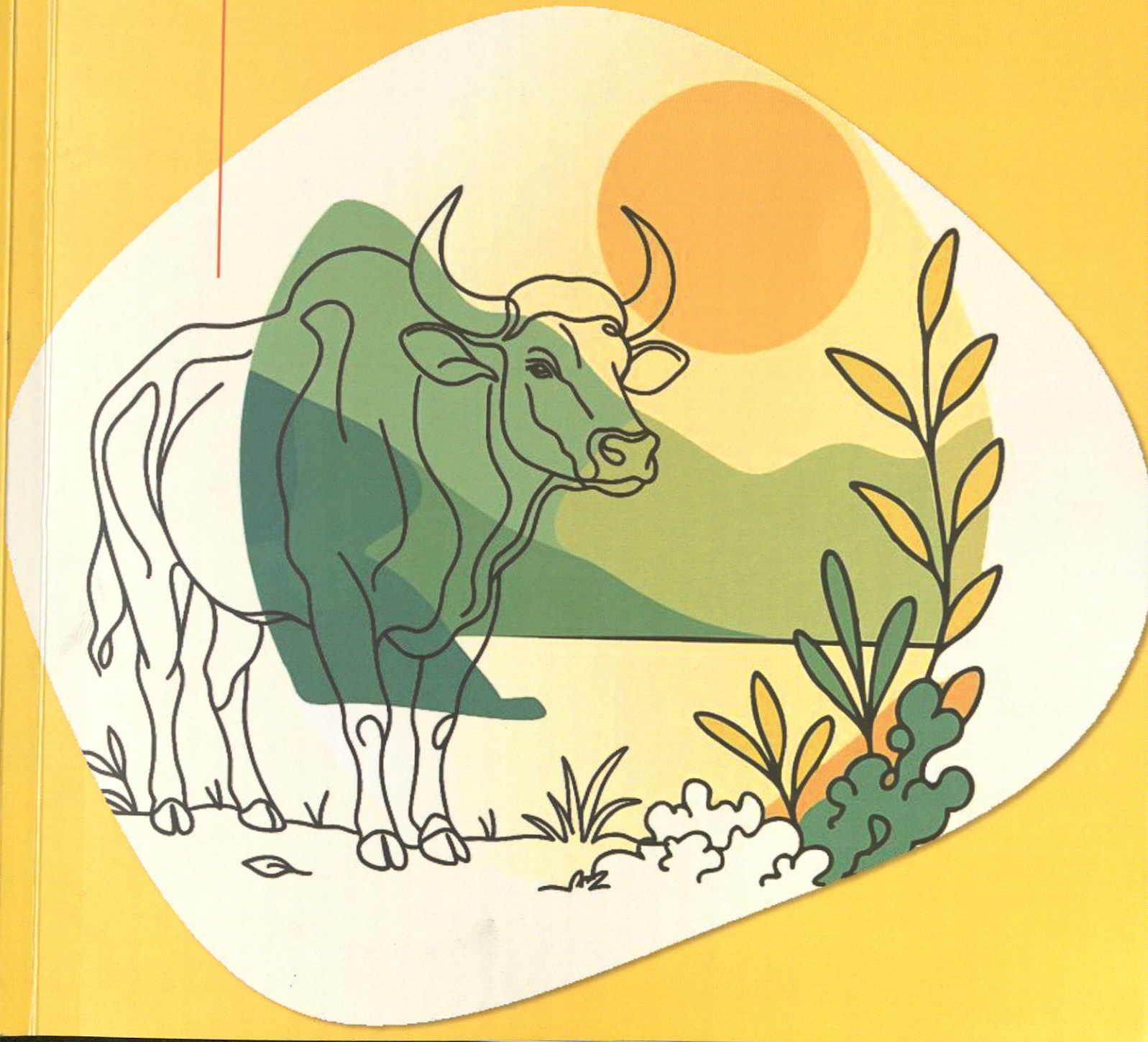
भारतीय वन्यजीव संस्थान
Wildlife Institute of India

TECHNICAL REPORT FEB-MAY 2025

Supplementation of Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh



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Wildlife Institute of India

Supplementation of Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh

Principal Investigator

Dr. Parag Nigam,
Scientist-G & Head,
Department of Wildlife Health Management,
Wildlife Institute of India
nigamp@wii.gov.in

Co-Principal Investigator(s)

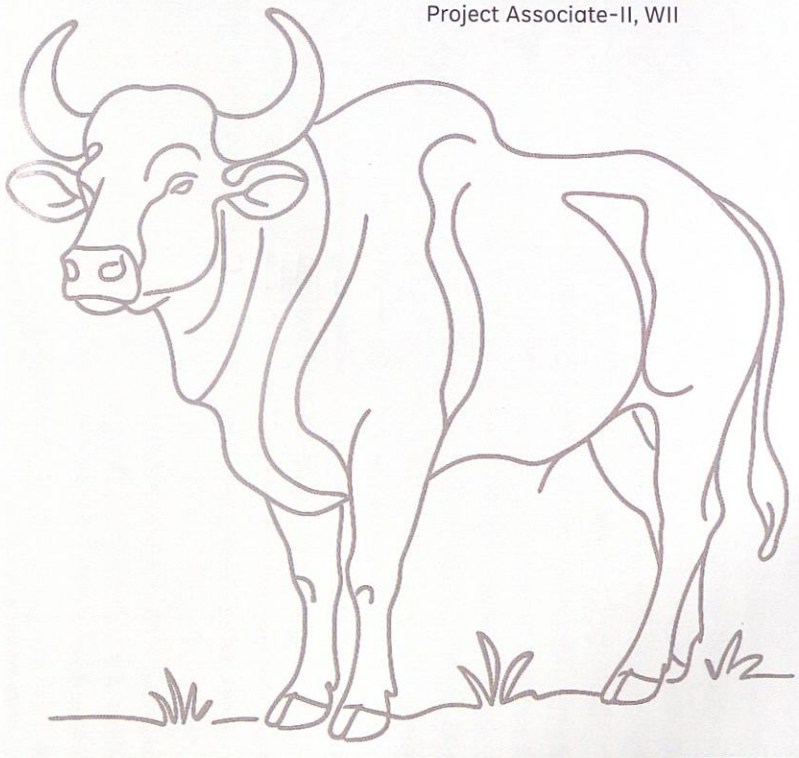
Dr. Bilal Habib,
Scientist F, WII
Dr. Samrat Mondol,
Scientist F, WII

Project Researcher

Mr. Gorati Arun Kumar
Project Associate I, WII

Technical Inputs

Mr. Ritesh Vishwakarma
Senior Project Associate, WII
Mr. Bhaskar Bhandari
Project Associate-II, WII



Wildlife Institute of India
Post Box #18, Chandrabani
Dehradun – 248001, Uttarakhand, India
E-mail: wii@wii.gov.in
Telephone: +91 135 2640114 -15, 2646100
Fax: +91 135 264011

Madhya Pradesh Forest Department
Office of PCCF (WL) and Chief Wildlife Warden
Ground Floor, C-Wing, Van Bhawan Link Road-2,
Tulsi Nagar Bhopal 462003, Madhya Pradesh
Email: pccfwl@mp.gov.in

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Madhya Pradesh Forest Department

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Gorati Arun Kumar, Ritesh Vishwakarma, Parag Nigam, Bhaskar Bhandari and Nishant Shukla

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Ritesh Vishwakarma

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Gorati Arun Kumar

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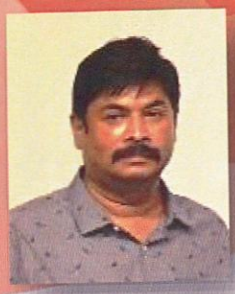


Principal Chief Conservator of Forest
(WL) & Chief Wildlife Warden,
Madhya Pradesh Forest Department
Government of Madhya Pradesh

Foreword

The Madhya Pradesh Forest Department made a pioneering effort by reintroducing the gaur to its historical range. With the population growing rapidly, supplementation of the population became necessary to ensure the long-term survivability of the species. The reinforcement of the Bandhavgarh Tiger Reserve's gaur population has been a remarkable milestone in the process of India's conservation translocation and preserving the mega herbivores. This innovative work shows that, by adopting an active strategy, we can deal with severe conservation problems of wild animals in India and successfully recover species.

This document emphasises the value of intensive conservation and long-term management efforts towards the gaur. Scientific information gathered in this report offers important information for field professionals. It provides crucial insights for scientists, researchers, field biologists, and veterinary officers regarding the translocation protocols and modern drug use for the capture of animals.

I congratulate everyone who has contributed for their sustained commitment. I am hopeful that this document will provide valuable information for professionals involved in similar species recovery programs.

Subharanjan Sen, IFS

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Director

Wildlife Institute of India

(An Autonomous Institution of the Ministry of Environment, Forest, and Climate Change, Government of India)

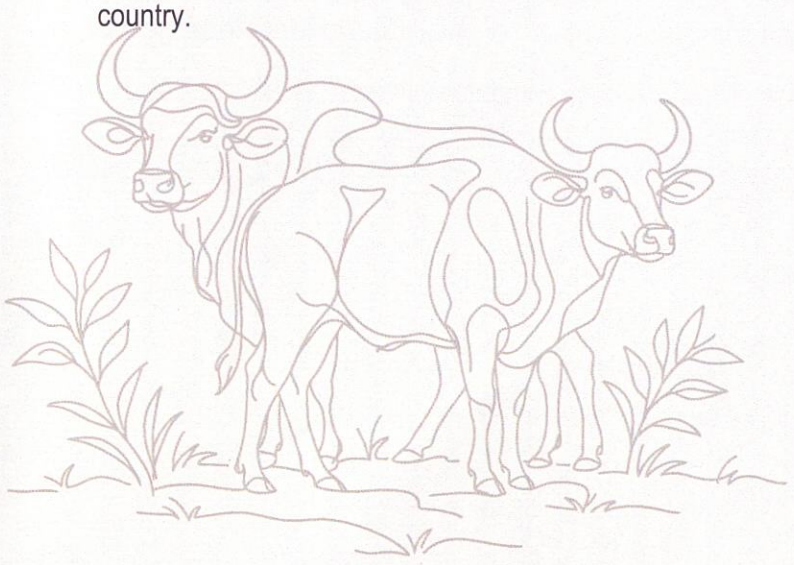
Foreword

Wildlife conservation is a public issue since time immemorial and has caused increasing concern over the 21st century. Wildlife in countries with open frontiers generally has gone unregulated until human-animal interactions changed to a point that threatened the survival or abundance of the wildlife. Especially in developing countries, wildlife conservation has become challenging owing to rapidly shrinking habitats, rampant poaching, and anthropogenic pressure. There is a need for innovative management interventions to conserve wildlife and prevent local extinction. Species like the gaur or Indian bison had rarely been focused on until the 21st century. Disappearing from its natural ranges made park officials undertake innovative management interventions to bring back the species.

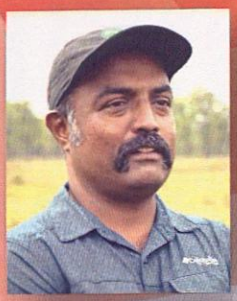
Reintroductions have become a crucial tool for the restoration of species into their historical ranges. In this context, the gaur is reintroduced in the Bandhavgarh Tiger Reserve. Over time, the growing population requires new genes to replenish and ensure long-term survival. The efforts of the Madhya Pradesh Forest Department in collaboration with the Wildlife Institute of India are highly remarkable and have made a significant milestone in the field of Indian conservation science.

This document is collated with scientific information that provides valuable information on animal capture, conservation translocations, pharmacological advances, animal behaviour, and ecology. It underscores the need for an intensive management approach and effective long-term measures for the gaur. I am confident that the wildlife heritage of the country can be preserved by using such active management strategies.

I congratulate the contributors for their utmost efforts and contributions to Gaur Translocation. Their dedicated efforts serve as a model for initiating and managing species recovery programmes across the country.



Virendra R. Tiwari, IFS



Addl. Principal Chief Conservator of Forest
(Wildlife Division)
Madhya Pradesh Forest Department
Government of Madhya Pradesh

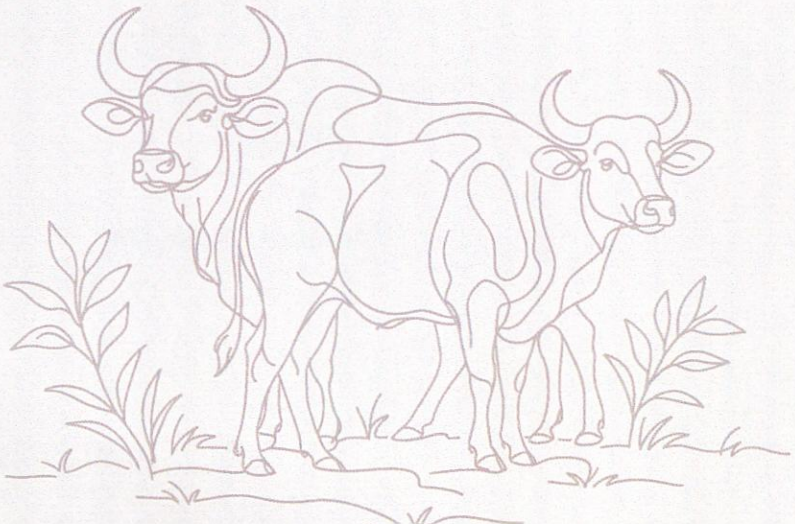
Foreword

In today's world, conservation translocations have become a common practice and an important tool to conserve species and restore ecosystem functions. The Madhya Pradesh Forest Department has implemented an ambitious, significant conservation effort through reinforcing the gaur population in Bandhavgarh Tiger Reserve by adopting the global framework. This initiative ensures in improvement of long-term survivability of the gaur by enhancing genetic diversity. The project believed to ensures the restoration and set back ecosystem functions in turn will preserve the biodiversity.

This document highlights the preparations and field operations involved in the capture and translocation of gaur. It is intended for conservation practitioners, veterinary officials, stakeholders, forest officials, and frontline staff. Those involved in this project will find the technical report an invaluable resource for future mega herbivore translocations.

I wish success to everyone who has shown unwavering commitment. I am hopeful that this document will provide valuable information for strategic planning and highlight the significance of scientific evaluations in effective field implementation. The dedicated efforts of the Madhya Pradesh Forest Department in collaboration with Wildlife Institute of India stand as an exemplary model of mega herbivore conservation translocation.

L. Krishnamoorthy, IFS



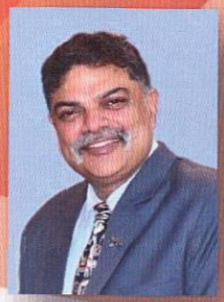
भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Scientist-G & Head

Dept. of Wildlife Health & Management

Wildlife Institute of India

(An Autonomous Institution of the Ministry of Environment, Forest, and Climate Change, Government of India



Scope of the document

Animal translocations are increasingly recognized as a crucial tool in contemporary conservation science. The rewilding of mega-herbivores has come to become a key element in ecosystem recovery, aimed at strengthening biodiversity resilience and restoring ecological processes. Nonetheless, the translocation of large mammals poses multifaceted challenges that require careful consideration of technical, ecological, and administrative factors.

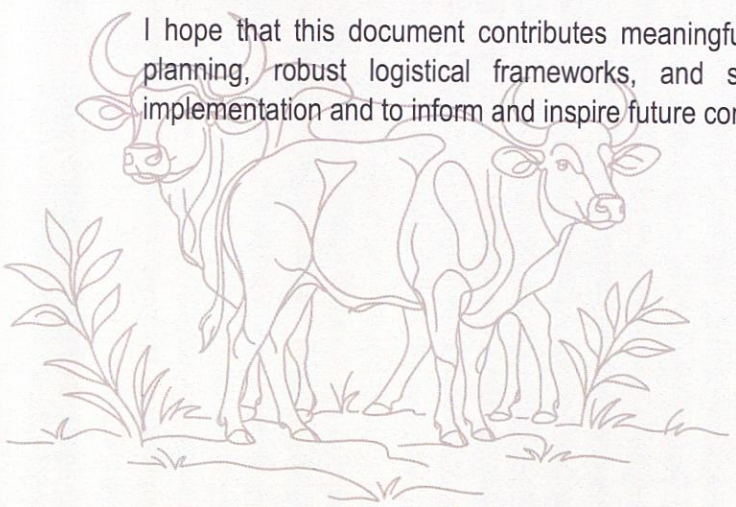
This document provides a detailed account of the supplementation of the vulnerable wild cattle, Indian Gaur (*Bos gaurus gaurus)*, into the re-established population at Bandhavgarh Tiger Reserve. The primary objective of the reinforcement is to enhance the genetic diversity and long-term viability of the gaur population.

This document outlines the comprehensive strategy adopted during the different phases of translocation. It encompasses (i) a step-by-step account of the planning process; (ii) a synthesis of available information and methodology used in similar reintroduction programs; (iii) a thorough review of literature; and (iv) incorporation of expert opinion through formal discussions with both national and international experts to learn from past experiences.

Additionally, this document summarizes the field operations involved in capturing and translocating animals, presented in a concise and accessible format for field practitioners. It also describes the scientific approaches, ranging from habitat evaluation, demographic and behavioural evaluation, and genetic analysis, that guided the supplementation of gaur at each step of implementation.

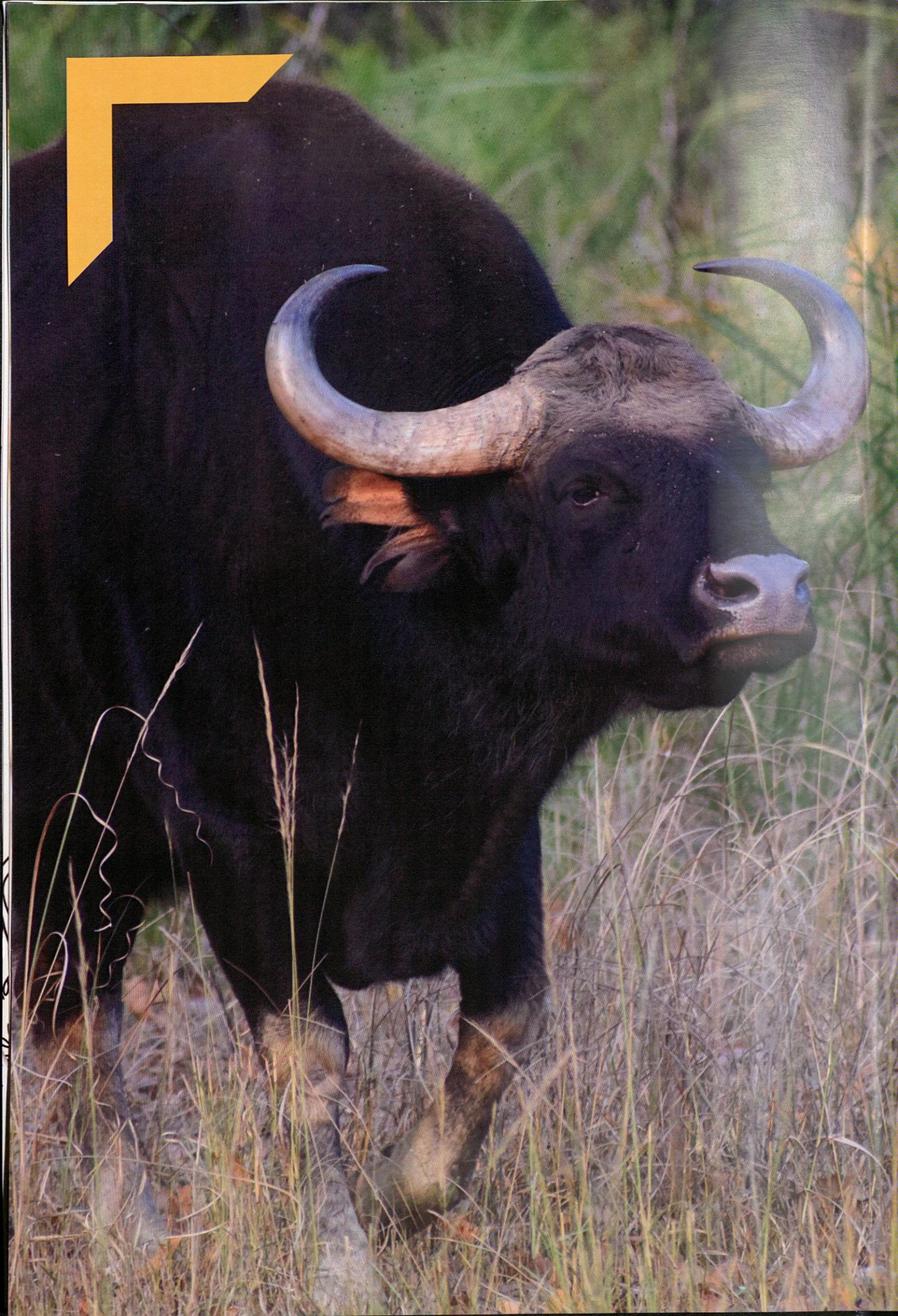
The document is intended primarily for wildlife managers, veterinary experts, field biologists, and frontline officers who collectively plan and execute large mammal reintroductions.

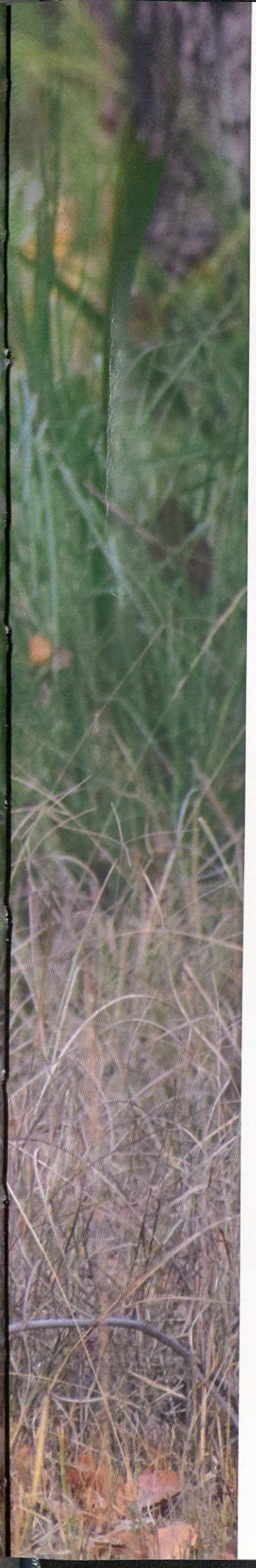
I hope that this document contributes meaningfully to the ongoing dialogue on rewilding, strategic planning, robust logistical frameworks, and scientific evaluations essential for effective field implementation and to inform and inspire future conservation initiatives.



Parag Nigam, MVSc, PhD

Contents





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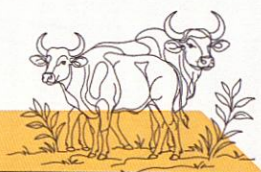
EXECUTIVE SUMMARY

Reintroduction and supplementation programs have been implemented worldwide to improve the conservation status of wildlife that have experienced a significant decline due to overexploitation, habitat destruction, and fragmentation. Genetic drift and inbreeding are the two processes particularly relevant in reintroduction efforts that lead to reduced fitness, decreased survival rates and increased susceptibility to diseases. Rapid intervention such as population supplementation or reinforcement through conservation translocation, especially demographic bottleneck, allows genetic restoration of ungulate populations.

