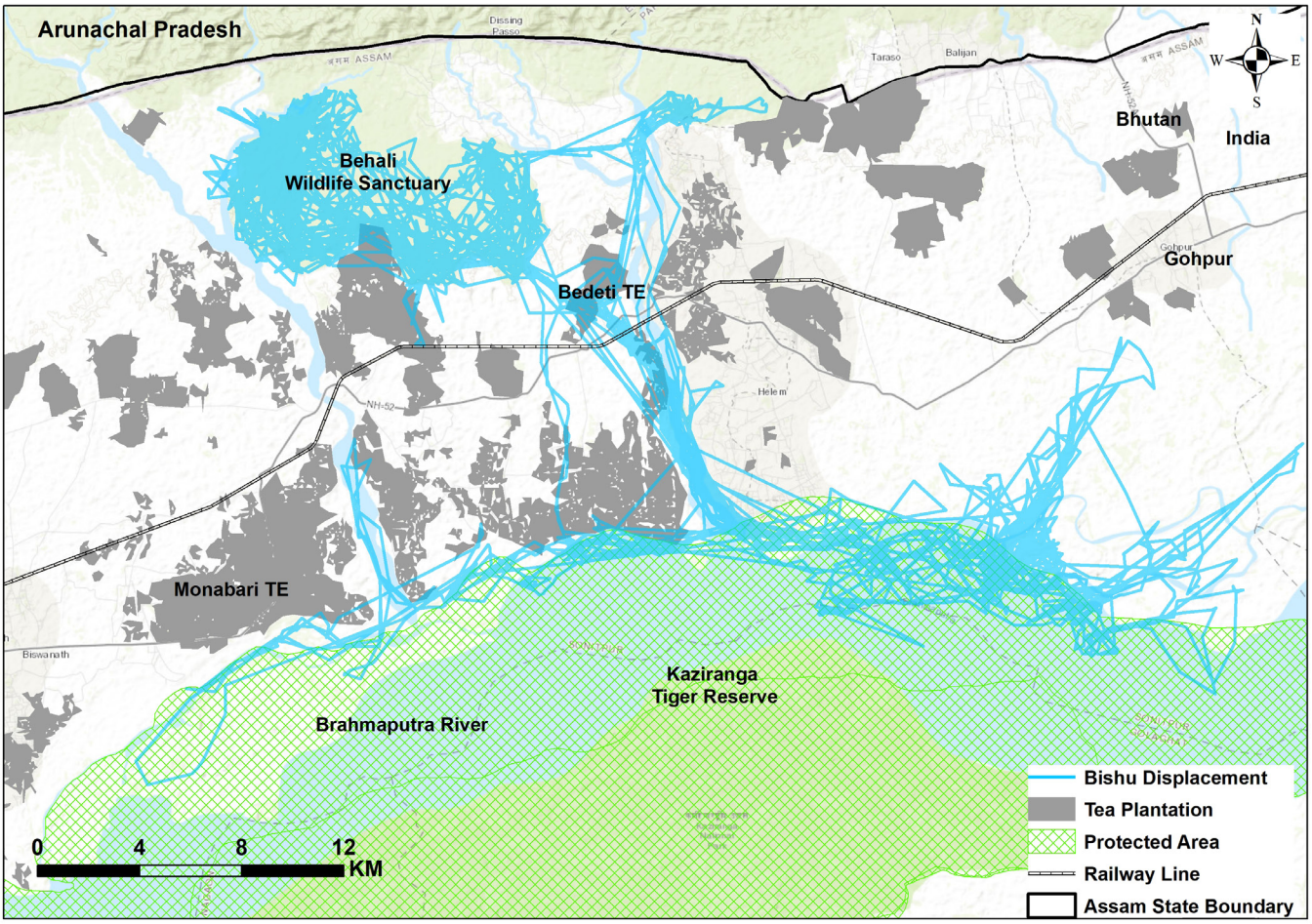



Figure 10: Movement tracks of Bishu in Biswanath

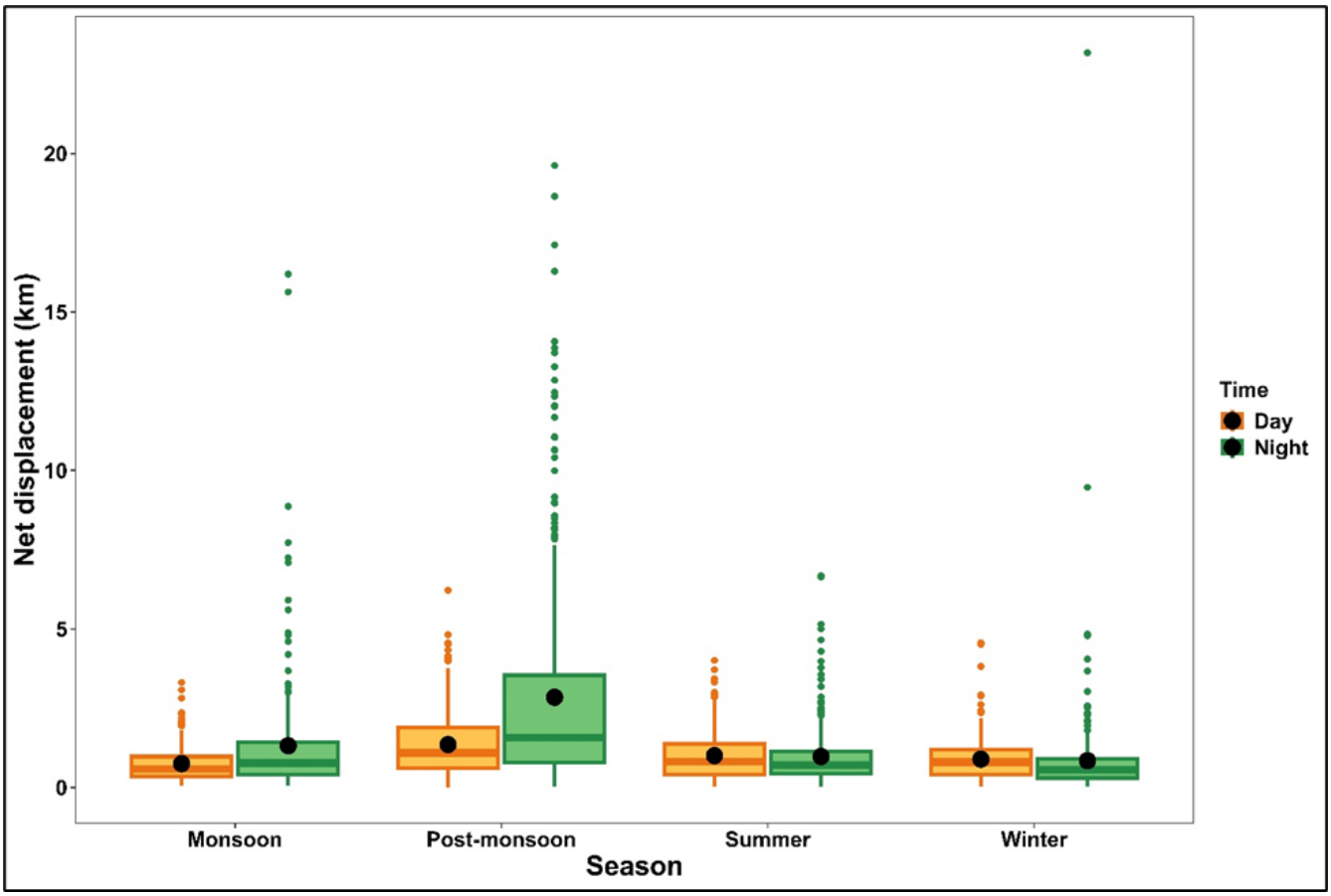



Figure 11: Overall displacement of elephants in Udalguri, Sonitpur and Biswanath Districts

