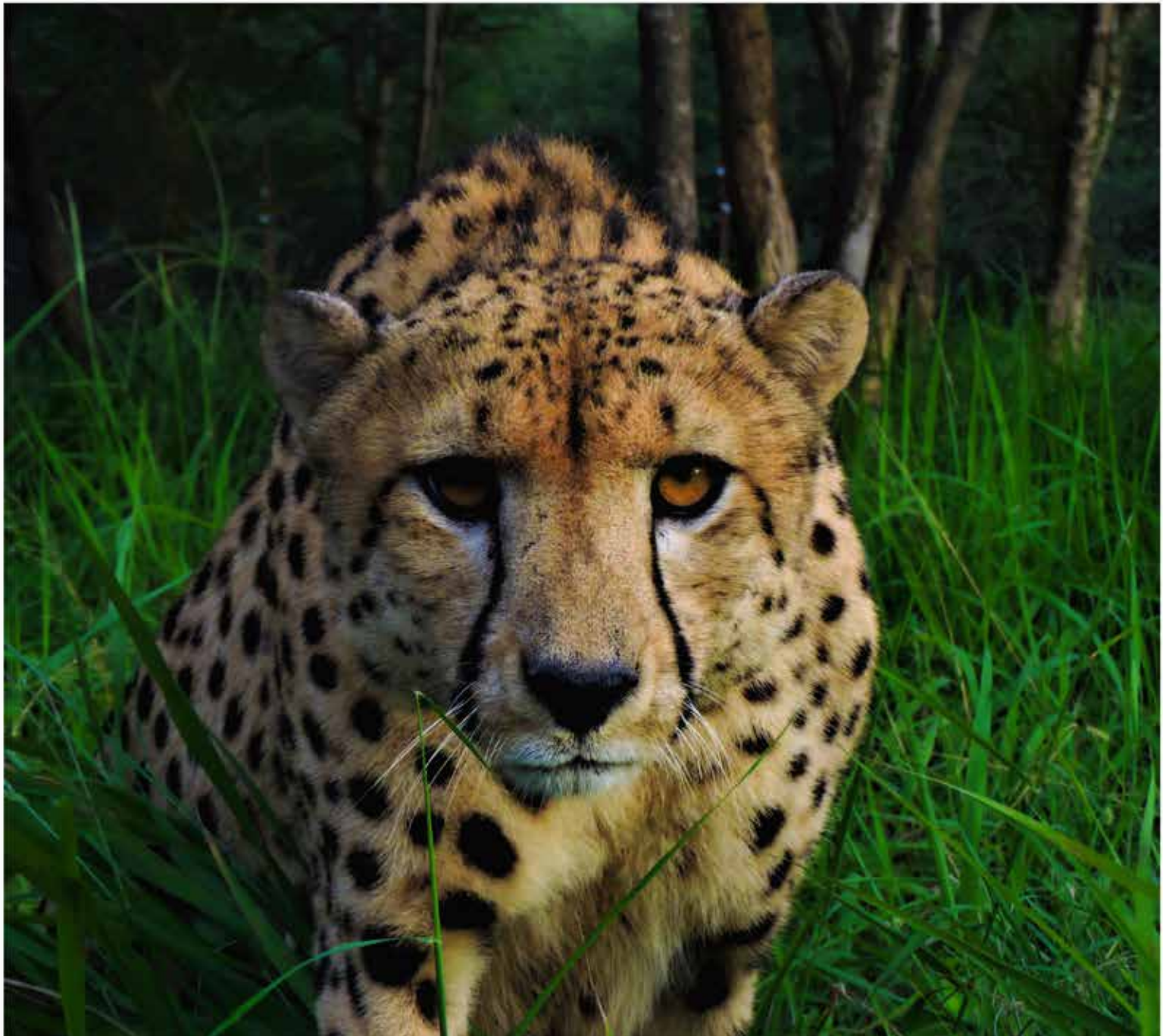


ACTION PLAN FOR INTRODUCTION OF

CHEETAH

IN GANDHISAGAR WILDLIFE SANCTUARY,
MADHYA PRADESH





Action plan for introduction of

CHEETAH

in Gandhisagar Wildlife Sanctuary, Madhya Pradesh



National Tiger Conservation Authority, Wildlife Institute of India & Madhya Pradesh Forest Department (2024). Action plan for introduction of cheetah in Gandhisagar Wildlife Sanctuary, Madhya Pradesh. Technical Report. New Delhi, Dehradun & Bhopal.

Cover photograph : Moulik Sarkar

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1. INTRODUCTION

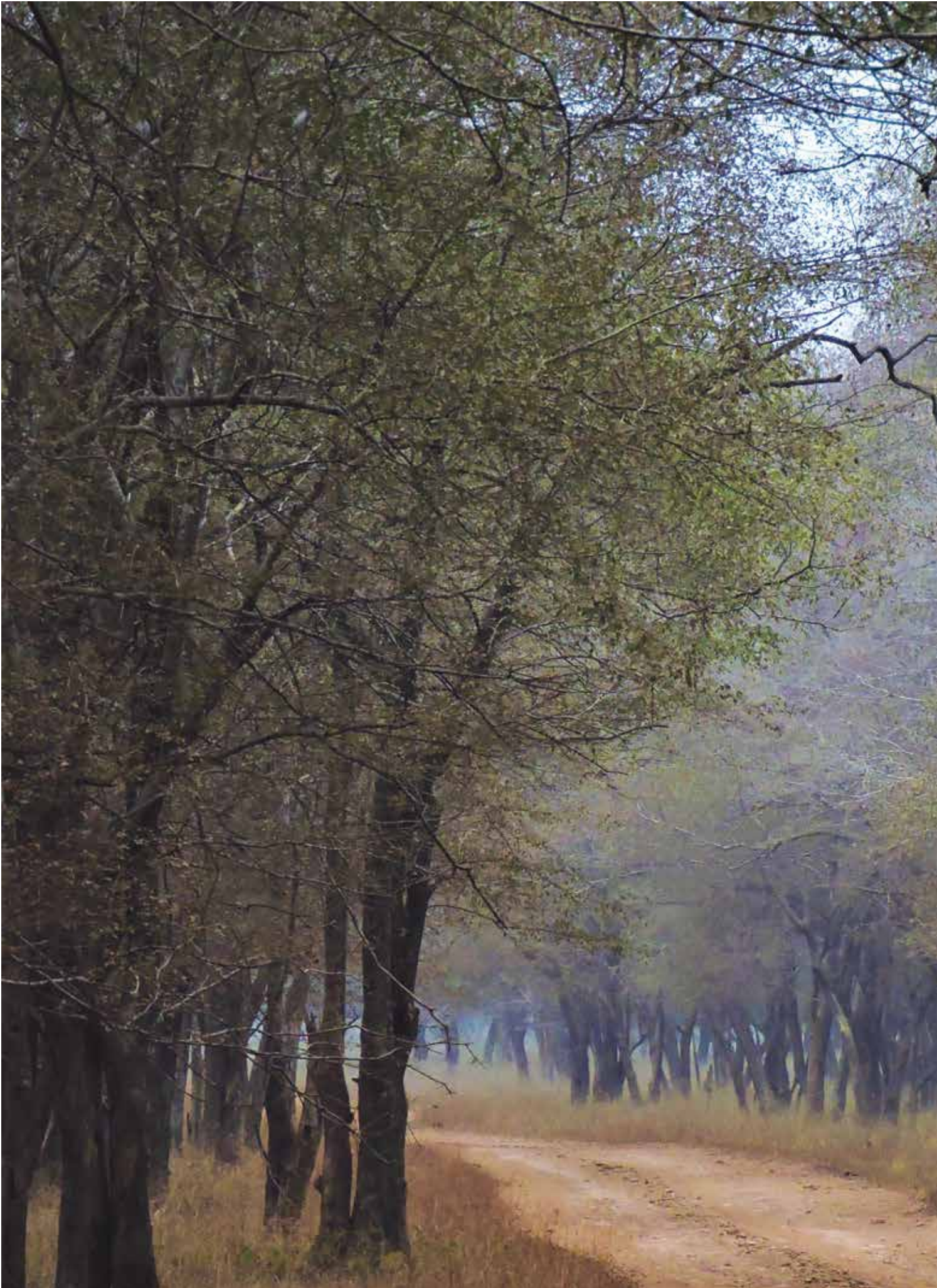


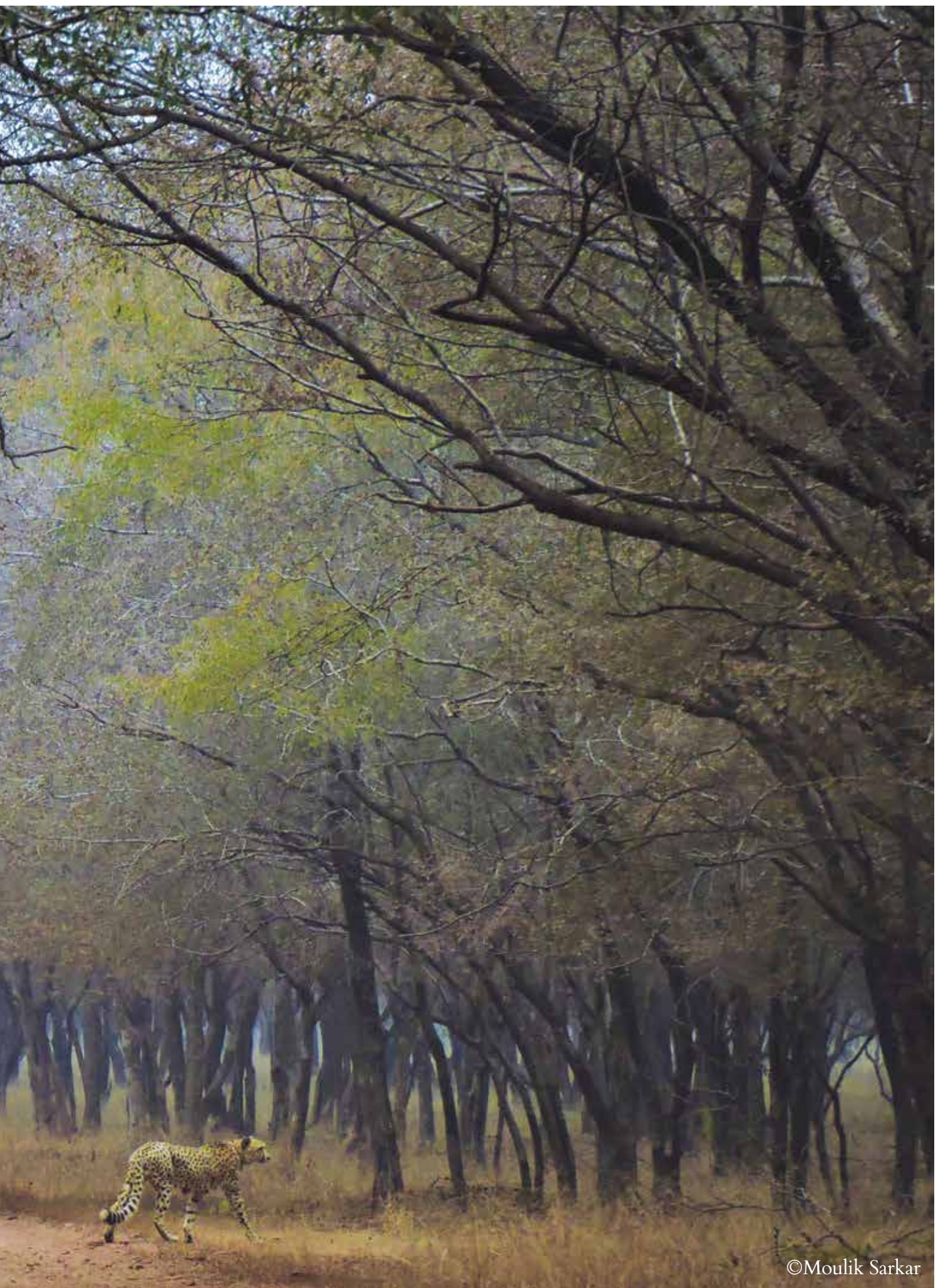
1. INTRODUCTION

Nearly 75 years after their extinction from India, cheetahs (*Acinonyx jubatus*) were brought back in a first-ever intercontinental wild to wild conservation translocation of a large carnivore in September 2022. Hon. Prime Minister of India released a batch of eight cheetahs in Kuno National Park, Madhya Pradesh, that were transported by air from Namibia. Subsequently, in February 2023 another batch of free-ranging twelve cheetahs were translocated from South Africa to Kuno National Park. A natural heritage with historical and cultural significance lost decades ago from the country was brought back to boost as well as highlight India's commitment to biodiversity conservation. In its effort to establish free-ranging population of cheetahs as a flagship to revive country's open natural ecosystems and restore degraded landscapes, India has taken a leading role in addressing biodiversity loss and mitigation of climate change that the world is currently facing.

Worldwide concern for the conservation of large carnivores is grounded in their vital ecological roles. These apex predators play important roles in maintenance of ecosystem structures and functioning. Beyond their ecological significance, these charismatic animals play a pivotal role in economies worldwide. They serve as flagship species, drawing tourists to regions for wildlife viewing, which, in turn, bolsters local economies through ecotourism. Furthermore, large carnivores often hold cultural and symbolic value for indigenous communities and societies. Nevertheless, most of the large carnivores face an array of threats. Habitat loss and fragmentation due to human activities isolate carnivore populations, while poaching and illegal wildlife trade pose grave dangers against their population persistence. Human-wildlife negative interactions, often leading to livestock depredation and retaliatory killings, are prevalent almost globally. Climate change further complicates the situation by altering prey distribution and habitat conditions. The world is currently witnessing an unprecedented level of concern for the conservation of large carnivores and their ecosystems (Mech 1996, Schaller 1996, Weber & Rabinowitz 1996). However, despite these efforts, the numbers and range of most large carnivores are still declining (Dinerstein *et al.*, 2007, Karanth & Chellam 2009). A significant endeavor to combat and possibly reverse this decline involves the reintroduction and conservation translocation of large carnivores that have disappeared from their historical ranges (Breitenmoser *et al.*, 2001). Reintroductions/conservation translocations of large carnivores have increasingly been recognized as a strategy to conserve threatened species and restore ecosystem functions. However, reintroductions/conservation translocations are not easy tools to implement without robust scientific understanding since such efforts have seen both successes and failures (Smith & Bangs 2009, Johnsingh & Madhusudan 2009).

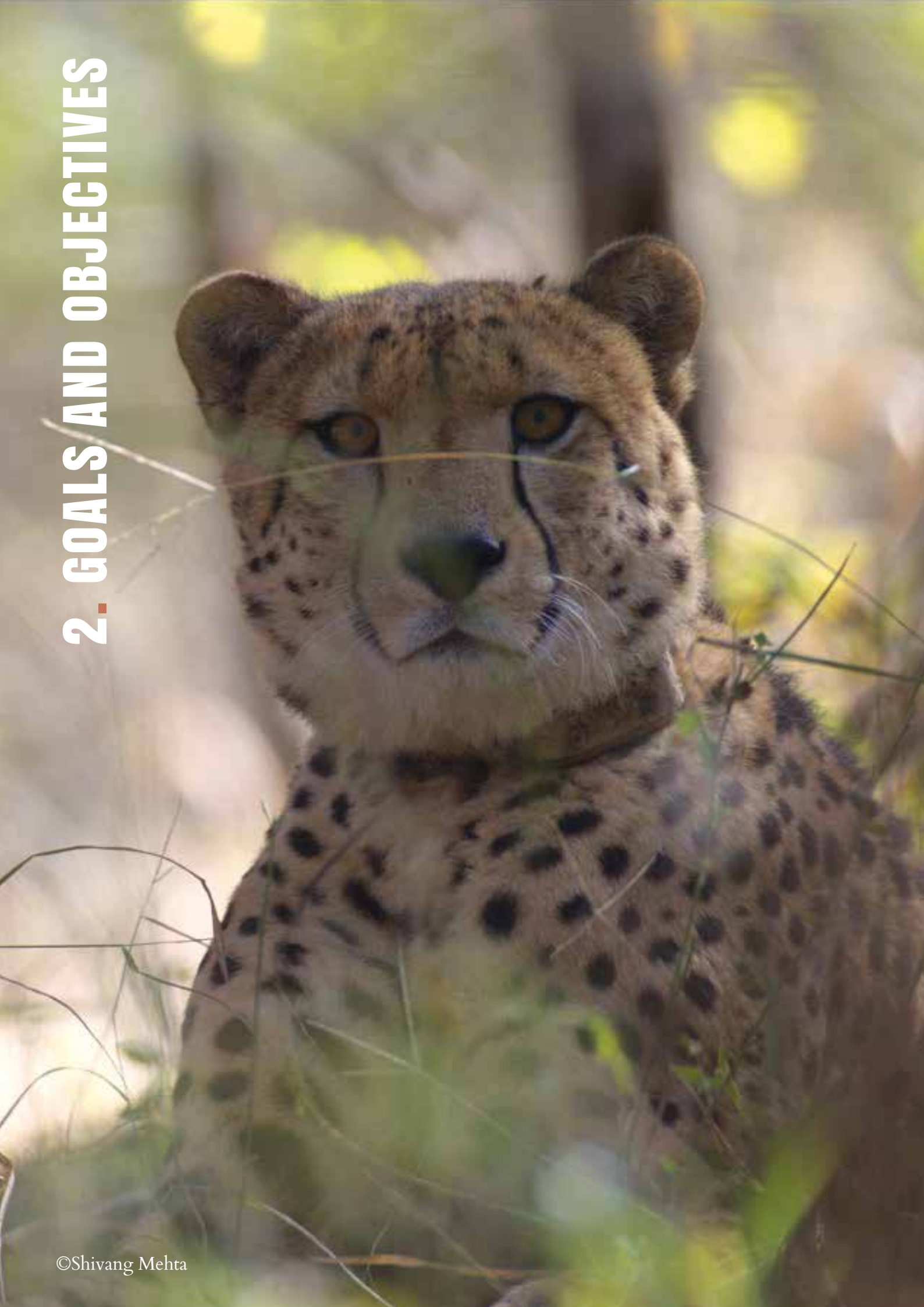
The first action plan for introduction of cheetahs in India (Jhala *et al.*, 2021) based on IUCN guidelines on reintroductions and conservation translocations (2013) formulated in a scientific framework incorporating various biological and social considerations is being used as a road map for establishing viable cheetah metapopulation in India. With more than a year of bringing back cheetahs to India, various initial challenges, learnings and insights of cheetah ecology and management have been understood and internalized as part of project planning. This work in progress has undergone multiple ebbs and flows with each experience integrated as part of adaptive management agenda of the project. The action plan published in 2021 for establishing cheetah populations in India has provided various aspects and details of the process that were undertaken, and are required, as well as outlined the entire phases and strategies undertaken as well as (for) implementation of this endeavor. Currently, there are 21 cheetahs (13 adults and 8 cubs) in Kuno with two free-ranging individuals. The cheetah population of Kuno landscape (Area~6500 km²) will be managed as metapopulation with three to five other sites including Gandhisagar Wildlife Sanctuary (WLS) in Madhya Pradesh State and the surrounding landscape (Area~ 2500 km²) as envisioned by the action plan for introduction of cheetah in India (Jhala *et al.*, 2021). As per the Population Habitat Viability Analysis (PHVA) for cheetah introduction in India, high probability of long-term cheetah persistence is within populations that exceed >50 individuals or when smaller populations are managed as a metapopulation (Jhala *et al.*, 2021). In the last five decades of establishment of a network of Protected Areas after the enactment of the Wildlife (Protection) Act of India in 1972 and implementation of effective wildlife legislation, as well as a dramatic change in the conservation ethos and awareness in the country inter alia, the original cause for the extinction of the cheetah in India has been adequately addressed (Jhala *et al.*, 2021). The overall management of the cheetah introduction in India is through the Ministry of Forest, Environment and Climate Change (MoEF&CC) and spearheaded by National Tiger Conservation Authority (NTCA) guided by the project steering committee comprised of wildlife experts and implemented in collaboration with the Government and the State Forest department of Madhya Pradesh (& other States) and the Wildlife Institute of India (WII). The next phase of cheetah introduction will be carried out in Gandhisagar WLS. The management and the process have been slightly adjusted and adapted for Gandhisagar WLS as compared to Kuno. In the first phase at Gandhisagar WLS, five to eight cheetahs will be released into a fenced area providing them opportunity to establish a breeding population. The habitat around the fenced area in the Protected Area (PA) and the surrounding areas is being restored in phases and subsequently, animals will be released into free-ranging conditions in Gandhisagar landscape after ecological restoration and prey recovery. The long-term goal is to establish a metapopulation of cheetahs in the Kuno-Gandhisagar landscape (Area~9000 km²) of 60-70 individuals after restorative measures, prey availability and scientific management is ensured. The current action plan, following the broad framework of the earlier action plan for introduction of cheetah in India, has been modified and formulated based on the experiences learnt from Kuno suited for the site-specific requirements of Gandhisagar WLS in consonance with the overarching guidelines of IUCN on reintroductions and conservation translocations (2013).





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2. GOALS AND OBJECTIVES



2. GOALS AND OBJECTIVES

2.1. Goal

Establish viable cheetah metapopulation in India that allows the cheetah to perform its functional role as a top predator and provides space for the expansion of the cheetah within its historical range thereby contributing to its global conservation efforts.

