Assessment of cheetah introduction sites and proposed actions- Technical note

2021

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

National Tiger Conservation Authority
राष्ट्रीय व्याघ्र संरक्षण प्राधिकरण

Government of Rajasthan
FOREST DEPARTMENT

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I. Introduction

In consequence of the Hon. Supreme Court direction on introduction of cheetah (*Acinonyx jubatus*) in India, meetings were held by the Expert Committee appointed by Hon. Supreme Court on this matter on 06 March 2020 and 30 September 2020 to decide on the future course of action. The committee decided that the rapid reassessment of all sites found suitable during the assessment conducted in 2010 (Ranjitsinh & Jhala 2010), along with assessment of those proposed newly by the States would be carried out by WII. As proposed by the State Governments of Rajasthan and Madhya Pradesh, a site visit was undertaken to 1) Mukundara Hills Tiger Reserve, 2) Shergarh Wildlife Sanctuary, in Rajasthan and, 3) Gandhi Sagar Wildlife Sanctuary, 4) Kuno National Park, 5) Madhav National Park and 6) Nauradehi Wildlife Sanctuary in Madhya Pradesh for a preliminary assessment as potential sites for cheetah reintroduction. Based on this assessment the following report lists further in-depth surveys for prey, habitat, and anthropogenic pressures at some of these sites as well as management actions that are required to prepare them for the introduction of the cheetah. Cheetah introduction at these sites would be contingent on completion of these tasks mentioned herein, and can be achieved at some sites as early as late 2021. Completing the proposed management actions could be decided by the States based on investment required and site priorities.

Site assessment teams

(1) Wildlife Institute of India	(2) Rajasthan	(3) Madhya Pradesh
Dr. Y.V. Jhala - Dean and Principal Investigator	Sh. Bharat Singh - Member of Legislative Assembly (Sangod, Kota)	Sh. J.S. Chauhan - APCCF (Wildlife)
Mr. Bipin C.M - Project Associate	Sh. Sedu Ram Yadav - CCF (Mukundara Tiger Reserve)	Sh. Y.P. Singh - DFO (Madhav National Park)
Ms. Harshini Y. Jhala - Project Fellow	Sh. Alok Gupta - DFO (Kota)	Smt. Rakhi Nanda - DFO (Nauradehi Wildlife Sanctuary)
		Sh. P.K. Verma - DFO (Kuno National Park)
		Sh. Ashok Kumar - DFO (Working Plan- Raisen)
		Sh. Sanjay Kumar Chauhan - DFO (Gandhi Sagar Wildlife Sanctuary)

1. Mukundara Hills Tiger Reserve

1.1. Site information

Attribute	Details
Location	Kota, Bundi, Chittorgarh and Jhalawar districts of Rajasthan (Figure 1a.)
Area	759 km^2 with 80 km^2 predator proof enclosure
Biogeographic zone	Semi-arid zone (4b), Gujarat- Rajputana
Forest type	Northern tropical dry deciduous
Climate	Temperature- average maximum summer temperature- 45°C, average minimum winter temperature- 6 °C Annual rainfall range – 600-900 mm
Topography	Elevation ranges between 355 to 503 m above mean sea level. Terrain comprises of parallel ridges with flat tops river valley of Chambal, Kali, Ahu and Ramzan rivers
Flora	Dominant tree species- *Anogeissus pendula, Anogeissus latifolia, Acacia catechu, Zizyphus mauratiana, Flacouritia indica,* and *Acacia leucofloea.* Grass species: *Heteropogon contortus, Apluda mutica, Aristida hystrix,* and *Themeda quadrivalvis*,
Fauna	Mammalian carnivores- Tigers (*Panthera tigris),* leopard (*Panthera pardus*), grey wolf (*Canis lupus*), honey badger (*Mellivera capensis*), golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), sloth bear (*Melursus ursinus*), striped hyena (*Hyena hyena*), jungle cat (*Felis chaus*), desert cat (*Felis silvestris*), rusty spotted cat (*Prionailurus rubiginosus*), common palm civet (*Paradoxurus hermaphroditus*), small Indian civet (*Viverricula indica*), ruddy mongoose (*Herpestes smithii*), and Indian grey mongoose (*Herpestes edwarsi*). Ungulates and herbivorous mammals- nilgai (*Boselaphus tragocamelus*) and chinkara (*Gazella bennettii*) while chital (*Axis axis*) and sambar (*Rusa unicolor*)., northern plains gray langur (S*emnopithecus entellus*), rhesus macaque (*Macaca mulatta*), Indian porcupine (*Hystrix indica*) and black-naped hare (*Lepus nigricollis*).
Anthropogenic activities	Two major highways i.e. State Highway 33 and National Highway 12 and a railway line (parallel to NH 12) cut across the Tiger reserve. However, the 80 km^2 predator proof enclosure is devoid of anthropogenic pressures. Other parts of the Tiger Reserve experience varying levels of livestock grazing and collection of forest products.
Landscape Connectivity for Cheetah	Mukundara TR is connected through Bhainsrodgarh Wildlife Sanctuary to Gandhi Sagar Wildlife Sanctuary in Madhya Pradesh.

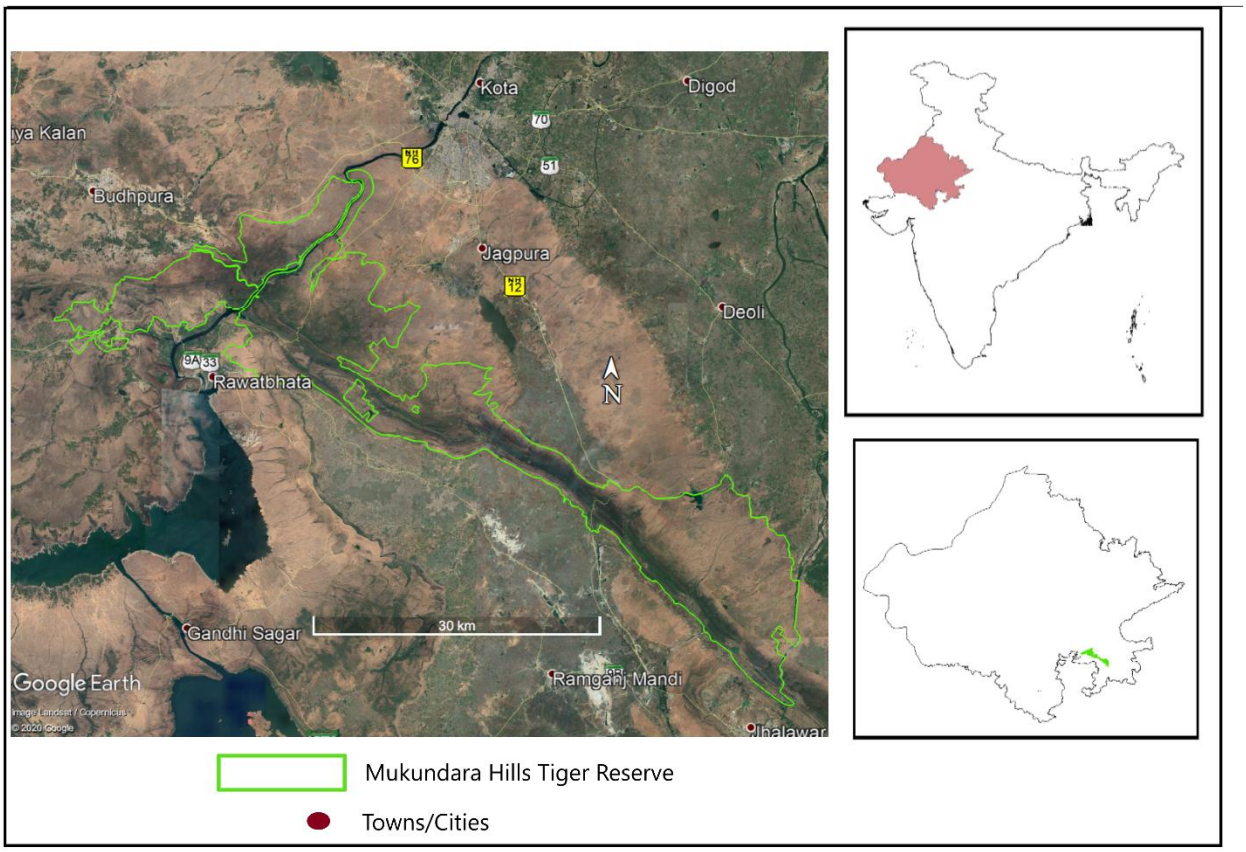

Figure 1a. Map of Mukundara Hills Tiger Reserve.

1.2. Assessment

A rapid site assessment was conducted (22nd- 23rd Nov 2020) to understand relative abundance of prey, quality of habitat and identify issues concerning park management related to cheetah introduction. A total of ~120 km (29 km within the 80 km^2 enclosure) (Figure 1b) were covered using a slow-moving vehicle to obtain encounter rates and densities of prey species viz. chital, sambar, nilgai, wild pig, chinkara, black buck and cattle (Tables 1 & 2). To calculate prey densities, the effective strip widths obtained from distance sampling conducted in Kuno during 2014 were used, as both areas have similar terrain and vegetation composition. Overall, the TR is under high pressure from livestock grazing, both cattle and goats heavily graze most of the TR. Parts that had lower livestock pressure had populations of wild ungulates like chital and chinkara but below any quantifiable density. A few blackbuck were seen within the fenced enclosure.

Table 1. Encounter rate of prey species in Mukundara TR predator enclosure.

S No	Species	Encounter rate (per km)
1	Chital	0.39
2	Nilgai	0.35
3	Wild pig	0.2
4	Chinkara	0.09
5	Black Buck	0.83

Table 2. Density of prey species in Mukundara predator enclosure.

S No	Species	ESW (effective strip width)- m	Density (individual per km^2)*
1	Chital	53.68	3.64
2	Nilgai	48.62	3.139
3	Wild pig	44.43	2.205
4	Chinkara	47.41	0.738
5	Blackbuck	53.68	0.777

*The effective strip width obtained from distance sampling conducted in Kuno during 2014 was used to calculate prey densities.

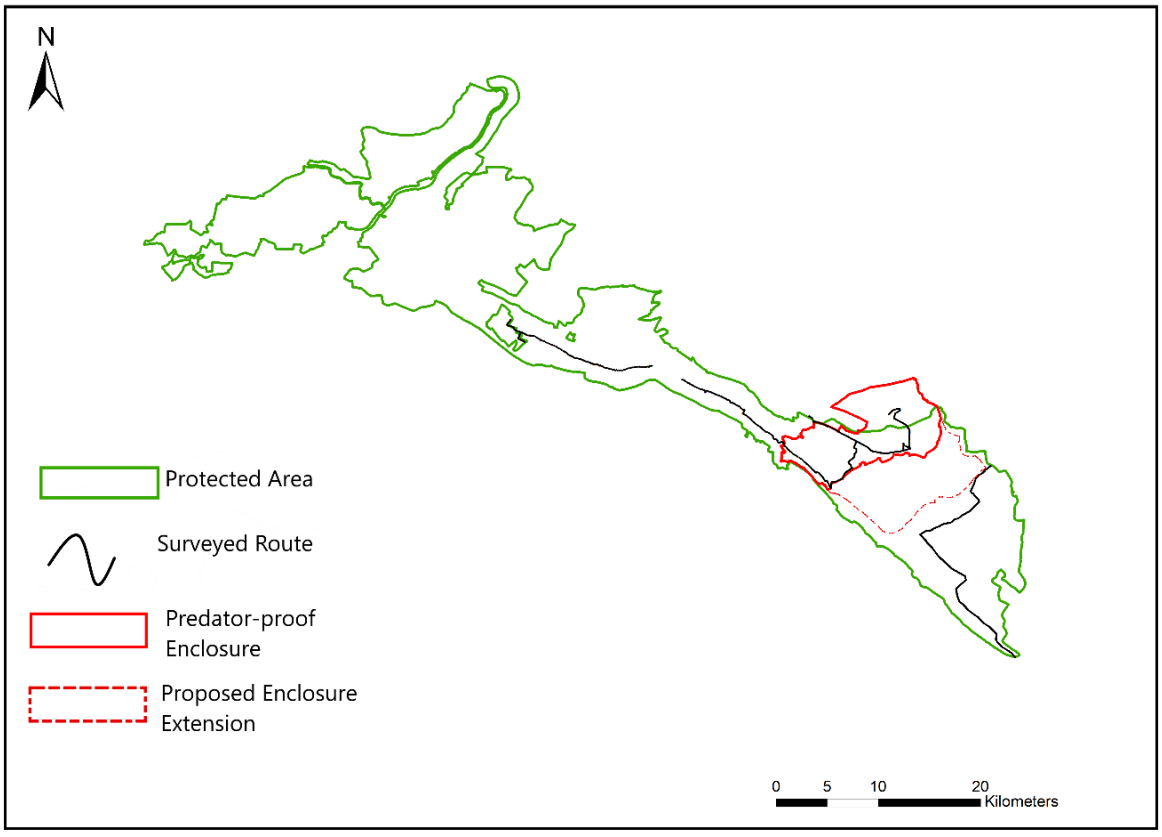

Figure 1b. Map of surveyed route in Mukundara Hills Tiger Reserve.