The Madhya Pradesh Forest Department in collaboration with the Wildlife Institute of India has initiated a three-year project (2024–2027) titled **"Population Management Strategies for Gaur (*Bos gaurus gaurus*) Conservation: Supplementation of Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh."** This project aims to ensure the long-term viability of the species by enhancing its genetic diversity. To facilitate the smooth execution of field operations, an action plan was developed and released during the Inception-cum-Planning Workshop held at Bandhavgarh Tiger Reserve (henceforth BTR).

Conservation translocations have become an important tool in recovering the threatened and locally extinct populations. Species translocations are increasing all around the globe to reverse biodiversity loss and restore ecosystem functions. Reintroductions require careful planning as small population size experience inbreeding depression, which leads to decreased fitness and demographic stochasticity. Although genetic diversity is not directly linked to species extirpation, low gene pool results in low species recovery. To enhance the gene pool and long-term viability of the restored species, supplementations are crucial, especially in small and isolated populations. The addition of new individuals amplify the gene flow in reintroduced species.

The supplementation of gaur in BTR was carried out in the following phases: i) pre translocation phase, ii) capture and translocation phase and iii) post translocation phase (monitoring). During the pre-translocation phases assessments related to habitat suitability, population viability, site selection for enclosure establishment at recipient site. Satpura Tiger Reserve (henceforth Satpura) was chosen as source site where distribution, population size, demography and health status of the gaur was carried out. Habitat suitability analysis predicted that while an area of 173.3 sq.km is highly suitable, 167.69 sq.km is moderately suitable, and 1,163.1 sq.km is least suitable for gaur. Population Viability Analysis revealed that supplementation of 3:1 (Female-to-Male Ratio) is required to maintain a healthy population. Based on rapid field survey conducted at different locations within the highly suitable habitats of BTR,



Karkachawah area in North Kallwah beat of Kallwah range is suitable to establish the enclosure for soft releasing of the translocated gaur. At source site, the survey showcased Bori and Churna forest ranges of Satpura Tiger Reserve as major gaur distribution areas. The disease investigation of gaur in Satpura found that animals are disease-free with minimal parasitic load in their body.

Gaur capture and translocation was carried out between 20th and 23rd February 2025. A total of 23 gaur were captured, of them 18 were females and 5 males. Amongst them, 8 individuals were fitted with VHF collars (Telonics USA) and 3 with LoRa (Long Range) devices. to ease individual identification of gaur, each animal was marked using color-coded neckbands and numbered horn sleeves and ear tags.

The post-translocation phase (monitoring phase) involved intensive monitoring of the translocated gaur. Gaur were soft released in a specially designed 2-hectare enclosure for veterinary action. They were later released into the larger 20-hectare enclosure to allow them to acclimatise to the novel environment and develop natural social bonds. Soft releasing also allows the animals to recover from the effects of drug and protect from immediate predation while enabling continuous close monitoring. Monitoring of the released animals is an important component of the translocation program. The research team of the Wildlife Institute of India and field staff of BTR were intensively monitoring the gaur by regularly recording the animal movement, diet, health condition, behaviour and interactions with established herds.

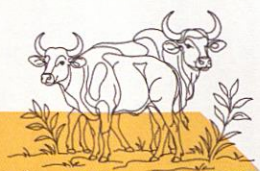
The reinforcement of gaur in BTR showcased the significance of regular population supplementation to enhance levels of genetic diversity and long-term survivability. This translocation program is becoming a remarkable milestone in conservation science in conserving small population within their natural habitats. The successful translocation highlights the significance of meticulous planning, collaborative participation and ongoing research in wildlife conservation efforts.

CHAPTER - 1
INTRODUCTION

Bandhavgarh Tiger Reserve (BTR) is situated between the Vindhyan and eastern flanks of the Satpura Hill ranges in Central India. The park supported a small population of gaurs (fewer than 40 individuals) until 1995, which became locally extinct by 1998. The primary reason was believed to be the disruption of the migratory corridor connecting the Bandhavgarh, Ghunghuti, and Amarkantak forests. As BTR has always maintained suitable habitats for the species, the Madhya Pradesh Forest Department (MPFD), in collaboration with the Wildlife Institute of India (WII) and &Beyond (formerly CC Africa), initiated a project to reintroduce the gaur in the tiger reserve. As part of this long-term programme, 50 wild gaur individuals were translocated from Kanha Tiger Reserve (KTR) in two phases: 19 individuals in January 2011 and 31 individuals in March 2012. During this process, 27 selected individuals were fitted with radio collars for detailed monitoring. Preliminary genetic analyses of biological samples from select founder individuals (n=19) indicated moderate genetic diversity, low inbreeding and largely unrelated genealogy (Pandey et al., 2025). The Wildlife Institute of India has been monitoring the reintroduced population as part of the collaborative project "Monitoring of Reintroduced Gaur in Bandhavgarh - *Phase I (2011-15), Phase II* (2015-18), and Phase III Extension (2018-22)" (Nigam et al., 2022). *The monitoring efforts have* predominantly centred on assessments of home ranges, resource partitioning, diet analysis, social networks, and more recently, genetic assessments.

Since its reintroduction, the gaur population in BTR has been increasing at an average rate of 5.7% every three years. By 2022, the population had reached 168 individuals, distributed across the tiger reserve in seven herds. Although this is a positive development, there are indications of genetic inbreeding, which raises concerns about the long-term viability of the population. Based on non-invasive DNA data from 59 individuals, genetic analyses revealed relatively low polymorphism in the recovered Gaur population in BTR. Qualitative demographic analysis using BOTTLENECK revealed strong population decline signatures, with 8 of 9 loci showing heterozygosity. The Garza Williamson Index supported this, showing a value of 0.30 (SD 0.11), indicating recent decline. Analyses of the inbreeding coefficient revealed high inbreeding in this population. RELATEDNESS analyses elucidated parent-offspring (0.15), full-sibling (0.59), and half-sibling (0.25) relationships in most of the sampled individuals. This information suggested an urgent need for genetic rescue by introducing new animals before adverse inbreeding effects occur (Nigam et al., 2022).

Accordingly, the MPFD initiated phase III in a project titled "Population Management Strategies for Gaur (*Bos gaurus gaurus*) Conservation: Supplementation of Gaur in Bandhavgarh Tiger Reserve" in collaboration with WII. The objective was to enhance genetic diversity and ensure the long-term viability of the gaur population in BTR by supplementing new individuals from the Satpura Tiger Reserve (henceforth Satpura). During phase I, 23 gaurs (5 males, 18 females) were translocated from Satpura to BTR between 19th – 23rd February 2025. They were released into a 20-ha enclosure in the Kallwah range. Among the translocated gaur, eight individuals were fitted with VHF collars, while three received LoRa tags (Long Ranging Bluetooth Beacons Devices). The remaining individuals were equipped with colour-coded neckbands and numbered ear tags.



Justification (Nigam et al., 2022):

In Phase II (Ext.) 2018-2022 final report emphasised that employing two separate qualitative methodologies to analyse the demographic patterns of the reintroduced gaur population in BTR, revealed pronounced indications of recent population bottlenecks. Results from the BOTTLENECK analysis exhibited heterozygosity excess in 8 out of 9 loci, strongly suggesting a recent bottleneck event. Additionally, the Garza Williamson Index, or M ratio analysis, yielded a value of 0.30 with a standard deviation of 0.11, further supporting the findings of the bottleneck analysis. In terms of inbreeding status and relatedness patterns, independent analyses conducted using GeneALEx and FSTAT revealed elevated fixation index values of 0.717 (with a standard error of 0.043, as reported by GeneALEx) and 0.721 (as determined by FSTAT), indicating a notable inbreeding signature within the population.

Furthermore, the RELATEDNESS analyses elucidated significant parent-offspring and full-sibling relationships, with proportions of 0.15 and 0.59, respectively, while the proportion of half-siblings was 0.25. This collective evidence suggests a population characterised by high levels of inbreeding, predominantly consisting of closely related individuals. Additionally, genetic markers indicated relatively low polymorphism among Gaur individuals, with summary statistics revealing low average allele numbers, allelic size range, and observed heterozygosity. Also, the PIDsibs value suggested unambiguous individual identification of Gaur using these markers.

Qualitative demography analysis through BOTTLENECK also confirmed strong evidence of population decline, with most loci exhibiting heterozygosity excess, indicative of a significant bottleneck event. The Garza-Williamson Index further supported this trend, suggesting a recent decline in population size. Multiple assessments of the inbreeding coefficient underscored high levels of inbreeding within the population, emphasising the urgent need for genetic rescue measures by introducing new animals to prevent adverse effects associated with intense inbreeding.

1.1 Objectives

1. To examine the post-release exploration and establishment of the supplemented gaur population in Bandhavgarh Tiger Reserve.
2. To investigate the ranging patterns and habitat utilisation of reintroduced gaur in Bandhavgarh Tiger Reserve.
3. To analyse the interactions of supplemented gaur with the already established gaur population and other conspecifics in Bandhavgarh Tiger Reserve.
4. To evaluate the genetic health and variation between the Bandhavgarh and Satpura gaur populations.

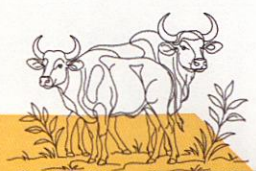
CHAPTER - 2
CONSERVATION TRANSLOCATION
REINTRODUCTION & SUPPLEMENTATION

Reintroduction, a conservation practice in which species are intentionally released into habitats where they have become locally extinct, with the goal of re-establishing viable populations (IUCN/SSC, 2013). Reintroduction is generally practised for species that have experienced a drastic decline in population due to habitat loss, overexploitation and other anthropogenic pressures. (Seddon et al., 2014). For effective reintroduction, ecological appropriateness, genetic suitability, and potential threats within the release environment must be carefully evaluated (Griffith et al., 1989). Historic range information, resource availability, habitat quality and habitat suitability are the important factors in assessing the feasibility of reintroduction efforts (Osborne & Seddon, 2012). Pre-release conditioning, including soft release in an enclosure, serves as a transitional phase for behavioural adjustment, acclimatization and adaptation to novel environment. It also provides forage and protection from immediate predation, allowing animals to recover from stress as well as improving their chances of post-release survival (Nigam et al., 2014). Post-release monitoring is crucial for assessing population establishment and evaluate the success or failure of the effort (Nicholas & Armstrong, 2012).

Supplementation, also known as reinforcement, is the process of releasing individuals into an existing population to enhance genetic diversity, increase population size and thereby improve the species' long-term survival (Frankham, 2015). Reinforcement is especially important for small and isolated populations suffering from inbreeding depression and demographic stochasticity (Weeks et al., 2011). The genetic composition of both source and recipient population must be considered in any supplementary interventions to avoid outbreeding depression, where the mixing of genetically distinct individuals may reduce fitness (Edmands, 2007). Disease risk is another important consideration, as pathogens can be introduced into established wild populations through the translocation of individuals. This necessitates thorough health screening of all individuals before capturing and releasing (Cunningham, 1996). Behavioural understanding of the species is another important factor to consider, as supplemented individuals must integrate into the resident population to avoid social disruption in case of social animals (Le Gouar et al., 2011).

Conservation translocations such as reintroduction or reinforcement face potential challenges that include low survival rates of released individuals, particularly when captive-bred animals lack essential survival skills (Jule et al., 2008). Human-wildlife conflict may also arise, especially when translocated species interact negatively with agricultural or urban communities (Linnell et al., 2001). Long-term financial and logistical support and stakeholder cooperation are therefore necessary for sustained success (Balmford et al., 2003).

Despite significant challenges, well-planned reintroduction and supplementation programs have achieved notable success, for example the recovery of the Arabian oryx (*Oryx leucoryx*) and the California condor (*Gymnogyps californianus*) (IUCN, 2017; Walters et al., 2010). Additionally, a variety of wild animals have

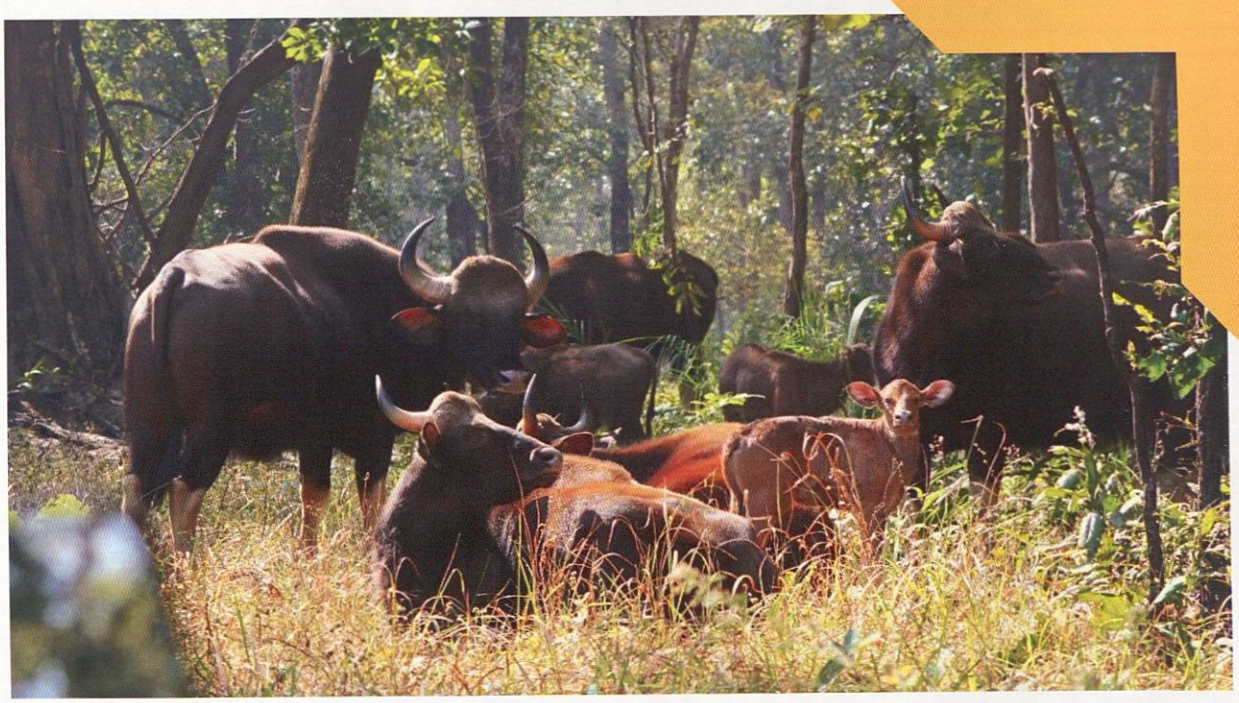


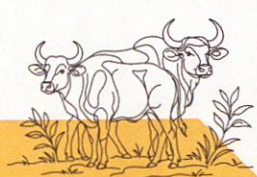
been captured and translocated to suitable habitats as part of conflict mitigation [Elephants (*Elephas maximus)* (Mukti et al., 2010), Blackbuck (*Antilope cervicapra*) (Bonal et al., 2002), Nilgai (*Boselaphus tragocamelus*) (Sale et al., 1988), Sloth bear (*Melursus ursinus*) (Arun et al., 2021), leopard (*Panthera pardus*) (Athreya et. al., 2010), tiger (*Panthera tigris)* (Dhungana et al., 2016)]; as part of developing meta-populations of small, vulnerable populations of Hard-ground Barasingha (*Rucervus duvaucelii*) (Shukla et al., 2015); or and as part of prey base building initiative Chital (*Axis axis*), Sambar (*Rucervus unicolor*), Nilgai (*Boselaphus tragocamelus)* etc. (Jhala et al., 2021).

These successes highlight the importance of adaptive management, where continuous monitoring and flexible strategies enable conservationists to respond to unforeseen challenges and improve outcomes over time (Ewen et al., 2011).

CHAPTER - 3
STUDY SPECIES
GAUR (*Bos gaurus gaurus*)

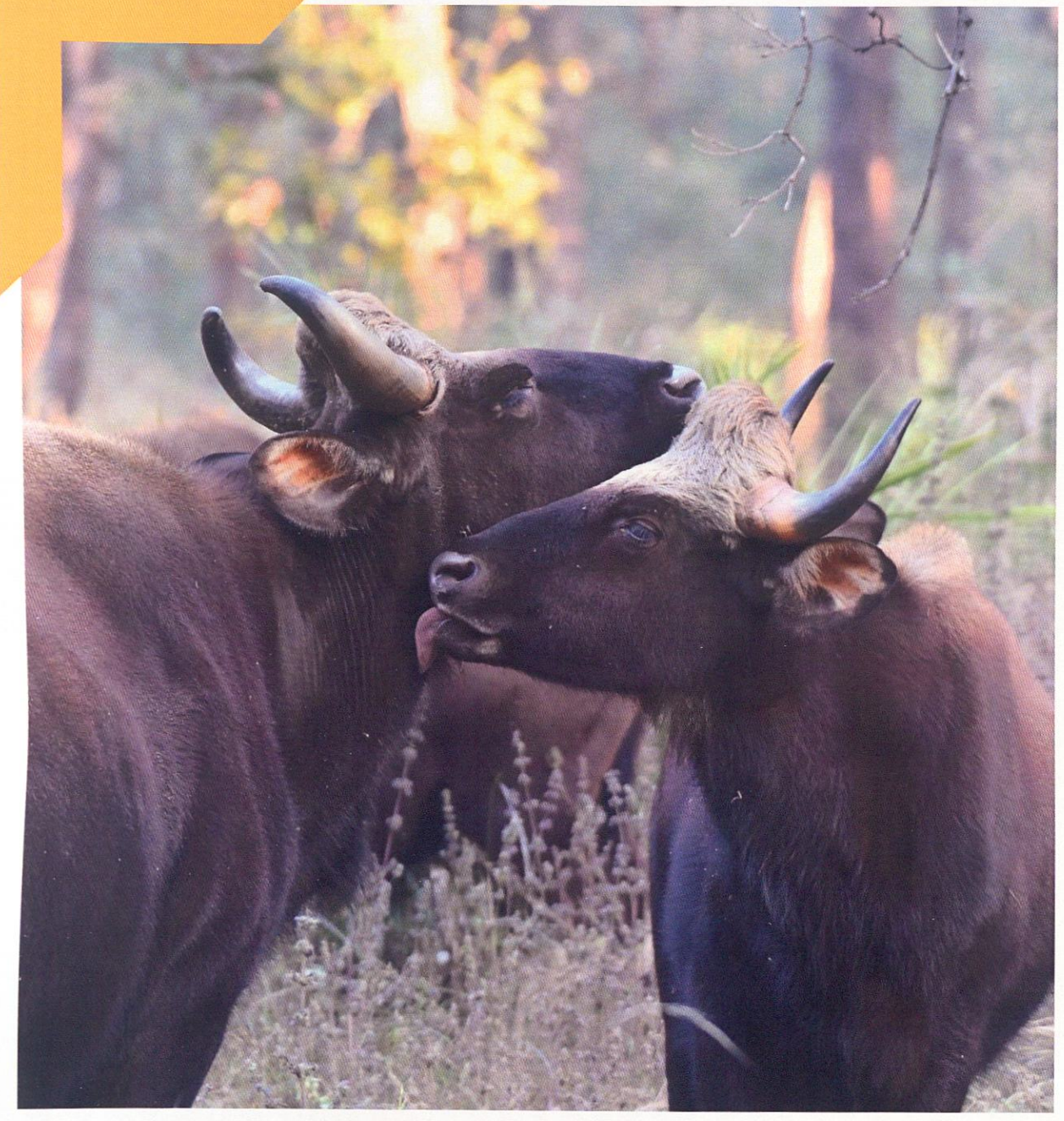
Gaur or Indian Bison(*Bos gaurus gaurus)*, is one of the largest extant bovid, found in South and Southeast Asia. The species once historically distributed across India, is now confined to the Northeast, Central, and South western parts of India. Gaur inhabits variety of forest types including tropical evergreen, tropical semi-evergreen, tropical moist deciduous, tropical dry deciduous, subtropical broadleaf and temperate broadleaf forest (Sankar et al., 2013, Nigam et al., 2014 & 2022). There are three recognised subspecies of gaur, *Bos gaurus readei* (Myanmar and Cambodia), *Bos gaurus hubbacki* (Southern Thailand and Malaysia), *Bos gaurus gaurus* (India and Nepal) (Groves and Grubb, 2011; Duckworth et al., 2016). In north-eastern part of India, a domestic form of gaur, Mithun or Gayal, *Bos frontalis*, occurs as a result of breeding between wild gaur and domestic cattle. Skull and horn based studies revealed that gaurs in North-eastern India are intermediate between Indian and Southeast Asian species but more similar to Southeast Asian variety (Duckworth et al., 2008). Consequently, considering the phenotypic differences *Bos gaurus gaurus* and *Bos gaurus laosiensis* have been provisionally accepted as the two main subspecies by the IUCN (Duckworth et al., 2016, Nigam et al., 2022).





3.1 Conservation Status

The gaur is classified as Vulnerable in the IUCN Red List of Threatened Species (criteria A2cd 3cd 4cd ver. 3.1). The species is listed in Appendix-I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Schedule I of the Wildlife (Protection) Act of 1972 in India (Duckworth et al., 2016).



Distribution Map

Bos gaurus

Legend

EXTANT (RESIDENT)

Compiled by:

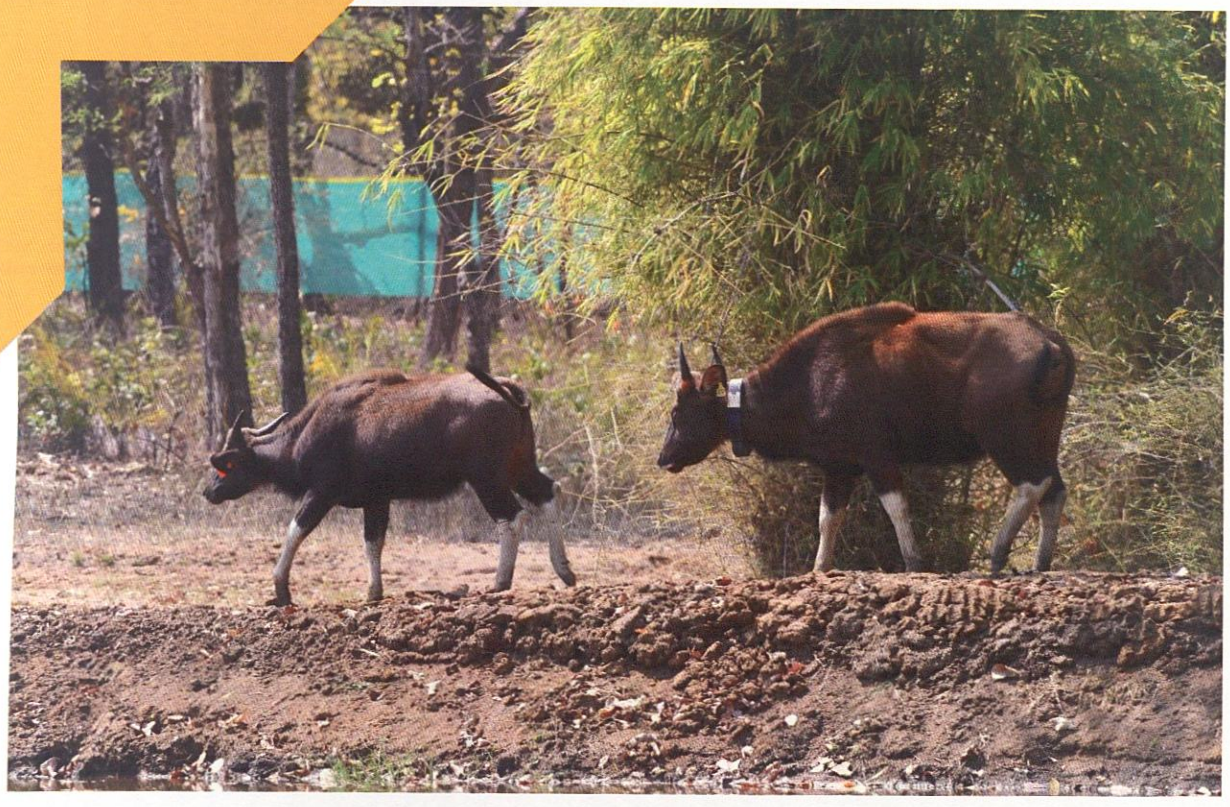
IUCN (International Union for Conservation of Nature) 2016

Map: Distribution map of gaur (*Bos gaurus gaurus*) (IUCN)

3.2 Distribution of Gaur

The current and historical distribution suggests that the gaur is native to the Indo-Malayan region. Historically, the species was distributed across the Indo-Malayan region, but is now found in isolated pockets of India, Nepal, Bhutan, Cambodia, China, Laos, Peninsular Malaysia, Myanmar, Thailand, and Vietnam. It is believed that the gaur has migrated into the Indian subcontinent through the north-eastern regions and eventually dispersed across different parts of India (Nigam et al., 2024; Duckworth et al, 2016; Sankar et al., 2004).