2.2. Objectives

1. To establish breeding cheetah populations in safe habitats across its historical range and manage them as a metapopulation.
2. To use the cheetah as a charismatic flagship and umbrella species to garner resources for restoring open forest and savanna systems that will benefit biodiversity and ecosystem services from these ecosystems.
3. To enhance India's capacity to sequester carbon through ecosystem restoration activities in cheetah conservation areas and thereby contribute towards the global climate change mitigation goals.
4. To use the ensuing opportunity for eco-development and eco-tourism to enhance local community livelihoods.
5. To manage any negative interactions by cheetah or other wildlife with local communities within cheetah conservation areas expediently through compensation, awareness, and management actions to win community support.

2.3. Aims of cheetah Translocation in Gandhisagar Wildlife Sanctuary

The primary aim is to establish a free-ranging population of cheetahs in and around the Gandhisagar Wildlife Sanctuary and the surrounding landscape spanning ~2500 km² in Madhya Pradesh (MP) and Rajasthan. Further, this population in Gandhisagar will be managed as a metapopulation with other two to three established populations of cheetah in India with occasional "immigrants" brought in from Africa, as and when needed.

Within this larger goal, the project will strive to achieve the following objectives:

- a. Provide adequate security and conserve local flora and fauna.
- b. Revive and maintain the grassland and open forest systems existing in the PA and adjacent areas in an optimum productive state and thereby evolve management techniques and practices for better conservation of these habitats.
- c. Build the capacity of the state forest department in the field of habitat and prey management, in view of the emerging needs.
- d. Use the expertise of Madhya Pradesh state forest department in mass translocation of herbivores, particularly blackbuck, nilgai and chital, in view of the emerging need for protection of crops and scientific management of wildlife populations while simultaneously augmenting prey base in Gandhisagar WLS and other cheetah introduction sites.
- e. Conserve and enhance the faunal diversity, especially the threatened species, such as the Indian wolf, rusty spotted cat, smooth coated otter and vultures and provide a future safe haven for even more endangered species such as the black buck, caracal, great Indian bustard and the lesser florican in the larger landscape.
- f. Generate benefits for the local people by creating alternative livelihood through development of wildlife tourism and ancillary activities.
- g. Develop the capacities of the local communities to co-exist with wild animals, particularly large carnivores.

3. Suitability of the Introduction Area



3. Suitability of the Introduction area

3.1. Site Information

Consequent to the decision to initiate the process of cheetah introduction in Gandhisagar WLS, preparations such as construction of a predator proof fence, quarantine setup, enclosures for prey have been completed and establishment of a veterinary setup and other logistics is underway. The WII carried out a fresh assessment of the status of the prey base in December 2023.

Gandhisagar WLS, located on the western border of the Malwa plateau in the central Indian State of Madhya Pradesh, lies on either side of the banks of the Chambal River. Encompassing an area of 368.62 km², with 187.12 km² (East Range) in Mandsaur and 181.5 km² (West Range) in Neemuch Districts, this sanctuary is a vital part of the region's ecosystem and was notified in 1974. The management of the Sanctuary is under the administration of Mandsaur forest division. River Chambal bisects the Sanctuary into almost two equal halves and portions of the southern side is bounded by the reservoir of Gandhisagar dam, whereas on the northern and eastern boundary (~60 km) is the State of Rajasthan. The submergence zone of the reservoir covers a vast area of ~750 km² and provides a natural barrier to the Sanctuary. An area of ~64 km² in the West Range has been cordoned off with predator proof fencing within which the cheetahs will be released during the initial years. Inside the fenced area, predator proof fenced quarantine bomas for holding cheetahs as well as enclosures for prey stocking and breeding have been constructed.

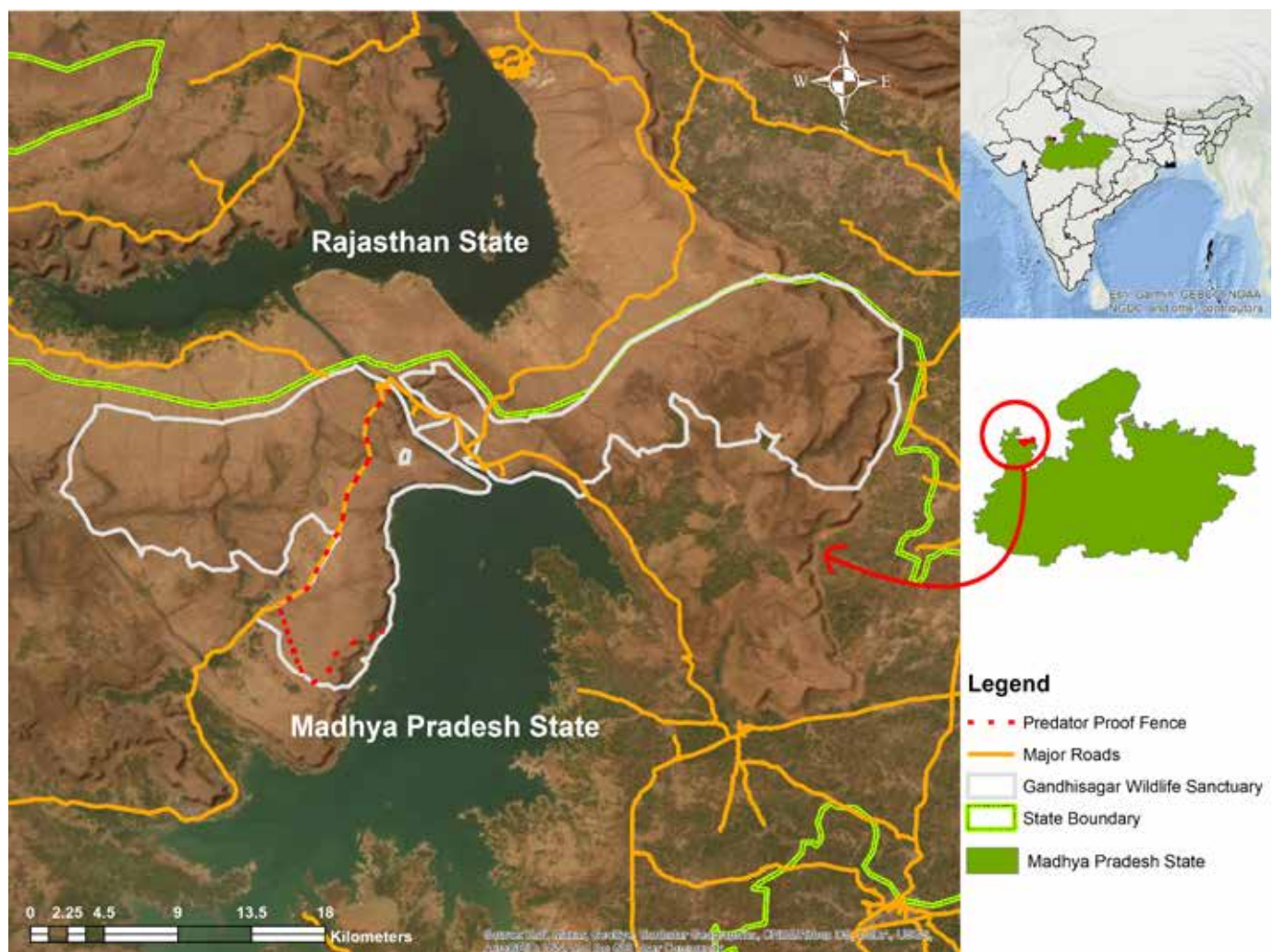


Figure 1. Map of Gandhisagar Wildlife Sanctuary depicting the predator proof fenced area

Situated between 74°13' and 75° 57' east longitude and 23°46' and 25°03' northern latitude, Gandhisagar WLS falls within the semi-arid zone (4b) of the Gujarat-Rajputana biogeographic region (Rodgers *et al.*, 2002). The average maximum sum-

mer temperatures reaching 42°C and the average minimum winter temperatures dropping to 10°C. Annual rainfall ranges from 880 to 1000 mm, essential for sustaining the diverse ecosystem within the sanctuary. The topography of the area is characterized by an average elevation of 300-500 meters above mean sea level. It features a flat rocky plateau top interspersed with river valleys and majority of the area is flat whereas certain parts have mild slopes. The portion abutting the Chambal River gorge has steep cliffs and valleys intermittently scattered along its length. The rocky terrain and exposed sheet rock contribute to the formation of shallow topsoil, creating a predominantly savanna habitat with grasslands dotting the landscape.

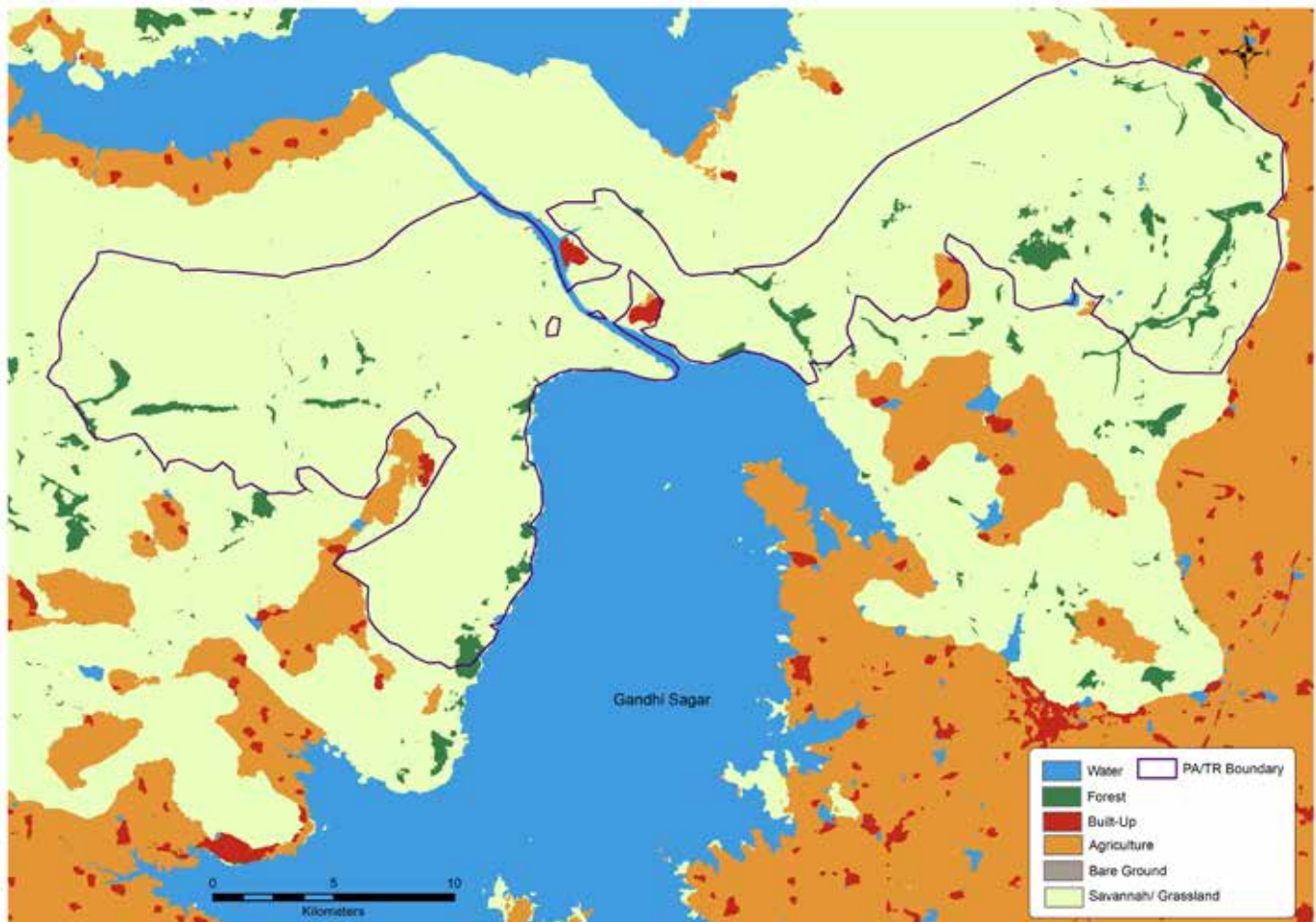


Figure 2. Land cover/ Land use (Karra, Kontgis *et al.*, 2021) Map of Gandhisagar Wildlife Sanctuary

The forest type is northern tropical dry deciduous forest, northern tropical dry mixed deciduous forest and dry deciduous scrub (Champion & Seth, 1968). Gandhisagar WLS boasts of a rich and diverse flora, dominated by species such as *Anogeissus pendula*, *Boswellia serratta*, *Diospyros melanoxylon*, *Zizyphus jujuba*, *Terminalia arjuna*, and *Butea monosperma*. The grasslands are adorned with a plethora of species including *Apluda mutica*, *Cynodon dactylon*, *Dichanthium annulatum*, *Digitariaci liaris*, *Eragrostis spp.*, *Heteropogon contortus*, *Sporobolus diandrus*, *Themeda quadrivalvis*, and *Vetiveria azizanioides*, contributing to the Sanctuary's biodiversity and ecosystem.

In terms of fauna, the Sanctuary is home to a diverse array of species. Mammalian carnivores include leopard (*Panthera pardus*), sloth bear (*Melursus ursinus*), striped hyena (*Hyaena hyaena*), gray wolf (*Canis lupus pallipes*), golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), ratel (*Mellivora capensis*), jungle cat (*Felis chaus*), rusty-spotted cat (*Prionailurus rubiginosus*), Asiatic wild cat (*Felis lybica ornata*), Indian pangolin (*Manis crassicaudata*), Palm civet (*Paradoxurus hermaphroditus*), small Indian civet (*Viverricula indica*) and Indian gray mongoose (*Herpestes edwardsii*). The river harbors smooth-coated otter (*Lutrogale perspicillata*), and marsh crocodile (*Crocodylus palustris*). Additionally, ungulates and herbivorous mammals such as nilgai (*Boselaphus tragocamelus*), chinkara (*Gazella bennettii*), wild pig (*Sus scrofa*), gray langur (*Semnopithecus entellus*), Indian porcupine (*Hystrix indica*), and black-naped hare (*Lepus nigricollis*) thrive in this sanctuary. Vulture species including red headed vulture (*Sarcogyps calvus*), Indian vulture (*Gyps indicus*) and white rumped vulture (*Gyps bengalensis*) are found in this Sanctuary.

Conservation efforts in the Sanctuary are aimed at preserving its rich biodiversity and natural habitat. Various governmental and non-governmental organizations are involved in initiatives focused on wildlife protection, habitat restoration, and community engagement to ensure the Sanctuary's sustainable management. Despite its protected status, the Sanctuary faces

anthropogenic pressures, primarily due to livestock grazing and agriculture along the banks of the Chambal River, which is a major occupation in the region. Additionally, the township of Gandhisagar, centrally located between the two ranges, houses employees of the hydroelectric project of the dam. Furthermore, fishing communities from West Bengal have settled in the region to harvest the fishery sector in the reservoir. Two main roads that run through the Sanctuary are State highway 31A and Rawatbhata- Gandhisagar interstate road. There are about 30 villages within a distance of 10 km from the boundary of the Park. The main communities of people living around the Sanctuary are Bhil, Banjara, Gurjar, Chamar, Thakurs etc. The chief agricultural crops grown in the surrounding areas are wheat, gram, jawar, bajra, dhan, saunf, orange and maize. Some of the farmers also cultivate vegetables. Government regulated cultivation of opium is also prevalent in this area.

The region is culturally very rich with many historical and religious sites situated in and around the Sanctuary. Additionally, the landscape is very scenic and the area has very high tourism potential, however requires proper regulation and management particularly for religious sites inside the Sanctuary. Gandhisagar WLS stands as a testament to the region's rich biodiversity and natural beauty. The vast savannah, grassland and open woodlands in the region with habitat and prey restoration has immense potential for large landscape cheetah conservation in the long-term. Along with the adjoining territorial divisions of Neemuch (Area~1000 km²) and Mandsaur (Area~500 km²) along with Bhainsrodgarh WLS (Area- 208 km²) and territorial division of Chittorgarh (Area~1000 km²) in Rajasthan, a larger habitat of ~2500 km² for the cheetah can be established. The Sanctuary is also connected with Mukundara Hills Tiger Reserve through Bhainsrodgarh WLS and Reserve Forests of Chittorgarh near Rawatbhata. Commitments are required from the Government of Madhya Pradesh for allocation of Neemuch and Mandsaur territorial division as buffer and from the Government of Rajasthan for allocation of Bhainsrodgarh WLS, predator proof enclosure in Mukundara Hills Tiger Reserve and territorial division of Chittorgarh Division for cheetah introduction and its expansion. Efforts towards conservation and sustainable management can ensure that a suitable large landscape area of ~2500 km² potential habitat to be secured as an interstate cheetah conservation complex.



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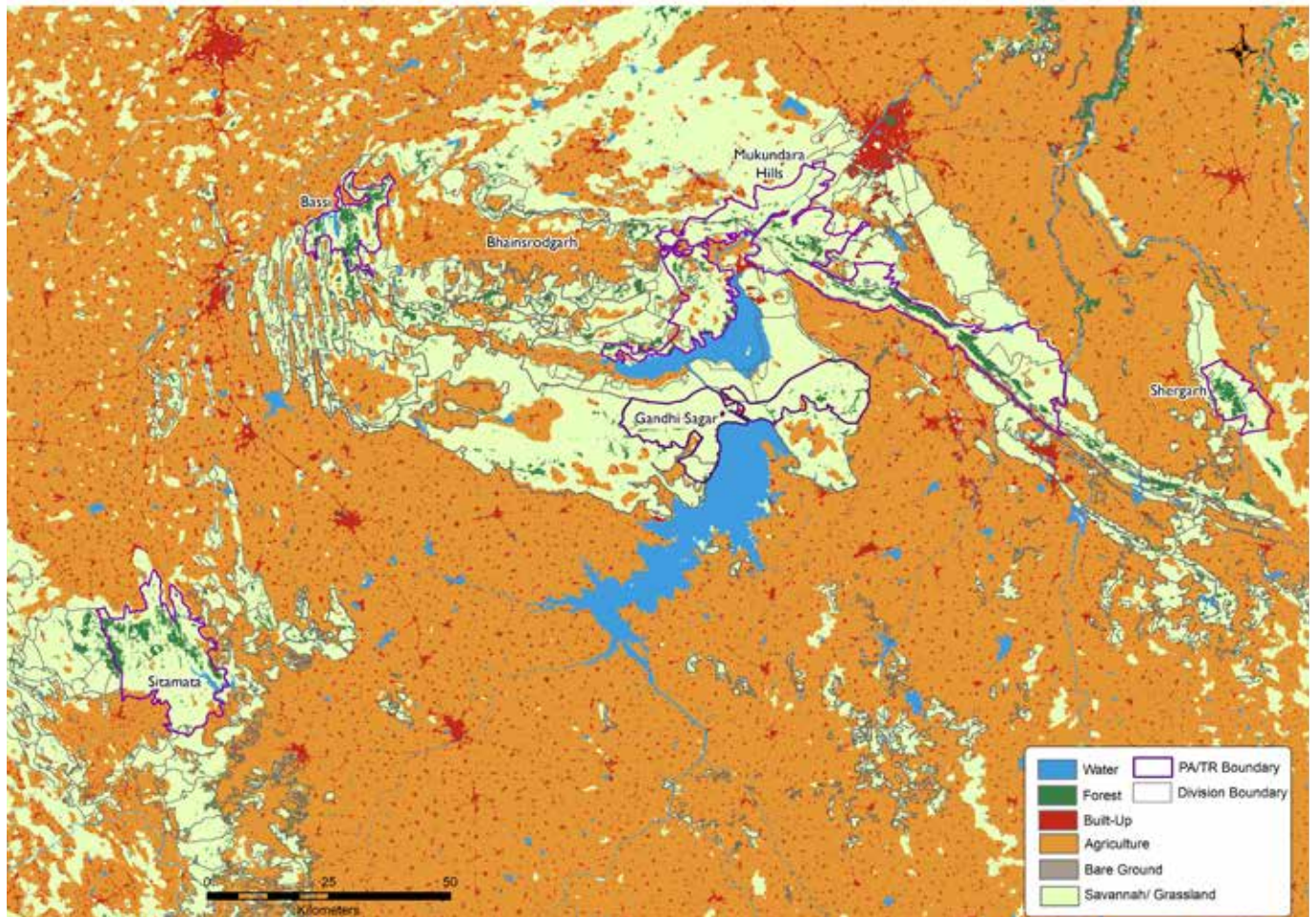


Figure 3. Land cover/ land use (Karra, Kontgis *et al.*, 2021) map of Gandhisagar Landscape spanning an area of 2500 km² potential cheetah habitat.