1.3. Actions required

Due to the human use and grazing pressures from villages within the TR as well as from the neighboring areas, and very low prey base the TR is not currently ready for reintroduction of the cheetah. However, there is excellent habitat recovery within the Predator Enclosure. The habitat has a mosaic of grasslands, savannah, dry deciduous forests and riverine evergreen patches with good water availability forming an ideal habitat for the cheetah. The prey base within the enclosure is recovering (but currently scanty) and this part of the TR has the potential to be considered further in the short-term for cheetah reintroduction. A major management activity that has to be commenced immediately is prey augmentation within the enclosure (as detailed below) and outside the enclosure. The villages within the TR need to be relocated in the long-term and the highways passing through the TR need to have appropriate mitigation for animal passage ways with speed regulation. Based on observations regarding habitat and interactions with park management the actions required to be undertaken immediately are listed below-

S No	Action	Details
1	Prey assessment	-An in-depth assessment of prey base within the enclosure (Area- 80 km^2) by Wildlife Institute of India during January-February 2021
2	Prey augmentation	-A minimum of 200 blackbuck, 150 chinkara, and 350 chital need to be translocated into the Enclosure. On an average cheetah family/coalition are expected to make a kill every 3-4 days. Considering finite growth rate of ungulates to be ~1.33 (Jhala et al., in press), a population of about 350 ungulates are required for a cheetah coalition family.
3	Enclosure reinforcement	-Reinforcement of the enclosure is required to make it dog proof especially at water drainage sites.
4	Increase the area of the enclosure	The predator enclosure can and should be extended into the Jhalawar part of the TR (Figure 1b) since this is good grassland habitat for the cheetah. Habitat recovery and control of human impacts in this highly disturbed TR can best be achieved by fencing. This additional 50-60 km^2 can be added (Total area- 150 km^2) to increase the carrying capacity of the enclosure for ~3 breeding units of cheetah.

With the above intervention, the enclosure within Mukundara Hills TR will be able to hold cheetah in the short-term as a staging area. Cheetah could be brought and released within the enclosure to acclimatize them to Indian conditions (climate and prey) before being released at suitable sites as free ranging cheetah or within larger fenced reserves. Currently, even without the extension but after prey augmentation, the enclosure can potentially house a coalition of males and 1-2 females as residents. The timeline for releasing cheetah would depend on prey augmentation and can be as early as mid-2021. After the extension of the fencing, the area can be a source of breeding cheetah in India within a secure enclosed area.

For the area outside of the enclosure, MHTR would require investments on a large scale in terms of reducing anthropogenic pressures through a) village relocation, b) grazing control of goats and cattle, c) mitigating infrastructure (road ways and railway). Once this is done, the MHTR can form a part of the larger landscape for cheetah in India by connecting it to Bhainsrodgarh WLS through the reserve forests of Chittorgarh Division and then onto Gandhi Sagar WLS in Madhya Pradesh. Free ranging tigers within Mukundara TR would not be a problem for cheetah introduction within the enclosure. The enclosure is better suited for cheetah habitat and prey compared to the requirement for tigers as majority of it is composed of open woodlands, savanna and grasslands with good habitat for chinkara and blackbuck (and not for sambar). Besides once restorative activities are undertaken in Mukundara TR (primarily reduction of human/livestock pressures), it can serve to hold both free ranging tigers and cheetah as well in the larger landscape.

2. Shergarh Wildlife Sanctuary

This site was visited on the suggestion of the CCF Wildlife-Kota and Shri Bharat Singh, MLA of the region as having potential for cheetah reintroduction. A rapid site assessment was conducted on 23rd Nov 2020.

2.1. Site information

Attribute	Details
Location	Baran district of Rajasthan (Figure 2a)
Area	81.67 km^2
Biogeographic zone	Semi-arid zone (4b), Gujarat- Rajputana
Forest type	Northern tropical dry deciduous
Climate	Temperature- average maximum summer temperature- 45°C, average minimum winter temperature 6 °C Annual rainfall range – 600-900 mm
Topography	Average elevation is about 300-500m from mean sea level. The area is mostly flat and rocky with a central river valley. Due to the rocky terrain and exposed sheet rock the top soil is prone to erosion, thus trenching activities must be avoided.
Flora	The major tree species are *Anogeissus pendula*, *Anogeissus latifolia, Butea spp*., *monosperma, Ziguphus mauritiana*, *Zizyphus zuzuba, Terminala arjuna, Aegle marmelose, and Acacia catechu*. Grass species: *Heteropogon contortus*, *Apluda mutica*, *Aristida hystrix*, and *Themeda quadrivalvis*,
Fauna	Mammalian carnivores- Leopard (*Panthera pardus*), golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), Jungle cat *(Felis chaus*), Langur (*Presbytis Entellus*), and Indian grey mongoose (*Herpestes edwarsi*). Ungulates and herbivorous mammals- nilgai (*Boselaphus tragocamelus*) and chinkara (*Gazella bennettii*) while chital (*Axis axis*) and sambar (*Rusa unicolor*)., northern plains gray langur (S*emnopithecus entellus*), rhesus macaque (*Macaca mulatta*), Indian porcupine (*Hystrix indica*) and black-naped hare (*Lepus nigricollis*).
Anthropogenic activities	The predominant community are Gujjars. A few villages are situated within the Sanctuary. The main occupations are agriculture and pastoralism.
Landscape	Although the area of Shergarh WLS itself is small, once combined with the adjoining plateau (Pathar) in the north the effective area can be substantially increased. Shergarh also has habitat connectivity with Mukundara Hills from the southern side.

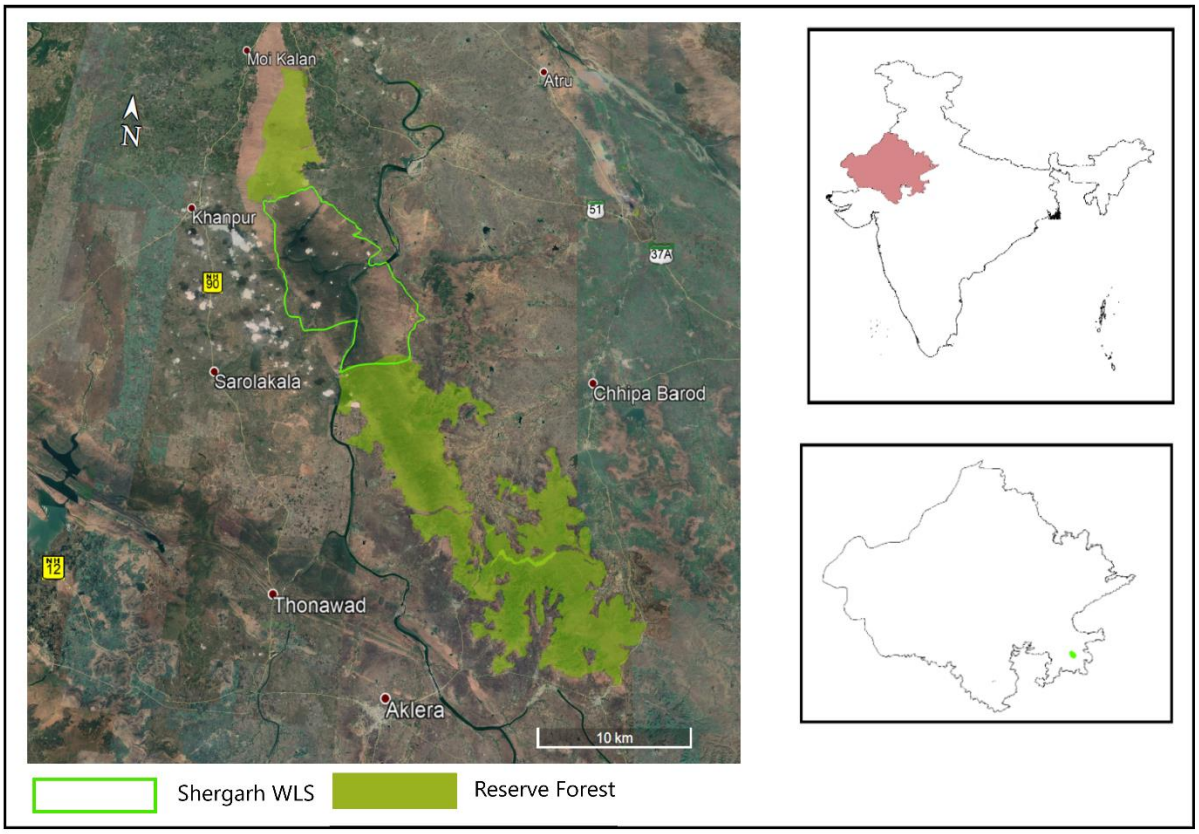

Figure 2a. Map of Shergarh Wildlife Sanctuary.

2.2. Assessment

The WLS was too small by itself for further consideration. However, Shergarh WLS along with the block of grassland to the north forming the *Pathar* and the reserve forest land to the south if enclosed by a predator fence can have the potential to hold a few cheetah (Figure 2a). The *Pathar* is also a Reserve Forest land with no human habitation. The combination of the Shergarh WLS, Pathar and the Reserve Forest of Baran division together cover 180 km^2. The habitat is ideal for cheetah (grassland, open woodland) and currently may hold a few leopards (no records) and striped hyena. The prey base was extremely low, mostly nilgai and few chinkara in the *Pathar* habitat. For further consideration as a site for cheetah reintroduction the entire ~250 km^2 would need to be fenced and human habitation from within the enclosed area relocated. Shri Bharat Singh was of the opinion of clearing Reserve Forest land along the Kota-Baran highway encroached by thick *Prosopis juliflora* and use these lands for village resettlement from Shergarh WLS and Mukundara Hills TR. These lands along the highway would be an extremely lucrative incentive for communities to relocate outside of the Protected Areas due to their road access, fertile nature and irrigation possibilities. Once villages are resettled and the area fenced, augmentation of prey

(chinkara, blackbuck and chital) would be required. The investments required for making Shergarh suitable for cheetah reintroduction are high and would take time (~ 5 years). However, the site should be considered for these investments as it will restore a degraded PA to its full potential and allow the State to harness its full potential for ecosystem services and for eco-tourism.

2.3. Actions required

Based on observations regarding habitat and interactions with park management the actions required to be undertaken immediately are listed below-

S No	Action	Details
1	Village relocation	- Relocation of Villages within the Sanctuary
2	Transfer of Reserve Forest	-Addition of Reserve Forests (RF) to the North (Pathar) and south (Baran Division) to increase the effective area for cheetah introduction
3	Boundary Fencing	-Predator proof fencing around the WLS and RF to the North and South (to cover ~ 250 km^2 Area)
4	Prey Augmentation	-Prey Augmentation by translocation of Blackbuck, Chital and Chinkara ~ 200 to 300 of each species
5	Road Mitigation	After addition of RF as part of the reintroduction area the roads passing through the RF would need mitigation (regulated traffic).

If the Rajasthan Government invests in fencing Shergarh WLS along with parts of the Reserve Forest areas suggested above and relocate the few human settlements with appropriate incentives the area would be suitable for a population of 3-4 breeding units of cheetah. The fencing in Mukundara TR has amply demonstrated the effectiveness it has on habitat recovery and with some effort in prey augmentation the Shergarh complex can be restored to its biological potential and provide the desired ecosystem services, achieve its conservation objectives and provide a big boost to the rural economy through cheetah based eco-tourism.

3. Gandhi Sagar Wildlife Sanctuary

The habitat composed of grassland, savanna, open woodland along with evergreen riverine ravines forms the perfect habitat for cheetah reintroduction. If Gandhi Sagar WLS can be managed along with neighboring state of Rajasthan (Chittorgarh Division and Bhainsrodgarh WLS) and addition of the territorial divisions of Mandsaur and Neemuch as buffers, a suitable area of ~2000 km^2 as cheetah habitat can be secured. The task involves commitment from both states of Madhya Pradesh and Rajasthan to work together in allocating these territorial forest divisions under a unified management plan with WLS. Such an effort would be an important objective for cheetah reintroduction i.e. to use the cheetah as a flagship and umbrella species for the conservation and restoration of habitats such as those represented by Gandhi Sagar and Bhainsrodgarh WLS (other than habitats where the tiger can serve as a flagship).