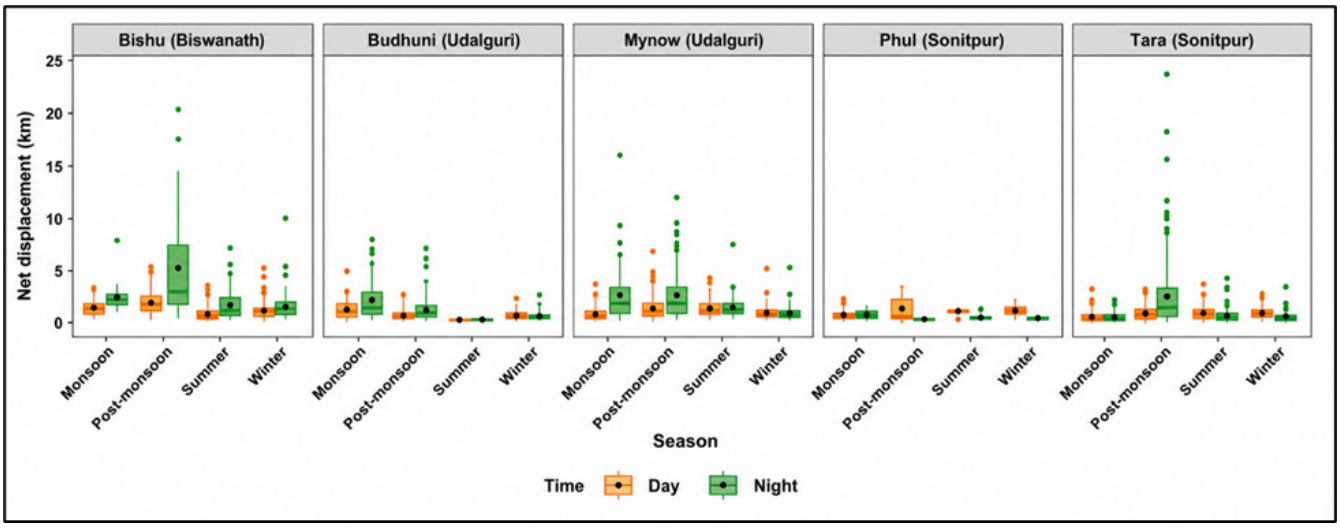



Figure 12: Net displacement of elephants in Udalguri, Sonitpur and Biswanath Districts

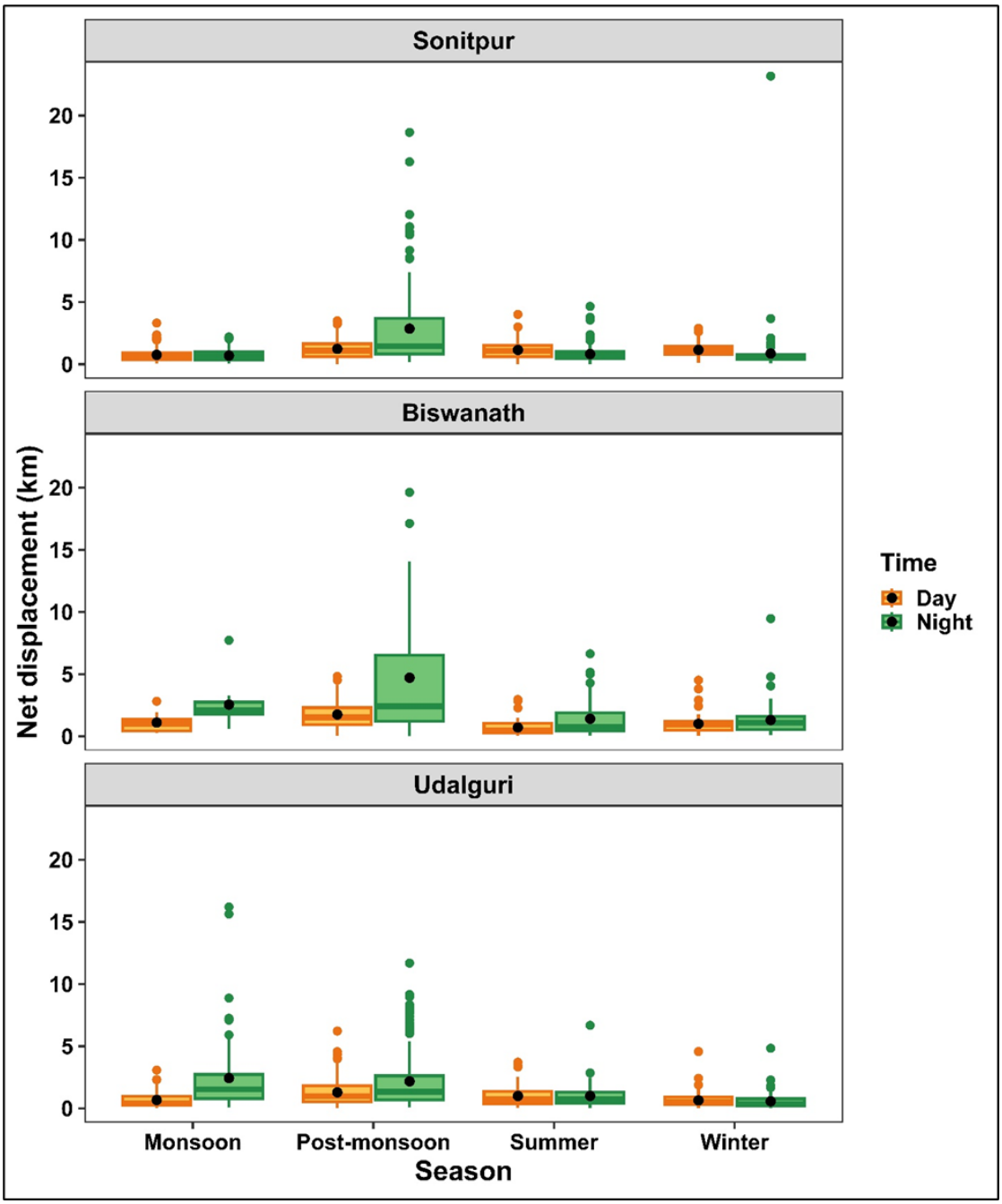



Figure 13: District-wise net displacement of elephants in Assam

# HABITAT USE

Elephants in Assam navigate a mosaic of forests, tea plantations, agricultural lands and human settlements. We analysed the relative use of various land-use types by the collared elephants by categorising the landscape into four broad land cover classes: (a) forest, (b) tea, (c) cropland and (d) grassland. The relative use of these land-cover classes was then examined across seasons. Since crop availability is a major driver of elephant movement in the landscape, the seasons were defined according to the Assam Agriculture Department classification as summer (March–May), monsoon (June–September), post-monsoon (October–December) and winter (January–February). The analyses were first carried out separately for each of the five collared elephants. Data from the three districts were then pooled to conduct a combined analysis across the five collars (*see Figure 14*). The locations were divided into daytime and night-time locations to understand diurnal variations in habitat use (*see Figure 16*).