Table 1: Area in km² of various landcover/ landuse classes (Karra, Kontgis *et al.*, 2021) of Protected Areas and territorial Forest Divisions of Gandhisagar Landscape

PA/Division/TR	Grassland/ Savannah	Forest	Bare Ground	Water	Agriculture	Built-Area
Gandhisagar WLS	359.7349	16.7509	0.0175	2.9593	2.1955	0.3835
Neemuch	1034.8258	60.7083	0.0144	2.9071	85.4318	2.5185
Mandsaur	529.1532	23.1631	0.2144	4.0878	26.7825	0.7417
Chittorgarh	1196.5367	63.8924	0.9567	23.1996	44.9689	6.7891
Bhainsrodgarh WLS	151.63	19.4829	0.0266	5.4712	21.0514	1.937
Mukundara Hills TR	587.9382	88.0174	0.1878	10.6641	39.244	3.6507
Kota	629.957	83.8145	2.0555	13.8405	99.209	26.7543
Total	4489.7758	355.8295	3.4729	63.1296	318.8831	42.7748



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4. ACTION PLAN



4. ACTION PLAN

This Action Plan has been developed in compliance with IUCN guidelines for formulating objectives & actions to achieve the goals of cheetah translocation in Gandhisagar WLS

As per IUCN (2013) guidelines for reintroductions and conservation translocations, any conservation translocation requires clearly defined goals and follow a logical process from initial concept to design, feasibility and risk assessment, decision-making, implementation, monitoring, adjustment and evaluation. Hayward & Somers (2009) have documented various biological and social considerations for designing conservation reintroductions of top-order predators.

Many aspects of this action plan are similar to the earlier action plan for introduction of cheetah in India (Jhala *et al.*, 2021) and additional points that need to be considered for formulating objectives and actions to achieve the cheetah introduction goals in Gandhisagar WLS include:

4.1. Site Assessment and Prey Density of the fenced area in Gandhisagar Wildlife Sanctuary

Gandhisagar WLS (Area- 368km²) is part of a large landscape (2500 km²) in Madhya Pradesh and Rajasthan that has potential to support viable cheetah population. The habitat in the Sanctuary is a mosaic of grasslands, savannah, dry deciduous forests and riverine evergreen patches with good water availability forming an ideal habitat for the cheetah. The latest prey assessment in the Sanctuary was carried out by the WII during 2023 used line transect based (Buckland *et al.*, 2001) DISTANCE sampling (Annexure I).

The predator proof fenced area (64 km²) inside the West Range of Gandhisagar WLS where the cheetahs will be initially released is predominantly a savannah grassland. Chinkara is the most abundant wild prey, with a population density of 7.4 individuals per km². The population density of Nilgai is 4.4 animals per km², wherein, one quarter of the observations comprised of calves. The other prey species found in low numbers are chital, wild pig, langur, peafowl and hare.

For free-ranging cheetah that would serve as a flagship and also perform their ecological role in a restored savannah-woodland system, Gandhisagar WLS-Territorial Divisions of Neemuch, Mandsaur and Chittorgarh-Bhainsrodgarh WLS with parts of Mukundara Hills TR landscape adequately meet the criteria.

4.2. Cheetah Carrying Capacity

Using the latest population densities of potential cheetah prey obtained from distance sampling, the carrying capacity for cheetah (Hayward *et al.*, 2007) was computed. To surrogate the weight of an average prey individual in the population, ¾ female weight was used. For calculating prey biomass, all prey species below weight of 60 kg were considered potential cheetah prey (Hayward *et al.*, 2007, Laurenson *et al.*, 1995). Among large ungulates like nilgai, only part of females and their young (50% of the population) were considered as potential cheetah prey.

Relationship between predator density (log₁₀; x-axis) and prey biomass (log₁₀; y-axis) Preferred prey weight range; $y = -2.641 + 0.411x$ (Hayward *et al.*, 2007) Gandhisagar WLS holds the potential to sustain up to 10 cheetahs based on its existing prey base. The potential cheetah habitat covering about 2500 km² in Gandhisagar landscape has to be secured along with Kuno landscape (Area~6500 km²) with restorative measures and scientific management to provide prey base for sustaining a viable metapopulation of 60-70 individuals in the Kuno-Gandhisagar landscape of ~9000 km². Further, a predator proof fenced area in Bhainsrodgarh WLS similar to Gandhisagar WLS and the existing enclosure with adequate reinforcements in Mukundara Hills Tiger Reserve can act as cheetah source sites and surplus animals from these areas can be released into the larger landscape after it is substantially restored.

Additionally, for prey management in the predator proof fenced area, based on cheetah predation while maintaining a stable ungulate population (Mech 1966, Peterson 1977, Keith 1983, Fuller, 1989), 260 prey animals are required annually to sustain one cheetah using the equation, $N=K/(\lambda-1)$ Where, K is the annual ungulate kill per predator (one kill every 4 days for Cheetah) and λ is the annual finite rate of increase for ungulate population (1.35 for Chital).

In order to sustain 06-08 cheetahs inside the predator proof fenced area, annual requirement is 1,560-2080 prey animals per annum or 26-35 prey animals per km². The current prey availability inside the fenced area is 475 animals and is being augmented with 1500 prey animals such as chital, blackbuck and nilgai.

4.3. Population Habitat Viability Analysis (PHVA)

As described in the earlier action plan for introduction of cheetah in India (Jhala *et al.*, 2021), the cheetahs in Gandhisagar will be managed as a metapopulation with Kuno and other sites. The Population Habitat Viability Analysis (PHVA) showed that the key factors were number and frequency of supplementation of individuals in these sites. The long-term goal is to establish a metapopulation as recommended by the PHVA, of 60-70 individuals in the Kuno-Gandhisagar landscape spanning an area of ~9000 km² after restoration to ensure long-term persistence and genetic diversity.

4.4. Habitat Management

4.4.1. The initial plan is to release a maximum of 06-08 cheetahs inside the predator proof fenced area in Gandhisagar WLS. Subsequently, the surrounding area and the larger Gandhisagar landscape after restoration along with restored Kuno landscape can accommodate about 60-70 cheetahs, which according to the PHVA has to be managed as a metapopulation. To this end, the need of further enhancing the current carrying capacity and prey base of Gandhisagar WLS and the larger landscape is imminent for long-term viability of the cheetah population.

This can be achieved by gradually managing the remaining part of the Gandhisagar WLS (Area~300 km²) and parts (potential cheetah habitat) of the larger Gandhisagar landscape (Area~2,500 km²) and Kuno landscape (Area~6500 km²) for restorative investments for habitat and revival of prey. Leopards are already there in Sanctuary in significant numbers with a population of ~70 individuals in the West Range of Gandhisagar WLS (Annexure II). All the leopards inside the fenced area will be captured and relocated before cheetahs are brought here. Cheetah and leopards can coexist if adequate prey base and other resources are available in other parts of the Sanctuary.

4.4.2. Water availability inside the fenced area is adequate with at least one water source (natural and artificial) at a distance of 04 km from each other. During summer season in this region, water can be a limiting resource and measures were implemented to ensure water availability inside the fenced area during the lean period. Further, water management in other parts of the Sanctuary and the larger landscape with at least one water hole within a radius of 4 km from each other would enhance the use of these areas by prey species and enhance the carrying capacity of the Sanctuary and the larger landscape. Grasslands will be managed by deterring growth of woody species to promote natural prey base for cheetahs and leopards and other endangered wildlife species of the region.

Continuous efforts would be undertaken to eradicate weed species like *Lantana camara*, *Prosopis juliflora*, *Cassia tora*, *Ageratum conyzoides*, and *Eupatorium spp.* from the grasslands. Another threat is the encroachment of grasslands by unpalatable species, which can reduce the area of productive grasslands (Rawat 2003). Woody tree growth would be regularly thinned to enable the existence of savanna-grasslands as an arrested successional stage, to promote high density of wild ungulates.

4.4.3. Fire incidences are minimal in Gandhisagar WLS. However, measures to prevent fire are in place as part of park management. Non-timber Forest Produce (NTFP) collection and incidence of fire would be managed through increased surveillance and regulation. With conservation investments in Kuno since 1990s (with the objective of lion reintroduction); situations were probably better and easier for cheetah introduction therein. However, Gandhisagar may need a lot more financial inputs.

4.4.4. Restoration activity in the larger landscape that would involve the forest departments of Madhya Pradesh and Rajasthan include managing grasslands, perennial water management, plantation of miscellaneous forage species like *Ziziphus*, *Acacia*, *Carissa*, *Dichrostachys*, *Aegle*, *Terminalia*, *Diospyros*, etc. to enhance the productivity and carrying capacity of the landscape.

4.4.5 The size of the Gandhisagar WLS is 368 km², whereas the size of the potential cheetah habitat is about 2,500 km² extending from territorial divisions of Mandsaur and Neemuch in Madhya Pradesh, through the Rawatbhata part of Chittorgarh Division and Bhainsrodgarh Wildlife Sanctuary in Rajasthan. This potential cheetah habitat can be initially managed as the potential buffer zone of Gandhisagar WLS before upgrading it to PA eventually. A buffer zone management strategy for this interstate cheetah conservation landscape will be developed in line with the NTCA's landscape management plan guidelines (Gopal *et al.*, 2007). Some of the aspects that these guidelines emphasize are incentives and enhancement of livelihood of resident communities, compensation for livestock kills, mitigation of human-wildlife negative interactions (as discussed in the later sections of the action plan), and curtailment of high impact infrastructure and industrial devel-

opmental activities. Potential wildlife corridors in the larger landscape need to be identified on priority so that they can be safeguarded against conservation hostile land use patterns. This should be concomitant with ecological restoration of the larger landscape.

4.5. Organizational commitments

As mentioned in the action plan for introduction of cheetah in India (Jhala *et al.*, 2021), the overall funding and necessary administrative support to the cheetah introduction program in India would be provided by NTCA. In this regard, a separate budget for project Cheetah has been allocated under the ongoing Centrally Sponsored Scheme of Project Tiger (CSS-PT), Government of India. The State Forest Department of Madhya Pradesh and Rajasthan (as well as other State Forest Departments as required) would provide financial assistance, logistical, infrastructural and administrative support. Participation of various Government agencies, public and private sector Corporate Social Responsibility (CSR) schemes would be encouraged for additional funding at the State and Central level. The WII, National and International carnivore/cheetah experts/agencies would provide technical and knowledge support to the cheetah introduction in India. Commitments are required from the Government of Madhya Pradesh for allocation of Neemuch and Mandsaur territorial division as buffer and from the Government of Rajasthan for allocation of Bhainsrodgarh WLS, predator proof enclosure in Mukundara Hills Tiger Reserve and territorial division of Chittorgarh Division for cheetah introduction and its expansion. Efforts towards conservation and sustainable management can ensure that a suitable large landscape area of ~2500 km² potential habitat to be secured as an interstate cheetah conservation complex.

A long-term (at least 25 years) Cheetah Program involving financial, technical and administrative commitments needs to be guaranteed by the Central and the State Governments to adhere to the Action Plan. Cheetah conservation should become a part of the mandate of the NTCA and under the Project Tiger Scheme of funding by the MoEF&CC. Financial commitments should be flexible to accommodate rational changes to translocation and population establishment plan during the course of the project.

4.6. Training of Personnel

Officials of the MoEF&CC, NTCA, WII, State Forest Departments would be regularly sensitized through study tours to cheetah conservation reserves in African countries. Cheetah managers and biologists from cheetah range countries would be invited to impart training to Indian colleagues. Indian cheetah project managers, veterinarians, biologists would be regularly trained at specific sites in cheetah range countries in techniques of capture, anesthesia, and management of cheetah. This action plan would be modified (if required) on the basis of these learnings. Trained staff would be posted at cheetah conservation sites for a minimum period of five years and possibly longer.

4.7. Founder Cheetah Population

As recommended by the IUCN reintroduction guidelines (IUCN 2013) reintroduction is defined “as the intentional movement and release of an organism inside its indigenous range from which it has disappeared”, while in the case where the original indigenous organism is not available, then the guidelines suggest to use the most suitable existing sub-species, or a close relative of the extinct species within the same genus that is similar in appearance, ecology and behavior to the extinct form; and is defined as Conservation introduction.

The locally extinct cheetah-subspecies of India (*Acinonyx jubatus venaticus*; Charruau *et al.*, 2009, O’Brien *et al.*, 2017, Rai *et al.*, 2020) survive as a small relict population in Iran currently numbering ~30 individuals (Kalatbari *et al.*, 2017) and are considered as critically endangered with a declining trend (Durant *et al.*, 2015). Recent popular media reports suggest that their population has further dwindled.

An important consideration for conservation translocations is that the sourcing of animals should not be detrimental for the survival of the source population (IUCN 2013). The founding population should also be genetically diverse, behaviorally appropriate, of ideal age and sex composition, able to adapt to the climatic, habitat conditions, and prey types of the introduction site, and be available in reasonable numbers for supplementation of the introduced population over a sustained period of time (IUCN 2013). As the cheetah from Iran are clearly unavailable and inappropriate as a source for translocation to India, the best alternative needs to be determined that meet these criteria are from African countries. The next ideal choice for the founder population would be from populations that were genetically, ecologically and behaviorally closest to the extinct cheetah in India. Amongst mammals, cheetahs are recorded to have one of the least genetic diversity and are more similar to each other across their entire extant range when compared to other species (Dobrynin *et al.*, 2015). Therefore, the considered opinion of cheetah geneticists from across the world after careful evaluation of all published scientific studies on cheetah genetics is that all sub-species of the cheetah are equally close to *A. jubatus ve-*

naticus (Jhala *et al.*, 2021) and therefore these specific genetic considerations do not play an important role in selecting a founding population in comparison to other criteria mentioned above. The criteria for the source would be the availability of a continuous supply of legally obtained healthy cheetah that are genetically diverse, can hunt wild prey, are wary of humans but not overly skittish so that managing them is difficult, and sourcing for introduction in India would not imperil source populations. Since India currently does not have any native cheetah, the ecologically and behaviourally most suited population that meets the source population criteria (IUCN 2013) would suffice the need since there would be no genetic mixing of subspecies.

The cheetah introduction program in India would boost the global conservation efforts for the cheetah as a species and help assist conserve vulnerable genetic lineages. However, these efforts should not be at the cost of jeopardizing the cheetah introduction program in India. In future, if cheetah range countries are in need of safe sites to house their endangered cheetah genetic lineages, India would strive to provide alternatives without mixing the sub-species, in distinct landscapes or in large fenced areas.

About 12-14 wild cheetahs (8-10 males and 4-6 females) from various parks/reserves/areas that are ideal (reproductive age group that is genetically diverse, disease-free, behaviorally sound e. g. not overly imprinted to humans but tolerant, predator wary, capable of hunting wild prey, and socially tolerant of each other) for establishing a new cheetah population would be imported as required from African Countries, as a founder stock for five years initially and then as may be required by the program. The animals' lineage and condition would be checked in the source country, to ensure that they are not from an excessively inbred stock and in the ideal age group, so as to conform to the needs of a founding population while securing a wide gene pool for the founding Indian cheetah population. The founders will be individuals with known life histories and lineages, being monitored by the supplying agencies/ experts/ donors and selected keeping in mind ecological aspects such as relatedness, behavior, sociality, etc.

Indian team would visit cheetah source sites and managed population sites for selecting founding individuals and understanding management issues. The selection of animals suitable for release would be the responsibilities of the chosen supplying agencies/experts/donors in African Countries and would be verified by Indian carnivore experts. Multiple populations of cheetah are envisaged to be established in India and are proposed to be managed as a metapopulation with occasional "immigrants" brought in from African countries, as and when needed.

4.8. Veterinary Interventions, Disease and Health Management of the Founders

The primary responsibilities of the veterinary team include active participation in actual translocation and introduction, implementation of adequate quarantine measures, health monitoring and disease prevention, animal welfare, population management initiatives, and emergency responses as needed (Kock *et al.*, 2007; NTCA *et al.*, 2023). These duties span the entire process, from pre-introduction preparations, intervention procedures, to the post-introduction phase taking into account general veterinary principles applicable to species introduction programs and drawing from past veterinary experiences gained in Kuno National Park during cheetah introductions.

4.8.1. Establishment of Veterinary Infrastructure

Historical experiences in species introductions worldwide, coupled with recent insights from Kuno, emphasize the need for a prolonged and dedicated commitment in every facet of the project for success. However, acknowledging that all attempts can face susceptibility to failure, often due to veterinary reasons, underscores the importance of careful planning. Hence, establishment of a well-equipped, state of the art veterinary facility is underway in Gandhisagar WLS before cheetahs are translocated. In the long run, the facility will be upgraded to international standards, ensuring long-term sustainability.

A veterinary team(s), composed of veterinarians from the NTCA, the Madhya Pradesh Forest Department, and the WII, will be stationed at Gandhisagar WLS. This team will oversee and facilitate the establishment of a comprehensive veterinary facility for cheetahs. Additionally, they will be responsible for ensuring the health and welfare of all animals, including the cheetahs and other wildlife in Gandhisagar, before, during, and after introduction. The team will manage veterinary intervention procedures such as capture, immobilization, treatment, and prophylaxis. Furthermore, provisions will be made for new veterinarians to undergo basic hands-on training in cheetah veterinary management, initially at Kuno and subsequently at advanced cheetah management facilities abroad. A panel of national and international veterinary experts will be established to provide specific guidance to the team regarding the veterinary care, management, and husbandry of cheetahs. This guidance will apply to both quarantine and later free-ranging conditions, ensuring comprehensive and informed care for the cheetahs at all stages of the project.

4.8.2. Disease Risk Analysis

During conservation introductions, the management of health risks, both communicable and non-communicable, are extremely important to maximise the survival of translocated animals and to minimise the risk of introducing a novel health

hazard to the destination country (Miller 2007; Sainsbury *et al.*, 2012; Sainsbury and Vaughan-Higgins 2012). To analyse and manage the possible outcomes of situations involving health risks in projects like this, a process known as Disease Risk Analysis (DRA) has been adopted by World Organisation for Animal Health & International Union for Conservation of Nature (OIE and IUCN, 2014). The objective of process is to identify all possible health risks of concern, while providing an evidence-based analysis of the above risks to the cheetahs translocated from Africa to reserves in India. In addition, prevention of alien/ novel disease introduction to the recipient area and native fauna is also considered.

A comprehensive list of potential hazards has already been compiled through a systematic scientific literature search as part of the “Disease Risk Analysis for Introduction of Cheetahs (*Acinonyx jubatus*) to India,” conducted during India’s first cheetah translocation to Kuno (Tordiffe *et al.*, 2021). Building upon this foundation and drawing from previous experiences in Kuno, a site-specific DRA will be formulated for Gandhisagar WLS. Initiatives will be undertaken to gather the following information, enhancing the DRA process at the field site:

- Seroprevalence of major carnivore and ungulate diseases in Gandhisagar WLS: Biological sampling will be carried out in conjunction with capture and radio-telemetry operations of other carnivores and prey species for ecosystem monitoring to be carried out by the WII. Samples will be analysed at the School of Wildlife Forensic and Health (SWFH), NDVSU, Jabalpur as per the existing agreement between SWFH and the WII.
- Seroprevalence of major diseases in feral/domestic animals in the vicinity of Gandhisagar WLS: Biological sampling will be carried out in conjunction with feral animal vaccination and population control drive to be carried out by Madhya Pradesh Forest Department. Samples will be analysed at the School of Wildlife Forensic and Health (SWFH), NDVSU, Jabalpur as per the existing agreement between SWFH and the WII.
- Prevalence of non-communicable risks in the Gandhisagar landscape: Assessment will be conducted using landscape level information available with Madhya Pradesh and Rajasthan Forest Department, complemented with field observations and environmental/ecological monitoring being carried out by the WII for the project.

Following the collation of the above data, a comprehensive document will be published, containing information on evaluation and classification of level of risk associated with each identified hazard, risk management measures to mitigate the same, and protocols for the operationalization of risk management measures. Identified risks will also be communicated to relevant experts and stakeholders, so as to enhance the quality of analysis and ensure the effective implementation of the developed protocols.

4.8.3. Establishment of Quarantine Facility for cheetahs in Gandhisagar WLS

In accordance with domestic requirements for the import of felids, after translocation, cheetahs must undergo a minimum quarantine period of 30 days in India. Following this, they must be certified by the Animal Quarantine and Certification Services (AQCS), Government of India, to be considered fit for release (DAHD, 2021). This underscores the need to establish a dedicated quarantine setup at release sites to identify any potential diseases or pathological conditions and prevent their transmission. The quarantine duration also facilitates the acclimatization of translocated cheetahs to the local environment before their release, ensuring their limited familiarity with the veterinary and husbandry team.