3.1. Site information

Attribute	Details
Location	Districts of Mandsaur and Neemuch in Madhya Pradesh (Figure 3a)
Area	368.62 km^2 with 187.12 km^2 in Mandsaur and 181.5 km^2 in Neemuch
Biogeographic zone	Semi-arid zone (4b), Gujarat- Rajputana
Forest type	Northern tropical dry deciduous forest, Northern tropical dry mixed deciduous forest and Dry deciduous scrub
Climate	Temperature- average maximum summer temperature- 42°C, average minimum winter temperature 10°C Annual rainfall range – 880-1000 mm
Topography	Average elevation is about 300-500 m from mean sea level. The area is a flat rocky plateau top with river valleys. The Chambal River cuts the Sanctuary into almost two equal halves. Due to the rocky terrain and exposed sheet rock, the top soil is shallow giving rise to savanna habitat with interspersed grasslands.
Flora	The dominanat tree species in the sanctuary are *Anogeissus pendula, Boswallia, Diospyros melanoxylon, Zizyphus zuzuba, Terminala arjuna and Butea spp.* The grasslands are dominated by species like *Apluda mutica, Cynodon dactylon, Dichanthium annulatum, Digitariaci liaris, Eragrostis spp., Heteropogon contortus, Sporobolus diandrus, Themeda quadrivalvis,* and *Vetiveri azizanioides*
Fauna	Mammalian carnivores leopard (*Panthera pardus*), sloth bear (*Melursus ursinus*), striped hyaena (*Hyaena hyaena*), gray wolf (*Canis lupus pallipes*), golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), ratel (*Mellivora capensis*), jungle cat (*Felis chaus*), Indian gray mongoose (*Herpestes edwardsii*), smooth coated otter (*Lutrogale perspicillata),* and Marsh crocodile *(Crocodylus palustris).* Ungulates and herbivorous mammals include nilgai (*Boselaphus tragocamelus*),chinkara (*Gazella bennettii*), chital (*Axis axis*), sambar (*Rusa*

	unicolor), gray langur (S*emnopithecus entellus*), Indian porcupine (*Hystrix indica*) and black-naped hare (*Lepus nigricollis*).
Anthropogenic activities	Agriculture along the banks of the Sagar is the major occupation in the region, along with some livestock rearing. The township of Gandhi Sagar is centrally located in the eastern range of the Sanctuary and houses the employees of the hydroelectric project of the Sagar. Fishing communities from West Bengal have also been settled in the region to exploit the fishery sector in the Sagar.
Landscape	The sanctuary is divided into almost two equal halves by the Chambal. With the adjoining territorial divisions of Neemuch and Mandsaur along with Bhainsrodgarh Wildlife Sanctuary and territorial division of Chittorgarh (Rajasthan), a larger habitat of ~2000 km^2 for the cheetah can be established. Gandhi Sagar is also connected to Mukundara via Bhainsrodgarh Wildlife Sanctuary and Reserve Forests of Chittorgarh near Rawatbhata.

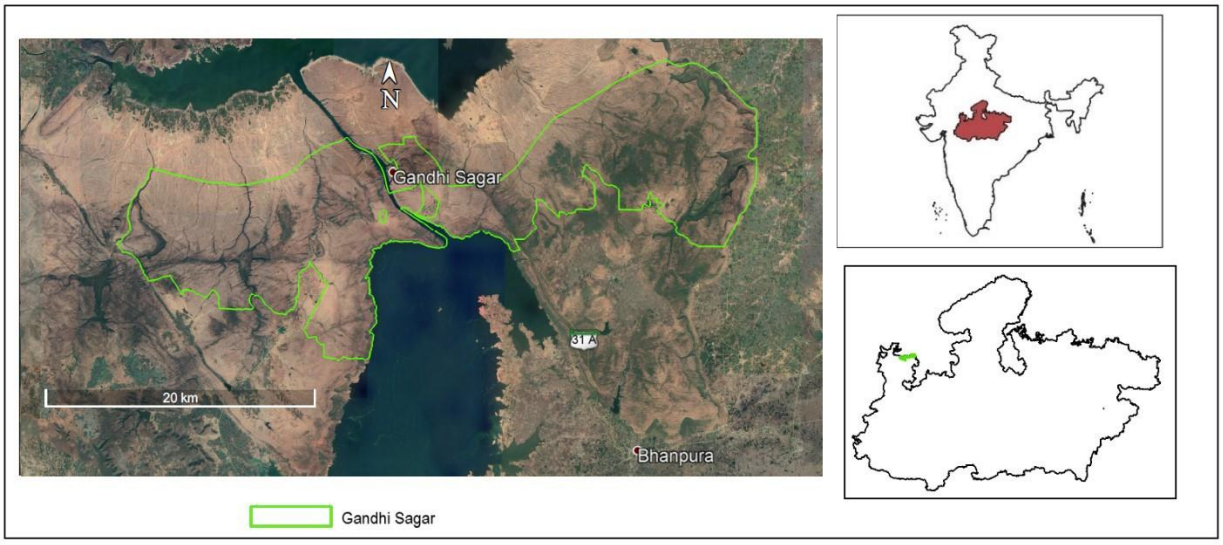

Figure 3a. Map of Gandhi Sagar Wildlife Sanctuary

3.2. Assessment:

A site assessment was conducted from 24th-25th Nov 2020 to understand relative abundance of prey, quality of habitat and identify issues concerning park management. A total of 111 km (Figure 3b) were covered to obtain encounter rates and densities of prey species (Tables 3 and 4). To calculate prey densities, the effective strip widths obtained from distance sampling conducted in Kuno during 2014 were used, as both areas have similar terrain and vegetation composition.

Table 3. Encounter rate of prey species in Gandhi Sagar Wildlife Sanctuary.

S No	Species	Encounter rate (per km)
1	Nilgai	0.32
2	Wild pig	0.18
3	Chinkara	0.18
4	Cattle	0.117
5	Buffalo	0.279

Table 4. Densities of Prey Species in Gandhi Sagar Wildlife Sanctuary.

S No	Species	ESW (effective strip width)- m	Density (individual per km^2)*
1	Nilgai	57.07	2.027
2	Wild pig	44.43	2.84
3	Chinkara	62.08	0.87
4	Cattle	56.99	1.02
5	Buffalo	56.99	2.45

*The effective strip width obtained from distance sampling conducted in Kuno during 2014 was used to calculate prey densities.

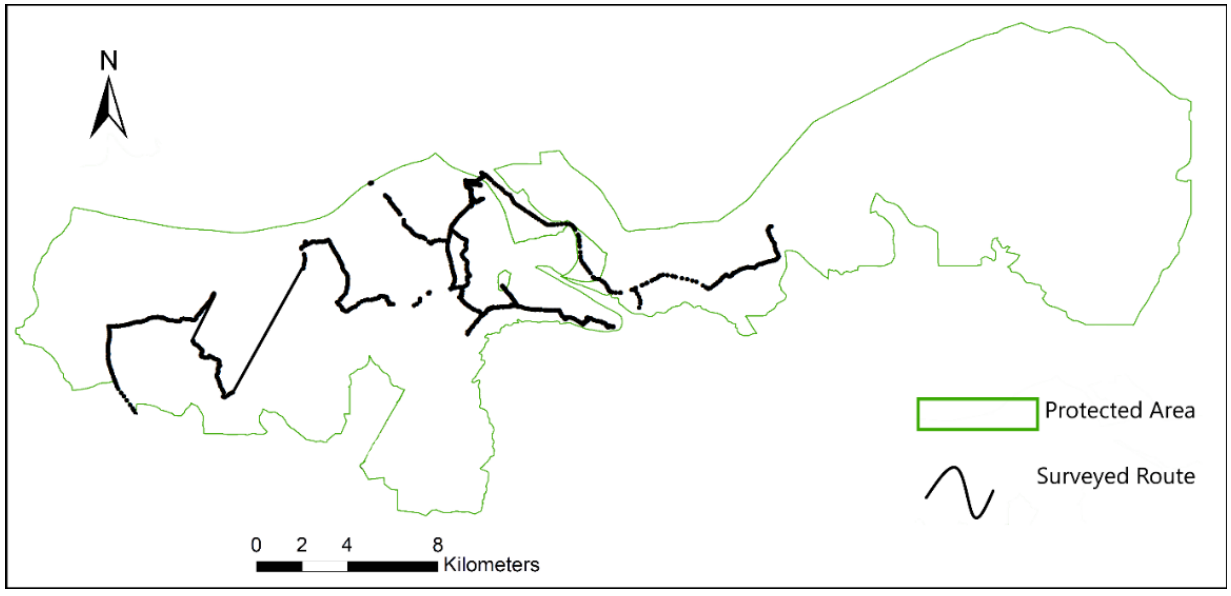

Figure 3b. Map of surveyed routes in Gandhi Sagar Wildlife Sanctuary.

3.3. Actions required

Specific management inputs required at Gandhi Sagar WLS are

1) Augmentation of prey base: On an average cheetah family/coalition are expected to make a kill every 3-4 days. Considering finite growth rate of ungulates to be ~1.33 (Jhala et al., in press), a population of about 350 ungulates are required for a cheetah coalition family. About 1500 chital, 1000 blackbuck and 350 chinkara should be translocated to Gandhi Sagar as soon as possible (within the next six months). This prey base would suffice for 7-8 cheetah family/ coalition. Assistance from professionally trained national and international agencies for mass capture and translocation of ungulates may be sought for this exercise. The first phase of augmentation should target the section west of the Chambal river so that cheetah reintroduction can commence in this part of the WLS as soon as there is sufficient prey available in this more protected part of the WLS.

2) Protection needs to be enhanced across the WLS. Forest Department was quite vehement in stressing that poaching was not a problem currently. However, given the reasonably good status of the habitat the ungulate densities were extremely low. The communities residing in the area were also non-vegetarian. Given these facts it would be prudent to enhance protection, patrolling, and law enforcement capabilities of the staff. Tools like MSTrIPES should be used to ensure spatial and timely coverage of sensitive areas.

3) The river Chambal cuts the WLS into parts. Fording this river is only possible in certain parts by highly motivated individual animals and it therefore forms a barrier to casual movement of wildlife. The development and restoration activities within Gandhi Sagar should commence from the Neemuch side of the Chambal, where, if the schedule given below is adhered, cheetah could be reintroduced in Gandhi Sagar by the end of 2021. Simultaneously, the Mandsaur side of Gandhi Sagar as well as Chittorgarh Division and Bhainsrodgarh WLS should be developed and restored.

Based on observations regarding habitat and interactions with park management the actions required to be undertaken immediately are listed below-

S No	Action	Details
1	Enhance protection	- Recruitment of staff to fill up vacancies - Training of field staff in anti-poaching activities
2	Prey Augmentation	-Prey Augmentation by translocation of Blackbuck (1000), Chital (1500) and Chinkara (350). On an average cheetah family/coalition are expected to make a kill every 3-4 days. Considering finite growth rate of ungulates to be ~1.33 (Jhala et al., in press), a population of about 350 ungulates are required for a cheetah coalition family. The proposed prey base augmentation can sustain 7-8 cheetah family/ coalitions.
3	Construction of soft release enclosure	A predator enclosure of 1 km^2 area to be constructed with four equal partitions. The height of the fence will have to be 2.5 m angled both inside and outside (Appendix 1).

4	Village community Sensitization	- Sensitization of communities towards cheetah reintroduction, and opportunities for eco- tourism.
5	Road regulation	-Vehicular movement on two roads- (1) State highway 31A and (2) Rawatbhata- Gandhisagar Road, have to be regulated with barriers and speed breakers so that vehicle speed is restricted to <40 kms/hr.
6	Water management	-Water hole construction/ filling and maintenance of natural water sources such that water is available throughout the year at a density of one in 25 km^2 (or within a radius of 3 km)

Cheetah introduction to Gandhi Sagar can commence in a phased manner as soon as prey supplementation is initiated and a soft release enclosure is built. Other actions can go on simultaneously with the introduction. The proposed prey base augmentation can sustain 7-8 cheetah family/ coalitions.

For the long-term viability of a cheetah population in India, commitment from the Governments of Madhya Pradesh for inclusion of the territorial reserve forest areas as buffers and from the Government of Rajasthan for the development of parts of the territorial Chittorgarh Division and Bhainsrodgarh WLS as a large inter-state cheetah conservation complex along with Gandhi Sagar should be obtained (Figure 3c).