## SONITPUR

The Sonitpur elephants spent more than 90% of their time within forested areas of Sonai Rupai WLS and Nameri National Park during the summer, monsoon, and winter seasons. However, their movement through agricultural fields and tea plantations increased during the post-monsoon period, with 40% of locations recorded in agricultural fields, 40% in forests, and 20% in tea plantations (*see Figure 16*). This period coincides with the harvest season, when standing paddy is present across most agricultural areas.

Table 2: Seasonal habitat-use composition for the five collared elephants in Assam

| ID | Season | Forest (%) | Grassland/riverbed (%) | Tea (%) | Cropland (%) |
|---|---|---|---|---|---|
| Tara | Winter | 83.8 | 10.7 | - | - |
| Tara | Summer | 79.1 | 13.6 | - | - |
| Tara | Monsoon | 67.9 | 20.9 | - | - |
| Tara | Post-monsoon | 45.5 | 9.9 | 25.2 | 17.8 |
| Phul | Winter | 88.9 | 7 | - | - |
| Phul | Summer | 76.6 | 16.5 | - | - |
| Phul | Monsoon | 54.4 | 35.7 | - | 5.2 |
| Phul | Post-monsoon | 71.5 | 15.2 | - | 8.2 |
| Mynow | Winter | 82.9 | - | 12 | - |
| Mynow | Summer | 62.2 | - | 25.6 | - |
| Mynow | Monsoon | 26.5 | 16.4 | 41.4 | 5.7 |
| Mynow | Post-monsoon | 27.6 | 9.1 | 39.6 | 15.1 |
| Budhini | Winter | 100 | - | - | - |
| Budhini | Summer | 99.2 | - | - | - |
| Budhini | Monsoon | 4 | - | 88 | - |
| Budhini | Post-monsoon | 27.8 | - | 40.7 | 16 |
| Bishu | Winter | 98.1 | - | - | - |
| Bishu | Summer | 75.9 | 10.6 | - | - |
| Bishu | Monsoon | 49.5 | 25.6 | - | 10.1 |
| Bishu | Post-monsoon | 26.3 | 29 | - | 26.4 |

During winter, 83.8% of Tara's recorded locations were in forests, with a limited 10.7% of her time spent in grasslands and riverbeds. In the summer months, forests continued to be her predominant habitat, accounting for 79.1% of her time, followed by grasslands and riverbeds at 13.6%. During the monsoon season, forest use declined to 67.9%, while there was a concomitant increase in grassland use to 20.90%. In the post-monsoon period, the use of forests and grassland reduced to 45.5% and 9.9% respectively, while use of tea plantations surged to 25.2%, with 17.8% of the locations recorded in croplands (*see Figure 16*).

Phul also displayed a similar habitat use, with 88.9% of her locations in winter located almost entirely within forests and 7% in riverbeds and grasslands (*see Figure 17*). Use of riverbeds and grasslands increased slightly in summer to 16.5%, whereas forest use declined marginally to 76.6%. During the monsoon, the percentage of locations recorded within forests reduced to 54.4% whereas the use of riverbeds and grasslands increased to 35.7%. A small proportion of Phul's locations (5.2%) was also recorded in croplands during monsoon. In the post-monsoon period, forest use increased to 71.5%, followed by grasslands (15.2%) and croplands (8.2%).

## UDALGURI

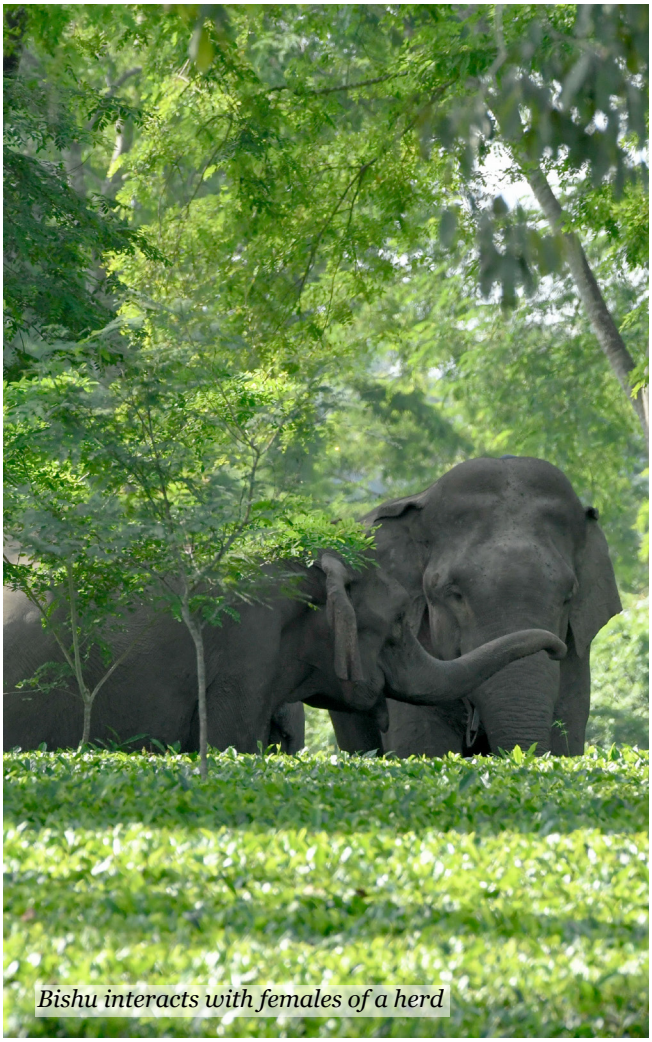
In stark contrast to Sonitpur, the Udalguri elephants spent a substantial proportion of their time in tea plantations, with 35–50% of locations recorded there during winter and summer. However, like the Sonitpur elephants, the use of agricultural areas during the post-monsoon, harvest season increased significantly. The collar data indicate that the elephant used tea plantations as refuges, particularly at night, and used them as bases to visit croplands during the post-monsoon months.

In the winter months, Mynow spent most of her time in forests (82.9%), followed by tea plantations (12%). During summer, the use of forests reduced to 62.2%, with an increase in the use of tea plantations (25.6%). In the monsoon season, forest use by Mynow and her herd declined to 26.5%, whereas use of tea plantations increased to 41.4%. During monsoon, the use of grasslands and riverbeds increased to 16.4% and use of crop fields (5.7%) and settlements (6.4%) also increased marginally. In the post-monsoon period, use of forests remained low at 27.6% with a marginal reduction in tea plantation use (39.6%). The use of croplands in the post-monsoon period increased to 15.1% (*see Figure 18*).