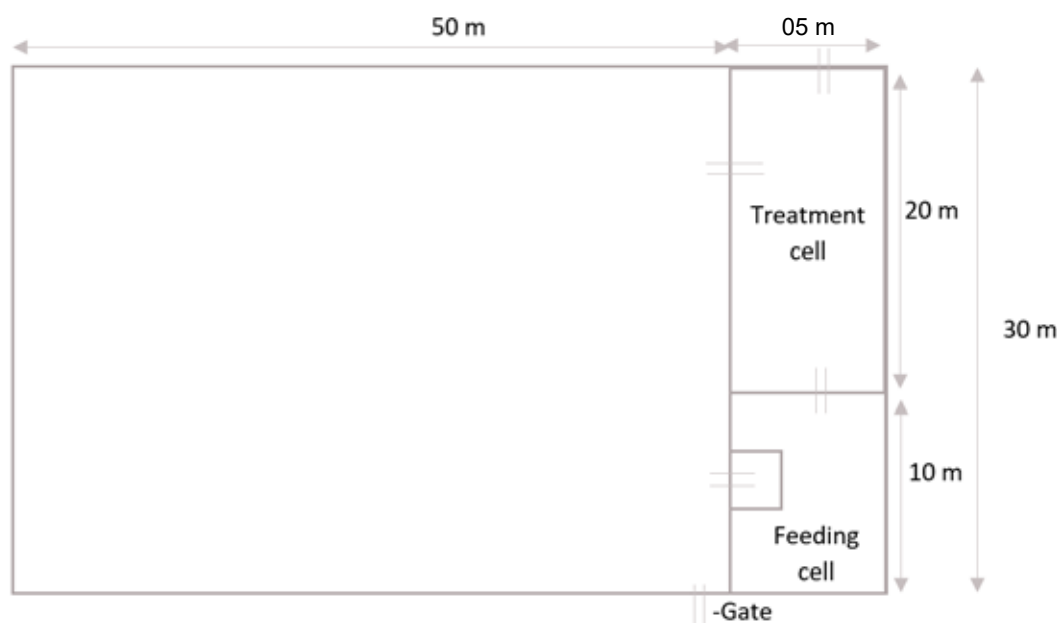


Figure 4: Diagram of cheetah quarantine boma

In adherence to existing standards and utilizing Kuno's quarantine facility designs as a model, a quarantine setup is being established in an isolated area within the Gandhisagar WLS. This facility will be equipped with essential facilities, including individual predator-proof electrified quarantine bomas. Each of the quarantine bomas have provision for natural shade, water facility, and enrichments, all tailored to emulate cheetahs' natural behaviours. Additionally, measures have been taken to incorporate all necessary suggestions provided by AQCS, New Delhi, and the previous Quarantine Clearance Committee based on past cheetah quarantine experiences in Kuno. After completion, the facility will undergo scrutiny and certification by a Quarantine Clearance Committee designated by AQCS and the Department of Animal Husbandry and Dairying (DAHD), Ministry of Fisheries, Animal Husbandry & Dairying, Government of India.



Figure 5: Map of the quarantine bomas for cheetahs in Gandhisagar Wildlife Sanctuary

4.8.4. Identification of Healthy Founder Cheetahs & Quarantine in the Source Country

To mitigate potential health complications, a crucial initial step involves selecting disease-resistant founder stock. The highest health risks are anticipated in animals born and bred ex-situ or in artificial conditions, such as zoological parks and captive breeding centres (Walker *et al.*, 2008; Kock *et al.*, 2010). Populations bred naturally (in-situ) would have undergone epidemiological processes and natural selection pressures, reducing the likelihood of pathogen persistence. Individuals from these populations are less likely to pose a high disease risk and may have developed resistance to certain diseases (Kock *et al.*, 2010). Therefore, the cheetahs for introduction to India will only be of wild origin and evaluated carefully by the project collaborators from the source country and verified by the Indian project team for selection. In countries such as South Africa, wildlife veterinarians immobilize and examine cheetahs if necessary as well as recording causes of mortality when applicable. Disease surveillance in this population is thus considered robust.

Nonetheless, thorough preliminary investigations, prophylaxis, and other veterinary preventive medicine measures will be implemented for each selected cheetah in accordance with existing international standards. After selection, each

founder cheetah will undergo observation in a quarantine facility in the source country for a minimum of one month to detect any signs of illness. If a cheetah is found to be a carrier of a pathogen novel to India, it will be excluded from translocation. Prior to transport to India, vaccinations and health checks/treatments will be administered in the country of origin, aligning with both the source country and domestic norms (DAHD, 2021).

Domestic requirement for the import of felids (tiger, lion, snow leopard, leopard, cheetah, puma, jaguar, other large & lesser cats) into India – Department of Animal

Husbandry & Dairying (DAHD), 2021- Ministry of Fisheries, Animal Husbandry & Dairying, Government of India

1. **Requirement:** Show /shows no clinical sign of diseases including Rabies, Feline enteritis, Feline pan leukopenia, Leptospirosis, Distemper, Scabies, Pseudorabies (Aujeszky's disease), Blood parasites (protozoan diseases) including Babesiosis, Anaplasmosis, Trypanosomiasis and Toxoplasmosis prior/during the transport.

Protocol to be followed: Cheetahs would be quarantined to observe clinical signs for above in the country of origin and appropriate diagnostic tests whenever necessary would be carried out to ensure absence of above diseases.

2. **Requirement:** The animal(s) should be vaccinated against rabies (for the animal(s) above three months of age) with a vaccine licensed and approved by the exporting country.

Protocol to be followed: Prophylactic Rabies vaccine, followed by a booster at 3 weeks post first dosage before being imported to India.

A Veterinary Health Certificate and test results for the above would be obtained from a certified/ designated veterinarian in the country of origin.

Additional protocols

1. **Requirement:** Cheetahs to be vaccinated against major carnivore diseases.

Protocol to be followed: The cheetahs to be translocated will be vaccinated with killed vaccines against Canine distemper, Feline rhinotracheitis, Feline calicivirus, Feline panleukopenia viruses, Feline herpes virus type 1 and Chlamydomphila felis – at least 02 doses 21 days apart.

2. **Requirement:** Prophylaxis against GI parasites

Protocol to be followed: Cheetahs to be treated with suitable oral de-wormers/parasitocidal during quarantine in host country.

3. **Requirement:** Prophylaxis against External parasites:

Protocol to be followed: Cheetahs to be administered with Fluralaner (Bravecto®) to treat and prevent flea and tick infestations during quarantine in host country.

A Veterinary Health Certificate for the above would be obtained from a certified/ designated veterinarian in the country of origin.

4.8.5. Immobilization, Capture, Holding and Transportation of Cheetahs from the Source Country to Gandhisagar WLS

With the primary objective of the program being establishment of a second cheetah population in India sourced from African countries, the welfare of each individual cheetah will be considered to be of paramount importance. In conjunction with the project collaborators from African countries, capture and translocation mechanisms will be designed to keep the stress at minimum, while prioritizing animal ethics and care throughout the process. Numerous cheetah introduction efforts have been undertaken in African countries, benefiting from the expertise and extensive experience of experts and veterinarians involved in such endeavours. Cheetahs would be captured from free-ranging conditions either by darting or in a trap-cage by experienced veterinarians and trappers.

Upon completion of the mandatory quarantine in the source country, the selected cheetahs will undergo chemical capture, preparation, and crating for transportation to India. Each sedated cheetah would be aged, weighed, measured and ecto-





parasites and blood samples collected using the standardized capture protocols. Each cheetah would be equipped with a satellite-GPS-VHF radio-collar facilitating their future monitoring and individual identification. Photo profiles of all the individual cheetahs would be maintained by the NTCA, WII, MP forest department, cheetah management and research teams in India.

The transportation process will adhere to all international, source, and recipient country laws, prioritize safety, minimize risks to the animals and personnel, and follow carefully planned routes with the fewest stops and transfers. Agencies in African countries with proven experience in road and air translocations of cheetah will be consulted for their valuable expertise in crate design and transportation protocols. For international flights from African countries, standard crates meeting the Live Animals Regulations of the International Air Transport Association (IATA) specifications will be used, with dimensions of Length 1.2m × Height 0.9m × Width 0.5m, as recommended for the transport of cheetahs.

International transportation of cheetahs from the source country to India will be carried out by either the Indian Air Force or a commercial airline. Veterinarians and experts will have continuous access to the cheetahs during the flight. Copies of health certificates, transaction permits, and all relevant documents will accompany the cheetahs and be presented to AQCS officials at the port of entry in India. Ensuing this, all possible modalities will be explored for subsequent transportation from the destination airport in India to Gandhisagar WLS guaranteeing a swift transfer to the release site with minimal stress.

4.8.6. Husbandry and Veterinary Management of Cheetahs during Quarantine at Gandhisagar WLS

Post arrival in India, cheetahs will be quarantined in isolated and secure predator proof individual quarantine bomas for a minimum period of one month. Nutritious diet will be supplemented to cheetahs every third or fourth day during the period, mimicking the natural feed starvation cycle. The condition of each cheetah will be routinely checked twice a day, once early morning and then in late evening by designated team of veterinarians and caretakers. Round the clock monitoring of the animals by observer(s) will also be undertaken from a distance through a concealed watchtower for their behaviour and activities such as water intake, urination, and defecation. High mast cameras are being installed for remote monitoring of the animals during quarantine. Routine cleaning activities to maintain hygiene will be carried out during feeding days. Caretakers will carefully enter the enclosures and maintain a safe distance from the animals and remove any bones, clean the water trough/saucer, refill the water and collect faecal matter. Using the same set of vehicles (4WD and All-Terrain Vehicle) will be maintained for approaching the animals in quarantine setup for limited habituation. Training on all aspects of cheetah care and behaviour will be imparted to Forest Department Staff of Gandhisagar WLS by a team of Veterinarians and researchers who have already been trained in Kuno on the same. A written protocol will be issued for activities and code of conduct during quarantine and strictly adhered to, so as to ensure adequate quarantine standards and minimal human interaction to avoid stress to cheetahs.

During the last quarter of the quarantine period, each cheetah will undergo chemical immobilization for a comprehensive physical examination and biological sampling. Collected samples, such as whole blood, serum, stools, nasal/tracheal swabs, etc., will be sent to designated laboratories for health evaluation and necessary disease investigations. Fitness certificates for each cheetah will be issued by the resident veterinary team based on routine visual health evaluations, physical examinations, and laboratory results. These certificates will then be submitted to the AQCS for further processing and acquisition of “Quarantine Completion Certificates”. In case of death or illness in cheetahs during the quarantine period, existing protocols will be followed to address the issue adequately, and the AQCS will be promptly informed about the situation.

4.8.7. Veterinary Management of Cheetahs Post Release at Gandhisagar WLS

After obtaining Quarantine Completion Certificates, cheetahs will be released out of the quarantine bomas in a phased manner. Deployed with radio collars, the cheetahs will be closely monitored 24/7 for the first couple of months (if necessary for longer) post-release. A dedicated tracking team will observe and assess their fitness, activity levels, health, behaviour, hunting, habitat preferences, predation, injuries, belly scores, and any unusual signs or symptoms. These observations will be documented systematically in daily datasheets. The veterinary team will conduct visual health examinations at least once a day, with a mobile veterinary unit on standby for field treatments if necessary. For anaesthesia during field treatments or captures, a combination of Medetomidine-Zoletil or Ketamine–Medetomidine–Butorphanol will be used, administered intramuscularly via a gas-powered remote drug delivery system. The veterinary team from Kuno will share their expertise with the Gandhisagar veterinary team to ensure safe and humane capture and immobilization procedures. All essential medications, including capture drugs, reversal agents, life-saving medications, and supportive equipment, will be procured and be readily available in the mobile veterinary unit for emergency situations. For cases requiring extended veterinary care, cheetahs will be relocated to treatment cubicles, which are located near the proposed veterinary hospital premises. In case of mortality or illness in cheetahs, existing protocols will be followed to address the issue adequately and biological samples will be collected/ preserved as per requirement.

Over the past year and a half, veterinarians from NTCA, MPFD and WII engaged in Kuno have acquired extensive hands-

on expertise in veterinary care and interventions in the species. This valuable experience will be extensively utilized in training new veterinarians and addressing complex situations as and when required in Gandhisagar WLS. Guidelines for management of unforeseen developments such as unexpected high rate of mortality due to some novel cause will be developed in consultation with national and international veterinary/ large carnivore experts. As mentioned above, a panel of national and international veterinary experts will also be constituted to offer specific guidance on the veterinary care, management, and husbandry of cheetahs at every stage of the project.

4.8.7.1. Captive Management of Cheetahs

The management of cheetahs in captivity indeed appears inevitable within a project of this nature. Such circumstances underscore the imperative need for a well-established captive care setup (NTCA *et al.*, 2023). Drawing insights from experiences in Kuno, it is evident that captive management is not merely an auxiliary aspect but a critical and integral component of the overall cheetah project. Emphasizing a comprehensive approach is essential in such instances. It involves prioritizing necessary veterinary care to ensure swift intervention for health concerns, while equally focusing on replicating the natural habitat within enclosures during interventions (Colburn *et al.*, 2018). This comprehensive strategy encompasses providing ample safe space and incorporating features aligned with the behavioural needs of the cheetahs. The establishment of specialized nutrition plans is also imperative to address their specific dietary requirements during these periods (Whitehouse *et al.*, 2017; Marker *et al.*, 2018). In essence, a meticulous and holistic captive management strategy would be the key to the success of the project, safeguarding the health, well-being, and conservation of the founder stock at Gandhisagar.

4.8.7.2. Neonatal care and hand-rearing strategies for cheetah cubs

While the primary goal of the project is to establish a self-sustaining population of cheetahs in the wild through natural breeding, there may be occasions where it becomes necessary to hand-rear cheetah cubs. Various factors such as maternal abandonment, health issues, or other unforeseen circumstances might prompt the need for human intervention (NTCA *et al.*, 2023). Hand rearing is a specialized and crucial component, involving the provision of dedicated care, nutrition, and socialization to ensure the cubs' well-being and successful development (Colburn *et al.*, 2018). However, it is crucial to strike a balance and minimize human imprinting, as the ultimate aim is for these cheetahs to exhibit natural behaviours and thrive independently in free-ranging habitat (Colburn *et al.*, 2018). Hand rearing should be viewed as a last resort, with every effort made to support natural reproduction and parenting behaviour in the wild. Nonetheless, it is imperative to have a cub rearing facility, including a neonatal care setup at Gandhisagar, to address unforeseen situations, as has been observed in Kuno.

4.9. Monitoring of cheetahs by Radio-Telemetry

The founder cheetahs would be fitted with satellite/GPS/VHF collars enabled with a ground data download facility. These collars would be fitted on the cheetahs before they are quarantined in India. WII/ MPFD/ NTCA would obtain the necessary permits and procure radio-telemetry and subsequent monitoring equipment from international firms. Cheetah cubs born in Gandhisagar WLS for at least two generations would be collared prior to their dispersal at the age of 16-17 months. Radio-telemetry would assist in daily monitoring of movement, behavior, predation, negative interactions and mortality. These are important aspects that need to be monitored to safeguard the introduced cheetah, assess their well-being and evaluate the progress of the introduction project. Radio-telemetry based monitoring would allow for active management interventions, fate of the animals and determine causes of cheetah mortality.

4.10. Release of cheetahs in the fenced area of Gandhisagar WLS

4.10.1. Animals would be released after an appropriate period within one or two months after the mandatory quarantine period. They are expected to explore and investigate the available habitat, but would tend to return to the boma for conspecifics. Female presence in the bomas would ensure that the males repeatedly return, after their exploration instinct is satiated. All the cheetahs would be monitored and kept under observation through radio telemetry and as far as possible by visual monitoring.

4.10.2. The movements of all released cheetahs would be monitored 24 hours a day by the local State Forest Department staff, assisted by the cheetah research team. After all the cheetahs settle down and establish home ranges/territories (one to three months), the homing-in monitoring frequency can be reduced to two-three (02-03) locations per day and one good visual observation on alternate days for verifying health, condition, and any injury signs. Remote location data from telemetry would be set for 10-12 GPS locations per day communicated daily through satellite/GSM communication. If any animal tends to get into undesirable environment, it would be brought back. Darting would only be done if essential, by qualified trained personnel.

4.10.3. As per requirement, experienced cheetah expert(s) from the source agency/country would visit/ stay at the project

site, to advise and assist on various aspects such as care of the cheetah in captivity, opine on their readiness and that of the habitat for the release and to help in post release monitoring, and coping with any unwarranted situations. The expert(s) would also train the local staff. The expert(s) would work in close association with the veterinary team in Gandhisagar WLS. A permanent veterinary unit and cheetah tracking and monitoring teams as mentioned above would be established at Gandhisagar WLS.

4.11. Post-Release Monitoring and Research

As followed in Kuno, the park administration in Gandhisagar WLS will be responsible for monitoring essential for protection and management, while a cheetah research team will monitor for research. These monitoring teams will work in close coordination and share information regularly. The research team will comprise of biologists, veterinarian(s), and sociologist(s) and field assistants equipped with research equipment, vehicles (at least two each of 4WD four wheelers, All Terrain Vehicles and two motorcycles) funded by the cheetah project (NTCA or MP Forest Department or both).

4.11.1. The cheetah population in Gandhisagar WLS needs to be intensively monitored and managed at least for 10 years with all the adult cheetahs fitted with GPS/satellite collars. All introduced cheetah and their F1 progeny (and if required for research some subsequent generation offspring) would be radio-collared (Satellite /GPRS /GPS /VHF). Radio-collars on cheetahs would be replaced immediately in case the battery life ends or there is a technical snag.

4.11.2. Research on all aspects of system recovery and interactions including ecology, physiology, and behavior of the cheetahs and their population trends, as well as of their prey species and other carnivores, would be addressed by the cheetah research team in collaboration with the NTCA. The research team would be facilitated by the MP Forest Department with four-wheel drive vehicles, field assistants and all other necessary logistical support. The team would work in close association with the local forest officials (Range and Sub-division levels). A quarterly monitoring/research review meeting during the initial period, and subsequently half-yearly, would be organized where the Steering committee, NTCA officials, WII representatives, MPFD officials and external expert(s)/agencies (as and when required) to assess the progress of cheetah project.

4.11.3. The following research/monitoring programs would be undertaken by the cheetah project team under the supervision of the NTCA

4.11.3.1. The establishment of the cheetah populations offers unique opportunity to understand the role of top predators in ecosystems. The experiment would be utilized to study the cheetah as a species a) its ecology with respect to ranging, habitat use, predation (Williams *et al.*, 2014), interactions with other carnivores; b) its behaviour with respect to intra- and inter-specific interactions, sociality, reproduction and predation strategies with respect to different prey; c) possibility of studying cheetah physiology with respect to field energetics, coping mechanism with the use of isotopes (Pagano & Williams 2019) and physiological bio-monitors (Laske *et al.*, 2017), hormones etc. would also be undertaken as required. Study of prey species with respect to their behaviour especially anti-predatory strategies and demography will be carried out. Appropriate collaborations with international experts would be established for addressing novel modern approaches. Monitoring through telemetry would be done by both the cheetah research team and the Forest Department team for informed management. Data between the two teams would be shared for the mutual objective of better conservation of the cheetah population.

4.11.3.2. Radio-telemetry

All adult cheetahs would be deployed with GPS/satellite collars for the first 10 years. Subsequently, select animals would be deployed with radio-collars to monitor a few individuals. Young animals would be radio-collared before they reach their dispersal ages (about 17 months). Information on survivorship, ranging, movement, dispersal, resource selection, predation and aspects of livestock depredation and interactions with humans if any would be recorded from radio-telemetered cheetahs. To understand the effects on other wildlife, prey species such as chinkara, nilgai, blackbuck, chital etc. as well as other carnivores such as leopard, hyena, wolf, sloth bear, jackal, ratel, jungle cat, pangolin, fox etc. would be attempted to be monitored through radio telemetry.

4.11.3.3. Monitoring cheetahs' diet

Systematic collection of cheetah scats would be undertaken on a regular basis to monitor the cheetah diet through scat analysis. Such samples would also be used for parasitological assay and hormone assessments, which may prove important in assessing the prevalence of parasitic infections and stressors respectively. Attempts would be made to locate all predation events (kills) by cheetahs for the first few years to understand feeding ecology and impact of cheetah predation on prey demography.

4.11.3.4. Monitoring prey populations

Annual abundances of wild prey species in Gandhisagar WLS would be estimated based on Distance sampling (both foot transects and camera trap based) to measure food availability for the cheetahs and other carnivores. Efforts would be made to estimate the prey abundance in the larger landscape (2,500 km²) at least once in two years to monitor the impacts of protection and eco-restoration on prey population.

Currently, the fenced area with augmentation has sufficient prey base to support about 06-08 cheetahs. However, introduction of a new predator in the area might lead to certain effects on certain prey species and even to habitat (trophic cascade effects- Ripple & Beschta 2012, Ripple *et al.*, 2014). The response of the prey species to cheetah would be monitored by the research team to understand the dynamics and, supplementation of prey (such as blackbuck, chital and nilgai) if needed would be decided on the basis of annual assessments. A few individuals of prey species such as chinkara, nilgai, blackbuck etc., would be deployed with radio collars to understand their behavior and habitat use in response to introduction of cheetah. Attempts would be made to radio collar the animals prior to the arrival of cheetahs.

4.11.3.5. Monitoring other carnivores

Abundances and population parameters of other carnivores (such as leopard, hyena, jackal, wolf, fox, ratel, jungle cat etc.) would be regularly monitored using methods such as mark recapture (Jhala *et al.*, 2020), random encounter models and distance sampling based on camera traps. At least 200 infrared flash camera traps would be required for this purpose. Scat samples of other carnivores would be collected to assess their diets and prey preferences. This would enable the management to understand the probable niche partitioning mechanism operating in Gandhisagar WLS. These exercises can, however, be started even before the cheetahs are released. This would be helpful in evaluating changes in population dynamics and dietary shift (if any) of carnivores in the area before and after cheetah introduction.

4.11.3.6. Molecular genetics

Genetic analysis of all founders (micro-satellite based and genomic analysis) would be carried out. Subsequent monitoring of the cheetah population genetics based on microsatellite and/ or SNP analysis would allow for monitoring loss of genetic variability and inbreeding (if any) and help decide on active management of the metapopulation through immigrants from other cheetah populations in India or from African countries.