Within India, the gaur population is distributed over three distinct regions: the northeastern, southwestern, and central Indian landscapes. In the south-western region, the species is primarily found in the Western Ghats, inhabiting the Nilgiris, Anamalais, Cardamom Hills, and surrounding plains (Davidar, 1986; Shukla & Khare, 1998). The gaur range in this region extends through the Palani and Dindigul Hills, the Shandamangalam ranges, the Shervaroys, and areas near the Vellore and Karnataka borders on the eastern side of the peninsula (Mukherjee, 1982). Notable populations also exist in Mudumalai, Anamalai, Wayand, Periyar, Parambikulam, Bandipur, Nagarhole, and Bhadra Tiger reserves (Davidar, 1986). These habitats range from tropical wet evergreen forests to scrub forests (Duckworth et al., 2016; Ashokkumar et al., 2011)



3.3 Population Status

The global population of gaur is provided below

S. No	Global population size	Reference
1	12,000 – 22,000	Rajitsinh, 1997
2	~ 23,500	Sankar et al., 2001
3	15,000 – 35,000	Duckworth et al., 2016
4	6,000 – 21,000*	Duckworth et al., 2016

*Population size of mature individuals

3.4 Threats

Habitat degradation, fragmentation and conversion of forest land are significant threats to gaur population, leading to a large-scale decline in their ranges. Incidents such as hunting and poaching for meat and horns is also a major threat occurring regularly within the protected areas (Duckworth et al., 2016, 2008; Arrendran, 2000).

Epidemic diseases, particularly rinderpest, foot and mouth disease (FMD), bovine tuberculosis and anthrax were responsible for significant decline of Gaur populations (Ashokkumar, 2011). Cattle grazing areas within forests are often associated with the spread of diseases that affect gaur (Nigam et al., 2022; Duckworth et al., 2016).

CHAPTER - 4
STUDY AREA
BANDHAVGARH TIGER RESERVE

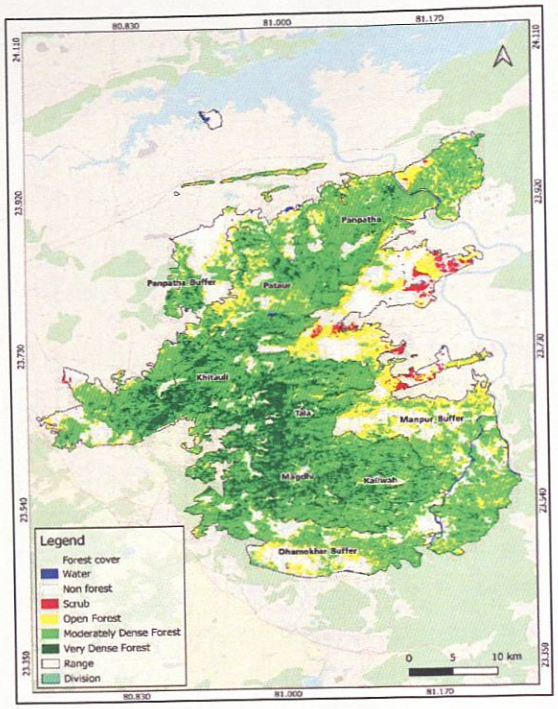
Bandhavgarh Tiger Reserve (BTR) is located in the north-eastern part of Madhya Pradesh, India, within the eastern Satpura Mountain range. It lies within coordinates 23°30'08" to 23°47'05" N and 80°11'43" to 80°47'05" E, between altitudes of 410 meters to 811 meters above sea level. The reserve comprises two major conservation units: Bandhavgarh National Park, covering 442.842 km², and Panpatha Wildlife Sanctuary, spanning 245.842 km². The soil in the region is predominantly sandy to sandy-loam. The park is traversed by at least twenty rivers, the largest of which is the Umaria River, forming the western boundary of the park. These watercourses ultimately flow into the Son River, a major southern tributary of the Ganges. Bandhavgarh Hill, rising to an elevation of 811 meters above sea level, defines the park's topography. It is surrounded by a series of lower hills and gently rolling valleys. The landscape is characterized by rocky terrain interspersed with swampy areas and densely forested valleys (Qureshi et al., 2023; Nigam et al., 2022; Jhala et al., 2020).

The flora of BTR is diverse and dense, comprising five primary forest types:

1. Moist Peninsular Low-Level Sal Forest
2. Northern Dry Mixed Deciduous Forest
3. Dry Deciduous Scrub
4. Dry Grassland
5. West Gangetic Moist Mixed Deciduous Forest.

The northern part of the park is dominated by extensive grasslands and bamboo jungles, and the vast southern part, included in 1986, consists of low hills and scattered grasslands.

Historical Overview Bandhavgarh Tiger Reserve is a historical treasure house with monuments such as the Bandhavgarh Fort, caves, rock paintings, and sculptures. The fort, which is around 2,000 years old, is referred to in ancient literature such as the Narad Panch and Shiv Samhita Puranas. The fort is said to be linked to Lord Ram, who gifted it to his brother Lakshman. The area also features 32 hillocks, inscribed caves, large sandstone tanks, and sculptures of Lord Vishnu, such as the famous Sheshshaiyya sculpture.



Map 4.1: Forest cover type of Bandhavgarh Tiger Reserve, Madhya Pradesh

Bandhavgarh Tiger Reserve is diversified with numerous species of herbivores, carnivores, primates and a variety of reptiles. The carnivore species include leopard (*Panthera pardus*), golden jackal (*Canis aureus*), sloth bear (*Melursus ursinus*), tiger (*Panthera tigris*), striped hyena (*Hyaena hyaena*), wild dog (*Cuon alpinus*), while gaur (*Bos gaurus*), barking deer (*Muntiacus vaginalis*), chital (*Axis axis*), sambar (*Rusa unicolor*), four-horned antelope (Tetracerus quadricornis), nilgai (Boselaphus tragocamelus), and chinkara (*Gazella bennettii*) are the major herbivores found tiger reserve. There are over 250 species of birds and variety of reptiles found in the park.

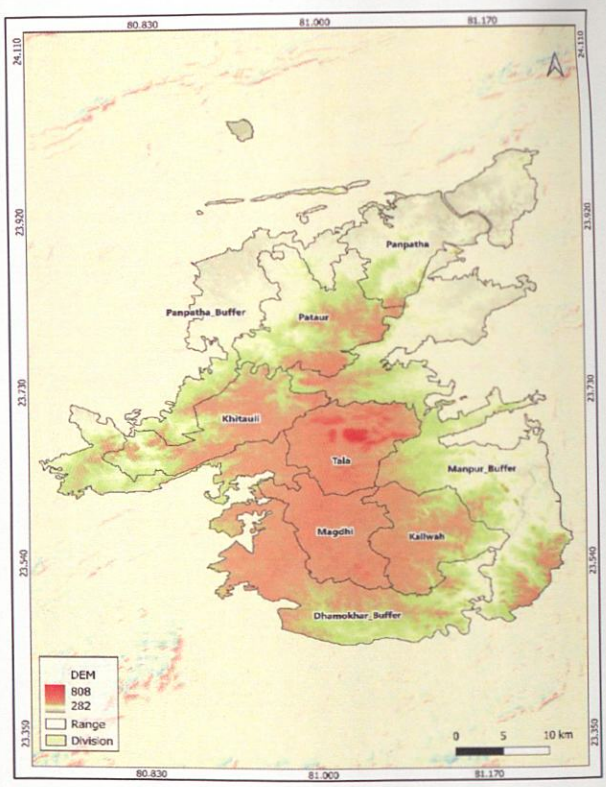
BTR has a winter season (November-February), a summer season (March-June), and a monsoon season (July-October) with a tropical climate. Temperature ranges from 2.2°C (36°F) during winter to 44°C (111°F) during summer, influencing local flora and fauna (Qureshi et al., 2023; Nigam et al., 2022; Jhala et al., 2020).

4.1 Physical Attributes

a) Topography and Geology: Topography of the reserve is undulating with small hillocks and green marshes. The highest point is. Panpatha Sanctuary is flat with small rolling hillocks. Geology of the region has some of the oldest Gondwana rocks on our planet, which are mainly sandstone (Nigam et al., 2022).

b) Soil: The soil is predominantly sandy or sandy-loam but richer black cotton and clay soils in some pockets. Park soils lack nitrogen and organic matter but are high in potash. Soil pH is around 20, and chloride content is around 13 (Nigam et al., 2022).

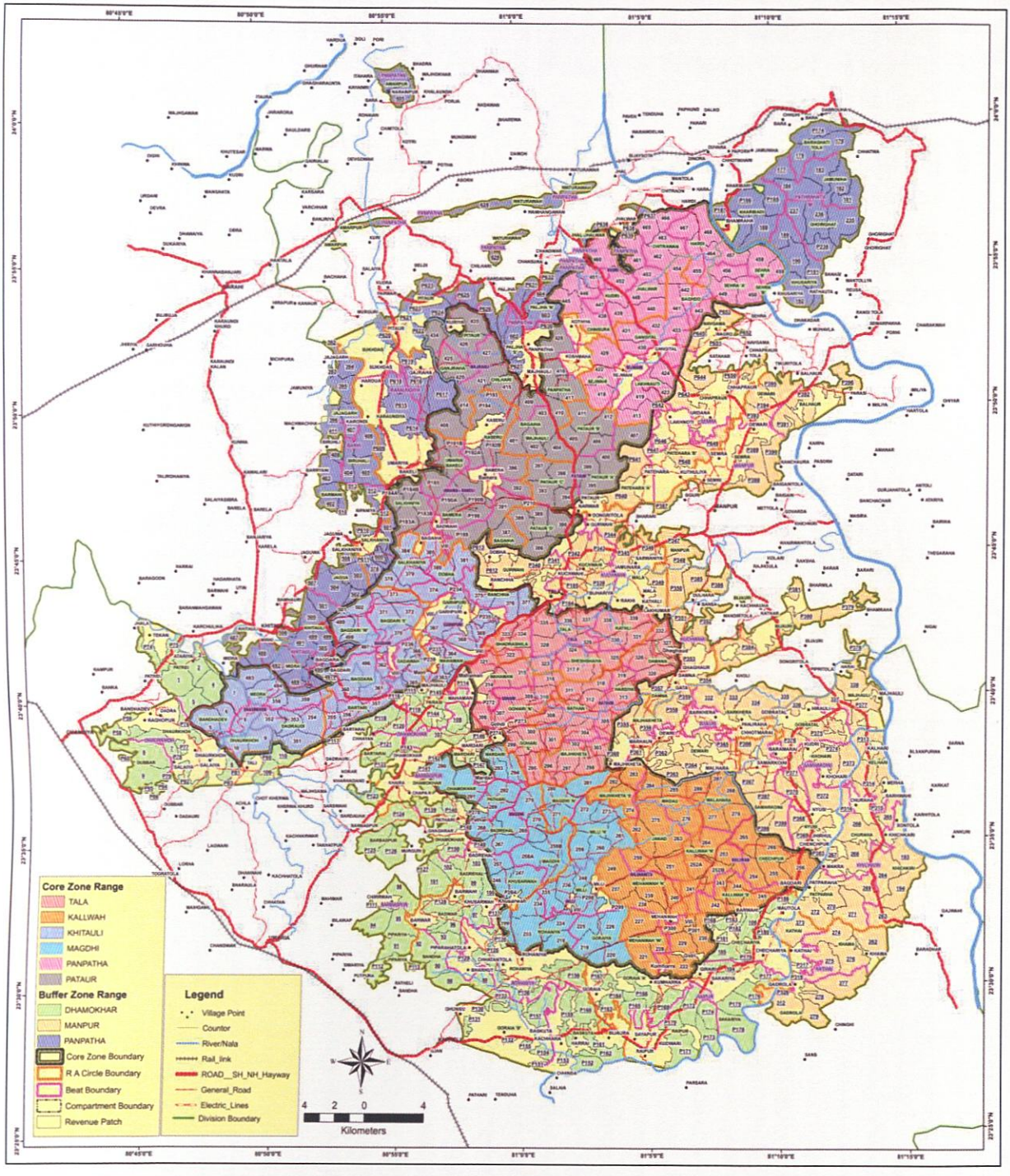
c) Slope: Park landscape consists of varied slope classes in which gentle to flat slope prevails throughout the majority of the landscape. There are patches of rough spots, particularly within the Tala range, with rugged steep slopes (Nigam et al., 2022).



Map 4.2: Digital Elevation Model of Bandhavgarh Tiger Reserve, Madhya Pradesh

d) Drainage and Water Availability: The park's sandstone formations act naturally as an aquifer, and the recharge of groundwater is high. The park contains numerous rivers, both perennial like

Umaria, Damnar, and Johila, and the Son River flows through Panpatha Sanctuary. There are numerous waterholes in the area, including Rajbehra Dam and Damdama Talab. During summer, all waterholes are dry, and water is supplied by tankers, solar pumps, and hand pumps (Nigam et al., 2022).



Map 4.3: Bandhavgarh Tiger Reserves, Madhya Pradesh (Source: BTR, MPFD)

4.2 Biological attributes (flora and fauna)

Flora:

Vegetation of Bandhavgarh Tiger Reserve falls under five categories (Champion and Seth, 1968) such as Moist peninsular low level Sal forest (3C/C2e), Northern dry mixed deciduous forest (5B/C2), Dry deciduous scrub (DS1), Dry grassland (5/DS4) and West Gangetic moist mixed deciduous forest (3C/C3a).

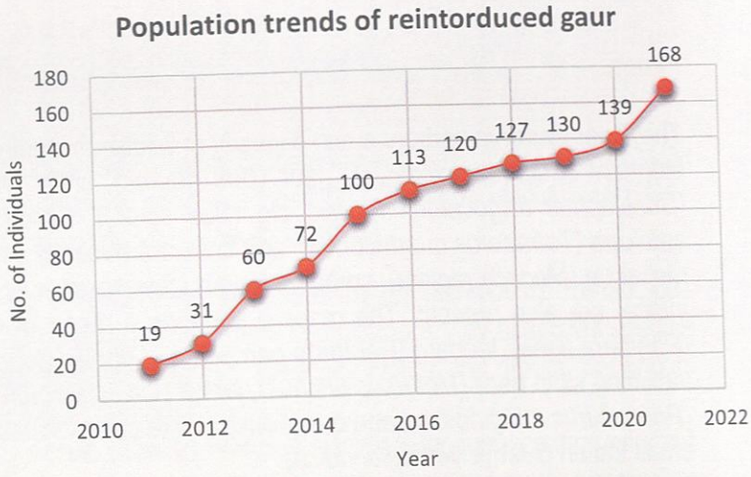
1. The Moist Peninsular Low-Level Sal Forest (3C/C2e) is dominated by *Shorea robusta*, forming 60–80% of the 25–40 m high canopy, with dense undergrowth and climbers. Key associate species include *Terminalia tomentosa*, *Pterocarpus marsupium*, *Madhuca indica*, and others. Sal and its associates cover about 60% of the Tiger Reserve.
2. The Northern Dry Mixed Deciduous Forest (5B/C2) features an open, uneven canopy of short deciduous trees, rarely exceeding 10 meters in height. Dominant species include *Anogeissus pendula*, *Acacia catechu*, *Butea monosperma*, *Syzygium cumini*, and *Mangifera indica*. The understorey is dense with shrubs and grasses such as *Ziziphus spp.*, *Carissa opaca*, and *Cynodon dactylon*.
3. *Dry grassland (5/DS4):* The dry grassland is found where the site has been subjected to biotic pressure. The soil surface has medium size stones. Grasses grow up to 1 m tall. The dominant grasses are *Themeda quadrivalvis*, *Aristida adscensionis* and *Heteropogon contortus*.
4. Dry Deciduous Scrub (DS1) is a degraded form of dry deciduous forest, resulting from pressures like overgrazing, felling, and frequent fires. Despite adequate rainfall, poor moisture retention has led to its stabilization as an edaphic climax. The vegetation is sparse, with species like *Butea monosperma*, *Diospyros melanoxylon*, and *Anogeissus latifolia*, and undergrowth dominated by *Woodfordia fruticosa* and *Flacourtia indica*.
5. The West Gangetic Moist Mixed Deciduous Forest (3C/C3a) features an open canopy that supports a rich growth of grasses and herbs. It shares many species with moist deciduous forests, including *Lagerstroemia parviflora*, *Anogeissus latifolia*, *Terminalia chebula*, *Diospyros tomentosa*, *Cassia fistula*, *Butea monosperma*, and *Dendrocalamus strictus*.

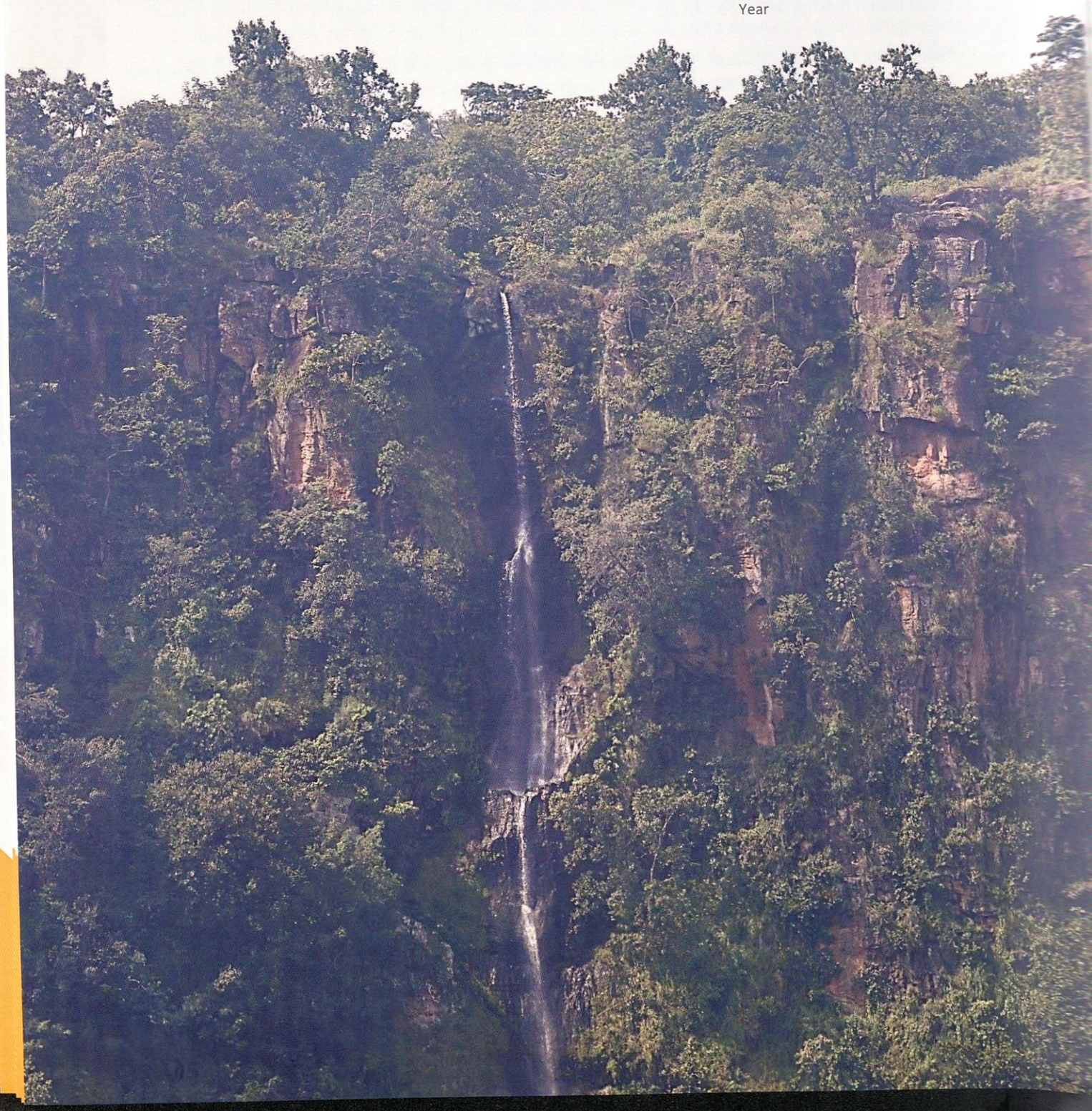
Fauna:

The Tiger Reserve harbors a rich diversity of wildlife, including a variety of herbivores such as the Asian elephant (*Elephas maximus*), gaur (*Bos gaurus*), chital (*Axis axis*), sambar (*Rusa unicolor*), nilgai (*Boselaphus tragocamelus*), wild pig (*Sus scrofa*), barking deer (*Muntiacus muntjak*), four-horned antelope (*Tetracerus quadricornis*), and chinkara (*Gazella bennettii*). Arboreal mammals like the bonnet macaque (*Macaca radiata*), common langur (*Semnopithecus entellus*), and Indian giant squirrel (*Ratufa indica*) are also present. The reserve supports a range of carnivores, from large predators like tiger (*Panthera tigris*), leopard (*Panthera pardus*), and dhole (*Cuon alpinus*), to medium and small carnivores including sloth bear (*Melursus ursinus*), jackal (*Canis aureus*), jungle cat (*Felis chaus*), rusty-spotted cat (*Prionailurus rubiginosus*), and civets such as the common palm civet (*Paradoxurus hermaphroditus*) and small Indian civet (*Viverricula indica*).

Several species of mongoose—*Herpestes edwardsii*, *H. smithii*, and *H. vitticollis*—are found, along with fringe-dwelling species like the Indian wolf (*Canis lupus*), striped hyena (*Hyaena hyaena*), and Indian fox (*Vulpes bengalensis*).