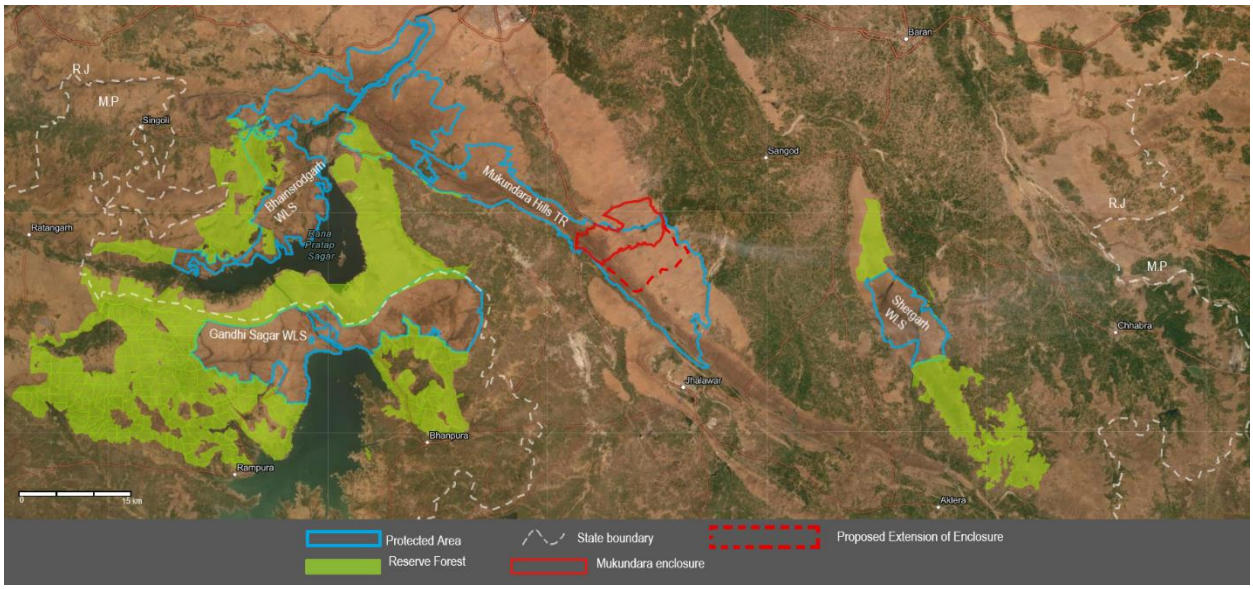

Figure 3c. Map of transboundary habitat shared between Rajasthan and Madhya Pradesh.

4. Kuno National Park

Kuno National Park has been regularly monitored since 2006 for lion reintroduction and it is due to the efforts of the Madhya Pradesh Forest Department on rehabilitation of villages from within the core area, and declaration of National Park status, that Kuno (Table 4.1) has shown remarkable recovery in its habitat, prey abundance and reduction of human impacts. Due to delays in lion reintroduction the site was considered for cheetah reintroduction in 2010. However, the Hon'ble Supreme Court in its order on the reintroduction of the Asiatic Lion in Kuno in 2013, also ruled against the reintroduction of the cheetah in Kuno. Subsequent, to affidavits filed by NTCA explaining that cheetah reintroduction would not impact lion reintroductions in any adverse manner, the Hon'ble Supreme Court has permitted cheetah introduction on an "*experimental basis in a careful chosen habitat and nurtured and watched to see whether it can adapt to the Indian conditions*". A site assessment was conducted from 25th to 29th Nov 2020 to understand relative abundance of prey, quality of habitat and identify issues concerning park management. A total of 54 km in the old Wildlife Sanctuary Part and 207 km in the old wildlife division part both of which now constitute the Kuno National Park (Figure 4c) were covered using a slow moving vehicle to obtain encounter rates and densities of prey species viz. chital, sambar, nilgai, wild pig, chinkara and cattle (Tables 5 and 6). To calculate prey densities, the effective strip widths obtained from distance sampling conducted in Kuno during 2014 were used.

4.1. Site information

Attribute	Details
Location	Sheopur District in Madhya Pradesh (Figure 4a)
Area	748 km^2
Biogeographic zone	Semi-arid zone (4b), Gujarat- Rajputana
Forest type	Northern tropical dry deciduous
Climate	Temperature- average maximum summer temperature- 42.3°C, average minimum winter temperature- 6.7°C Average annual rainfall- 760 mm
Topography	Elevation- 238m to 498m above mean sea level, Moderately undulating with gentle slopes and flat river valley
Flora	Dominant tree species- *Anogeisus pendula*, *Acacia catechu*, *Boswellia serrata*, *Diospyros melanoxylon*, *Butea monosperma*, *Anogeissus latifolia*, *Acacia leucophloea*, *Ziziphus mauritiana* and *Ziziphus xylopyrus*. Shrub species- *Grewia flavescens*, *Helicteres isora*, *Vitex negundo*. Grass species include *Heteropogon contortus*, *Apluda mutica*, *Aristida hystrix*, *Themeda quadrivalvis*, *Cenchrus ciliaris* and *Desmostachya bipinnata*.
Fauna	Mammalian carnivores- leopard (*Panthera pardus*), sloth bear (*Melursus ursinus*), striped hyaena (*Hyaena hyaena*), gray wolf (*Canis lupus pallipes*), golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), ratel (*Mellivora capensis*), jungle

	cat (*Felis chaus*), Indian gray mongoose (*Herpestes edwardsii*), ruddy mongoose (*Herpestes smithii*), Asian palm civet (*Paradoxurus hermaphroditus*) and small Indian civet (*Viverricula indica*), Ungulates and herbivorous mammals- chital (*Axis axis*), sambar (*Rusa unicolor*), nilgai (*Boselaphus tragocamelus*), wild pig (*Sus scrofa*), chinkara (*Gazella bennettii*), chousingha (*Tetracerus quadricornis*), blackbuck (*Antilope cervicapra*), northern plains gray langur (S*emnopithecus entellus*), rhesus macaque (*Macaca mulatta*), Indian porcupine (*Hystrix indica*) and black-naped hare (*Lepus nigricollis*).
Anthropogenic activities	The predominant communities in the area are Sahariyas, Gujjars and Yadavs. The main livelihoods of people are agriculture, pastoralism, casual labor and collection of non-timber forest products. People of Moghiya and Bhil tribes, well-known for their hunting abilities, reside in low numbers amongst the fringe villages. The other communities are Dhakad, Jatav and Thakur, who own some of the largest agricultural holdings.
Landscape	The National Park (Figure 4a) is part of Kuno Wildlife Division (Area- 1235 km^2) and the south-eastern portion of this area is patchily connected to Panna- Tiger Reserve through Madhav National Park- Shivpuri Forest Division. Ranthambhore Tiger Reserve in Rajasthan State across the River Chambal is connected on the north-western side. The extent of forest in this landscape is about 6800 km^2.

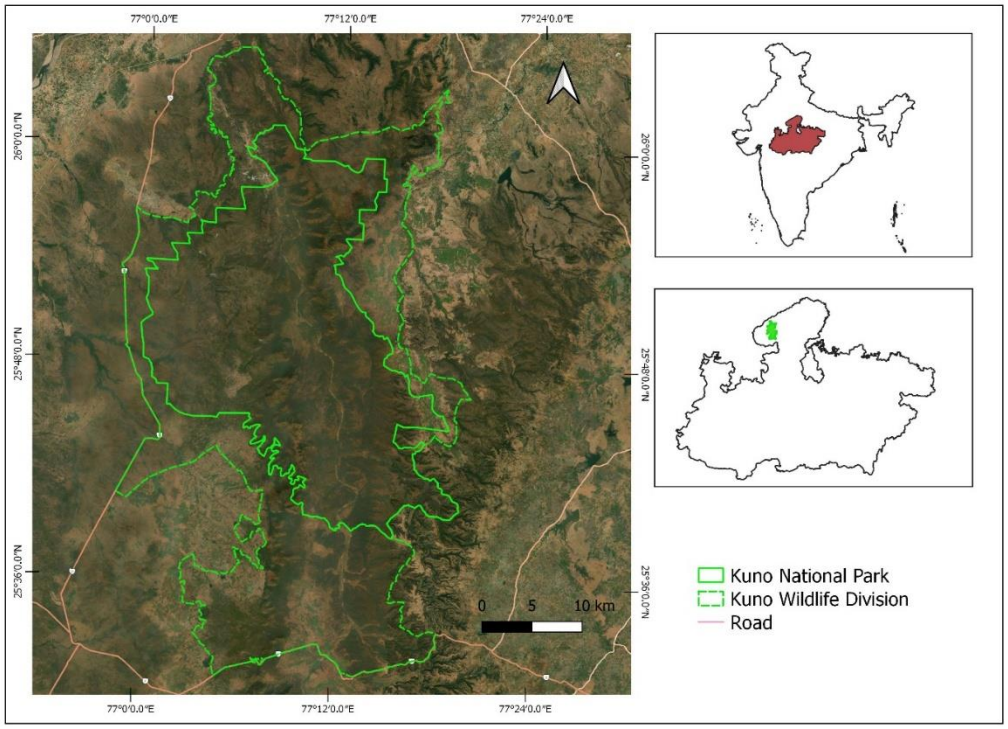

Figure 4a. Map of Kuno National Park.

4.2. Assessment

The Kuno National Park has diverse habitats conducive for lions and cheetah constituted by open woodlands, savanna, dry deciduous forests, and evergreen riverine forests. Forest grass species (*Themeda*, *Apluda*, *Heteropogon*, *Chloris*, *Desmostachya* spp) were common in valley habitats while plateau tops had shorter grasses like (*Aristida*, *Dicanthium*, *Eragrostis*, *Panicum*, and *Cenchrus* Spp). Kuno is part of a large forested landscape constituted by the Sheopur-Shivpuri forests covering an area of ~6800 km^2 (Figure 4b). Currently the leopard and striped hyena are the only larger carnivores within the National Park, the single lone tiger having returned to Ranthambore earlier this year. In the degraded forests outside the National Park, presence of wolves is also reported. The density of leopards was 8.9 (SE 1.4) per 100 km^2 (Jhala et al. 2020).

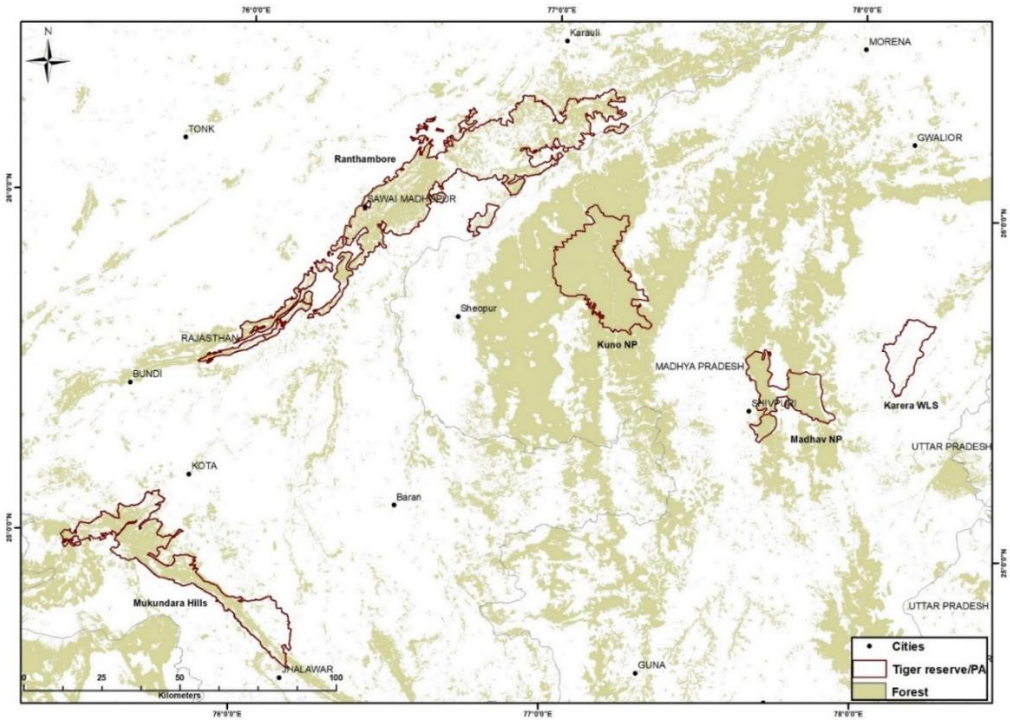

Figure 4b. Map of landscape connectivity of Kuno National Park with other protected areas and forests

Table 5. Encounter rate of prey species in Kuno National Park.

S No	Species	Encounter rate (per km)
1	Chital	1.23
2	Sambar	0.01
3	Nilgai	0.05
4	Wild pig	0.20
5	Chinkara	0.02
6	Cattle	1.36
7	Buffalo	0.03

Table 6. Densities of prey species in Kuno wildlife division part and old Wildlife Sanctuary of Kuno National Park.