4.11.3.7. Monitoring vegetation and anthropogenic disturbances

Sample plots in the major vegetation types would be established and monitored for seed germination, recruitment and succession. This would be achieved by marking adequate sample area and collecting data repeatedly at an interval of three to five years for a period of 25 to 30 years. High-resolution habitat mapping of the landscape on a GIS domain at an interval of every five years would be done so as to monitor the changes in the habitat and landscape connectivity. Data on various anthropogenic activities (such as cutting, lopping, grazing, human trails etc.) would be collected following the protocol (field guide) developed by Jhala *et al.*, (2013). The vegetation and anthropogenic data would be collected from localities under varying intensities of anthropogenic activities and under different management practices including the larger landscape. These would be particularly studied, including the composition of and changes therein, of perennial grass species that are the preferred food of the herbivores. Invasive exotics would be controlled annually by appropriate managerial interventions.

4.11.3.8. Monitoring and studying human-wildlife interactions in the landscape

The success of the cheetah introduction program in the long-term would depend on human-cheetah relationships. Before the arrival of cheetahs in Kuno, The Chief Minister of Madhya Pradesh has asked all state officials and elected members of the state assembly from the constituencies around the release sites to disseminate correct information regarding the cheetah-human interface. Further, it needs to be ensured that local communities are aware that there is no threat to humans from cheetahs and that any livestock depredation by wildlife would be immediately and effectively compensated. Actual instances of carnivore presence near human habitations would be quantified through data from radio-telemetered animals. Human perceptions would be assessed through structured questionnaire surveys for adaptive management of community attitudes. Such information would become crucial in active management of the landscape and for future policymaking.

4.11.3.9. Monitoring cheetah population through individual identification

A computer database wherein profiles of individually identified cheetahs would be maintained by the research team and NTCA and analyzed to study cheetah demography and population dynamics. Individual profiles of all the cheetahs of Gandhisagar would be maintained by the research team as well as by the park management so as to monitor cheetah survival and other vital rates. This becomes an important tool to monitor cheetah population in Gandhisagar when the collaring of individuals is reduced or eventually stopped (i.e. after the three-four generations of cheetah population).

4.11.4. If approximately 5% growth rate in the initial population is achieved, after incorporating natural mortality, births and annual supplementation, this population should reach carrying capacity level in about 15 years. To reach the land-

scape carrying capacity after restoration of the habitat, for a population size of 25-30 cheetahs, the time required would be close to 30-40 years depending on survival, recruitment and supplementation. During the initial years of cheetah introduction (5 – 6 years) or population below 18-20 adult cheetahs, it may be prudent not to allow cheetahs to disperse into sink habitats of the landscape. If there are such instances, cheetah(s) would be captured and brought back to the PA or translocated to other release sites. This would be done as per NTCA's Standard Operating Procedure available for managing straying tigers in human dominated landscapes- available at-http://projecttiger.nic.in/WriteReadData/CMS/Final_SOP_11_01_2013.pdf.

The larger landscape would be allowed to be populated by cheetahs only after the landscape is secured, the prey base adequately enhanced and risks to their survival are minimized. However, such landscape level efforts are not quick fix since their enactments demand time and they must not impede the immediate goal of establishing cheetah population first inside the Sanctuary after adequate restoration. Rather they would be concomitant with cheetah introduction exercises inside Gandhisagar.

4.11.5. Simultaneously, hard boundaries of areas in Gandhisagar WLS, abutting human habitation would be secured through proper fencing at appropriate locations, if needed, in consultation with the local community, to minimize live-stock depredation, poaching, and forays of wildlife into human settlements and of livestock into the PA, thereby precipitating negative interactions. This would be vetted by the Cheetah Steering Committee after careful consideration of possibility of natural dispersal of cheetah in future.

4.12. Genetic Management: Supplementation

4.12.1. Genetic management of the cheetah population in India would be done in a similar manner as is being done for game reserves in South Africa through a managed metapopulation program (Buk *et al.*, 2018) and national/international experts would be consulted. Cheetah would be moved between populations in India, supplemented by cheetahs brought in from African countries. Genetic profile of individuals and populations will be maintained and monitored through microsatellite/SNP markers.

4.12.2. Capture, handling, transport and release of the cheetahs during the subsequent years would be as per the norms discussed before (or by any improved facility available in future and deemed technically feasible for translocations) and would aim at minimizing injury/stress and mortality.

4.13. Management of cheetahs and Leopards in Gandhisagar WLS

Currently, the population of leopards is ~70 individuals in the West Range of Gandhisagar WLS. Cheetahs and leopards may sometimes get involved in inter-specific strife resulting into injuries and even deaths. However, that would be a natural process and management by appropriate supplementation and recruitment from the introduced population would compensate for these. All the leopards within the predator proof fenced area will be captured and relocated before the cheetahs are brought to Gandhisagar WLS.

The leopard population in the Sanctuary and the larger landscape needs to be managed during initial years of cheetah introduction (first 10 years) so as to avoid/minimize interspecific strife and allow the cheetah population to stabilize. The best strategy would be to radio-collar (GPS/satellite) 10 leopards at least, so as to study the interaction between these two carnivores as part of the research program in Gandhisagar WLS. The research would aim at radio-collaring of leopards and other carnivores (hyena, wolf, sloth bear, jackal, ratel, jungle cat, pangolin, fox etc.) and monitor them. This would generate valuable information on resource separation amongst carnivore communities in Gandhisagar and would be of immense help in formulating future management plans. Based on this research, management strategies to permit and promote co-existence or to manage these carnivore populations need to be decided for the future.

4.14. Capacity Building

4.14.1. Veterinary team(s) (each with at least one veterinarian and minimum three assistants) would be recruited and posted at Gandhisagar WLS to manage the cheetahs and other wildlife. The team(s) would be equipped with a wildlife rescue van (preferably a 4WD mini truck), wireless systems, adequate drugs, darting equipment and other necessary paraphernalia. Appropriate remuneration and incentives would be provided to them and all forest staff of Gandhisagar WLS as per the MP Government's rules. A well-equipped veterinary hospital and rescue care center would be constructed with long-term housing facilities for at least 03-05 cheetahs and other wildlife for medical interventions and treatments. This is essential so as to provide treatment for mild ailments, injuries, or to temporarily hold animals that may be unfit for wild release. Each Range office in the Sanctuary and adjacent ranges (eventually the landscape) would be provided with two

each of capture and transport cages, to expedite rescue operations of wildlife outside the park.

4.14.2. Two-three separate cheetah tracking teams would be constituted. Each team would be comprised of two to three young, motivated staff having interest in wildlife and two to three assistants. The primary duty of this team would be to continuously monitor radio-collared cheetahs and assist the cheetah management and research teams. This has been practiced in Kuno. The team would also learn to track non-collared cheetahs and other carnivores over time. Each team would also be equipped with at least two-three motorcycles and a wireless system so that they can report any case of negative interactions with humans, injury and/or disease instantly to the veterinary teams. The tracking team would also be trained over the years to capture and handle cheetahs and other wildlife so as to augment the capabilities of the veterinary team.

4.14.3. Importance of protection for successful conservation cannot be overemphasized. A protection regime against poaching by firearm, snaring, trapping, poisoning and electrocution and accidental deaths due to road accidents would be initiated urgently in and around Gandhisagar WLS. This would be achieved by patrolling (both in vehicle and on foot) different areas of the Sanctuary and the larger landscape. Modern smart patrol monitoring system like M-STrIPES have been implemented in Gandhisagar WLS and would be carried out in the larger landscape. Drones and dog squads will be employed for strengthening the protection infrastructure. A patrolling squad led by a Sub- Division Officer/ Assistant Conservator of Forest/ Range Forest Officer (SDO/ACF/RFO) ranking officer and comprising of 02-03 armed frontline staff (including one lady guard) and 1-2 police constables (as and when required including a lady constable) would be constituted. The squad would be provided with a well-equipped vehicle to patrol areas of Gandhisagar WLS and outer landscape anytime of the day. Maintenance, creation and upgradation of road networks within the park and in the surrounding areas would be a continuous process. A vigil would be kept on illegal mining, illegal fishing and hazardous electric connections in the villages and farmlands. The patrolling squad is not a replacement of the regular patrolling done by the Rangers and other frontline staff; it is an addition to that.

4.14.4. Intelligence gathering would be done at various locations such as bus stations/stands, roadside dhabas (restaurants), liquor shops, hotels, railway stations through a network of local contacts amongst the communities. Check posts with CCTV surveillance would be erected at strategic points on State Highway 31A and Gandhisagar- Rawatbhata interstate road to monitor vehicles passing through there. Maintenance of individual crime dossiers and monitoring of perpetual offenders should be made at Range level of the park as well as in the landscape.

4.14.5. Local people would be employed on daily wages, one in every village to develop a landscape level informal informant system. Identity of such informants would be kept secret as far as possible and they would be awarded with monetary incentives for useful and timely information. The local informants would directly report to the local Range Forest Officers about any movement of suspicious vehicles/people, use of electric fences/snares in the farmlands, incidence of any poaching, rescue/relief needs of wildlife, crop depredation, any livestock kills by predators etc. This information network would play an important role in prevention of poaching and other such negative interactions in and around Gandhisagar WLS.

4.14.6. A project implementation team consisting of NTCA, WII, Veterinarians, experts & personnel (as required), MP (& other states as required) Forest Department personnel- Chief Conservator of Forests (CCF) in charge of the project, Division Forest Officer/ Deputy Conservator of Forest (DFO/ DCF), ACF(s), RFO(s), deputy rangers, foresters and to the extent possible the forest guards would be selected on the basis of their interest, commitment and capabilities and posted for a minimum period of at least 3 years and if possible up to 5 years as decided mutually by the implementation agencies. The senior members of the team, including senior officer(s), lead scientist, project biologist(s), veterinarian(s) and others as required would be sent on a training tour to selected tiger reintroduction sites in India and cheetah reintroduction sites in African countries. The composition of the team for training would be decided by as decided mutually by the implementation agencies and National/ International cheetah experts. The senior members, who would be trained abroad, would train the junior staff of Gandhisagar WLS. Modalities would be explored for payment of 'Project Allowance' to the entire staff working for Gandhisagar WLS similar to the allowance paid to the staff working for Project Tiger.

4.14.7. To provide adequate amenities and ensure welfare of the staff, a staff welfare fund would be developed based on revenue generated through tourism (canteen, sale of merchandise, etc. as is being done in Kanha Tiger Reserve). The fund would provide the frontline staff with financial assistance and incentives as and when required. Each staff (permanent and temporary) working under the cheetah introduction project would be provided with a life and accident insurance as well as a full medical reimbursement policy during his/her service period under the project. Uninterrupted supply of field kits, medicines, mosquito nets, torches etc. to the frontline staff of Gandhisagar WLS would be ensured. Remote area allowances as per the government rules would be paid to staff deputed in the park.

4.14.8. Increased mobility of staff, arms and equipment

Gandhisagar WLS would be provided with at least two additional patrolling vehicles (four-wheel drives for regular patrolling) and two mini trucks (with four wheel drives) for carrying trap cages and other necessary gear and materials during wildlife rescue operations. Additional four-wheel vehicles would also be provided to the adjacent forest ranges,





which are sensitive to wildlife crimes. Frontline staff would be provided with motorcycles for daily beat patrolling. Running costs of the vehicles/motorcycles (fuel and maintenance) would be borne by the State Forest Department. Arms and ammunitions would be purchased in sufficient amount with a minimum of three rifles, three shot guns and two pistols per range and distributed to the frontline staff after appropriate training in their safe use. Each forest beat would have a GPS unit, a laser range finder, one see through compass (Sunnto), one binocular and one digital camera for patrolling and monitoring wildlife. Photo documentation of wildlife crimes, wildlife rescue/treatment operations and human-wildlife negative interaction cases would be made mandatory. Night patrolling (on foot or motorcycles) is helpful for catching offenders and acts as a major deterrent of crime. A photo-copier-fax-printer and a computer would be provided to each Range office for facilitating office work and managing data on patrolling through M-STriPES. Distribution of adequate mobile phones, wireless walkie-talkie sets (minimum one hand set per beat) to all frontline staff would be ensured. Staff without any access to electric connections would be provided with extra batteries and solar chargers.

4.14.9. Training

Regular in-house training of the forest officials, veterinary team, frontline staff and cheetah tracking teams would Regular in-house training of the forest officials, veterinary team, frontline staff and cheetah tracking teams would be organized periodically. The field staff would be trained by international cheetah experts and the possibility of having an expert at the field site for longer durations during the initial phase of the cheetah introduction would be explored as required. Training on jurisprudence, wildlife forensics, and aspects of illegal wildlife trade would be organized for local forest department staff with the help of institutions/organizations of national repute and expertise. Cheetah management and research teams in coordination with the NTCA would organize regular training programs for the officers and staff on issues like protection and enforcement, smart patrolling, ecological monitoring of cheetah, prey, other wildlife and habitat (such as handling of GPS and other equipment, line transects, camera traps, drones, radio-telemetry, M-STriPES, digital photography, habitat management, wildlife crimes, wildlife forensic, jungle survival skill, rescue operations, personal safety and first aid etc.) in Gandhisagar WLS.

4.14.10. Additional computers and peripherals would be purchased at various administrative -Circle, Division and Range levels to cope up with maintenance of increasing amounts of records. Additional clerical posts (data manager, computer operator, hardware engineer, accountant, wireless operators etc.) would be created and recruited as per need in the future.

4.14.11. Inter-sectoral collaborations

Much of the success of the Gandhisagar cheetah introduction program would depend on inter-sectoral collaborations with different line agencies in the long-term. Collaboration with police and revenue department is essential to design conservation friendly land policy and strengthening protection in and around Gandhisagar WLS. Assistance of armed police force would be sought in cases of confrontations. Similar alliances with other state governmental departments like agriculture, animal husbandry, rural development, tribal development, Public works department, transport, tourism, power, law etc. would be maintained. Officers from other departments would be oriented towards various aspects of wildlife conservation and legislations on a regular basis. A tehsil level monitoring committee under the chairmanship of SDO/DFO/DCF, Gandhisagar WLS/ Mandsaar Division and a district level coordination committee under the chairmanship of CCF/CF Ujjain would meet at least once in two months to supervise various facets of management and collaborations. MP forest department would also be prepared to work in close cooperation with the Rajasthan forest department especially with the adjoining territorial divisions of Chittorgarh and Kota for landscape management.

4.15. Community Participation: Awareness & Outreach, Human-Wildlife Negative Interaction Mitigation and Livelihood Enhancement

4.15.1. People's support and eco-development

Human dimensions of conservation interventions are pivotal, particularly in programs of carnivore introduction. The pre-eminent importance of considering people's reactions to receiving previously absent wild carnivores in their environment shines through in many of the contributions. The need to involve people whose livelihoods may be affected is absolutely essential, but when ignored may have disastrous consequences. The situation is relatively easy to manage in Gandhisagar landscape as the communities are used to living in close proximity of large carnivores.

4.15.1.1. Any conservation program cannot be sustained without the help of local communities, particularly large carnivores which require large landscape level management. Confidence of local villagers would be won through various outreach & awareness programs. Sarpanch/ Gram-pradhan/ Mukhiya (village headmen), local leaders, teachers, social workers, religious figures and other conservation agencies would be provided with a better stake in the conservation. Awareness programs would be run at schools, colleges and villages sensitizing people about the conservation issues and various schemes available with the forest department. Dissemination of public opinion (pro cheetah/ conservation) developed by elected representatives as well as civil servants will be a continuous process. Various pro-active rural development and eco-development projects such as construction and repair of village roads, financial and logistic aids for education and self-employment, construction of bridges, check dams,

anicut and cause ways, facilities to schools, clean drinking water facilities, sanitation (mobile toilets), medical facilities, solar street lights, solar cookers, improvement and repair of houses and protection from open irrigation well etc. would be introduced through inter-sectoral collaborations. Range officers would hold regular meetings with the village Panchayats (Councils)/ Gram Sabha (elected representatives) and other stakeholders about their concerns and attempts would be made whole-heartedly to solve them by inter-departmental deliberations. Social survey aiming at understanding the acceptance of local communities at various stages of cheetah introduction will be undertaken for developing management strategies.

4.15.1.2. A Cheetah Conservation Foundation (like Tiger Conservation Foundation) would be established where gate receipts, donations get deposited and 40% of the revenue generated goes to communities in the peripheral villages as well as proposed buffer zone and percolate to the marginalized local communities of the society while the rest are used for park management. This would substantially prevent them from anti-social activities.

4.15.1.3. To enhance the natural prey population in the area, poaching proclivities, if any, among the local communities would have to be controlled. Collaborations with state animal husbandry department would be made to promote and establish poultry farms in the area for providing easy access to meat for local people.

4.15.2. Veterinary initiatives

All free-ranging dogs in the surrounding villages would be vaccinated against rabies, canine distemper and parvovirus periodically, to prevent the contagion from reaching cheetahs and other wildlife and to prevent infection of the local human population. Free-ranging dogs seen inside the cheetah habitat within the sanctuary harassing wild ungulates would be controlled.

Persons bitten by dogs or jackals in and around the Sanctuary would be inoculated against rabies free of cost by the forest department. To prevent spread of livestock borne diseases (such as anthrax), a veterinary monitoring system would be introduced wherein all the livestock of the surrounding villages would be vaccinated for foot and mouth disease (FMD), rinderpest at free of costs by the forest department. Water points would be cleared with lime annually. Continuous disease monitoring of the populations of wild ungulate and feral cattle within the NP would be undertaken

4.15.3. There are no known or historically recorded attacks by cheetah on humans. Cheetah may predate small livestock like sheep and goats. Understanding people-carnivore relationship becomes crucial especially for the conservation of large carnivores and contribute to success of the cheetah introduction program in Gandhisagar landscape in the long-term. Cheetah research team would carry out a continuous study to understand livestock predation pattern by large carnivores and aim to understand local people's perception towards conservation. Site-specific mitigation measures would be implemented based on the inferences of such studies. Livelihood securities for the local communities need to be ensured at any cost. Reparative measures such as compensation schemes have no substitute in shaping successful conservation programs worldwide. Activities like paying timely compensation would be considered as ecosystem maintenance costs that need to be paid to the local communities.

4.15.4. Since various carnivores will be radio-collared, predation events on livestock would be very easy to validate and compensation would be paid within 24 hrs. of the event to prevent retaliation. Compensation cannot buy one's tolerances but majority of the people see it as an instant financial relief. Therefore, the compensation rates for livestock predation for various livestock productivity classes would be decided after a thorough market survey. The compensation scheme would be revised regularly (preferably every 3 years) to truly reflect the changing local market prices.

4.15.5. Crop damage compensation in reflectance with market price would be initiated urgently. A single channel mechanism of payment by Forest Department needs to be explored for ease of efficient dispensation and preventing local antagonism. A forest officer not below the rank of a Deputy Range Forest Officer would investigate the site within 48 hours of the occurrence and decide upon the extent of damage and compensation. Quantifying crop damage is not always an easy task because of a number of ambiguities. National conservation agencies having experience in working on similar front would be involved in this. A better alternative is to subsidize crop insurance against damage by wild ungulates from the Cheetah Conservation Foundation. Crop damage compensation is likely to diminish negative interactions in two ways. On one hand, it would allow farmers to stay away from fields thereby exposing them less to the attacks by wildlife. On the other hand, the farmers neither need to possess guns nor fix snares and electric fences around their farmlands thereby decreasing the likelihood of accidental deaths to non-target wildlife. Other crop damage mitigation measures such as pulsating electric fences (Chauhan, 2006), chain-link fencing of farms, erecting makeshift machans (watch/ guard huts) etc. would be subsidized. Collectively it would ensure greater tolerance of the local people towards wildlife.

4.15.6. A study on the patterns of crop damage would be undertaken as a part of the research and monitoring plan of Gandhisagar landscape so as to identify the areas prone to such damage and quantify the extent of economic loss faced by the communities. Based on the finding, fencing off boundaries of Gandhisagar WLS at certain strategic points in consultation with the local community to reduce crop damage and livestock grazing inside the park would be considered.

4.15.7. Farmers' choice of cropping patterns shape human-wildlife negative interactions considerably (Jhala 1993, Vijayan & Pati, 2002). An awareness program involving officials and experts from agriculture and wildlife departments and agriculture universities would be initiated educating local communities about this important aspect as well as guiding them about the high yielding yet eco-friendly varieties of crops available.

4.16. Wildlife Tourism, Eco-Clubs, Nature Education Camps and Revenue Generation

4.16.1. There would be a clear cut policy about wildlife tourism in Gandhisagar WLS. The park authorities and the civil administration of the region would prepare a five to ten-year site specific tourism policy in accordance with the Comprehensive Guidelines of the NTCA (memo no 15-31/2012-NTCA dated 15.10.2012) which would address the land-use and development of the surrounding areas as well. The plan prepared by the park management and civil authorities would be endorsed by the project steering committee and NTCA in consultation with cheetah management and research team. The plan would explicitly demarcate the park roads and the tourism zones in the Sanctuary and the larger Gandhisagar landscape. A tourism carrying capacity for the park would be estimated. This figure would be included in the Management Plan and be followed stringently without any violation.

4.16.2. Sustainable and conservative tourism subservient to the conservation needs of the PA and of the project would be encouraged so that jobs and business opportunities for the local people can be created, and the project and the Gandhisagar landscape get adequate public support. An attempt to generate revenues through brand building, marketing, sponsorships, merchandising etc. would be undertaken in complete consonance with the conservation objectives.

4.16.3. Wildlife tourism strategy being formulated for Gandhisagar has the opportunity to serve as a model for the rest of the country as there is scope and the opportunity to plan afresh here. However, many site-specific strategies need to be implemented well in advance. The control of tourism and the entry of vehicles in the PA would be controlled by administration of Gandhisagar WLS based on the tourism carrying capacity.