Population of Gaur in BTR: The population of the Gaur is nearing 168 individuals, estimated in March, 2021 up from the initial reintroduced population of 50 individuals over a ten-year period (Nigam et al., 2022). The established population has been exploring newer areas over the years. Habitat improvement efforts at BTR have resulted in positive outcomes.

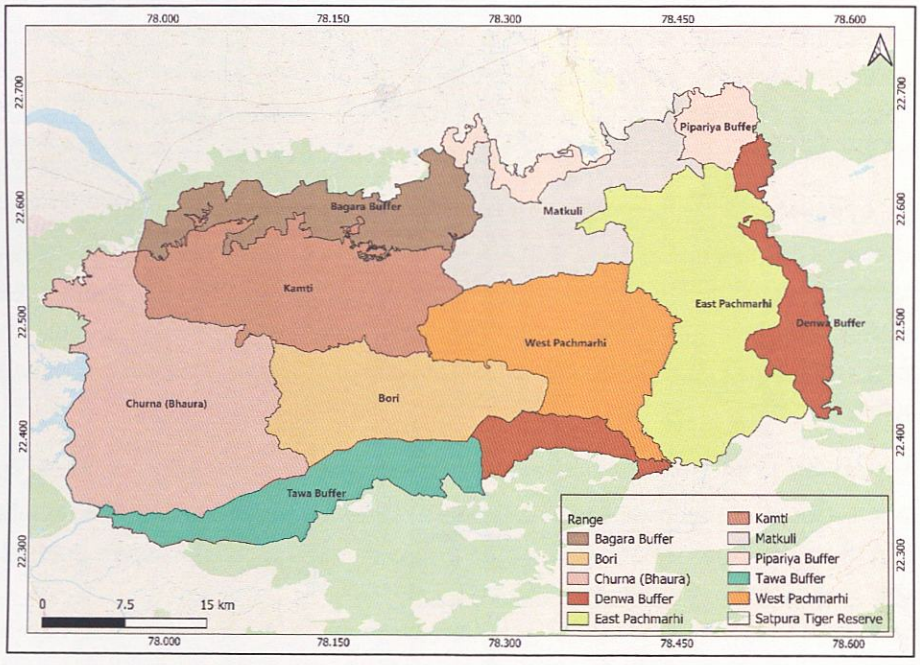




CHAPTER - 5
SOURCE SITE
SATPURA TIGER RESERVE

Satpura Tiger Reserve (STR) is located in the Narmadapuram district, Madhya Pradesh. Covering a total area of 2,133.30 km^2, includes the Satpura National Park, Bori Wildlife Sanctuary, and Panchmarhi Wildlife Sanctuary. The core zone is measuring 1,339.26 km^2 and the buffer zone is 794.04 km^2 spread across the Hoshangabad Division, Rampur Bhatodi Project Division, and West Chhindwara Division. The reserve is situated south of the Narmada River, extending from longitudes 77°53'48" E to 78°34'00" E and latitudes 22°19'28" N to 22°45'30" N (Jhala et al., 2020; Qureshi et al., 2023).

The geography of Satpura Tiger Reserve consists of steep slopes, valleys, sandstone mountains, gorges, small streams, forests, and dams. Due to variations in climate and soil types at different elevations, the area is dominated by tropical forests, which include southern moist mixed deciduous forests, southern dry mixed deciduous forests, and dry peninsular sal forests. Panchmarhi consists of a plateau primarily composed of sal trees, which grow on Gondwana sandstone at high altitudes. Lower hills are dominated with teak. Some of the major fauna include tiger, leopard, sloth bear, wild dog, striped hyena, golden jackal etc. Herbivores include chital, sambar, gaur, barking deer, four-horned antelope, blackbuck, chinkara, wild pig (Jhala et al., 2020; Qureshi et al., 2023).



Map 5.1: Satpura Tiger Reserve, Madhya Pradesh

CHAPTER - 6
PRE TRANSLOCATION
FEASIBILITY ASSESSMENT

A feasibility assessment was conducted in September 2024 at Bandhavgarh Tiger Reserve and Satpura Tiger Reserve. This assessment serves as a foundation for evaluating habitat suitability, population viability, and site selection for enclosure establishment at the recipient site, Bandhavgarh Tiger Reserve. At the source site, Satpura Tiger Reserve, the survey aimed to determine the geographic distribution of gaur and herd dynamics, as well as to assess health status through body condition index and parasitic load. The summary of the feasibility assessment is provided below.

5.1 HABITAT SUITABILITY MODELLING

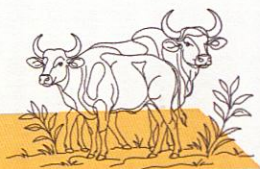
A habitat suitability analysis was performed to identify the potential suitable habitats and gaur preferred ranges in Bandhavgarh Tiger Reserve. The previous studies in Bandhavgarh Tiger Reserve showed that land cover type, terrain ruggedness, vegetation type and availability of palatable species, water availability, anthropogenic disturbance and predator occurrence were the major factors that determine the habitat selection of Gaur. A series of environmental variables such as forest cover, climatic layers, elevation gradient, changes in land cover, and human disturbances were used to perform the habitat suitability modelling for gaur in Bandhavgarh Tiger Reserve (Nigam et al., 2022). The results were then index into least suitable, moderately suitable and highly suitable habitats.

Using the MaxEnt software (MaxEnt v 3.4), species distribution modelling was performed to simulate the species' potential distribution, with default prevalence parameter settings and a 10,000-point background sampling density. Models were run with 20 bootstrap replicates, with presence records randomly assigned to the training (80%) and test (20%) datasets. In addition, a Jack knife analysis was used to identify the most important variables for modelling. The logistic model output was selected which displays suitability from 0 to 1.

Among the 11 variables, annual mean temperature, elevation gradient, forest cover type, land cover and mean diurnal range were the important factors in determining the habitat suitability of Gaur in Bandhvagarh Tiger Reserve. The most potential suitable habitats were present in high dense forest and with areas with minimal human disturbance.

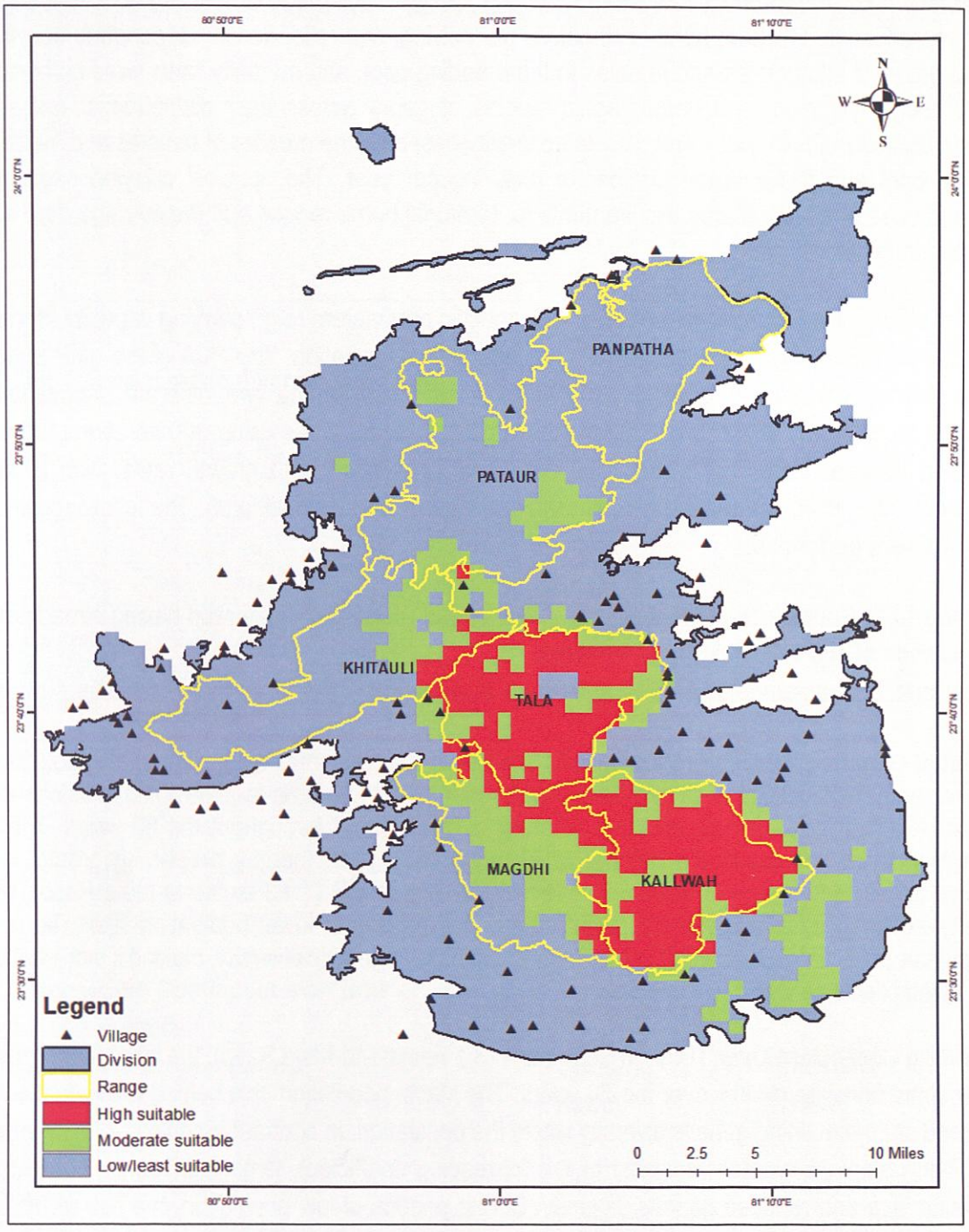
5.1.1 Habitat Suitability of Gaur in Bandhavgarh Tiger Reserve

Habitat suitability analysis was conducted over an area of 1504.1 sq. km of which 173.3 sq. km was identified as highly suitable, 167.69 sq. km as moderately suitable, and 1,163.1 sq. km as least suitable for gaur (Table 5.1 & Map 5.1). Within the Tiger Reserve, the forest ranges Kallwah, Tala, and Magdhi have a higher potential suitable habitat for gaur.



Total area (HSM performed)	Low/least suitable	Moderate suitable	High Suitable
1504.1 sq.km	1,163.1sq.km	167.69 sq.km	173.3 sq.km

Table 5.1: Habitat Suitability of Gaur in Bandhavgarh Tiger Reserves, Madhya Pradesh



Map 5.1: Habitat Suitability of Gaur in Bandhavgarh Tiger Reserves, Madhya Pradesh

5.2. POPULATION VIALBILITY ANALYSIS

Population Viability analysis (PVA) simulations were performed using the *'popbio'* package (Stubben et al., 2024) in R software version 2024.04.2 (R Core Team, 2024). To determine input scenarios for *'popbio'*, a literature review was conducted to gather information on the life history traits of gaur. Parameters such as reproductive system type (e.g., polygamous), age of first reproduction, maximum age of reproduction, lifespan, number of calves per calving, sex ratio, density-dependent reproduction, the proportion of adult males and females in the breeding pool, and mortality rates were gathered from peer-reviewed biological and demographic studies of gaurs across their distributional ranges. The package utilizes mortality rates and calculates fertility based on the number of females and males in the breeding pool and the average number of offspring per year. The species' carrying capacity was estimated based on habitat area requirements for territorial home ranges and the average herd size, as described in the literature.

Two simulations used a baseline template, with specific parameters (e.g., carrying capacity, disease as a catastrophe, and mortality) adjusted for each alternative simulation. The PVA of the gaur population was performed on already existing population (n=168) considering two different supplementation strategies (scenarios). These two simulations were run over 50 years using 500 iterations to estimate population decline, extinction probabilities, inbreeding coefficient and growth rates, with a carrying capacity of 300 individuals (Based on literature and experimental simulations). The following simulation scenarios were performed:

1) **Scenario 1:** Supplementation of 50 individuals at a 3:1 female-to-male ratio having already existing population of 168 individuals after 10 years.
2) **Scenario 2:** Supplementation of 50 individuals at an even 1:1 female-to-male ratio after 10 years.

Simulated Genetic Diversity Trend: Genetic diversity is crucial for maintaining a healthy population that is resilient to genetic issues such as inbreeding. Scenario 1 (3:1 Female-to-Male Ratio) was observed to maintain relatively high genetic diversity, showing a stable trend throughout the 50 years. The larger female population increased the number of offspring each year, thereby preserving greater genetic variation and avoiding sharp declines in diversity. In Scenario 2 (1:1 Female-to-Male Ratio), genetic diversity exhibited more fluctuations, particularly during periods of lower population size. The reduced reproductive potential in Scenario 2 led to a slower increase in genetic diversity, making it more vulnerable to stochastic declines (Fig:5.1; table 5.2).

Inbreeding Coefficient Over Time: In Scenario 1 (3:1 Female-to-Male Ratio), the inbreeding coefficient (F) remained consistently low over the 50 years. The stable population size helped alleviate the effects of inbreeding, maintaining genetic diversity within the population. In contrast, Scenario 2 (1:1 Female-to-Male Ratio) showed greater variability in the inbreeding coefficient, largely driven by fluctuations in population size and reduced genetic diversity. During periods of low population, the risk of inbreeding increased due to the limited number of individuals contributing to the gene pool (fig 5.2; table 5.2).

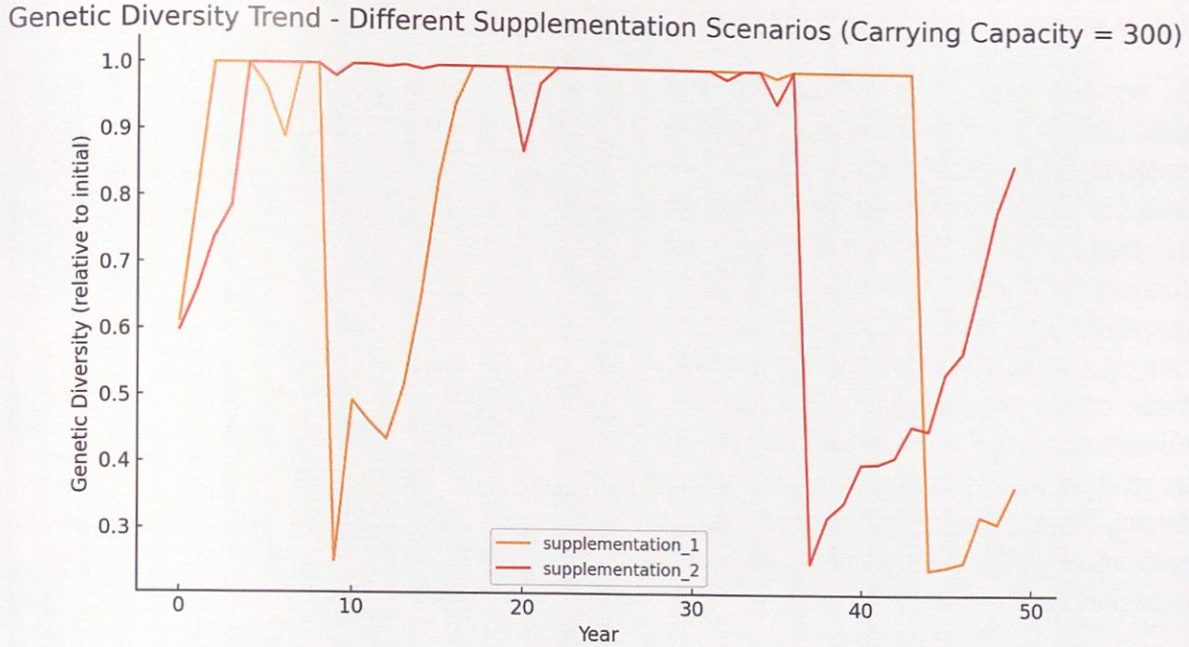


Fig 5.1: Simulated genetic diversity over time

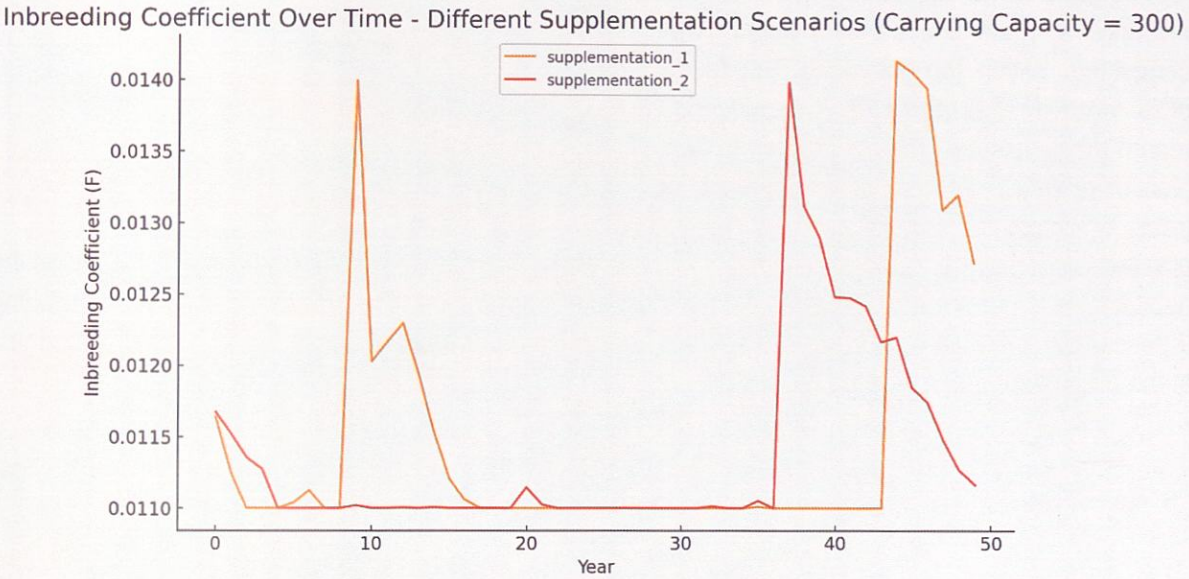


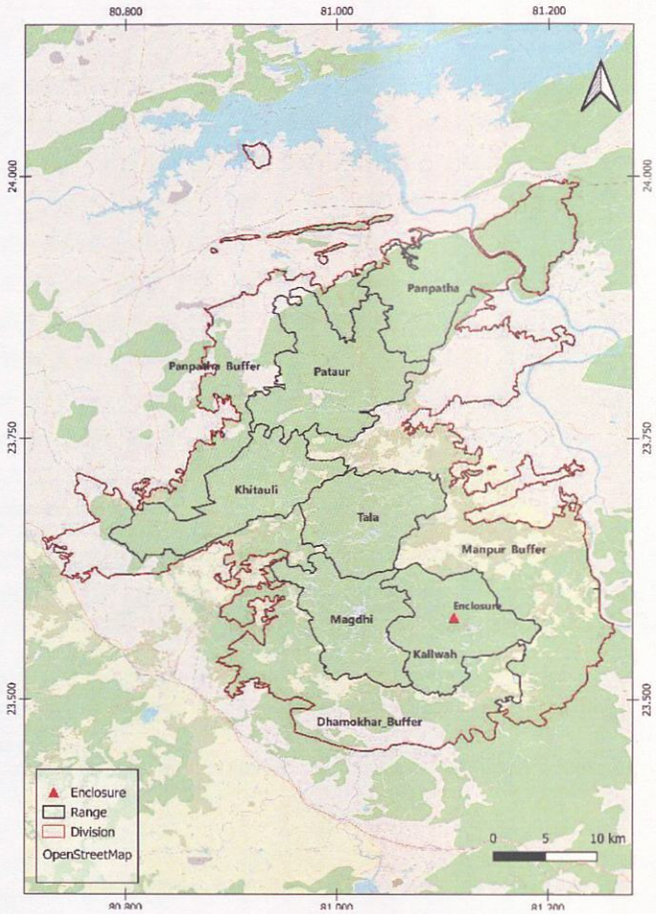
Fig 5.2: Inbreeding Coefficient over time

Table 5.2: Parameters

Parameter (over 50-year period)	Scenario 1 (3:1 Ratio)	Scenario 2 (1:1 Ratio)
Average Extinction Risk	0	0
Average Genetic Diversity	0.891511235	0.830342434
Average Inbreeding Coefficient	0.011490395	0.011368024
Average Adult animal Survival Rate	0.801575562	0.692017122

5.3. SELECTION OF RELEASE SITE & ENCLOSURE ESTABLISHMENT

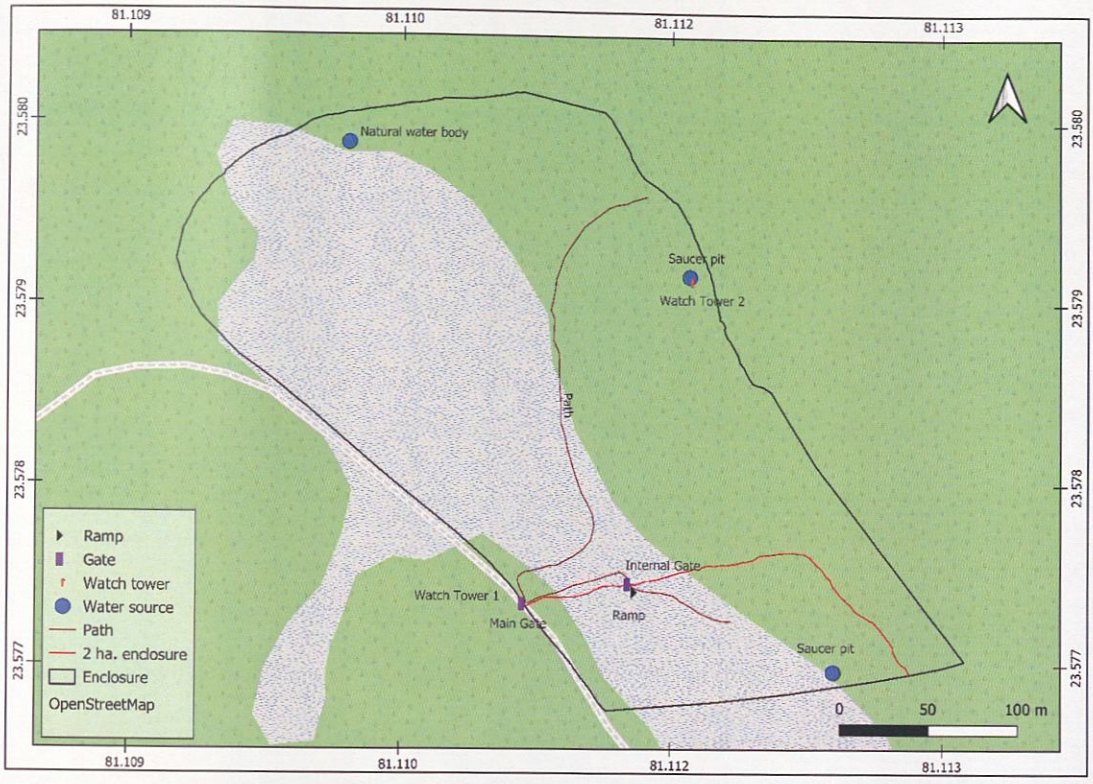
A one-day rapid field assessment was conducted in the Kallwah Range to identify suitable sites for establishing enclosures. The selection process considered key factors such as distance from human habitation, road connectivity, water availability, available grassland area, grass species, forest type, canopy cover, and terrain conditions. Based on these criteria, Karkachawah, Kudrakeerwah, Kumarwah, and Kallwah areas were shortlisted as potential sites for enclosure establishment. Among the shortlisted sites, Karkachawah is recommended as the enclosure site for the soft release of Gaur.