S No	Species	ESW (effective strip width)- m	Density (individual per km^2) *	
			Old Wildlife Sanctuary	Wildlife division
1	Chital	53.68	41.40	11.47
2	Sambar	53.67	0.52	0.14
3	Nilgai	57.07	1.30	0.47
4	Wild pig	44.43	3.75	2.28
5	Chinkara	62.08	-	0.19
6	Cattle	56.99	20.96	11.95
7	Buffalo	56.99	-	0.34

*The effective strip width obtained from distance sampling conducted in Kuno during 2014 was used to calculate prey densities.

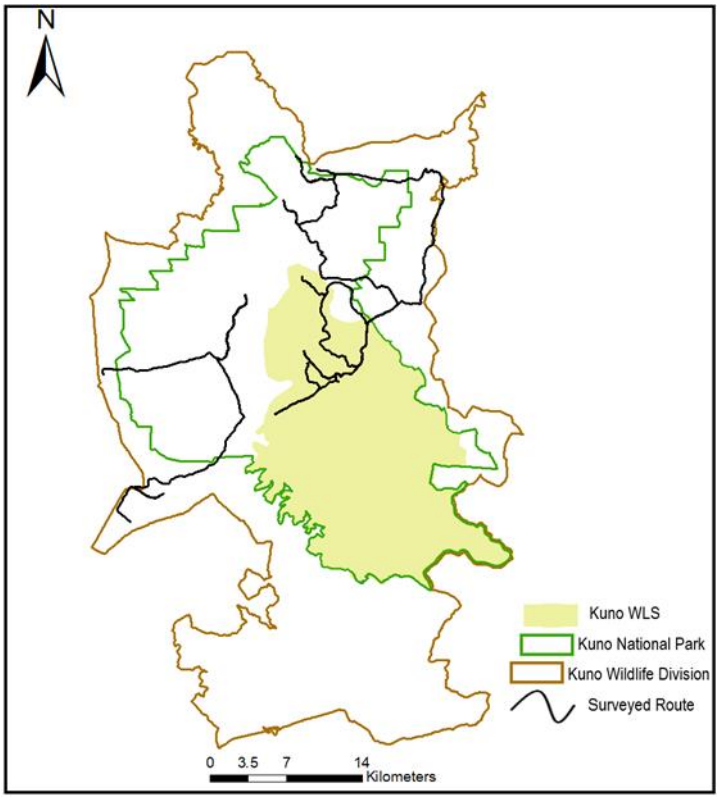

Figure 4c. Map of surveyed routes in Kuno Wildlife Division

4.3. Actions required

Based on observations regarding habitat and interactions with park management the actions required to be undertaken immediately are listed below-

S No	Action	Details
1	Enhance protection	- Hiring of ex-army personnel - Recruitment of staff to fill up vacancies - Training of field staff in anti-poaching activities
2	Grassland management	- Pruning of *Zizyphus* - Removal of *Desmostachya* - Removal of *Acacia lucophyla* from grasslands -Selective and controlled use of cattle to manage grasslands
3	Water management	On the south western and eastern side of the National Park
4	Construction of soft release enclosure for holding cheetah	Size 1km^2 in Jakhoda/Paira grassland. A predator enclosure of 1 km^2 area to be constructed with four equal partitions. The height of the fence will have to be 2.5 m angled both inside and outside (Appendix 1).
5	*Prosopis juliflora* plantation removal & ban further plantation of this species.	In the Wildlife Division
6	Village relocation	Two villages- Bagcha and Jahangarh
7	Dog vaccination	In villages inside and on the periphery of the Wildlife Division against rabies, canine distemper and parvovirus
8	Prey base estimation	Kuno has been monitored since 2006, last assessment was done in 2018. A fresh assessment in 2021 would be useful.

Kuno National Park is currently ready for the reintroduction of cheetah with minimal actions required (above). Introduction can commence in a phased manner with few individuals after the construction of the soft release enclosure and augmentation of protection, while other actions are under way. The action plan prepared for the reintroduction of cheetah in Kuno in 2012 (Jhala et al. 2011) remains valid. These first batch of cheetah (6-8 individuals) should be soft released in the enclosure with GPS/GSM or GPS/Satellite transmitters. Males would be released first while females remain within the enclosure. This would ensure that males, during their exploratory movements, would not stray very far from the soft release enclosure where females are housed. Once males settle down females should be released. The introduction of the cheetah in Kuno in no way compromises the objectives or potential for reintroducing the Asiatic lions here as per the Hon'ble Supreme Court Order (2013). Once cheetah have established, they are known to be able to evade lion predation effectively. Many habitats (Protected Areas) as well as fenced game reserves in Africa have sympatric cheetah and lions. In historical times in India too, lions, tigers, leopards, and cheetah were once sympatric (Divyabhanusinh 2002).

5. Madhav National Park

Madhav National (NP) was evaluated on the recommendation of the Madhya Pradesh Forest department. This forested patch of Shivpuri still has some habitat connectivity to Sheopur forests (with Kuno National Park). Though Madhav NP is small and highly impacted with anthropogenic pressures, consideration of introduction of a charismatic species like the cheetah may bring in the required resources for its restoration while simultaneously increasing the livelihood options for local communities through wildlife tourism.

5.1. Site information

Attribute	**Details**
Location	Shivpuri District in Madhya Pradesh (Figure 5a)
Area	354 km^2
Biogeographic zone	Semi-arid zone (4b), Gujarat- Rajputana
Forest type	Northern tropical dry deciduous (type 5B)
Climate	Temperature- average maximum summer temperature- 40°C, average minimum winter temperature- 5°C Average annual rainfall- 895 mm
Topography	Elevation- 350m to 487m above mean sea level
Flora	Dominant tree species- *Anogeisus pendula*, *Acacia catechu*, *Boswellia serrata*, *Diospyros melanoxylon*, *Butea monosperma*, *Anogeissus latifolia*, *Acacia leucophloea*, *Ziziphus mauritiana* and *Ziziphus xylopyrus*. Shrub species- *Grewia flavescens*, *Helicteres isora*, *Vitex negundo*. Grass species include *Heteropogon contortus*, *Apluda mutica*, *Aristida hystrix*, *Themeda quadrivalvis*, *Cenchrus ciliaris* and *Desmostachya bipinnata*.
Fauna	Mammalian carnivores- leopard, sloth bear, striped hyaena, golden jackal, Indian fox, ratel, jungle cat, Indian gray mongoose, ruddy mongoose, Asian palm civet and small Indian civet, Ungulates and herbivorous mammals- chital, sambar, nilgai, wild pig, chinkara, chousingha, blackbuck, northern plains gray langur, rhesus macaque, Indian porcupine and black-naped hare.
Anthropogenic activities	Due to the proximity of Madhav NP to the town of Shivpuri, anthropogenic impacts are very high including livestock grazing, fuel wood collection and possibility of poaching.
Landscape	The National Park (Figure 4b) is part of Ranthambore- Kuno – Sheopur-Shivpuri Forest landscape and the extent of forested habitat is about 6800 km^2.

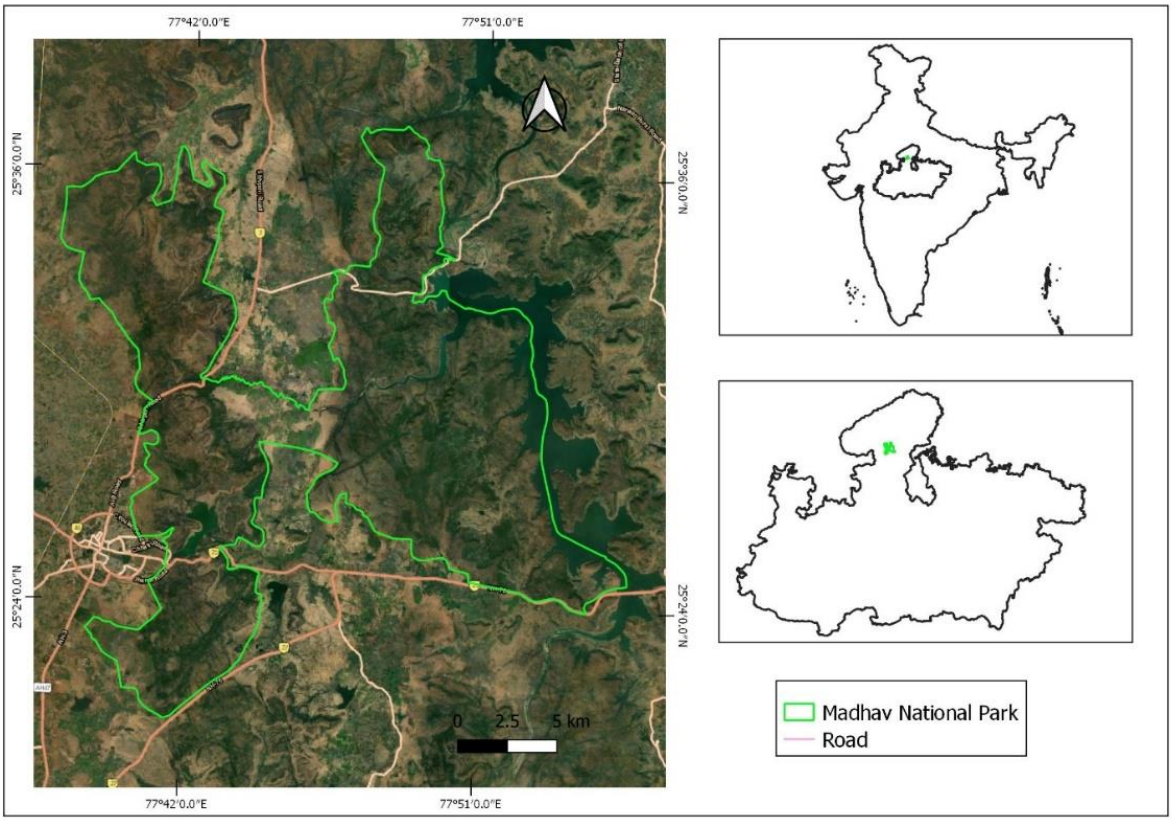

Figure 5a. Map of Madhav National Park.

5.2. Assessment:

A rapid site assessment was conducted from 29th November 2020 to understand relative abundance of prey, quality of habitat and identify issues concerning park management. A total of 41 km (Figure 5b) were covered using a slow moving vehicle in the eastern part of the PA as suggested by park management. to obtain encounter rates and densities of prey species viz. chital, sambar, nilgai, wild pig, chinkara and cattle (Tables 7 and 8). To calculate prey densities, the effective strip widths obtained from distance sampling conducted in Kuno during 2014 were used, as both areas have similar terrain and vegetation composition.

Table 7. Encounter rate of prey species in Madhav National Park.

S No	Species	Encounter rate (per km)
1	Chital	0.3
2	Nilgai	0.45
3	Wild pig	0.45
4	Chinkara	0.09
5	Cattle	0.76
6	Buffalo	0.81

Table 8. Densities of Prey in Madhav National Park.

S No	Species	ESW (effective strip width) - m	Density (individual per km^2) *
1	Chital	53.68	2.90
2	Nilgai	57.07	3.98
3	Wild pig	44.43	2.15
4	Chinkara	62.08	0.77
5	Cattle	56.99	6.72
6	Buffalo	56.99	7.14

*The effective strip width obtained from distance sampling conducted in Kuno during 2014 was used to calculate prey densities.

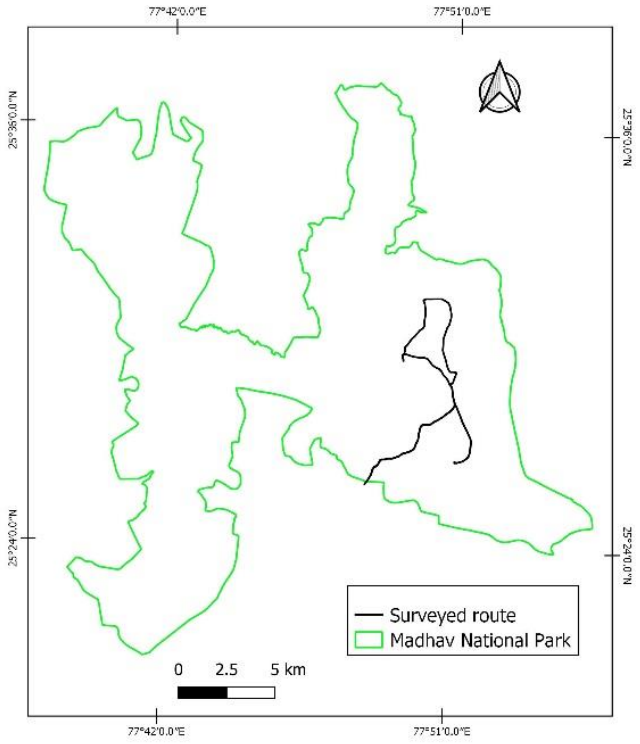

Figure 5b. Map of surveyed routes in Madhav National Park.