4.16.4. Business enterprises such as hotels, resorts, other commercial structures around the Sanctuary and the landscape as well as vehicles entering inside the park would be kept under strict vigil. No detrimental commercial establishment/ activity would be allowed within 1 km from the Sanctuary boundary. Ideally there should be a committee to ensure that any permanent buildings being constructed in a radius of 2 km of Sanctuary boundary should be approved by an aesthetics committee constituted by the SDO/ DFO/ DCF, representative(s) of the District Magistrate Office, local Panchayat Office and a member of the local NGO, to ensure that gaudy concrete block buildings are not constructed that mar the beauty of the landscape.

4.16.5. A Cheetah Conservation Foundation on the lines of Tiger Conservation Foundations would be set-up as mentioned above, where all gate and permit fees would remain with the park as being done in other Tiger Reserves of Madhya Pradesh. Hotels and resorts that use Gandhisagar WLS for their guest visits would be charged a small (~5%) but significant tax on their profits that would be deposited in the Cheetah Conservation Foundation. Forty percent of the tourist revenue would be ploughed back in to local community welfare in the peripheral villages and the proposed buffer zone subsequently. Preference would be given to those communities that have been resettled from within Gandhisagar WLS as far as possible. Mechanisms would be put in place so that all community members are aware of the financial benefits they are receiving are due to cheetah introduction. Awareness campaigns, school nature camps, illustrated talks, video shows, special films made on this topic would be screened on regular intervals in all villages around the Park.

4.16.6. There is potential for earning significant revenues from the project from filming, photo documentation, merchandising, sponsorship and tourism on a competitive basis. This income would be credited to the Cheetah Conservation Foundation and would be spent on its management as well as for assisting the local communities, as per the system already prevailing in the State of MP. A proactive approach to market the project as a brand would be adopted to promote conservation as an economic activity, after fully ensuring that it in no way hampers the conservation interest and priorities of the project and of the Protected Area.

4.16.7. In order to spread awareness among local people and sensitize the youth, eco-clubs, nature education camps, teacher training camps, street plays etc. would be organized regularly. A directory of local NGOs, wildlife enthusiasts and nature lovers would be maintained for assisting the department in such awareness programs.

4.17. Publicity and Media Management

Pro-active media management with scientific facts and not based on speculations or educated guesses would be adopted by the project implementing agencies. A media spokesperson (preferably the project Steering Committee, Forest department representative, NTCA representative, Cheetah management and research teams' representative(s)) would only officially liaise with the media and statement from any other person from the departments should not be considered as 'official'. A media note briefing the latest updates about the project would also be issued/uploaded at a regular intervals by the NTCA and forest department of Madhya Pradesh in consultation with the project Steering Committee and the cheetah management and research teams. Content on important information/ developments of the project would be created as and when required would be updated on social media through appropriate channels. Media would be sensitized to acknowledge that they have an immense role in making local/global audience aware of the scientific facts and figures about the project/ conservation issues, shaping public opinion and they should act responsibly while promoting conservation efforts.

4.18. Landscape management

The larger landscape of interstate cheetah conservation complex envisaged for cheetah in this action plan and population establishment requires availability of gregarious ungulates in the restored habitat with a high relative abundance, as other large carnivores such as leopard and wolves inhabit the area. The fenced area in Gandhisagar WLS would be fostered as a cheetah source area to supplement populations of cheetah in areas outside after habitat restoration. Additionally, Bhainsrodgarh WLS with a predator proof fenced area similar to Gandhisagar WLS and the existing enclosure with adequate reinforcements in Mukundara Hills Tiger Reserve can serve as cheetah source sites and surplus animals from these sites can be released into the larger landscape after substantially restoration. Thus, there is a need for an ongoing, in-situ, as well as active, prey augmentation actions with habitat restoration in Gandhisagar WLS and the surrounding larger landscape including Kuno landscape. Gandhisagar WLS will be managed with an "exclusive" cheetah mandate and including the source-sink dynamics of the cheetah along with the "inclusive" restoration mandate for the surrounding larger landscape (Gopal *et al.*, 2023).

The cheetah translocation is proceeding in the right direction with valuable understandings from Kuno for its field management, paving the way for such future endeavors. Surroundings of every wildlife PA require preventive and control measures for addressing human-wildlife interface situations with Rapid Response Teams constituted from various sectors. A multi-sectoral masterplan of landscape approach for cheetah management with mutually beneficial local community stewardship and stakeholder engagement is required. The implementation and monitoring of the masterplan based on sustainable indicators which are multidimensional, requires an administrative mechanism with due legitimacy (Gopal *et al.*, 2013).

The landscape approach will focus on multi-stakeholder engagement. The conservation of cheetah, as well as other wildlife, would have to be incorporated in all sectors/land uses/practices of stakeholders, based on mutually beneficial deliberations, agreements and actions. The formulation of the planning process would be at the district level, through the existing process of bottoms up planning, viz. at gram panchayat for areas of rural-forest interface, ward levels/local bodies for urban areas, and linkages with wildlife/PA management plan for notified PAs. The integration at district level is crucial to enable funding support for actions prescribed for the regional plan, apart from implementation and monitoring (Gopal *et al.*, 2023).

The initial funding allocation needs to start at the district level for all proposed actions. However, some may necessitate extra allocation warranting a complementary funding strategy. The resource mobilization strategy needs to aim towards leveraging funding from multiple sources, based on the identified action portfolio across three categories for each planning unit (gram panchayat/urban wards/PA) in a district or portions of more than one district within the envisaged greater landscape. An abstract of available financial outlay needs to be formulated for mapping available sources of funding, and integrated in the Annual Plan of Operations (APO), and communicated to every planning unit. A few of the funding sources that could be channelized are State and Central Government Scheme/funds, Central/State Finance Commission grants, Member of Legislative Assembly (MLA)/Member of Parliament (MP) funds, Local revenue (receipt through tax, cess for local use), Incidental receipts, Special projects and donor grants, Investments from public enterprises. (Gopal *et al.*, 2023). Additionally, money available under Corporate Social Responsibility (CSR) and Corporate Environmental Responsibility (CER).

4.19. Annual Review and Monitoring

NTCA in coordination with project Steering committee, MPFD and the cheetah management and research teams would invite wildlife managers and conservation biologists and agencies of the country/abroad with subject knowledge/working experiences to seek their expertise during several phases of the project implementation. This is also likely to broaden institutional representation in the project implementation and enhance its credence and credibility. After the cheetahs are brought to Gandhisagar WLS, the progress of the project would be reviewed every six months in the first five years and subsequently once a year by NTCA, MPFD and cheetah management and research teams along with the International/National experts (as and when required), and wildlife biologists of the country. Such monitoring would be a long-term (20-25 years) process and be coordinated by NTCA in association with MPFD and cheetah management and research teams. It is recommended that the results and findings of cheetah introduction be published and peer-reviewed at frequent intervals to allow other conservation attempts

to benefit from the experiences. This would be part of a continuous feedback loop with the results of the documented evaluation leading to alterations to the existing cheetah introduction program via an adaptive management strategy. Although the guidelines promulgated in the current Action Plan are likely to be relevant for long-term (15-20 years); they would, however, be revised by NTCA in consultation with MPFD and national/ international cheetah experts/agencies as per emerging situations during various implementation phases of cheetah introduction.

4.20. Criteria for Assessing Success and Exit strategy

The cheetah introduction program requires long-term (at least 25 years) financial, technical and administrative commitments from MoEF&CC, NTCA, MPFD (State forest departments of other introduction sites) and WII. Similar to the criteria envisaged for Kuno, the following aspects will be used as indicators of progress.

4.20.1. Criteria for project success for the short-term

- 50% survival of the introduced cheetah for the first year.
- Cheetah establish home ranges.
- Cheetah successfully reproduce.
- Some wild born cheetah cubs survive to > 1 year.
- F1 generation breeds successfully.
- Cheetah based revenues contribute to community livelihoods.

4.20.2. Criteria for assessing long-term success of the project

- Cheetah are established as an integral part of the ecosystem with natural rates of survival (~70% adults, 25-40% cubs/juveniles) and reproduction.
- Long-term viable metapopulation is established in India (in combination of 3-5 cheetah reserves).
- Genetic diversity of established cheetah population(s) in India are representative of their founder population(s).
- Major increase in quality habitat, prey, and mammalian diversity seen in Cheetah Conservation Reserves.
- Local communities make significant improvements in their economies through Eco development from cheetah conservation foundations and direct remunerations through employment generation.

4.20.3. Failure

Introduced cheetah do not survive or fail to reproduce in five years. Failure of securing cheetah habitats in the larger landscape and commence investments in their restoration through protection, habitat management and prey augmentation. In such a case, the Program needs to be reviewed for alternative strategies or discontinuation.

4.21. Conclusion

Cheetah as a species are constrained by space across their range, protected landscapes of India offer to extend the range of the cheetah and contribute to global efforts in conserving them. Additionally, cheetah introduction in India would greatly enhance local community livelihoods through eco-tourism prospects. Carnivore reintroduction/ conservation translocation is an appropriate conservation strategy to restore the integrity of ecosystems. The restoration of cheetah in India must be viewed not simply as an introduction of a species, however charismatic it may be, but as an endeavour to better manage and restore some of country's most valuable yet most neglected open natural ecosystems and the species dependent upon them.

This Action Plan developed in accordance with the IUCN guidelines aims to implement the cheetah introduction program in Gandhisagar WLS based on science, proactive and adaptive management. After successful introduction in Gandhisagar WLS and at couple of other sites has been demonstrated and a metapopulation established at Kuno- Gandhisagar and other sites, cheetah could then be considered for release in suitable sites within other States. This would achieve the full potential of Project Cheetah in reviving the ecosystem services from these cheetah conservation landscapes, enhance local livelihoods and restore the lost natural heritage of India.



ANNEXURE I

Status of prey in Gandhisagar Wildlife Sanctuary

Field sampling to assess prey populations was conducted in Gandhisagar Wildlife Sanctuary (WLS) in December 2023. Sampling protocols were designed and adopted from to assess tigers, co-predators, prey and habitats across tiger landscapes in India (Jhala *et al.*, 2013). Distance sampling survey was conducted during December 2023-January 2024.



Figure 1A. Map of the line transects sampled in each beat of in Gandhisagar Wildlife Sanctuary to assess the status of prey.

A1. 1. Estimation of prey densities using line transect Line

Line transect method was used to estimate population density of prey (Buckland *et al.*, 2001). A forest beat (area demarcated for patrolling) was considered as the sampling unit and a fixed habitat-stratified line transect with length varying from 02 to 03 km was walked. A total of foot survey effort of 372 km using 82 line transects was carried out in ~368 km² of the Sanctuary to estimate prey densities. As per All-India Tiger Estimation Protocol, all data were collected through M-STrIPES application and imported & analysed in the M-STrIPES desktop software (Qureshi *et al.* 2023). Start and end locations (GPS coordinates) of each transect were recorded using an e-Trex 30 GARMIN® GPS unit. Accurate distance measurement of prey sighted on the line transect was recorded with the aid of a laser range finder (Bushnell 800 pro). A see through compass (Suunto) was used to record transect walk bearing and animal bearing. All prey species detected along with their cluster sizes were recorded. During the sampling, chinkara, nilgai, chital, wild pig, hare, peafowl, langur, buffalo, cattle and goat were observed.

To quantify the habitat parameters and determine levels of human activities, vegetation plots were sampled at every 400 meters along the line transect. A total of 432 vegetation plots were sampled for number of trees per species in 15-meter radius, shrub percentage per species in 5- meter radius and grass species in 1-meter radius. Human activities such as number of woodcutting and lopping signs, bamboo cutting signs and presence of fire and domestic cattle (direct or indirect

evidence) were noted. For ungulate pellets count, an area of 2m×20m was sampled on the alternatively on the opposite side of the vegetation plot along the transect line.

A1. 2. Analytical methods

Estimation of prey densities using line transect data: Animal sightings from the line transect data were analysed using DISTANCE 7.5 software (Thomas et al. 2010). Distance analysis enables the computation of detection probability for the sightings obtained during transects (Buckland 1985; Buckland *et al.*, 1993). This detection probability provides estimation of animal abundances without the influence of biases in detection of animals that may arise due to varying habitat types, animal sizes or group sizes. Density Surface models were obtained for two species viz. chinkara and nilgai.

A1. 2. 1. Model selection

For DISTANCE analysis, several models were used with varying group intervals and truncations of perpendicular distances to select a model that best fit the data. Detection function was usually fitted using half-normal, hazard rate or uniform models as key functions with cosine series expansion. Outliers from the data were truncated. AIC values, goodness of fit tests, visual inspection of the detection function and variances associated with the estimates obtained were used to select the most appropriate model for each prey species (Buckland *et al.*, 2001). The data obtained with adequate number observations was post-stratified to estimate densities of chinkara, nilgai, hare, buffalo, and cattle in three areas viz., inside and outside the fenced areas in West Range and East Range of Gandhisagar WLS.

Table 1A: Species wise encounter detected during the line transect based distance sampling in Gandhisagar Wildlife Sanctuary.

	Fenced-Gandhisagar West		Outside-Gandhisagar West		Gandhisagar East	
Effort in km	72		156		144	
Species	No. of observations (individuals)	Encounter rate per km -Group (individuals)	No of observations (individuals)	Encounter rate per km -Group (individuals)	No of observations (individuals)	Encounter rate per km -Group (individuals)
Chinkara	37 (131)	0.51 (1.82)	11 (15)	0.07 (0.10)	23 (99)	0.16 (0.69)
Nilgai	36 (63)	0.50 (0.88)	32 (79)	0.21 (0.51)	47 (90)	0.33 (0.63)
Hare	4 (4)	0.06 (0.06)	6 (6)	0.04 (0.04)	24 (24)	0.17 (0.17)
Peafowl	0	0	4 (8)	0.03 (0.05)	6 (20)	0.04 (0.14)
Wild pig	2 (35)	0.03 (0.49)	7 (87)	0.04 (0.56)	1 (10)	0.01 (0.07)
Chital	1 (5)	0.01 (0.07)	2 (5)	0.01 (0.03)	0	0
Langur	0	0	1 (1)	0.01 (0.01)	0	0
Buffalo	19 (116)	0.26 (1.61)	12 (80)	0.08 (0.51)	21 (102)	0.15 (0.71)
Cattle	34 (304)	0.47 (4.22)	32 (242)	0.21 (1.55)	25 (232)	0.17 (1.61)
Goat	0	0	1 (6)	0.01 (0.04)	1 (28)	0.01 (0.19)

A1. 3. Results

The density of chinkara, nilgai and livestock inside the fenced area were found to be higher than outside (Table 2). Livestock density was the highest inside the fenced area followed by chinkara and nilgai. Outside the fenced area, livestock density was the highest followed by nilgai and chinkara. The disproportionality of livestock density within and outside the fenced area was due to increase in patrolling and security near the fence but limited to broad daylight hours. The survey was conducted when portions of the fence was open and livestock were sent inside early mornings by the local people and encountered during sampling, whereas outside the fenced area, livestock would be driven towards the forest later in the day as it was winter.

The density estimate of chinkara inside the fenced area was 7.38 (2.00SE) animals per km², whereas outside in the West Range, it was found to be very low with 0.3 (0.14SE) animals per km². Within the fenced area of ~60 km², the estimated population of chinkara is ~443 animals. Density estimate of nilgai inside the fenced area was 4.35 (1.17 SE) animals per km² and almost double compared to that of density outside. A quarter of the Nilgai sighted during the sampling comprised of calves and young animals. Prey estimates of three wild prey species were obtained from distance sampling using line transect. Chinkara was the most abundant wild prey species inside the fenced area followed by Nilgai and hare (1.82, SE 0.88).

Table 2A. Summary of prey densities in Gandhisagar Wildlife Sanctuary obtained from line transect based distance sampling during.

Species	Area	Density (SE)	CV	MCS (SE)	ESW	Model	Adjustment key	Estimated population
Chinkara	Fenced - GSW	7.38 (2.00)	27.15	3.96 (0.50)	138.02 (13.36)	Half normal	Simple Polynomial	442.8
	Outside side GSW	0.33 (0.13)	39.52	1.31 (0.2)				39.6
	GSE	3.33 (1.33)	40.11	5.76 (1.09)				599.4
	Global	11.05	22.81					1081.8
Nilgai	Fenced - GSW	4.35 (1.17)	27.05	1.59 (0.15)	91.77 (8.26)	Half normal	Simple Polynomial	261
	Outside GSW	2.7 (0.94)	34.91	2.49 (0.44)				324
	GSE	2.86 (0.63)	22.26	1.6 (0.14)				514.8
	Global	9.91	18.04					1099.8
Hare	Fenced - GSW	1.82 (0.88)	48.18	1	15.201 (2.02)	Half normal	Simple Polynomial	109.2
	Outside - GSW	1.26 (0.65)	51.63	1				151.2
	GSE	5.48 (1.54)	28.21	1				986.4
	Global	8.57	24.11					1246.8
Buffalo	Fenced - GSW	8.98 (3.68)	40.96	7.06 (1.5)	103.75 (17.22)	Uniform	Simple Polynomial	538.8
	Outside - GSW	4.57 (2.48)	54.24	12.33 (3.69)				548.4
	GSE	3.13 (1.15)	36.78	4.46 (0.75)				563.4
	Global	16.99	30.33					1650.6
Cattle	Fenced - GSW	21.47 (8.01)	37.32	11.25 (3.07)	123.68 (7.91)	Half normal	Simple Polynomial	1288.2
	Outside - GSW	6.29 (2.91)	46.24	7.59 (2.26)				754.8
	GSE	6.58 (2.85)	43.3	9.37 (2.4)				1184.4
	Global	34.35	26.81					3227.4
Large Livestock	Fenced - GSW	28.39 (8.43)	29.7	9.32 (1.66)	120.89 (7.47)	Half normal	Cosine	1703.4
	Outside - GSW	9.84 (3.50)	35.38	8.63 (1.98)				1180.8
	GSE	8.70 (2.37)	27.28	6.59 (1.01)				1566
	Global	46.94	20.62					4450.2

CV- Coefficient of Variation, MCS- Mean Cluster Size, ESW- Effective Strip Width, GSW- Gandhisagar West Range, GSE- Gandhisagar East Range