Budhini's movement pattern was similar to Mynow's and contrasted with the habitat use of the Sonitpur elephants. In winter and summer, the herd ranged entirely within the forests of Bhutan and India. During the monsoon, elephants ranged predominantly in tea plantations, which accounted for 88% of all recorded locations. During the post-monsoon period, Budhini's movements remained predominantly within tea plantations (40.7%), followed by forests (27.8%) and cropland (16%) (Figure 19).

## BISWANATH

Bishu's movements were characterised by extensive use of rivers to move between the Brahmaputra River and the forests of the Himalayan foothills in Behali WLS. Bishu also moved extensively in the grasslands of the Brahmaputra River in the Sixth Addition area of the Kaziranga Tiger Reserve. In winter, Bishu ranged almost exclusively within the forests (98%), whereas in summer he used a combination of forests (75.9%) and grasslands (10.6%). During the monsoon, his forest use decreased to 49.5% and his use of grasslands increased to 25.6%. Bishu was also observed to increase his use of croplands in the monsoon, with 10.1% of all recorded locations occurring in croplands during this season. During the post-monsoon period, 26.3% of Bishu's recorded locations occurred within forests, while his use of croplands increased to 26.4%. Bishu also spent 29% of his time in riverine grasslands and riverbeds as he used river channels extensively for movement (*see Figure 20*).



*Bishu interacts with females of a herd*

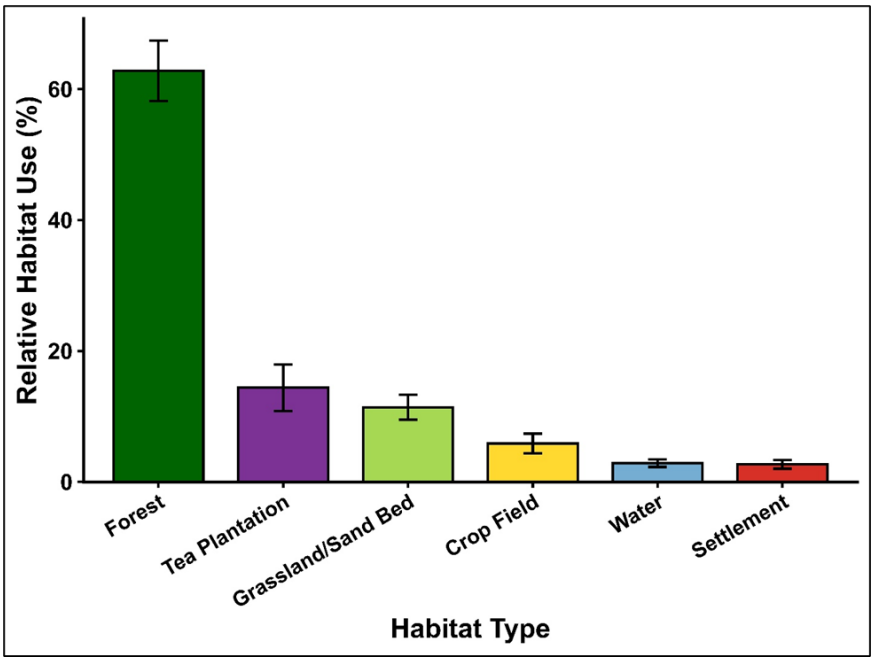



Figure 14: Overall habitat use of elephants in Udalguri, Sonitpur and Biswanath Districts

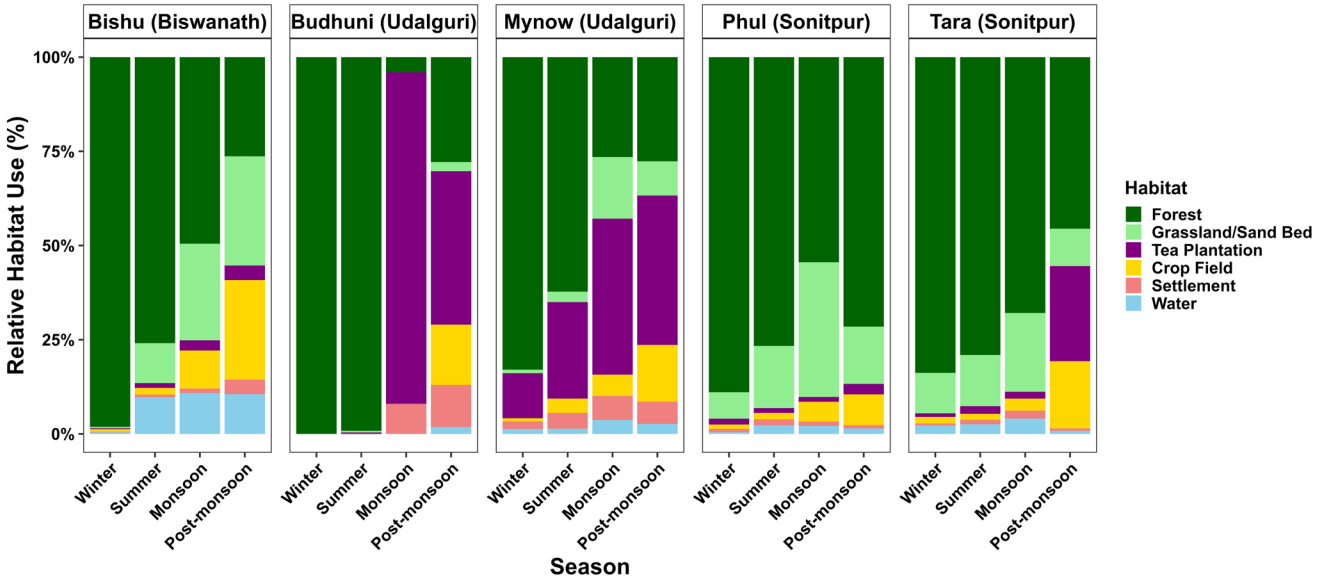



Figure 15: Habitat use by elephants in Udalguri, Sonitpur and Biswanath Districts in Assam