5.3. Actions required

Based on observations regarding habitat and interactions with park management the actions required to be undertaken immediately are listed below-

S No	Action	Details
1	Boundary Fencing	Chain link fencing of the area in the Sanctuary (Figure 5c) length- 87 km, Cost approximately 20 Crore
2	Enhance protection	- Recruitment of staff to fill up vacancies - Training of field staff in anti-poaching activities

3	Assessment of prey and predator populations	To be conducted by Wildlife Institute of India with trained Forest Department staff and volunteers (if MP govt. agrees for fencing the area).
4	Prey augmentation	Translocation of Chital (1000), blackbuck (500) and chinkara (200)
5	Village relocation	Required in the fenced area
6	Temple road and festival regulation	Vehicular movement on forest road to Ballarpur temple and shifting of the festival outside the PA

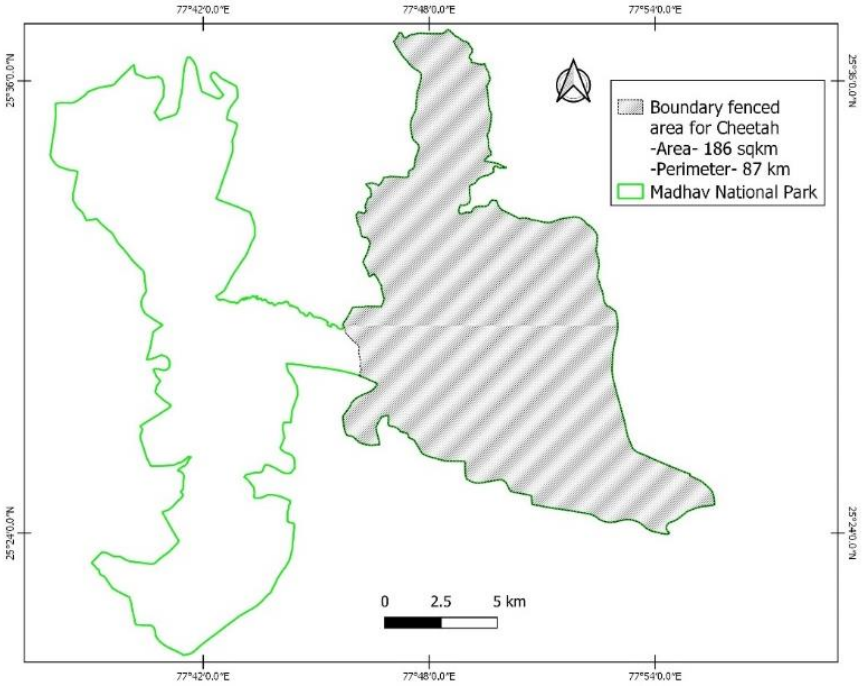

Figure 5c. Map of proposed cheetah enclosure at Madhav National Park.

With the current situation of Madhav NP, cheetah can only be introduced within a fenced area of the NP. The effectiveness of fencing in restoring habitats has been amply demonstrated in Mukundara TR predator enclosure. Such an investment in Madhav NP will help restore a substantial part of the National Park. Once the fence is erected and cheetah introduced after prey assessment/ and required augmentation, the success of the model should be assessed and subsequently the fenced area can be extended to the western part of the National Park. Madhav NP does not add substantially to the objective of establishing cheetah in India, but by introducing the cheetah to Madhav NP, the National Park would benefit substantially with the associated investments and also increase its potential for generating revenue through wildlife tourism.

6. Nauradehi Wildlife Sanctuary

Nauradehi WLS was one of the priority sites identified in 2010 for cheetah reintroduction (Ranjitsinh and Jhala 2010) and an action plan for cheetah reintroduction prepared (Jhala et al. 2012). The forest department of Madhya Pradesh has already implemented a lot of actions mentioned in the plan. Noteworthy is the relocation of 12 of the 24 recommended villages targeted for relocation (Jhala et al 2012). A total of 15 villages have been relocated with plans of additional 10 villages to be relocated in 2021. These investments and management actions has resulted in visible and substantial recovery of Nauradehi WLS. The habitat is much improved with reduction of livestock grazing and an increase in wild prey. The habitat composed of open woodlands, savannah and patches of grasslands at relocated village sites form ideal conditions for cheetah reintroduction.

6.1. Site information

Attribute	Details
Location	Sagar, Damoh and Narsinghpur Districts in Madhya Pradesh (Figures 6a & 6b)
Area	1197 km^2
Biogeographic zone	Deccan peninsula zone (6A)
Forest type	Southern tropical dry deciduous forest (type 5A)
Climate	Temperature- average maximum summer temperature- 40°C, average minimum winter temperature- 12°C Average annual rainfall- 942-1522 mm
Topography	Elevation- 328m to 660m above mean sea level, situated on a plateau, rising gently from the north which terminates into low hill ranges and drops steeply into the Narmada valley in the south
Flora	Dominant tree species- *Tectona grandis*, *Terminalia tomentosa, Lagerstroemia parviflora, Diospyros melanoxylon, Madhuca indica, Chloroxylon sweitenia, Phyllanthus emblica* and *Aegle marmelos.* Grass species- *Eragrostis tenella*, *Themeda quadrivalvis*, *Heteropogon contortus* and *Cynodon dactylon*.
Fauna	Mammalian carnivores- tiger (*Panthera tigris*) leopard, sloth bear, Indian wolf, dhole (*Cuon alpinus*), striped hyeana, golden jackal, Indian fox, jungle cat, desert cat (*Felis silvestris ornata*), ratel, ruddy mongoose, Indian grey mongoose and small Asian mongoose (*Herpestes javanicus*). Ungulates and herbivorous mammals- nilgai, chital, sambar, barking deer or Northern red muntjac (*Muntiacus vaginalis*), chinkara, blackbuck, chowsingha, wild pig, rhesus macaque and southern plains gray langur (*Semnopethicus dussumieri*) Indian porcupine and black-naped hare

Anthropogenic activities	The predominant communities residing in the villages present inside the Sanctuary are the Gond tribe and the Yadavs. Agriculture is the main source of livelihood for these communities although Yadavs are also traditional pastoralists. Gwaliya, Lodhi, Chaudhary and Harijan are the other communities living in the Sanctuary and are dependent on the forest resources. Two important roads bisect the Sanctuary, Sagar to Jabalpur and Tendukheda to Deori which, along with National Highway no. 12 on the southern boundary of the park (Figure 6a).
Landscape	The Sanctuary is patchily connected to Veerangana Durgawati WLS towards the east in Damoh district which extends upto Bandhavgarh Tiger Reserve and towards the west as a thin strip of forest in Bareli Tehsil of Raisen district. The area of this forested habitat is about 5500km^2 (Figure 6b).

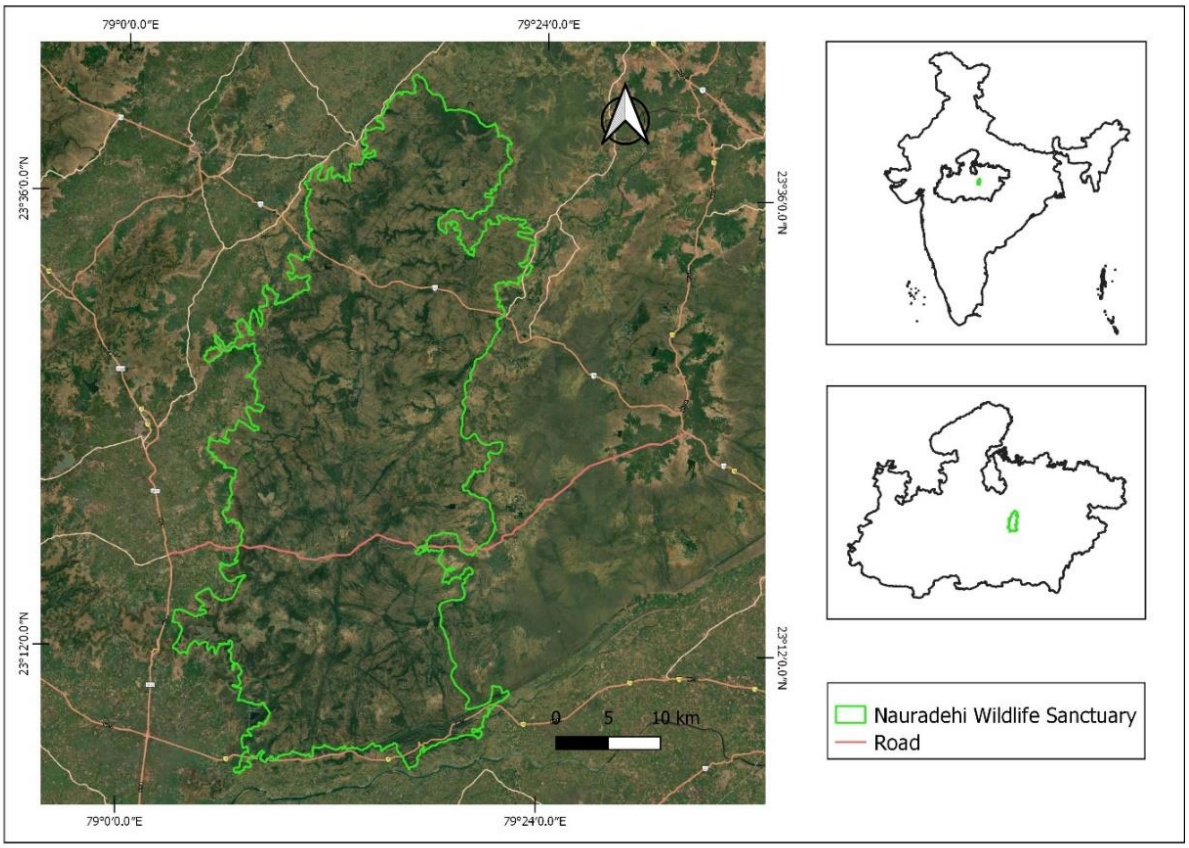

Figure 6a. Map of Nauradehi Wildlife Sanctuary.

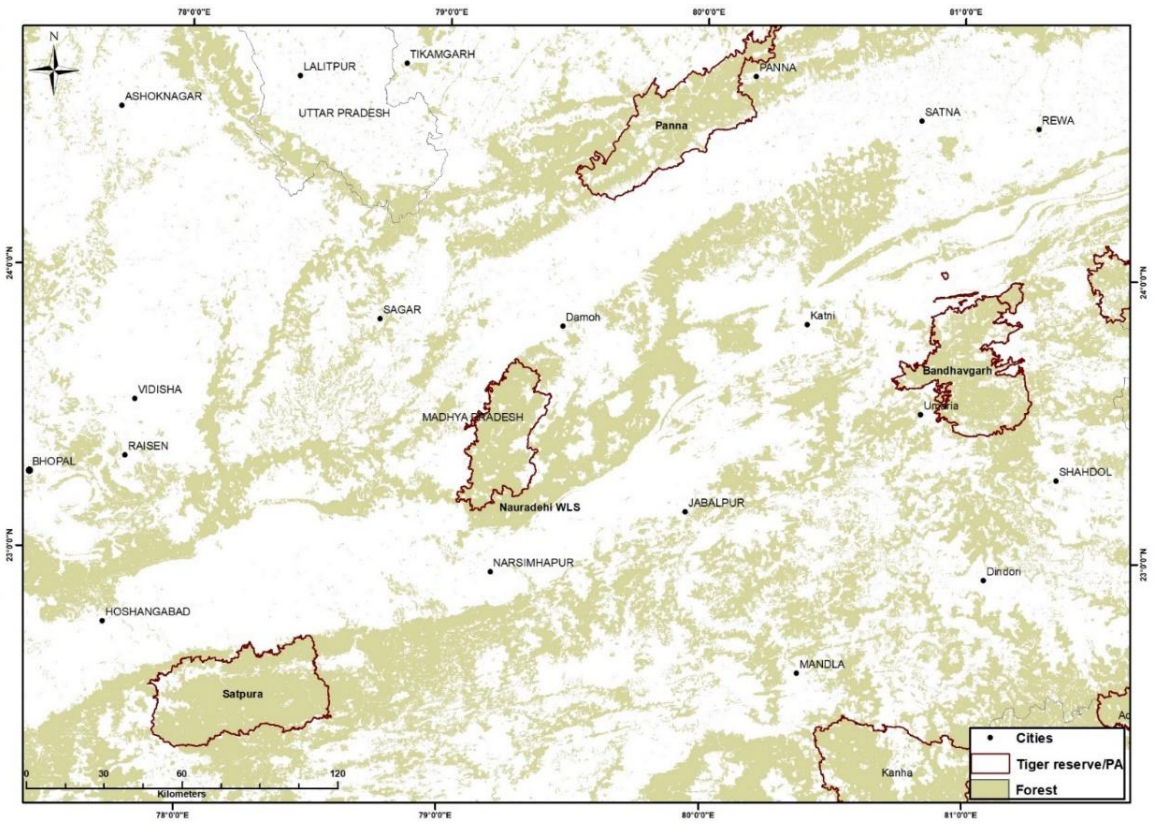

Figure 6b. Map of landscape connectivity of Nauradehi Wildlife Sanctuary with other Protected Areas and forests.