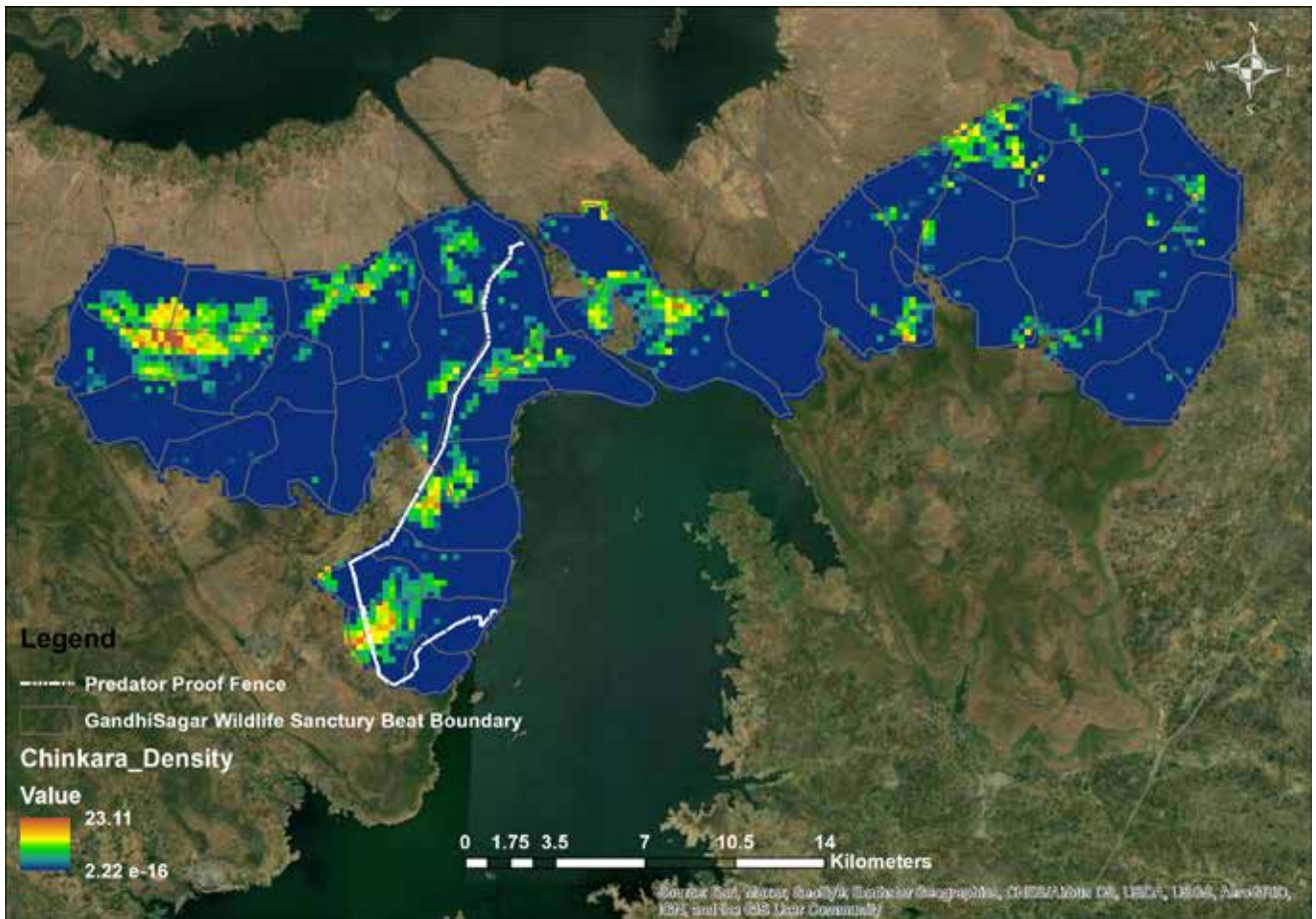


Figure A 1.1: Density surface map of Chinkara in Gandhisagar Wildlife Sanctuary

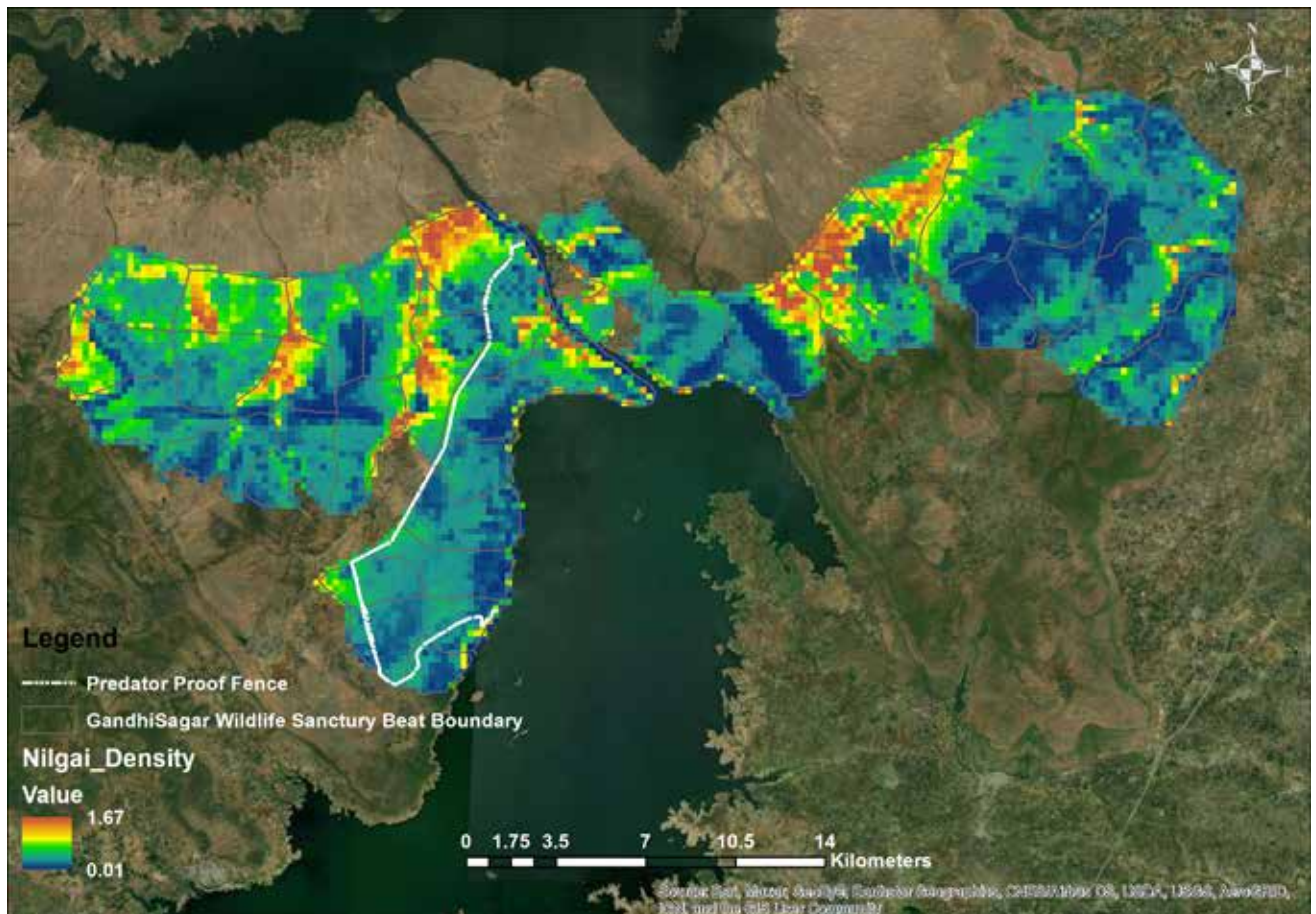


Figure A 1.2: Density surface map of Nilgai in Gandhisagar Wildlife Sanctuary

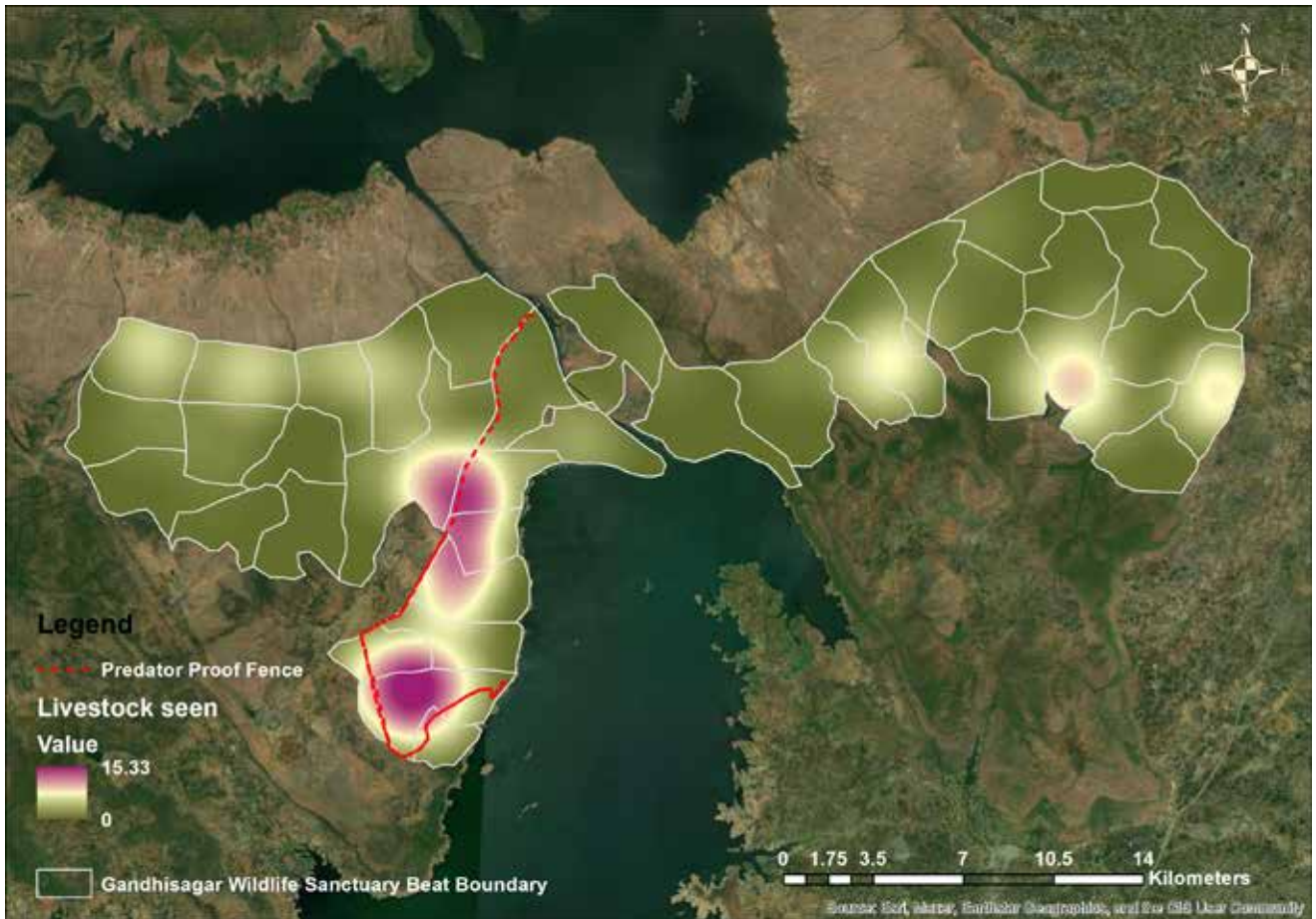


Figure A 1.3: Figure Distribution of Livestock encountered in Gandhisagar Wildlife Sanctuary

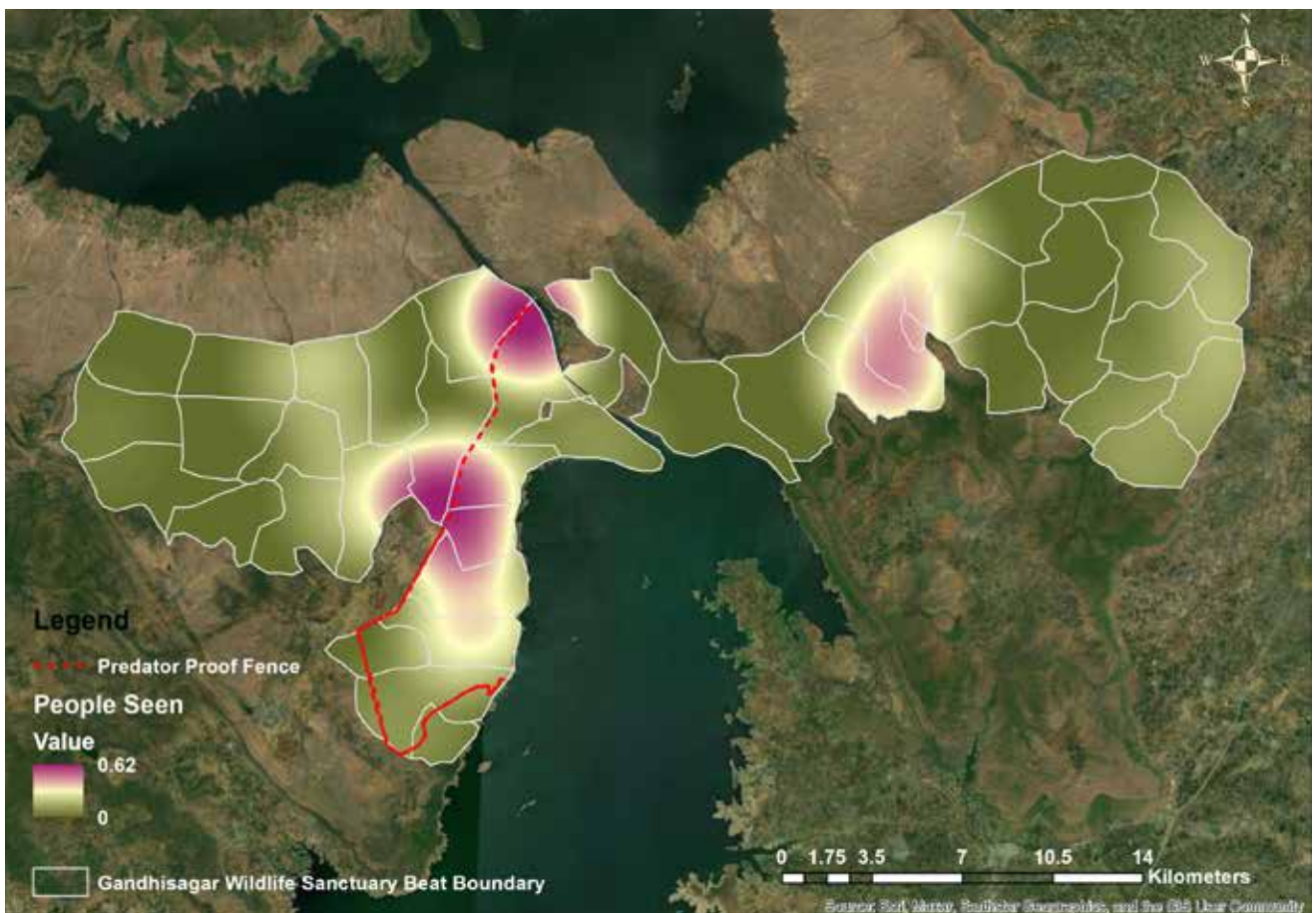


Figure A 1.4: Distribution of people encountered in Gandhisagar Wildlife Sanctuary

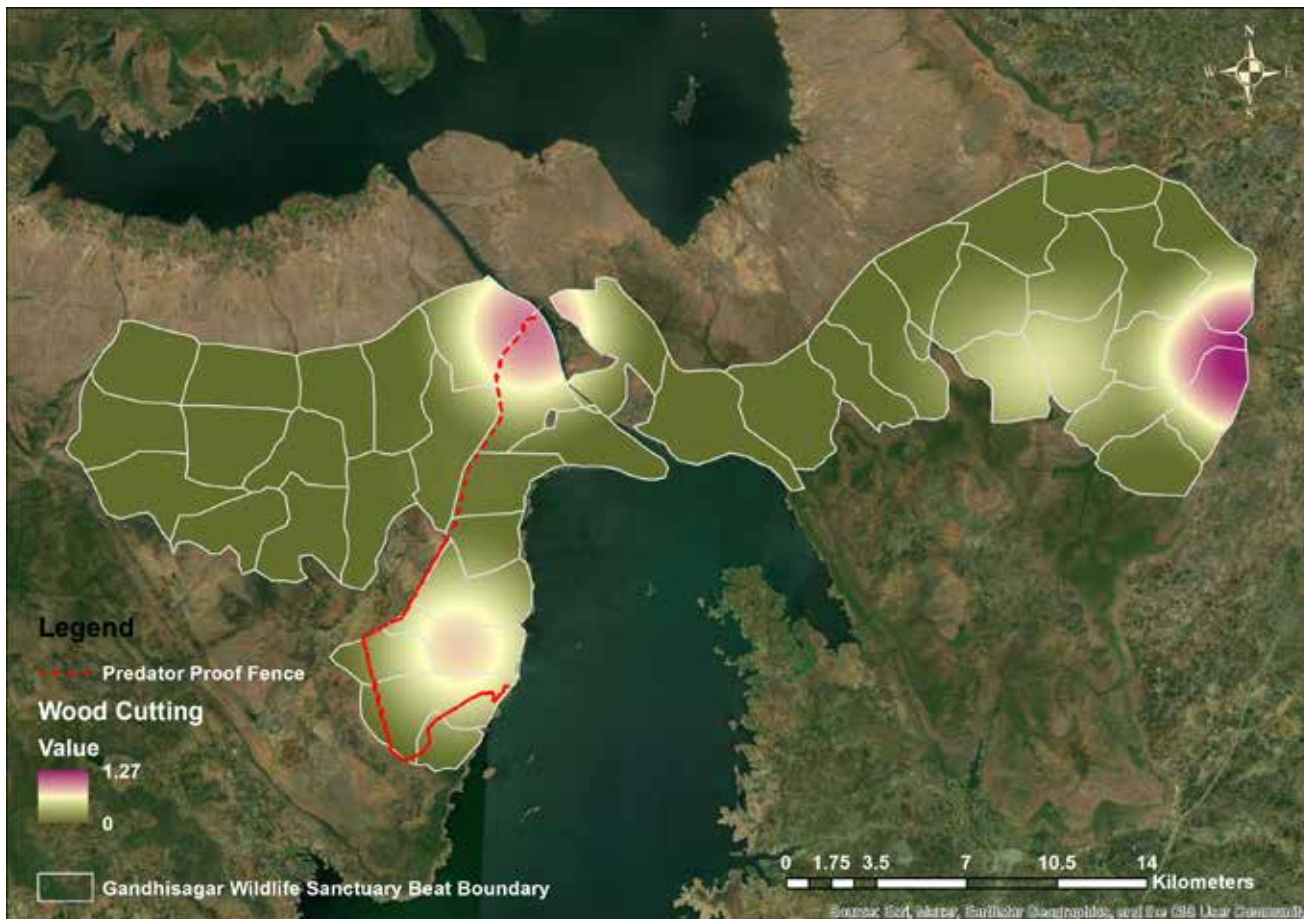


Figure A 1.5: Distribution of signs of wood cutting encountered in Gandhisagar Wildlife Sanctuary

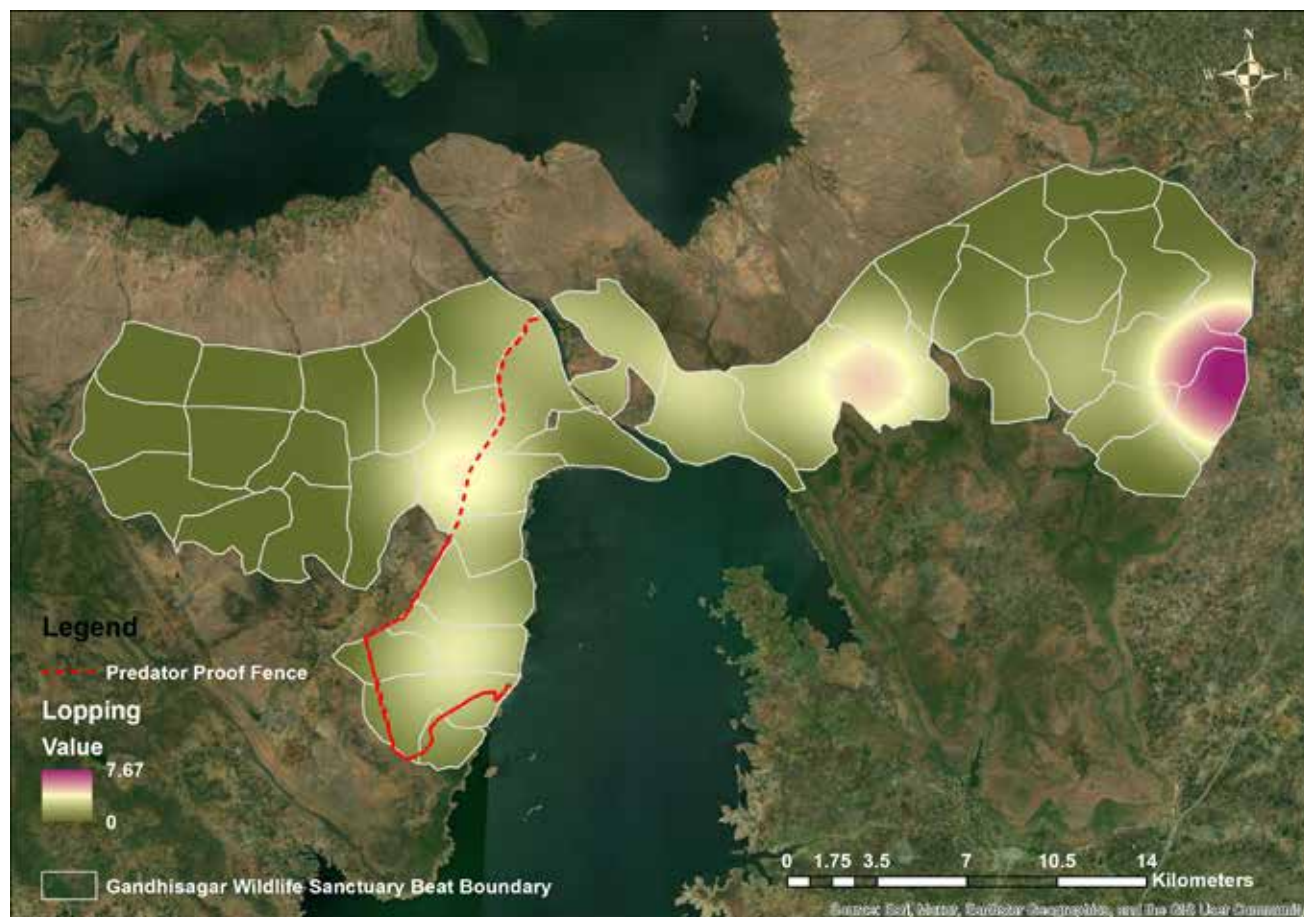


Figure A 1.6: Distribution of signs of lopping encountered in Gandhisagar Wildlife Sanctuary