*Mynow moves through a tea plantation section of Hatigarh Tea Estate*

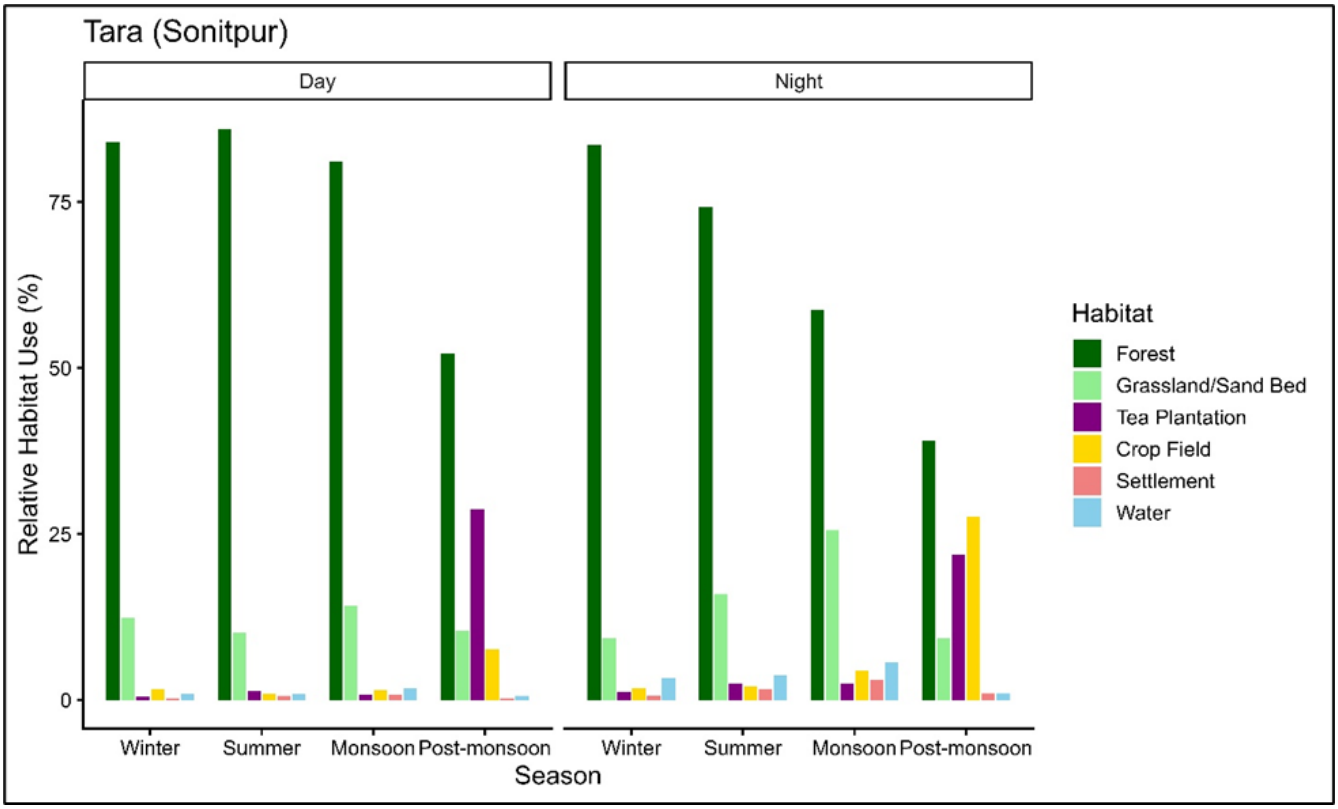



Figure 16: Daytime and night-time habitat use by Tara across seasons in Sonitpur

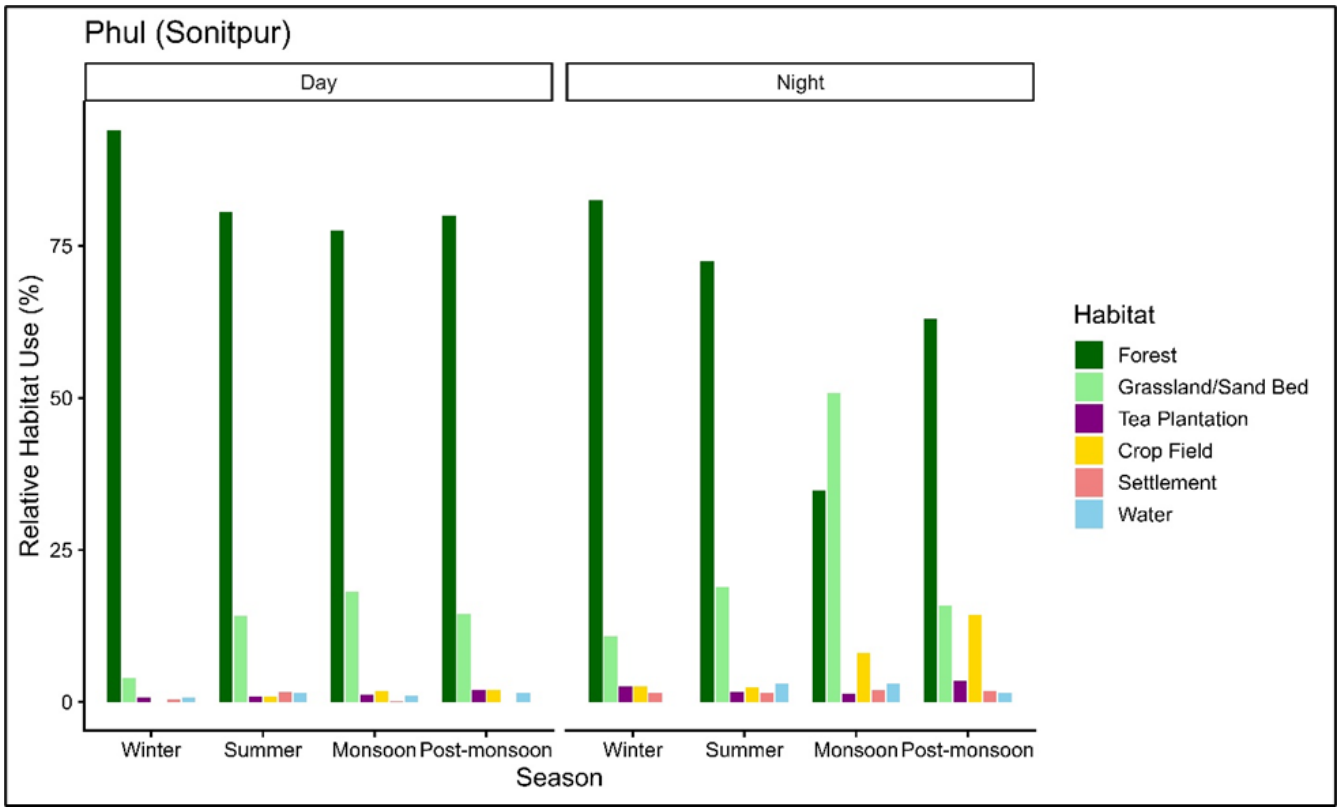



Figure 17: Daytime and night-time habitat use by Phul across seasons in Sonitpur