6.2. Assessment:

A rapid site assessment was conducted from 01st to 03rd December 2020 to understand relative abundance of prey, quality of habitat and identify issues concerning park management. A total of 157km (Figure 6c) were covered using a slow-moving vehicle to obtain encounter rates and densities of prey species viz. chital, sambar, nilgai, wild pig, chinkara and cattle (Tables 9 and 10). To calculate prey densities, the effective strip widths obtained from distance sampling conducted in Kuno during 2014 were used, as both areas have similar terrain and vegetation composition.

Table 9. Encounter rate of prey species in Nauradehi Wildlife Sanctuary.

S No	Species	Encounter rate (per km)
1	Chital	0.120
2	Sambar	0.15
3	Nilgai	0.47
4	Wild pig	0.057
5	Chinkara	0.15
6	Cattle	3.57
7	Buffalo	1.23

Table 10. Density of Prey species in Nauradehi Wildlife Sanctuary.

S No	Species	ESW (effective strip width)- m	Density (individual per km^2) *
1	Chital	53.68	1.12
2	Sambar	53.67	0.30
3	Nilgai	57.07	4.12
4	Wild pig	44.43	0.64
5	Chinkara	62.08	1.28
6	Cattle	56.99	31.38
7	Buffalo	56.99	10.81

*The effective strip width obtained from distance sampling conducted in Kuno during 2014 was used to calculate prey densities.

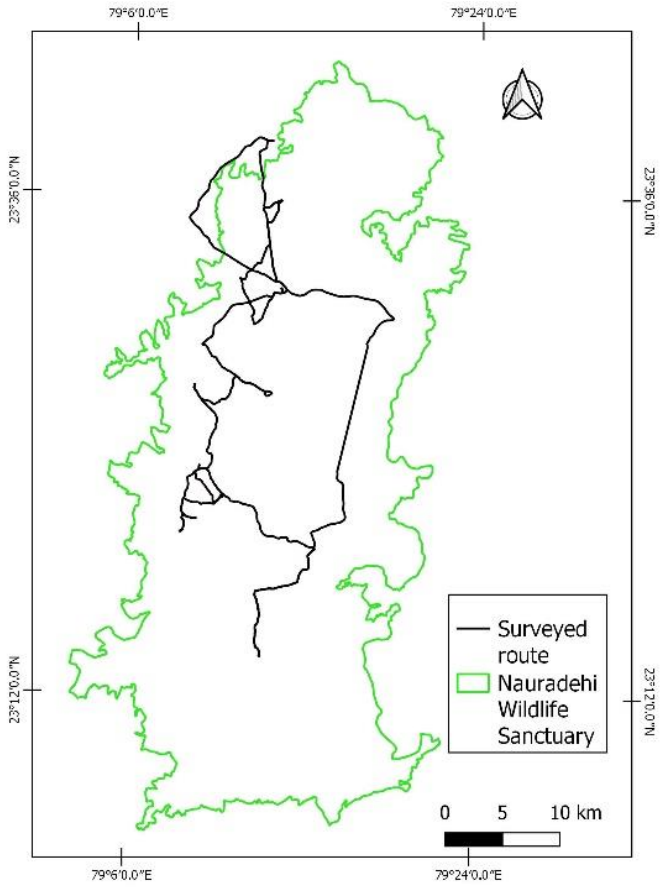

Figure 6c. Map of Surveyed routes in Nauradehi Wildlife Sanctuary.

6.3. Actions required

Based on observations regarding habitat and interactions with park management the actions required to be undertaken immediately are listed below-

S No	Action	Details
1	Boundary Fencing	Chain link fencing of the area in the Sanctuary (Figure 6d) length- ~230km, Cost ~50 Crore
2	Enhance protection	- Recruitment of staff to fill up vacancies - Training of field staff in anti-poaching activities
3	Assessment of prey and predator populations	Conducted by Wildlife Institute of India with trained Forest Department staff and volunteers (if required).
4	Prey augmentation	By translocation of Chital (~1000), blackbuck (~500) and chinkara (~200). On an average cheetah family/coalition are expected to make a kill every 3-4 days. Considering finite growth rate of ungulates to be ~1.33 (Jhala et al., in press), a population of about 350 ungulates are required for a cheetah coalition family. The proposed prey base after augmentation along with existing prey can sustain 7-8 cheetah family/ coalitions.
5	Construction of soft release enclosure for holding cheetah	Size 1km^2 in Pipla grassland (Appendix 1). A predator enclosure of 1 km^2 area to be constructed with four equal partitions. The height of the fence will have to be 2.5 m angled both inside and outside (Appendix 1).
6	Village relocation	Relocation of the following villages might be required in the fenced area- Boma, Deolpani, Ankhikheda, Patna, Jamun, Khapa, Singhpuri
7	Road regulation	Vehicular movement on two roads- (1) Sagar to Jabalpur and (2) Tendukheda to Deori have to be regulated with barriers and speed breakers
8	Dog vaccination	In villages inside and on the periphery of the Sanctuary against rabies, canine distemper and parvovirus

Since the cheetah reintroduction was put on-hold by the Hon'ble Supreme Court order of 2013, Madhya Pradesh has reintroduced a pair of tigers in the south-central portion of Nauradehi WLS. These tigers have bred and now have three sub-adult cubs. Newly reintroduced cheetah will find it difficult to escape tiger predation in a habitat unknown to them. Besides, despite several village relocations, Nauradehi still experiences a large amount of anthropogenic pressures from adjoining villages outside of the WLS borders. To initially contain cheetah within a restricted area, remove human impacts and to allow cheetah to establish without interference from tigers, an area on the northern and central parts of the WLS needs to be fenced (Figure 6d). This area (536 km^2) has

relatively better cheetah prey populations and is outside the range of the reintroduced tigers. The fencing will serve all of the above as well as allow prey populations to build up by stopping all poaching and through augmentation (if required). Once cheetah start to breed here and have established themselves the southern boundary fencing could be removed and the cheetah allowed to expand their range southwards and the tigers northward. Tigers are unlikely to cause extirpation of cheetah that are already established since they would know their habitat intimately so as to escape predation.

Roads with public access passing through the enclosed area (Figure 6d) would need to be regulated with barriers at both entry/exit points and with speed breakers to control vehicle speed <40 km/hr.

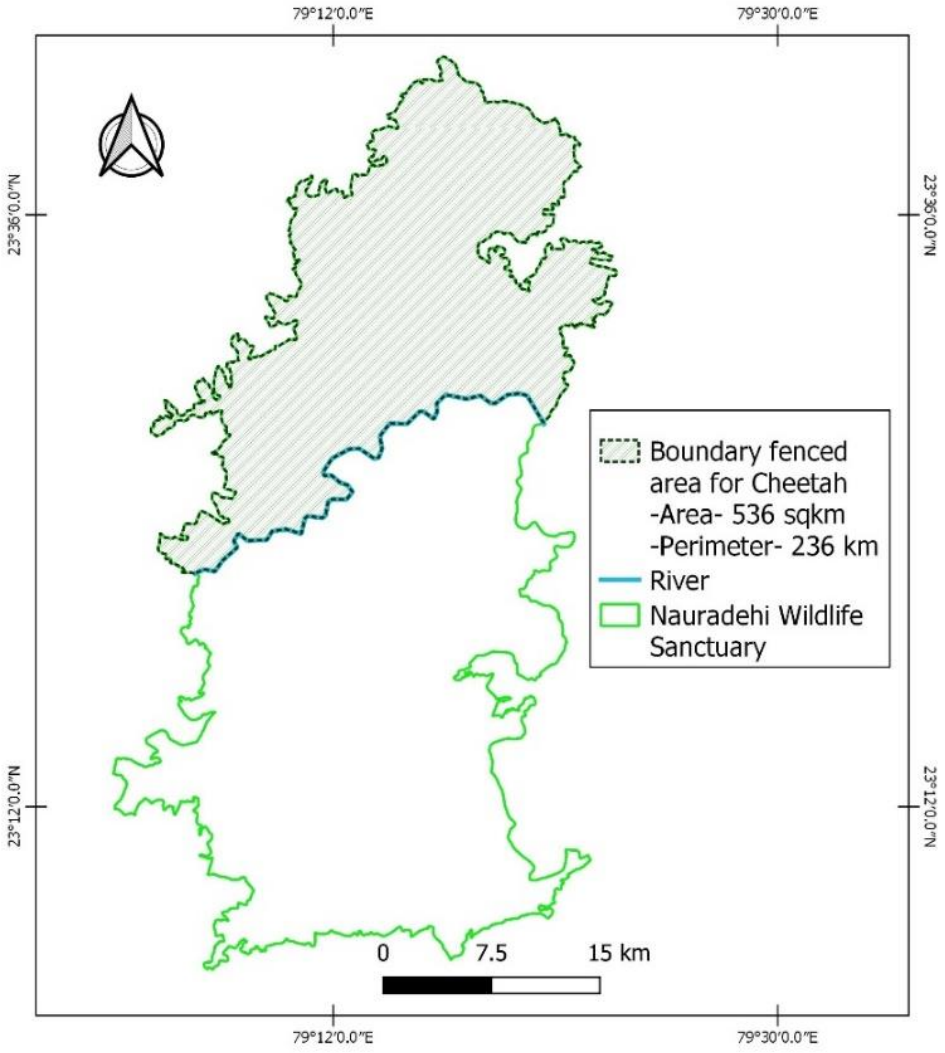

Figure 6d. Map of proposed cheetah enclosure at Nauradehi Wildlife Sanctuary.

7. Concluding Points

As envisaged in the cheetah reintroduction in India (Ranjitsinh and Jhala 2010), several populations of cheetah (three to five) need to be established and subsequently managed as a meta-population. The above assessment was based on previous knowledge of many of the sites as well as a reconnaissance of their current status. As seen from the above assessment, cheetah introduction can be done at all the surveyed sites with appropriate investments (some more than others) and management actions. However, clearly, some sites have the potential to achieve the full range of objectives for the reintroduction of cheetah while others serve to address a limited number of objectives. For free ranging cheetah that would serve as a flagship and also perform their ecological role in a restored savannah-woodland system, clearly 1) Kuno National Park-Sheopur Forest landscape and 2) Gandhi Sagar-Chittorgarh-Bhainsrodgarh WLS with parts of Mukundara TR landscape adequately meet the criteria. Of these two, Kuno National Park is ready with the least investments required for reintroduction, while the Gandhi Sagar- Bhainsrodgarh landscape requires concurrence from the governments of Madhya Pradesh and Rajasthan and investments in terms of prey supplementation and protection. Both sites would benefit immensely through the cheetah reintroduction program and are priority landscapes. Nauradehi WLS has very high potential initially for housing a fenced population and later of becoming a free ranging population as well. Investments required here were for fencing and prey restoration.

The enclosure in Mukundara TR can immediately be used to bring cheetah into India and allow these animals to acclimatize prior to their release at other select sites. Also, Mukundara enclosure after extension can serve to hold a secure population of 3-4 cheetah breeding units and can be used to produce cheetah for reinforcements of reintroduced populations.

7.1. Necessary preparations

7.1.1. From Government of Rajasthan for a) allocation of Mukundara TR enclosure for cheetah introduction and its expansion, b) allocation of some of the Territorial Chittorgarh Division ranges along with Bhainsrodgarh WLS for the larger inter-state cheetah conservation landscape.

7.1.2. From the Government of Madhya Pradesh to allocate a) Territorial Neemuch and Mandsaur Division ranges adjoining Gandhi Sagar WLS as buffer and part of the larger Cheetah conservation landscape, b) Prey augmentation in Gandhi Sagar WLS, c) fencing part of Nauradehi WLS and prey augmentation.

In addition to the above two, the states of Rajasthan and Madhya Pradesh can also opt to fence off Shergarh and Madhav as well as implement the recommendations mentioned above. If such an investment was undertaken, then both sites could potentially hold cheetah. These sites are not considered as priority for achieving the holistic objectives of cheetah reintroduction, but would serve to restore both sites and achieve the objectives of biodiversity conservation and eco-tourism.