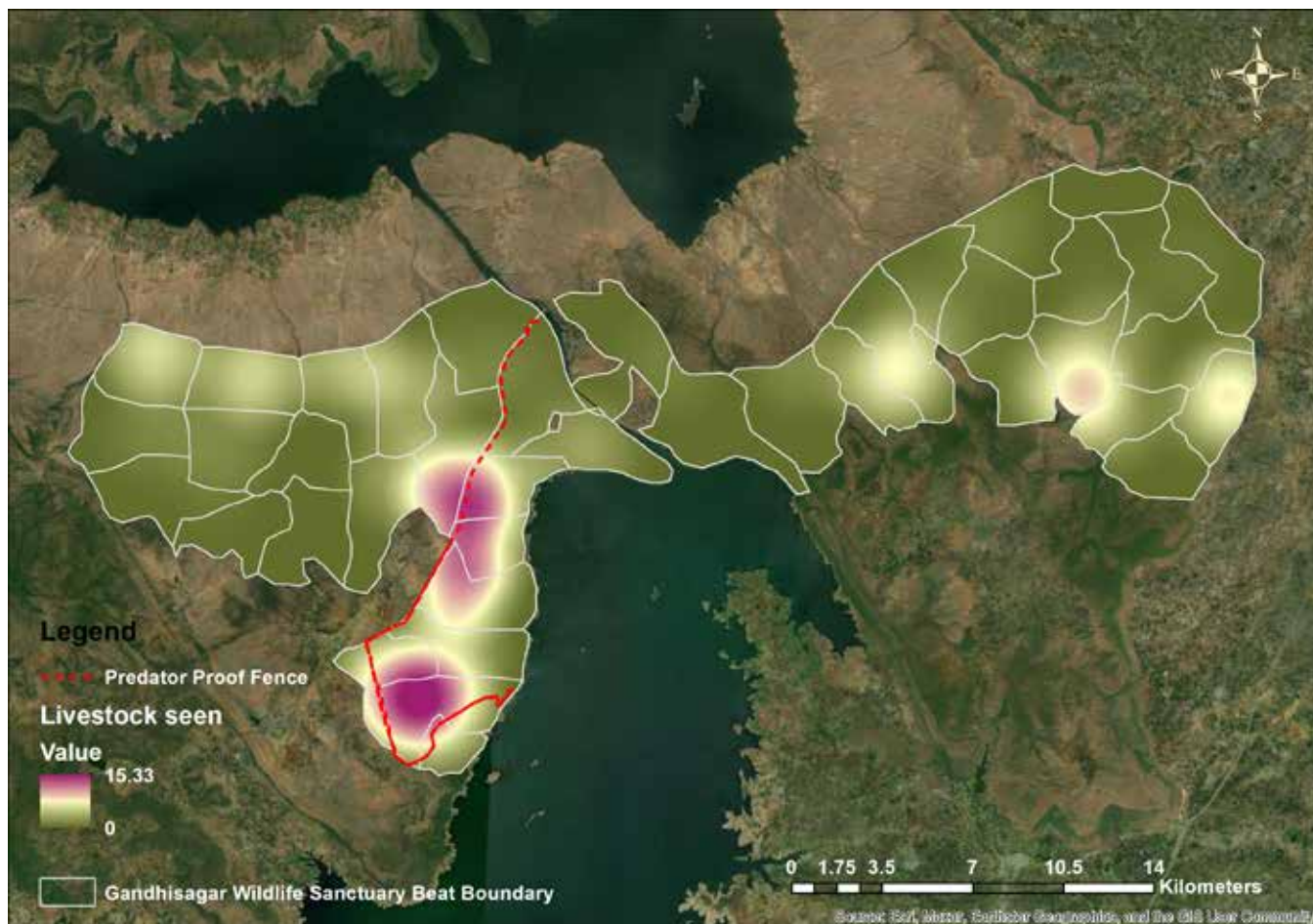


Figure A 1.7: Distribution of human trails encountered in Gandhisagar Wildlife Sanctuary

Detection function plots for prey species obtained from line transect based distance sampling in Gandhisagar Wildlife Sanctuary

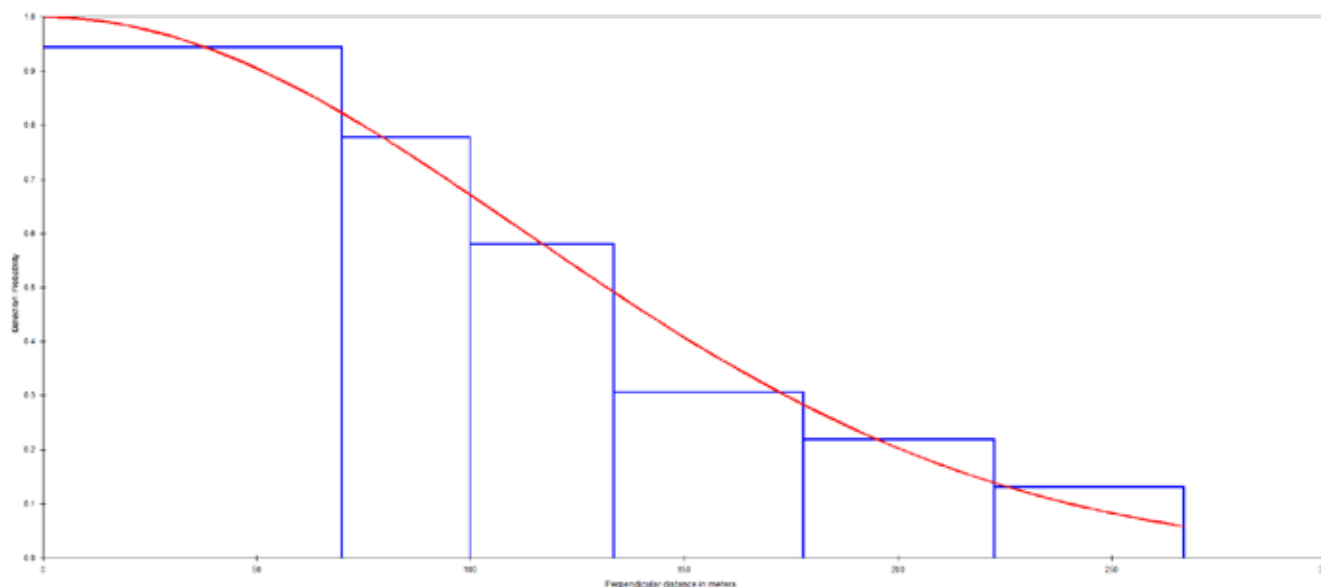


Figure A 1.8: Chinkara Fitted model: Half normal key model with polynomial adjustment term. ($\chi^2 - p = 0.94$, $p = 0.51$).

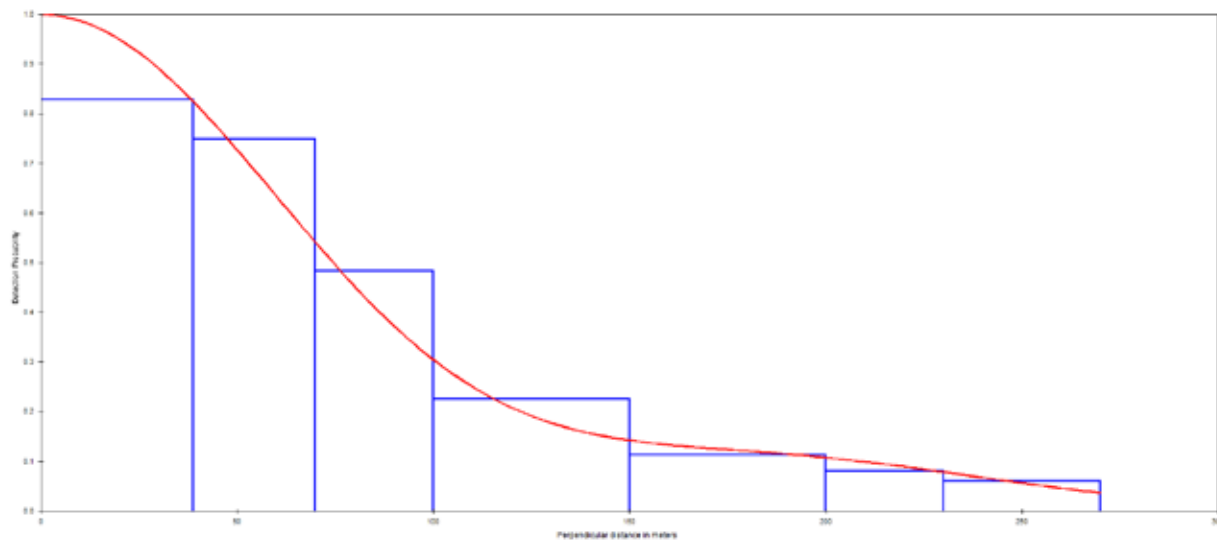


Figure A 1.9: Nilgai Fitted model: Half normal key model with cosine adjustment term. (chi -p = 0.81, p= 0.33).

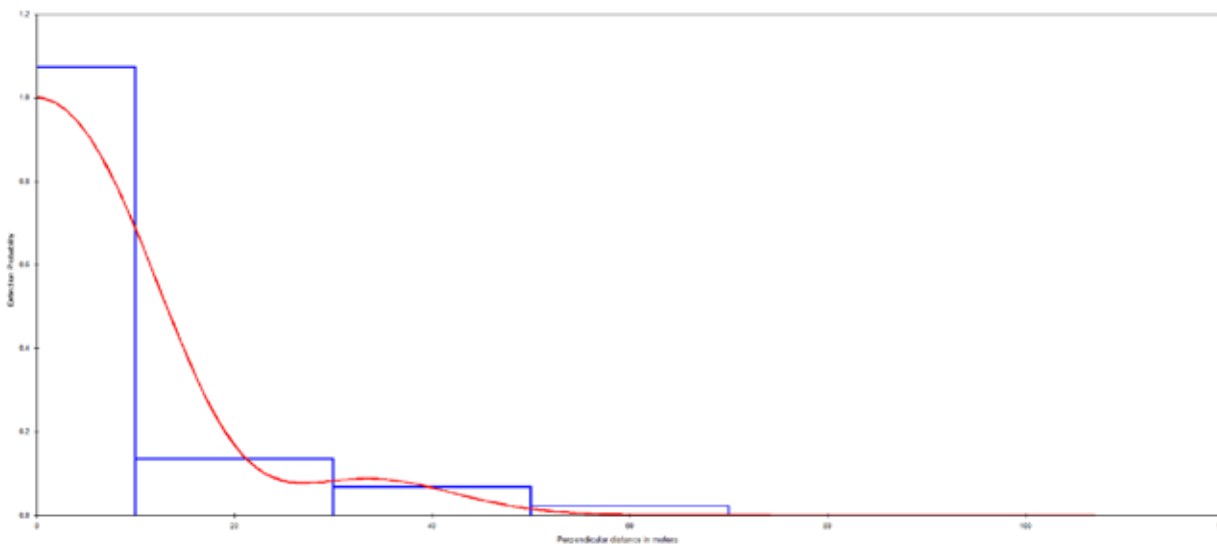


Figure A 1.10: Hare Fitted model: Half normal key model with polynomial adjustment term. (chi -p = 0.004, p= 0.14).

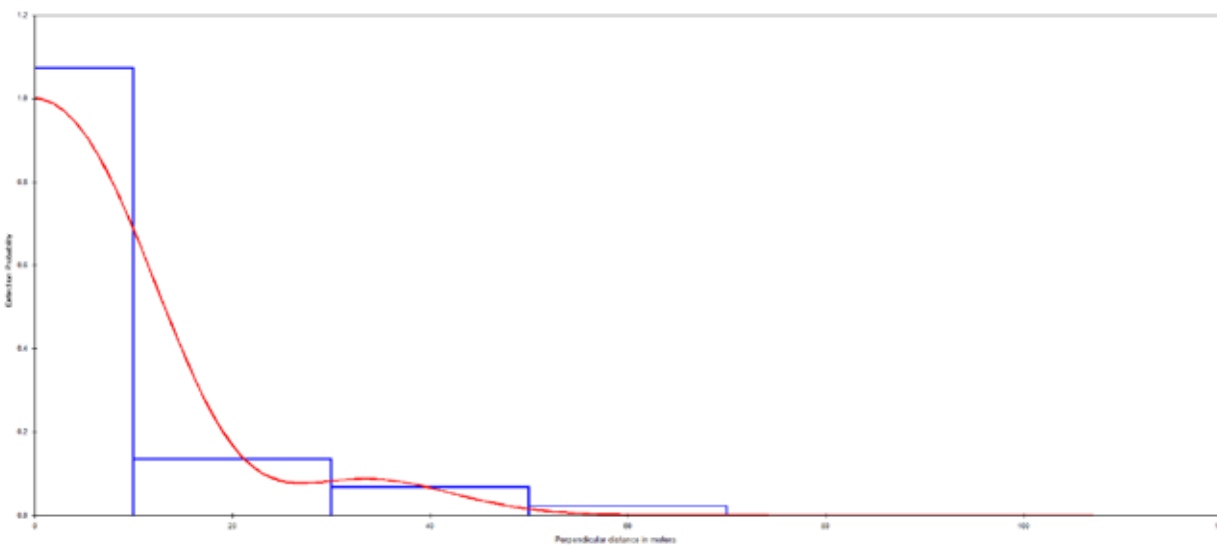


Figure A 1.11: Hare Fitted model: Half normal key model with polynomial adjustment term. (chi -p = 0.004, p= 0.14).

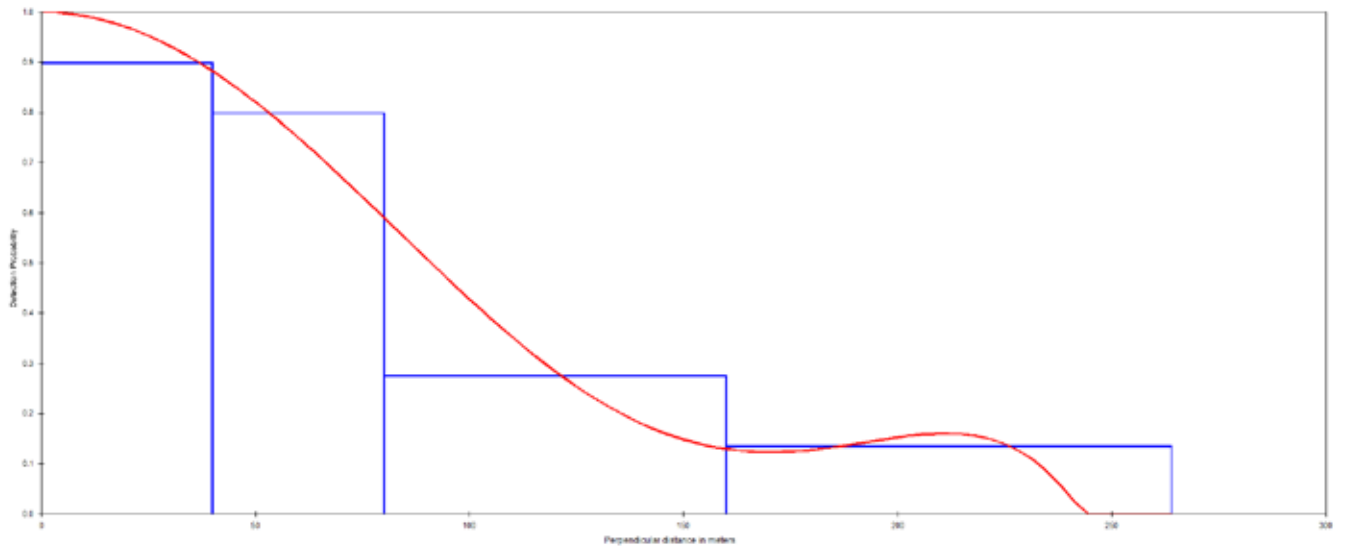


Figure A 1.12: Buffalo Fitted model: Uniform key model with polynomial adjustment term. ($\chi^2 - p = -1$, $p = 0.39$).

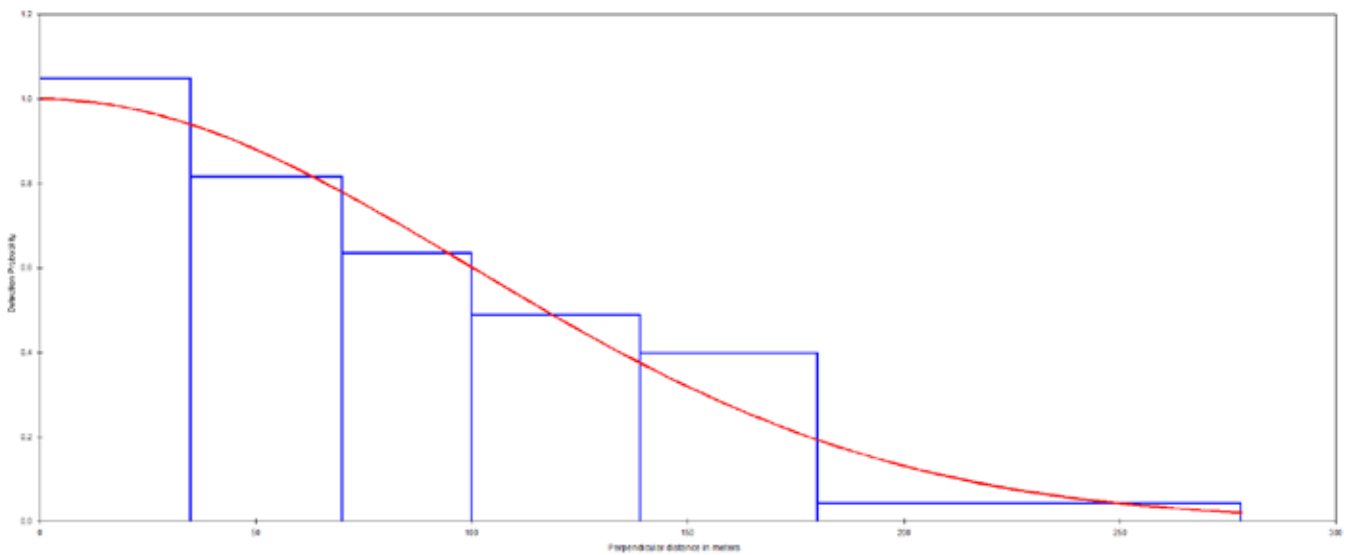


Figure A 1.13: Cattle Fitted model: Half normal key model with polynomial adjustment term. ($\chi^2 - p = 0.5$, $p = 0.44$).





ANNEXURE II

Status of Leopards in the West Range of Gandhisagar Wildlife Sanctuary

Table A2. Summary of leopard population estimation in the West Range of Gandhisagar Wildlife Sanctuary

Method	Spatially explicit capture recapture
Number of camera trap locations	80
Sampled Area	160 km ²
Effort	3630 camera trap days
Cumulative number of detected individuals ($M_{(t+1)}$)	70
Maximum displacement (male)	12 km
Maximum displacement (female)	6.8 km
Magnitude of detection function (g_0)- Male	0.0294
Magnitude of detection function (g_0)- Female	0.052
Spatial scale of detection function (σ)- Male	1853.36m (96.83)
Spatial scale of detection function (σ)- Female	1042.22m (41.18)
Mixing proportion (P_{mix})- Male	28.6%
Mixing proportion (P_{mix})- Female	71.3%
Density (SE)	28.5 (3.4) individuals per 100 km ²
Confidence limits (Upper-Lower)	22.5-36.1 individuals per 100 km ²

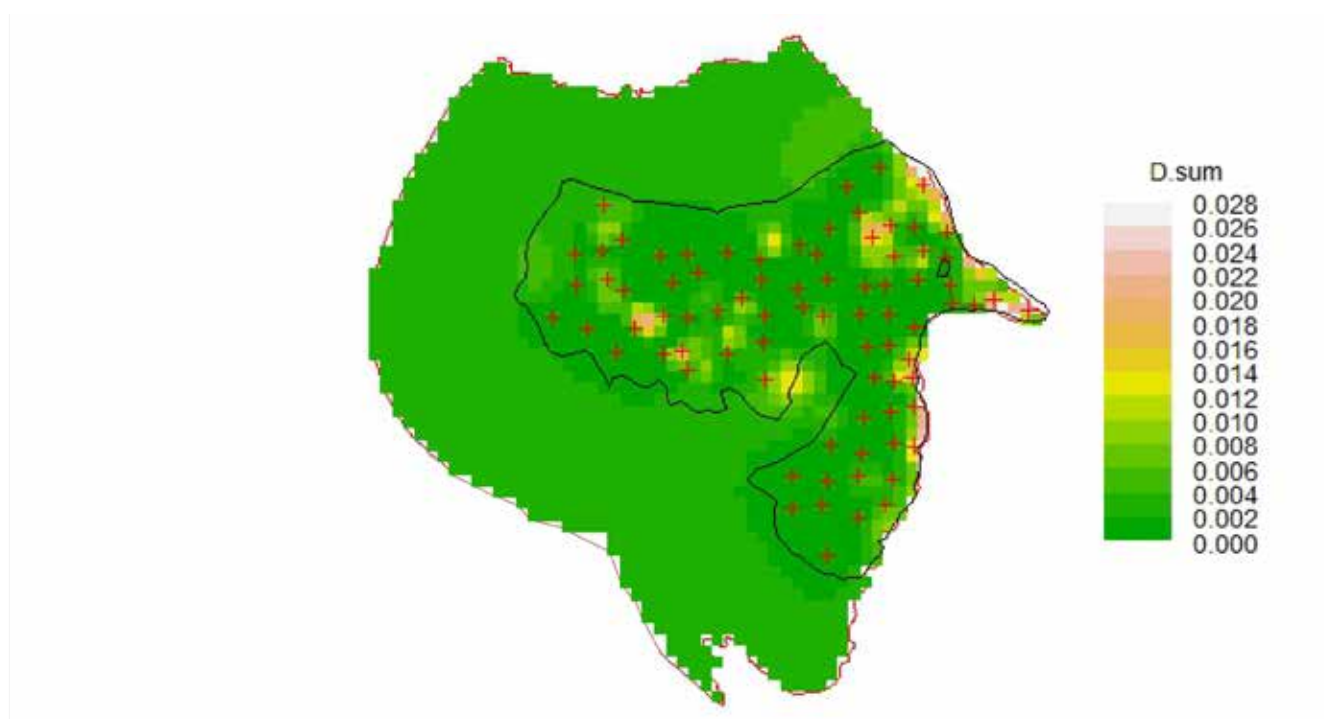


Figure A2.1. Distribution of leopards in the West Range of Gandhisagar Wildlife Sanctuary overlaid with camera trap locations (+)

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