Floral diversity was estimated in the recommended areas by the forest department for enclosure establishment. To estimate floral diversity, a 1 km line transect survey was conducted. Within the grassland, 1m radius plots were established every 10 meters to record grass species. In the forest landscape, plots of varying sizes were used: 15 meters for trees, 5 meters for shrubs, and 1 meter for grasses, placed every 50 meters. A total of 21 plots were recorded during this assessment. Based on the habitat assessment by the BTR team, a total of 25 species were identified within the enclosure, including 9 trees, 4 shrubs, 3 herbs and 9 grass species. *Dendrocalamus strictus* was found to be highly dominant at the proposed enclosure site (Table 5.3).

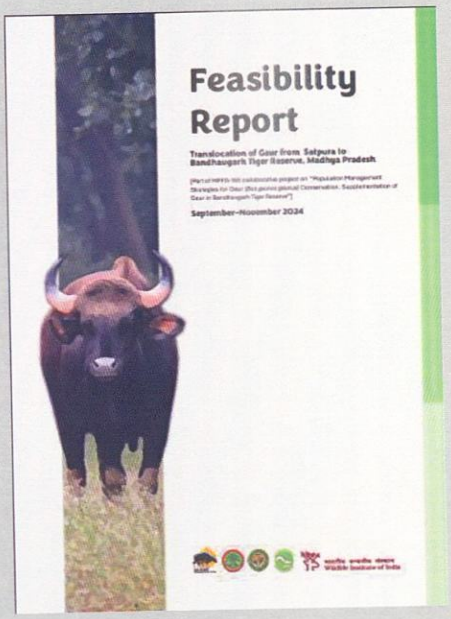
S. No	Trees	Shrubs	Herbs	Grasses
1	*Shorea robusta*	*Dendrocalamus strictus*	*Desmodium triflorium*	*Aristida Sp.*
2	*Bauhinia sp*	*Emblica officinalis*	*Hyptis suaveolens*	*Eragrostis sp.*
3	*Emblica officinalis*	*Zizipus sp.*	*Spermacoce ocymoides*	*Brachiaria ramosa*
4	*Dendrocalamus strictus*	*Pheonix sp.*		*Ischamum Indicum*
5	*Lagerstromia parviflora*			*Heteropogon sp.*
6	*Diospyra melanoxylon*			*Paspalum scrobiculatum*
7	*Madhuca indica*			*Themeda quadrivalvis*
8	*Lannea coromandelica*			*Saccharum Sp.*
9	*Miliusa tomentosa*			*Seteria sp.*

Table 5.3: Floral Diversity in Karkachawah (enclosure site)



Map 5.2: Soft release enclosure for gaur

Summary: Feasibility Report Translocation of Gaur from Satpura to Bandhavgarh Tiger Reserve, Madhya Pradesh



A feasibility assessment was carried out at Bandhavgarh Tiger Reserve from 19th September to 23rd September 2024 to predict habitat suitability, analyse population viability analysis, the status of the gaur population, enclosure site identification, and vegetation assessment and in Satpura Tiger Reserve to assess the gaur distributed areas, to check the health status of the source population. The performed habitat suitability using MaxEnt software predicted potential gaur suitable areas, which has resulted in 173.3 sq. km being a highly suitable area for gaur, 167.69 sq. km being a moderately suitable area, and 1,163.1 sq. km being a low /least suitable area for gaur, resulting in a total area of 1504.1 sq. km. Considering two different scenarios such as supplementation of 1:3 and 1:1 male-female ratio to the existing population a Population Viability Analysis was performed. The scenario of translocating 50 individuals in 1: 3 ratio of male-female has significantly emphasised the improved genetic diversity compared to supplementing a 1: 1 ratio of male-female over 50 years.

However, considering the 2022 survey and mortality count the current population is estimated at around ~ 168 individuals. The enclosure site was recommended considering factors such as mapping out the latest mortality data of gaur caused due to tuberculosis, water availability, terrain conditions, road connectivity, weed-infected areas, and vegetation type. Based on this key factor, Karkacha located in Kallwah Forest Range is suggested for the enclosure establishment. Within the suggested enclosure site, a vegetation assessment along a 1km line transect was performed to assess the floral diversity. The assessment has revealed that the site is dominated by *Dendrocalamus strictus* which is an important food source of gaur.

Simultaneously, a source population assessment of gaur is conducted at Satpura Tiger Reserve from 20th October 2024 to 23rd October 2024 to map out the gaur distributed areas, to check the health status, parasitic and disease investigation of gaur. The Satpura Tiger Reserve is south of the Narmada River, in Hoshangabad district, Madhya Pradesh covering a total area of 2,133.30 sq. km. The geographical features of STR consist of slopes, steep valleys, streams, and sandstone hills and are occupied by tropical forests. The estimated gaur population in Satpura Tiger Reserve is n = 6,323, distributed across Churna, Bori, Kamti, West Pachmarhi, East Pachmarhi, Matkuli, Tawa, Denwa, Bagra, and Pipariya. The rapid assessment has mapped out a total of 6 herds in the Bori and Churna Ranges, with a minimum herd size of six individuals to a maximum herd size of twenty-four individuals. A total of 29 dung samples of gaur were collected for parasitic and disease analysis. The Body condition index evaluated that the gaur species is good in condition. The laboratory investigation has revealed that animals are disease-free with minimal parasitic load in their body.

Citation: WII-MPFD, (2024a) Feasibility Report: Translocation of Gaur from Satpura to Bandhavgarh Tiger Reserve, Madhya Pradesh. Part of MPFD-WII collaborative project on "Population Management Strategies for Gaur (*Bos gaurus gaurus*)Conservation: Supplementation of Gaur in Bandhavgarh Tiger Reserve. Pp.33

5.4. PRE-ASSESSMENT SURVEY AT SATPURA TIGER RESERVE

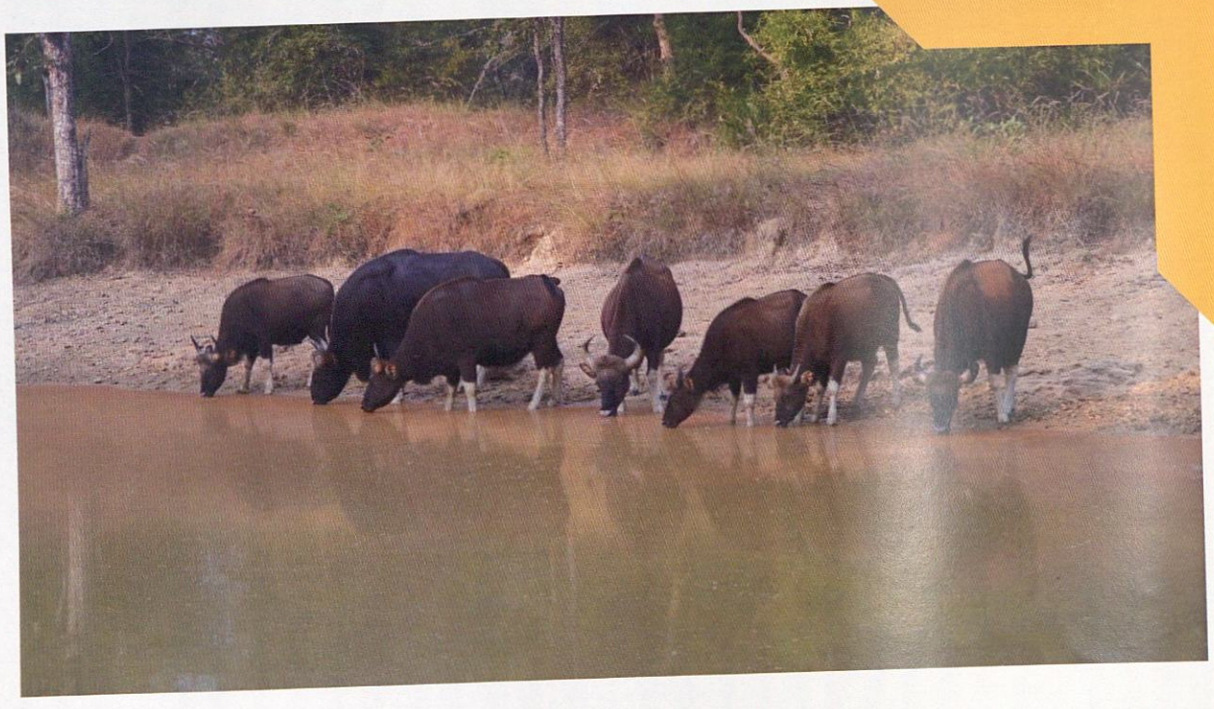
A four-day reconnaissance survey was conducted in the Satpura Tiger Reserve (STR) from October 20 to October 23, 2024. Based on literature reviews, field surveys, and information from the authorities of STR, the survey focused on two regions, known for their high gaur density: Churna and Bori Forest Range. Specific areas of interest were Kankri, Dhain, and Bori within the Bori range and Ratibanda, Malni, and Sakot in the Churna range. These areas were selected for random searches for Gaur herds based on ease of access and significant population size.

Bori and Churna ranges of STR displaying varying group size and demographic composition were identified. The health condition of the animals was assessed using Riney's (1960) Body Condition Index (BCI). The assessment revealed a healthy gaur population in Satpura Tiger Reserve as indicated by overall body condition scores.

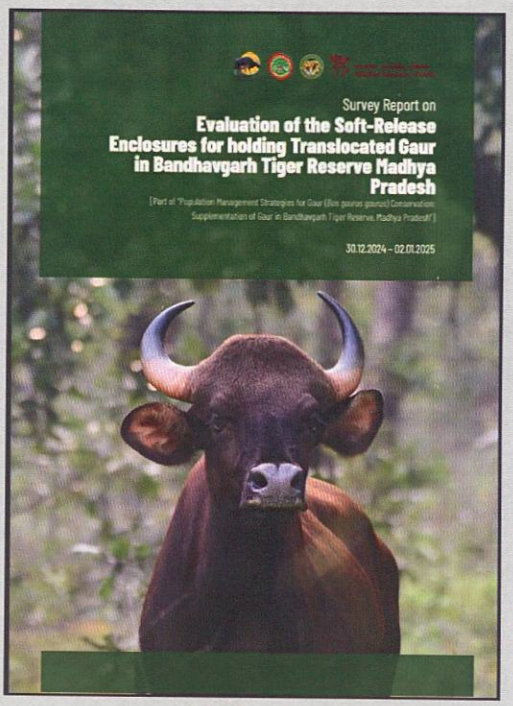
The dung samples were sent to the School of Wildlife Forensics and Health (SWFH) at Nanaji Deshmukh Veterinary and Animal Science University (NDVSU) in Jabalpur for disease investigation. The laboratory examination suggested that individuals are in good health and did not reveal any significant parasitic load.

Site priority for herd selection

The prioritisation of sites for herd selection for translocation was based on field assessments, and factors such as distance to road, health status, age class within the herd, physiological condition and results from laboratory investigations (WII – MPFD, 2024a). These criteria were used to identify the most suitable area from which gaur herd could be selected for translocation.



Summary: Survey Report on 'Evaluation of the Soft-Release Enclosures for holding Translocated Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh



An evaluation for utilising, the existing soft-release enclosures (1. Behraha enclosure- utilising for holding rescued tigers; 2. Lalmata enclosure: originally constructed and utilised as quarantine facility for diseased/injured gaurs) was carried out to form basis for holding the gaur for the initial period following translocation. The evaluation survey was carried out between 30th December 2024 to 2nd January 2025.The report highlighted that existing enclosure is deemed suitable for utilization following the implementation of structural modifications and adherence to the criteria outlined in this report. Essential interventions included the removal of internal walls to create a single, contiguous habitat conducive to free movement and socialization of gaurs, and reinforcement of structural design. Habitat improvements, such as the removal of invasive weed species and the integration of additional grassland patches to mitigate forage deficiencies, were documented to be critical in enhancing vegetation quality. Comprehensive sanitization measures, including the removal of organic waste, surface burning to reduce pathogen loads, and the application of non-toxic, biodegradable disinfectants or enzymatic cleaners, to ensure a pathogen-free environment were recommended. The use of eco-friendly odour-neutralizing agents was also recommended to reduce stress-inducing pheromonal residues. Upon the completion of these modifications and fulfilment of the specified conditions, the enclosure was recommended to provide a safe and ecologically suitable environment for the translocated gaurs. The report concluded that existing enclosures are currently unsuitable for housing translocated gaurs due to their compartmentalization, limited vegetation, disease threat due to leftover carcasses, carnivore scats and smell (in Beherha enclosure), and limited quantity of vegetation small size of enclosure (in Lalmata enclosure).

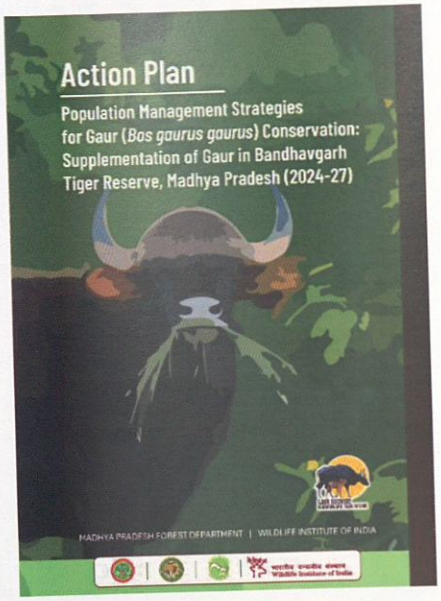
Citation: WII-MPFD (2025) Evaluation of the Soft-Release Enclosures for holding Translocated Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh [Component of the collaborative project entitled "Population Management Strategies for Gaur (*Bos gaurus gaurus*) Conservation: Supplementation of Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh"], Survey Report I, pp.12.

CHAPTER - 7
CAPTURE & TRANSLOCATION

7.1 Capture operation: An Overview

Inception cum Planning Workshop

To ensure the successful execution of the supplementation project and to prevent any potential lapses, an inception cum planning workshop was held on October 15, 2024 (WII-MPFD, 2024b). The primary goal of the workshop was to bring together forest officials, conservationists, veterinarians, wildlife biologists, and other key stakeholders. The gathering was to emphasize the importance of the project, discuss future strategies, finalize the action plan and clarify the roles of various organizations and personnel involved in the project.



The workshop also focused on reviewing insights from long-term monitoring of gaur in Bandhavgarh Tiger Reserve, refining approaches to conservation management, and recognizing the dedicated efforts of individuals involved in monitoring and protecting the species. A total of 32 forest officials, scientists from WII, research scholars, frontline staff, and veterinary officers participated in the workshop.

Micro-plan Development

A micro-plan outlining the roles and responsibilities of all personnel involved including detailed procedures involved in the capture operation was approved by the Madhya Pradesh Forest Department that

Capture Operation

Based on the feasibility assessment carried out at the source site (WII-MPFD, 2024a), Churna and the Bori Ranges of the STR were identified as ranges having healthy herds with required social groups and individuals for capture.

The field capture operation was conducted from February 20th to 23rd, 2025. The process began with locating a gaur herd and identifying individuals for capture, followed by the initiation of the capture operation. A team of eight captive elephants, sourced from Kanha, Bandhavgarh, and Satpura Tiger Reserves, assisted the darting team in approaching the herd. To ensure safe and manageable transport, only 3-5 animals were captured at a time. Once an animal was darted, the darting team communicated effectively with the ground team via radio, allowing them to promptly reach the location and minimize additional stress to the animals. Each animal was then carefully loaded onto a stretcher, secured with supportive ropes, and transferred to a transportation truck. After loading, a reversal drug was administered to the animal. Meanwhile, biological samples were collected, and collaring was done before the animals were transported to Bandhavgarh Tiger Reserve (BTR). The entire operation was well-coordinated, with effective communication between the darting and ground teams ensuring a smooth and safe capture process.

During the release of animals at the recipient site, the transportation truck's doors were precisely aligned with the loading ramp to facilitate a smooth and safe exit. To minimize stress and ensure a successful release, officials and staff were instructed to avoid unnecessary movements and maintain a calm environment.

Photography and documentation at the release site were carefully planned and executed to capture key moments without disrupting the animals. This meticulous approach ensured the well-being of the 23 gaur individuals that were successfully captured and translocated from Satpura Tiger Reserve (STR) to Bandhavgarh Tiger Reserve (BTR).

The capture operation has been detailed in three phases: (i) Pre-translocation Phase (see chapter 6), (ii) Translocation Phase and (iii) Post translocation phase

7.2 Planning a capture Operation

Capture and translocation operations are complex processes that require meticulous and careful planning.

A comprehensive planning phase was undertaken (Action plan, WII-MPFD, 2024c), involving feasibility assessments at source and release sites, detailed discussions with personnel, securing necessary permissions, and procuring equipment. Preliminary knowledge on animal condition, pregnancy status, and presence of young was gathered to inform capture strategies. Roles were assigned to teams, and mock drills were conducted to ensure smooth operations. Capture planning considered seasonal movement patterns, terrain type, and animal health requirements, with careful selection of animals to avoid pregnant or nursing individuals. Additionally, arrangements were made for translocation vehicles, human healthcare, and medical personnel to ensure a safe and successful operation.A comprehensive planning phase was undertaken, involving feasibility assessments at source and release sites, detailed discussions with personnel, securing necessary permissions, and procuring equipment. Preliminary knowledge on animal condition, pregnancy status, and presence of young was gathered to inform capture strategies. Roles were assigned to teams, and mock drills were conducted to ensure smooth operations. Capture planning considered seasonal movement patterns, terrain type, and animal health requirements, with careful selection of animals to avoid pregnant or nursing individuals. Additionally, arrangements were made for translocation vehicles, human healthcare, and medical personnel to ensure a safe and successful operation.

7.3 Permissions for Translocation of Gaur

As the gaur is listed in schedule I of the Wildlife Protection Act, 1972, it receives the highest level of protection. Any activities involving capture, handling and translocation require prior approval and permission form the Government of India and the Chief Wildlife Warden, Government of Madhya Pradesh. Necessary permissions were sought before the field operation and are placed in annexure I.

7.4 Drugs for immobilization: Procurement and secure permissions

To immobilize wild bovids like gaur, narcotics- primarily opioids and neuroleptics are preferred drugs. Procurement and use of these drugs require administrative approval and license. The Madhya Pradesh Forest Department facilitated the procurement of drugs and necessary approvals. These include clearances from Drug Controller General of India, the Ministry of Agriculture, Government of India (Department of Animal Husbandry and Dairying) and the Narcotic Commissioner, Ministry of Finance, Government of India (Central Bureau of Narcotics).

7.5 Procurement of Radio collars, ear tags and fabrication of color coded neck band

To facilitate post-release monitoring and individual identification of translocated gaur, the project adopted telemetry and various marking strategies. Very High Frequency (VHF) radio collars (Telonics, USA; MOD-515-3 VHF radio collars, CAST-1, MS6A Mortality sensor) were fitted on select animals to enable accurate tracking of their movements during the post-release period. Before deploying, all the VHF collars were tested to ensure that equipment is in good working condition. In addition to VHF collars, individual-specific color-coded neck bands and ear tags (locally designed and fabricated) were prepared. Three neck bands were equipped with Long Range (LoRa) tracking satellite devices donated by the Wildlife Conservation Trust, India.

7.6 Reconnaissance survey of the route

A trail run was conducted from the source site (Satpura Tiger Reserve) to recipient site (Bandhavgarh Tiger Reserve) to assess the road conditions, estimate journey time, identify suitable halting points, and determine the optimal vehicular speed. The reconnaissance run was supervised by designated field officer from Bandhavgarh and Satpura Tiger Reserves. The journey usually commenced in the late evening hours to reduce disturbances from human activity and traffic, ensuring arrival at the release site by early morning. However, for animals captured during the morning hours, a meticulous plan was made to commence the journey soon, taking due care and managing emergencies that may arise, such as cooling systems arrangement, fodder and water availability, as well as road clearance. The distance between Satpura Tiger Reserve and Bandhavgarh Tiger Reserve was approximately 570 km, requiring around 16 -18 hours to cover (WII-MPFD, 2024c; Annexure III).

7.7 Mock drills and Training sessions

To ensure a successful capture and translocation operation, regular mock drills and training sessions were conducted for field staff, veterinarians, transportation teams, and collaring teams. These exercises enhanced their skills, deepened their understanding of tasks, and prepared them for potential scenarios, ultimately improving the efficacy and effectiveness of the operation. By identifying teams responsible for different aspects of the process in advance, a comprehensive training program was facilitated, equipping all team members with a clear understanding of their roles and responsibilities. This proactive approach

significantly contributed to the smooth execution of field operations, prioritizing the safety and well-being of both personnel and animals involved.

7.8 Infrastructure Development and Resources

7.8.1 Transportation Vehicle

Specialised transportation trucks available at Bandhavgarh Tiger Reserve, Kanha Tiger Reserve, Kuno National Park and Vanvihar National Park were utilised for the purpose of translocation gaur. The vehicles were rigorously inspected for roadworthiness and compliance with animal welfare. Key features inspected in the vehicle were

- Non-slippery flooring using securely bolted rubber mats
- Smooth interior surfaces to avoid any possible injuries to animals during travel
- Integrated cooling systems (water sprinklers)
- CCTV cameras for animal(s) monitoring
- Adequate ventilation
- Communication facilities (VHF radio sets)
- Visual and physical access to the personnel.

A transport vehicle was kept on standby to address any emergencies. Additionally, a supporting vehicle was arranged for carrying immobilised animals from the site of capture to the transport vehicle.

Vehicle dimensions (Pabla et al., 2011; Nigam et al., 2024)

- Standard container length of ± 6.7 m.
- Roof of the container: minimum internal height of 2.2 m.
- Two external doors: one on the right rear side and one on the front right side of the front compartment.
- Doors 1.2 m wide, suspended from a 2.4 m rail with rubber stoppers to prevent over-opening or over-closing; each door has a U-shaped locking mechanism.
- Each door is suspended by two 500 kg (minimum) rollers.
- The bottom of each door runs behind a 6 mm steel flat bar.
- 'D' rubber attached below each door extending beyond the opening.
- Hatches provided in the center of the roof, 75 cm wide.
- Hatches raised and made waterproof.
- Latches to lock the hatches open.
- 1 adjustable partition with a sliding door in each compartment.
- Centre compartment sliding door operated from outside.
- Standard sliding doors, 1.2 m wide and made of solid steel.
- Four side hatches (30 cm x 70 cm) on both sides just above the base of the wall, except the front right compartment, which has one hatch to facilitate sliding door access.
- Lower container wall with 4 mm thick to allow free flow of urine.
- Floor: checkered solid steel plate with 100 sq. cm grids made of round iron bars.
- Outside of the roof: painted white with anti-skid surface (sprinkle sand on wet paint).
- Roof tapered by 5 cm from raised center to side walls.
- 50 mm hollow tube welded between verticals to form a ladder to climb onto the roof.
- 75 cm mechanical louvres along both sides

7.8.2 Stretcher

A critical component of the capture operation is the customised stretcher used for safe lifting, weighing, and loading of immobilised animals into a transportation vehicle (Nigam et al., 2024).