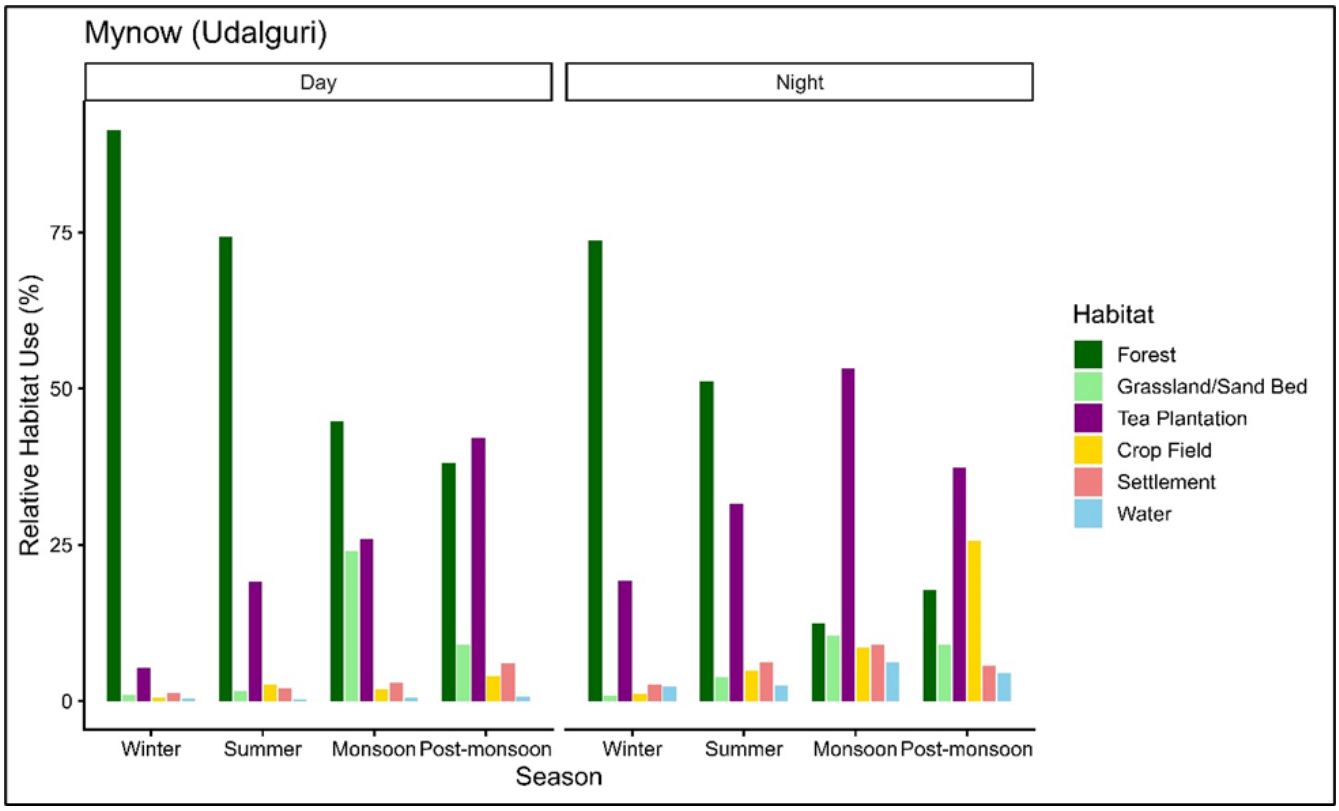



Figure 18: Daytime and night-time habitat use by Mynow across seasons in Udalguri

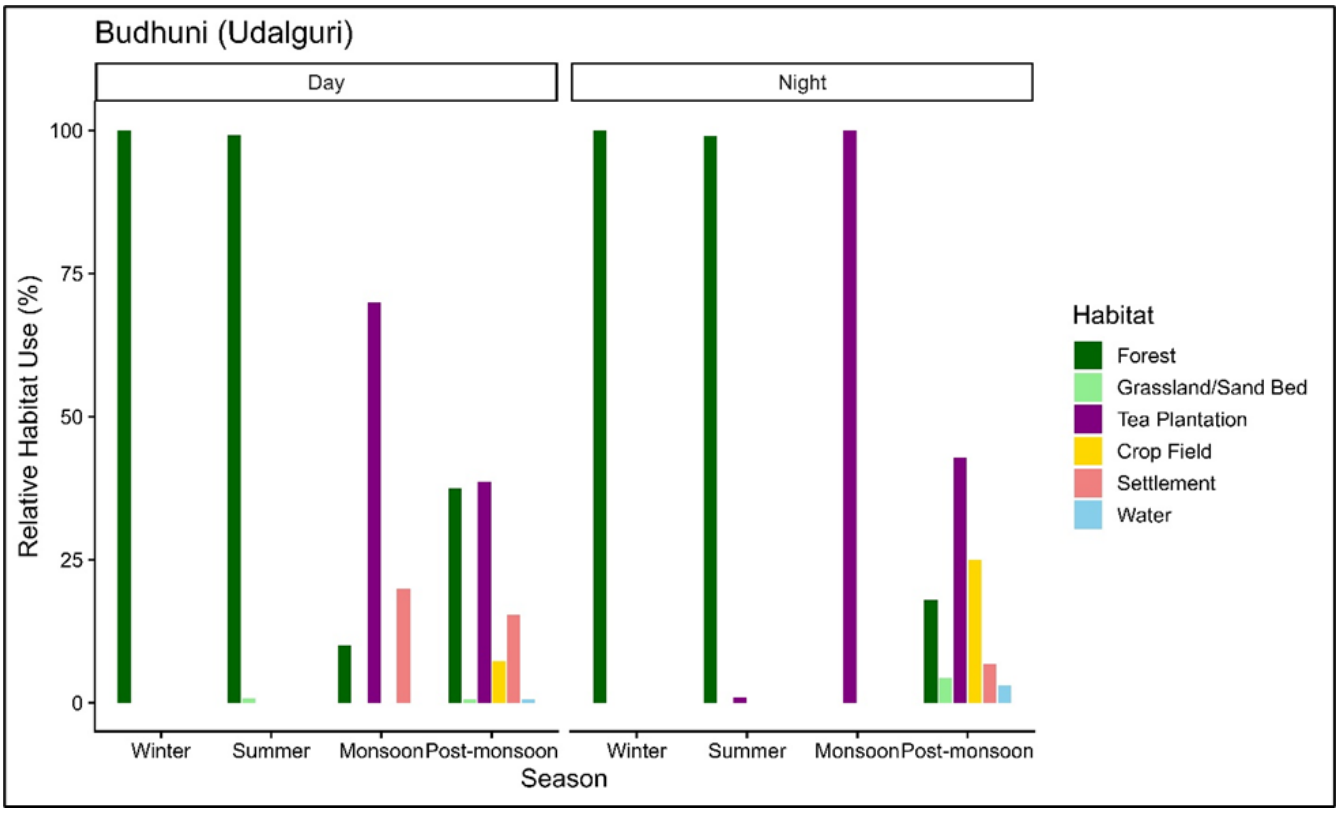



Figure 19: Daytime and night-time habitat use by Budhini across seasons in Udalguri