Based on the response from the two states, further actions will be taken up by WII and NTCA for the reintroduction of cheetah in India. Permission for work on assessment of prey is being sought

for Mukundara TR, Kuno NP and Nauradehi WLS from the Chief Wildlife Wardens of Rajasthan and Madhya Pradesh.

Additional potential sites that need surveys in near future include the Shahgarh bulge in Jaisalmer, Rajasthan; Kaimur-Bagdhara complex, Guru Ghasidas NP, amongst a few others. Permissions for the above are being sought from the respective CWLW's of Rajasthan, Bihar, Madhya Pradesh, and Chhattisgarh.

8. References

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Appendix 1

Cheetah Barriers – Enclosure design

A 1 km^2 predator enclosure for soft release has to be constructed with four equal partitions. The height of the fence will have to be 2.5 metres angled both inside and outside. The animals shall be housed, in the fenced enclosure constructed in the release site so as to minimize their homing instinct and keep them as far as possible within the release area/PA. Males and females shall be kept in separate but adjoining compartments so that they are able to know each other before release. If an existing enclosure is available at the selected location, it will be suitably repaired and modified to house the imported animals. The location of the enclosure would be such that the cheetahs can see for some distance to understand the environment and the presence of prey, before release. The height of the fence will have to be 2.5 metres angled both inside and outside to discourage leopards from entering and cheetah from leaving the enclosure. Adequate water and shade in the enclosure would be suitably augmented as needed. Natural prey within the enclosure would ensure that cheetah become accustomed to hunting Indian prey species before their release. Additionally, the animals would be fed thrice weekly during this period.

BARRIERS

Cheetahs can be housed in open-topped enclosures behind moats (see water source) chain-link/wire mesh, solid walls, glass (lexan or acrylic) windows or a combination of these materials. Bars are not recommended since they may trap limbs or heads due to inadequate spacing and may permit trauma from adjacent cats.

"Glass front" exhibits (glass, lexan, plexiglass, etc.) have the advantages of providing an unobstructed and up close view of cats for zoo guests. Materials must be strong enough to withstand abuse from the public and should be minimally able to withstand the impact of a 150 lb object striking it at 60 mph. When introducing new cats to exhibits with glass viewing, visual barriers should be placed on the windows to prevent the cats from running into them because they are perceived as open space.

Solid walls can be used, but are more easily scaled and a greater height may therefore be required. When using a solid wall that does not have an overhang, it is recommended that the walls be a minimum of 12' high. Solid walls can be 10 ft high if they have a 2 ft overhang at 45 degree angle. The addition of electric wire along the top may help prevent escapes.

Cheetahs have been documented to jump 24' horizontally, so moats should be at least 25 ft wide. If the interior (cat side) surface of the exhibit is higher than the top of a moat wall, the width of the moat should be increased. Cheetahs can swim, so wet moats if used need to have an adequate barrier on the non exhibit side to prevent escapes. Wet moats should not be used in enclosures where young cubs will be housed.

Cheetahs are typically housed behind chain-link/ wire mesh. Wire mesh should be no lighter than 11 gauge and have spaces no larger than 2" x 4". Wire mesh barriers should be at least 8 ft tall with an inward, 45 degree overhang at least 24" wide. Wire mesh fences without an overhang should be at least 10 ft tall.
Cheetahs generally do not dig out of exhibits, so extensive dig barriers are not necessary; fences should be tight to the ground. Cheetahs will however take advantage of holes under fences dug by other animals so fence lines should be inspected regularly.

No matter what restraining material is used, the composition of the material and the external coatings applied must be non-toxic, non-irritating, or non-traumatic.

Adult cheetahs are not very agile and will rarely climb straight up vertical trees, but they can jump or climb up steeply angled trees, so care must be taken with trees growing near exhibit edges. Cheetah cubs are more agile and can climb up vertical trees and chain link fence. Collars should be placed on trees close to perimeter fences to prevent climbing and possible escapes. Collars may also be placed high up in a tree allowing cats access to the lower/safer parts of the tree while preventing them from going to high. Some cheetahs will get into a tree and are unable to figure out how to get down or may get injured in the process.

Any area that will be used to catch cubs for physical exams should be covered, as young cubs will climb just about anything to escape being captured.

Enclosures should not have corners tighter than 90 degrees or contain small spaces where cats can easily climb barriers or corner cage-mates.

← *White Oak; collars on trees to prevent climbing*

Boma dimensions should preferably be 100m × 100m or minimum 50m × 50m. The boma should include a double gate that allows for vehicles to drive in for feeding and maintenance without the possibility of Cheetah escaping.

Fence:

Option A:

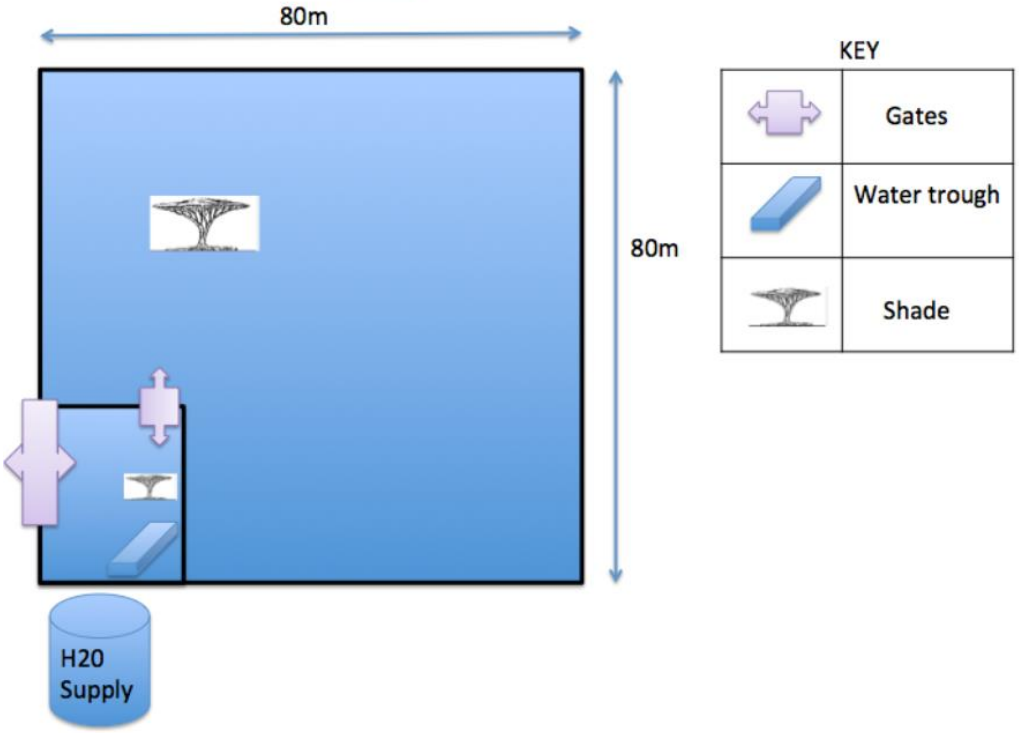
- Bonnox fencing from steel wire;
- 2.4m high with minimum 50cm apron (folded over on the ground towards the inside of the boma)
- Rocks to be packed onto the folded fence;
- Electrification on the inside of boma recommended with three live strands on the lower half of the fence;
- Similar electrification on the outside of the fence is recommended to prevent other predators, including other Cheetah, from getting into the boma.

Option B:

- Standard game fence;
- Three live strands on the lower half of the fence using double offset brackets (live/neutral);
- A trip wire 450mm away from the fence at 150mm high on the inside (link to fencing specifications pic);
- Similar electrification on the outside of the fence is recommended to prevent other predators getting into the boma.

Water should be available to the Cheetah at all times. The water source should be designed in such a manner that it can be drained and filled from the outside of the boma. A corridor and corner camp should be erected inside the boma. Cheetah should be fed in this area. In this way old carcasses can be removed without entering the main boma and Cheetah can be easily handled for veterinary purposes. The absence of herbivores from the boma often results in disproportionate plant growth. Grass in the boma needs to be cut before bringing Cheetah in. This will also reduce tick loads. Tick toxicosis is often responsible for Cheetah mortalities when moving them over large distances into new vegetation types. Different vegetation types hold different tick diversity to which newly arrived Cheetah have not yet developed an immunity to. Tick loads should therefore be reduced to a minimum by applying an acaricide (Frontline) and by good boma maintenance.

Standard predator boma



Boma specifications

Size:

Minimum of 50m × 50m.

Fence:

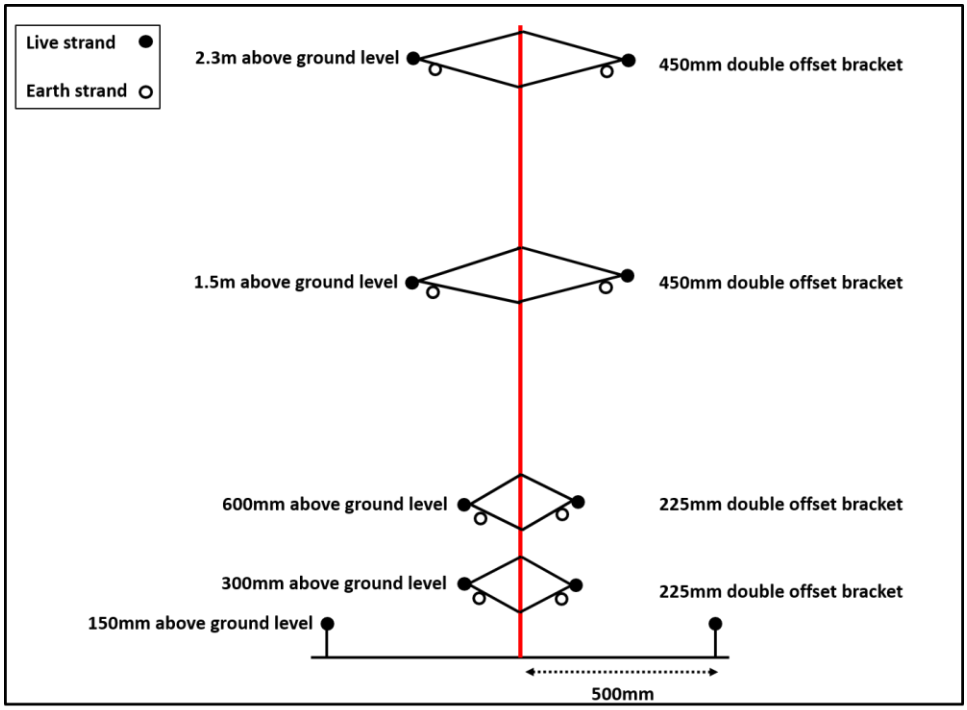
Option A:

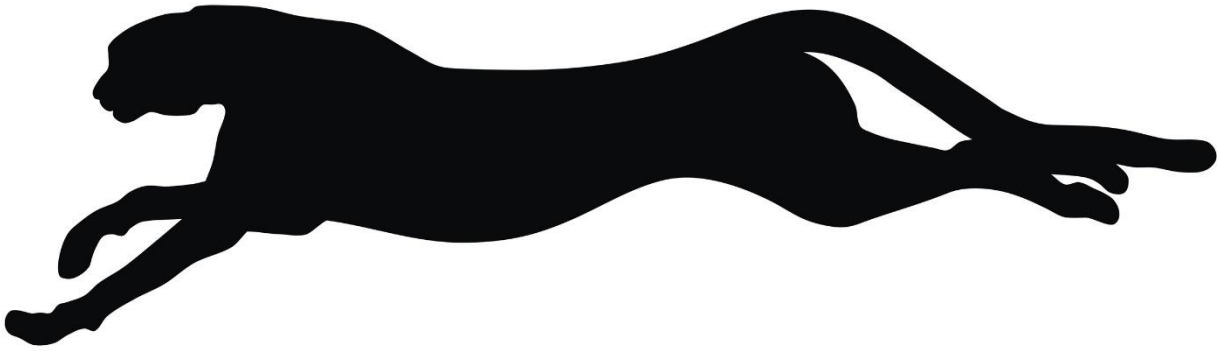
- Bonnox fencing from steel;
- 2.4m high and folded over on the ground towards the inside of the boma for at least 50cm;
- Rocks to be packed onto the folded fence;
- Electrification recommended with three live strands on the lower half of the fence;
- Electrification on the inside and outside recommended, thereby preventing other predators getting into the boma.

Option B:

- Standard game fence;
- Three live strands on the lower half of the fence using double offset brackets (live/neutral);

- A trip wire 500mm away from the fence at 150mm high – refer to diagram below;
- Electrification on the inside and outside recommended, thereby preventing other predators getting into the boma.





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Wildlife Institute of India

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