Stretcher dimensions (Nigam et al., 2024)

- The outside width of the stretcher is not more than 110 cm.
- A 3 cm diameter pipe is used as a holding rail along the entire length on both sides.
- Four 4 cm hollow pipe cross members, equally spaced.
- Six 3 cm extensions (each 3 m in length) to fit into the 4 cm.
- 90 cm wide double canvas covers the full length of the internal 90 cm wide poles.
- The canvas has eyeholes along the full length on both undersides for stitching.
- Runners made of 4 cm diameter pipe welded underneath the 90 cm bearers, supported on 10 cm supports.
- Two stretcher rails made of 5 cm channel iron, spaced 90 cm apart and braced at 1 m from each end; designed to fit into the door slots under the door's lower rail.
- Length of the stretcher: 2 m.

7.9 Assigning teams and Task

The success of the capture and translocation operation relies heavily on coordinated teamwork with predesignated roles and responsibilities. The capture team consists of various teams, with each team assigned specific tasks before takeoff. Responsibilities assigned to teams were:

1. Herd identification and selection of individuals
2. Darting, animal approach, blindfolding and animal positioning and stabilization
3. Animal monitoring and emergency management
4. Animal collaring
5. Stretcher loading and offloading
6. Animal weighing, body measurements and data recording
7. Biological sampling, field testing and laboratory testing
8. Animal transportation
9. Photography and videography documentation
10. Administrative and logistical support
11. Enclosure preparation at Bandhavgarh Tiger Reserve
12. Post-release monitoring

7.10 Capturing and Translocation process

7.10.1 Capture area

The animals were captured at Sridhana Grass meadow and Marram beat at Churna Range of Satpura Tiger Reserve. To ensure efficient capture, areas with dense vegetation, hilly terrain, valleys, or water

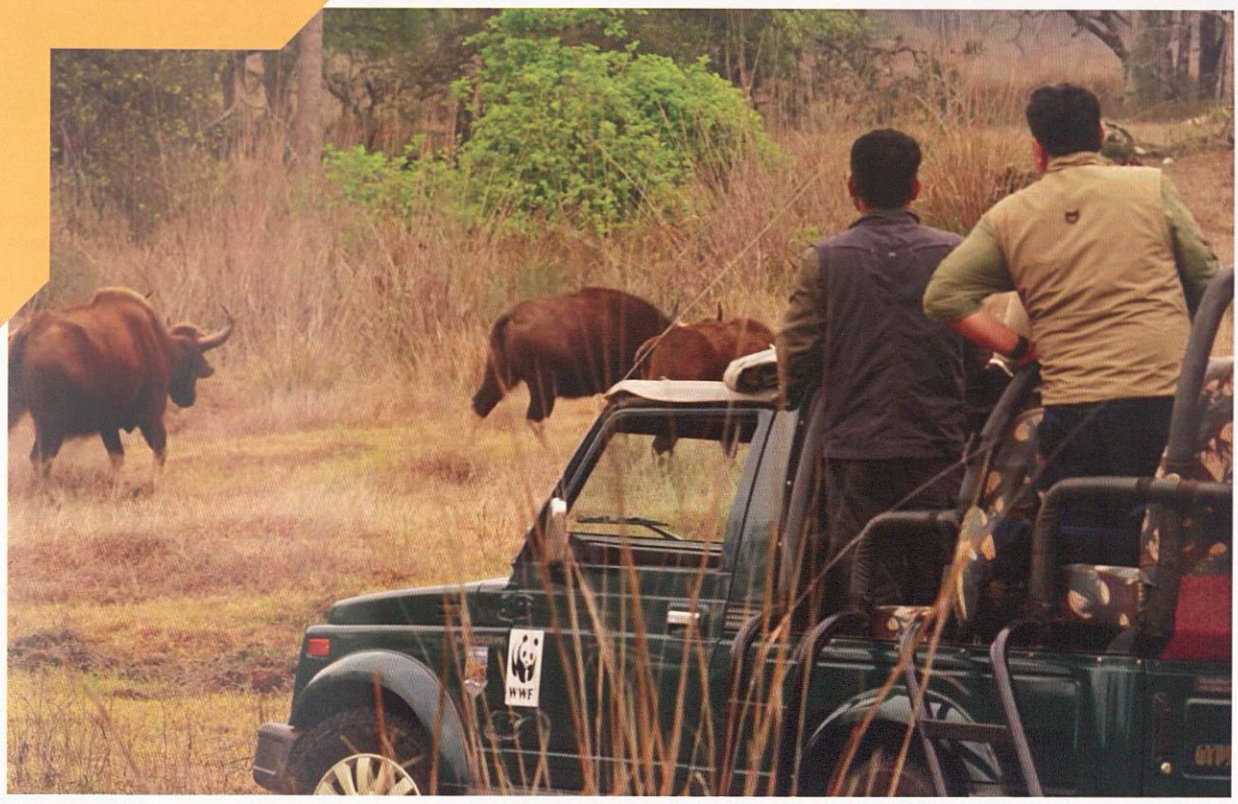
bodies were avoided. The animals when located in unsuitable areas were moved to plains and open patches with the help of captive elephants to ease capturing and loading.

7.10.2 Capture timings

Winter was strategically chosen for the capture and translocation of animals, as they migrate from hilly regions to plains during this season, making them more accessible. The cooler temperatures and dry terrain of winter also facilitated optimal capture conditions, allowing for better vehicular access and reducing the risk of heat-related complications. To further minimize stress and health risks, captures were typically conducted during the cooler morning hours, when temperatures were below 25°C. This timing also took advantage of the animals' natural physiology, as morning captures benefited from lower rumen content, reducing the likelihood of tympany and regurgitation.

7.10.3 Selection of animals for capture and translocation

Satpura Tiger Reserve was identified as the source population for the supplementation programme, as the departmental records indicate a well-established gaur population in the landscape. Healthy animals from spatially distinct areas were selected across various age and sex classes. Care was taken to avoid capturing old individuals, pregnant females and nursing mothers with calves, to prevent disruption of herd dynamics (Nigam et al., 2014).



7.10.4 Approaching herd for darting

Once a gaur herd was selected, the team carefully approached the animals to within 20-25 meters using captive elephants, taking great care not to disturb the herd. The elephants, brought in from different directions, were strategically used to hold the animals in place, preventing any individual from breaking away and alerting the rest of the group. This careful approach was crucial to maintaining the herd's calm and ensuring a successful operation.

7.10.5 Chemical Anaesthesia: Capture and Immobilisation

Prior to the operation, a meticulous check of immobilization and emergency drugs, accessories, and equipment functionality was conducted to ensure a safe and successful capture. Effective capture requires a high degree of expertise, experience, and knowledge of the animal's anatomy, physiology, and behavior. The ultimate success of reintroduction depends on how animals are handled, transported, and cared for after capture, as well as their ability to adapt and thrive in their new environment. Given the dense habitats and size of mega herbivores like gaur, secure capture and tranquilization methods are crucial, necessitating the use of safe and effective techniques to minimize risks and ensure the well-being of both animals and handlers

7.10.6 Drug Delivery

The animals were immobilized using a DanInject (Model JM) syringe projector, delivering a combination of narcotic (Thiafentanil) and neuroleptic (Butyrophenone tranquilizer: Azaperone). This air-pressurized system is renowned for its accuracy, versatility, reliability, safety, and compact design, making it ideal for use in confined areas or from the back of elephants. The device's lightweight and gentle nature minimizes trauma and disturbance to the animals. While the DanInject has an effective range of up to 60 meters, most animals were darted within 30 meters. To ensure efficient drug delivery, all animals were darted in the hindquarters, targeting the large muscle mass in this area.

Thiafentanil oxalate (10mg/ml, ThianilTM, Wildlife Pharmaceuticals (Pty) Ltd.) at a dose rate of 0.007 – 0.013 mg/kg alongwith Azaperone 80-100 mg of (50 mg/ml, Novecy Pharmacy CC) was used for animal immobilization (Nigam et al. 2014). Azaperone was used as an adjunct to primary anesthetic to hasten smooth induction and recovery and provides tranquilization support to the animal during initial time of capture. The drug has also been reported to counteract some of the respiratory depression caused by opioids and has the advantage of lack of effect upon thermoregulation (Marsboom, 1969)

7.11 Capture and Handling of Gaur

7.11.1 Animal capture and Monitoring

Once the animal was darted, the team remained on the elephants, monitoring its movement and staying in position until the animal calmed down and succumbed to the drugs, eventually achieving sternal recumbency due to the effective opioid dosages. The animal was then approached quietly and slowly from the rear, avoiding direct eye contact and staying partially concealed by vegetation, to minimize stress. From a safe distance, the response of the individual was observed by making little noise and tapping on its back with a long stick. Once the animal was sufficiently sedated, it was carefully restrained

by grasping both horns and hindquarters and rolled back into sternal recumbency to aid in induction. To further reduce stress, blindfolds were used to cover the eyes and earplugs made of cotton were used to prevent auditory stimulation. Throughout the procedure, vital physiological parameters such as respiration rate, pulse rate, and rectal temperature were closely monitored, with oxygen supplementation provided to stabilize the animals. The animals' respiration was generally deep and regular, with 16-18 beats per minute, and ear veins and oral mucous membranes were used as reliable external indicators of cardiac and respiratory functions. Notably, none of the immobilizations resulted in hyperthermia during the capture operations.

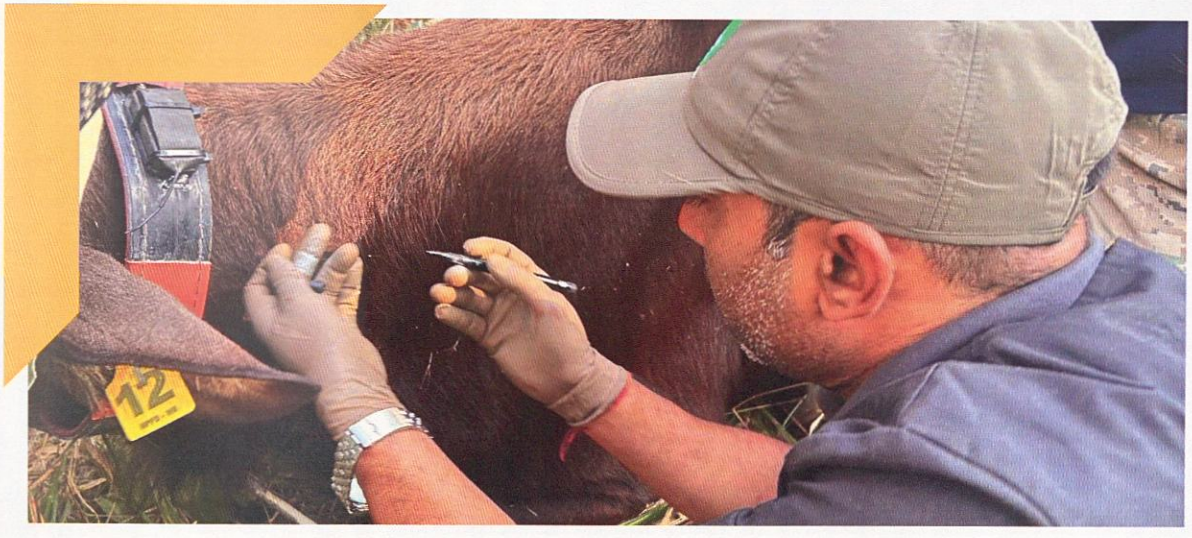
Ketamine was administered intravenously as a supplement and was found to be an effective top-up drug. It demonstrated the ability to induce sedation instantly for safe handling of the gaur and to execute further procedures. To maintain patent airways and prevent the regurgitation of gut content into the trachea, efforts were made to keep the head of the animal high.

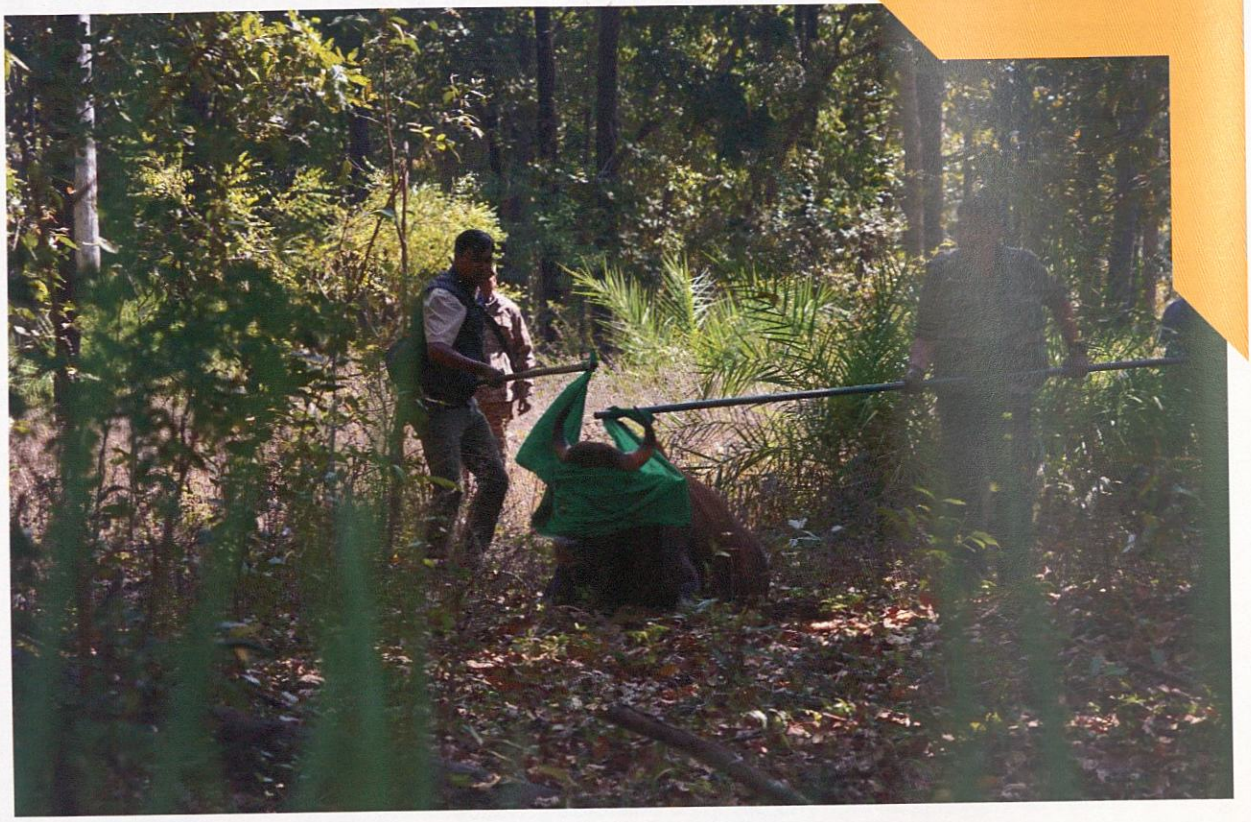
All the captured animals were subjected to Tuberculin testing in immobilized state, intradermal tuberculin test was performed using Purified Protein Derivative (PPD). A Complete physical examination of the animal was done at this stage followed by collection of biological samples for reference. The biological samples would be sent to field laboratory for basic tests and if required to School of Wildlife Forensics and Health, Jabalpur.

7.11.2 Biological Sampling and Animal Collaring

Simultaneously, Biological sampling was carried out for disease screening, health evaluation and for genetic studies for health profiling. The samples collected included:

- Blood in vacutainers (both plain and EDTA) for haematology, serum biochemistry, serology and genetic studies
- Dung sample in preserved 10% formalin for parasitic load assessment and diet analysis
- Hair sample without preservatives for genetic and forensic study
- Nasal swab for culture
- Sample collection kit: Sample collection vials, vacutainers (plain and EDTA), storage/ shipment, boxes, ice packs, tapes, Zip lock bags etc.





7.11.3 Animal Collaring and Body Measurements

A total of 8 VHF (Very High Frequency) radio collars were strategically deployed on the captured animals, enabling real-time monitoring and tracking of their movements. Additionally, 3 animals were fitted with LoRa (Long Range) devices, which provide extended range and efficient data transmission capabilities. To facilitate visual identification and monitoring, all animals were marked using a combination of external marking methods, including color-coded neck bands (except for 6 individuals that were fitted with VHF collars), numbered ear tags, and numbered horn rubber sleeves. Furthermore, body length measurements were meticulously recorded for each animal. To ensure their safety during transportation, horn tips were carefully fitted with protective tubes, effectively preventing potential injuries and minimizing stress.

7.11.4 Animal lifting, weighing and loading

After stabilization, the animals were carefully and gently transferred onto a stretcher, where they were positioned in sternal recumbency to ensure their safety and comfort. To prevent any movement or injury, the animals were securely fastened to the stretcher using ropes. Each animal was then weighed to record accurate body weight, a crucial piece of data for monitoring and care. The stretcher was subsequently loaded onto a support vehicle, which transported it to the main transport truck. The entire immobilization procedure, from darting to loading, was efficiently completed in under 30 minutes, minimizing stress and risk to the animals. Once the animals were safely loaded onto the transport truck, they were maintained in sternal recumbency to ensure their stability and comfort. To reverse the effects of the immobilizing agent, the antidote naltrexone was administered, helping to facilitate a smooth recovery

7.11.5 Translocation

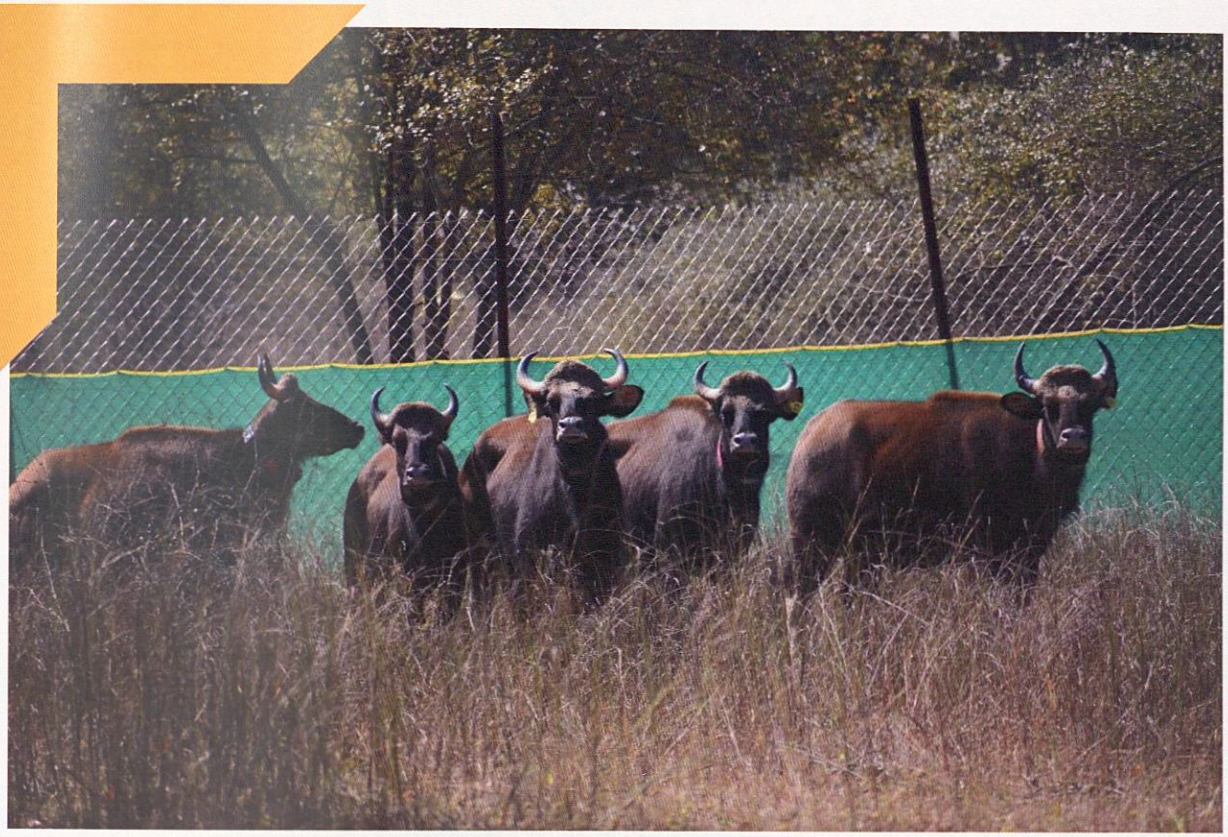
To ensure safe and stress-free transportation, each truck carried 2-5 animals per trip, with individuals placed in separate compartments to minimize aggression and stress. Adult bulls and cows were kept apart, with bulls separated from cows to prevent aggression and reduce stress on the females. Transportation was typically scheduled during late evening hours, taking advantage of cooler

temperatures and reduced human and vehicle disturbance, which also allowed for planned early morning releases at Bandhavgarh Tiger Reserve. However, animals captured in the early morning were translocated promptly to minimize holding time. During the journey, drivers maintained a uniform speed to avoid sudden jerks, and animals were continuously monitored for comfort and safety, with measures taken to prevent injuries. Notably, the majority of animals remained calm and showed no obvious signs of distress, indicating the effectiveness of the transportation strategy. The distance between Satpura and Bandhavgarh was approximately ~570 km and it took an average of 16 -18 hours to reach the release site (Annexure III).

7.11.6 Animal release

Upon arrival at Bandhavgarh Tiger Reserve, the truck containing the animals was carefully positioned at the off-loading ramp within a secure enclosure. The animals were initially released into a smaller 2-hectare enclosure situated within a larger 20-hectare enclosure, allowing for close monitoring of their health and adaptation. Once deemed stable, they were released into the larger enclosure, where supplementary feeding was provided to support their physical conditioning and acclimatization to the new environment. Between February 20th and 23rd 2025, a total of 23 gaur (18 females and 5 males) were successfully translocated from Satpura Tiger Reserve to Bandhavgarh Tiger Reserve. Unfortunately, one

sub-adult female (ID: BF-8) succumbed to traumatic injuries sustained during transportation, due to aggressive adult cow during journey.