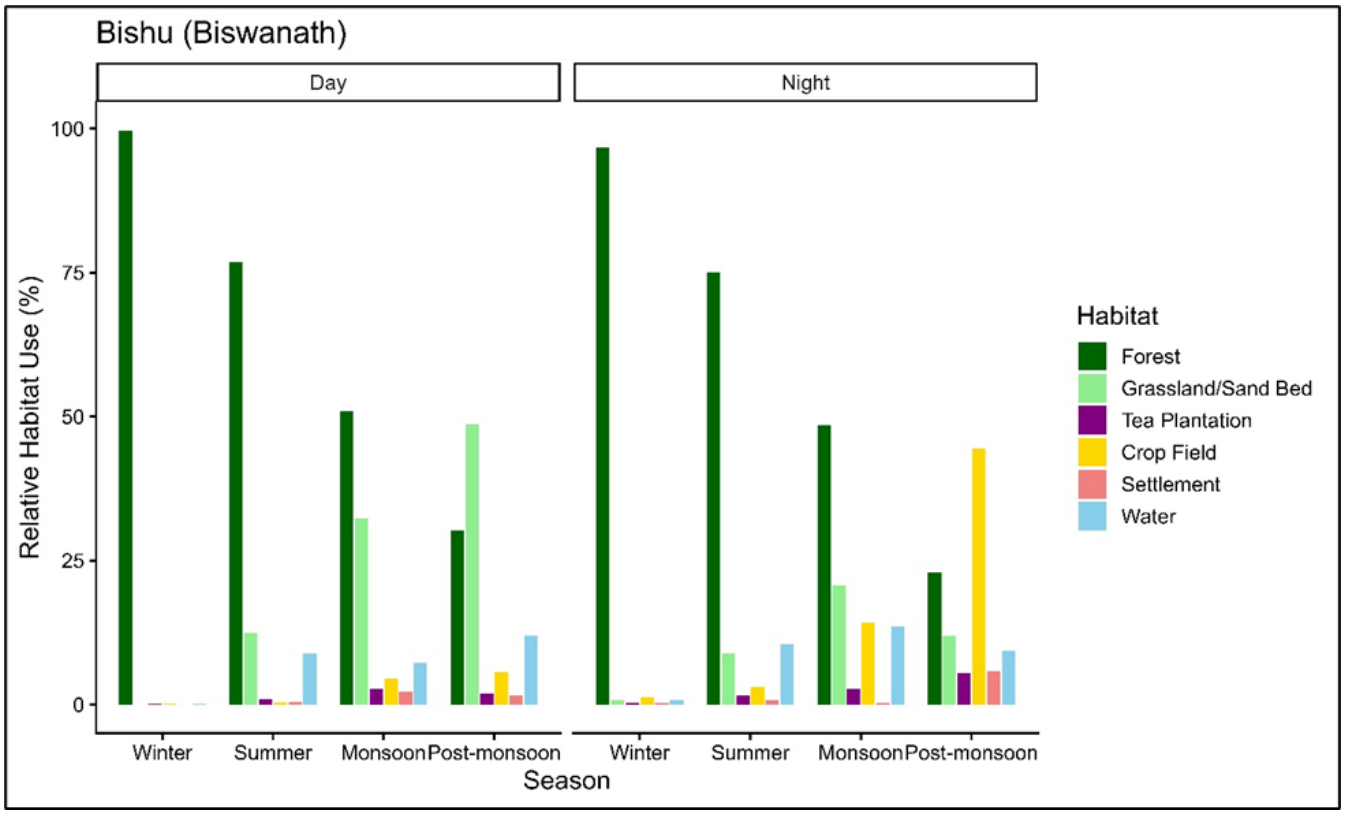



Figure 20: Daytime and night-time habitat use by Bishu across seasons in Biswanath



*Tara with her calf feeding on bamboo in Sonitpur District*

# 6. CONSERVATION AND MANAGEMENT IMPLICATIONS

## 1. SEASONAL RANGE EXPANSION AND IMPLICATIONS FOR ADVERSE HUMAN–ELEPHANT INTERACTIONS

All collared elephants (herds and solitary male) displayed a significant expansion of range in the monsoon and post-monsoon periods. The expansion also corresponds to increased use of croplands. The presence of paddy during this season indicates that elephants feed on crops during the harvest season and also make greater use of human-use areas during this period. This observation has implications for both crop damage probability and potential human and elephant casualties. Increased use of croplands by elephants during this season could result in substantial losses for agriculture-dependent communities. To counter such damage, local communities resort to installing illegal live-wire fences, as observed during ground tracking of the elephants. Additionally, sagging transmission lines increase the risk of accidental electrocution deaths during this season. During field consultations, it was also observed that many farmers had been cultivating lands that were not owned by them as many of these areas were designated as revenue or forest lands. This introduces the added complication of farmers being ineligible for ex gratia compensation from the Government for crop losses in fields that are not owned by them. This compels farmers to resort to protecting the croplands using illegal live-wire fences.

## 2. USE OF TEA PLANTATIONS BY ELEPHANTS

All four collared females and their herds extensively used tea plantations in Sonitpur and Udalguri for movement and habitation, underscoring the importance of these spaces for elephant passage and ranging. In Sonitpur, elephants are actively chased and mobbed in tea plantations, which increases the risks of accidental human casualties. In contrast, there is less hostility towards elephants in the tea plantations of Udalguri. Consequently, they tend to spend longer periods within the plantations. However, local hostility may not be the only driver for this habitat use as elephants in Sonitpur spend considerable time in Protected Areas, an advantage that is unavailable to the Udalguri elephants. Further investigation is needed to understand the reasons for the differential use of tea plantations by the two herds in Sonitpur and Udalguri. As elephants move through and spend time in tea plantations, the likelihood of direct encounters with people increases, requiring focused measures to prevent accidents. Adequate lighting in tea estate settlements and along adjoining roads is needed to ensure night-time visibility so that people can easily detect elephants and prevent sudden encounters. Additionally, the low-lying areas within the estates where tea has not been planted may be identified for restoration to ensure adequate forage availability for elephants. Many estates have also installed energised fences to prevent elephants from entering tea sections. Such fences need to be carefully aligned to prevent blocking elephant movement routes while also securing vulnerable areas. When strategically deployed and maintained, these fences have been known to effectively keep elephants from entering vulnerable areas such as settlements and crop fields.

While tracking elephants in tea plantations, two additional issues were observed that require intervention. First, there have been instances of large crowds gathering to watch elephants, which can escalate into a frenzy, with people chasing elephants to take selfies. This can have potentially fatal consequences. Strict restrictions on the entry of people need to be imposed by tea estate management, with prompt support from the police and forest departments. Second, alcohol consumption and the brewing of local liquor are also serious concerns, as inebriated people often venture too close to elephants, while stored liquor attracts solitary male elephants into settlements. A community-led movement to address and reduce indiscriminate alcohol consumption in the tea estates is required. The brewing and storage of local liquor within settlements also needs to be discouraged and liquor brewing units need to be moved away from settlement areas.

## 3. CRITICAL ELEPHANT HABITATS

The telemetry exercise has helped identify core natural habitats and secondary habitats that are used by the elephants. Protected Areas, namely Sonai Rupai WLS, Behali WLS, and Bornadi WLS were used by elephants extensively. Vegetation mapping needs to be undertaken, and water availability and pressures on these habitats need to be assessed, to determine their habitat value and to explore room for enrichment and conservation. The reserve forests in Udalguri were used sparingly by elephants, and their forage quality and water availability need to be assessed.

## 4. ELEPHANT MOVEMENT AND CORRIDORS

GPS telemetry of the five elephants provided high-resolution data on movement routes and corridors. In Udalguri, transboundary movement into Bhutan was observed as both the herds went to Bhutan during the dry season, potentially due to the lack of water availability on the Indian side. Hence, close coordination with Bhutan on elephant movement and corridor conservation is required to ensure that elephants are able to move freely across the international border with minimal risks and costs to local communities on both sides. Obstructions along the border need to be opened up in strategic locations for the elephants to pass and these areas may be jointly identified by Bhutan and India based on the telemetry data.