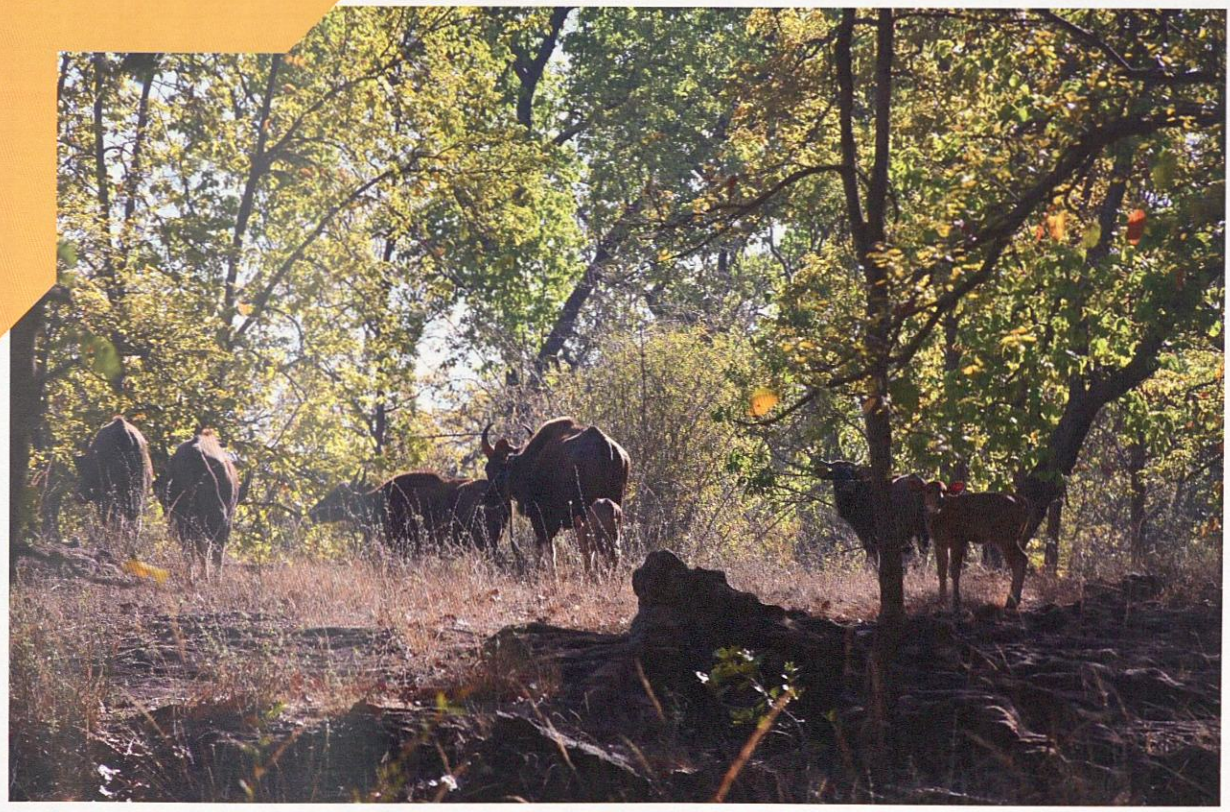


Table 7.1: Details of the animals captured and translocated from Satpura Tiger Reserve

Sr. No.	Capture Date	Capture ID	Sex	Estimated Age (in years)	Age Class	Colour Coded Bands / VHF Collar	Ear tag number	Release in 2 ha. Enclosure
1	20-02-2025 (Morning Hours)	BF-1	Female	5-6	Adult	VHF: 150.450 MHz,	01 (Y)	21-02-2025
2		BF-2	Female	6	Adult	Red Band (with D47 LORA device)	02 (Y)	
3		BF-3	Female	8-9	Adult	Brown-Blue Band (VHF: 150.600 MHz)	03 (Y)	
4		BM-1	Male	5-6	Adult	Orange Band	04 (Y)	
5		BM-2	Male	2.5-3	Sub-Adult	VHF: 150.800 MHz	01 (O)	
6	20-02-2025 (Evening Hours)	BF-4	Female	4-5	Adult	Yellow Band	05 (Y)	21-02-2025
7		BF-5	Female	3-4	Adult	Sky Blue-Yellow Band (VHF: 150.900 MHz)	06 (Y)	
8		BF-6	Female	4-5	Adult	Green Band	08 (Y)	
9	21-02-2025	BF-7	Female	3-4	Adult	Red-Green Band	07 (Y)	22-02-2025
10		BM-3	Male	2.5-3	Sub-Adult	Brown-White Band (with D29 LORA device)	03 (O)	
11		BM-4	Male	1.5-2.5	Sub-Adult	No markings	04 (O)	
12		BF-8*	Female	1.5-2	Sub-Adult	No markings	09 (Y)	
13	22-02-2025 (Morning Hours)	BF-9	Female	3-4	Adult	White Band	10 (Y)	23-02-2025
14		BF-10	Female	4-5	Adult	Brown Band (with D39 LORA device)	12 (Y)	
15		BF-11	Female	4-5	Adult	Pink Band	13 (Y)	
16		BF-12	Female	5-6	Adult	VHF: 150.150 MHz	14 (Y)	
17		BF-13	Female	4-5	Adult	Red-Blue Band	15 (Y)	
18		BF-14	Female	4-5	Adult	VHF: 150.400 MHz	16 (Y)	
19	22-02-2025 (Evening Hours)	BF-15	Female	2.5-3	Sub-Adult	Yellow-Red Band	05 (O)	23-02-2025
20		BF-16	Female	2.5-3	Sub-Adult	VHF: 149.610 MHz	19 (Y)	
21	23-02-2025	BF-17	Female	2.5-3	Sub-Adult	White-Blue Band	20 (Y)	24-02-2025
22		BM-5	Male	5-6	Adult	VHF: 149.510 MHz	06 (O)	
23		BF-18	Female	4-5	Adult	Blue-Green Band	23 (Y)	

BF-8* Succumbed during the transportation owing to traumatic injuries

Y: Yellow colour; O: Orange colour

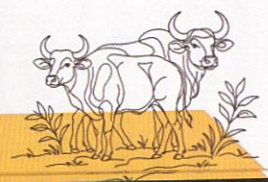
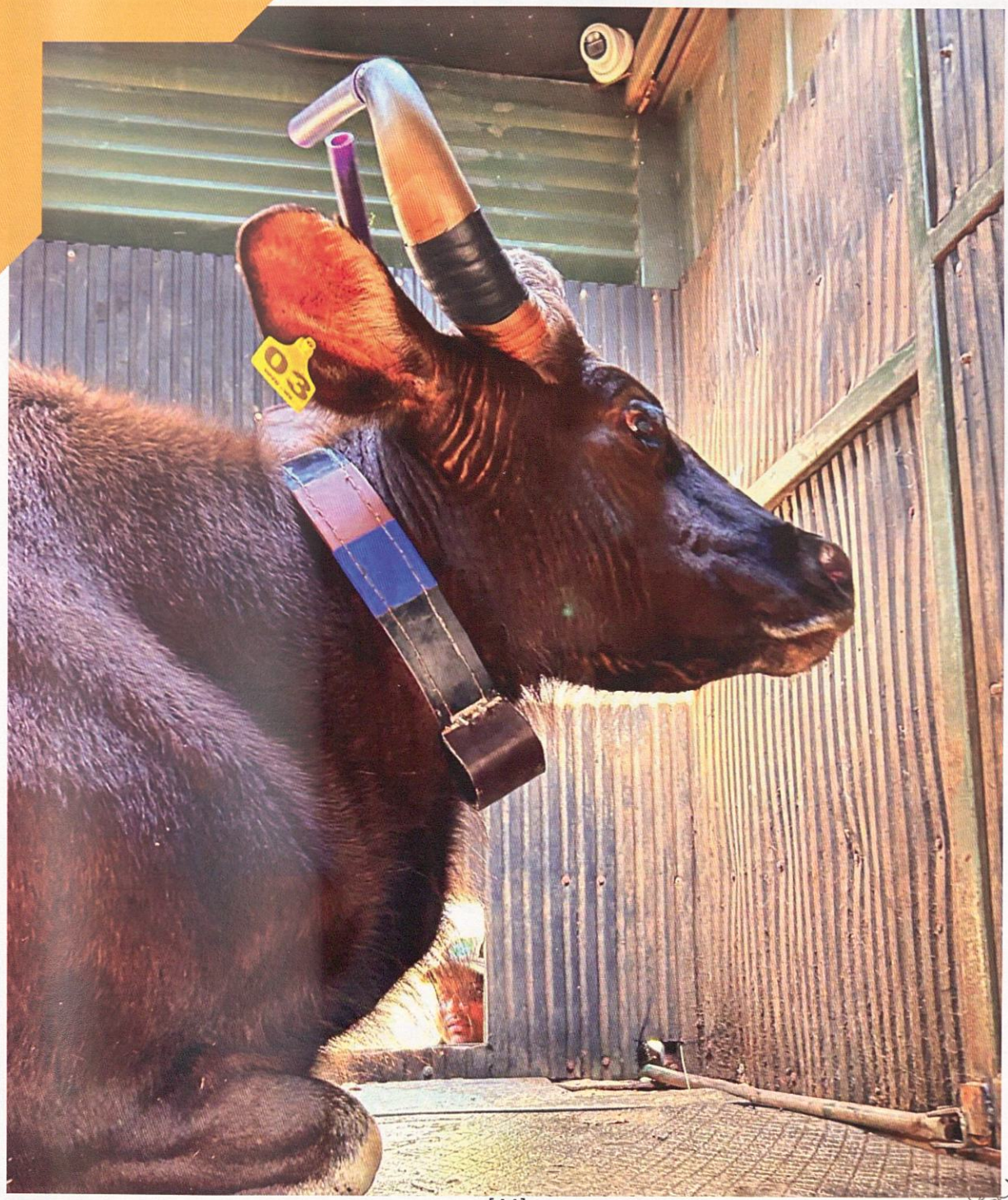


Table 7.2: Summary of Collars

Identification Type	Total Individuals
VHF collar	08 individuals
LoRa devices (with colour coded neck bands)	03 individuals
Colour coded neck bands	11 individuals
Without neck band/ collar	01 individual (BF-8* Succumbed during the transportation owing to traumatic injuries)



CHAPTER - 8
POST TRANSLOCATION PHASE

8.1 Inside the Soft Release Enclosure

Continuous monitoring of the translocated animals' behavior and health was essential to gauge their well-being and adaptation to the new environment. The animals' health was assessed through regular observations of their body condition, which initially indicated a low state due to the stress of translocation. However, with the provision of supplemental feeding and access to natural vegetation in the larger enclosure, the animals gradually regained their physical condition, demonstrating the effectiveness of the post-translocation care and management strategy.

8.2 Release in the Wild

After allowing the translocated gaur sufficient time and space to acclimate to their new environment and establish social bonds within the soft release enclosure, the animals were finally released into the wild on March 31st, 2025. Following their release, intensive post-release monitoring was conducted to track the herds' movements, behavior, ecology, food habits, and integration with the existing gaur population in Bandhavgarh Tiger Reserve. To facilitate individual identification and monitoring, the animals were marked with distinctive VHF collars, unique color-coded neck bands, numbered ear tags, and horn sleeves. Specifically, males were fitted with orange ear tags, while females were marked with yellow ear tags, enabling researchers to easily distinguish between sexes and track individual animals.

8.3 Post-Release Monitoring

Post-release monitoring of the translocated gaur has been an ongoing endeavor since their introduction to Bandhavgarh Tiger Reserve, with a commitment to continue tracking their progress until 2027. A dedicated team comprising researchers from the Wildlife Institute of India and frontline staff from BTR has been meticulously monitoring the radio (VHF) collared gaur, gathering valuable information into their behavior, habitat utilization, and adaptation to the new environment. Upon locating an individual, the team records a range of critical data, including habitat type, terrain, geographical coordinates, herd size, and individual activity patterns. Focal observations are also conducted to elucidate the dietary preferences of the species in their new habitat, providing essential information on their foraging behavior and ecological niche. These observations are systematically carried out during daylight hours, between 0600 and 1800 hours, ensuring a comprehensive understanding of the gaur's daily activity patterns and habitat use.

8.3.1 Tracking Methods

The team employs homing-in and triangulation techniques to track the radio-collared gaur. The individuals with colour-coded neck bands (but without radio collar) are tracked by following indirect signs such as hoof marks. Homing-in, is a standard method for locating VHF-collared animals by moving towards the radio signal until the individual is visually observed (White & Garrott, 1990). This technique allows direct verification of movement patterns, habitat use, and behaviour while ensuring minimal disturbance to the

animal. A handheld receiver (model: Telonics TR8 & TR4) and directional antenna are used for triangulation (Kenward, 2001). The researchers establish three fixed receiver stations during each tracking session and record bearings in the direction of the strongest signal. The intersection of these bearings provides an estimated location when direct visual confirmation is not possible (Millspaugh & Marzluff, 2001).

8.3.2 Tracking Animals

In instances where terrain and visibility permit, researchers follow the animals after locating them via VHF signals (Laver & Kelly, 2008). Behavioural observations are conducted using systematic focal sampling, recording movement patterns, social interactions, and environmental variables such as vegetation cover and elevation (Powell, 2000).

8.3.3 Field Data Recording

The following data is recorded during each tracking session:

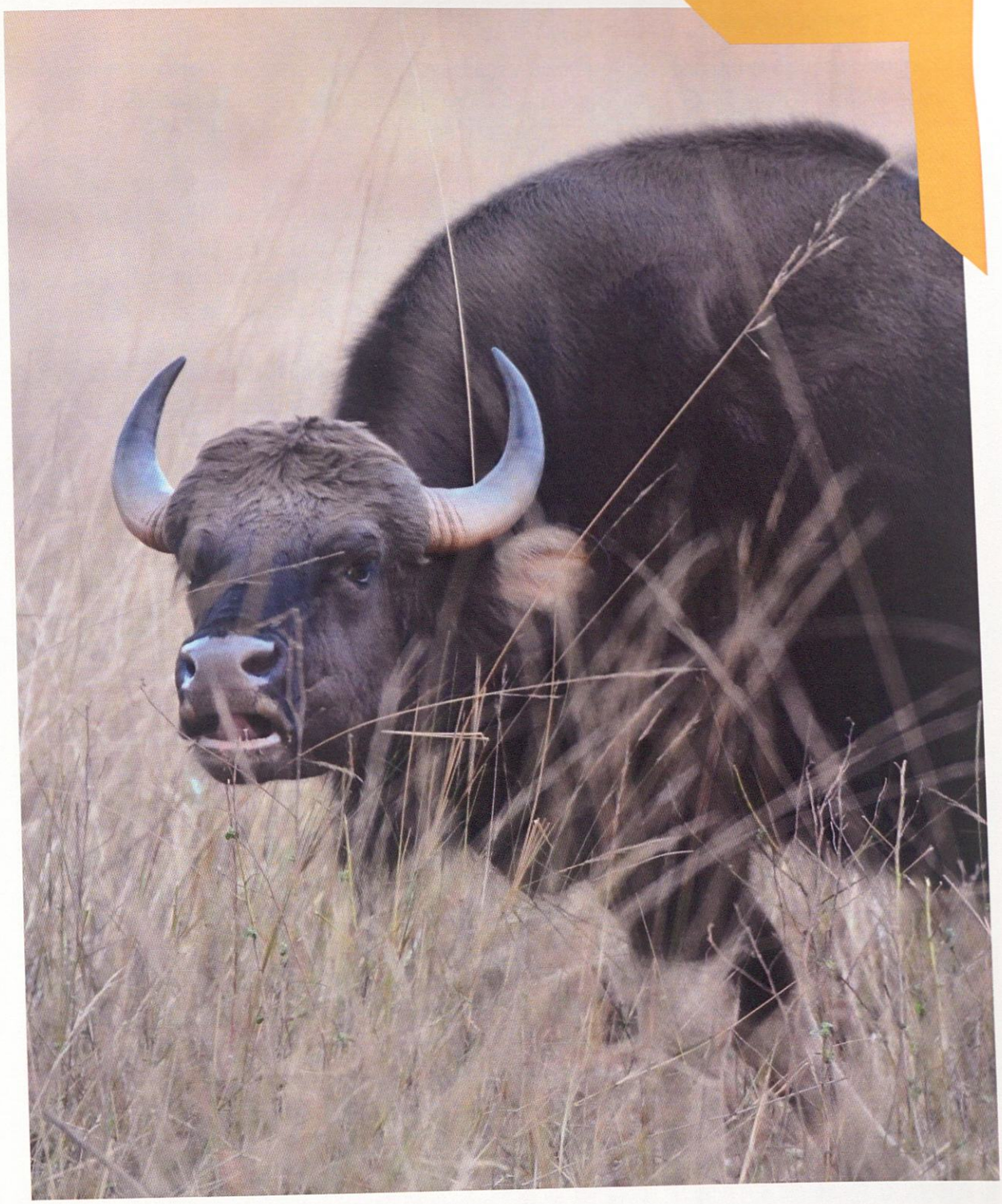
a) Time & Date: All location fixes are time-stamped to analyse diel movement patterns (Samuel & Fuller, 1996).
b) GPS Coordinates: Verified locations are logged using a handheld GPS device (Seaman & Powell, 1996).
c) Habitat Variables: Vegetation type, elevation, and proximity to water sources are recorded (McLoughlin et al., 2004).
d) Animal Behaviour: Resting, feeding, or traveling behaviour is noted, along with social interactions if observed (Moorcroft et al., 2006).

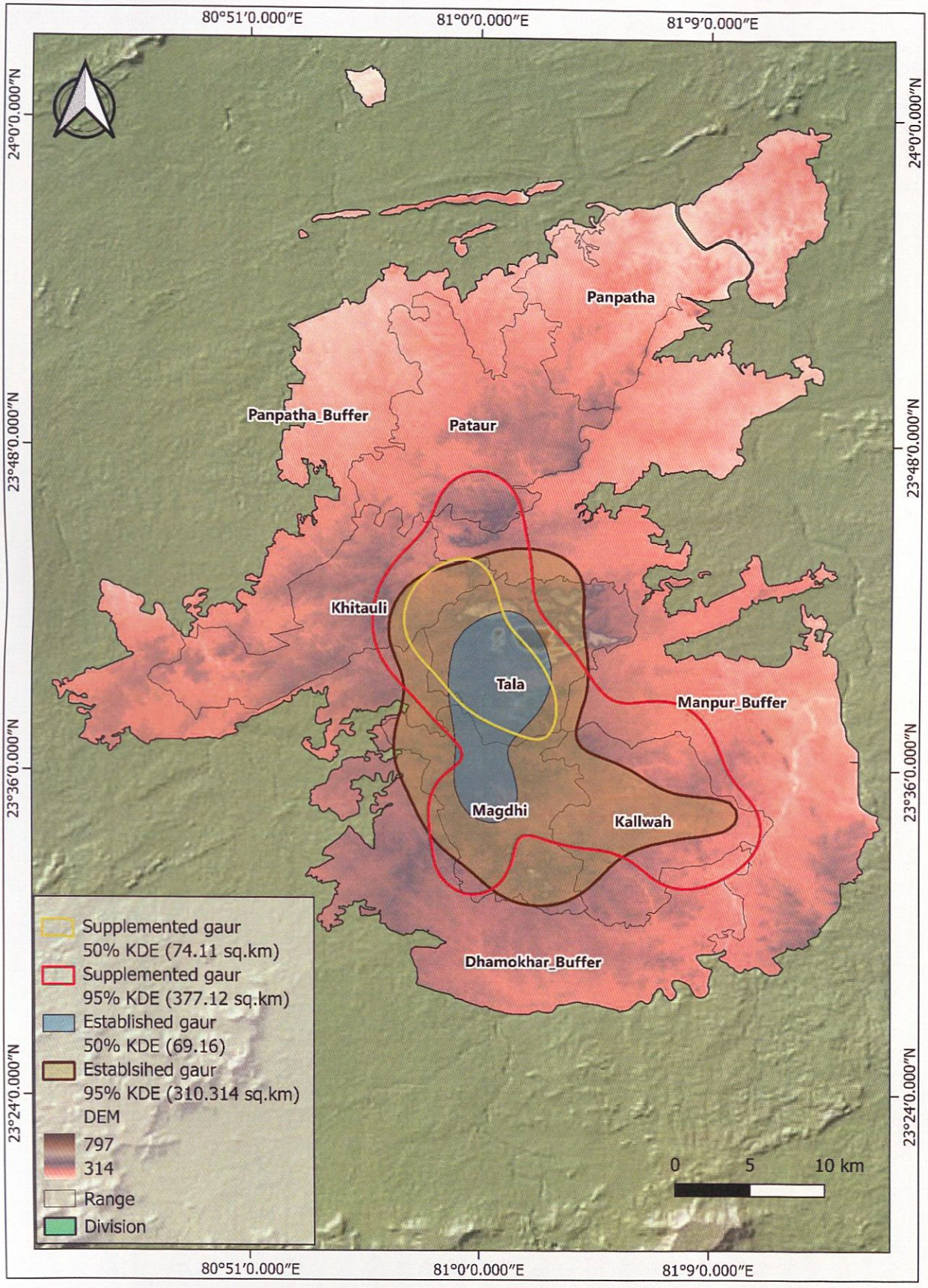
To ensure the accuracy and reliability of the tracking data, the monitoring team has conducted test tracking sessions to assess potential signal interference caused by terrain or habitat features, such as dense vegetation, hills, or valleys (Cochran & Lord, 1963). This proactive approach enables the team to identify and mitigate any technical issues that may impact the quality of the data. Furthermore, to minimize observer bias and ensure consistency in data collection, the monitoring team has standardized procedures across all personnel involved in the fieldwork, following established protocols and guidelines (Kenward, 2001). By adopting a rigorous and systematic approach to data collection, the team has ensured the validity and reliability of their findings, ultimately contributing to a more comprehensive understanding of the gaur's behavior and ecology.

8.4 Result

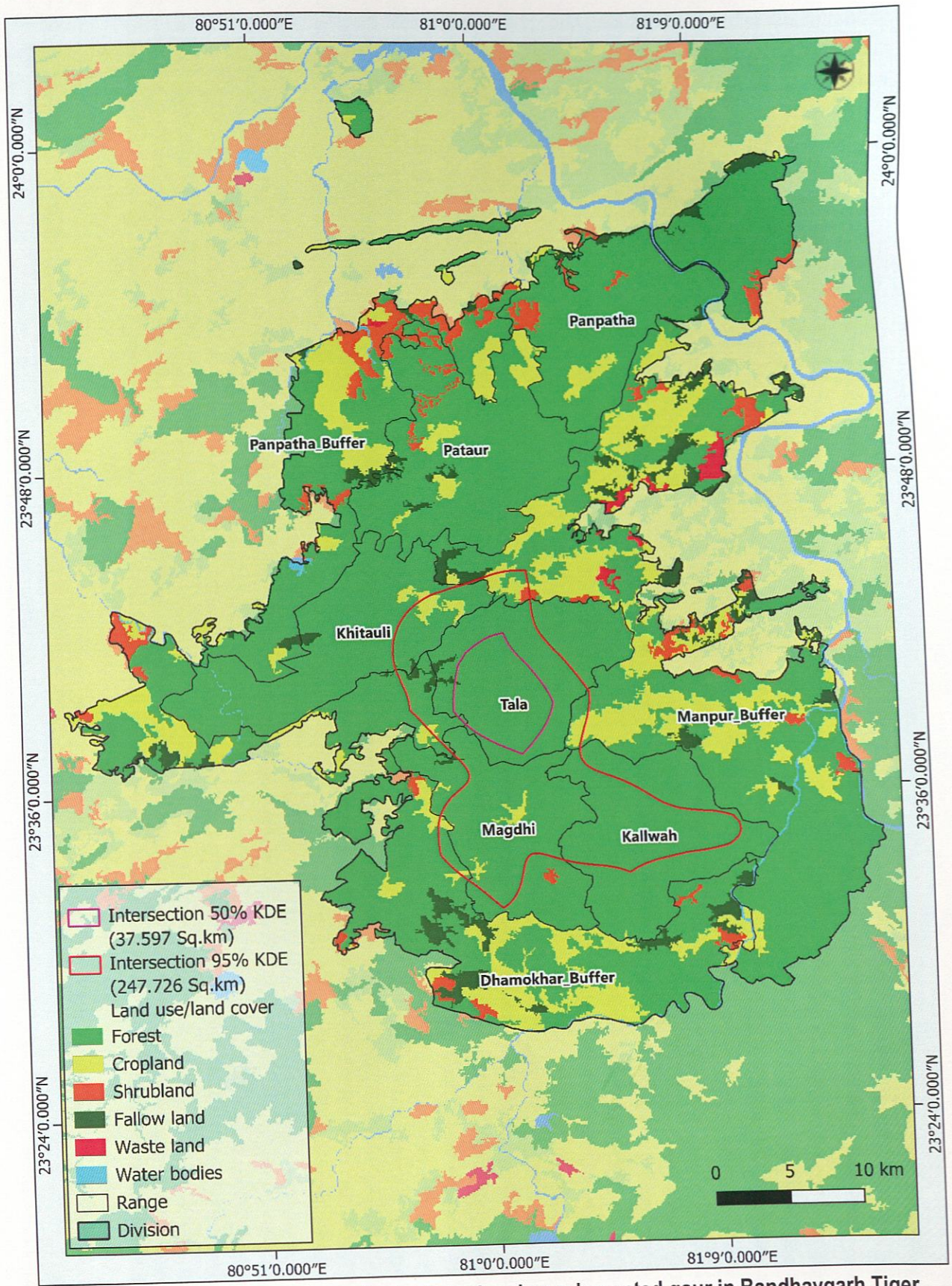
The supplemented animals are still in the exploration phase and have moved across four ranges (Kallwah, Khitauli, Magdhi, Tala), including the release site (Kallwah Range) of Bandhavgarh Tiger Reserve. The translocated gaurs have formed six distinct groups (Table 8.2) and have been observed sharing resources with the existing gaur population. Three gaur individuals have given birth, while one mortality (sub-adult female) and one missing calf have been recorded in the supplemented population. During the first month post-release, the gaur individuals explored an area of 377.12 km^2 (95% KDE) and core area of 74.11 km^2 (50% KDE). In comparison, the already existing gaur population occupied an area of 310.34 km^2 (95% KDE) and a core area of 69.16 km^2 (50% KDE). The area of spatial overlap between the supplemented and established gaur population is 247.73 km^2 (95% KDE) with a core area of 37.597 km^2 (50% KDE) (Map 8.1 & 8.2).