Within the range of the collared elephants in India, rivers were also found to be used for north–south movement. Bishu, the collared male from Biswanath District, was found to use the river networks extensively to move between the Brahmaputra and the forests of Behali WLS. Additionally, several movement routes were identified within Udalguri which were used by the herds to move between tea plantations. These routes have roads, railways, and settlements which need to be prioritised to safeguard human lives and prevent elephant casualties along linear infrastructure.

In Sonitpur, the use of the NSA (Nameri–Sonai Rupai–Arimora Chapori) Corridor was evident from the telemetry data, as elephants used this route to reach the Brahmaputra between September and December. In 2025–2026, during the post-monsoon period, elephant movement was blocked as the herds were driven back towards Sonai Rupai whenever they attempted to move south into the tea estates, preventing them from reaching the Brahmaputra River. While the blockade does prevent crop loss and reduces the risk of human casualties, it remains to be seen if the elephants will attempt to use an alternative route to reach the Brahmaputra River. Notably, prior to the year 2000, elephants from Sonai Rupai reached the river through Dhekiajuli and the adjoining tea estates. With rapid loss of forest cover, this route was abandoned by the elephants and the new route through the NSA Corridor was used after 2000.



*Tara displaying vigilant behaviour*



*Bishu rests under the shade trees of a tea plantation*

# 7. KEY RECOMMENDATIONS

## 1. DISTRICT-LEVEL COORDINATION COMMITTEE (DLCC) FOR HUMAN–ELEPHANT CONFLICT MANAGEMENT

Establishment of a DLCC under the leadership of the District Commissioner is vital for Udalguri, Sonitpur and Biswanath districts. The role of this committee would be to ensure coordination between line agencies for effective implementation of schemes that can help prevent and mitigate human–elephant conflict situations. This may include, but need not be limited to, the civil administration, police and forest departments, other official agencies such as disaster management, veterinary, agriculture and rural development, as well as tea estate management, village-level community institutions and NGOs. A preliminary coordination meeting was facilitated in Udalguri in 2025 under the chairmanship of the Hon'ble Deputy Executive Member, Bodoland Territorial Council (BTC); however, a formal committee is yet to be constituted.

## 2. ANTI-ELECTROCUTION CELL TO PREVENT ELEPHANT ELECTROCUTION

An anti-electrocution cell should be set up at the range level in each district to prevent accidental or deliberate electrocution of elephants. This cell should comprise representatives from the forest, electricity, and police departments, NGOs, Gajamitras (community based initiative launched by Governement of Assam to mitigate human-elephant conflict) , tea estate management, and local volunteers. The role of this cell would be to monitor and discourage the use of illegal live-wire fences, and detect and repair sagging transmission lines, exposed live wires and transformers in elephant range areas. Measures that may reduce the vulnerability of elephants to electrocution include establishing a subsidy scheme for the adoption of safe energised fences, use of Aerial Bundled Cables for overhead power lines, provision of adequate solar lighting facilities in tea estate settlements, and targeted communication campaigns, among others. Assam Forest Department and WWF-India have jointly prepared a report on elephant movement areas and overhead power line risks in Sonitpur District, which was submitted to the Assam Power Distribution Corporation Limited (APDCL) for remedial action in 2025. This needs to be followed up.

## 3. SUPPORT TO AGRICULTURE-DEPENDENT COMMUNITIES

Crop loss offset mechanisms need to be explored to prevent losses faced by local communities. These could be in the form of compensation, financial incentives, and alternate crops, among other suitable mechanisms. Agriculture-dependent local communities without land titles may also be included under appropriate easements/ ex-gratia schemes as these communities have no way to seek relief in case of damage by elephants. Alternatively, strict measures may be enforced to prevent cultivation in revenue and forest lands. A third model may be to develop grasslands with palatable grasses to provide fodder for elephants, while involving current cultivators in their management to provide them with a source of income. The choice of these sites needs to be carefully planned to ensure that they are close to primary and secondary elephant habitats.

## 4. TRANSBOUNDARY COORDINATION

Evidence of elephant movement across the India–Bhutan border necessitates coordination between the counterparts in both the countries for monitoring, protection, experience-sharing, and to ensure unhindered passage for elephants across artificial barriers.

## 5. INFRASTRUCTURE MITIGATION

Critical elephant movement paths like the Nameri–Sonai Rupai–Arimora (NSA) Corridor and other riverine channels should be secured from infrastructure and development pressures such as the NH 15, railway tracks, commercial structures, etc. Safeguards in the form of underpasses, overpasses, and land-use regulations are essential for this purpose.

## 6. EARLY WARNING SYSTEMS

Early warning and detection systems need to be installed along roads and railway stretches that are regularly used by elephants to prevent accidental human and elephant casualties. Display boards, bulk SMS and public announcement systems are some of the measures that may be considered. Radio telemetry data may be used to identify stretches where such measures are required.

## 7. HABITAT QUALITY ASSESSMENT

A detailed study of elephant forage selection in Sonai Rupai WLS, Behali WLS, and Bornadi WLS would provide critical information on the quality and availability of vegetation, water, and pressures on these habitats. This will aid in understanding and ensuring these habitats' long-term potential to host elephants.

## 8. DIET AND HEALTH STUDY

Seasonal diet selection and genetic health of the elephants need to be studied through non-invasive molecular methods such as single nucleotide polymorphism genotyping and DNA metabarcoding.

## 9. ADDITIONAL COLLARING OPERATIONS

Collaring of male elephants in Sonitpur and Udalguri, and female elephants in Biswanath may be considered as a follow-up to complement the current data from the same locations and help plug existing gaps in our understanding of varying male and female elephant ranging and habitat-use patterns. Further, new collaring initiatives in other districts with elephant presence would also contribute to our understanding of variations in local movement, connectivity and human–elephant conflict management imperatives.



*Mynow's juvenile looks on during the collaring operation*

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*Bishu crosses a tea estate irrigation drain*

Assam remains a stronghold for Asian elephants, hosting over 20% of India's population. However, widespread habitat loss and fragmentation have increasingly brought elephants into human-use landscapes. Effective conservation and management of human–elephant conflict require a clearer understanding of where elephants move, how they use different habitats and land-use types, and how these patterns change across seasons.

*Tracking the Giants: Movement and Habitat-Use Patterns of GPS-Collared Elephants in Assam*, presents the findings of a first-of-its-kind initiative in the state to scientifically monitor elephant movement through GPS telemetry. Between 2021 and 2026, the Assam Forest Department, in partnership with WWF-India, tracked four female-led herds and one solitary male across Sonitpur, Udalguri and Biswanath Districts. The study provided important insights into the seasonal movement of elephants, transboundary movement between India and Bhutan, and the extensive use of tea plantations and river networks as secondary habitats and corridors. The findings have implications for both long-term conservation of elephants in the forest-tea-agriculture mosaics of Assam as well as proactive management of adverse human–elephant interactions in the state.



*Budhini crosses from a tea plantation to an adjacent forest patch*

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