The supplemented gaur is primarily utilizing dense forests and open grasslands that offer ample fodder, water and minimal disturbance. Their recorded diet comprises of 12 floral species, including *Dendrocalamus strictus, Shorea robusta, Diospyros melanoxylon, Gardenia latifolia, Ziziphus sp., Madhuca latifolia, Phoenix acaulis, Butea superba, Sida cardifolia, Saccharum spontaneum, Heteropogon contortus, Aristida sp.*





Map 8.1: Explored area of established and supplemented gaur in Bandhavgarh Tiger Reserve



Map 8.2: Common habitat use of established and supplemented gaur in Bandhavgarh Tiger Reserve

8.5.1 Post release movement and signs of integration

Immediately after the release, the supplemented gaur dispersed across the Tala, Kallwah, Magdhi and Khitauli ranges of Bandhavgarh Tiger Reserve (Map 8.1). During the initial dispersion period, majority of the supplemented animals-maintained group cohesion among themselves. Although forage areas of the supplemented and existing gaur populations overlapped, no interactions were recorded between the two groups during the reporting period from (31 March - 15 June 2025). Internal fission-fusion were observed within the supplemented population, with temporarily established subgroups exploring new environments. This suggests that prior familiarity had ensured group cohesion in supplemented population during the initial exploration period as observed through the daily observation and monitoring of the released animals.

Although the spatial ranges of the supplemented and existing gaur populations overlapped, temporal partitioning in habitat use was evident, indicating limited integration between and within the populations. While occasional group-level associations were observed, social interactions predominantly occurred within the supplemented individuals. This pattern suggests a gradual integration process, likely influenced by pre-established social bonds formed during the soft-release phase and the lack of prior familiarity with the resident population.

8.5.2 Conclusion

During the initial month of post-release monitoring in the open forest, the translocated gaur's social dynamics were largely confined to their own group, with limited interaction observed between the supplemented and existing populations. Ongoing monitoring efforts aim to capture the evolving dynamics between the two groups, including potential integration and fission-fusion patterns within mixed subgroups. Regular observations will provide valuable insights into the translocated population's adaptation and social structure, shedding light on their ability to integrate with the existing gaur population.

8.6 Population status and Distribution

Since the translocation, three cows gave birth and one calf witnessed mortality/ missing; one sub adult female was succumbed during the transportation owing to traumatic injuries.

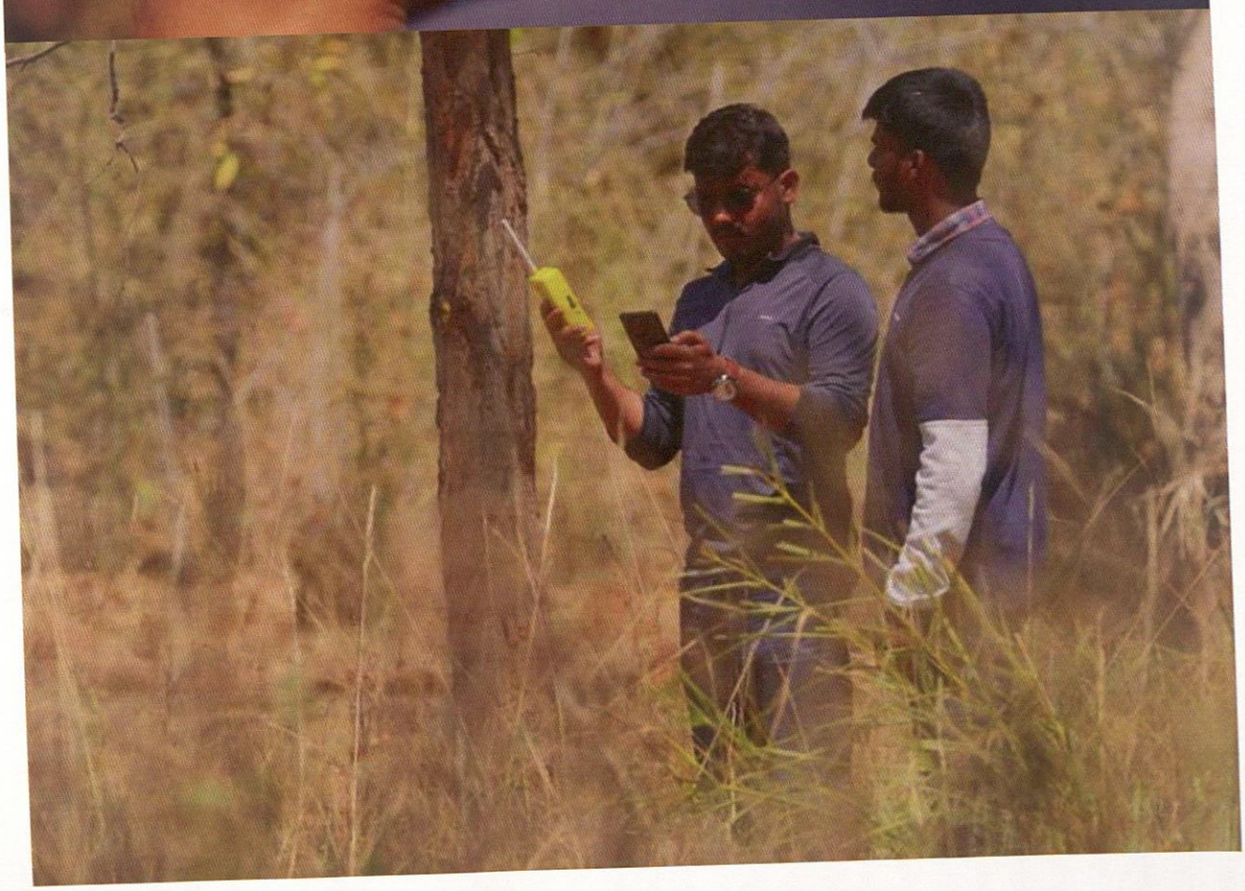
No. of Animals Translocated	Adult / Sub Adult Mortality	Natality	Calf Mortality/ Missing	Total Population*
23	1	3	1	25

*Calf Mortality/ Missing information is not included in the total population

Distribution of supplemented gaur population

Herd	No. of Individuals	Beat	Range	Remarks
1	3	Bhatan	Tala	
2	3	Chechpur	Kallwah	
3	13	Kallwah N	Kallwah	
4	1	Kallwah N	Kallwah	Integrated with the resident gaur population
5	1	Gohari N	Tala	Exploring alone
6	1	Magdhi N	Magdhi	Integrated with the resident gaur population

Table 8.2 Beat-vis distribution of gaur supplemented gaur in Bandhavgarh Tiger Reserve



CHAPTER - 9
FUTURE STRATEGIES

Following the release of the animals into the open forest, a collaborative research team from the Wildlife Institute of India (WII) and Bandhavgarh Tiger Reserve (BTR) staff conducted continuous monitoring efforts. Radio-collared individuals were tracked using a mobile receiver and antennae, employing triangulation and homing-in methods to determine their locations. Meanwhile, individuals without radio collars were monitored through indirect signs, such as tracking hoof marks and other field signs. The habitat utilization patterns of the animals were estimated using the Minimum Convex Polygon (MCP) method, the details of which are provided in Chapter 8

Future research will focus on understanding habitat use, selection, and availability for individually tracked gaur in Bandhavgarh Tiger Reserve. A comprehensive approach will be used to study habitat use, seasonal distribution patterns, and home ranges. By combining ground tracking, VHF collars, and marking techniques (color-coded neck bands, ear tags, and horn sleeves), the research team plans to study the coexistence and interactions between the supplemented and existing gaur populations. Specifically, we will identify shared areas and determine the temporal sequence of use, providing insights into the dynamics between the two populations

The second phase of the capture and translocation of animals is planned for winter season (November and December), which involves capture of individuals from identified herds in Churna and Bori ranges of Satpura Tiger Reserve. This season provides ideal environmental conditions for capturing animals when animals also usually move towards the lower elevations.

The gaur supplementation initiative in Bandhavgarh Tiger Reserve stands has proved to be a successful conservation efforts, with 23 individuals successfully translocated during Phase I of the capture operation. The capture process adhered to stringent protocols, ensuring the safety and well-being of the animals. Following capture, the gaur were housed in a specially designed enclosure, allowing them to recover from the tranquilization, form social bonds, and acclimate to their new environment. After a month-long acclimatization period, the animals were released into the open forest, where intensive monitoring by a collaborative research team from the Wildlife Institute of India and frontline staff from Bandhavgarh Tiger Reserve is ongoing. This monitoring effort aims to elucidate the species' ecology and inform future conservation translocations. To date, the translocated gaur have explored four ranges within the reserve, namely Tala, Kallwah, Magdhi, and Khitauli. The success of this initiative is attributed to the tireless efforts and dedication of conservation practitioners, veterinary officials, stakeholders, forest officials, and frontline staff, whose collaborative endeavors have made this conservation effort possible.

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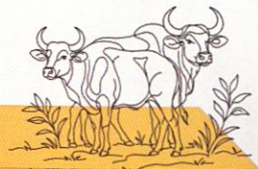

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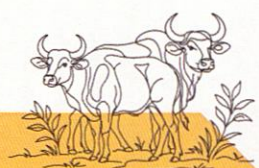


Annexure I: Permission Letters

F. No. WL-1/15/2023-WL
Government of India
Ministry of Environment, Forest and Climate Change
Wildlife Division

6th Floor, Vayu Wing,
Indira Paryavaran Bhawan,
Jor Bagh Road, New Delhi - 110003.

Date: 8th February 2024

The Chief Wild Life Warden,
Madhya Pradesh Forest Department,
Bhopal.

Sub: Request for permission for translocation of 50 Gaurs from Satpura TR to Bandhavgarh TR- reg

Sir,

Reference is invited to the letter dated 25.01.2024 from the Chief Wild Life Warden, Madhya Pradesh seeking this Ministry's permission for the translocation of 50 Gaurs from Satpura Tiger Reserve to Bandhavgarh Tiger Reserve in Madhya Pradesh under the Wild Life (Protection) Act, 1972.

In this context, the undersigned is directed to convey the permission in accordance with proviso under Section 12 of the Wild Life (Protection) Act, 1972 to translocate 50 Gaurs from Satpura Tiger Reserve to Bandhavgarh Tiger Reserve in Madhya Pradesh subject to the following conditions:

i. The capture, chemical immobilization, and translocation shall be undertaken strictly under the supervision of the State Forest Department.
ii. Adequate veterinary care shall be ensured at all stages of capture, chemical immobilization, and translocation and all should be done with utmost caution.
iii. Due care shall also be taken to avoid post-capture complications.
iv. It shall be ensured that minimal trauma is caused to the Gaurs during the entire operation.
v. There shall be regular monitoring during and after the capture and translocation by the Chief Wild Life Warden/State Forest Department and quarterly reports shall be submitted by the Chief Wild Life Warden to the Ministry.
vi. The reports on all the previous capturing and translocation exercises in which the prior approval was given by the Ministry shall be sent to the Ministry through the Chief Wild Life Warden, Madhya Pradesh before making any further request.
vii. In case of any mis-happening during the process, that endangers or may endanger the safety of the Gaurs, the Ministry may review/revoke the permission given.

The Chief Wild Life Warden may take further needful action in this regard.

Yours faithfully,

Signed by
Rakesh Kumar Jagenia
Date: 08-02-2024 07:48:10

(Rakesh Kumar Jagenia)
Deputy Inspector General of Forests (WL)
E-mail: digwl-mefcc@gov.in

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

कार्यालय प्रधान मुख्य वन संरक्षक, (वन्यजीव) एवं मुख्य वन्यजीव अभिरक्षक, मध्यप्रदेश
भू-तल, सी-ब्लॉक, वन भवन, लिंक रोड नम्बर-2, तुलसी नगर, भोपाल-462003
दूरभाष : 0755-2674206, 2524275. *E-mail: pccfwl@mp.gov.in*

क्रमांक/व.जी./प्रबंध/08/ 8898 भोपाल, दिनांक : 20 / 9 /2024

प्रति,

निदेशक,
भारतीय वन्यजीव संस्थान,
देहरादून, उत्तराखंड।

विषय :- Initation of Project: "Population Management Strategies for Gaur (*Bos gaurus gaurus*) Conservation: Supplementation of Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh" : reg.

संदर्भ :- आपका पत्र क्रमांक/WHM/ Vet/ 395/BTR/Gaur Project Phase II (Ext) दिनांक: 03.09.2024 एवं कार्यालयीन पत्र क्रमांक/8020 दिनांक: 10.09.2024 तथा आपका पत्र क्रमांक/WHM/Vet/ 395/BTR/Gaur Project Phase II (Ext) दिनांक: 18.09.2024.

उपरोक्त विषयांकित संदर्भित पत्र का अवलोकन करने का अनुरोध है। जिसके द्वारा बांधवगढ़ टाइगर रिज़र्व में Initation of Project: "Population Management Strategies for Gaur (*Bos gaurus gaurus*) Conservation: Supplementation of Gaur in Bandhavgarh Tiger Reserve, Madhya Pradesh" हेतु सतपुड़ा टाइगर रिज़र्व एवं बांधवगढ़ टाइगर रिज़र्व में फील्ड वर्क कार्य हेतु अनुमति चाही गई है।

उक्त संबंध में कार्यालयीन पत्र क्रमांक/8020 दिनांक: 10.09.2024 से जारी अनुमति को संशोधित करते हुए सतपुड़ा टाइगर रिज़र्व से बांधवगढ़ टाइगर रिज़र्व में द्वितीय चरण में गौरों के स्थानांतरण हेतु 03 वर्ष की अवधि के लिए दिनांक: 21.08.2024 से 20.08.2027 तक फील्ड वर्क करने हेतु **संशोधित** अनुमति इस कार्यालय द्वारा दिनांक: 23.11.2016 को जारी दिशा-निर्देश (छायाप्रति संलग्न) में उल्लेखित 21 शर्तों के अधीन प्रदान की जाती है। उपरोक्त शर्तों का पालन कड़ाई से किया जाये।

संलग्न: उपरोक्तानुसार।

20/9/2024
(व्ही.एन. अम्बाडे)
मुख्य वन्यजीव अभिरक्षक एवं
प्रधान मुख्य वन संरक्षक, (वन्यजीव) म.प्र.

पृ.क्रमांक/व.जी./प्रबंध/08/ 8899 भोपाल, दिनांक : 20 / 9 /2024

प्रतिलिपि:

1. प्रधान मुख्य वन संरक्षक एवं वन बल प्रमुख, मध्यप्रदेश की ओर सूचनार्थ प्रेषित।
2. क्षेत्र संचालक, बांधवगढ़/ कान्हा एवं सतपुड़ा टाइगर रिज़र्व, म.प्र. की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित। उपरोक्त कार्य हेतु भारतीय वन्यजीव संस्थान के सदस्यों/ दल को आवश्यक सहयोग प्रदान किया जाना सुनिश्चित करें।

20/9/2024
मुख्य वन्यजीव अभिरक्षक एवं
प्रधान मुख्य वन संरक्षक, (वन्यजीव) म.प्र.

Annexure II: Data Sheet for Recording and Monitoring Immobilized Animal (Gaur)

Area Details Date .....

Location ..... GPS Lat..... Long.....
....
Purpose of capture .....

Collar Frequency/make/color.....

Ambient temperature ..... Day (cloudy, bright) .....

Animal Details

Species ..... Physical condition .....

Emotional state before drugging ..... Sex .....

Approximate age ..... Breeding status .....

Weight (kg) Estimated ..... Actual.....

Immobilization Details

Name of Immobilizing Drug/ Concentration	Time of Injection	Total volume	Mg used	Route & site
1.				
2.				
3.				

Behavior at the time of darting (running, walking, standing, excited)

Induction time Ataxia.....min, dropping of head.....min, Incoordination and Sternal recumbency.....
. Min (Right/left), Salivation (present/ absent), Any other observation.....

Sequence of events following darting till animal is approached (Sequence of event) .....
.....
.....

Animal Monitoring

Time	Observations following Immobilization	Respiration Shallow/ deep/ irregular & rate	Rectal temp. (^{0}F)	Pulse (rate)	Oxygen saturation/ Capillary filling time/ Mucus membrane

Name of reversal Drug(s)	Time of Injection	Mg used and & volume	Route	Site
1.				
2.				

Details about recovery event till animal regains consciousness /shows signs of recovery
.....
.....
.....

Name of other supportive Drug(s)/antibiotic(s) etc. given	Volume used	mg used	Route & site
1			
2.			
3.			

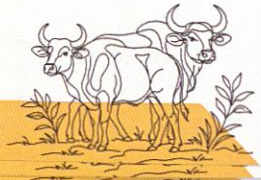
Biological sampling

Name of sample	Preservative used	Examination required	Handed over to	Remarks

Team:

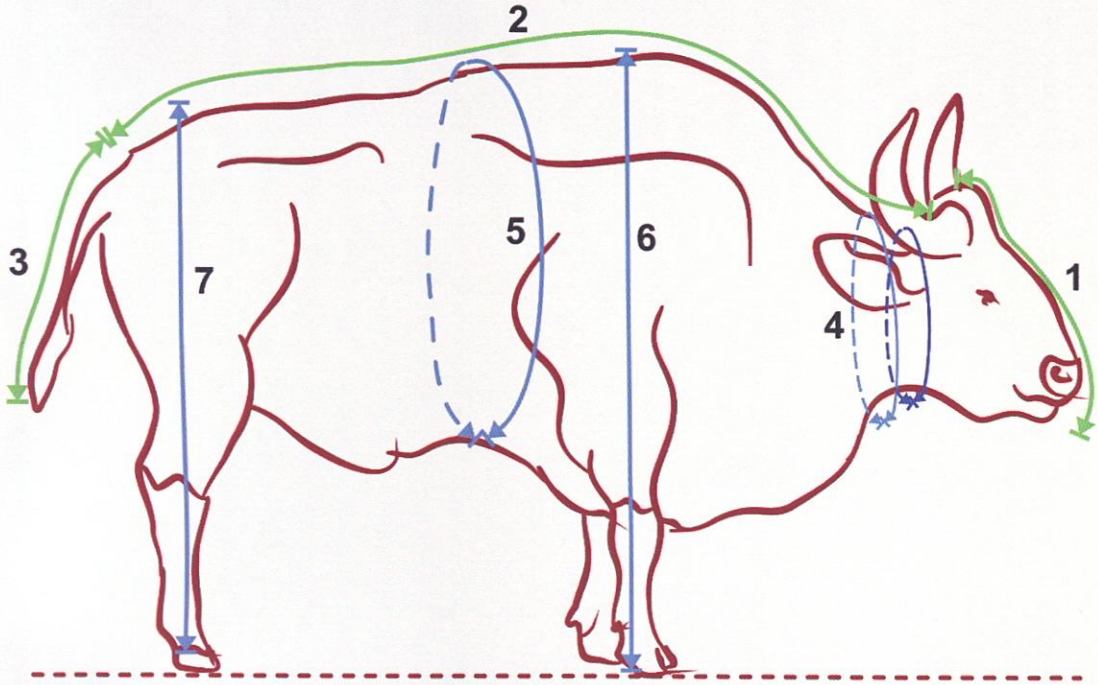
Comments:

Signature :

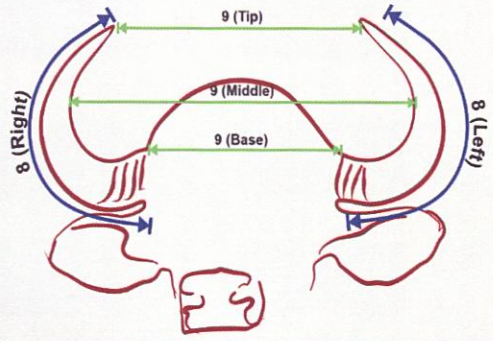


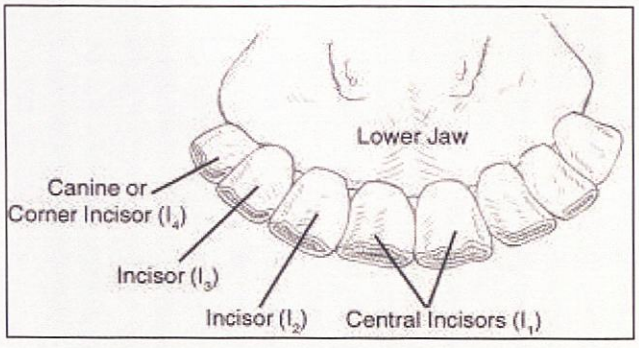
Body Measurements

1. Nose tip to Base of Occiput.....
2. Base of Occiput to base of tail .....
3. Tail length.....
4. Neck girth (U).....M).....(L).....
5. Chest girth .....
6. Height (Shoulder blade to heel) .....
7. Hind limb length .....



8. Horn length (R) .....(L).....
9. Horn spread .....
10. Testicular Dimensions.....
11. Hoof condition .....
12. Skin condition.....
13. Dentition/wear & tear I ----, C ----, PM ---, M ---
14. Identification marks: Scar and location/ Ear tear/etc. .....
.....





Annexure III: Route Map